Environment Performance Assessment on the "11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture
(Revised)

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Abstract

Environmental problem has become one of the key factors for the sustainable development of human society. To strengthen the environmental protection and maintain the ecological balance have become the consensus of the international community. Environmental problem and relevant policies have become the main part of public policy. Therefore, the performance assessment of environment and that of other aspects (like economic performance) are deemed equally important. Environment performance assessment (EPA), as one kind of effective environmental instruments, has been applied by multiple international organizations.

"Environment Performance Assessment for the "11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture" is one of Yunnan demonstration projects in WB BCI Phase II. For it, prefecture-level popularizing demonstration is implemented and the institutionalized operational mode for EPA of Xishuangbanna Prefecture is discussed on the basis of Strategic Environment Framework Phase II and Phase III projects (SEF II & SEF III).

The project research contents involve such 5 aspects as the up-to-standard analysis of the indicators in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture*, the establishment of complete EPA indicator system, EPA analysis, local EPA capacity building, and application of EPA in annual environmental report. In line with the "12th Five-Year" environmental protection work in Xishuangbanna Prefecture and with the *Construction Planning for Ecological Xishuangbanna Prefecture* as guideline, the research group correspondingly adjusted part of the research contents. Part 1-3 in the research contents still deems the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* as objectives for EPA in 2005-2010. The assessment guidebook for driving the institutionalization of EPA of Xishuangbanna Prefecture deems the *Construction Planning for Ecological Xishuangbanna Prefecture* as objectives for establishment of EPA indicator system and implementation of EPA in 2011-2015.

The results obtained in up-to-standard analysis of the EPA indicators in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* show that except the four unanalyzed indicators due to the lack of statistical data, 16 of the remaining 25 indicators of Xishuangbanna Prefecture were up to standard in 2010 with a up-to-standard rate of 64%. Of urban environment quality indicators, water environment quality and air environment quality were not up to standard, solid waste (household garbage) treatment was up to standard, and sound environment was not assessed; of pollution prevention and control indicators, wastewater discharge was up to standard and exhaust emission and solid waste disposal and utilization rate were not up to standard; of ecological construction indicators, forest coverage rate and urban per capita public green area were up to standard, national townships and towns of beautiful environment was not up to standard, and percentage of above-provincial-level nature reserve management institutions meeting the planning and construction requirements was not assessed; of environment management capacity indicators, radiation environment safety monitoring and environmental protection propagandizing & education were up to standard, environmental law enforcement system construction and monitoring network construction were not up to standard; water quality indicators of Lancang River and 7 main tributaries were up to standard.

On the basis of the indicators in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture*, the "drive – pressure – state – impact – response" (DPSIR) EPA indicator system composed of 32 indicators were established for EPA in development of ecological construction and

environmental protection in Xishuangbanna Prefecture during the "11th Five-Year" (2006-2010). Meanwhile, the research group created a DPSIR EPA indicator system composed of 20 indicators as per the indicators in the *Construction Planning for Ecological Xishuangbanna Prefecture* for EPA during construction of ecological Xishuangbanna Prefecture in 2011-2015. Detailed description concerning the establishment of EPA indicator system used in "11th Five-Year Plan" for Ecological Construction and Environmental Protection is as shown in the research report and that concerning the establishment of EPA indicator system used in construction planning of ecological prefecture is as presented in Appendix 2 "Guidebook for Environment Performance Assessment of Ecological Xishuangbanna Prefecture Construction".

The results of "EPA in the '11th Five-Year Plan' for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture" revealed that EPA comprehensive index (88.11) of Xishuangbanna Prefecture in 2010 was lower than the EPA comprehensive index (92.36) in the "11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture. The assessed results were consistent with the conclusion reached in up-to-standard analysis of the indicators in the Plan (an up-to-standard rate of 64%). As shown by 2005-2010 EPA comprehensive index variation trend of Xishuangbanna Prefecture, the comprehensive index in 2006 showed a trend of steady and slow rising; that in 2007 showed a trend of salutatory descending; that in 2008-2010 showed a trend of gradual increasing; and that in 2010 still failed to rise to the level in 2006. EPA comprehensive index of Xishuangbanna Prefecture was mainly affected by “impact”, “response” and “state”. Both “drive” and “pressure” belong to the restriction factor. Driven by social economic benefits, Xishuangbanna Prefecture sees increased environmental pressure and wavelike decrease in environmental state. In view of these problems, Xishuangbanna Prefecture adopted active measures which brought wavelike improvement in environment.

In the research report, the contribution of each indicator under such 5 criterion levels as "drive – pressure – state – impact – response" to the EPA comprehensive index in "11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture was analyzed in detail; the defects and deficiencies existing in the ecological construction and environmental protection management of Xishuangbanna Prefecture were identified; and corresponding suggestions were made from these 5 aspects of "drive – pressure – state – impact – response". In terms of "drive", it is suggested that Xishuangbanna Prefecture explore low-carbon and circular economy and develop organic agriculture. In terms of "pressure", it is suggested that Xishuangbanna Prefecture popularizes "cleaner production" and technical innovation to reduce the discharge of pollution load and mitigate the environmental pressure. In terms of "state", it is suggested to expand the sound environment and air quality monitoring range of Xishuangbanna Prefecture, strengthen the surface water quality monitoring of Lancang River and its main tributaries, and enhance the survey on biodiversity state in Xishuangbanna Prefecture. In terms of "impact", it is suggested to further optimize the overall urban development planning and design of Xishuangbanna Prefecture and gradually increase urban per capita public green area; intensify the management of multilevel nature reserves in Xishuangbanna Prefecture and further strengthen the role of the nature reserves in environmental protection; further consolidate the protection and monitoring of drinking water source; reinforce the research and popularization on the construction of environmentally friendly ecological rubber plantation. In terms of "response", it is suggested to promote the construction of national-level ecological townships and towns; further improve the environmental monitoring capacity building and environmental law enforcement capacity building; further strengthen environmental publicity and education and regularly conduct a survey on satisfaction rate of the public towards the environment; gradually improve the municipal sewage treatment rate and urban garbage disposal rate in the

urbanization process; introduce advanced technologies and adopt incentive measures to encourage the enterprises to recycle and reuse the valuable waste.

By systematically analyzing and identifying the defects and deficiencies in the ecological construction and environmental management of Xishuangbanna Prefecture, corresponding suggestions are proposed in the assessment report. These suggestions will be of a guiding significance in promoting and optimizing the planning and construction in future and will lay a sound foundation for the institutionalization and mainstreaming of EPA at regional (ASEAN) and national levels.

Contents

1 General

1.1 Research background

Environmental problem has become one of the key factors for the sustainable development of human society. To strengthen the environmental protection and maintain the ecological balance have become the consensus of the international community. Environmental problem and relevant policies have become the main part of public policy. Therefore, the performance assessment of environment and that of other aspects (like economic performance) are deemed equally important.

Environment performance assessment (EPA), as one kind of effective environmental instruments, has been applied by multiple international organizations. Asia Development Bank (ADB) and Organization for Economic Cooperation and Development (OECD) successively conducted EPA in Yunnan Province and at the national level. Of them, ADB initiated Greater Mekong Subregion Strategic Environment Framework Phase II and III projects respectively in 2004 and 2008 and applied the "pressure – state - response" model and the "drive – pressure – state – impact – response" model respectively in combined qualitative and quantitative assessment of intended environmental objective realization degree and environmental management level of Yunnan Province. The assessment has acquired a very good effect and aroused wide social repercussions in our country.

A batch of technical backbones is cultivated and some experiences are accumulated in the EPA of Yunnan Province in 2008-2010. This lays the foundation for the institutionalization of EPA in Yunnan. However, the EPA in Yunnan is still at the stage of the concept introduction and the application of research methods. Namely, it is far from popularization and institutionalization throughout this province. Therefore, Xishuangbanna is taken as the demonstration prefecture in this study, so as to popularize the concept of EPA, gather the experiences concerning EPA at the level of prefecture (city), improve the assessment indicator system, and explore the institutionalized operational mode of EPA.

1.2 Purpose, significance and assessment indicators

1.2.1 Purpose

This research aims at its demonstrational popularization and the discussion of its institutionalized operational mode in Xishuangbanna Prefecture on the basis of Yunnan Province's EPA achievements, so as to lay a sound foundation for the institutionalization of EPA herein.

1.2.2 Significance

EPA demonstration at the prefecture level enriches the EPA demonstration system and lays a solid foundation for the institutionalization and mainstreaming of EPA at the regional (ASEAN) and national level.

The adoption of the "drive – pressure – state – impact – response" (DPSIR) model in EPA can facilitate systematic analysis and identification of defects and deficiencies existing in ecological construction and environmental management of Xishuangbanna Prefecture and thus has very important directive significance in promoting and optimizing the planning and construction in future.

The EPA Guidebook can provide technical support for local environmental protection departments, promote the year-by-year EPA in Xishuangbanna Prefecture, and make

an important contribution in enhancing local EPA capability.

1.2.3 Assessment indicators

The assessment indicators mainly involve the following two aspects as per the project activities and expected results:

(1) EPA Guidebook of the Development Plan in Xishuangbanna for Ecological Construction and Environmental Protection;

(2) General project report.

1.3 Research method and technology roadmap

1.3.1 Research method

During assessment, the "drive – pressure – state – impact - response" model, namely, the "DPSIR" model can be used. This model is a conceptual framework: D – the driving force of economic growth, P – the pressure caused by human activities on the environment and natural resources, S – the state of the environment and natural resources that may be changed thereby, I – the impact of human activities on human health and social and economic structure, and R – human society's response to these changes and impact via environmental and economic policies, decisions or management measures; and it is to ease the pressure on the environment and thus achieve sustainable development. An indicator system will be built through this framework. Countermeasures and suggestions can be proposed by collecting, analyzing and sorting out relevant data, comparing the difference between current environmental status and intended environmental objective and identifying the defects and deficiencies in environmental management. "DPSIR" model reveals to some extent the chained causal relationship of interaction between the human, environment and resources.

The analytical method of DPSIR model can, via time-series data, reveal and clarify the correlation among all the indicators of drive – pressure – state – impact – response concerning the environmental problems of Xishuangbanna Prefecture, analyze its linkage situation, diagnose the main problems in environmental conditions and management, assess the performance of Xishuangbanna Prefecture in solving environmental problems, and provide direct basis for the formulation of environmental protection policies and schemes. The structure of DPSIR model is as shown in Fig. 1.

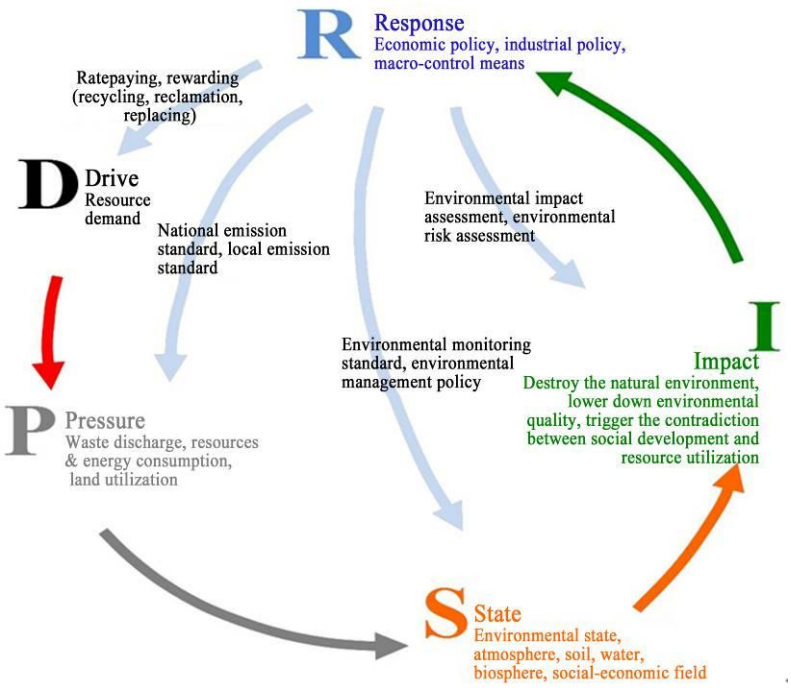

Fig. 1.1 Schematic Diagram of DPSIR Model

Comprehensive index will be used to realize the quantification of EPA results of which the weight coefficient will be determined via analytic hierarchy process (AHP). AHP is a method which combines qualitative and quantitative analysis and realizes the mathematicization of thinking process. Not only can it simplify the analysis and calculation of the system, but it can also help a decision maker in maintaining his/her consistency in thinking process. The principle of this method is to treat all the complex problems to be studied as a large system and find out the inter-associated orderly hierarchy among various factors by analyzing multiple factors in this big system; experts are then invited to judge objectively all the factors in each hierarchy, build a mathematical model and calculate the relative importance weights of all the factors at each hierarchy. This method is most often used to determine the weight of each assessment indicators in a multi-indicator evaluation system. By methodizing the inter-associated orderly hierarchy, the data, experts' opinions and the analyst's subjective judgment can be effectively linked and the relative importance of each hierarchy can be expressed quantificationally. Finally, a mathematical method can be used to determine the relative importance weights of all the elements at each hierarchy and the problem proposed can be solved by ranking result analysis.

The mathematical model of AHP is simply introduced as follows:

Assuming an assessment objective O, its impact factor is I_i (i=1, 2, …, n) and the importance weights of I_i are W_i (i=1, 2, … , n) respectively, in which:

$$W_1+W_2+\ldots+W_n=1$$

$$O= W_1I_1+W_2I_2+\ldots+W_nI_n$$

As the extent of impact Wi (i.e., importance weight) of each impact factor I_i on the objective O is different, a matrix A formed by importance weight ratio (i.e., relative importance) of each impact factor to the objective can be obtained through pairwise comparison of all the impact factors. Matrix A is called judgment matrix; n is a characteristic root of A; the eigenvector of n corresponding to A is W. Therefore, the

importance weight of impact factor I_i of objective O can be obtained by solving the eigenvalue problem, namely, by obtaining normalized eigenvector via $AW=\lambda_{max}*W$. In this formula, λ_{max} is the unique maximum eigenvalue of A, W is the normalized eigenvector corresponding to λ_{max}; component W_i of W is the weight of corresponding element in single arrangement.

1.3.2 Technology roadmap

In this research, specific environmental problems in Xishuangbanna Prefecture were not identified, assessed or analyzed, but DPSIR model was used for EPA in "11th Five-Year" ecological construction and environmental protection herein by taking the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* as the environment performance objectives and basing on the planning objective and planning indicators. The technology roadmap used for assessment is as shown in the following figure, in which the Plan refers to the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture.*

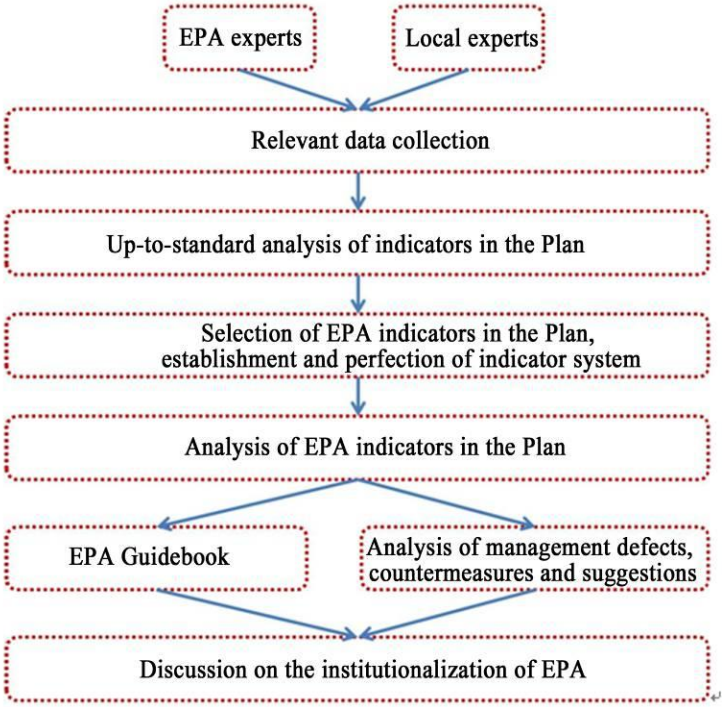

Fig. 1.2 Schematic Technology Roadmap

1.4 Research contents

On the basis of Yunnan Province's EPA achievements, the "pressure – drive - state – impact - response" model was used for the comprehensive and objective assessment of the implementation effect of the ecological construction and environmental protection in Xishuangbanna Prefecture during the "11th Five-Year" and the up-to-standard assessment of the indicators in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture*. The environment performance in ecological construction and environmental protection during the "11th Five-Year" was assessed from such 5 aspects as drive, pressure, state, impact and response; the defects and deficiencies in ecological construction and environmental protection of Xishuangbanna Prefecture were systematically identified; and corresponding measures and suggestions were

further proposed as per the assessment and analysis. Furthermore, the popularizing demonstration of EPA in Xishuangbanna Prefecture enables local government to master the EPA method and discuss the institutionalized operating mode of EPA. This can lay a solid foundation for the institutionalization of EPA in Xishuangbanna Prefecture. The research contents consist of the following 5 aspects:

1.4.1 Up-to-standard analysis of planning indicators

Collect the annual series data (2005-2010) of main indicators proposed in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture*. The indicator system consists of such five categories as environmental quality, pollution control, ecological construction, environment management capacity, and the water environment quality of Lancang River and its 7 main tributaries. Sum up the change law and development tendency of each indicator in recent 6 years by analyzing all the indicators from 2005 (base year) to 2010 (planning year) via calculation, mathematical statistics, charts and the like and analyze the realization degree of planned and stated objectives in the "11th Five-Year Plan" by comparing with the "11th Five-Year Plan" planning objectives.

1.4.2 Establishment of complete EPA indicator system

Analyze the indicator system in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* on the basis of DPSIR conceptual framework and with reference to the causal relationship defined by DPSIR model and meanwhile select specific assessment indicators as per policy relevancy, representativeness, comprehensiveness, data availability and scientific and practical principles. Establish high quality EPA indicator system by comparing international, national and Yunnan EPA indicators and the generally accepted conclusions in relevant research fields. Collect, as per the indicator system, relevant data (2006-2010) from Xishuangbanna Statistical Yearbook, Xishuangbanna Yearbook, Annual Report on the State of the Environment in Xishuangbanna, Report on Water Resources, and the research results and academic papers released by relevant research institutions.

1.4.3 Analysis of EPA

Perform EPA of the indicators in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* using the comprehensive index method, determine the weight coefficient of each indicator using AHP and on the basis of created indicator system, and calculate the comprehensive index using weighted average method. Firstly, perform data standardization as per the environmental objectives of base year (2005) and planning year (2010); secondly, establish target level – criterion level – indicator level structural model; thirdly, use AHP to determine corresponding weights and invite experts to grade in terms of pair-wise relative importance of all the indicators at each level by using Saaty Scaling Law; fourthly, conduct a comprehensive assessment as per grading standard. Find out the environmental management defects and deficiencies in major environmental problem domains in view of the realization degree of intended objectives and the indicators with low realization degree and give feasible countermeasures and suggestions.

1.4.4 Local EPA capacity building

In view of the different objects, local EPA capacity building is to be realized in three different approaches:

1) "**On-the-job training**": The experts from local environmental protection departments and other departments will participate in the project implementation as project team members and receive the training and guidance of EPA experts to learn and master the principles and basic methods concerning EPA.

2) **Training workshop**: In the form of workshops, capacity building activities will be carried out in the project for such relevant departments as Xishuangbanna Bureau of Environmental Protection, Management Bureau of Xishuangbanna National Natural Conservation Area, Management Bureau of Nabanhe River Basin National Conservation Area, Xishuangbanna Forestry Bureau and Xishuangbanna Water Conservancy Bureau.

Project initiation, data collection and analysis workshop: Research group members introduce to the representatives and experts present at the workshop the main achievements in Yunnan EPA research report, the purpose for popularizing demonstration of EPA in Xishuangbanna and the research method **(**DPSIR), discuss and analyze with the representatives the implementation effect and the rationality and attainability of the assessment indicators in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* so as to deepen the understanding of local experts for EPA principles and methods via the workshop; invite the representatives and experts to grade the optimum indicators as per their experience and participate in the assessment process.

Result feedback workshop: on the basis of EPA in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture*, analyze with local experts the defects and deficiencies in the development of ecological construction and environmental protection in Xishuangbanna Prefecture and discuss how to include EIA into local government's assessment system and how to realize the institutionalization of EPA.

3) **EPA Guidebook**: the research group will, based on the establishment of complete EPA system, prepare an assessment guidebook for relevant local environmental protection units' performance of EPA in the development plan of ecological construction and environmental protection.

1.4.5 Application of EPA in annual environmental report

To give suggestions concerning supplement, amendment and regular update to the report in line of the policy and content of existing Xishuangbanna environment quality report and by utilizing the methods used and results obtained in this EPA. Xishuangbanna Bureau of Environmental Protection can perform the EPA in the development of ecological construction and environmental protection in Xishuangbanna Prefecture as per the EPA Guidebook provided by the research group and the annual environment indicators and release the assessment results in the annual environmental report.

2 Overview of Research Region

2.1 Natural environment condition

2.1.1 Geographical location

Xishuangbanna Prefecture, located at the southmost part of Yunnan Province, PRC, is an ethnic autonomous prefecture in Yunnan (Fig. 2.1). It is situated in northern latitude of 21°10′-22°36′ and east longitude of 99°55′-101°50′ and consists of one city and two counties (Jinghong City, Menghai County and Mengla County) with a national territorial area of 19124.5 km^2. It is jointed with Jiangcheng County and Pu'er City in the east and west; adjacent to Lancang County in the northwest; jointed with Laos and Myanmar respectively in the southeast and south & southwest; adjacent to Thailand and Vietnam; its straight-line distance from Thailand is only more than 200km. It is over 400km from the Beibu Gulf of the Pacific in the east and over 600km from the Bay of Bengal of the Indian Ocean in the west. The border line is up to 966.3km long, about 1/4 the total border line length of Yunnan Province.

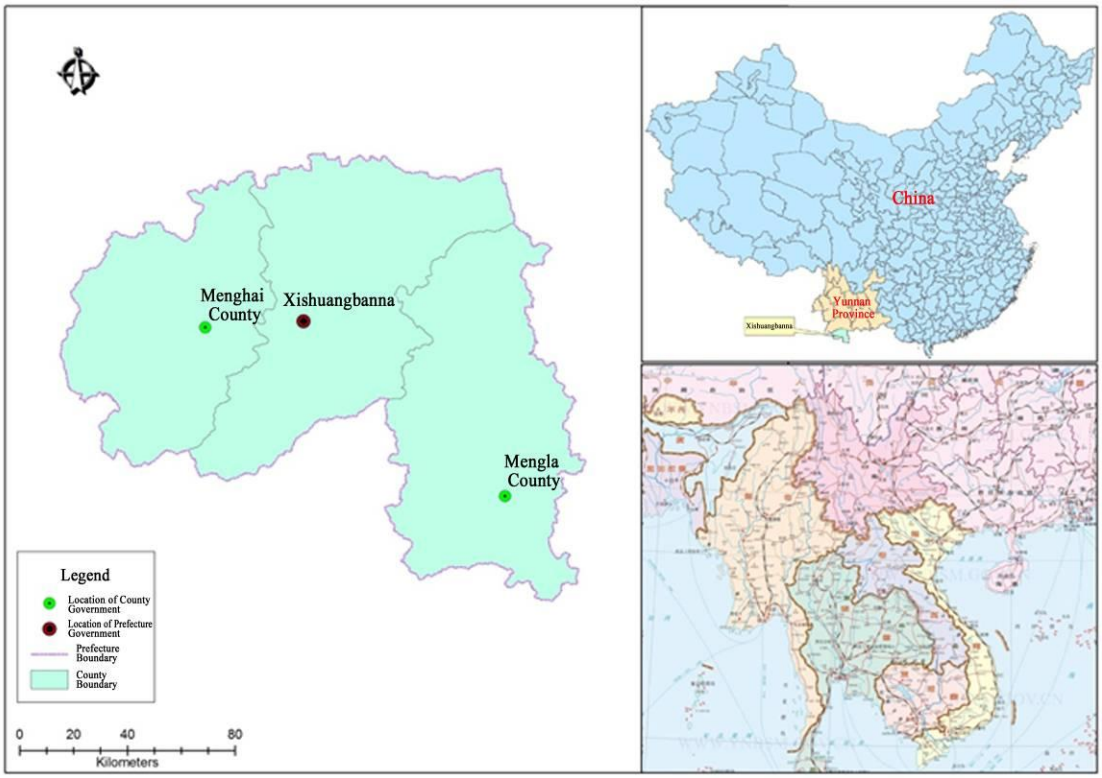

Fig. 2.1 Geographical Location of Xishuangbanna Prefecture

2.1.2 Landform

Xishuangbanna Prefecture, located at the southern extension part of Hengduan Mountains and the tail end of Nujiang River, Lancang River, Jinsha River fold system, is topographically characterized by higher in the north and lower in the south and higher in two sides and lower in the middle. Xishuangbanna is geomorphologically characterized by middle and lower mountains and hilly areas. The low-relief terrain at an altitude of 800m-1300m accounts for 65.3% of its total area, constituting the main physiognomy pattern of Xishuangbanna. The low hill area at an altitude of 500m-800m accounts for 19.4% of Xishuangbanna. The moderate mountainous area at an altitude of 1300m-2500m accounts for 10.6%. The

intermountain basin and river valley area only accounts for 4.7%. Xishuangbanna has 49 basins, each with an area exceeding 1km^2. Of them, Mengzhe – Menghun basin is the largest with an area of 229 km^2; that of all the remaining ones is below 100 km^2, in which there are 19 basins, each with an area between 10-99 km^2 and with a total area of 684.2 km^2. The highest point in this prefecture is at Huazhuliangzi in the northeast of Menghai County and its altitude is 2429.5m, while the lowest point is at Lancang River valley in the southwest of Lianggejiao, Mengla County and its altitude is 470m. The mountainous area of the whole prefecture is 18168 km^2, accounting for 95% the total area.

2.1.3 Climatic characteristics

Xishuangbanna is a tropical humid region in the south of the Tropic of Cancer. Its annual average temperature is 18-22°C and its isothermal of an annual average temperature (20°C) is equivalent to 850m contour line. Its lowest monthly average temperature is 8.8-15.6°C; its active accumulated temperature not lower than 10°C is 5062-8000°C; the active accumulated temperature for the regions at the altitude below 800m in 2013 was above 7500°C. It is with long summers and no winters and its springs and autumns are close and short. Annual sunshine hours of Xishuangbanna is 1800-2100 hours; its season distributes comparatively homogeneously; its annual range of temperature is not big, while daily range of temperature is big, e.g., the temperature in the coldest and hottest month is only 9.9°C, but the maximum daily range of temperature can be up to 27.3°C. This differs greatly with most areas in China. In terms of landscape vertical differentiation in Xishuangbanna, that below 800m has hot climate (tropical), that at 800m-1500m has warm hot climate (south subtropical) and that above 1500m has warm temperate climate (mid-subtropical). Affected by altitude and regional location, it has superior three-dimensional climatope. According to the division of climate type indicators, Xishuangbanna has such different climate types as north tropic, south subtropical and mid-subtropical. Overall climate characteristics are high temperature, raininess, moist and calm wind and the vertical variation of the temperature is significant. In this prefecture, there is no snow but light frost in the places at higher altitude. During heavy cold, short-time low temperature may be at about 0°C which may cause damage to tropical crops sensitive to heat.

Xishuangbanna has clear-cut wet and dry seasons and its annual rainfall is 1193.7-2491.5mmm. That in the basin area is lower, while that in mountainous area is higher. In 2013, rainfall in wet season accounted for 82-85% the annual total; that in July and August was above 250mm, while that in February was only 20mm. However, dry season saw little rainfall but heavy fog and dew which increased the humidity of the dry season and compensate the inadequacy of rainfall to some extent.

2.1.4 Soil and vegetation

Xishuangbanna shows obvious soil characteristics of zonality and regionality. The soil here is dominated by scarlet soil, accounting for 62.07% the total land area; followed by laterite, accounting for 15.9%; krasnozem, accounting for 8.75%; purple soil, accounting for 7.74%; paddy soil, accounting for 3.4%; atteration and limestone soil, accounting for 0.59%. In terms of pH value, it is dominated by acid and strong acid soil. The soil is characterized by deep soil layer; high content of organic matter, uniform soil texture, sound physical performance and high soil fertility.

The forest land area throughout the prefecture is 1,497,000hm^2 and the forest coverage rate is 78.3%. Special geographical environment and unique climatic conditions in Xishuangbanna contributes to the formation of complex and diverse

natural environment here. Enjoying harmonious hydrothermal resources, rich biological species, diverse forest vegetation and many precious rare animals and plants, Xishuangbanna is a natural treasure-house for tropical forest animals and plants and their original germplasm resources in China. The vegetation here is diverse, including such 9 forms as tropical forest, tropical monsoon forest, subtropical monsoon evergreen broad-leaved forest, broadleaved deciduous forest, warm coniferous forest, bamboo forest, shrubwood, grasses and artificial vegetation. Of them, there are 13 vegetation subtypes and 39 plant formations.

2.1.5 River system

Rivers in Xishuangbanna belong to Lancang River system. Lancang River originates from the east of Tanggula Mountains in Qinghai Province, flows through Qinghai, Tibet, Sichuan and Yunnan, and flows out of China at China – Laos – Myanmar boundary junction – Mangang Village, Guanlei Town, Mengla County, Xishuangbanna Prefecture. The section beyond China is called Mekong River. Lancang River – Mekong River, 4880.3km long in total, flows through China, Laos, Myanmar, Thailand, Cambodia and Vietnam. Its drainage area is 295,000km^2 and average runoff is 475 billion m^3. It is an important international river in Southeast Asia region and enjoys the laudatory title of "the east Danube". The overall length of main stream of Lancang River within China is 2153 km; the fall of water flow is 4543m; perennial average discharge of Lancang River is 1840m^3/s; maximum and minimum annual average discharge is 2500m^3/s and 1470m^3/s respectively; perennial mean minimum flow is 485 m^3/s and the flow path in Yunnan Province is 1247km. Lancang River flows through Xishuangbanna Prefecture from north to south. Its flow path in this prefecture is 167km and the boundary river of China, Laos and Myanmar boundary is 31.5km.

In Xishuangbanna, there are 2761 big and small rivers belonging to Lancang River system. The overall length of river network is up to 12177km and the density of it is 0.633km^2. Of them, there are more than 30 relatively larger rivers and such 6 first grade tributaries (catchment area exceeding 1000km^2) of Lancang River as Nanguo River, Liusha River, Buyuan River, Nan'a River, Nanla River and Nanlan River; smaller first grade tributaries include Mengwang River, Nankun River, Nanyang River, Nan'e River, Nanmuleng River, and the like; secondary tributaries with catchment area exceeding 1000 km^2 is Puwen River. Water resources throughout this region are rich, with total amount up to 14.5 billion m^3.

2.2 Socioeconomic condition

2.2.1 Social profile

Xishuangbanna Prefecture involves one city and two counties (Jinghong City, Menghai County and Mengla County), "three zones" (Xishuangbanna tourist holiday zone, Mohan Economic Development Zone and Jinghong Industrial Park), 31 townships and towns and 1 sub-district office, 222 villagers' committees and 22 communities, 2223 unincorporated villages, 10 state farms, 10 rubber branches and 6 central and provincial R & D institutions. In 2013, Xishuangbanna Prefecture had a total population (permanent resident population) of 972,500. Of them, Jinghong City had 412,800, accounting for 42.45%; Menghai County had 325,600, accounting for 33.48%; and Mengla County had 234,100, accounting for 24.07%. The agricultural population was 608,600 and nonagricultural population was 363,900. The urbanization rate of the whole prefecture was 40.44%, an annual growth of 1.18% over 2012.

Xishuangbanna Prefecture is an ethnic autonomous prefecture with dominated Dai nationality and its 13 long-dwelling people includes Dai, Han, Hani, Lahu, Yi, Blang, Miao, Yao, Jino, Hui, Va, Zhuang, and Jingpo. By the end of 2013, the minority population here was up to 753,300, accounting for 77.46% the total.

2.2.2 Economic profile

In 2013, the total output value of Xishuangbanna was RMB 23263.69 million, 13.7% more than the previous year. In terms of industries, the value-added of primary industry was RMB 6753.41 million, up 6.7%; that of secondary industry was RMB 6815.60 million, up 15.7%; and that of tertiary industry was RMB 9694.68 million, up 16.5%. The proportion of primary industry value-added accounted for 29% in the GDP of Xishuangbanna, equaling that of the previous year; that of the secondary industry value-added accounted for 29.3%, down 1% from the previous year; that of the tertiary industry value-added accounted for 41.7%, up 1% from the previous year.

(1) Primary industry

In 2013, the total output value of agriculture, forestry, husbandry and fishery was RMB 11519.73 million, 7.3% more than the previous year. Of them, the output value of agriculture was RMB 4146.05 million, up 11.5%; that of forestry was RMB 5941.63 million, up 4.2%; that of husbandry was RMB 809.47 million, up 4.2%; that of fishery was RMB 328.57 million, up 12.4%; that of services of agriculture, forestry, husbandry and fishery was RMB 294.01 million, up 26.1%.

(2) Secondary industry

In 2013, gross industrial output value was RMB 8507.61 million, 14.5% more than the previous year. Of them, the total output value of light industry was RMB 4322.61 million, up 20.6%; that of heavy industry was RMB 4185.00 million, up 6.1%.

In 2013, the total industrial output value of industrial enterprises above designated size was RMB 6896.51 million, 23.5% more than the previous year. The added value of industrial enterprises above designated size was RMB 377,869, up 14.1%. In 2013, the prime operating income of industrial enterprises above designated size was RMB 6304.77 million, 14.5% more than the previous year; the realized profit and tax was RMB 1559.11 million, down 9.7%; the realized profit was RMB 1110.71 million, down 5.7%.

(3) Tertiary industry

In 2013, the total retail sales of consumer goods were RMB 7120.66 million, 17.3% more than the previous year. In terms of urban and rural, the urban retail sales of consumer goods reached RMB 5150.92 million, up 17.8% and the rural retail sales of consumer goods reached RMB 1969.74 million, up 16.1%. In terms of economic types, the retail sales of public ownership economy was RMB 1422.22 million, up 19% and that of nonpublic ownership economy was RMB 5698.44 million, up 16.9%. In terms of industries, that of wholesale and retail sales was RMB 6167.92 million, up 17.5% and that of quarters & catering was RMB 952.74 million, up 16.2%.

In 2013, the business total of posts and telecommunications was RMB 1092.10 million, 13% more than the previous year. At the end of 2013, total deposit balance of the financial institutions was RMB 36.14 billion, 12.8% more than that at the end of the previous year. At the end of 2013, total loan balance of the

financial institutions was RMB 19,307 million, 15.1% more than that at the end of the previous year.

2.2.3 Resources

(1) Land resources

In accordance with *Xishuangbanna Statistical Yearbook in 2013*, the total area of utilized land throughout the prefecture was 19096.0km^2, of which 1051.79 km^2 was for cultivated land, accounting for 5.51% and 15909.55 km^2 was for forest land, accounting for 83.31%. Of the forest land, 441.02 km^2 was for rubber plantation, 82.54 km^2 for tea garden, 23.82 km^2 for orchard, and 17.54 km^2 for other tropical plants. The whole prefecture is endowed with numerous hills and less flat ground and can be divided into intermountain basin (flatland) and mountain-plateau mountain land with the former and latter respectively accounting for 4.94% and 95.6% the total land area. The intermountain basin featuring relatively flat terrain, good water conservancy conditions, fecund soil and centralized paddy field is the main producing area of grain and sugarcane. The mountain-plateau mountain land featuring poor water conservancy conditions and large non-cultivated land area is suitable for the plantation of tropical and subtropical crops, like rubber, tea, tropical fruits, South China medicinal plants, and other cash crops.

(2) Water resources

Xishuangbanna is rich in water resources and its surface water resources are from three sources: water passing here from main stream of Lancang River, with a total runoff of 55.52 billion m^3; the water flowing from the rivers originating outside this prefecture to this prefecture, with a total runoff of 2.36 billion m^3; surface water generated in the prefecture, with a total runoff of 11.92 billion m^3. The total amount of water flowing out of China from Xishuangbanna reaches 69.5 billion m^3. The total amount of groundwater resources is 2,252 million m^3. The theoretical reserve of water resources in Xishuangbanna is 5,292,300 kW and annual energy output can reach 46.3 billion KWH. In short, Xishuangbanna is endowed with plenty of rainfall and rich hydropower and water resources and thus is of great potential for development.

(3) Tourism resources

Enjoying abundant and unique tourism resources, enriched natural resources, distinctive ethnic style and superior locational conditions, it is a famous tourist attraction in China.

Xishuangbanna is rich in natural resources. It has such natural ecological scenes as forest, river and farmland ecosystems with tropical and subtropical features and such famous tourist areas and scenic spots as Menglun Botanical Garden, Wild Elephant Valley, Primeval Forest Park, Wangtianshu Air Corridor and Tropical Flower Garden. All these form the main route for attractive ecotourism. Xishuangbanna is a national scenic area, nationally designated eco-demonstration region and the member of UN world biodiversity guard circle and enjoys the laudatory titles of "the animal and plant kingdoms", "global gene pool of natural species", "forest ecological museum" and "emerald at the Tropic of Cancer". The area of two national nature reserves is 269,000 hm^2, accounting for 14.1% the national territorial area of this prefecture; Xishuangbanna is the second largest production base of natural rubber in China, the place of origin for big leaf species tea and the hometown of Pu'er tea. It has ancient wild tea tree

ceno species, 1700-year-old wild tea tress, six ancient tea mountains of Pu'er tea and over 80,000mu of hundred-year cultivated ancient tea garden.

Xishuangbanna has distinctive ethnic style and rich humanistic tourism resources. 13 nationalities live here, including Dai, Han, Hani, Blang, Jino, Lahu, Yao, Va, Hui, Miao, Zhuang and Jingpo and the people here includes Khmu, Laopin and Bajia. The minority population accounts for 76.9% the total population of the whole prefecture. Of them, the Dai nationality is the dominated, accounting for 34.3% the total. In 1979, the nationality determined last was the Jino nationality living in Xishuangbanna and it had a population of 21,900. The culture of each nationality in Xishuangbanna has a long history and is rich and colorful. The Dai nationality has long-standing traditional culture and its pattra culture is the major minority culture in Yunnan. The south-spreading Theravada Buddhism culture is nationally representative and the Dai nationalistic medicine is one of four major national medicines. 10 projects, including the Water Splashing Festival of the Dai nationality, the Big Drum Dance of the Jino nationality, the playing and singing of the Blang nationality and the traditional production process of Pu'er tea, are listed into the List of National Intangible Cultural Heritages.

Xishuangbanna has superior locational conditions. Xishuangbanna borders on Laos and Myanmar with shared rivers and mountains and is adjacent to Thailand. The boundary line of the whole prefecture is 966.3km, nearly 1/4 the boundary line of Yunnan Province (in which the boundary line bordering with Laos is 677.8km, accounting for 95.5% of the China –Laos boundary line); in Xishuangbanna, there are 4 national Class I ports, accounting for 1/3 the total in Yunnan. Lancang River – Mekong River which connects six countries (China, Myanmar, Laos, Thailand, Cambodia and Vietnam) flows out of Xishuangbanna. The upper Mekong River course is a national Class V course; China, Myanmar, Laos and Thailand allow for the navigation of 250t passenger and cargo ships throughout the year. Kunming – Bangkok Great International Passage also exits from Xishuangbanna. Xishuangbanna International Airport has opened 12 domestic routes and the international routes to Bangkok and Chiengmai.

(4) Geothermal resources

Xishuangbanna is rich in geothermal resources, ranking 2 in Yunnan, only after Tengchong and has 149 hot springs and mineral springs. The hydrothermal springs are mainly distributed over Lancang – Mengzhe - Menghai trunk fracture zone and Jinghong dam. Of them, 16 springs are distributed in Gasa, Jinghong; 5 from Xiaojie to Damenglong; 8 in Meng'e, Menghai County; 11 from Mengwang to Banggang; 5 in Mengmai; and others in Mengbang, Guanlei and so on in Mengla County. The lowest and highest water temperature is 25°C and 103°C respectively and the discharge is 0.1-3.9l/s. The bittern springs are distributed in the east of Mengla County and concentrated in Mengbang, Shangyong, Dahuangba, Manlong, and so on. They are rich in kali salt and other salts and thus called "salt spring".

2.3 Ecological environment condition

2.3.1 Environment quality status

(1) Water quality condition

1) Water quality of main rivers

In 2013, all the 12 monitoring sections in such 8 main rivers as Lancang

River, Puwen River, Buyuan River, Liusha River, Nan'a River, Nanla River, Nanlan River and Nanguo River met the requirements of water environmental function and the water quality was sound in general. In terms of water quality, 4 monitoring sections met Class II standards, accounting for 33.3% and 8 monitoring sections met Class III standards, accounting for 66.7%. Compared with 2012, the number of monitoring sections meeting Class II water quality requirements decreased from 5 in 2012 to 4 in 2013 and that meeting Class III water quality requirements increased from 7 in 2012 to 8 in 2013.

Assessed as per the provisions in the *Functional Zoning of Surface Water Environment in Yunnan Province (2010-2020*), all the 12 sections met the requirements of water environmental function in 2013 and the water quality was stable as compared with that in the previous year.

2) Urban drinking water sources

The water quality of all the drinking water sources in these three counties (cities) met the requirements of Class III water quality standards for national centralized drinking water sources.

In 2013, urban drinking water sources (Lancang River) of Jinghong City were monitored 12 times. Of them, 8 times met Class II standards and 4 times met Class III standards. The water quality was excellent. Those (Nadameng Reservoir) of Menghai County were monitored 12 times. Of them, 11 times met Class II standards and the remaining met Class III standards. The water quality was excellent. Those (Nanxi River) of Mengla County were monitored 12 times. Of them, 11 times met Class II standards and the remaining met Class III standards. The water quality was excellent.

3) Urban landscape waters

In 2013, all the landscape waters (Kongquehu and Baixianghu) in Jinghong City met the requirements for water used in landscape. For Kongquehu, the water quality met Class III and IV standards respectively in 9 and 3 monitoring results. For Baixianghu, the water quality met Class III, IV and V standards respectively in 1, 3 and 8 monitoring results. Compared with 2012, the water quality was improved.

(2) Air environment condition

1) Air in urban areas

In 2013, the number of days with excellent air pollution index in Jinghong City was 179, accounting for 49% and that of days with good air pollution index was 186, accounting for 51%. The major pollution factor was the inhalable particles less than 10μm. Compared with 2012, the number of days with excellent air pollution index decreased by 17 days.

The air environment quality in Menghai County met the Class I standards in *Ambient Air Quality Standard* (GB3095-1996) and was excellent.

The air environment quality in Mengla County met the Class I standards in *Ambient Air Quality Standard* (GB3095-1996) and was excellent.

2) Acid rain

In 2013, 92 precipitation samples of Jinghong City were monitored

throughout the year and no acid rain samples were discovered.

(3) Sound environment condition

1) Traffic sound environment

In 2013, the average equivalent sound level of urban road traffic noise in Jinghong City was 58.2-68.8dB(A) and the average equivalent sound level of city-wide road traffic noise was 62.2dB(A). Both were within national limit. Therefore, the traffic noise quality was "good".

2) Sound environment in function zones

In 2013, the noise monitoring results of functional zones in Jinghong central urban area revealed that the equivalent sound level of all the Class 2 and 4 zones met the sound environment requirements for functional zones and the sound environment quality of functional zones was "good".

3) Regional sound environment

In 2013, the regional environmental noise equivalent sound level in Jinghong City was 40.6-67.2dB (A) and the average equivalent sound level was 52.3dB (A). Assessed as per national sound environment quality assessment method, the regional environmental noise quality in Jinghong City was rated as "fine" and was up to the standards for regional environmental noise function zoning.

(4) Industrial solid waste disposal condition

Industrial solid wastes are mainly generated by sugar, mining, smelting industries and the like. The industrial solid waste yield of the whole prefecture in 2013 was up to 8,655,600t and the comprehensive utilized volume was 4,613,800t, accounting for 53.30% the total.

2.3.2 Ecological environmental protection

(1) Nature reserve, national park and scenic spot

Complicated zones, diverse natural environment and abundant biodiversity are formed due to the special geographic position and unique climate condition of Xishuangbanna Prefecture where the sole and well preserved tropical rainforest is located in China with various natural conservation values. At present, there are 8 national, prefectural, municipal and county-level nature reserves, with the area up to 3551.08km^2, accounting for 18.57% the national territorial area of the whole prefecture. There are another 5 protected areas (2 inland waters ecosystem-type nature reserves and 3 wild rice in-situ protection place and 1 introduction propagation demonstration park), with the area up to 1414.618 km^2, accounting for 7.4% the national territorial area thereof.

According to the overall thought of the Provincial Party Committee and Provincial People's Government concerning the construction of the national park and relying on Xishuangbanna National Nature Reserve and National Forest Park, Xishuangbanna build the Tropical Rain Forest National Park in 2008. This National Park crosses Menghai County, Mengla County and Jinghong City and consists of such six unconnected areas as Menghai, Youle, Mengyang, Menglun, Mengla and Shangyong. Its total area is 2854.21 km^2, 429.11 km^2 larger than original national nature reserve.

During 2006-2009, Xishuangbanna revised the *Overall Planning for National Scenic Areas in Xishuangbanna*. The total area of national scenic areas after revised was 641.61 km^2.

(2) Forest resources and wildlife protection

1 million trees were planted voluntarily in 2013. The construction of precious timber base was promoted; the planting area was up to 120,000*mu*; and 3,830,000 precious tree seedlings were planted.

During provincial and ministerial-level and prefectural-level fishery resources proliferation and releasing activities carried out in Lancang River and Nanla River basins, the fry (like sinilabeo yunnanensis) released was up to 735,600, which effectively protected aquatic living resources of the river basins in this prefecture. In 2013, the public liability insurance premium input for wildlife was RMB 7.7 million, the claimed amount was over RMB 5.12 million and the settled portion was RMB 1.02 million. The number of housed and rescued wild animals protected by the state was 394 and the number of wild animals for which dispatching licenses were obtained was 4248.

In 2013, the number of accepted cases involving damage to forest and wildlife was 1239. Of them, 1236 cases were investigated and settled and 3785 illegal and criminal suspects were investigated and punished. 1.8 hectares of forest land, 140m^3 woods and trees, 144m^3 timber, 300 plants/pcs. of wild plants/products made therefrom, 512 heads (Nr./pcs) of wild animals/products made therefrom and 564 guns were confiscated.

(3) Natural forest protection and rural ecological environment construction

In 2008, the whole prefecture fulfilled the natural forest protection project task and forest management & protection task assigned by Yunnan Province. The completed forest management & protection task was 17,000,000*mu* and the constructed public welfare forest was 59,000*mu*. The survival rate of afforestation was 88% and the percentage of pass was 100%. In afforestation, the artificial afforestation was 14,000*mu* and closed forest was 45,000*mu*. In the same year, the whole prefecture also fulfilled the 35,000*mu* barren hill afforestation task by returning the grain plots to forestry, with a survival rate of afforestation higher than 90%.

The mechanism for ecological compensation was established and RMB 2.3 million was used for prefectural-level forest ecological benefit compensation. RMB 5.57 million was used for wildlife accident compensation.

The construction of ecological townships, towns and villages was actively implemented. At present, 22 of all the 31 townships and towns throughout the prefecture were named by the Provincial Government as "ecological townships and towns in Yunnan". Till February 2013, 179 prefectural-level ecological villages had been built in 5 batches. Of them, 19 in the first batch were built in May 2011; 72 in the second batch were built in November 2011; 25 in the third batch were built in April 2012; 38 in the fourth batch were built in October 2012; and the remaining 25 in the fifth batch were built in February 2013.

(4) Soil and water loss control

The controlled soil and water loss area in 2013 was 42.09km^2. The controlling projects of Mengla County and Manlongdai section of Nanla River, Menghai

County section of Liusha River and Daluo trans-boundary River were implemented.

3 Up-to-standard Analysis of Indicators

On February 28, 2007, the People's Government of Xishuangbanna Prefecture issued the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture*. In the Plan, the achievements was reviewed; the guiding thought, development objectives and main indicators (Table 3.1) were put forward; the major fields and main tasks were defined; and the construction of corresponding supporting measures and systems was proposed.

In the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture*, the indicator system composed of 29 indicators were proposed from such five aspects as urban environment quality indicator, pollution prevention and control indicator, ecological construction indicator, environment management capacity indicator and water quality indicator of Lancang River and its seven main tributaries and the up-to-standard conditions of each indicator in 2010 were presented with 2005 as the base year and 2010 as the planning year. In this section, 2005-2010 data of relevant indicator system will be analyzed to check whether the indicators in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* are up to standards. The statistical value (2006-2010) of the indicators in the Plan is presented in Table 3.2, in which qualitative indicators are not described. For details, please see the up-to-standard analysis of indicators.

Table 3.1 Main Indicators in the "11th Five-Year Environmental Plan" for Xishuangbanna Prefecture

Indicator	Indicator System		Base Year	Planning Year
	Indicator System	**Unit**	**2005**	**2010**
Urban environment quality indicator	**Water environment**			
	Percentage of urban drinking water source meeting the requirements for centralized drinking water source	%	100	100
	Water qualification rate of the state/province-controlled sections in Lancang River system meeting the standards of water environmental functions	%	91.7	91.7
	Discharge of domestic sewage in the whole prefecture	10,000t	1491	1540
	Urban domestic sewage treatment rate	%	43.9	65
	Atmospheric environment			
	Number of days with good air quality in Jinghong City (indicators: NO_X, SO_2 and PM_{10})	Day	329	347
	Acid rain frequency and intensity in Jinghong	%	19.1	6
	Sound environment			
	Percentage of key cities with urban regional environmental noise ≤55dB(A)	%	82.4	100
	Percentage of key counties (cities) with urban road traffic noise ≤70dB(A)	%	11.1	100
	Solid waste			
	Urban garbage harmless disposal rate of counties (cities)	%	49	60
Pollution	**Wastewater**			

prevention and control indicator	Discharge of industrial wastewater	10,000t	1543	4000
	Discharge of COD	10,000t	2.1	2.7
	Discharge of ammoniacal nitrogen	t	720.3	940
	Industrial wastewater discharge qualification rate of key pollution sources	%	87	90
	Exhaust gas			
	Discharge of industrial exhaust gas	10,000 nm^3	14.1	21
	Discharge of sulfur dioxide	t	952.2	1240
	Discharge of flue dust	t	551.9	720
	Discharge of industrial dust	t	100.9	130
	Solid waste			
	Safe disposal rate of medical waste	%	15	70
	Comprehensive utilization rate of industrial solid waste	%	99.7	100
	Comprehensive excrement utilization rate in large-scale livestock farm (centralized breeding area)	%	91	95
Ecological construction indicator	Forest coverage rate	%	67.7	70
	Percentage of nature reserve management institutions above the provincial level meeting the standard construction requirements	%	14	100
	Urban per capita public green area	m^2	9.6	13
	National townships and towns of beautiful environment	Nr.	0	3
Environment management capacity indicator	Construction of environmental law enforcement system	Law enforcement team and its capability up to national standards		
	Monitoring network construction	Monitoring capacity up to national standards; construction of 25 on-line monitoring system for major pollution sources		
	Radiation environment safety monitoring	Organizations involving the pollution source use the radioactive source legally and safely		
	Environmental publicity and education	Make environmental quality and administrative information open to the public throughout the prefecture, create green units, and generally improve the environmental awareness of the public		
Water quality indicator of Lancang River and its main tributaries	Comprehensive water quality indicator of Lancang River and its seven main tributaries (Nanguo River, Liusha River, Buyuan River, Nanla River, Nanlan River, Nan'a River and Dakai River)		III	III

Table 3.2 Statistical Value of Main Indicators in the "11th Five-Year Environmental Plan" for Xishuangbanna Prefecture

Indicator	Indicator System		Statistical Value				
	Indicator System	**Unit**	**2006**	**2007**	**2008**	**2009**	**2010**
Urban environme	**Water environment**						
	Percentage of urban drinking water source meeting the	%	10	10	10	10	10

nt quality indicator	requirements for centralized drinking water source		0	0	0	0	0
	Water qualification rate of the state/province-controlled sections in Lancang River system meeting the standards of water environmental functions	%	83.3	75	100	100	100
	Discharge of domestic sewage in the whole prefecture	10,000t	1532	1829	1858	2045	2069
	Urban domestic sewage treatment rate	%	43.5	40.5	40.3	36.6	37.1
	Atmospheric environment						
	Number of days with good air quality in Jinghong City (indicators: NO_X, SO_2 and PM_{10})	Day	357	353	306	325	208
	Acid rain frequency and intensity in Jinghong	%	0.9	3.5	0	0	0
	Sound environment						
	Percentage of key cities with urban regional environmental noise ≤55dB(A)	%	-	-	-	-	-
	Percentage of key counties (cities) with urban road traffic noise ≤70dB(A)	%	-	-	-	-	-
	Solid waste						
	Urban garbage harmless disposal rate of counties (cities)	%	100	100	100	100	100
Pollution prevention and control indicator	**Wastewater**						
	Discharge of industrial wastewater	10,000t	1613	1670	1749	1822	1965
	Discharge of COD	10,000t	21584	20297	20321	21586	23025
	Discharge of ammoniacal nitrogen	t	804	598	837	819	831
	Industrial wastewater discharge qualification rate of key pollution sources	%	80.9	86.4	88.9	90.2	91.4
	Exhaust gas						
	Discharge of industrial exhaust gas	10,000 nm^3	193328	196985	248053	250367	237649
	Discharge of sulfur dioxide	t	991	959	1071	1038	1105
	Discharge of flue dust	t	582	574	741	757	673
	Discharge of industrial dust	t	189	238	306	411	325
	Solid waste						
	Safe disposal rate of medical waste	%	99.1	100.0	3.6	98.3	100.0
	Comprehensive utilization rate of industrial solid waste	%	99.6	98.8	67.9	67.7	66.7
	Comprehensive excrement utilization rate in large-scale livestock farm (centralized breeding area)	%	-	-	-	-	-
Ecological construction indicator	Forest coverage rate	%	78.3	78.3	78.3	78.3	78.3
	Percentage of nature reserve management institutions above the provincial level meeting the standard construction requirements	%	-	-	-	-	-

	Urban per capita public green area	m^2	9.8	9.82	9.87	12.14	13.27
	National townships and towns of beautiful environment	Nr.	0	0	0	0	1
Environment management capacity indicator	Construction of environmental law enforcement system						
	Monitoring network construction						
	Radiation environment safety monitoring						
	Environmental publicity and education						
Water quality indicator of Lancang River and its main tributaries	Comprehensive water quality indicator of Lancang River and its seven main tributaries (Nanguo River, Liusha River, Buyuan River, Nanla River, Nanlan River, Nan'a River and Dakai River)		IV	IV	III	III	III

3.1 Urban environment quality indicator

3.1.1 Water environment

(1) Percentage of urban drinking water source meeting the requirements for centralized drinking water source

The range of centralized drinking water source refers to the protection zone from 1000m at the upper reach of surface water river intake to the 100m at its lower reach and the protection zone about 500m from the lake or reservoir intake or the core zone with the water source well as the centre of a circle and with a radius of 50m. The water quality of centralized drinking water source shall meet the requirements of *Standards for Drinking Water Quality* (GB 5749-2006).

Statistical data (Fig. 3.1) revealed that the water quality (2005-2010) of all the urban drinking water sources in Xishuangbanna met the national standards for centralized drinking water source, with an up-to-standard rate of 100%. As it is required in the Plan that the percentage of urban drinking water sources meeting the requirements for centralized drinking water source should be 100%, the planned objective for required up-to-standard percentage in 2010 was realized.

Fig. 3.1 Percentage of Urban Drinking Water Source Meeting the Requirements for Centralized Drinking Water Source (2005-2010)

(Source: *Report on Environmental Quality of Xishuangbanna*)

(2) Water qualification rate of the state/province-controlled sections in Lancang River system meeting the standards of water environmental functions

Lancang River flows through Xishuangbanna from north to south and its flow path in this prefecture is 167km. In Xishuangbanna, there are 2761 large and small rivers, with river density up to 0.633km^2. To assess the water environmental functions of Lancang River system, Xishuangbanna Environmental Monitor Station has provided 12 state/province-controlled monitoring sections in Lancang River main stream and its 7 main tributaries (Nanguo, Liusha, Buyuan, Nanla, Nanlan, Nan'a and Dakai) for routine water quality monitoring. The water qualification rate of state/province-controlled sections in Lancang River system meeting water environmental functions refers to the percentage of the sections with up-to-standard water quality in all the monitored sections.

Water qualification rate of state/province-controlled sections in Lancang River system meeting water environmental functions in 2005-2010 is as shown in Fig. 3.2. This Figure shows that the water qualification rate of state/province-controlled sections in Lancang River system meeting water environmental functions in 2005-2007 was lower than 100% and was 91.7%, 83.3% and 75% respectively. In 2006 and 2007, the water qualification rate decreased; in 2008-2010, the water qualification rate increased and that of all the monitored sections was up to standard. As it is required in the Plan that the water qualification rate of state/province-controlled sections in Lancang River system meeting water environmental functions should be 91.7%, the planned objective for required up-to-standard rate in 2010 was realized.

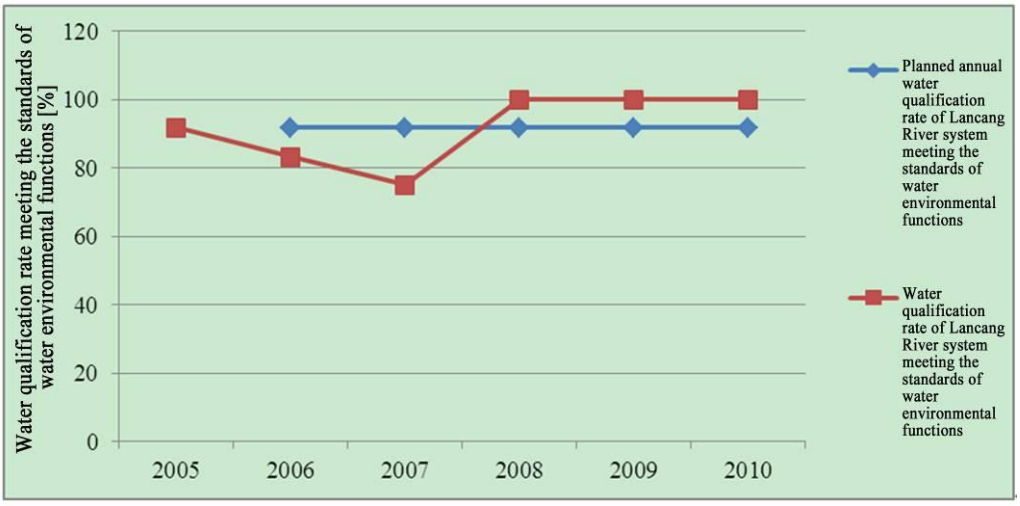

Fig. 3.2 Water Qualification Rate of the State/Province-controlled Sections in Lancang River System meeting the Standards of Water Environmental Functions (2005-2010)

(Source: *Report on Environmental Quality of Xishuangbanna*)

(3) Discharge and treatment rate of urban sewage

According to the statistical data, Fig. 3.3 and 3.4 respectively present the variation trend in discharge and treatment rate of domestic sewage in Xishuangbanna during 2005-2010. These figures reveal that with the speeding up of its urbanization process, the discharge of domestic sewage showed a trend of sustained growth, increasing from 14,910,000t to 20,680,000t during

2005-2010, with a growth rate of nearly 1.4 times. However, the variation trend in the treatment rate is contrary to that in discharge. The treatment rate of domestic sewage decreased from 43.86% in 2005 to 37.05% in 2010, which shows the downtrend of Xishuangbanna's urban domestic sewage treatment capacity. It is required in the Plan that the discharge and treatment rate of urban domestic sewage in 2010 should be controlled within 15,400,000t and should reach 65% respectively. Therefore, both failed the planned objectives.

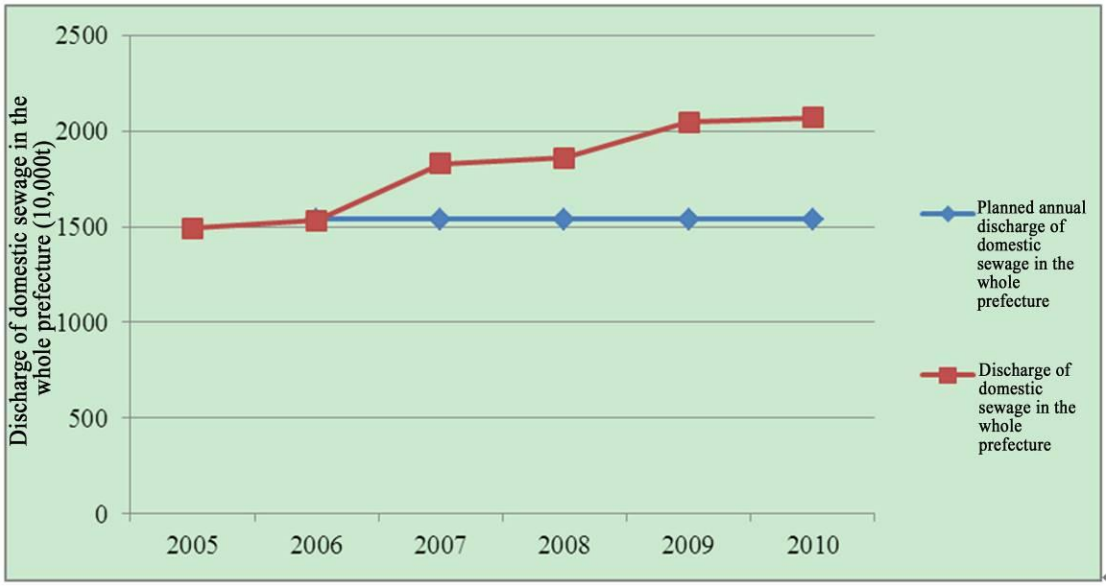

Fig. 3.3 Discharge of Domestic Sewage in the Whole Prefecture (2005-2010)

(Source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*)

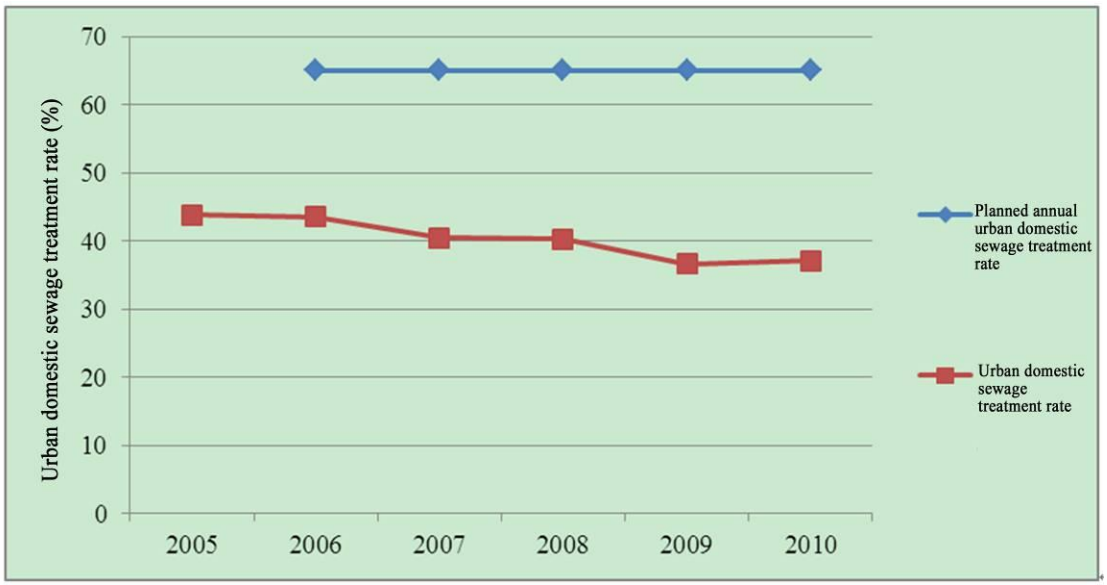

Fig. 3.4 Urban Domestic Sewage Treatment Rate (2005-2010)

(Source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*)

3.1.2 Atmospheric environment

(1) Number of days with good urban air quality (Jinghong City)

The urban ambient air quality is assessed by the number of days with urban air quality (such indicators as NO_X, SO_2 and PM_{10}) meeting the functional zone

requirements. The data detected in Jinghong is used to illustrate Xishuangbanna's urban air quality situation as Menghai County and Mengla County were not monitored for this in 2005 to 2010.

It can be seen from the monitoring data in Jinghong (Fig. 3.5) that the number of days with good air quality in 2005 to 2009 does not have a sharp rangeability and varies around 330, where the number of days with good air quality both in 2006 and 2007 exceeds 350, and that in 2008 becomes 300 or so. However, the number of days with good air quality in 2010, as per the Plan, which ought to have reached 347, declines sharply to 208. Therefore, number of days with good air quality in Jinghong, Xishuangbanna in 2010 fails to reach the planning target.

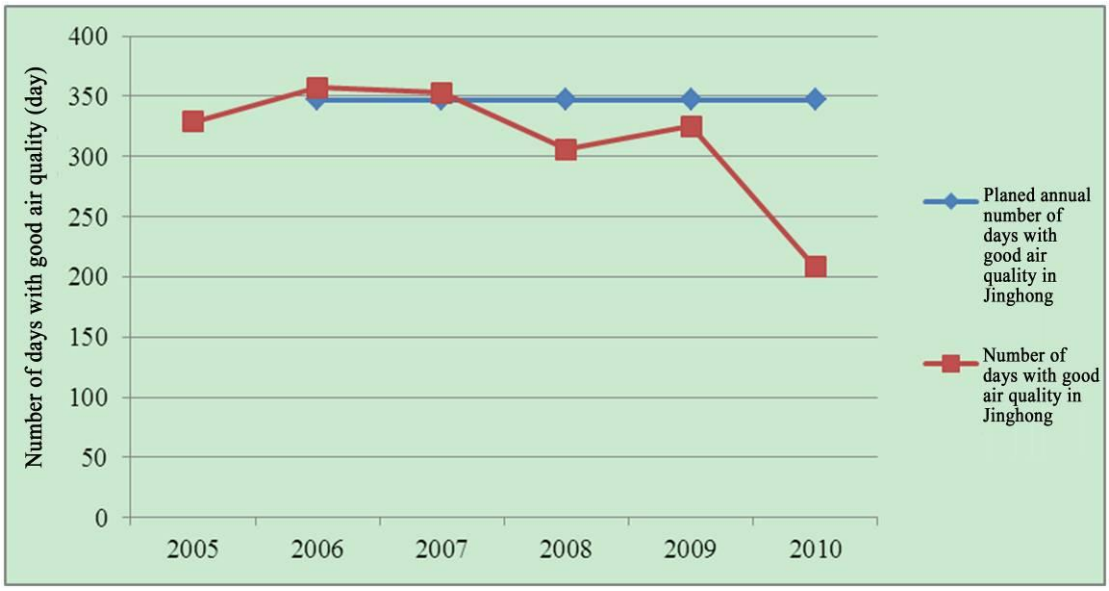

Fig. 3.5 Number of Days with Good Air Quality in Jinghong City (2005-2010)

(Source: *Report on Environmental Quality of Xishuangbanna)*

(2) Acid rain frequency and intensity

The acid rain internationally refers to the rain of pH lower than 5.6 and the acid rain frequency refers to the ratio between the occurrence days and overall rainy days. The acid rain intensity is affected by the rainfall intensity and pH thereof. The data detected in Jinghong is used to illustrate the acid rain frequency and intensity in Xishuangbanna Prefecture as Menghai County and Mengla County were not monitored for this in 2005 to 2010.

As per the statistic data (Fig. 3.6), 2005 - 2007 saw acid rain in Jinghong City, with the frequency respectively being 19.1%, 0.9% and 3.5%. There was no acid rain detected in 2008 to 2010. According to the Plan, the acid rain frequency in 2010 ought to have been controlled within 6%. Therefore, the acid rain frequency and intensity of Xishuangbanna Prefecture in 2010 is within the planning target.

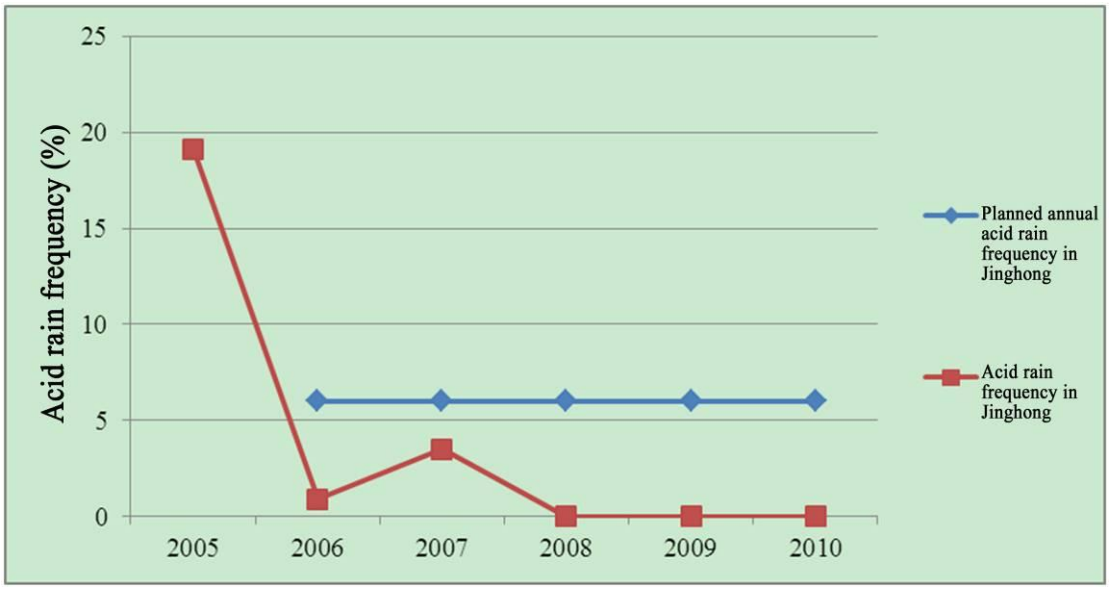

Fig. 3.6 Acid Rain Frequency in Jinghong (2005-2010)

(Source: *Report on Environmental Quality of Xishuangbanna*)

3.1.3 Sound environment

There are two indicators to assess the sound environment: the percentage of key cities where the environmental noise of urban area is not greater than 55dB(A) and the percentage of key counties (cities) where the urban traffic noise is not greater than 70dB(A).

In 2005-2010, only Jinghong was monitored for the urban regional environmental noise and urban road traffic noise. As a result, there are no statistics on the said two items. Hence no up-to-standard analysis has been done for the two indicators.

3.1.4 Solid waste

In the Plan, the urban garbage harmless disposal rate in a county (city) is used as an indicator to assess the disposal and utilization situations of solid waste in Xishuangbanna Prefecture. It refers to the ratio between the harmless disposal capacity and the total garbage capacity in a county (city) during a given period.

Of the 3 counties (cities) (Jinghong City, Menghai County and Mengla County) of Xishuangbanna Prefecture, only Jinghong implemented urban garbage harmless disposal in 2005 to 2009 and while the other two counties did so in 2010. If spoken only from Jinghong City, the solid waste (urban garbage) harmless disposal rate is 100%, meeting the planning target (Fig. 3.7).

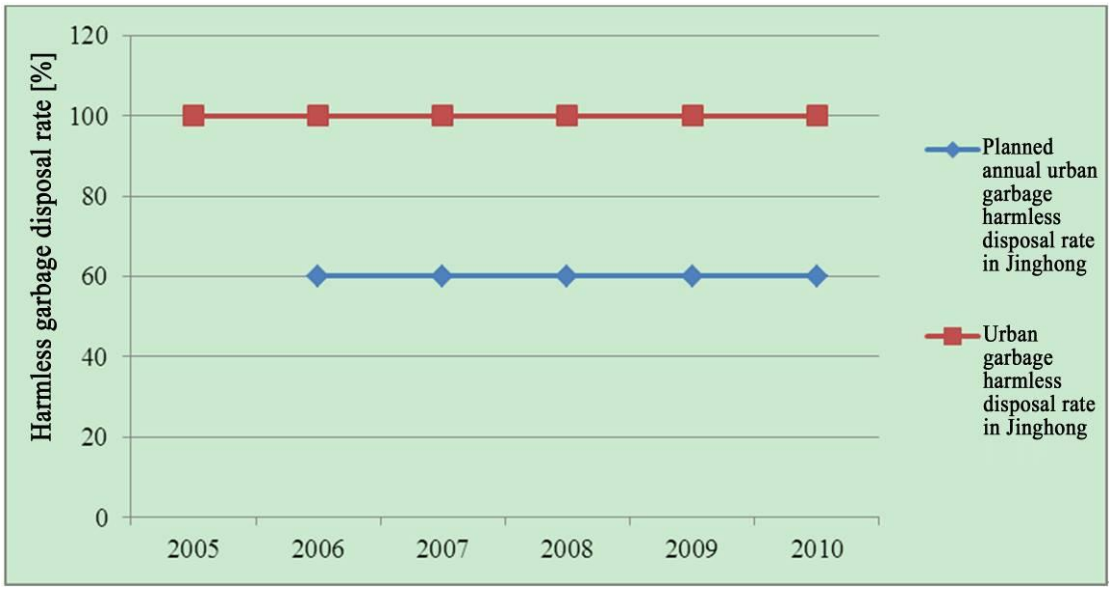

Fig. 3.6 Urban Garbage Harmless Disposal Rate in Jinghong (2005-2010)

(Source: statistical data from the Information Construction Bureau of Xishuangbanna Prefecture)

3.1.5 Conclusion

Among the water environment quality indicators of Xishuangbanna Prefecture in 2010, the planning targets reached were the ratio of urban drinking water source meeting the requirements for centralized drinking water source and national (provincial)-controlled cross-section water qualification rate of Lancang River System for environmental functions; nevertheless, the discharge and disposal rate of town sanitary sewage failed to reach the planning target.

Among the atmospheric environment quality indicators of Xishuangbanna Prefecture in 2010, the number of days with good air quality failed to reach the planning target in Jinghong City, but the acid rain frequency and intensity did.

The up-to-standard analyses of sound environment quality indicators of Xishuangbanna Prefecture in 2010 were not carried out.

For the solid waste disposal of Xishuangbanna Prefecture in 2010, the harmless disposal was done for all solid waste in Jinghong City with a rate of 100%. Therefore, the planning target for solid waste was reached in Jinghong.

3.2 Pollution prevention indicators

3.2.1 Wastewater

(1) Discharge of industrial wastewater

The discharge of industrial wastewater refers to the wastewater discharged during the production procedure of industrial enterprises.

Pursuant to the statistical data (Fig. 3.7), the discharge of industrial wastewater shows a continuous growth trend in Xishuangbanna Prefecture in 2005 to 2010. The discharge of industrial wastewater in 2010 (19.4679 million tons) is 1.3 times as that in 2005 and is within the planning target with that lower than 40 million tons as required in the Plan.

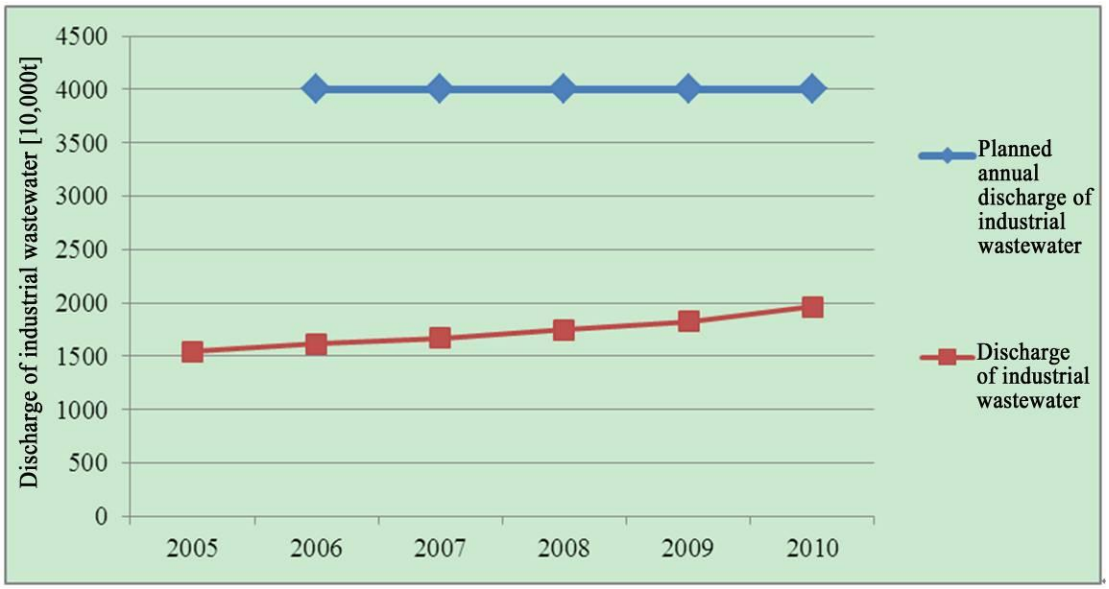

Fig. 3.7 Discharge of Industrial Wastewater in Xishuangbanna Prefecture (2005-2010)

(Source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*)

(2) Chemical oxygen demand (COD) and discharge of ammoniacal nitrogen

COD (unit: mg/L) refers to the amount of reducing matters in the water sample required to be oxidized via chemical measuring methods and reflects the water pollution level out of reducing matters. It's one of the comprehensive indicators of relative organic content in water. The higher the COD is, the heavier the organic pollution is in water. The COD sum discharged from various production and livings is the total discharge of COD.

Ammoniacal nitrogen refers to the nitrogen in the forms of free ammonium (NH_3) and ammonium ions (NH_4^+). The nitrogen content of animal organics is higher than that of vegetal organics. In addition, the nitrogenous organic compounds in the human and animal excreta are so unstable that they are easy to be resolved into ammonia. Hence, the ammoniacal nitrogen of which the content increases in water refers to the ammoniate in the forms of ammonia or ammonium ions. Ammoniacal nitrogen is a kind of nutrient which can lead to water eutrophication and the major pollutant consuming oxygen, as well as poisonous for fishes and some aquatic organism.

The COD and ammoniacal nitrogen discharge of Xishuangbanna Prefecture in 2005 to 2010 are shown in Fig. 3.8 and 3.9. The data indicates that the COD and ammoniacal nitrogen discharge both suffer such changing process: increase, decrease and then increase again. The discharge of COD in 2005 is 20,720t, increasing to 21,580t in 2006, decreasing to 20,321t in 2007 and then again increasing to 23,025t in 2010; the discharge of ammoniacal nitrogen is 7.2032 million tons in 2005, increasing to 8.0405 million tons in 2006, decreasing to 5.9777 million tons in 2007 and then again increasing to 8.3081 million tons in 2010. The COD and ammoniacal nitrogen discharge are respectively 27,000t and 9.40 million tons in 2010 as required in the Plan, thus both in Xishuangbanna Prefecture are lower than the planning targets.

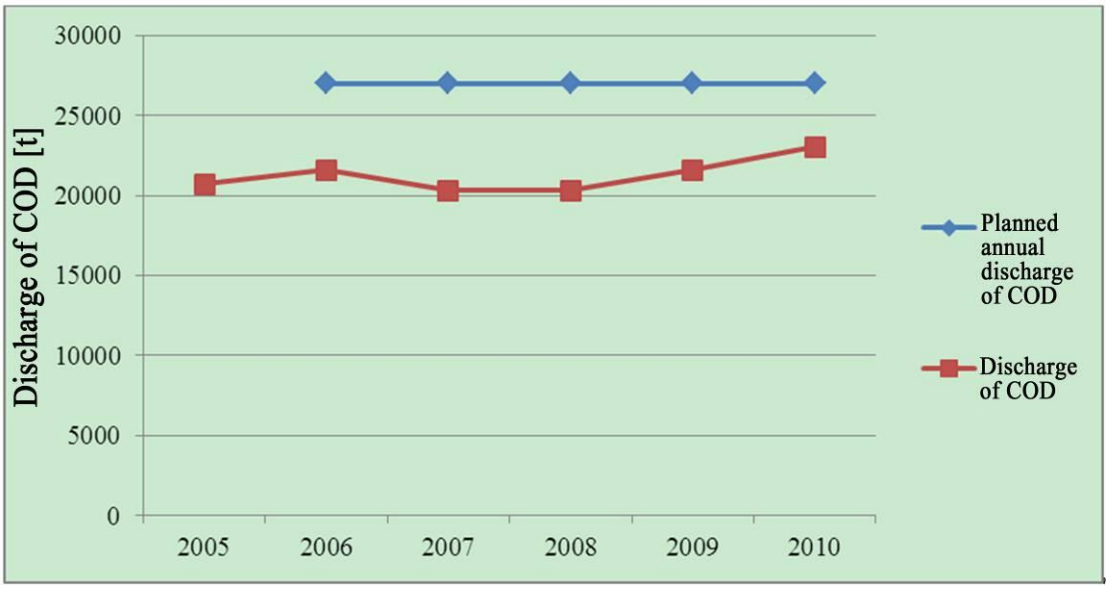

Fig. 3.8 COD in Xishuangbanna Prefecture (2005-2010)

(Source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*)

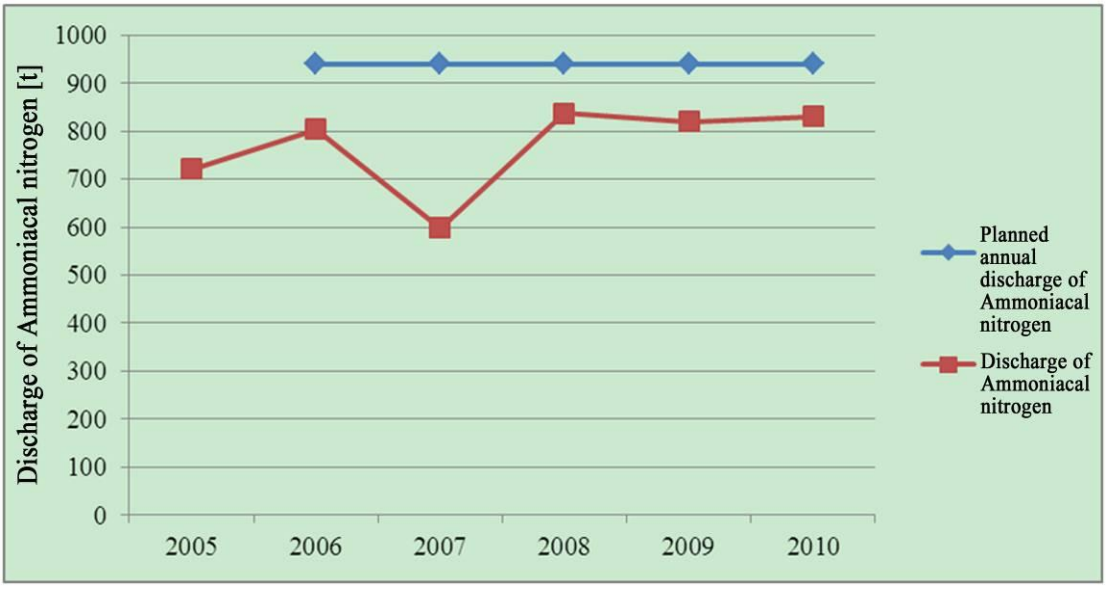

Fig. 3.9 Discharge of Ammoniacal Nitrogen in Xishuangbanna Prefecture (2005-2010)

(Source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*)

(3) Industrial wastewater discharge qualification rate of key pollution sources

The industrial wastewater discharge qualification rate refers to the ratio between the urban (regional) industrial wastewater discharge qualification amount and the total industrial wastewater discharge amount.

See Fig. 3.10 for the industrial wastewater discharge qualification rate of key pollution sources in Xishuangbanna Prefecture in 2005 to 2010. The data indicates that the industrial wastewater discharge qualification rate in Xishuangbanna Prefecture decreases from 93.98% (2005) to 80.91% in 2006 and shows an increasing trend in 2007 to 2010 and was 91.37% in 2010. The industrial wastewater discharge qualification rate of key pollution sources ought to have reached 90% as required in the Plan, thus that of Xishuangbanna Prefecture is within the planning target.

Fig. 3.10 Industrial Wastewater Discharge Qualification Rate of Key Pollution Sources in Xishuangbanna Prefecture (2005-2010)

(Source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*)

3.2.2 Exhaust gas

(1) Discharge of industrial exhaust gas

The discharge of industrial exhaust gas refers to the total gases inclusive of pollutants discharged into the air and generated from the fuel burning and production processes in factories and is calculated under the standard state (273K, 101325Pa).

See Fig. 3.11 for the discharge of industrial exhaust gas in Xishuangbanna Prefecture in 2005 to 2010 as per statistical data. The discharge of industrial exhaust gas shows a continuous growth trend in Xishuangbanna Prefecture in 2005 to 2009, where the discharge in 2009 is 1.8 times as that in 2005 and that in 2010 (237,650 nm^3) is slightly lower than that in 2009 (with a reduction rate of 6%). The discharge of industrial exhaust gas ought to have been 210,000 nm^3 in 2010 as required in the Plan, thus that in Xishuangbanna Prefecture fails to reach the planning target.

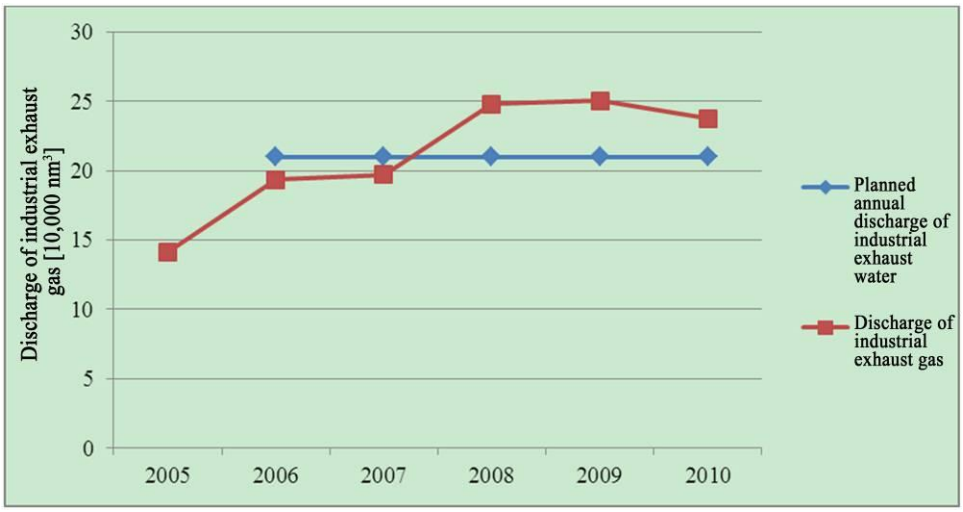

Fig. 3.11 Discharge of Industrial Exhaust Water in Xishuangbanna Prefecture (2005-2010)

(Source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*)

(2) Discharge of sulfur dioxide

See Fig. 3.12 for the discharge of sulfur dioxide in Xishuangbanna Prefecture in 2005 to 2010 as per statistical data. It indicates that the discharge of sulfur dioxide in Xishuangbanna Prefecture shows an overall rising trend, where that in 2006 increases to 991t from around 950t (2005), decreasing to 950t in 2007, increasing to 1,070t in 2008, decreasing to 1,038t in 2009 and again increasing to 1,104 in 2010. The discharge of sulfur dioxide ought to have been controlled within 1,240t in 2010 as required in the Plan, thus that in Xishuangbanna Prefecture is within the planning target.

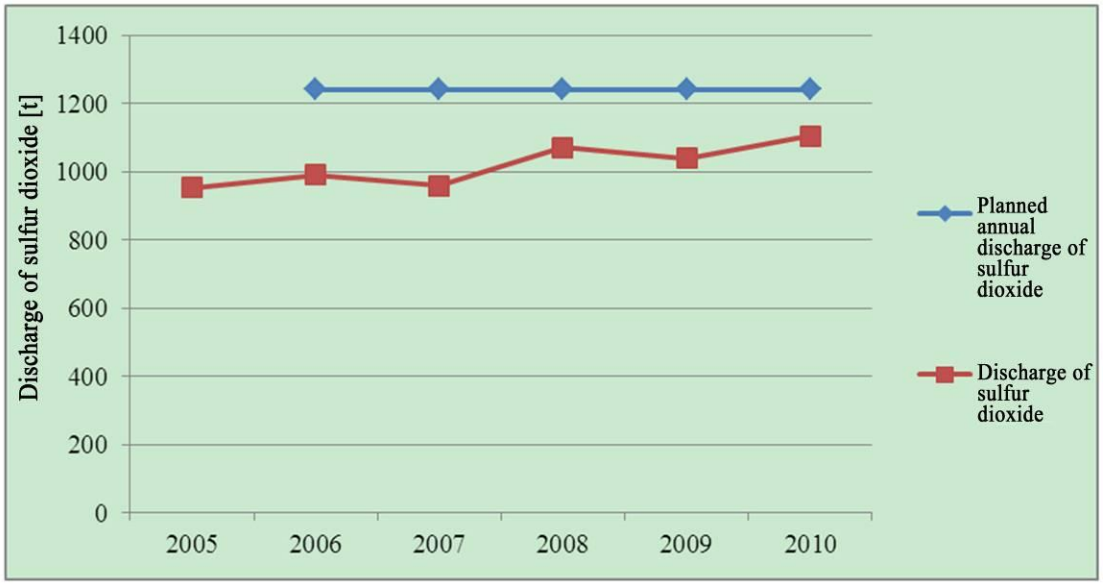

Fig. 3.12 Discharge of Sulfur Dioxide in Xishuangbanna Prefecture (2005-2010)

(Source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*)

(3) Discharge of flue dust and industrial dust

The flue dust mainly consists of dust particles, unburned (carbon black) particles and other visible particles out of fuels. The discharge of smoke dust is generally measured as per the contents of burning carriers – boiler, kiln, smelter and the like; the discharge of industrial dust refers to the weight of particles discharged in the production processes, such as from fireproofing materials of steel enterprises, coke screening system of coking enterprises, sintering machines, lime kilns, cement of building material enterprises and the like.

It can be seen from the statistical data that the discharge of flue dust and industrial dust of Xishuangbanna Prefecture is basically consistent in 2005 to 2010 (Fig. 3.13 and 3.14), where those in 2005 are respectively 551.87t and 100.91t, those in 2005 to 2009 show a rising trend and those in 2010 are respectively 673.09t and 325.2t, increasing by 11% and 21% respectively compared with those in the year before. The discharge of flue dust and industrial dust ought to have been controlled respectively within 720t and 130t in 2010 as required in the Plan, thus the former in Xishuangbanna Prefecture is within the planning target, but the latter fails.

Fig. 3.13 Discharge of Flue Dust in Xishuangbanna Prefecture (2005-2010)

(Source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*)

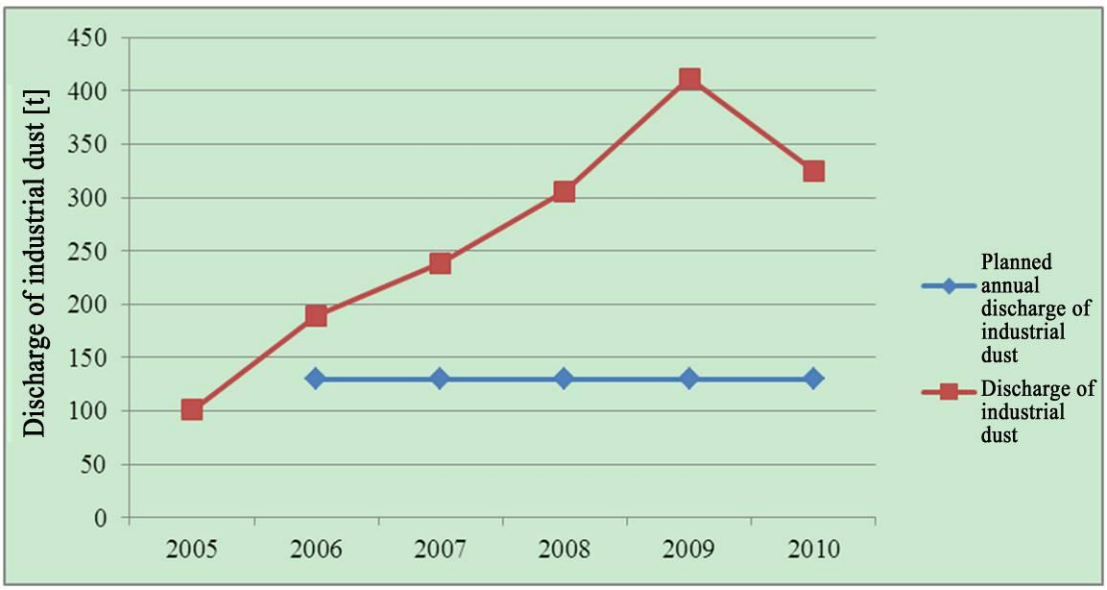

Fig. 3.14 Discharge of Industrial Dust in Xishuangbanna Prefecture (2005-2010)

(Source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*)

3.2.3 Solid waste

(1) Safe disposal rate of medical waste

Medical waste refers to the waste with direct, indirect infectivity, poisonousness and other harmfulnesses generated from medical, preventive, health-care and other activities of medical and sanitary institutions. The safe disposal rate of medical waste refers to the ratio between the safe disposal amount of medical waste and total medical waste amount.

See Fig. 3.15 for the variation trend of safe disposal rate of medical waste in Xishuangbanna Prefecture in 2005 to 2010 as per statistical data. It indicates that the safe disposal rates of medical waste are greater than 98% except in the base year (2005) and 2008, and 100% in 2010. The safe disposal rates of medical

waste ought to have reached 70% in 2010 as required in the Plan, thus that of Xishuangbanna Prefecture is within the planning target.

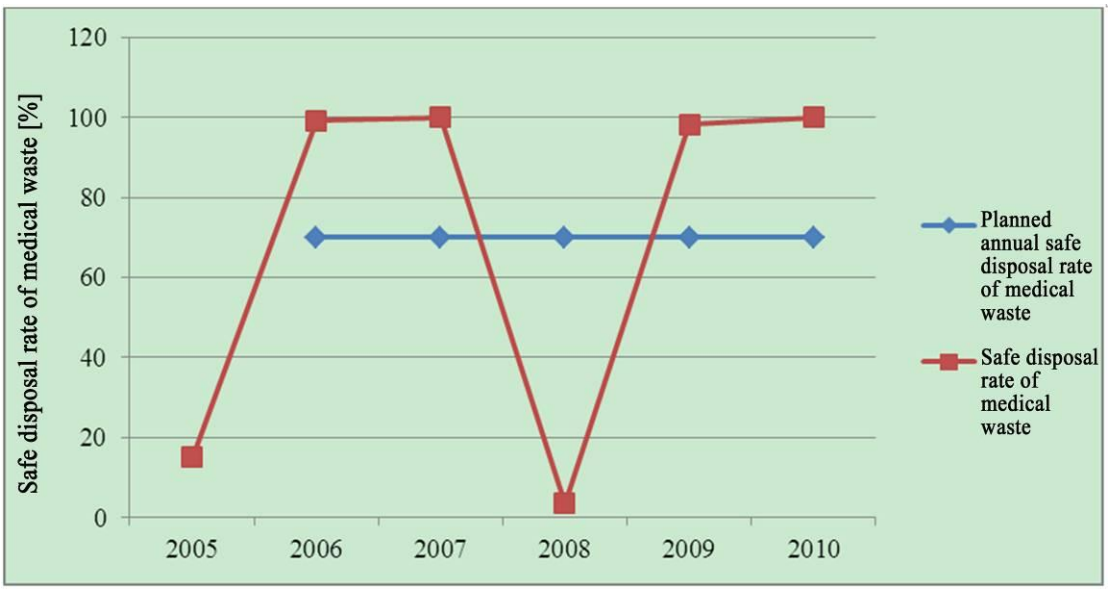

Fig. 3.15 Safe Disposal Rate of Medical Waste in Xishuangbanna Prefecture (2005-2010)

(Source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*)

(2) Comprehensive utilization rate of industrial solid waste

The comprehensive utilization of solid waste refers to extracting the solid waste amount or converting it into the solid waste amount of available resource, energy and other raw materials (including utilizing previously accumulated storage capacity of industrial solid waste) as agricultural fertilizer or for producing construction materials, building roads and the like via such methods as recycling, processing, circulation and exchange. The comprehensive utilization rate of industrial solid waste refers to the ratio between the annual total comprehensively utilized industrial solid waste amount and the industrial solid waste output of the same year.

See Fig. 3.16 for the variation trend of comprehensive utilization rate of industrial solid waste in Xishuangbanna Prefecture in 2005 to 2010 as per statistical data. It indicates that the comprehensive utilization rate of industrial solid waste in Xishuangbanna Prefecture shows a decreasing trend and keeps around 99% in 2005 to 2007, decreasing to 68% in 2008, continuously decreasing in 2009 to 2010 and to 66.7% in 2010. The comprehensive utilization rate of industrial solid waste ought to have reached 100% in 2010 as required in the Plan, thus that of Xishuangbanna Prefecture fails to reach the planning target.

Fig. 3.16 Comprehensive Utilization Efficiency of Industrial Solid Waste in Xishuangbanna Prefecture (2005-2010)

(Source: *Xishuangbanna Statistical Yearbook*)

(3) Comprehensive excrement utilization rate in large-scale livestock farm (centralized breeding area)

The up-to-standard analysis of this indicator was not carried out since the lack of relevant data on the Comprehensive excrement utilization rate in large-scale livestock farm (centralized breeding area) in the statistical data.

3.2.4 Conclusion

Among the wastewater discharge indicators of Xishuangbanna Prefecture in 2010, the discharge of industrial wastewater, COD and ammoniacal nitrogen is within the planning target, so is the industrial wastewater discharge qualification rate of key pollution sources.

Among the exhaust gas discharge indicators of Xishuangbanna Prefecture in 2010, the discharge of industrial exhaust gas and industrial dust fails to reach the planning target, but the discharge of sulfur dioxide and flue dust does.

Among the solid waste disposal rate indicators of Xishuangbanna Prefecture in 2010, the safe disposal rate of medical waste is within the planning target, but the comprehensive utilization rate of industrial solid waste fails.

3.3 Ecological construction indicators

3.3.1 Forest coverage rate

The forest coverage rate refers to the ratio between the forest land area and national territorial area in Xishuangbanna Prefecture and is an indicator reflecting the forestry area occupation situation, forest resource richness and achieved greening level, as well as an important basis for determining forest operation and developing utilization strategies.

The variation trend of forest coverage rate of Xishuangbanna in 2005 to 2010 is shown in Fig. 3.17 as per the statistical data and keeps 78.3%. The forest coverage rate ought to have reached 70% in 2010 as required in the Plan, thus that of

Xishuangbanna Prefecture is within the planning target.

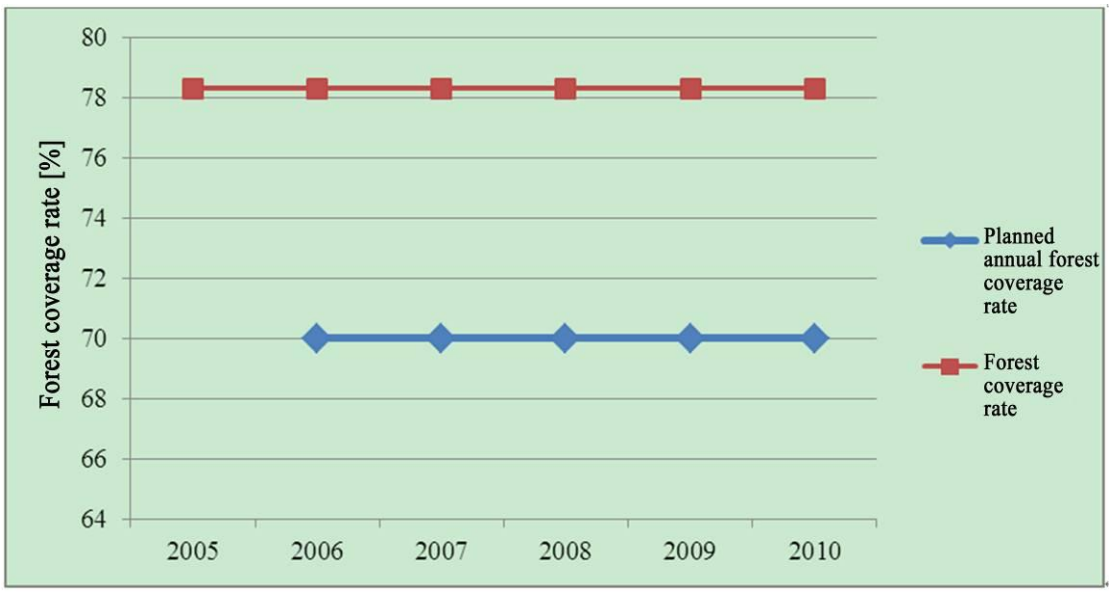

Fig. 3.17 Forest Coverage Rate of Xishuangbanna Prefecture (2005-2010)

(Source: statistical data from Xishuangbanna Forestry Bureau)

3.3.2 Percentage of nature reserve management institutions above the provincial level meeting the standard construction requirements

Nature reserve management institutions are those specialized institutions set up by the government to manage nature reserves. Administrative offices or bureaus are set up for national nature reserves, administrative stations are set up for city-level or county-level nature reserves, provided with necessary administrative staff and scientific technicians. Nature reserve management institutions are mainly responsible for: ① executing national policies and regulations related to natural conservation; ②investigating resources and establishing resource files for natural environment and resources in nature reserves; ③preparing rules and regulations and managing various activities in nature reserves; ④developing scientific researches and natural conservation publicity; ⑤assisting local governments in arranging the production and livings for the residents in nature reserves; ⑥conducting sound business activities based on the protection of environmental resources.

Complicated zones, diverse natural environment and abundant biodiversity are formed due to the special geographic position and unique climate condition of Xishuangbanna Prefecture where the sole and well preserved tropical rainforest is located in China with various natural conservation values. Since the establishment of the first nature reserve – Xishuangbanna Nature Reserve (becoming national nature reserve in 1986) – of Yunnan Province in 1958, the accumulated conservation area have reached 4965.7km^2, making up 25.97% of the total area in the whole prefecture. Where there are 8 nature reserves of various types of 3551.1km^2, making up 18.57% of the national territorial area in the whole prefecture and 5 other protected zones of 1414.6km^2, making up 7.4% of the total area in the whole prefecture. Xishuangbanna Prefecture, among 16 prefectures (cities) in Yunnan Province, forms the first and sole nationally designated eco-demonstration region.

At present, there are 2 national nature reserves in Xishuangbanna Prefecture: Xishuangbanna National Nature Reserve and Xishuangbanna Nabanhe River Basin National Conservation Area, Where the former covers a total area of 2425.10km^2,

making up 12.68% of the total area in the whole prefecture and is divided into five subsidiary nature reserves, Mengyang, Mangao, Menglun, Mengla and Shangyong, involving 20 townships and towns in 1 city and 2 counties of the whole prefecture; and where the latter covers a total area of 266.00km^2, making up 1.4% of the total area in the whole prefecture, involving 2 townships and towns in Jinghong City and Menghai County. The two nature reserves are both equipped with administrative institutions. The up-to-standard analysis is not done due to the lack of statistical data related to the standard construction of administrative institutions.

3.3.3 Urban per capita public green area

Urban per capita public green area refers to the ratio between the urban public green area and urban nonagricultural population. Public green area refers to the area of various city-level, district-level and resident-level parks and roadside parks opened to the public, including the water area therein.

The urban per capita public green area of Xishuangbanna, as per the statistical data, shows a rising trend in 2005 to 2010, where that in 2005 to 2008 keeps 9.8m^2 or so, increasing to 12.14m^2 in 2009 and to 13.27m^2 in 2010, exceeding the 2010 planning target (13m^2).

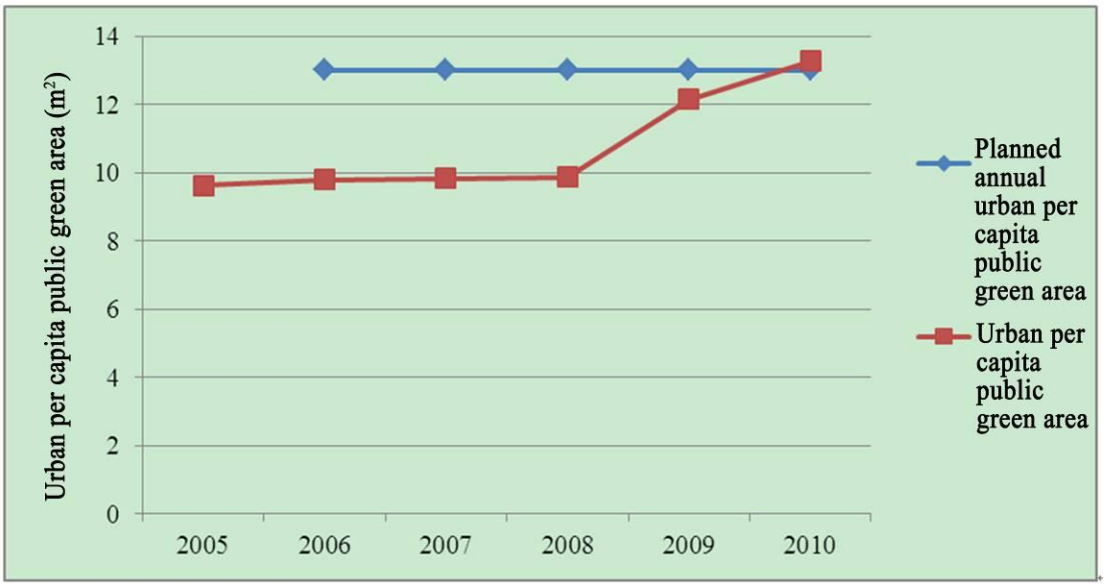

Fig. 3.18 Urban Per Capita Public Green Area in Xishuangbanna Prefecture (2005-2010)

(Source: *Xishuangbanna Statistical Yearbook*)

3.3.4 National townships and towns of beautiful environment

National-level ecological townships and towns, formerly National townships and towns of beautiful environment, shall be applied for with the construction indicator of Yunnan Province reached for over a year and over 80% administrative villages meeting the construction standards for over city (prefecture)-level ecological villages and the environmental conservation planning of townships and towns, as well as the conduction over years after the approval of the county people's congress or the government. Where the specific indicator includes: the water qualification rate of centralized drinking water source reaches 100%; the planting area ratio between the organic, green and harmless products and major agricultural products is equal to or greater than 60%; the rural drinking water qualification rate is equal to or greater than 90% to 100%; the harmless garbage disposal rate is equal to or greater than 90% to 95%; the centralized disposal rate of domestic sewage is equal to or greater than

70% to 80%; the per capita public green area is equal to or greater than 11 to 12 m^2/person.

According to the statistical data, there were no national-level ecological townships and towns in Xishuangbanna Prefecture in 2005 to 2009, but one was built in 2010. There ought to have been 3 national-level ecological townships and towns built in Xishuangbanna Prefecture in 2010 as per the Plan, therefore, this indicator fails to reach the planning target.

3.3.5 Conclusion

Among the ecological construction indicators, the up-to-standard analysis was not done for the Percentage of nature reserve management institutions above the provincial level meeting the standard construction requirements, the forest coverage rate and urban per capita public green area are within the 2010 planning target, while the National townships and towns of beautiful environment fail.

3.4 Environmental management capacity indicators

The Environmental management capacity indicators, as per the Plan, include four: construction of environmental law enforcement system, monitoring network construction, radiation environment safety monitoring and environmental publicity and education. This assessment evaluates the construction of environmental law enforcement system and monitoring network construction in Xishuangbanna Prefecture as per the second-level construction of Xishuangbanna environmental supervision standardization and environmental monitoring station, combined with the reality of Xishuangbanna Prefecture, as well as the environmental publicity and education.

3.4.1 Construction of environmental law enforcement system

The construction of environmental law enforcement system in 2005 to 2010 shall be assessed based on the *Standard for National Environmental Monitoring Standardization Construction* (Rev. 2006, HF[2006], No. 185) and the *Detailed Rules for Up-to-standard Acceptance and Scoring of Environmental Monitoring Standardization Construction* , as well as the understanding of the standardization construction of Xishuangbanna Environmental Monitoring Group in 2005 to 2010.

(1) Team construction

All 8 persons of an environmental monitoring team in Xishuangbanna Prefecture gain the educational background (over junior college) in 2005 to 2010 with 12.5% of the personnel related to environmental protection, failing to meet the construction standard (30%).

All law enforcement officials go through relevant trainings and work with certificates, strictly abiding by the environmental monitoring work system and carrying out environmental monitoring based on the system with complete and proper processes, simple and practical operations, well-organized execution and responsibilities in place.

The administrative information shall be made public with standard and neat files and complete materials strictly in accordance with the opening administration system.

All law enforcement expenditure shall be brought into the financial budget and strictly arranged as per such financial budget.

(2) Equipment construction

8 persons share a law enforcement vehicle for the standard configuration of environmental monitoring equipment in Xishuangbanna Prefecture in 2005 to 2010, failing to meet the construction standard (3 persons sharing 1 vehicle). Each vehicle is equipped with a GPS, meeting the construction standard; while such optional means of transportation fail to be equipped as: law enforcement command vehicle with multi-channel satellite communication, on-board communication equipment, on-board office equipment, on-board sample storage equipment, on-board radio, environmental monitoring law enforcement ship and unpiloted aerial-photography aircraft.

For evidence collection equipment, 8 persons share a DV, 4 share a camera and 8 share a sound recorder in 2005 to 2010, all failing to meet the standard equipment (3 sharing a DV, 3 sharing a camera and 3 sharing a sound recorder); while such optional evidence collection equipment fails to be equipped as: imaging equipment (TV, DVD, etc.), hand-held GPS, range finder, flowmeter, acidimeter, sound level meter, sampling device, service DVR and pipeline detector.

For office equipment, 2 persons share a fixed-line telephone, 1 shares a desktop computer and a duplicator, all meeting the standard equipment (3 sharing a fixed-line telephone and 1 sharing a desktop computer and a duplicator); in addition, 2 offices share a fax machine, 2 printer and a portable printer and 4 persons share a laptop, failing to meet the standard equipment (each office sharing a fax machine, 8 printers and 3 portable printers and 3 persons sharing a laptop).

For informationizing equipment, there is only one set of tip-off hotline (12369) for environmental protection; while such standard equipment fails to be equipped as: pollution charge management system, environmental law enforcement management and mobile law enforcement systems and online pollution source monitoring center, as well as optional satellite remote sensing images.

(3) Operation housing

The per capita office housing area for environmental monitoring is not less than $7m^2$ and the archive office area is $15m^2$ in Xishuangbanna Prefecture in 2005 to 2010, both failing to meet the construction standard; while such housing fails to be equipped as: law enforcement reception room, evidence collection room, sample room, archive office, pollution discharge declaration & acceptance office, parking space, pollution source monitoring center.

3.4.2 Monitoring network construction

(1) Environmental Monitoring Station standardization construction

The construction of environmental monitoring network in 2005 to 2010 shall be assessed based on the *Environmental Monitoring Station Construction Standard (on trial)* (Rev. 2002, HF[2003], No. 118) via the understanding of the Environmental Monitoring Station standardization construction of Xishuangbanna Prefecture in 2005 to 2010.

1) Staffing and structure

There are 15-18 persons staffed in 2005 to 2010, failing to meet the

construction standard (not fewer than 70 persons); the percentage of environmental monitoring technicians keep 80% in 2005 to 2007 and reached 83% during 2008 and 2010, failing to meet the construction standard (not less than 85%); the percentage of senior technicians is 23% in 2005, increasing to 30% in 2006, decreasing to 26% during 2008 and 2010, meeting the construction standard (not less than 20%); the percentage of intermediate technicians remains between 50% and 69% in 2005 to 2010, meeting the construction standard (not less than 50%).

2) Monitoring expenditure

From the statistical data, the per capita operating expense per year is RMB 40,000 in 2005 to 2010, meeting the construction standard (not less than RMB 40,000); the operating expense of water-quality automatic monitoring and information system is RMB 140,000/year in 2005 to 2010, failing to meet the construction standard (not less than RMB 200,000/year/station), but there is no atmosphere monitoring construction ; the equipment acquisition expenses in 2005, 2008 and 2010 are respectively RMB 1,000,000, 1,960,000 and 4,920,000, meeting the construction standard (not less than RMB 800,000), while those in 2006, 2007 and 2009 are respectively RMB 80,000, 750,000 and 230,000, failing to meet the construction standard; the equipment maintenance expense remains between RMB 20,000 to 50,000 per year in 2005 to 2010.

3) Monitoring housing

The laboratory area remains 950m^2 in 2005 to 2010, failing to meet the construction standard (2500m^2); the administrative office remains 300m^2 in 2005 to 2010, meeting the construction standard (per capita area not less than 15m^2).

4) Basic instrument

The Environmental Monitoring Station ought to be equipped with 83 kinds of basic instruments in accordance with the *Environmental Monitoring Station Construction Standard*. While the Environmental Monitoring Station of Xishuangbanna Prefecture had been equipped with 55 kinds of basic instruments (160 sets) by 2010, failing to meet the construction standard.

5) Emergency environmental monitor

The Environmental Monitoring Station ought to be equipped with 21 kinds of emergency environmental monitors in accordance with the *Environmental Monitoring Station Construction Standard*. While the Environmental Monitoring Station of Xishuangbanna Prefecture had been equipped with 17 kinds of emergency environmental monitors (21 sets) by 2010, failing to meet the construction standard.

(2) Construction of other monitoring networks

According to the *Annual Report on the State of the Environment in Xishuangbanna*, the Prefecture, since 2005, has continuously intensified the construction of environmental monitoring network, improved the requirements for monitoring personnel, techniques, equipment and expenditure in different degrees and developed the construction in the round, operation and maintenance of online monitoring systems for key pollution sources. By 2010, 16 key

enterprises has taken the lead in installing such systems with 14 passing the acceptance, still failing to reach the 25 enterprises as required in the Plan.

3.4.3 Radiation environment safety monitoring

According to the *Annual Report on the State of the Environment in Xishuangbanna*, the Prefecture carried out the environmental impact assessment, supervision & administration, radiation safety permit application and potential safety hazard check for radiation resources in 2005 to 2010 and strictly managed the radiation environment as per relevant national standards, with no occurrence of radiation resource loss, theft or radioactive contamination during the research, meeting the requirements in the Plan.

3.4.4 Environmental publicity and education

Xishuangbanna Bureau of Environmental Protection prepared the *information publication guide for Xishuangbanna Bureau of Environmental Protection* in 2008 and actively made public its information strictly in accordance with the said guide, including environmental quality bulletin, administrative information, work dynamic and other information, via the uniform governmental information publication web and handling face to face. Since the release of the guide, Xishuangbanna Prefecture had opened up the e-government affair information web and publicly displayed all approved and accepted projects via various media, and publicly reported the environmental quality of urban centralized drinking water sources in the whole Prefecture, the urban water quality and the urban ambient air quality of Jinghong via newspapers, network, broadcast and cable TV network.

"Green" is mainly built to integrate the green concept into our daily lives and social undertakings all round, at present primarily by green schools, communities, hospitals, restaurants and other institutions. In 2005, there were 9 green schools of the first batch in Xishuangbanna Prefecture: Xishuangbanna Ethnic Middle School, Xishuangbanna Dai Autonomous Prefecture Yunjinghong Primary School, Jinghong First Middle School, Jinghong Vocational High School, Jinghong Menghan Middle School, Jinghong Gasa Central Primary School, Mengla Mengcang Middle School, Mengla Mengrun Middle School and Mengla Second Primary School; In 2006, there were 13 green communities of the first batch of prefecture-level environment-friendly enterprises: Simao Jianfeng Co., Ltd., Jinghong Branch, The 3rd Glue Factory of Yunnan Natural Rubber Industrial Co., Ltd., Dongfeng Branch, The 8th Glue Factory of Yunnan Natural Rubber Industrial Co., Ltd., Dongfeng Branch, Mannankan Iron Mines of An'ning Taiyuan Industry & Trade Co., Ltd., Xishuangbanna Dai Park Co., Ltd., Xishuangbanna Dai Park Hotel of Yunnan Tobacco, Xishuangbanna Tropical Flower Garden, Jinghong Flower Garden Community, Jingzhen Sugar Refinery of Yunnan Xishuangbanna Yinmore Sugar Co., Ltd., Sugar Refinery of Yunnan Liming Agriculture, Industry & Commerce Associated Co. ,Ltd., Menghai Langhe Tea Factory, Menghai Guanghe Gold Mines Co., Ltd. and The 3rd Glue Factory of Yunnan Natural Rubber Industrial Co., Ltd., Mengbang Branch; In 2008, there were 15 environment-friendly demonstration units: Xishuangbanna Tropical Flower Garden, Xishuangbanna Ethnic Middle School, Xishuangbanna Dai Autonomous Prefecture Yunjinghong Primary School, Jinghong Kongquehu Community, Meng'a Sugar Refinery of Yunnan Xishuangbanna Yinmore Sugar Co., Ltd., Power Supply Bureau of Xishuangbanna Prefecture, Finance Bureau of Xishuangbanna Prefecture, Xishuangbanna Environmental Monitoring Station, Mengla County Environmental Protection Bureau, Menghan Town of Jinghong, Mohan Economic Development Zone, Glue Factory of Mengbang

Rubber Branch Company, Tiansheng Bridge Power Station and Xishuangbanna Prefecture Kindergarten; In 2009, the second batch of green schools included Jinghong Jingne Village Middle School, Jinghong Xiaojie Village Middle School, Jinghong Menglong Central Primary School and Jinghong Menglong Mannamingtian Primary School, and there were 5 prefecture-level environment-friendly enterprises of the second batch: Manmai Glue Factory of Xishuangbanna Weisheng Rubber Co., Ltd., Xishuangbanna Huofa Hotel, Xishuangbanna Zhengyuan Real Estate Development Co., Ltd., Menghai Bamboo & Wood Product Branch of Yunnan Mengxiang Bamboo Industry Co., Ltd. and Dasha Dam-rear Power Station; In 2010, there were 2 green schools of the third batch, respectively Jinghong 5th Middle School and Jinghong Mengyang Central Primary School, and there were 11 ecological green units: State-run Dongfeng Farm, Huaneng Jinghong Hydropower Station, Rubber & Solid Wood Furniture Factory of Yunnan Natural Rubber Industrial Co., Ltd., Wood Industry Branch, Wild Elephant Valley, Manjinghan Village Group of Manjinghan Village Committee, Gasa Town, Menghai Hanma Industry Holding Co., Ltd., Mengjinglai Scenic Area, Manban Village Group of Manao Village Committee, Manhai Town, Mengla Administrative Centre, Nanla Town – Southeast Asia Style Residential Area of Mengla County and Wangtianshu Air Corridor. Overall, there were more green units and generally higher public environmental awareness.

3.4.5 Conclusion

In 2010, Xishuangbanna Prefecture obviously improved its environmental management capacity, had its radiation environment safety monitoring met as required in the Plan, made public the environmental quality and administrative information, had a series of green units established and had the public widely enhance their environmental awareness. Nevertheless, the law enforcement team and capacity failed fully met the national standard, neither did the monitoring network construction.

3.5 Water quality indicator of Lancang River and its main tributaries

The water quality of Lancang River and its main tributaries in Xishuangbanna Prefecture remain stable in 2005 to 2010 in accordance with the statistical data (Table 3.2). Most of them keep good water quality (II or III) except that the water quality of Nanguo River is of V or IV in 2005 to 2007 and that of Liusha River is of IV in 2007.

The water quality type of Lancang River and its main tributaries ought to have remained III or above in 2010 as required in the Plan, thus that of Xishuangbanna Prefecture is within the planning target.

Table 3.2 Water Quality Type of Lancang River and Its Main Tributaries

Name	2005	2006	2007	2008	2009	2010
Lancang River	III	III	II and III	II and III	II	II
Puwen River	III	III	II	II	II	III
Xiaohei River	II	II	II	II	III	II
Liusha River	III	III	III and IV	III	III	III
Nan’a River	III	III	III	II	II	III
Nanla River	III	III	III	II and III	II and III	III
Nanguo River	V	IV	IV	III	III	III
Nanlan River	II	III	IV	III	III	II

4 EPA Analysis

4.1 Establishment of EPA indicator system

The EPA indicator system is the core of environment performance assessment and an important content in the assessment. The setting of EPA indicators is closely related to the assessment objects, objectives, etc. The main work in the process of formulating of assessment indicators includes three aspects: establishment & screening, establishment method & process, and concrete content. This assessment, mainly based on the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture*, is carried out for Xishuangbanna's environment performance during the "11th Five-Year Plan". Therefore, the assessment indicator system herein is formulated on the basis of the system put forward in the plan, complying with certain establishment and screening principles. Its main work content is developed through expert consultation method and brainstorming method and DPSIR model, closely sticking to the said *"11th Five-Year Plan"*.

4.1.1 Establishment & screening principles

The indicators shall be established by following certain principles to ensure that they can really reflect the characteristics of the assessment objects and the assessment objectives can be achieved. Domestic scholars summarize the principles as data availability, policy relevance, simplification and effectiveness, representativeness, comprehensiveness, fairness, transparency, etc. From the perspective of operability, the report, for establishing environment performance assessment indicators of the "11th Five-Year Plan" in Xishuangbanna Prefecture, follows the following principles:

(1) Policy relevance

The assessment indicators and objects are closely related to the assessment content. In order to reflect the environment conditions of the assessment objects objectively, the indicators shall be selected based on the local characteristics. Therefore, the indicators shall be selected based on the policies of the assessment area during the assessment period to make sure they can measure the environment performance of the area concerned accurately.

(2) Representativeness

The selected indicators shall be able to represent the natural environment features and environmental work characteristics of the area concerned and highlight the difference between the area and other places so as to establish an indicator system suitable for the assessment area.

(3) Comprehensiveness

The environmental protection involves all aspects of the society. In order to reflect the performance and results of the environmental protection comprehensively and effectively, the assessment indicator system shall be able to reflect the information required for environment performance assessment comprehensively so as to obtain more accurate and effective results and achieve the assessment objectives.

(4) Data availability

Accurate and effective data is the guarantee of the following assessment. The indicator, the data of which is unavailable or inaccurate, will affect the

objectiveness and fairness of the assessment results. Therefore, the selected indicators shall be obtained from the existing statistical data or become available after actual monitoring.

(5) Scientific practicability

The indicator system is systemic, with relatively independent but correlative indicators. That is to say, each indicator can not only represent certain aspect of the environmental problem, not overlapping with other indicators, but also contain as more information as possible. This characteristic embodies the scientific practicability of the indicators.

4.1.2 Establishment method and process

This EPA indicator system is established based on the indicator system in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* and by adopting the "DPSIR" model, expert consultation and brainstorming.

(1) Analysis of indicators in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture*

The *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* is a guidebook for Xishuangbanna to carry out its ecological construction and environmental protection during the "11th Five-Year Plan". In this document, an indicator system is established, including 5 indicators at criterion level and 29 indicators at indicator level. See Table 3.1 for details. The indicators at criterion level include urban environment quality, pollution control, ecological construction, environment management capacity, and water quality of Lancang River and its seven main tributaries. Urban environment quality, according to the natural elements, is divided into 9 sub-indicators, for example, water environment, atmospheric environment, sound environment and solid waste, which are all quantitative. Pollution control, as per the "three wastes", is divided into 11 sub-indicators, such as wastewater, waste gas and solid waste, which are all quantitative too. Ecological construction includes 4 quantitative sub-indicators. Environment management capacity includes 4 qualitative sub-indicators. Water quality of Lancang River and its seven main tributaries only includes 1 sub-indicator.

(2) "DPSIR"-based indicator establishment

The indicators in Table 3.1 are analyzed by classification based on the "DPSIR" model. The indicator system in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* is reclassified and re-screened following the indicator establishment principles put forward in the report. In order to ensure representativeness and scientific practicability of the indicators, the EPA indicator system for the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* is established by using expert consultation method and brainstorming method.

On October 11, 2014, the research group held an expert consultation meeting on EPA indicator system for the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna*

Prefecture at Xishuangbanna Bureau of Environmental Protection. At the meeting, the classification and screening of indicators was fully discussed. On the basis of full discussion, the indicators in Table 3.1 were, as per their features, included into the indicator system with “drive – pressure– state – impact – response” as the criterion level. Meanwhile, the experts participated in the meeting put forward suggestions on addition, deletion and modification of the indicators. Their comments and suggestions are summarized as follows:

1) The original indicator system does not have indicators at drive criterion level, so it is suggested to add population, total output value and agricultural fertilizer application amount as drive indicators;

2) In order to reflect the characteristics of ecological environment of Xishuangbanna Prefecture, it is suggested to add four indicators: percentage of wild vertebrate species in the nationwide species, percentage of wild higher plant species in the nationwide species, percentage of public welfare forest area in forest area, and percentage of rubber plantation area in forest area;

3) In the principles of data availability and scientific practicability, it is suggested to modify three original indicators: Modify the “key cities where the environmental noise of urban area is not greater than 55dB(A)” as “average equivalent sound level of urban environmental noise in Jinghong”, the “key counties (cities) where the urban traffic noise is not greater than 70dB(A)” as “average equivalent sound level of urban road traffic noise in Jinghong”, and the “percentage of nature reserve management institutions above the provincial level meeting the standard construction requirements” as “percentage of nature reserve area in the prefecture's land area”.

4) It is also suggested to delete 3 indicators in the original indicator system: safe disposal rate of medical waste, comprehensive excrement utilization rate in large-scale livestock farm (centralized breeding area)) and radiation environment safety monitoring. The reason is that the above three indicators are unrepresentative and the three environmental problems are not prominent in Xishuangbanna Prefecture and not the main environmental problems.

After the above discussion, the EPA indicator system for the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* is established. See Table 4.1 for details.

4.1.3 Content of the EPA indicator system

The EPA Indicator System for the "11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture (Table 4.1) includes 5 indicators at criterion level and 32 indicator levels including 3 drive indicators, 7 pressure indicators, 6 state indicators, 7 impact indicators and 9 response indicators. Content, definition and data source of the indicators are as follows:

(1) Drive

1) Population: the total population in Xishuangbanna Prefecture at the end of the assessment year, unit: person (data source: *Xishuangbanna Statistical Yearbook*, 2005-2010)

Table 4.1EPA Indicator System for the "11th Five-Year Plan" for Development of Ecological

Construction and Environmental Protection in Xishuangbanna Prefecture

Target Level	Criterion Level	Indicator Level
"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture	**D (Drive)**	Population (person)
		Total output value (RMB 10,000/present price)
		Agricultural fertilizer application amount (t)
	P (Pressure)	Discharge of domestic sewage in the whole prefecture (10,000t)
		Discharge of Industrial Wastewater (10,000t)
		Discharge of COD (10,000t)
		Discharge of ammoniacal nitrogen (10,000t)
		Discharge of industrial exhaust gas (10,000 nm^3)
		Discharge of sulfur dioxide (t)
		Discharge of flue dust and industrial dust (t)
	S (State)	Number of days with good air quality in Jinghong City (indicators NO_X, SO_2 and PM_{10}) (day)
		Average equivalent sound level of urban environmental noise in Jinghong (dB(A))
		Average equivalent sound level of urban road traffic noise in Jinghong (dB(A))
		Comprehensive water quality classification of Lancang River and its seven main tributaries (Nanguo River, Liusha River, Buyuan River, Nanla River, Nanlan River, Nan'a River and Dakai River)
		Percentage of wild vertebrate species in the nationwide species (%)
		Percentage of wild higher plant species in the nationwide species (%)
	I (Impact)	Acid rain frequency and intensity in Jinghong (%)
		Percentage of urban drinking water source meeting the requirements for centralized drinking water source (%)
		Forest coverage rate (%)
		Percentage of public welfare forest area in forest area (%)
		Percentage of rubber plantation area in forest area (%)
		Percentage of nature reserve area in the prefecture's land area (%)
		Urban per capita public green area (m^2)
	R (Response)	Industrial wastewater discharge qualification rate of key pollution sources (%)
		Water qualification rate of the state/province-controlled sections in Lancang River system meeting the standards of water environmental functions (%)
		National-level ecological townships and towns (Nr.)
		Urban domestic sewage treatment rate (%)
		Urban garbage harmless disposal rate of county (city) (%)
		Comprehensive utilization rate of industrial solid waste (%)
		Construction of environmental law enforcement system
		Monitoring network construction
		Environmental publicity and education

2) Total output value: the calculated total output value in the current year in Xishuangbanna Prefecture, unit: RMB 10,000 (present price) (data source: *Xishuangbanna Statistical Yearbook*, 2005-2010)

3) Agricultural fertilizer application amount: the total statistical agricultural fertilizer application amount in the current year in Xishuangbanna Prefecture, unit: t (data source: *Xishuangbanna Statistical Yearbook*, 2005-2010)

(2) Pressure

1) Discharge of domestic sewage in the whole prefecture: discharge of domestic sewage in the whole prefecture calculated based on the population of Xishuangbanna Prefecture and by means of pollution discharge coefficient, unit: 10,000t (data source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*, 2005-2010. Refer to the statement for specific calculation method and coefficient.)

2) Discharge of Industrial Wastewater: the total discharge of wastewater by industrial enterprises in Xishuangbanna Prefecture, unit: 10,000t (data source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*, 2005-2010. Refer to the statement for specific calculation method and coefficient.)

3) Discharge of COD: the total calculated Discharge of COD in Xishuangbanna Prefecture, unit: 10,000t (data source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*, 2005-2010. Refer to the statement for specific calculation method.)

4) Discharge of ammoniacal nitrogen: the total calculated discharge of ammoniacal nitrogen in Xishuangbanna Prefecture, unit: 10,000t (data source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*, 2005-2010. Refer to the statement for specific calculation method.)

5) Discharge of industrial exhaust gas: the total discharge of exhaust gas by industrial enterprises in Xishuangbanna Prefecture, unit: 10,000 nm^3 (data source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*, 2005-2013. Refer to the statement for specific calculation method and coefficient.)

6) Discharge of sulfur dioxide: the total calculated discharge of sulfur dioxide in Xishuangbanna Prefecture, unit: t (data source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*, 2005-2010. Refer to the statement for specific calculation method.)

7) Discharge of flue dust and industrial dust: the total calculated discharge of flue dust and industrial dust in Xishuangbanna Prefecture, unit: t (data source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*, 2005-2010. Refer to the statement for specific calculation method.)

(3) State

1) Number of days with good air quality in Jinghong City (indicators NO_X, SO_2 and PM_{10}): the total days when the air quality index is calculated as excellent in the current year in Xishuangbanna Prefecture, unit: day (data source: *Annual Report on the State of the Environment in Xishuangbanna*, 2005-2010)

2) Average equivalent sound level of urban environmental noise in Jinghong: the average equivalent sound level of regional environmental noise monitored in urban area of Jinghong, unit: dB(A) (data source: *Annual Report on the State of the Environment in Xishuangbanna*, 2005-2010)

3) Average equivalent sound level of urban road traffic noise in Jinghong: the

average equivalent sound level of main traffic road environmental noise monitored in urban area of Jinghong, unit: dB(A) (data source: *Annual Report on the State of the Environment in Xishuangbanna*, 2005-2010)

4) Comprehensive water quality classification of Lancang River and its seven main tributaries (Nanguo River, Liusha River, Buyuan River, Nanla River, Nanlan River, Nan'a River and Dakai River): the percentage of rivers up to the Class III of comprehensive water quality classification in the total rivers, unit: % (data source: *Annual Report on the State of the Environment in Xishuangbanna*, 2005-2010)

5) Percentage of wild vertebrate species in the nationwide species: the percentage of wild vertebrate species found in Xishuangbanna Prefecture in the nationwide wild vertebrate species, unit: % (*data source: Annals of Xishuangbanna Nature Reserves (1958-2008)*)

6) Percentage of wild higher plant species in the nationwide species: the percentage of wild higher plant species found in Xishuangbanna Prefecture in the nationwide wild higher plant species, unit: % (*data source: Annals of Xishuangbanna Nature Reserves (1958-2008)*)

(4) Impact

1) Acid rain frequency and intensity in Jinghong: the acid rain frequency and intensity monitored in Jinghong, unit: % (data source: *Annual Report on the State of the Environment in Xishuangbanna*, 2005-2010)

2) Percentage of urban drinking water source meeting the requirements for centralized drinking water source: the percentage urban drinking water sources in Xishuangbanna Prefecture with the monitored comprehensive water quality classification meeting the functional requirements for water quality of centralized drinking water source, unit: % (data source: *Annual Report on the State of the Environment in Xishuangbanna*, 2005-2010)

3) Forest coverage rate: the percentage of forest land area in land area in Xishuangbanna Prefecture, unit: % (data source: Department of Forestry)

4) Percentage of public welfare forest area in forest area: the percentage of ecological public welfare forest area in forest area in Xishuangbanna Prefecture, unit: % (data source: Department of Forestry)

5) Percentage of rubber plantation area in forest area: the percentage of rubber plantation area in forest area in Xishuangbanna Prefecture, unit: % (data source: Department of Forestry)

6) Percentage of nature reserve area in the prefecture's land area: the percentage of the area of nature reserves at state, province, prefecture and county levels in land area in Xishuangbanna Prefecture, unit: % (data source: Department of Forestry)

7) Urban per capita public green area: the ratio between the urban public green area and urban nonagricultural population in Xishuangbanna Prefecture, unit: m^2 (data source: *Xishuangbanna Statistical Yearbook*, 2005-2010)

(5) Response

1) Industrial wastewater discharge qualification rate of key pollution sources: the industrial wastewater discharge qualification rate of key pollution

sources based on the key industrial pollution source survey, unit: % (data source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*, 2005-2010)

2) Water qualification rate of the state/province-controlled sections in Lancang River system meeting the standards of water environmental functions: the percentage of sections meeting the standards of water environmental functions in the total monitored sections based on section water quality monitoring, unit: % (data source: *Annual Report on the State of the Environment in Xishuangbanna*, 2005-2010)

3) National-level ecological townships and towns: the number of townships and towns rewarded as the National-level ecological townships and towns in Xishuangbanna Prefecture, unit: Nr. (data source: Xishuangbanna Bureau of Environmental Protection)

4) Urban domestic sewage treatment rate: the percentage of water treatment amount by sewage treatment facilities in the total discharge amount based on the service condition of sewage treatment facilities in Jinghong City, Mengla County and Menghai County of Xishuangbanna Prefecture, unit: % (data source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*, 2005-2010)

5) Urban garbage harmless disposal rate of county (city): the percentage of urban population serviced by garbage disposal facilities in the total urban population in Jinghong City, Mengla County and Menghai County based on the service condition of urban garbage harmless disposal facilities in the three places of Xishuangbanna Prefecture, unit: % (data source: Xishuangbanna Housing and Urban-Rural Development Bureau, *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*, 2005-2010)

6) The comprehensive utilization rate of industrial solid waste: the percentage of the annual total comprehensively utilized industrial solid waste amount in the total amount of the industrial solid waste output of the same year and the comprehensively utilized storage amount of previous years, unit: %, (data source: *Annual Environmental Statistic Reports of Xishuangbanna Prefecture*, 2005-2010)

7) Construction of environmental law enforcement system: The research group, referring to the detailed rules for up-to-standard acceptance and scoring, gives scores for the environmental law enforcement system every year on the basis of the *Standard for National Environmental Monitoring Standardization Construction* (Rev. 2006, HF [2006], No. 185) and the *Detailed Rules for Up-to-standard Acceptance and Scoring of Environmental Monitoring Standardization Construction*, and the annual environmental monitoring enforcement condition during the assessment provided by the Xishuangbannan Environmental Monitoring Group as per the construction standards. The final result is the score of construction of environmental law enforcement system of the same year. Unit: none (data source: Xishuangbannan Environmental Monitoring Group)

8) Monitoring network construction: The research group, referring to the up-to-standard acceptance and scoring method, gives scores for environmental monitoring station construction every year on the basis of the *Standard for Environmental Monitoring Station Construction (Trial)* (Rev.

2002, HF [2003], No. 118) and the *Method for Up-to-standard Acceptance and Scoring of Environmental Monitoring Station Standardization Construction* and the annual environmental monitoring standardization construction condition during the assessment provided by Xishuangbanna Environmental Monitoring Station as per the construction standards. The final result is the score of the environmental monitoring construction of the same year. Unit: none (data source: Xishuangbannan Environmental Monitoring Station)

9) Environmental publicity and education: According to the indicators of 11th Five-Year Plan" for ecological construction and environmental protection in Xishuangbanna Prefecture, the objectives of environmental publicity and education involve four aspects: improvement of environmental quality of the whole prefecture, publicity of administrative information, establishment of series of green units, and general improvement of public environmental awareness. After brainstorming, the research group determines that the four aspects are scored as per equal weight. The group gives scores for the four aspects by referring to relevant information and mainly based on the data in the *Annual Report on the State of the Environment in Xishuangbanna*, and works out the sum as per the weight. The final result is the score of the environmental publicity and education. Unit: none (data source: *Annual Report on the State of the Environment in Xishuangbanna*, 2005-2010)

4.2 Calculation and analysis of EPI

4.2.1 Positive conversion of indicator

In multi-indicator comprehensive evaluation, according to the meaning of the indicators themselves, for some indicators, the larger the indicator value, the better the evaluation. These are called positive indicators (also known as "benefit type" indicators); while for some indicators, the smaller the indicator value, the better the evaluation. These are called negative indicators (also known as “cost type” indicators); and for some indicators, the more close to a certain value the indicator value, the better the evaluation. These are called moderate indicators. In comprehensive evaluation, all the indicators must be converted to the same trend. Generally, this is accomplished by converting the negative indicators and moderate indicators to positive indicators. Therefore, it is also called positive conversion of indicators. There are many methods to convert the indicators to positive ones. The common methods include reciprocal method, taking opposite number, subtracting indicator value from the maximum value in the data series, etc. The results obtained by taking different methods are different. In this research, reciprocal method is taken.

In this research, the indicator system has 18 positive indicators, 14 negative indicators and no moderate indicator. See Table 4.2 for details.

Table 4.2 Classification of Indicators

Criterion Level	Positive Indicators	Negative Indicators
Drive	-	Population, total output value, agricultural fertilizer application amount
Pressure	-	Discharge of domestic sewage in the whole prefecture, Discharge of Industrial Wastewater, Discharge of COD, discharge of ammoniacal nitrogen, discharge of industrial exhaust gas, discharge of sulfur dioxide, Discharge of flue dust

Criterion Level	Positive Indicators	Negative Indicators
		and industrial dust
State	Number of days with good air quality in Jinghong City, comprehensive water quality classification of Lancang River and its seven main tributaries, percentage of wild vertebrate species in the nationwide species, percentage of wild higher plant species in the nationwide species	Average equivalent sound level of urban environmental noise in Jinghong, average equivalent sound level of urban road traffic noise in Jinghong
Impact	Percentage of urban drinking water source meeting the requirements for centralized drinking water source, forest coverage rate, percentage of public welfare forest area in forest area, percentage of nature reserve area in the prefecture's land area, urban per capita public green area	Percentage of rubber plantation area in forest area
Response	Industrial wastewater discharge qualification rate of key pollution sources, water qualification rate of the state/province-controlled sections in Lancang River system meeting the standards of water environmental functions, National-level ecological townships and towns, Urban domestic sewage treatment rate, urban garbage harmless disposal rate of county (city), comprehensive utilization rate of industrial solid waste, construction of environmental law enforcement system, monitoring network construction, environmental publicity and education	-

The above table shows that the indicators of drive and pressure levels are negative ones, indicating that population, economic development and pollutant discharge have negative effect on protection of ecological environment. The indicators of response level are positive ones, indicating that the environmental pollution control measures play a positive role in alleviating the environmental pollution. The values of negative indicators in the above table are converted in to positive ones by taking reciprocal method and then non-dimensionalized.

4.2.2 Non-dimensionalization of indicator value

Since the dimension of indicator values is different, the value range is greatly different accordingly. When the value is processed, if the value magnitude of the indicators is greatly different, directly taking the original indicator values for analysis is certain to strengthen the action of larger indicators and weaken the smaller indicators in the compressive analysis, making the indicators calculated and analyzed as per different weights. This may be inconsistent with the actual condition and lead to large deviation of results. To avoid this problem, for comprehensive analysis of indicator values with different dimensions, it is usually necessary to make the values non-dimensionalized first. Non-dimensionalization, also called standardization and normalization of data, is a method to eliminate effect of dimensions of indicators via simple mathematical manipulation.

There are many non-dimensionalization methods, to sum up, including linear

non-dimensionalization method, fold-line non-dimensionalization method, and curve non-dimensionalization method. Some domestic scholars put forward many methods and principles for how to choose non-dimensionalization method: (1) one shall determine the appropriate non-dimensionalization method based on the characteristics of the objective things and the selected statistical analysis method; (2) try to follow the principle of simplicity, i.e. if simple non-dimensionalization method is available, do not use complex one. For example, if linear non-dimensionalization method can be used, do not use fold-line or curve formula; (3) each non-dimensionalization method has its own characteristics. Therefore, the non-dimensionalization formula shall be selected based on the characteristics of the indicators and those of the conversion methods. Only in this way can possibility and feasibility be guaranteed.

Process the indicator values by following the above principles, combining with the characteristics of the indicator values and selecting one of the extremum methods in the linear non-dimensionalization methods.

The formula of extremum method is $Z=Y/Y_{max}*100$.

Where, Z refers to the converted indicator value;

Y refers to the unconverted indicator value;

Y_{max} refers to the maximum of the indicator values;

After the above non-dimensionalization, the range of converted indicator values is $0 \leq Z \leq 100$. The closer to 100 the Z is, the better the result will be.

4.2.3 Determination of indicator weight

The weights on indicators and those at the criterion level are determined by analytic hierarchy process (AHP) and expert consultation method. The specific steps and methods are as follows:

(1) Establishment of indicator system

This step has been completed in the indicator establishment phase. Refer to Table 4.1 for the established indicator system consisting of target level, criterion level and indicator level. The target level includes the EPA objectives. The criterion level includes drive factor, pressure factor, state factor, impact factor and response factor. And each criterion level includes various indicators (32 in total).

(2) Construction of judgment matrix

Six judgment matrixes (Appendix 1: Table 3- Table 8) are constructed based on the levels of the indicators: judgment matrix for importance comparison between two indicators in the 5 indicators at criterion level, 3 indicators of drive factor, 7 indicators of pressure factor, 6 indicators of state factor, 7 indicators of impact factor and 9 indicators of response factor.

(3) Invitation of experts for filling the judgment matrixes

In the research, 8 experts from Xishuangbanna Bureau of Environmental Protection, Nabanhe National Nature Reserve Management Bureau, Xishuangbanna Environmental Monitoring Station, Xishuangbanna Institute of Environmental Science, and Xishuangbanna Environmental Monitoring Detachment are invited to give scores for the six judgment matrixes. Before that, the research group has introduced definitions of indicators, rating methods and

standards in detail for the experts. Refer to the following Table 4.3 for the rating standards.

Table 4.3 Rating Standards and Definition of Scores

Score (1-9)	Definition
1	Indicator i and Indicator j are equally important.
3	Indicator i is a little more important than Indicator j. Contrarily, it is reciprocal, 1/3
5	Indicator i is relatively more important than Indicator j. Contrarily, it is reciprocal, 1/5
7	Indicator i is obviously more important than Indicator j. Contrarily, it is reciprocal, 1/7
9	Indicator i is absolutely more important than Indicator j. Contrarily, it is reciprocal, 1/9
2,4,6,8	Mid-value of two adjacent judgments and importance comparison value of Indicator i and Indicator j are between two adjacent ranks. Contrarily, they are reciprocal, 1/2, 1/4, 1/6, and 1/8
Meaning of reciprocal	If the judging result between i and j is a, then that between j and i is 1/a

Note: i represents indicators in columns of the judgment matrix, and j represents those in rows of the judgment matrix.

Moreover, the experts, while filling the judgment matrix, shall abide by the following requirements:

- Only fill the part below the diagonal in the judgment matrix. The values of the upper part can be obtained by taking reciprocals;
- Carry out simple ranking for the indicators in the matrix before grading and compare important degree of indicators to avoid failing to pass the consistency check.

The 8 experts, who are experience experts in Xishuangbanna and have many years of work experience on ecological environmental protection of Xishuangbanna and rich specialized knowledge, compare and grade the six matrixes based on the grading standards in Table 4.3, their experience and the definitions of indicators.

(4) Single hierarchical arrangement and consistency check

Use AHP calculation software developed by Tianjin University to calculate the indicator weight for the result of each matrix based on the scores given by the 8 experts and use consistency indicator to check consistency of the results.

The principle and method of consistency check can be simply summarized as that: theoretically, if consistency condition is satisfied, the only calculated maximum characteristic value of the matrix (λ_{max}) shall be equal to the number of indicators (n). However, in reality, the judgment matrixes filled by the experts generally cannot completely meet the consistency condition. In this case, λ_{max} is greater than n. To check the consistency, the consistency indicator CI of the matrix is calculated. The definition of CI is as follows:

$$CI=(\lambda_{max} – n)/(n- 1)$$

If the consistency condition is satisfied completely, CI is equal to 0. The larger the λ_{max} is, the larger the CI value and the poorer the consistency will be. In statistics, CI is compared with average random consistency indicator RI and the

ratio is called consistency ratio of the judgment matrix and expressed as CR=CI/RI. In consistency check, if CR is less than 0.10, the consistency of the judgment matrix is considered to be satisfactory.

Conduct modeling of the indicator system in the AHP calculation software developed by Tianjin University and enter the grading results into the matrix (the same as the previously established matrix sent to the experts for grading) generated automatically by the software. Then the model will work out the results of each matrix automatically, including weights of indicators in the matrix and the results of the consistency check.

According the results calculated by the AHP software, if matrixes of the scores given by the 8 experts meet the consistency check, all are taken as valid results. As for the matrixes cannot pass the consistency check, the research group will fine tune the comparison results of the matrixes via arrangement of scores given by the experts until the matrixes pass the consistency check.

(5) Overall hierarchical arrangement and consistency check

The overall hierarchical arrangement is to calculate importance weights of all the elements at this hierarchy compared with the last hierarchy by using all the single hierarchical arrangement results at the same hierarchy. The overall hierarchical arrangement is required to be conducted by hierarchies from top to bottom. The overall hierarchical arrangement shall also be subject to consistency check. The method is the same as that for single hierarchical arrangement, namely calculate the values of CI, RI and CR. If CR is less than 0.10, the overall hierarchical arrangement passes the consistency check.

In case AHP calculation software is used for consistency check of overall hierarchical arrangement, the research group will fine tune the comparison between matrixes for the hierarchies failing to pass the consistency check until the overall hierarchical arrangement passes the consistency check.

(6) Determination of final weight

After the above calculation, we obtain the result of each indicator weight calculated by every involved expert. These results show that the judgment by different experts for the same matrix may either be similar or different greatly. Since the results are different, the research group thinks that the opinions of the experts should be integrated to obtain the final weight of each indicator.

The final weight of each indicator can be obtained by weighted average method, i.e. integrating the results of the experts by using the same weight. The research group thinks that every expert's grading is important because they all have rich specialized knowledge and experience in their own fields and their experience are equally important for understanding of the indicators. Table 4.4 lists the integrated weights of the indicators.

In the five indicators at criterion level, the impact factor and response factor are given high weights and the difference between the weights is small. It means that the impact factor and response factor are more important than drive factor, pressure factor and state factor for environment performance. The state factor is relatively important. The drive factor is equally important to the pressure factor and their weights are the minimum in the five indicators at criterion level.

In the 3 indicators of drive factor, the weight of agricultural fertilizer application

amount is the highest, followed by that of population and then that of total output value.

In the 7 indicators of pressure factor, the weight of Discharge of Industrial Wastewater is the highest and the weights of other indicators are not quite different.

In the 6 indicators of state factor, the weight of number of days with good air quality in Jinghong City is the highest, followed by that of average equivalent sound level of urban environmental noise in Jinghong. The weights of percentage of wild vertebrate species in the provincial species and percentage of wild higher plant species in the provincial species are equal and also the lowest in the 6 indicators.

In the 7 indicators of impact factor, the weight of percentage of public welfare forest area in forest area is the highest, followed by that of percentage of urban drinking water source meeting the requirements for centralized drinking water source. The weights of other four indicators are not quite different.

In the 9 indicators of response factor, the weight of environmental publicity and education is the highest, followed by that of industrial wastewater discharge qualification rate of key pollution sources. The weights of other 7 indicators are equal.

Table 4.4 Final Weights of Indicators

Target Level	Criterion Level	Weight	Indicator Level	Weight
"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture	**D (drive)**	**0.145**	Population (person)	**0.393**
			Total output value (RMB 10,000/present price)	**0.200**
			Agricultural fertilizer application amount (t)	**0.407**
	P (Pressure)	**0.142**	Discharge of domestic sewage in the whole prefecture (10,000t)	**0.108**
			Discharge of Industrial Wastewater (10,000t)	**0.251**
			Discharge of COD (10,000t)	**0.142**
			Discharge of ammoniacal nitrogen (10,000t)	**0.124**
			Discharge of industrial exhaust gas (10,000 nm^3)	**0.114**
			Discharge of sulfur dioxide (t)	**0.152**
			Discharge of flue dust and industrial dust (t)	**0.109**
	S (State)	**0.197**	Number of days with good air quality in Jinghong City (indicators NO_X, SO_2 and PM_{10}) (day)	**0.262**
			Average equivalent sound level of urban environmental noise in Jinghong (dB(A))	**0.201**
			Average equivalent sound level of urban road traffic noise in Jinghong (dB(A))	**0.139**
			Comprehensive water quality classification of Lancang River and its seven main tributaries (Nanguo River, Liusha River, Buyuan River, Nanla River, Nanlan River, Nan'a River and Dakai River)	**0.197**
			Percentage of wild vertebrate species in the nationwide species (%)	**0.110**
			Percentage of wild higher plant species in the nationwide species (%)	**0.092**
	I (Impact)	**0.272**	Acid rain frequency and intensity in Jinghong (%)	**0.124**

Target Level	Criterion Level	Weight	Indicator Level	Weight
			Percentage of urban drinking water source meeting the requirements for centralized drinking water source (%)	**0.172**
			Forest coverage rate (%)	**0.123**
			Percentage of public welfare forest area in forest area (%)	**0.229**
			Percentage of rubber plantation area in forest area (%)	**0.083**
			Percentage of nature reserve area in the prefecture's land area (%)	**0.143**
			Urban per capita public green area (m^2)	**0.127**
	R (Response)	**0.244**	Industrial wastewater discharge qualification rate of key pollution sources (%)	**0.133**
			Water qualification rate of the state/province-controlled sections in Lancang River system meeting the standards of water environmental functions (%)	**0.094**
			National-level ecological townships and towns (Nr.)	**0.096**
			Urban domestic sewage treatment rate (%)	**0.111**
			Urban garbage harmless disposal rate of county (city) (%)	**0.106**
			Comprehensive utilization rate of industrial solid waste (%)	**0.096**
			Construction of environmental law enforcement system	**0.094**
			Monitoring network construction	**0.072**
			Environmental publicity and education	**0.198**

4.2.4 Analysis of EPI and its variation trend

(1) Comprehensive EPI of objectives of "11th Five-Year Plan"

The *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* sets out target values of the indicators till the end of the "11th Five-Year Plan". The EPA indicator system is established on the basis of the planned indicator system. For the indicators in the EPA indicator system that are the same as those in the planned indicator system, target values of 2010 put forward in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* are adopted as the planned target values; For the target values of added indicators in the EPA indicator system, two methods are adopted in the principle of data availability of indicators. The first is to refer to other related supplementary during the "11th Five-Year Plan" in Xishuangbanna Prefecture. The target values of two indicators – population and total output value under the drive factor is the population and total output value of 2010 anticipated as per the annual natural population growth rate (6‰) and annual growth rate of total output value (10%) put forward in *Outline of the 11th Five-Year Plan for National Economic and Social Development in Xishuangbanna Prefecture*; the agricultural fertilizer application amount is that of 2010 calculated by taking 2005 as the reference year at the annual decline rate of 10% in accordance with the policy requirements for increasing soil fertilizer application scope and amount put forward in the agricultural development plan of Xishuangbanna Prefecture. The second is to take the actual values of 2010 directly as the target values in case of unavailability of relevant target data.

The EPI of expected target of the "11th Five-Year Plan" is calculated as per the same data processing method and weight as the target value of the EPA. After

calculation, the target value of comprehensive EPI of expected target of the "11th Five-Year Plan" in Xishuangbanna Prefecture is 92.36.

(2) EPIs from 2005 to 2010

The comprehensive EPIs in Xishuangbanna Prefecture from 2005 to 2010 are calculated by multiplying the 2005-2010 indicator values subject to positive conversion and non-dimensionalization of indicators by relevant weight coefficients. See Table 4.5. The results show that EPIs of Xishuangbanna Prefecture from 2005 to the end of 2010 are lower than the target values and the comprehensive EPI of 2010 is 88.11, not reaching the target EPI (92.36) of 2010.

Table 4.5 Comprehensive EPIs of Xishuangbanna Prefecture from 2005 to 2010

Year	2005	2006	2007	2008	2009	2010	**Target value of 2010**
EPI	**89.37**	**89.57**	**85.42**	**86.68**	**87.56**	**88.11**	**92.36**

(3) Analysis of trend and influencing factors of the EPI during the "11th Five-Year"

1) Comparative analysis of the EPI and target value in 2010

During the "11th Five-Year", the EPI of Xishuangbanna Prefecture showed a trend of fluctuation: a slight increase from 2005 to 2006, a decrease in 2007, a little bit increase from 2008 to 2010, but not reaching the target value proposed in the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* in 2010. See Fig. 4.1 for details.

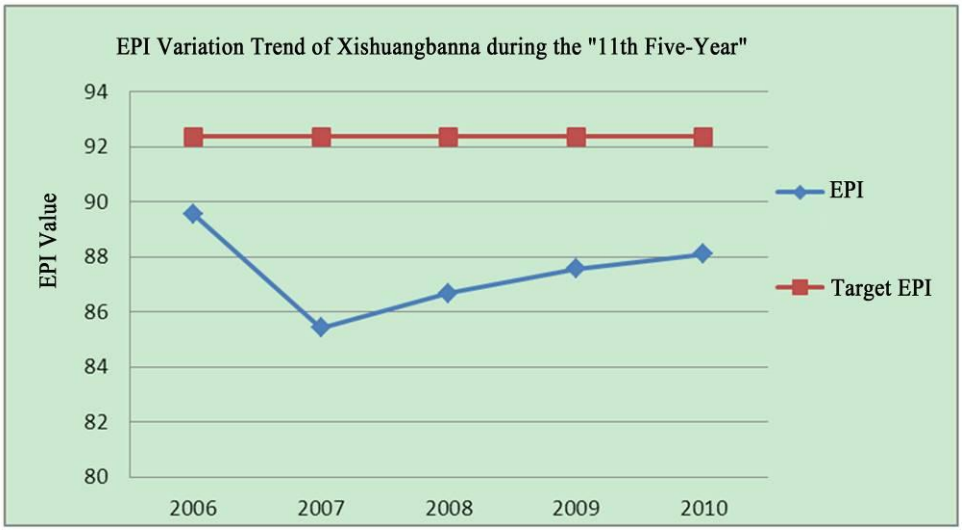

Fig. 4.1 EPI Variation Trend of Xishuangbanna during the "11th Five-Year"

By comparing the target EPI and the actual value in 2010, the EPI value did not reach the target value mainly because of "drive", as well as some state and response indicators. For example, the number of days with good air quality in Jinghong City under "state" and the urban sewage treatment rate under "response" failed to reach the expected target values in 2010. In detail, 347 days with good air quality were expected in Jinghong City in 2010, while there were only 208 in fact. The actual urban sewage treatment rate in 2010 was only 37.05% which was far below the target value (65%). The increase rate of the three drive indicators, namely, total year-end population,

GDP and agricultural fertilizer application amount, was greater than the expected target proposed in the Plan. This shows that the population growth, rapid economic development and increase of agricultural fertilizer application amount brought significant negative impacts on the regional environment performance.

On the other, some indicators in 2010 exceeded the planned target values. For instance, the discharge amount of industrial wastewater, COD and sulfur dioxide, forest coverage rate, and other indicators reached or even exceeded the target values in 2010. The overall contribution of these indicators to increase of environment performance, however, cannot outweigh the negative impact brought by "drive". The EPI, therefore, did not reach the expected target in 2010.

2) Analysis of the impacts of the five criterion-level indicators on EPI and the variation trends during the "11th Five-Year"

According to the EPI radar chart of the 5 indicators of Xishuangbanna Prefecture (2005-2010) (Fig. 4.2), the 3 indicators ("impact", "response" and "state") made greater contribution to Xishuangbanna's comprehensive EPI. Among these three, "impact" made especially outstanding contribution; while the contribution made by the other two was similar and that by "response" slightly greater than that by "state". Of the five criterion-level indicators, "drive" and "pressure" made the minimum and roughly equivalent contribution to the environment performance. The main restriction factors for the not up-to-standard comprehensive EPI of Xishuangbanna were "drive" and "pressure".

As shown in the EPI variation trend of the 5 indicators of Xishuangbanna Prefecture (2005-2010) (Fig. 4.2), the trends of "drive" and "pressure" were similar and both declined gradually from 2005 to 2010. This shows that the two indicators brought continuous negative impacts on the comprehensive EPI; while in the period from 2005 to 2009, "state" and "response" changed relatively gently. In 2010, the two changed in a completely opposite manner: "response" increased significantly and "state" declined significantly. This indicates that more attention was paid to environmental protection in 2009 and the comprehensive EPI was affected. "State", however, changed in the opposite way in 2010. The trend of "impact" was similar to that of the comprehensive EPI, i.e. "impact" increased in 2006, declined in 2007 and slowly increased in 2008 and the values in 2008-2010 were higher than those of the previous three years.

3) Analysis of the impacts of indicator-level indicators on EPI and the variation trends

Discuss the interrelation between the indicators and the comprehensive EPI and analyze the reason why the indicators influence change of the comprehensive EPI, based on the change of each indicator.

The three drive indicators made smaller and smaller contribution to the comprehensive EPI year by year, as shown in Fig. 4.3. The total year-end population declined gently, GDP fell greatly and agricultural fertilizer application amount decreased significantly. The EPI of the three declining due to the increase of the three became a reason why the comprehensive EPI in 2010 (88.11) was lower than that in the base year (2005, 89.37).

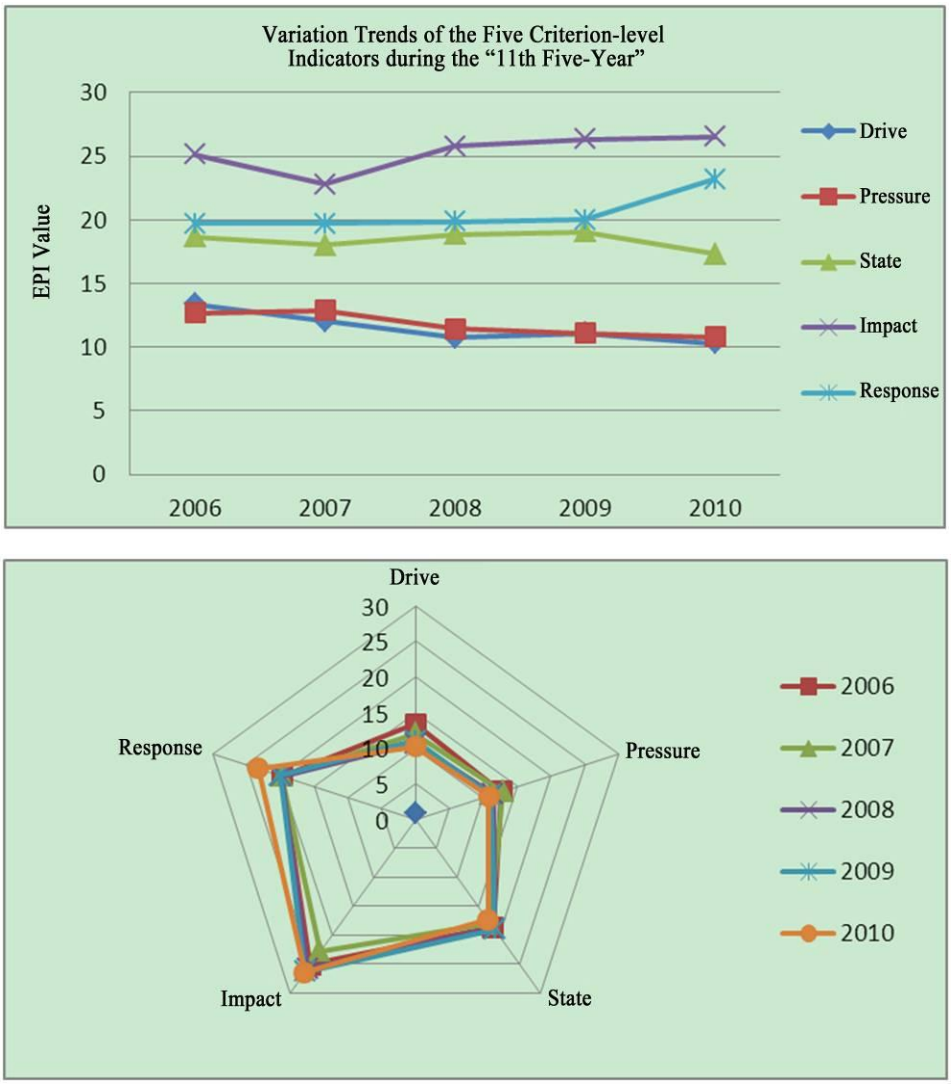

Fig. 4.2 Variation Trends of the Five Criterion-level Indicators during the "11th Five-Year"

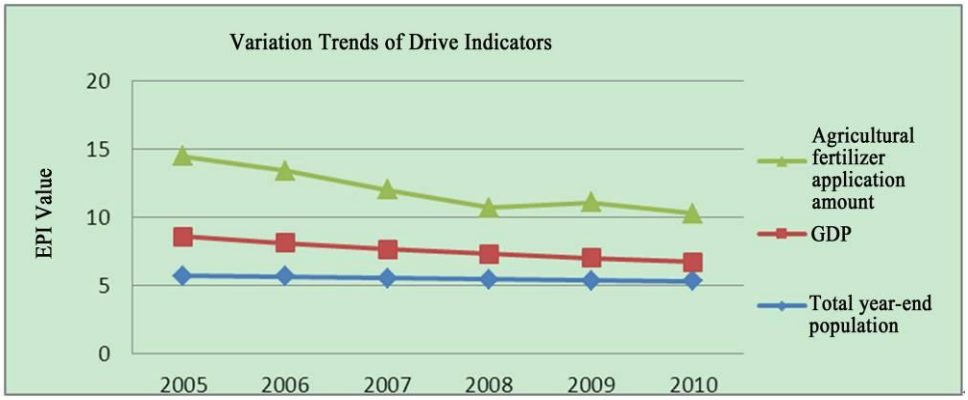

Fig. 4.3 Variation Trends of Drive Indicators

In general, the EPI of the seven drive indicators showed a downtrend, as shown in Fig. 4.4. The change of discharge of flue dust, sulfur dioxide, industrial exhaust gas and ammoniacal nitrogen appeared to be relatively consistent, increasing in 2007 (the discharge declined) and continuously declining then (the discharge increased continuously). The discharge of COD, industrial wastewater and domestic sewage in the whole prefecture

showed a trend of continuous declining (the discharge increased continuously). According to the EPI variation trends of pressure indicators, under the influence of "drive", the economy developed and the population grew. These have greatly contributed to continuous increase of discharge of various pollutants and thus brought greater and greater pressure to the environment and led to continuous drop of the EPI. The environment performance values of the 7 pressure indicators in 2010 were lower than the corresponding values in the base year (2005). "Pressure" has become another factor resulting in low comprehensive EPI in 2010. As per the downtrend of each pressure indicator, Xishuangbanna Prefecture has not realized the sustainable development pattern where the output increases and the pollution is minimized during the "11th Five-Year Plan" period. Besides, the overall pollution control capacity and technical level of the prefecture were very limited. The pollution control capacity and level, therefore, should be strengthened in the next stage.

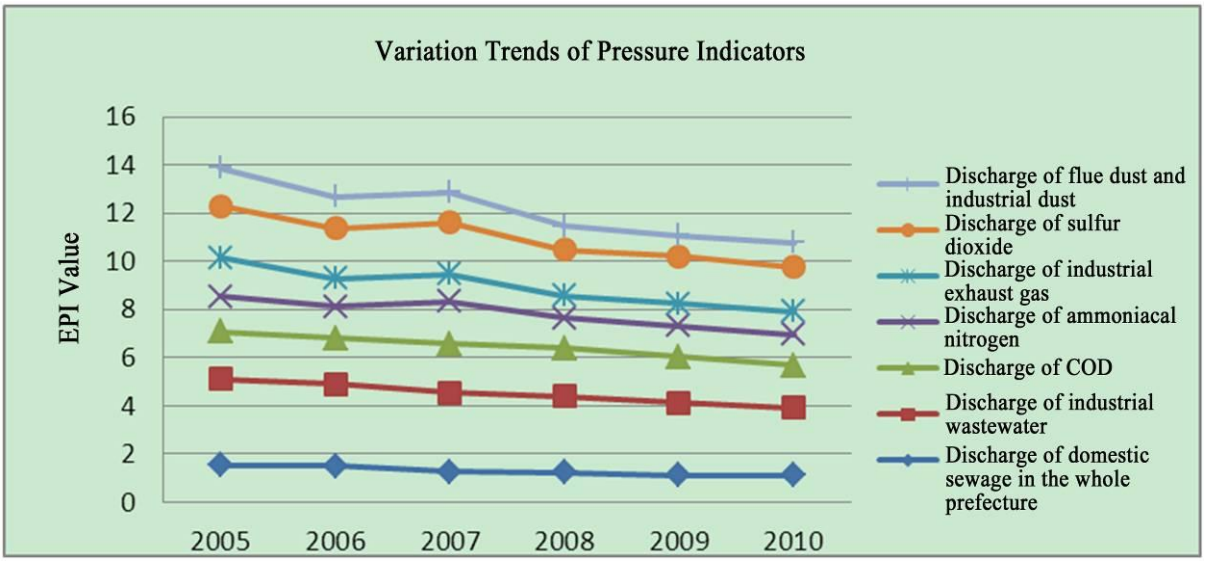

Fig. 4.4 Variation Trends of Pressure Indicators

The EPIs of the 6 state indicators showed different trends, as shown in Fig. 4.5. The two indicators including the percentage of wild vertebrate species in the nationwide species and the percentage of wild higher plant species in the nationwide species remained unchanged during the "11th Five-Year" and, thus, the corresponding EPIs remained unchanged; the number of days with good air quality in Jinghong City declined gradually and reached the minimum value in 2010 and, thus, the corresponding EPI declined significantly; the average equivalent sound level of urban environmental noises in Jinghong and the average equivalent sound level of urban road traffic noise in Jinghong changed very little and the corresponding EPIs showed fluctuating rising trends; the comprehensive water quality of the main rivers declined in 2007 because Liusha River, Nanguo River and Nanlan River failed to meet the water function requirements in 2007. The satisfaction of the requirements in 2006 and after 2008 contributed to dramatic decline of the EPI in 2007 and became a significant reason for decline of the comprehensive EPI in 2007.

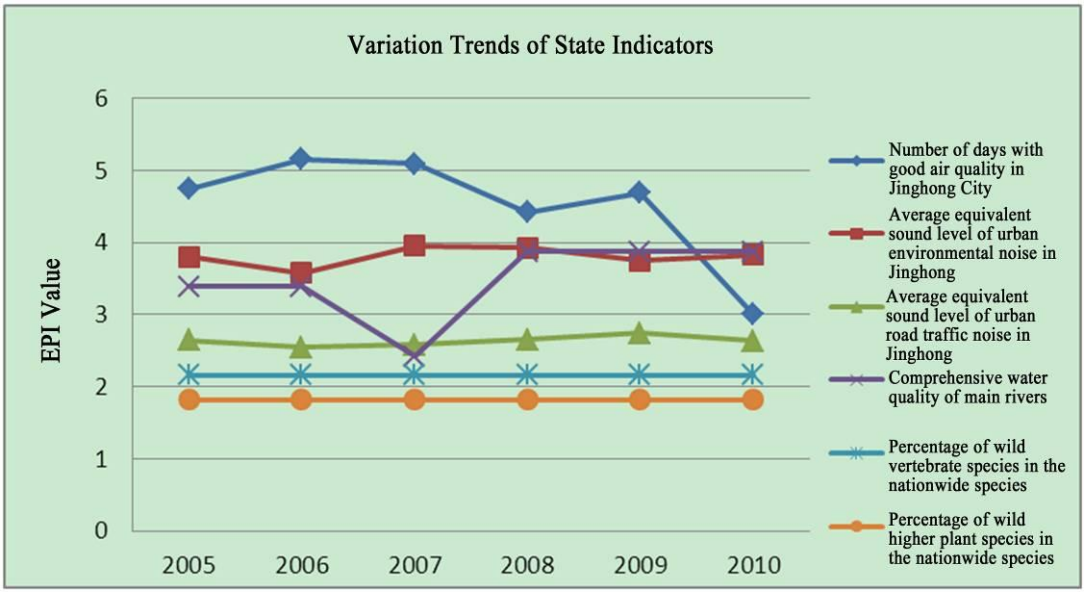

Fig. 4.5 Variation Trends of State Indicators

The EPIs of impact indicators also showed different trends, as shown in Fig. 4.6. The acid rain frequency and intensity in Jinghong experienced the greatest change: the acid rain frequency and intensity reduced obviously from 2005 to 2006, increased significantly in 2007, reduced in 2008 and then became steady. The corresponding EPI improved significantly in 2006, dropped dramatically in 2007, increased in 2008 and then became steady. This trend is the most similar to that of the comprehensive EPI, indicating that this indicator was one of the key factors for change of the comprehensive EPI. The occurrence of acid rain is closely related to sulfur dioxide in the air, weather conditions and other factors. Multiple uncertain factors led to the significant change of acid rain frequency and intensity in Jinghong. No acid rain was detected in Xishuangbanna for the three consecutive years from 2008 to 2010. It indicates that the acid rain frequency dropped in Xishuangbanna. The percentage of urban drinking water source meeting the requirements for centralized drinking water source, forest coverage rate and percentage of public welfare forest area in forest area changed very little during the "11th Five-Year", and the EPIs of the three changed little as well. The percentage of nature reserve area in the prefecture's land area and the urban per capita public green area showed rising trends after 2007. Accordingly, the EPIs of the two appeared to rise. Due to the increasing expansion of rubber plantation area during the "11th Five-Year", the percentage of rubber plantation area in forest area increased and the EPI decreased gradually. This was an influencing factor causing the comprehensive EPI not reaching the level of the base year.

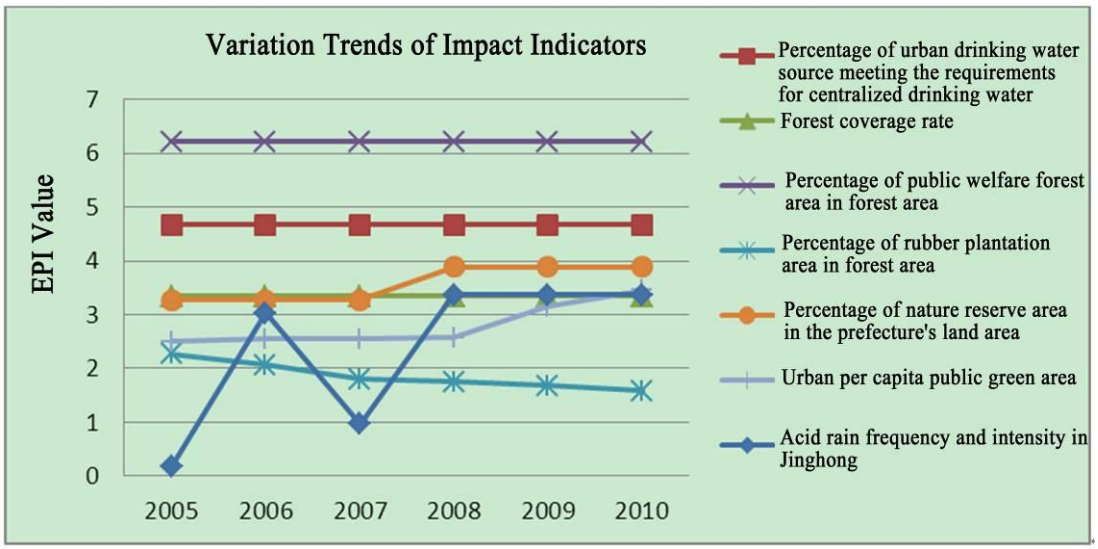

Fig. 4.6 Variation Trends of Impact Indicators

The EPIs of response indicators changed in a diversified manner, as shown in Fig. 4.7. The construction of environmental law enforcement system and the monitoring network construction changed little with slight increase, indicating that the environmental supervision capacity and the environmental monitoring capacity of Xishuangbanna improved a lot, but failed to meet requirements of relevant national regulations. The industrial wastewater discharge qualification rate of key pollution sources increased slightly year by year. The water qualification rate meeting the standards of water environmental functions reduced first and then increased. The urban domestic sewage treatment rate and the comprehensive utilization rate of industrial solid waste reduced increasingly and this reflects the fact that the regional pollution prevention and control capacity needed improvement. Operation of sewage treatment plants, pressure brought by the growing urban population and failure of sewage treatment facilities to improve the treatment capacity led to the increasing reduction of sewage treatment rate. As to the construction of national-level ecological townships and towns, 1 township (town) was awarded the title in 2010; while there were no national-level ecological townships or towns from 2005 to 2009. The corresponding EPI, therefore, leaped from 0 to 2.35 in 2010. The EPI of the environmental publicity and education showed a rising trend year by year due to diversified environmental publicity methods and wider coverage.

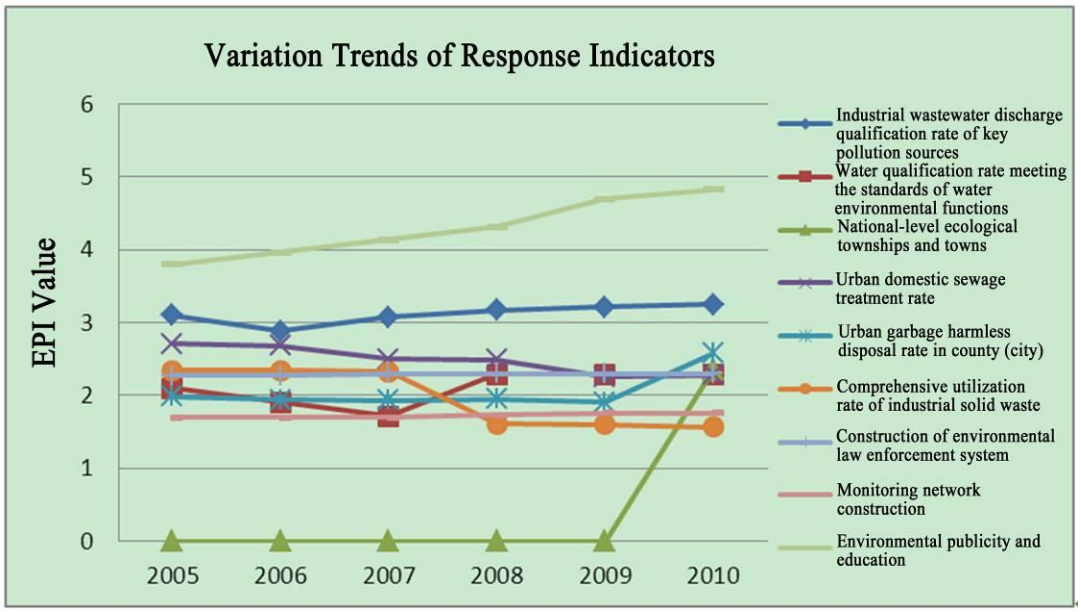

Fig. 4.7 Variation Trends of Response Indicators

To sum up, the comprehensive EPI of Xishuangbanna Prefecture during the "11th Five-Year" exhibited a fluctuating change: dramatically dropping in 2007 and gradually increasing year by year from 2008 to 2010. The comprehensive EPI in 2010 was smaller than the target EPI value and the comprehensive EPI at the end of 2010 was lower than that of the base year (2005). Variation trend of the comprehensive EPI in Xishuangbanna Prefecture was mainly influenced from the following aspects:

(1) The increasing increase of the drive indicators (total year-end population, GDP and agricultural fertilizer application amount) contributed to drop of the comprehensive EPI;

(2) The continuous increase of the seven pressure indicators regarding discharge (discharge of flue dust, sulfur dioxide, industrial exhaust gas, ammoniacal nitrogen, COD, industrial wastewater and domestic sewage in the whole prefecture) contributed to drop of the comprehensive EPI;

(3) The change of the acid rain frequency and intensity in Jinghong and the comprehensive water quality of main rivers has affected the trend of EPI. The comprehensive EPI of Xishuangbanna Prefecture in 2007 dropped dramatically because the comprehensive water quality of main rivers in the prefecture failed to meet relevant standard and the acid rain frequency and intensity in Jinghong was intensified in the year;

(4) The increasing expansion of rubber plantation area contributed to drop of the comprehensive EPI;

(5) The continuous drop of the urban domestic sewage treatment rate and the comprehensive utilization rate of industrial solid waste contributed to drop of the comprehensive EPI of Xishuangbanna;

(6) The nature reserve area in the prefecture, the urban per capita public green area, the water qualification rate meeting the standards of water environmental functions and the industrial wastewater discharge qualification rate of key pollution sources increased after 2007. A rising trend was shown between 2008 and 2010 for the comprehensive EPI of

the prefecture, along with diversified promotion of environmental publicity. The expected target value, however, was not reached in 2010 due to influence of "drive" and "pressure".

5 Promotion of Institutionalized EPA in Xishuangbanna

5.1 Improvement of local EPA capacity construction

The research group held a workshop on EPA for the development of ecological construction and environmental protection in Xishuangbanna Prefecture during the "11th Five-Year" at Xishuangbanna Bureau of Environmental Protection on October 11, 2014. Experts from Xishuangbanna Bureau of Environmental Protection, Management Bureau of Nabanhe River Basin National Conservation Area, Xishuangbanna Environmental Monitor Station, Xishuangbanna Institute of Environmental Science and Xishuangbanna Environmental Monitoring Detachment were invited to attend the workshop.

The research group introduced the project background first, including the research achievements and methods of the EPAs carried out in Yunnan (respectively in 2006 and 2012), for Greater Mekong Subregion Strategic Environment Framework (SEF) Phase II and III projects respectively, and the purpose of the prefecture-level popularizing demonstration regarding EPA implemented by Asian Development Bank. The group then detailed the "drive – pressure – state – impact – response" (DPSIR) model adopted in this EPA, and, from the perspective of system, the framework of the model and interaction of the 5 factors, so as to let the experts understand and master DPSIR assessment principles and methods. The group also discussed and analyzed with the experts the rationality and reachability of assessment indicators proposed in the Plan and selected the EPA indicator system for the development of ecological construction and environmental protection in Xishuangbanna Prefecture during the "11th Five-Year Plan" period based on the above-mentioned indicators by taking into account the framework of DPSIR model. Finally, the research group introduced analytic hierarchy process (AHP), a comprehensive indicator analysis method, and invited the experts to score the criterion level and indicator level for EPA based on their working experience.

Fig. 5.1 Experts Are Scoring Assessment Indicators by Using AHP

(2014-10-11, the meeting room on the second floor of Xishuangbanna Bureau of Environmental Protection)

Concerned environmental protection departments of Xishuangbanna, through the

workshop, have gained a better understanding of the background and purpose of EPAs carried out in the prefecture. Local environmental protection experts have known better the EPA theories and methods through a series of activities including indicator selection, indicator scoring by using AHP, etc. Construction of local EPA capacity has been improved as a result.

5.2 EPA Guidebook

In order to further improve the EPA capacity of Xishuangbanna, the research group, on the basis of the guideline for ecological Xishuangbanna Prefecture construction during the "12th Five-Year Plan" period, namely the *Construction Planning for Ecological Xishuangbanna Prefecture*, prepared the *Guidebook for Environment Performance Assessment of Ecological Xishuangbanna Prefecture Construction in the "12th Five-Year Plan"* to guide the implementation of EPAs of ecological Xishuangbanna Prefecture construction by Xishuangbanna Bureau of Environmental Protection during 2011-2015.

In the *Guidebook for Environment Performance Assessment of Ecological Xishuangbanna Prefecture Construction during the "12th Five-Year Plan" Period*, an EPA indicator system was established based on the indicator system in the *Construction Planning for Ecological Xishuangbanna Prefecture*. The research group adopted AHP to calculate the weight on indicators at each target level according to scores graded by the experts, so as to comprehensively assess the environment performance (2011-2013). The guiding principle for preparation of the guidebook is to introduce EPA process and analytical methods with the simplest words. The EPI guidebook is composed of two parts: textual description (see Appendix 2), including introduction to assessment principles (indicator selection, determination of weight on indicators, data standardization, comprehensive indicator analysis, etc.) and instructions for use of the EPA guidebook; Excel sheets (see Appendix 3), including corresponding calculation methods and results.

In March 2015, the research group will carry out a training session in Xishuangbanna themed as the "Training on EPA of Ecological Xishuangbanna Prefecture Construction during the "12th Five-Year"". Relevant technical personnel from Xishuangbanna Bureau of Environmental Protection will be invited to attend the training and the assessment process and analytical methods adopted in the "EPA of Ecological Xishuangbanna Prefecture Construction during the "12th Five-Year"" will be explained in detail in the training session, with practical operation of the Excel sheets, so as to guarantee that all participants can understand the EPA principles for ecological Xishuangbanna Prefecture construction during the "12th Five-Year " and be familiar with the operating steps and analytical methods.

5.3 Discussion on institutionalized EPA in Xishuangbanna

According to investigation of the research group, main sources of the EPI indicator data in the prefecture are the *Annual Report on the State of the Environment in Xishuangbanna* and the *Annual Statement of Xishuangbanna Environmental Statistics*. The former is released by Xishuangbanna Bureau of Environmental Protection to the public every year and can be accessed at the website of Xishuangbanna Bureau of Environmental Protection (http://xxgk.yn.gov.cn/Z_M_014/?departmentid=9278) and other websites such as the website of Xishuangbanna Daily (http://bndaily.com/gqgg/zfgg/107643.shtml).

The *Annual Report on the State of the Environment in Xishuangbanna*, currently, includes 11 parts: overview, surface water environment quality, urban water

environment quality, urban air environment quality, urban sound environment quality, solid waste, natural ecological environmental protection, ecological construction & rural ecological environmental protection, environment management, environmental supervision, and environmental monitoring. It is suggested to add another part – "environment performance assessment" on the above basis to assess ecological Xishuangbanna Prefecture construction.

In the "environment performance assessment" column, the comprehensive index can be used to assess ecological Xishuangbanna Prefecture construction and be compared with the comprehensive index of the previous year to assess relevant construction achievements obtained in that year. Charts can be inserted for illustration of "drive" and "pressure" encountered during the construction, "state" and "impact" of the construction and "response" taken during the construction in order to systematically analyze the achievements and problems of ecological Xishuangbanna Prefecture construction.

6 Conclusions & Suggestions

6.1 Conclusions

6.1.1 Up-to-standard analysis of indicators in the "11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture

The results obtained in the up-to-standard analysis of main indicators in the "11th Five-Year Plan" for environment in Xishuangbanna show that except the four analyzed indicators (key cities where the environmental noise of urban area is not greater than 55dB(A), key counties (cities) where the urban traffic noise is not greater than 70dB(A), comprehensive excrement utilization rate in large-scale livestock farm (centralized breeding area) and percentage of nature reserve management institutions above the provincial level meeting the standard construction requirements) due to the lack of statistical data, 16 of the remaining 25 indicators reached the planning target in 2010 and the other 9 failed to reach the planning target with an up-to-standard rate of 64%.

Of urban environment quality indicators, water environment quality and air environment quality failed to reach the planning target, sound environment was unassessed, and solid waste (household garbage) treatment reached the planning target. Among the water environment quality indicators, 2 (percentage of urban drinking water source meeting the requirements for centralized drinking water source and water qualification rate of the state/province-controlled sections in Lancang River system meeting the standards of water environmental functions) reached the planning target and 2 (discharge of domestic sewage in Xishuangbanna and treatment rate of urban domestic sewage treatment rate) failed; among the air environment quality indicators, 1 succeeded and 1 failed. In specific, the acid rain frequency and intensity reached the planning target in 2010 and the number of days with good air quality in Jinghong City failed to reach the planning target in 2010; as to the solid waste indicator, the urban garbage harmless disposal rate in Jinghong reached the planning target in 2010.

Of pollution control indicators, wastewater discharge reached the planning target, while exhaust gas discharge and solid waste disposal and utilization rate failed. As to wastewater discharge, all the 4 indicators (discharge of industrial wastewater, COD discharge, discharge of ammoniacal nitrogen and industrial wastewater discharge qualification rate of key pollution sources) reached the planning target in 2010; among exhaust gas indicators, 2 succeeded while 2 failed. In specific, the discharge of sulfur dioxide and fuse dust reached the planning target in 2010, while the discharge of industrial exhaust gas and dust failed; as to solid waste, safe disposal rate of medical waste reached the planning target in 2010, while the comprehensive utilization rate of industrial solid waste failed. The comprehensive excrement utilization rate in large-scale livestock farm (centralized breeding area) was unassessed.

Of ecological construction indicators, the forest coverage rate and the urban per capital public green area reached the planning target in 2010; while the national townships and towns of beautiful environment (national-level ecological townships and towns) failed. The percentage of nature reserve management institutions above the provincial level meeting the standard construction requirements was unassessed.

Of environment management capacity indicators, the construction of environmental law enforcement system and the monitoring network construction failed to reach the

planning target in 2010; while the radiation environment safety monitoring and the environmental publicity and education succeeded in the year.

The water quality indicator of Lancang River and its 7 main tributaries reached the planning target in 2010.

6.1.2 Conclusions of the EPA for the "11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture

According to the assessment results via the "DPSIR" EPA indicator system consisting of the 32 selected indicators, in 2010, the comprehensive EPI in the prefecture (88.11) was lower than that specified in the Plan (92.36). The assessment results were consistent with the results obtained in the up-to-standard analysis of indicators in the Plan (up-to-standard rate: 64%). From such 5 aspects as "drive – pressure – state – impact - response", under the influence "drive" and along with population growth, rapid economic development and increase of agricultural fertilizer application amount, "pressure" (discharge of fuse dust, industrial exhaust gas, ammoniacal nitrogen and domestic sewage in the whole prefecture) of the prefecture increased, "state" (number of days with good air quality) quality dropped, "impact" (percentage of rubber plantation area in forest area) brought more significant negative impacts; as restricted by technical conditions and other factors, the coping level of "response" (urban domestic sewage treatment rate and comprehensive utilization rate of industrial solid waste) was very low. All these indicate that the comprehensive EPI in 2010 was lower than the planned value.

As shown by 2005-2010 EPA comprehensive index variation trend of Xishuangbanna Prefecture, the comprehensive index in 2006 showed a trend of steady and slow rising; that in 2007 showed a trend of salutatory descending; that in 2008-2010 showed a trend of gradual increasing; and that in 2010 still failed to rise to the level in 2006. According to the variation trend from the above said 5 aspects, in 2005-2010, "drive" and "pressure" showed continuous downtrends, "state" and "impact" changed in a fluctuated manner (fluctuating rising for "impact" and fluctuating drop for "state"), and "response" showed a rising trend. This shows that the prefecture, driven by social economic benefits, faced greater environmental pressure and the state of environment became worse in a fluctuated manner. To cope with these conditions, the prefecture had taken responses, leading to the fluctuating improvement trend of environmental impacts.

EPA comprehensive index of Xishuangbanna Prefecture was mainly affected by "impact", "response" and "state". Both "drive" and "pressure" belong to the restriction factor.

According to the analysis of the change of EPA comprehensive index in Xishuangbanna at the criterion level, the 3 drive indicators and the 7 pressure indicators showed continuous decreasing trends. This indicates that the growth of total year-end population, GDP and agricultural fertilizer application amount contributed to decrease of the EPA comprehensive index; the continuous increase of discharge of fuse dust, sulfur dioxide, industrial exhaust gas, ammoniacal nitrogen, COD, industrial wastewater and domestic sewage in the whole prefecture contributed to drop of the comprehensive environment performance indicator. The fluctuating change of "state" was mainly affected by the fluctuating change of comprehensive water quality classification of Lancang River and its main tributaries and the decrease of number of days with good air quality in Jinghong City contributed to drop of the comprehensive EPI. The fluctuating change of "impact" was mainly

affected by the fluctuating change of acid rain frequency and intensity in Jinghong and the continuous expansion of rubber plantation area contributed to drop of the comprehensive EPI. As to "response", the continuous drop of the urban domestic sewage treatment rate and the comprehensive utilization rate of industrial solid waste contributed to drop of the comprehensive EPI of the prefecture.

The drop of comprehensive EPI in 2007 was mainly because the comprehensive water quality of the main tributaries of Lancang River (under "state") was degraded to IV, the acid rain frequency and intensity in Jinghong (under "impact") was intensified, and the water qualification rate of the state/province-controlled sections in Lancang River system meeting the standards of water environmental functions (under "response") was low.

The nature reserve area in the prefecture, the urban per capita public green area, the water qualification rate meeting the standards of water environmental functions and the industrial wastewater discharge qualification rate of key pollution sources increased after 2007. A rising trend was shown between 2008 and 2010 for the comprehensive EPI of the prefecture, along with diversified promotion of environmental publicity. The expected target value, however, was not reached in 2010 due to influence of "drive" and "pressure".

6.2 Suggestions

Several suggestions are made as below in terms of “Drive – Pressure – State – Impact – Response” based on the EPA results of Xishuangbanna's ecological construction and environmental protection in the “11th Five-Year”:

(1) In terms of “drive”, it is suggested that Xishuangbanna Prefecture explore low-carbon and circular economy and develop organic agriculture.

The environment performance assessment on Xishuangbanna's ecological construction and environmental protection in the “11th Five-Year” reflects the conflict between its economic development and environmental protection: there is huge environmental pressure arising from economic development. To relieve the environmental pressure while keeping economic development, it is suggested that Xishuangbanna Prefecture explore and promote low-carbon and circular economy and develop organic agriculture

(2) In terms of “pressure”, it is suggested that Xishuangbanna Prefecture popularize “cleaner production” and technical innovation to reduce the discharge of pollution load and mitigate the environmental pressure.

In the “11th Five-Year”, the discharge of industrial wastewater, COD and ammoniacal nitrogen is all within the planning target in 2010, but showed an arising trend from 2005 to 2010, thus bringing about great pressure on the environmental capacity of Xishuangbanna Prefecture. As a result, the discharge of industrial exhaust gas, flue dust and industrial dust failed to reach the planning target. It is suggested that Xishuangbanna Prefecture popularize “cleaner production” and technical innovation to reduce the discharge of pollution load and mitigate the pressure environmental capacity.

(3) In terms of “state”, it is suggested that Xishuangbanna Prefecture further strengthen the environmental quality monitoring, specifically including:

1) To expand the monitoring range of sound environment and atmospheric quality in Xishuangbanna Prefecture

During the "11th Five-Year" of Xishuangbanna Prefecture, the environmental noise and air environment quality monitoring was carried out only in Jinghong City. In the "12th Five-Year", Menghai and Mengla county towns were added. To further assess the sound and atmospheric environment of Xishuangbanna Prefecture, it is suggested Xishuangbanna include key townships and towns (for example, Yunnan ecological townships and towns) into the monitoring network.

2) To reinforce the surface water quality monitoring of Lancang River and its main tributaries in Xishuangbanna Prefecture

At present, there are 12 monitoring sections of 8 rivers under surface water quality monitoring in Xishuangbanna. To further assess the surface water environment quality, it is suggested to reinforce the routine and dynamic monitoring of the surface water quality of Lancang River and its main tributaries, acquire the pollution source information in real time, carry out the researches on the agricultural area source migration and transformation rules and assess its impact of agricultural area source on the surface river water.

3) To reinforce the research on biodiversity of Xishuangbanna Prefecture

Xishuangbanna is characterized by abundant biodiversity, but it is short of data updating. It is suggested that Xishuangbanna Prefecture develop general investigation for the species and quantity of wild vertebrates and higher plants.

(4) In terms of "impact", it is suggested that the work as below should be done:

1) Further optimize Xishuangbanna's overall urban development planning and design and gradually increase the urban per capita public green area.

The urban per capita public green area of Xishuangbanna Prefecture failed to reach the planning target in 2006 to 2009, but basically kept above $13m^2$ after 2010. It indicates that the percentage of the urban per capita public green area has gradually been taken consideration into the overall planning design of urban development. It is suggested that Xishuangbanna Prefecture further optimize its overall urban development planning and design and gradually increase the urban per capita public green area.

2) Intensify the management of multilevel nature reserves in Xishuangbanna Prefecture and further strengthen the role of the nature reserves in environmental protection.

Xishuangbanna possesses comparatively perfect multilevel nature reserves: national, prefectural, city and county levels. Nature reserves play a vital role in the environmental protection of Xishuangbanna Prefecture. It is suggested that Xishuangbanna Prefecture further reinforce the management capacity building of multilevel nature reserves and enhance and give play to the role of nature reserves in biodiversity protection, ecological environment protection and ecological tourism.

3) Further consolidate the protection and monitoring of drinking water sources

The protection of drinking water resources concerns the drinking water safety of urban and rural residents in Xishuangbanna Prefecture. The percentage of urban drinking water source meeting the requirements for centralized drinking water source, 100% for Xishuangbanna Prefecture at present, is assessed in the "11th Five-Year " for ecological construction and

environmental protection planning in Xishuangbanna Prefecture. It is suggested that Xishuangbanna Prefecture further consolidate the protection and monitoring of urban water sources, in addition, develop the protection and monitoring of rural drinking water sources to ensure the drinking water safety of rural residents.

4) Reinforce the research and popularization on the construction of environmentally friendly ecological rubber plantation

The on-going expansion of rubber plantation area has brought in a series of ecological environment problems, such as biodiversity loss, plant diseases and insect pests, landscape fragmentation and water loss and soil erosion. In view of this, Yunnan Province developed the construction of environmentally friendly ecological rubber plantations in 2014. It is suggested that Xishuangbanna Prefecture further reinforce the research on the construction of environmentally friendly ecological rubber plantations, popularize the research achievements of ecological rubber plantation construction and embody the ecological, economic and social values thereof.

(5) In terms of "response", it is suggested that such works as below should be done:

1) Promote the construction of national-level ecological townships and towns.

The construction of national-level ecological townships and towns in Xishuangbanna failed to reach the planning goal in 2010, influencing the environmental performance assessment on ecological construction and environmental protection planning in 2010. Since 2011, Xishuangbanna has established a large batch of prefecture-level ecological villages and laid the foundation for establishing national-level ecological townships and towns. It is suggested that Xishuangbanna promote the construction of national-level ecological villages and towns.

2) Further improve the construction of environmental monitoring network and environmental law enforcement system.

Both the construction of environmental monitoring network and environmental law enforcement system of Xishuangbanna Prefecture failed to reach the national standards in 2010. To further enhance the environmental monitoring and law enforcement capacities, it is suggested that Xishuangbanna Prefecture further improve the construction of environmental monitoring network and environmental law enforcement system.

3) Further strengthen environmental publicity and education and regularly conduct a survey on satisfaction rate of the public towards the environment.

Xishuangbanna Bureau of Environmental Protection has made public the environmental quality and administrative information, established a series of green units and has the public generally improve their environmental awareness via various kinds of environmental publicity and education, but fails to regularly conduct a survey on satisfaction rate of the public towards the environment. It is suggested that Xishuangbanna Bureau of Environmental Protection further strengthen environmental publicity and

education and regularly conduct a survey on satisfaction rate of the public towards the environment with various methods, for example, online survey on the website of Xishuangbanna Bureau of Environmental Protection or commissioning social consulting agencies to do so.

4) **Gradually improve the municipal sewage treatment rate and urban garbage disposal rate in the urbanization process.**

   During the urbanization process of Xishuangbanna Prefecture, the infrastructure construction is comparatively backward. The urbanization construction shall be in synchronization with the infrastructure construction. It is suggested that Xishuangbanna Prefecture improve its management capacity, ensure the normal operation of environmental protection facilities, regularly train relevant employees and update and maintain the environmental protection facilities in time so as to ensure the gradual improvement of municipal sewage treatment rate and urban garbage disposal rate.

5) **Introduce advanced technologies and adopt incentive measures to encourage the enterprises to recycle and reuse the valuable waste.**

   The comprehensive utilization rate of industrial solid waste of Xishuangbanna Prefecture was only 66.72% in 2010 and increased to 96-99% from 2011 to 2013. It is suggested that Xishuangbanna Prefecture introduce advanced technologies and adopt incentive measures to encourage the enterprises to recycle and reuse the valuable waste.

7 Appendix

7.1 Appendix 1: Expert Consultation Tables

Expert Consultation of Environment Performance Assessment Indicator System for the "11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture

I. Environment performance assessment indicator system establishment of the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture*

32 indicators are selected to constitute the environment performance assessment indicator system for the "11th Five-Year Plan" for development of ecological construction and environmental protection in Xishuangbanna Prefecture based on the indicator system of the *"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* and in accordance with the DPSIR model concept and principles of policy relevance, representativeness and comprehensiveness, data availability and scientific practicability, as well as the advice on addition, deletion and alteration of the indicators proposed by the participating experts. See details in Table 1.

Table 1 Environment Performance Assessment Indicator System for the "11th Five-Year" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture

Target Level	Criterion Level	Indicator Level
"11th Five-Year Plan" for Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture	D (Drive)	Population (person)
		GDP (RMB 10,000/present price)
		Agricultural fertilizer application amount (t)
	P (Pressure)	Discharge of domestic sewage in the whole prefecture (10,000t)
		Discharge of Industrial Wastewater (10,000t)
		Discharge of COD (10,000t)
		Discharge of ammoniacal nitrogen (10,000t)
		Discharge of industrial exhaust gas (10,000 nm^3)
		Discharge of sulfur dioxide (t)
		Discharge of flue dust and industrial dust (t)
	S (State)	Number of days with good air quality in Jinghong City (indicators: NO_X, SO_2 and PM_{10}) (day)
		Average equivalent sound level of urban environmental noise in Jinghong (dB(A))
		Average equivalent sound level of urban road traffic noise in Jinghong (dB(A))
		Comprehensive water quality classification of Lancang River and its seven main tributaries (Nanguo River, Liusha River, Buyuan River, Nanla River, Nanlan River, Nan'a River and Dakai River)
		Percentage of wild vertebrate species in the provincial species (%)
		Percentage of wild higher plant species in the provincial species (%)
	I (Impact)	Acid rain frequency and intensity in Jinghong (%)
		Percentage of urban drinking water source meeting the requirements for centralized drinking water source (%)
		Forest coverage rate (%)

		Percentage of public welfare forest area in forest area (%)
		Percentage of rubber plantation area in forest area (%)
		Percentage of nature reserve area in the prefecture's land area (%)
		Urban per capita public green area (m^2)
	R (Response)	Industrial wastewater discharge qualification rate of key pollution sources (%)
		Water qualification rate of the state/province-controlled sections in Lancang River system meeting the standards of water environmental functions (%)
		National-level ecological townships and towns (Nr.)
		Urban Domestic Sewage Treatment Rate (%)
		Urban-garbage harmless disposal rate of county (city) (%)
		Comprehensive utilization rate of industrial solid waste (%)
		Construction of environmental law enforcement system
		Monitoring network construction
		Environmental publicity and education

II. Determining indicator weight through expert rating

The environment performance assessment of the "11th Five-Year Plan" for *Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture* consists of 3 levels: target, criterion and indicator levels. In this research, the indicator weight is determined through the combination weighting of analytic hierarchy process (AHP) and clustering analysis. Therefore, each expert is expected to grade the said two analyses for each hierarchical structure of the indicator system in accordance with his (her) understanding and valuable experience of the "11th Five-Year Plan" for *Development of Ecological Construction and Environmental Protection in Xishuangbanna Prefecture*. See Table 2 for detailed rating standards.

Table 2 Rating Score Implication

Score (1-9 points)	Implication
1	Indicator i is the same important as j.
3	Indicator i is a little more important than Indicator j. Contrarily, it is reciprocal, 1/3.
5	Indicator i is relatively more important than Indicator j. Contrarily, it is reciprocal, 1/5.
7	Indicator i is obviously more important than Indicator j. Contrarily, it is reciprocal, 1/7.
9	Indicator i is absolutely more important than Indicator j. Contrarily, it is reciprocal, 1/9.
2, 4, 6, 8	The comparison value of indicator i and j is between the said adjacent ratings; on the contrary, it respectively becomes the reciprocal 1/2, 1/4, 1/6 and 1/8.
Meaning of reciprocal	If the judging result between i and j is a, then that between j and i is 1/a.

Table 3 Importance Rating of Sensitivity Indicator Based on Target-Criterion Levels

j / i	Drive	Pressure	State	Impact	Response
Drive	1				
Pressure		1			

State			1		
Impact				1	
Response					1

Table 4 Importance Rating of Drive Indicator Based on Criterion-Criterion Levels

j / i	Population	Total Output Value	Agricultural Fertilizer Application Amount
Population	1		
Total Output Value		1	
Agricultural Fertilizer Application Amount			1

Table 5 Importance Rating of Pressure Indicator Based on Criterion-Criterion Levels

j / i	Discharge of Domestic Sewage in the Whole Prefecture	Discharge of Industrial Wastewater	Discharge of COD	Discharge of Ammoniacal Nitrogen	Discharge of Industrial Exhaust Gas	Discharge of Sulfur Dioxide	Discharge of flue dust and industrial dust
Discharge of Domestic Sewage in the Whole Prefecture	1						
Discharge of Industrial Wastewater		1					
Discharge of COD			1				
Discharge of Ammoniacal Nitrogen				1			
Discharge of Industrial Exhaust Gas					1		
Discharge of Sulfur Dioxide						1	
Discharge of flue dust and industrial dust							1

Table 6 Importance Rating of State Indicator Based on Criterion-Criterion Levels

j / i	Number of Days with Good Air Quality in Jinghong City	Average Equivalent Sound Level of Urban Environmental Noise in Jinghong	Average Equivalent Sound Level of Urban Road Traffic Noise in Jinghong	Comprehensive Water Quality Classification of Lancang River and its 7 Main Tributaries	Percentage of Animal Species Between the Whole Prefecture and Yunnan Province	Percentage of Higher Plant Species Between the Whole Prefecture and Yunnan Province
Number of Days with Good Air Quality in Jinghong City	1					
Average Equivalent Sound Level of Urban Environmental Noise in Jinghong		1				
Average Equivalent Sound Level of Urban Road Traffic Noise in Jinghong			1			
Comprehensive				1		

Water Quality Classification of Lancang River and its 7 Main Tributaries						
Percentage of Animal Species Between the Whole Prefecture and Yunnan Province					1	
Percentage of Higher Plant Species Between the Whole Prefecture and Yunnan Province						1

Table 7 Importance Rating of Impact Indicator Based on Criterion-Criterion Levels

j / i	Acid Rain Frequency and Intensity in Jinghong	Percentage of Public Welfare Forest Area in Forest Area	Percentage of Urban Drinking Water Source Meeting the Requirements for Centralized Drinking Water Source	Forest Coverage Rate	Percentage of Rubber Plantation Area in Forest Area	Percentage of Nature Reserve Area in the Prefecture's Land Area	Urban Per Capita Public Green Area
Acid Rain Frequency and Intensity in Jinghong	1						
Percentage of Public Welfare Forest Area in Forest Area		1					
Percentage of Urban Drinking Water Source Meeting the Requirements for Centralized Drinking Water Source			1				
Forest Coverage Rate				1			
Percentage of Rubber Plantation Area in Forest Area					1		
Percentage of Nature Reserve Area in the Prefecture's Land Area						1	

Urban Per Capita Public Green Area							1

Table 8 Importance Rating of Environmental Adaptation Based on Criterion-Criterion Levels

j / i	Industrial Wastewater Discharge Qualification Rate of Key Pollution Sources	Percentage of Public Welfare Forest Area in Forest Area	Urban Garbage Harmless Disposal Rate of County (City)	National-level Ecological Townships and towns	Urban Domestic Sewage Treatment Rate	Comprehensive Utilization Rate of Industrial Solid Waste	Construction of Environmental Law Enforcement System	Monitoring network construction	Environmental Publicity and Education
Industrial Wastewater Discharge Qualification Rate of Key Pollution Sources	1								
Percentage of Public Welfare Forest Area in Forest Area		1							
Urban Garbage Harmless Disposal Rate of County (City)			1						
National-level Ecological Townships and towns				1					
Urban Domestic Sewage Treatment Rate					1				
Comprehensive Utilization Rate of Industrial Solid Waste						1			
Construction of Environmental Law							1		

Enforcement System									
Monitoring network construction								1	
Environmental Publicity and Education									1

Expert Signatures:

Date:

7.2 Appendix 2: Guidebook for Environment Performance Assessment of Ecological Xishuangbanna Prefecture Construction

Guidebook for Environment Performance Assessment of Ecological Xishuangbanna Prefecture Construction

Yunnan Institute of Environmental Science

January 2015

7.3 Appendix 3: Environment Performance Assessment Calculation of Ecological Xishuangbanna Prefecture Construction

Table 1 Environment Performance Assessment Indicator System and Statistical Data of "12th Five-Year Plan" for Ecological Construction in Xishuangbanna Prefecture

Criterion Level	Target Level	"12th Five-Year" Data					Planned Value
		2011	2012	2013	2014	2015	2015
D (Drive)	Annual per capita net income of farmers (RMB/person)	5327.00	6174.00	7107.00			≥6000
	Share of tertiary industry in GDP (%)	40.90	41.70	41 10			≥40
	Energy consumption per unit of GDP (standard coal (t) /RMB 10,000)	0.77	0.67	0.65			≤0.9
	Fresh water consumption per unit of industrial added value (m^3/RMB 10,000)	29.49	26.42	16.52			≤20
	Urbanization level (%)	37.10	39.26	40.44			≥55
P (Pressure)	Chemical oxygen demand (COD) emission intensity (kg/RMB 10,000)	17.35	14.62	11.77			<4.0
	Sulfur dioxide (SO_2) emission intensity (kg/RMB 10,000)	1.77	1.56	1.43			<5.0
S (State)	Percentage of the one city and two counties attaining the air quality environment standards for functional areas (%)	100.00	100.00	100.00			100.00
	Percentage of water environment quality up to functional area standards	100.00	100.00	100.00			100.00
	Percentage of the one city and two counties attaining the noise environment quality standards for functional zones (%)	100.00	100.00	100.00			100.00
I (Impact)	Forest coverage rate (%)	78.30	78.30	78.30			≥70
	Percentage of the protected area in national territorial area (%)	19.00	19.00	19.00			≥17
	Urban per capita public green area (m^2/ person)	13.06	13.41	13.55			≥11
R (Response)	Water qualification rate of centralized drinking water source (%)	100.00	100.00	100.00			100.00
	Urban centralized sewage treatment rate (%)	49.28	46.87	53.99			≥85
	Industrial water recycle rate (%)	59.85	59.57	66.08			≥80
	Urban garbage harmless disposal rate (%)	73.00	100.00	100.00			≥90
	Industrial solid waste disposal and utilization rates (%)	96.72	96.95	99.93			90.00
	Share of environmental input in GDP (%)	0.54	0.09	1.03			3.50
	Inspection pass rate of the enterprises which should implement mandatory clean production (%)	100.00	100.00	100.00			100.00

Table 2 Grading Standard for Environment Performance Assessment Indicator of "12th Five-Year Plan" for Ecological Construction in Xishuangbanna Prefecture

Criterion Level	Target Level	Grading Standard						Indicator Property
		100	80	60	40	20	0	
D (Drive)	Annual per capita net income of farmers (RMB/person)	6000.00	5400.00	5000.00	4500.00	4000.00	<4000	Positive
	Share of tertiary industry in GDP (%)	40.00	35.00	30.00	25.00	20.00	<20.00	Positive
	Energy consumption per unit of GDP (standard coal (t) /RMB 10,000)	0.90	1.20	1.30	1.40	1.50	>1.50	Negative
	Fresh water consumption per unit of industrial added value (m^3/RMB 10,000)	20.00	25.00	30.00	35.00	40.00	>40	Negative
	Urbanization level (%)	55.00	45.00	35.00	25.00	15.00	<15.00	Positive
P (Pressure)	Chemical oxygen demand (COD) emission intensity (kg/RMB 10,000)	4.00	8.00	12.00	16.00	22.00	>22.00	Negative
	Sulfur dioxide (SO_2) emission intensity (kg/RMB 10,000)	5.00	6.00	7.00	8.00	9.00	>9.00	Negative
S (State)	Percentage of the one city and two counties attaining the air quality environment standards for functional areas (%)	100.00	80.00	60.00	40.00	20.00	0.00	Positive
	Percentage of water environment quality up to functional area standards	100.00	90.00	80.00	70.00	60.00	<60.00	Positive
	Percentage of the one city and two counties attaining the noise environment quality standards for functional zones (%)	100.00	80.00	60.00	40.00	20.00	0.00	Positive
I (Impact)	Forest coverage rate (%)	70.00	65.00	60.00	55.00	50.00	<50.00	Positive
	Percentage of the protected area in national territorial area (%)	17.00	16.00	15.00	14.00	13.00	<13.00	Positive
	Urban per capita public green area (m^2/ person)	11.00	10.00	9.00	8.00	7.00	<7.00	Positive
R (Response)	Water qualification rate of centralized drinking water source (%)	100.00	80.00	60.00	40.00	20.00	0.00	Positive
	Urban centralized sewage treatment rate (%)	85.00	70.00	50.00	40.00	30.00	<30.00	Positive
	Industrial water recycle rate (%)	80.00	70.00	60.00	50.00	40.00	<40.00	Positive

	Urban garbage harmless disposal rate (%)	90.00	80.00	70.00	60.00	50.00	<50.00	Positive
	Industrial solid waste disposal and utilization rates (%)	90.00	85.00	80.00	75.00	70.00	<70.00	Positive
	Share of environmental input in GDP (%)	3.50	2.00	1.50	0.10	0.01	<0.01	Positive
	Inspection pass rate of the enterprises which should implement mandatory clean production (%)	100.00	90.00	80.00	70.00	60.00	<60.00	Positive

Table 3 Non-dimensionalization of Environment Performance Assessment Indicator of "12th Five-Year Plan" Ecological Construction in Xishuangbanna Prefecture

Criterion Level	Target Level	Non-dimensionalization of "12th Five-Year Plan" Indicator				
		2011	2012	2013	2014	2015
D (Drive)	Annual per capita net income of farmers	76.35	100.00	100.00	0.00	0.00
	Share of tertiary industry in GDP	100.00	100.00	100.00	0.00	0.00
	Energy consumption per unit of GDP	100.00	100.00	100.00	100.00	100.00
	Fresh water consumption per unit of industrial added value	62.05	74.30	100.00	100.00	100.00
	Urbanization level	64.20	68.52	70.88	0.00	0.00
P (Pressure)	Chemical oxygen demand (COD) emission intensity	35.49	46.90	61.15	100.00	100.00
	Sulfur dioxide (SO_2) emission intensity	100.00	100.00	100.00	100.00	100.00
S (State)	Percentage of the one city and two counties attaining the air quality environment standards for functional areas	100.00	100.00	100.00	0.00	0.00
	Percentage of water environment quality up to functional area standards	100.00	100.00	100.00	0.00	0.00
	Percentage of the one city and two counties attaining the noise environment quality standards for functional zones	100.00	100.00	100.00	0.00	0.00
I (Impact)	Forest Coverage Rate	100.00	100.00	100.00	0.00	0.00
	Percentage of the protected area in national territorial area	100.00	100.00	100.00	0.00	0.00
	Urban per capita public green area	100.00	100.00	100.00	0.00	0.00
R (Response)	Water qualification rate of centralized drinking water source	100.00	100.00	100.00	000	0.00

	Urban centralized sewage treatment rate	58.56	53.75	63.99	0.00	0.00
	Industrial water recycle rate	59.69	59.13	72.15	0.00	0.00
	Urban garbage harmless disposal rate	66.00	100.00	100.00	0.00	0.00
	Industrial solid waste disposal and utilization rates	100.00	100.00	100.00	0.00	0.00
	Share of environmental input in GDP	46.27	38.26	53.29	0.00	0.00
	Inspection pass rate of the enterprises which should implement mandatory clean production	100.00	100.00	100.00	0.00	0.00

Table 4 Weight and Property of Environment Performance Assessment Indicator of the "12th Five-Year Plan" Ecological Construction in Xishuangbanna Prefecture

Criterion Level	Target Level	Weight	Indicator Property
D (Drive)	Annual per capita net income of farmers	0.20	Positive
	Share of tertiary industry in GDP	0.18	Positive
	Energy consumption per unit of GDP	0.40	Negative
	Fresh water consumption per unit of industrial added value	0.20	Positive
	Urbanization level	0.02	Positive
		0.15	
P (Pressure)	Chemical oxygen demand (COD) emission intensity	0.60	Negative
	Sulfur dioxide (SO_2) emission intensity	0.40	Negative
		0.15	
S (State)	Percentage of the one city and two counties attaining the air quality environment standards for functional areas	0.35	Positive
	Percentage of water environment quality up to functional area standards	0.40	Positive
	Percentage of the one city and two counties attaining the noise environment quality standards for functional zones	0.25	Positive
		0.20	
I (Impact)	Forest Coverage Rate	0.45	Positive
	Percentage of protected region in national territorial area	0.35	Positive
	Urban per capita public green area	0.20	Positive
		0.25	
R (Response)	Water qualification rate of centralized drinking water source	0.20	Positive
	Urban centralized sewage treatment rate	0.20	Positive
	Industrial water recycle rate	0.10	Positive
	Urban garbage harmless disposal rate	0.15	Positive
	Industrial solid waste disposal and utilization rate	0.15	Positive

Criterion Level	Weight Coefficient
D (Drive)	0.15
P (Pressure)	0.15
S (State)	0.20
I (Impact)	0.25
R (Response)	0.25

	Share of environmental input in GDP	0.15	Positive
	Inspection pass rate of the enterprises which should implement mandatory clean production	0.05	Positive
		0.25	

Table 5 Calculation of Environment Performance Assessment Index of the "12th Five-Year Plan" Ecological Construction in Xishuangbanna Prefecture

Criterion Level	Target Level	Indicator Identification	EPI				
			2011	2012	2013	2014	2015
D (Drive)	Annual per capita net income of farmers	D1	2.3	3.0	3.0	0.0	0.0
	Share of tertiary industry in GDP	D2	2.7	2.7	2.7	0.0	0.0
	Energy consumption per unit of GDP	D3	6.0	6.0	6.0	6.0	6.0
	Fresh water consumption per unit of industrial added value	D4	1.9	2.2	3.0	3.0	3.0
	Urbanization level	D5	0.2	0.2	0.2	0.0	0.0
P (Pressure)	Chemical oxygen demand (COD) emission intensity	P1	3.2	4.2	5.5	9.0	9.0
	Sulfur dioxide (SO_2) emission intensity	P2	6.0	6.0	6.0	6.0	6.0
S (State)	Percentage of the one city and two counties attaining the air quality environment standards for functional areas	S1	7.0	7.0	7.0	0.0	0.0
	Percentage of water environment quality up to functional area standards	S2	8.0	8.0	8.0	0.0	0.0
	Percentage of the one city and two counties attaining the noise environment quality standards for functional zones	S3	5.0	5.0	5.0	0.0	0.0
I (Impact)	Forest Coverage Rate	I1	11.3	11.3	11.3	0.0	0.0
	Percentage of protected region in national territorial area	I2	8.8	8.8	8.8	0.0	0.0
	Urban per capita public green area	I3	5.0	5.0	5.0	0.0	0.0
R (Response)	Water qualification rate of centralized drinking water source	R1	5.0	5.0	5.0	0.0	0.0
	Urban centralized sewage treatment rate	R2	2.9	2.7	3.2	0.0	0.0
	Industrial water recycle rate	R3	1.5	1.5	1.8	0.0	0.0
	Urban garbage harmless disposal rate	R4	2.5	3.8	3.8	0.0	0.0

	Industrial solid waste disposal and utilization rate	R5	3.8	3.8	3.8	0.0	0.0
	Share of environmental input in GDP	R6	1.7	1.4	2.0	0.0	0.0
	Inspection pass rate of the enterprises which should implement mandatory clean production	R7	1.3	1.3	1.3	0.0	0.0
Comprehensive EPI			**85.9**	**88.7**	**92.2**	**24.0**	**24.0**

Table 6 EPA Rule Level Index of the "12th Five-Year Plan" Ecological Construction in Xishuangbanna Prefecture

Criterion Level	EPI				
	2011	2012	2013	2014	2015
D (Drive)	13.0	14.1	14.9	9.0	9.0
P (Pressure)	9.2	10.2	11.5	15.0	15.0
S (State)	20.0	20.0	20.0	0.0	0.0
I (Impact)	25.0	25.0	25.0	0.0	0.0
R (Response)	18.6	19.4	20.8	0.0	0.0
Comprehensive index	85.9	88.7	92.2	24.0	24.0