

Baseline Study of Environment Planning and Risk Management in China

CAO Guozhi, TIAN Chao, JIA Qian, DONG Jingqi, ZHOU You, YU Fang, Haakon Vennemo

VISTA ANALYSIS AS



Document Details

Vista Analysis AS	Report number 2013/37
Title	Baseline Study of Environment Planning and Risk Management in China
ISBN	978-82-8126-133-4
Author	Cao Gouzhi et al
Finished date	September 23, 2013
Project Managers	Haakon Vennemo, Yu Fang
Quality Control	Rasmus Reinvang
Client	Chinese Academy for Environmental Planning
Access	Public
Published	pdf
Key words	Environmental risk, environmental planning, China

Preface

This report surveys the baseline situation with respect to planning for environmental risk mitigation in China, with particular focus on two provinces (Jiangsu and Guizhou Province) and two cities (Anshun City in Guizhou Province and Tongling City in Anhui Province). The purpose is to record the situation at the initiation of the project *Planning for Cost-effective Environmental Risk Reduction* that is carried out by Vista Analysis and Chinese Academy for Environmental Planning (CAEP) on behalf of the Ministry of Environmental Protection in China. The report is mainly written by a team from CAEP led by Cao Gouzhi, with inputs from Rasmus Reinvang and Haakon Vennemo at Vista Analysis, and with baseline data and survey contributions from local environmental authorities in Jiangsu, Guizhou, Anshun and Tongling. We also would like to express our sincere appreciation to Foreign Economic Cooperation Centre, Department of Planning and Finance, Environmental Emergency Response and Accident Investigation Centre, Department of International Cooperation of Ministry of Environmental Protection for their support of this baseline report.

23 September 2013

Haakon Vennemo

Project Manager

Vista Analysis AS

Content

Preface	3
Summary.....	9
About the project.....	20
1 Target Groups of the project.....	21
1.1 List of target groups	21
1.1.1 Local EPBs of pilot places	21
1.1.2 Ministry of Environmental Protection	22
1.1.3 Other institutions.....	26
1.2 The business relationship between various target groups.....	27
2 Research and Practice at the State Level	28
2.1 Cognition of the international experience of environment planning and risk management	28
2.1.1 Environmental planning	28
2.1.2 Environment risk management	30
2.2 Current status of environmental planning, risk assessment and management	36
2.2.1 Environmental planning and management.....	36
2.2.2 Environment risk assessment and management	38
2.2.3 Applications of GAINS model and CGE model	43
3 Research and Practice at Provincial and City Level.....	46
3.1 Jiangsu Province	46
3.1.1 Environmental risk introduction and its characteristic analysis.....	46
3.1.2 Present situation of environmental risk management in Jiangsu Province ..	52
3.1.3 Environmental risk management work faces a huge challenge and opportunity	61
3.2 Guizhou Province	66
3.2.1 Environmental risk introduction and its characteristic analysis.....	66

3.2.2	Current situation of environmental risk management in Guizhou Province	69
3.2.3	Challenges and opportunities	74
3.3	Tongling in Anhui	79
3.3.1	Main environmental risk problems for Tongling City	79
3.3.2	Related works already done	80
3.3.3	Problems and need	85
3.4	Summary	88
4	Questionnaire survey result	89
4.1	Statistical result	89
4.2	Main conclusion	115
5	Conclusion	117
5.1	Many efforts have been done in response to solve environmental risk problems in China	117
5.2	There are still many problems in national and local environmental risk management	118
5.3	Improving technical methods application is critical to solve the current environmental risk reduction planning and management problems	119
	Appendix A.....	120

Tables:

Tabell 3.1	Environmental Safety Information Quantity for Major Industries(2010)	50
------------	--	----

Figures:

Figure 1.1	Target groups	21
Figure 3.1	Number of Major Environmental Risk Source Enterprises in Provinces in China 48	
Figure 3.2	Number of Major Environmental Risk Source Enterprises in Municipalities Directly Controlled by Jiangsu Provincial Government	49
Figure 4.1	Completed questionnaires	89
Figure 4.2	Number at the provincial level	90
Figure 4.3	Number of respondents with job responsibility for environmental planning 90	
Figure 4.4	Number of respondents engaged in emergency response	91
Figure 4.5	Application of CBA.....	92
Figure 4.6	Familiarity with CBA	92
Figure 4.7	Familiarity with CBA (MEP&CAEP)	93
Figure 4.8	Familiarity with CBA (provincial EPBs).....	93
Figure 4.9	Familiarity with CBA (municipal EPBs)	94
Figure 4.10	Application of SEA	95
Figure 4.11	Familiarity of SEA	95
Figure 4.12	Familiarity of SEA (MEP&CAEP).....	96
Figure 4.13	Familiarity of SEA (provincial EPBs).....	96
Figure 4.14	Familiarity of SEA(municipal EPBs).....	97
Figure 4.15	Type of Work.....	98
Figure 4.16	Type of work.....	98
Figure 4.17	Applied condition of CBA and SEA	99
Figure 4.18	Knowledge of CBA level.....	99
Figure 4.19	Knowledge of SEA level.....	100
Figure 4.20	Application of CBA and SEA at province level	101

Figure 4.21	Familiarity of international experiences and best practice.....	101
Figure 4.22	Familiarity of international experiences and best practice (MEP&CAEP) 102	
Figure 4.23	Familiarity of international experiences and best practice (provincial EPBs) 102	
Figure 4.24	Familiarity of international experiences and best practice (municipal EPBs) 103	
Figure 4.25	Level of knowledge and experience with environmental risk reduction methodologies.....	104
Figure 4.26	Level of knowledge and experience with environmental risk reduction methodologies (MEP&CAEP)	104
Figure 4.27	Level of knowledge and experience with environmental risk reduction methodologies (provincial EPBs)	105
Figure 4.28	Level of knowledge and experience with environmental risk reduction methodologies (municipal EPBs)	105
Figure 4.29	Level of knowledge of international experiences and best practice related to environmental risk methodologies.....	106
Figure 4.30	Knowledge level of international environmental planning experience ...	106
Figure 4.31	Knowledge level of international environmental planning experience ...	107
Figure 4.32	Level of knowledge about GAINS, CGE-models and other models for integrated evaluation of environmental impact	108
Figure 4.33	Level of knowledge about GAINS, CGE-models and other models for integrated evaluation of environmental impact (MEP&CAEP).....	108
Figure 4.34	Level of knowledge about GAINS, CGE-models and other models for integrated evaluation of environmental impact (provincial EPBs)	109
Figure 4.35	Level of knowledge about GAINS, CGE-models and other models for integrated evaluation of environmental impact (municipal EPBs).....	109
Figure 4.36	Knowledge level of GAINS, CGE models	110
Figure 4.37	Knowledge level of GAINS, CGE models	110
Figure 4.38	Conformance to its requirements of methods and tools	111
Figure 4.39	Conformance to its requirements of methods and tools (MEP&CAEP)....	111

Figure 4.40	Conformance to its requirements of methods and tools (provincial EPBs)	112
Figure 4.41	Conformance to its requirements of methods and tools (municipal EPBs)	112
Figure 4.42	Demand analysis of specific type of international experience.....	113
Figure 4.43	Demand analysis of specific type of international experience(MEP&CAEP)	113
Figure 4.45	Demand analysis of specific type of international experience (provincial EPBs)	114
Figure 4.46	Demand analysis of specific type of international experiences (municipal EPBs)	114

Summary

Background

China has during the last 20 years moved through a rapid industrialization phase, where rapid increase in GDP in many cases has taken place at the expense of sustainable resource use, environmental quality and public health. It is recognized by the Chinese government that the environmental challenges are huge and need to be tackled as part of China's future economic development.

Environmental policy in China is currently in a phase where basic legislation and principles are in place but where necessary institutional development, baseline data collection, policy and cross-sector mainstreaming as well practical application of environmental policy are still at a youthful stage. Many practical problems remain for integrated application of high-quality environmental planning and risk management.

Examples of current risk-related environmental problems include; frequently occurring acute environmental pollution accidents, sources of drinking water are frequently threatened by pollution, large amounts of persistent organic pollutants spread widely, regulation and practice for handling of chemicals and hazardous waste is lacking etc. The public is exposed to such kinds of environmental problems and the annual "mass events" involving protests and related to the environment, have the latter years increased by 30% per year.

In the 12th 5-Year Plan (2011-2015), the Chinese government made it a priority to "strengthen the environmental risk prevention and control in key fields." Key fields include heavy metals, hazardous wastes, persistent organic pollutants, enterprises that produce or use dangerous chemicals, waste disposal and regional planning. In the 12th Environmental Protection 5-Year Plan (2011-2015), risk prevention is listed as one of the main tasks of environmental protection for the first time.

Current overall challenges regarding environmental planning and risks management, include lack of dissemination and standardization of experience and tools for environmental risk planning, lack of overview and risk handling capacity on the ground,

lack of experience and methods for regional planning to manage environmental risk, lack of standardization of practices across different departments and regions, and lack of integration of environmental risk principles in relevant laws and regulations. Current environmental risk management mostly relies on the investigation, troubleshooting and regulation of government departments, while enterprises generally do not carry out risk management assessments and they often lack competence and awareness about the importance of risk management. The situation for enterprises can be challenging, as the official targets of environmental risk prevention and control as well as the means, are often not clear.

Jiangsu province

Jiangsu is a province on the east coast of China, north of Shanghai, with a population of 79 million and an area of 102,600 km² (roughly the size of Iceland). The capital of Jiangsu is Nanjing (pop. 8.2 million). Jiangsu is an economically advanced province with one of the highest GDP per capita (68 347 RMB, 2012) and economic growth rates in China. Economic development is, however, primarily concentrated in the southern part of the province. Since 1949, Jiangsu has developed heavy industries such as chemicals industry and construction materials. Today, the most important industries are machinery, chemicals, electronics, automobiles and solar industry. The majority of the population in Jiangsu lives in densely populated urban areas where environmental risk factors are complicated and numerous, road capacity is relatively insufficient, and the access to space and natural and ecological lands is rare. A major environmental risk event has potential to bring cities and towns to a standstill.

Data from MEP for the period 2004-2009 shows that Jiangsu in the period ranked second among provinces in China with regards to “Sudden Environmental Events”, with 55 such events. Especially the chemicals industry is considered to involve high risk, as it involves many different and often dangerous chemicals, complicated operating conditions, many potential leak points, transport of large quantities of chemicals that are dangerous unless they are kept under the right conditions. Mapping by MEP (2010) showed that Jiangsu has more than 38 000 chemical enterprises of which more than 10

000 handles quantities making them “Major Environmental Risk Source Enterprises” – the highest number of any province in China. (Guangdong follows second with about 7 500 such enterprises.) Many of these factories were built in the 1980ies, and have outdated equipment and standards. Many chemical factories are also located along rivers, near lakes, adjacent to the sea, near ecologically sensitive and/or important areas, within the upper reaches of urban drinking water zones or adjacent to residential areas – making the impact of potential environmental accidents high. Weak planning and zoning has also lead to a situation where energy and industry pipe networks indiscriminately spread underground in populated areas and come into conflict with other infrastructure development, leading to increasing occurrences of environmental events and increasing complexity. Emergency equipment, facilities and plans are often lacking on enterprise level, on industrial park level and on local or regional government level. Most risk source enterprises are located in the southern part of the province. Due to weaker environmental management and emergency response capability in the North, however, the impact of an environmental event will probably be higher if it occurs there.

The Jiangsu province EPB began mapping environmental risks for major industries and enterprises in 2009 and at present has completed basic environmental risk information entries for more than 7 000 enterprises. Jiangsu EPB has also mapped land source oil spill risks in the province, as well as risks to drinking water sources from industrial chemical parks. The mapping of risk sources is archived according to the risk levels; major risk sources are listed and supervised by provincial authorities, relatively large risk sources are listed and supervised by municipal bureaus, while average risk sources are listed and supervised at local levels. Risks to sensitive areas such as drinking water sources are prioritized.

The EPB has issued guidelines for the development emergency plans at enterprise, industrial park and government levels. The provincial government is also working to establish a suitable monitoring and early warning monitoring system, a comprehensive emergency response system and has taken steps to improve regional communication mechanisms enabling joint response action on a regional level. In 2012, environmental protection authorities in Jiangsu conducted more than 30 different emergency drills and major risk enterprises and industrial zones conducted more than 100 drills.

Jiangsu's 12th 5-Year Plan for Environmental protection and ecological Construction requires that environmental supervision, management and risk prevention ability shall be enhanced markedly by 2015. For instance, the centralized drinking water quality compliance rate for the county and township level shall reach 100% and 95% respectively, urban household waste handling shall reach 100% and safe handling of urban sewage shall reach 90%. Annual pollutant emission quantities of main pollutants (NO_x, SO₂, NH₃-N and COD) as well as annual phosphorous emissions in Taihu Basin shall be reduced significantly to set quantitative targets. In the five-year plan period, Jiangsu province shall also set up 14 provincial environmental emergency response teams and establish 13 bases with emergency response equipment.

At present main challenges are: Increasing pressure from economic development enhancing unbalances and risks, sub-optimal standards in the relevant industries and weak planning (especially lack of zoning), lack of research and understanding of environmental risk and how to handle it on a regional level, lack of awareness and competence among stakeholders, lack of necessary technology and equipment, lack of implementation of necessary mitigation measures, lack of awareness and precise information among the general public, and a not fully developed environmental risk management system on a regional level.

Guizhou province and Anshun city

Guizhou is a landlocked province in the southwestern part of China, with a population of 35 million and an area of 176 000 km² (roughly the size of Sweden). The capital of Guizhou is Guiyang (pop. 4.3 million). Guizhou is a relatively poor and economically underdeveloped province, but rich in natural, cultural and environmental resources. In 2012, Guizhou had the lowest GDP per capita (19 566 RMB) of China's provinces.

Anshun is a prefecture-level city in Guizhou province with a population of 2.3 million (of which about 800 000 in the city proper). Anshun City has been selected as a pilot region to develop environmental emergency response ability at prefecture city level.

The main industries in Guizhou are timber and forestry, tobacco and mining. Guizhou is one of the major mining provinces in China and pollution from heavy metals (such as mercury, lead, zinc-cadmium, antimony, thallium, manganese, vanadium and arsenic) constitutes its most important type of environmental risk. The main environmental risk industries in Guizhou are chemical and heavy metal smelting enterprises. The heavy metal pollution in Guizhou have two main sources; historic pollution retained in the soil, and pollution generated by discharge from current industrial enterprises.

Since 2010, a total of 19 acute environmental events have occurred in Guizhou, including two consequential environmental events, one relatively consequential event and 16 average level environmental events. About 50% of the events were caused by traffic accidents, 25% by accidents taking place in production, and 25% for other reasons. Most events mainly involved water pollution (63%), and some events involved air pollution (21%) and radiation (16%). MEP assessments of development trends indicate that environmental risks related to chemical and heavy metal smelting enterprises will increase in the 12th 5-Year Plan period and that the frequency of environmental accidents will increase.

As an example of the scale of historic pollution, Wanshan Mercury Mine has since 1949 discharged 126 million tons of waste residues containing heavy metals and 20.2 billion m³ of waste gases containing mercury without proper control measures. In the Bijie region, the total quantity of waste residues from zinc smelting is about 12 million tons and the total floor area of waste residues is 11 km². In Dushan County, there are 104 abandoned antimony ore pits where leaking water transports heavy metals into the surroundings incl. waterways. There is a general lack of proper land management and mitigation measures in and around mining sites, leading to safety risks, habitat degradation, deforestation, soil and water pollution, erosion and health risks.

Several studies show the negative impact on human health from heavy metal pollution in Guizhou. In the mercury contaminated areas of Wanshan, the mercury content of residents hair is 2.6 times above what is normally considered a safe level and the sick rate is 4% above average. Hundreds of examples have been documented of local people in contaminated areas (Wanshan, Huilong) suffering from mercury or thallium poisoning. In Hejiachong area, the soil cadmium content is 5.2 times higher than normal

and very close to the levels in Toyama prefecture in Japan during the infamous mass cadmium poisoning (the *itai-itai* disease) at the beginning of the 20th century.

Guizhou EPB has mapped that there are currently 414 major environmental risk enterprises in Guizhou (chemical and mining enterprises). In cities (incl. Anshun), hazardous waste, production wastewater, smoke-dust and waste gases from such enterprises pose a big risk to the local environment.

A number of steps have been taken the last years to improve the environmental risk situation in Guizhou. A survey of environmental risk sources was carried out, a database of environmental risk enterprises was established and monitoring and control of such enterprises were strengthened. Special response attention has been put on periods where natural conditions (such as freezing or flood season) increase environmental risks and priority areas (such as the drinking water source for Guiyang City, Hongfeng Lake Reservoir) have been identified for inclusion in a on-line monitoring system. Mechanisms have also been put up to increase the interaction between different relevant departments and government units to secure early warning and information sharing as well as joint and effective response. Contingency plans for acute environmental events have been developed and independent environmental emergency management agencies and response centers have been established. However, lack of funds causes an insufficient level of equipment and response capacity. In Anshun city, a number of measures have been introduced to limit discharge of pollutants from enterprises in the city, to more properly manage solid waste and wastewater – including separating rain and wastewater in the pipe network system, and thereby inter alia reducing pollution in the Sancha river basin.

Guizhou province has ambitious goals for the 12th 5-Year Plan period. The total discharge of main pollutants (NH₃-N, SO₂, NO_x, COD) are to be reduced by between 6 and 10 %. The percentage of national surface water monitoring sections classified with the lowest water quality (class V) is to be reduced to below 20% (the 2010 level), and the percentage of urban concentrated drinking water sources with quality above the national standard is to exceed 90% (up from 82,3% in 2010).

At present main challenges include: Lack of full baseline and trend data enabling the setting of precise planning targets, lack of scientific and operational technical methods and competence, lack of coordination between environmental protection plans and economic and social development plans, lack of integration between environmental protection plans and key construction projects – partly due to lack of information about environmental implications of different projects, lack of overall and cross-sector planning, insufficiently developed environmental risk management system where orientation, responsibility and capacity of agencies of all sectors at all levels are defined and secured, and insufficient risk prevention, prediction and early warning ability.

Tongling in Anhui province

Tongling (pop. 742 000) is a prefecture level city on the Yangtze river in Anhui province (pop. 60 million), bordering to the east to Jiangsu and Zhejiang provinces. Anhui province has lagged behind in economic development compared to its more successful neighbor provinces to the east, with a GDP per capita in 2012 (28 792 RMB) less than half of those provinces. Economic development varies markedly within Anhui province and Tongling is among the most developed and prosperous regions in the province.

Tongling is a historic mining town and an important basic raw material production base in China today. Exploitation and production of copper, sulfur, limestone resources, nonferrous metals, cement, phosphorus chemicals, iron and steel, coking, thermal power production and electronic industries are characteristic of the city's industry. At present, copper smelting production capacity in Tongling has reached 1 million tons/year, cement production capacity 1.8 million tons/year, sulfuric acid production capacity 4.5 million tons/year and chemical fertilizer 2 million tons.

The heavy chemical and mining industrial structure causes considerable production and discharge of pollutants that leads to severe environmental risks and pollution problems. Production and discharge of wastewater, waste gas, sulfur dioxide, nitric oxides, heavy metals and solid waste per unit national land area in Tongling City are higher than the average level in Anhui Province. Heavy metal pollution to soil and water is a huge

problem, as well as erosion and ecological deterioration. Annual average values of sulfur dioxide and inhalable particulate matters in urban air in Tongling are below the national Grade II standard applying to urban and rural areas, and Tongling is also a national acid rain control area. Historically Tongling city is built around mines, which has the effect that residential and industrial zones often are mixed and that heavy industrial enterprises are located so that the wind carries the pollution into the city and/or in upper reaches of drinking water resources. Environmental health and ecological risk is thus substantial.

A number of steps have been taken the last years to improve the environmental risk situation. Mapping of environmental risk sources has been increased, environmental risk assessments and requirements have been increased for construction projects, emergency plans defining responsibilities of different stakeholders have been developed for pollution accidents and for major enterprises, emergency response capacity has been developed, and test-introduction of environmental pollution liability insurance has been introduced for the nonferrous metal smelting industry.

In the 12th 5-Year Plan, Tongling has ambitious environmental goals including reducing the total quantity of major pollutants with 9 to 15% (compared with 2010), reduce discharge of heavy metals from main areas with 15% (compared with 2007), improved waste treatment including safe treatment of all hazardous wastes, ensure more than 330 days with ambient air quality better than grade II, and to establish a full environmental risk prevention and control system. Priority topics to address are the preservation of drinking water sources, soil restoration, prevention and control of heavy metal pollution, centralized treatment of hazardous wastes, improving standards in key industries and enhancing risk supervision and control.

At present main challenges include: Data and research on environmental risks and health hazards related to pollutants in Tongling is weak, lack of mainstreaming of environmental risk considerations across sectors, standards and regulations, lack of standardized environmental risk management mechanism for enterprises, the assessments of environmental risks related to new construction projects are not deep enough, lack of capacity and competence to prevent and control environmental risks.

Chinese experience with CGE-models and GAINS

Research related to Computable General Equilibrium (CGE) model started relatively late in China (1989) and currently Chinese scholars use CGE-models in fields such as environmental tax and price policy making, pollution prevention and control policies concerning water, air and solid waste, emissions trading, reduction of GHG emissions, climate change impact assessment, water source pricing as well as price policy research related to land and mineral resources. Still, CGE-models are mostly used on a research level and there is a lack of experience in use CGE-models to simulate outcomes in a way making the research directly relevant for policy development and decision-making.

The application of the GAINS-model in China has just started, and is being applied in research by Tsinghua University and the Chinese Academy of Agricultural Sciences. Tsinghua University is currently cooperating with the International Institute for Applied System Analysis (IIASA) in Austria on developing a version of GAINS for application on Chinese city level. Few institutions use GAINS in the field of air pollution and climate change simulation and there is need for further training in China on how to use GAINS.

The level of knowledge among the target group

The main target group of the project consists of 103 persons, of which 18 are working for five different departments within MEP involved in environmental planning and risk management at a central level, 9 are working at CAEP, and 76 are working in the EPBs of the pilot provinces (35 in Jiangsu, 14 in Guizhou) and pilot cities (12 in Tongling of Anhui, 15 in Anshun of Guizhou). Note that especially the Jiangsu EPB will be involved in the project, with approximately 35 participants. There is an even gender balance in the involved institutions and departments.

A survey was carried out during the inception phase of the project in order to map the current level of knowledge among the target group. The findings of the survey confirms

the need for competence development and training related to environmental planning and environmental risk reduction, and sets a baseline for the knowledge level of the target group of the project. Main results are:

53% of the respondents currently use Cost-Benefit Analysis (CBA) in their work, but on average 8% report that they have more than a theoretical level of knowledge with use of CBA. 36% of respondents currently use Strategic Environmental Assessment (SEA) in their work, but on average only 3% report that they have more than a theoretical level of knowledge and 55% report that they have no knowledge of SEA. There is clearly a need for further training in the use of CBA and SEA at all levels.

51% of respondents report that they have some knowledge of international experiences and best practice related to environmental planning, but only 6% on a level where they are able to apply this knowledge. 49% report that they have no knowledge of international experiences and best practice with environmental planning (at provincial and city level 60%). There is clearly a need for knowledge dissemination and training related to international experiences and best practice with environmental planning.

68% of respondents report that they have some knowledge of environmental risk reduction methodologies, but only 9% on a level where they are able to apply this knowledge. There is clearly a general need for training related to introduction to and application of environmental risk reduction methodologies in the target group.

55% of respondents report that they have some knowledge of international experiences and best practice related to environmental risk reduction methodologies, but only 7% on a level where they are able to apply this knowledge. 45% report that they have no knowledge of international experiences and best practice with environmental risk reduction methodologies. There is clearly a need for knowledge dissemination and training in these fields among the target group.

25% of respondents report that they have some experience with CGE, GAINS and other integrated environmental impact models, and only 4% on a level where they are able to

apply this knowledge. There is clearly a need for knowledge dissemination and training related to CGE, GAINS and other integrated environmental impact models.

When asked to what extent respondents are satisfied with the current methods and tools they have available for environmental risk prevention, control and response, only 13% reported a certain degree of satisfaction (“they cover my needs but there is a lack of practice”). 87% reported insufficiency in various ways, with 18% noting that they are “directly useful but insufficient in scope”, 39% that they are “merely of indirect use” and 30% noting that they are “not at all sufficient”. When asked about the relevance and need to further know about international experiences, 89% of the respondents answered “yes”. There is clearly a need for further methods and tools related to environmental risk among the target group.

The survey shows systematic variations between the central level and more local levels, and between persons with different types of responsibilities (planning vs. emergency response) that should be taken into account in the detailed design of trainings.

About the project

The Sino-Norwegian project “Planning for cost-effective environmental risk reduction in China” (2012-2015) focuses on training in Cost-Benefit Analysis (CBA) and Strategic Environmental Assessment (SEA) for environmental planning, and the application of CBA, SEA and other methodologies to planning for environmental risk reduction/prevention.

The implementing institutions are:

- Chinese side: Foreign Economic Cooperation Centre (FECO) of MEP supported by Chinese Academy for Environmental Planning.
- Norwegian side: Vista Analysis supported by Center for International Climate and Environmental Research Oslo (CICERO).

1 Target Groups of the project

1.1 List of target groups

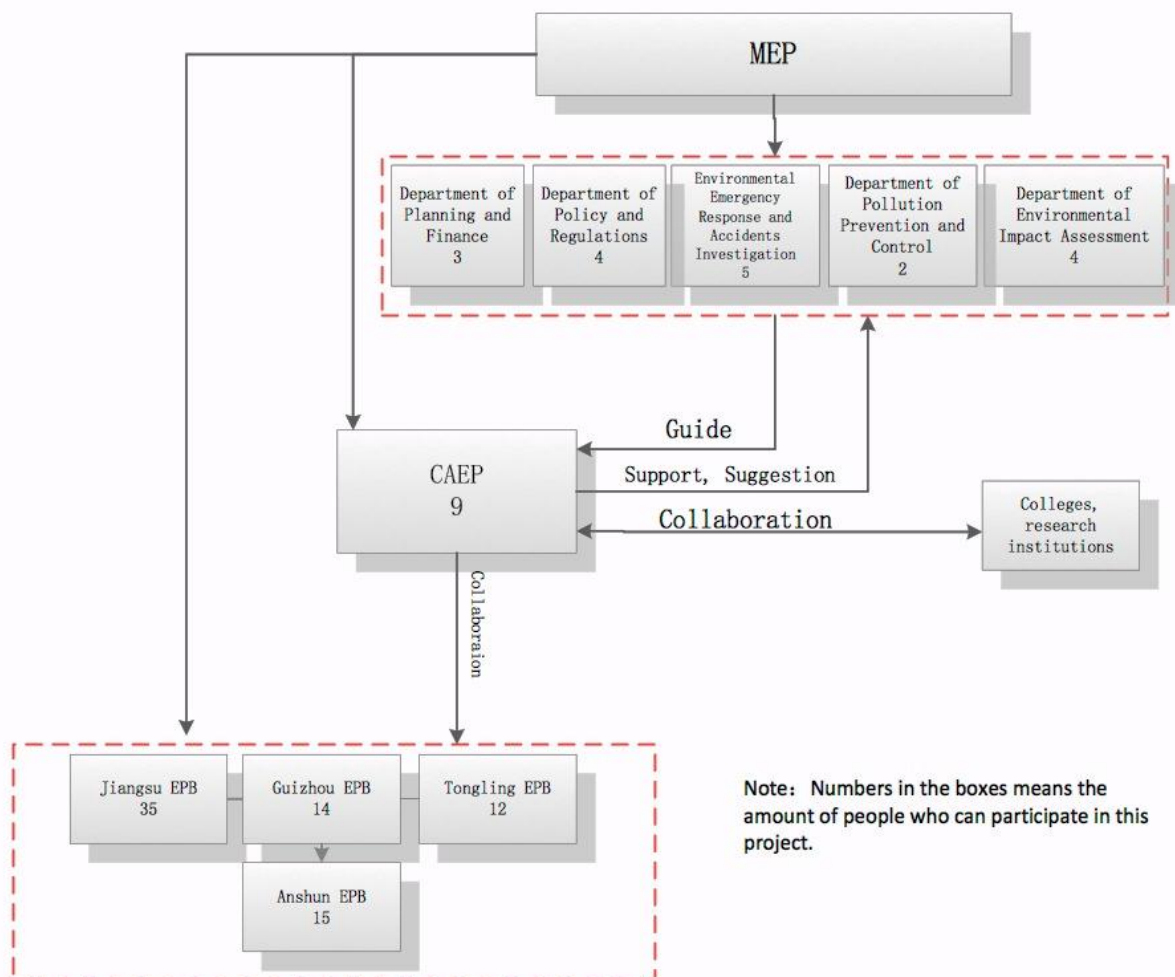


Figure 1.1 Target groups

1.1.1 Local EPBs of pilot places

Jiangsu province, Guizhou province, Tongling city of Anhui, and Anshun city of Guizhou are the four pilot places of this project. The Environmental Protection Bureaus (EPB) on the provincial (Jiangsu, Guizhou) and city levels (Tongling, Anshun) are authoritative institutions responsible for local environmental protection. 35 people from Jiangsu EPB, 14 from Guizhou EPB, 12 from Tongling, and 15 from Anshun will participate and get direct benefit from this project.

These pilot local EPBs can get help in work from this project or provide business support. These places can be involved in this project based on the following reasons:

- (1) Need of environmental protection. The smelting and chemical industry, etc. at these places have formed certain risks to the people and environment. Risk identification, risk assessment and prevention work are needed to fight against the pollution risk;
- (2) Possessing certain ability. Jiangsu Province and Guizhou Province were involved in the first phase of Sino-Norwegian cooperation project and have preliminarily learned about the operation rules of SEA and CBA. They have professional people to carry out the practical work and are more competent for the environmental risk assessment and prevention work on the basis of the first phase of the project;
- (3) Local governments support. In order to achieve a sustainable economic development and better protect the environment, and maintain the environmental rights and interests of local masses, the local governments want to learn more international experiences and make good use of methods of environmental planning, risk reduction, and perform more efficiently, effectively and economically.

1.1.2 Ministry of Environmental Protection

The following business departments and units under the Ministry of Environmental Protection can get benefits from the project or provide business support. Normally, a department has 12-15 employees.

(1) Department of Planning and Finance

Department of Planning and Finance is responsible for environmental protection planning and basic ability build-up, for formulation of environmental protection planning, investment, expenditure budget and settlement, financial department regulations, system and supervision of implementation, and for organizing the preparation of foreign capital utilization plan.

The achievements of environmental risk prevention and control planning methods can provide technical reference for the environmental protection planning and help to put the environmental risk assessment and prevention system into China's environmental protection program, in order to carry out the environmental risk prevention and to control the overall deployment and measures from the planning level and to provide

technical support for the systematic construction of the environmental risk assessment and prevention system.

(2) Department of Policies and Laws

The Department's main function is to establish and develop the environmental protection laws, administrative regulations, economic policy and other basic system, draw up national environmental protection comprehensive guidelines, policies and macro strategy, to organize the formulation of comprehensive name lists for the products, for example, with high pollution and high environmental risk as well as the ones encouraged by the national environmental protection. It is also responsible for conducting research and formulation of environmental liability insurance policies.

The research achievement of this project may provide valuable reference and lessons for Department of Policies and Laws in terms of environmental risk assessment and prevention laws and regulations and policy research and actively help China to establish the environmental risk assessment and prevention system. It will also help to draw lessons from experiences of foreign laws and regulations, economic and management policies, insurance and liability, information disclosure and public participation and to promote the introduction of environmental risk assessment and prevention by combining with China's current situation and demand of environmental protection.

(3) Pollution Prevention and Control Department

Pollution Prevention and Control Department is responsible for the supervision and management of environmental pollution prevention and control and the environmental situation analysis and study. It also takes charge of the formulation of pollution control policies, plans, laws, administrative regulations, department regulations, standards and specifications for city water body, atmosphere, land, noise, light, stench, solid waste, chemicals and motor vehicles, and the organization and implementation of the comprehensive study on environmental situation in China.

The summary of experiences of environmental risk assessment and prevention at home and abroad helps Pollution Prevention and Control Department with the analysis, study and judgment of the situation of China's environmental risk, and with the formulation of relevant policies of environmental risk prevention on the basis of learning from foreign experiences. The *National "Twelfth Five-year" Plan for the Prevention and Control of*

Chemical Environmental Risks set by the Pollution Prevention and Control Department is the first specific plan of environmental risk prevention and control. The related research achievements of this project have a positive role of promotion for environmental risk assessment and prevention work of chemicals and other areas.

(4) Environmental Impact Assessment (EIA) Department

The Environmental Impact Assessment Department is responsible for source prevention and control of environmental pollution and ecological destruction, for environmental impact assessment of major development plans and significant economic development plans as well as important industries and key areas, for review of the environmental impact assessment of major development area planning and industry planning according to the provisions of the state, for organization of national ecological status assessment, and for supervision of development and utilization of natural resources affecting the ecological environment, important ecological environment constructions and restoration of the ecological destruction.

Environment planning assessment and EIA for construction projects are currently the most important strategic pass of environmental risk prevention. The execution of the project, especially the experiences of foreign environmental risk assessment and prevention in terms of methods, criteria and model, contribute to the promotion of environmental risk assessment of areas such as planning and construction projects from the aspects of techniques and management systems. It also benefits the extension of the application of environmental risk assessment and the final check function of the environmental risk assessment in planning and construction projects.

(5) Environmental Emergency Response and Accident Investigation Center

Environmental Emergency Response and Accident Investigation Center (shortly as Emergency Center) is responsible for coping with, information reporting and emergency warning of major and especially big acute environmental accidents, for undertaking investigation of major environmental pollution and ecological damage and environmental violation cases and accidents of major construction projects, for assisting Technology and Standards Department to assess damages of major and especially big acute environmental accidents and for participating environmental law enforcement inspection organized by Environment Supervision Bureau.

The outcomes of the project can provide Emergency Center with technical support in risk assessment and prediction, forecasting and early warning of emergency environmental accidents. Emergency Center can accurately and efficiently identify environmental risks and provide decision-making reference for building an environmental risk management system by using the environment risk assessment technologies and management experiences of other countries for reference according to China's practical situation.

(6) Center for Environment Risk and Damage Assessment of the Chinese Academy for Environmental Planning

The major research area of the center is to provide the Ministry of Environmental Protection with technological, systematic and policy support for the environmental risk assessment and management, pollution damage identification assessment, pollution damage claims and remediation of contaminated sites, to participate in making related state and regional policies and regulations and to carry out qualification administration of environmental risk and damage appraisal institutions of China.

The center is directly involved in theory exploration, technology research and practical work of environmental risk assessment and prevention. It can systematically obtain from the project the international experiences of environment risk prevention principles, classification standards, methods, models and policy tools and legal systems. Therefore the center is able to propose corresponding opinions for construction and improvement on the basis of further combing problems and the insufficiency of the domestic environmental protection planning and implementation of related risk assessment and prevention.

(7) Consulting Department and Water Department of the Chinese Academy for Environmental Planning

The main scope of business of the Consulting Department of the Academy is the power of office and power of property concerning environment protection and public fiscal policy, technical evaluation of pollution prevention and control projects, and development policy and planning research of environmental protection industry and environmental service industry. The main business scope of the Water Environment Planning Department is the research of water environment protection system, policy

and program such as water pollution prevention plans of the state and of the river basin and policies of total amount of water pollutants.

Two departments in their respective areas carried out research and policy formulation of underground water and chemicals. The execution of this project will also benefit the two departments, and the related technology and management experiences will be converted and applied to their respective research fields.

1.1.3 Other institutions

Institutions under the Ministry of Environmental Protection, institutions of higher learning such as Tsinghua University, Peking University, Beijing General Research Institute of Mining and Metallurgy, Nanjing University, research institutions and some environmental consulting firms are all paying close attention to the work of environment risk research. The research process and achievements of this project may help all these units to some extent.

According to the preliminary survey, women in target groups at the national and local level account considerable proportion, and play an important role in the environmental planning and environmental risk prevention work in research and management practices. Taking Center for Environmental Risk and Damage Assessment of Chinese Academy for Environmental Planning for example, nearly 50% of the staff are female, mainly are engaged in environmental risk assessment and management, environmental damage assessment, environmental planning and management studies.

1.2 The business relationship between various target groups

The Chinese Academy for Environmental Planning provides the various business departments under the Ministry of Environmental Protection with technical supports and policy researches.

The Chinese Academy for Environmental Planning cooperates with the Emergency Center under the Ministry of Environmental Protection to carry out the environmental risk prevention, control and management of the environmental risk identification, evaluation, forecasting, early warning at enterprises, industrial parks, tailings and regions, directly involves itself in emergency disposal of acute environmental accidents and in environmental damage assessment of the acute environmental accidents and provide technical support for environmental risk assessment and emergency decision-making. By means of investigation and survey, expert argumentation, seminars, experiments and technical training, it provides the Department of Policy and Law under the Ministry of Environmental Protection with technical supports for special research projects of environmental damage assessment and compensation fund raising and so on. The Chinese Academy for Environmental Planning provides Department of Planning and Finance with technical assistance and also made policy researches supports. There is no direct corporation between Department of Planning and Finance and Center for Environmental Risk and Damage Assessment in risk prevention field.

The Chinese Academy for Environmental Planning jointly carried out environmental risk assessment and prevention research with institutes of higher learning such Tsinghua University, Peking University, Beijing Normal University, China University of Political Science and Law through the project cooperation.

In term of local relationship, Guizhou and Jiangsu were the pilot areas of cooperation in the first phase of the Sino-Norwegian Project and Tongling participated in the trial work of Phase II of the project as an experimental unit for the general plan of city environment. Through work communication by conferences, training, etc. the Chinese Academy for Environmental Planning has established good relations of cooperation with the local pilot units.

2 Research and Practice at the State Level

2.1 Cognition of the international experience of environment planning and risk management

Environmental planning is the main business field of the Chinese Academy for Environmental Planning (CAEP), environmental risk assessment and management is one of the main research fields of Center for Environmental Risk and Damage Assessment (CERDA). In previous studies, some of the related project reports, academic papers and lectures have summarized international experience about environmental planning, environmental risk assessment and management. Therefore, in this part, cognition of the overall progress, methods, institutions of the international experience about environment planning and risk management are mainly from the reports of previous research projects, academic papers of CAEP and other research institutions, universities, academic researchers.

2.1.1 Environmental planning

Since 1950s and 1960s the large scale of economic constructions in USA and the European countries have resulted in a series of biological and environmental problems, the people there realized that the environment on which they lived must be developed, protected and managed with plans. Under this situation and since 1960s, the developed countries such as USA, Japan and UK have been paying great attention to the environment planning.

Every state of USA has set up an environment planning committee and the environment targets are planned by legislation. Generally, the regional environment planning plays a major role in the national environment planning. The energy researches are basis of the environment planning research with emphases on the research methods of environment planning. In accordance with the requirements of Government Performance and Results Act of 1993, USEPA started in 1997 to make its strategic plan that put forward its targets of work for the coming five years and described how it would make the environment in USA cleaner and healthier. The plan was both a statement to the public about its obligations and a route map to realize the established environment targets. USEPA has made five strategic plans. The undergoing strategic plan is the “Strategic Plan 2011-2015” promulgated in 2011. The plan describes the works USEPA plan to do and the

targets they hope to meet. The plan was deployed around the five targets which were raised in the previous strategic plan, including air cleaning and the global climate changes, clean and safe water, land protection and restoration, healthy society and ecological system, compliance and environment management.

UK takes the environment planning as an organic component of an economic development plan, the contents of an environment plan are given full attention in a new city or town plan and a management mechanism of development plan of "Plan-guided Type" is implemented. In Holland, an environment plan includes three contents that are environment policy plan, elements plan and action plan. Risk management was first time introduced in the Government Risk Management Plan of 1986-1990. In "the State Environment Plan" promulgated in 1991, the preconditions of risk management explicated the risk management standard.

Japan's environmental planning is based on the "Manual of the Regional Environmental Management Planning" issued by Environment Agency, and can be divided into four categories namely comprehensive type, guiding type, pollution control type and specific environmental goal type. It attaches great importance to direct administrative management, takes "standard" as the basic planning objectives and means, and focuses on prevention and protection of human body health more than economic development. Russia's environmental planning is of coordination type, which pays attention to the characteristics of the local environment, natural resources and productivity layout to reasonably arrange for regional development planning and environmental planning. The planning method adopted is "Environmental Target Outline Method", which is entirely different from those of the western countries.

With regard to research on environment planning methods, related researchers have made a lot of exploration. In America, the model prediction methods are widely used such as atmospheric model and water model, which have provided scientific basis for the regional environment planning; The German scholars F. Vester and A. Von Hesler have set up a planning sensitivity model for cities and regions by combining the system planning with biological control theory; Mikiko Kainuma is the first to develop a system supporting compound decision making for environment planning and the system was used for the environment planning of Tokyo Bay; Risto Lahdelma and others explored the application of the target planning method in the process of environment planning and decision making based on the practical experiences of application; VILLA

Ferdinando and others researched on the model and framework of quantitative environment vulnerability and obtained the index of the approximate and standard environment vulnerability with minimum subjective and maximum objective.

2.1.2 Environment risk management

2.1.2.1 Principle

The principle of risk prevention was widely used in decision-making about risk management of health in USA in 1950s but generally it is believed that 1970 is the time when USA began to legislate about the principle of risk prevention of America. The following legislation such as Toxic Substances Control Act (TSCA), Marine Mammal Protection Act (MMPA) and Clean Air Act Amendment (CAAA) all reflect the idea of the principle of risk prevention. The application of American environmental laws is apt to conservative evidence view of estimation of risks on higher side, which is one of the connotations of risk prevention. The laws of USA concerning evaluation of ecological risks such as Superfund Law (CERCLA), Resource Conservation and Recycling Method (RCRA), Toxic Substances Control Act (TSCA), Federal Insecticide Fungicide and Rodenticide Act (FIFRA) mostly have chemicals as the object of the evaluation.

The European countries raised the principle of risk prevention in terms of law quite early and had clear and detailed expressions. The Clean Air Act that Germany issued in 1976 is regarded as the earliest example of risk prevention legislation, demanding for risk evaluation prevention of air pollution sources with the guidance of this principle; the framework of risk management by Dutch Ministry of Housing, Physical Planning and Environment put forward a application threshold to judge if a specific risk level is acceptable or not, such as death rate or other critical responding indexes to expressly state the maximum acceptable or negligible risk levels; the EU basic law of the Maastricht Treaty stipulates that the community's principle of environmental policy is to make the principle of risk prevention at the height of EU constitution; the Britain's Ministry of Environment requests that all activities of environment risk evaluation and risk management follow the national sustainable development strategy by emphasizing that if major environmental risks exist, even though the present science does not have enough scientific evidence, actions must be adopted to prevent and reduce the hidden hazards. Bulletin about Environmental Risk Prevention Principles were passed by EU in

2002, which set up a clear and effective guideline for environmental risk evaluation and have become the basic principle to follow to make environmental risk evaluation in EU.

Since 1990s, the principle of risk prevention has been successively adopted by the domestic lawful document of Australia. “Prudent treatment of risks and irreversible” is the basis of principles under discussion and is seen as a target to be realized.

2.1.2.2 Priority fields

Along with the advancement of theory research and practical work, the environmental risk assessment and management abroad has experienced a process from accidental risk to health risks to the process of ecological risk, especially in recent years from single source, single pathway and single receptor to multi-source, multi-pathway, multi-receptor, and attention range has expanded from local to regional scale, having become an important trend of the progress of the environmental risk assessment and management.

- USA

The current U.S. environmental risk assessment objects in summary can be classified into three categories: chemical technology and its products which have risk to human health and ecological safety, biological technology and its products and civil nuclear facilities, nuclear materials and electromagnetic radiation. Along with the changes of focuses, the continuous expansion of the scope of environmental risk assessment and management from local to regional development and from biological individual development to the community and even the whole ecological system, the importance of the interrelated coordination of risk assessment, risk management and risk communication has become more and more obvious. In the latest issue of the American EPA Strategic Plan 2011-2015, the five strategic goals of climate change and improvement of environmental quality, water environment, community and sustainable development, chemical safety and pollution prevention and environmental law have all involved the contents of risk reduction, with particular emphasis on reduction of the risk of outdoor and indoor air pollutants, the community residents health risks and assessment and management of chemicals in consumer goods, in workplaces and in the environment and at the same time making chemicals, ecological degradation and other

environmental problems caused by risk as the focus of scientific research and technology innovation.

- European Union

Chemicals and the environmental risks of industrial activities have been a focus of European Union environmental risk prevention and control. Since 1960s, the European Union has been strengthening the control of environmental risks of new chemicals and the existing chemical environment by continuously perfecting the legislation. Article 14 of the European Union's Regulations on the "Registration, Evaluation, Authorization and Restriction of Chemicals" (REACH) stipulates that safety evaluation of chemicals includes human health hazard assessment, physical and chemical hazard assessment, the environmental risk assessment, lasting, biological accumulation and toxic assessment and very durable and very biological accumulation effect assessment, and Article 44 stipulates that the evaluation standard of priority substances based on risk development shall consider three aspects of information namely toxic information, exposure information and tonnage information; the environmental risk management of EU industrial enterprises is mainly based on the Seveso Directives promulgated by EU, which have been developed and perfected step by step in the course of solving the threat to the human health and restoring the environment by major accidental damages during the industrial development. The main purpose is to prevent the occurrence of major accident hazards of dangerous chemicals and to weaken or restrict dangerous hazards after major accidents of chemicals happened.

2.1.2.3 Methods and models

- Evaluation of environmental risk

The earliest example of environmental risk assessment is put forward by the Atomic Energy Commission of the United States. It is a research report on the theoretical possibility and consequences of major accidents of major nuclear power plants, the purpose of which is to reduce losses by risks of nuclear power construction. Generally it is believed that environmental risk assessment arose in the 1970s, mainly in the developed industrial countries represented by USA. After decades of development, the risk assessment in general has experienced three stages of development namely the germination - development – perfect and its content and method both have been considerably developed. Along with the development of the related basic subjects, the

EPA has carried out a series of projects and case studies, introduced some new standards and guidelines and supplemented and reviewed the existing standards and guidelines. The World Health Organization (WHO) has modified EPA's framework and put the ecological risk assessment, the risk management, the participation of owners at a parallel position to further emphasizes the position of managers and owners. Other countries such as Canada, Britain, and Australia also carried out studies on ecological risk assessment work in the mid-1990s.

At present, the models of environmental risk assessment are mainly to evaluate exposures, ecological risk prediction and field risk assessment, etc. There are many types of pollutants environmental exposure evaluation models, such as EUSES and GREAT2ER. EUSES is mainly used in the chemical risk assessment and the exposure model GREAT2ER that EU established on the basis of GIS can predict distribution of compounds concentration in unit structures; common models of ecological risk assessment include EcoFate model and EMSOFT model, etc., EcoFate model is a collection of compound environment end-result, accumulation of biological food chain, eco-toxicological harm and the human health risk assessment model, and EMSOFT model is a model evaluating migration and fate of pollutants in soil; models of environmental risk assessment of contaminated sites mainly include CLEA, RBCA, etc., CLEA is a model that British officials recommend to use to evaluate contaminated sites and to obtain soil guide values (SGVs) and RBCA (uttales Rebecca) (Risk-Based Corrective Action) is a model of standard development. It can be used for risk analysis of contaminated sites and can also be used to make a risk-based soil screening values and to fix target values.

● **Maximum acceptable risk level**

Maximum acceptable risk level (MARL) is one of the most concerned problems in environment risk research and is also an important indicator in risk-cost-benefit analysis, which is not conclusive. The risk acceptable level of theoretical research converted into a standard of the risk management has been widely used in many developed countries. Based on a large amount of statistical analysis many countries have given the maximum risk level that citizens can accept. American studies over many years have shown that MARL value is 10^{-6} , 10^{-8} is negligible risk level. Many organizations or scholars (such as the Swedish Environmental Protection Agency, the Royal Society, ICRP,

Travis, Gunnar Bengtsson, IAEA, etc.) believe that common hazard level of risk is $10^{-6} \sim 10^{-3}$, MARL value is $10^{-6} \sim 10^{-5}$ and negligible risk level is $10^{-8} \sim 10^{-7}$.

- **Environmental risk zoning and mapping**

After decades of research and application, a large number of international environmental risk zoning methods have been formed. Many scholars have established simple grading and sorting systems, which are based on chemicals, the health risks of risk areas (or problems), the ecological risk and comprehensive risk zoning and ranking. In recent years, along with the development of GIS spatial technologies, the environmental risk mapping based on environmental risk zoning (environmental risk mapping, ERM) has become a new field supporting the rapid rise of environmental risk management, and has provided an important tool for environmental risk management. Some international organizations (e.g., the World Health Organization (WHO) and the developed countries (such as the European Union, the United States, etc.) have paid attention to the potential use of environmental risk mapping and begun practical applications.

2.1.2.4 Institution and policy

- **USA**

The environmental risk prevention thoughts have penetrated into many fields and generally reflected in environmental management decision-making. The basis of relevant laws and regulations is relatively complete and many environmental laws are related to the content of the risk prevention, for example, the Clean Water Act, the Clean Air Act, the toxic Substances Control Act, the Emergency Planning and Community Right-to-Know Act, the Comprehensive Environmental Response, Compensation and Liability Act. A set of related guidelines and guideline systems to guide the work different regions and fields is formed as well. As for the macro management, the four institutions, namely U.S. Environmental Protection agency, the Ministry of Agriculture, the Food and Drug Administration, the Commodity Inspection Bureau are mainly responsible for the environmental risk assessment and management of the federation. The EPA requests that the enterprises or operators of specific installations prepare and implement the Risk Management Plan (RMP), which includes risk assessment, prevention plan and emergency response plan, etc. In view of the national pollution accident emergency oil and dangerous substances, EPA compiled and implemented the National Contingency Plan (NCP). The National Emergency Response Center (NRC) as the core of emergency is

responsible for corresponding coordination of the environment and other emergency work. The environmental liability insurance and other economic measures are relatively complete and have played an important role in prevention and control of environmental risks. In addition, through passing laws and regulations, the public's right to know of environmental risk is guaranteed to capacity.

- **EU**

EU 89/391/EEC Framework Directive that put forward the concept of risk assessment long time ago, is the general standard to protect the workers' occupational safety and health and provides a method framework for lots of other single instruction about health and safety. In addition, No.793/93/EEC and No.93/67/EEC are two specific instructions of risk assessment. The EU's environmental risk management and security management are linked rather closely and pay special attention to chemicals and industrial pollution prevention and control. Through chemical control legislation, a series of regulations, directives and decisions are introduced to carry out the management of hazardous chemicals in the principle of prevention. For example, "Regulations of Chemical Substances Registration, Evaluation, Authorization and Restriction" implemented by EU in 2007 is considered the most important legislation in the past 20 years, which stipulates about relevant obligation and behaviors of chemical producers and users. As for the risk management of industrial activities, risk identification and evaluation are made to prevent and control the environmental pollution accidents caused by industrial activities to realize classification and grading management, to release a series of instructions and relevant rules as well as the Guide for Major Accidents of Industrial Activities, designed to reduce the happening of environmental accidents and the impact by the accidents.

In UK, the Inter-departmental Liaison Group of Risk Assessment (ILGRA) is responsible for the UK government policy making and the practical application of risk evaluation. The Risk Evaluation and Toxicology Steering Committee as a subordinate body of ILGRA has the main function to newly develop or improve the risk assessment methods of chemical risks to human health. In 2011, the Department of Environment, Food and Agricultural Affairs revised and issued "Environmental Risk Assessment and Management Guidelines. The revision is mainly manifested in the new thinking of combination risk communication with public participation in the decision making process. The National Center of Risk Analysis and Plan Evaluation of UK Environment

Agency are responsible for assessment of environmental risks, guidance on how to avoid or reduce the risk and making the society and industry bear the reasonable expenses. The UK Health and Safety Executive Board and the Ministry of Health have established more than 10 occupational health and safety guidelines.

2.2 Current status of environmental planning, risk assessment and management

2.2.1 Environmental planning and management

2.2.1.1 History of environment planning development

In general, China's environmental planning and management theory and practice research can be divided into three stages: the first is the initial stage (1973-1983), during which successively the first meeting of the national environmental protection was held, the 32 words (Comprehensive planning, rational layout, comprehensive utilization, harm to benefit, rely on the masses, all together, protect environment, the benefit of the people) environmental protection policy and Provisions of Protecting and Improving Environment were examined and approved, the environmental protection leading group was set up, the Environmental Protection Law of the People's Republic of China (Trial) was passed and it was clarified that the environmental protection is a basic national policy of China. The second is a development phase, during which the State Council made the Decisions about Environmental Protection Work and established the environmental protection committee of the State Council and then the state council set up the National Environmental Protection Bureau. In 1992, the "Ten Countermeasures on Environment and Development" was made to explicitly put forward the guiding ideology of sustainable development. Here, the state successively formulated and revised a number of environmental protection laws, regulations, policies, standards, etc.; the third is a deepening phase (1996 - present), during which the "Decisions on some issues of environmental protection" was promulgated in 1996 and the state started two major measures which are the implementation of pollutant total amount control and the trans-century green engineering plan, and ensured that the "three rivers, three lakes and two regions" are key areas to be controlled. The "National Environmental Protection" Twelfth Five-year Plan" promulgated in 2011 lists risk prevention as one of the main tasks of environmental protection for the first time.

2.2.1.2 Environmental planning research and practice

Since the kickoff of "11th Five-year Plan", the regional environmental planning has been placed in an important position. Chinese researchers launched discussions on the formulation and implementation of regional environment planning from different perspectives. For example, Zhang Jingxiang¹ believes that the transformation from "ultimate reasonable goal" of regional planning to the concrete "action process" is the key to the success of regional planning, and planning objectives should be limited, while Gao Changbo² introduces the Circular Economy Theory to the environmental protection planning of the Pearl River Delta, and proposes the theory of environmental protection planning to pay more attention to waste emission reduction, clean production, ecological industries and regional waste recycling.

As environmental risk prevention and control has drawn more and more attention, it has been put into the environmental planning as one of the main tasks and planning objectives. The planning puts forward the risk mitigation measures and tasks on the basis of risk identification and analysis and evaluation of key risk areas and main risk problems to promote the realization of risk prevention and control goals. Huangpu District of Guangzhou City, in 2007, began to organize the formulation of environmental protection planning, which tentatively conducted environmental risk management planning. Li Mingguang and others took the planning as an example and discussed the idea of regional environmental risk management planning and believed that as the regions' increasing demand for environmental risk management and along with the increasing maturity of the regional environmental risk assessment technology, regions will surely request to incorporate environmental risk into the environmental planning³.

Both the Planning Outline of Creating National Environmental Protection Model City and the Overall Planning Outline of Environmental Protection for Pilot Cities put the "safeguard of urban environmental safety" as one of the main tasks, and required to establish a fully preventative and controllable environmental risk prevention and

¹ Zhang Jingxiang, Wu Qiyang. Preparation and implementation of regional planning in the new period[J], Economic Geography. 2001: 9(5): 513-526.

² Gao Changbo, Chen Xingeng, Peng Xiaochun, et al. On the Environmental Planning Strategy of the Pearl River Delta, based on the Concept of Circular Economy[J]. Ecology Economic. 2006(7)

³ Li Mingguang, Zhang Yalan, Yu Huaiyi, et al. Regional environmental management planning- a case study in Guangzhou Huangpu district. Guangzhou Environmental Sciences. 2009, 24(1): 35-39

control system, and to strengthen the prevention and control of heavy metal pollution and chemical risks. In recent years, the Heavy Metal Pollution Prevention and Control Planning of Lingwu Section at the Upstream of Beijiang River in the Pearl River Basin, the Heavy Metal Pollution Assessment and Risk Control Planning of Yongxing County and other planning all put “regional environmental risk prevention and control of heavy metals” as the goal and, by focusing on regional environmental risk problem identification and risk assessment, put forward the planning objectives, main tasks and key projects. Based on the risk assessment about health and ecology, the key area and pollution sources will be find out, and then some suggestion and project which focus on the risk control will be given. Such as the history contamination site remediation, ecological environmental quality improvement, reduction of the total emission of pollutants.

2.2.1.3 Problems and challenges

The Chinese environmental planning theory system and the technologies are still imperfect. At present, the practice is biased with compilation over implementation. Confined to planning formulation, few studies have been made on how to execute plans, what means to use to guarantee the smooth implementation of plans and realization of goals. Moreover, the simplicity of the technologies and methods of environmental planning is not able to meet the requirements of time-varying, high order and complexity of the complex system of regional environment. Finally, the fact that the analysis of present status of the planning is blurred may cause planning being lack of targets and not highlighting main points, while whether the proposed key project can solve the current problems and achieve the goal of planning cannot be precisely judged.

2.2.2 Environment risk assessment and management

2.2.2.1 Major environmental risks, current status and trend

(1) Identification of major environmental risks

China is now in an important historical period of accelerating the modernization. In the traditional mode of industrialization, the increasing GDP is mostly based on overdrawing resources and environment and public health. The environmental problems that the developed countries experienced in different stages of nearly a century for industrialization are taking places in China at the same time. The grim

situation of environmental security and the serious environment pollution status have raised the environmental risk of public health, social security and the ecological environment quality. There are many major environmental risk problems, including the facts that acute environmental pollution accidents occur frequently, the sources of drinking water are frequently threatened by pollutions, large amount of persistent organics spread widely, hazardous wastes and chemicals regulation is of imperfection, etc.

(2) Analysis of situation and trend of environmental risk

Compared with the developed countries, the situation in China is more serious. The reasons for that are: firstly, the economic foundation of the environmental governance is still relatively weak; secondly, rigid demands for economic development is very strong as China's economy is now still in the 8% ~ 12% annual growth rate of GDP of high-speed growth and the strong demand for economic development means a great environmental stress; thirdly, there is a big gap of emergency management mechanism for acute accidents of environment pollution compared with the developed countries; fourthly, the widening gap between the rich and the poor, food securities and securities of public facilities and environment are all overlapped with the environment as contradictions and the public are now highly environmentally sensitive and fragile. At present, China's complaint and mass events initiated by environmental problems are rising at an annual rate of 30%⁴. That a series of environmental pollution incidents occurred consecutively indicates that China has entered a period of highlighted environmental risk and frequent environmental pollution accidents which may last for the next 10 years.

2.2.2.2 Basic principles, key areas, methods, models and policies of environment risk management

(1) Basic principles of environment risk management

The whole process management and priority management are the two important strategies and basic principles in Chinese environmental risk management processes. The former is mainly based on environmental risk dynamics and heterogeneity to emphasize prior prevention, emergency responses and rehabilitation and compensation

⁴ China statistical yearbook on environmental.

afterwards; the latter is based on the requirements of optimization under certain conditions in environmental risk management. Due to constraint factors such as society, economy and technology, environmental risk managers often need to follow the principle of "priority management" to optimize the implementation effect at a certain cost.

In the ten current laws, only the Marine Environmental Protection Law gets "risk" involved and stipulates "in accordance with the principle that the ship owner and the cargo owner will share the risk of paying for compensation of the marine oil pollution liability, the compensation funds are established for ship oil pollution insurance and oil pollution damages". In the dozens of administrative rules and regulations on environmental pollution control, the risk prevention and evaluation were only mentioned in the Decision on Implementation of the Scientific Concept of Development and Strengthening Environmental Protection and Regulation of Radioactive Goods Transportation Safety Management.

(2) Key fields of environment risk management

The "Twelfth Five-Year Plan" clearly points out "to strengthen the environmental risk prevention and control of key fields". At this stage, the planning focuses on heavy metal, hazardous wastes, persistent organic pollutants and enterprises that produce and use dangerous chemicals, which shall improve the environmental risk management measures and establish environmental accident disposal and damage compensation recovery mechanism. And around the nuclear and radiation, industrial and regional heavy metal pollution control, solid waste, chemicals and other key bodies, the tasks and goals of environmental risk management are put forward.

(3) Methods and models of environment risk management

- Identification and analysis of environmental risks

The environmental risk identification is a process that the environmental risk factors of a system bringing environmental risks to human society and ecological system are identified. The process of analyzing inducing factors and the possible impact of risk on the basis of identification is the analysis of environmental risk. Methods such as expert investigation method, safety inspection table method, critical mass comparison method, the fault tree analysis method, event analysis method and bow-tie analysis, which

connect fault tree analysis and event tree analysis . bow-tie analysis has been used in environmental risk identification and analysis.

- Environmental risk assessment

The objects of environmental risk assessment include chemicals and pollutants, construction project, regions (basins) and contaminated sites. The evaluation results can serve daily environmental monitoring and accident prevention and emergency responses. Different types of environmental risk assessment are briefly described in Table A-1 of Appendix A.

To standardize the technologies and methods of environmental risk assessment and better serve the environmental risk management decision-making, China has issued a number of technical guidance and determined technical specifications for environmental risk assessment according to different objects and purposes. The technical specifications of environmental risk assessments are listed in Table A-2 of Appendix A.

- Proposal and screening of environmental risk prevention and control measures

On the basis of environmental risk assessment and the level of risk source, reduction of source intensity and probability and risk receptor protection, the risk prevention and control measures such as the hazardous source management, risk management system construction, monitoring and warning devices, and emergency response plan could be proposed. Methods could be used for screening prevention and control measures include cost effect analysis, entropy-TOPSIS method, the multi-objective integer programming, principal component analysis method, etc.

(4) Policy and institution of environment risk management

In order to reduce the environmental risks of dangerous chemicals, new chemical substance, acute environmental pollution incidents of construction project and regional basin, relevant policies have been issued, being governed from perspectives of registration and record, searching for hidden perils by checks, classification, gradation and multi-sectorial joint supervision regulation, liability insurance, emergency response, etc, which are shown in Table A-3 of Appendix A.

But environmental risk management has not yet officially been involved in China's relevant laws and regulations and no concrete and complete management system has been formed. The regulations about environmental risk management system by the

Chinese law are still by principle and rough and have not reached the point of legal standardization, routinization and institutionalization.

2.2.2.3 Problems and challenges

With the deepening of the academic research and on the publishing of environmental risk management legislation, policy and systems, the risk prevention and management has become a hot focus. In general, the current environmental risk assessment and the prevention and control still have the following problems:

(1) Different from foreign environmental risk assessment and regulatory objects, which are chemicals and pollutants, and out of the monitoring and control of hazardous chemicals, prevention and control of environmental risks by acute accidents, environmental risk classification management on construction projects and regional watershed, etc., the objects of the environment risk assessment and management include chemicals, construction projects, industrial parks and regional (basin), etc. The corresponding evaluation methods and the technical specifications are published in parallel. However, due to lack of top design for the system and each department separately making rules, the documents and guidelines have crossings and some enterprises face duplicate regulation problems.

(2) The current environmental risk management mostly relies on the investigation, troubleshooting and regulation by government departments, the enterprises are not carrying out enough risk management as their main responsibilities and most enterprises are lack of awareness of environmental risk management and the enthusiasm is not high enough. In addition, the environmental risk management is of more administrative control measures. Although the environmental pollution liability insurance and other economic means are applied, because of the lack of laws and regulations, policy system and technical methods to form a complete set, its application effect is not ideal.

(3) The targets of environmental risk prevention and control are not clear and the means are unknown. We don't know the acceptable level of environmental risk and neither do not know what exact method we can carry out to reduce the risk under the acceptable level. Under the current stage of economic development, environment and the public demands and facing the present situation which is becoming more and more serious, what is the goal of environmental risk control and how to determine it are still

problems to be solved. Therefore, the environmental risk management becomes a hindrance. In addition, the lack of research on the effects of risk control measures has led to that the level of current environmental risk regulation couldn't be determined and there is no way to analyze whether the objectives of the risk control could be achieved.

2.2.3 Applications of GAINS model and CGE model

2.2.3.1 GAINS model

The Greenhouse gases and Air pollution Interactions and Synergies (GAINS) model reflects the information of gaseous pollutants and greenhouse gas, such as their sources, influences and interactions between the two, along with the data of economic development, structure, the potential control method and costs of the emission sources. It is also composed of the formation and diffusion of atmospheric pollutants and the environment impact assessment of the pollution. The model simulates the effects of gaseous pollutants on human health, including the fine particulate matters, ground level ozone and its damage to plants, terrestrial and aquatic ecosystem acidification and effects of excess nitrogen deposition on soil. GAINS model can also describe the complex effects of pollutants such as O₂, NO_x, PM, NMVOC, NH₃, CO₂, CH₄, N₂O and fluorine-containing gases.

The application of GAINS model in China has just started. Tsinghua University and the Institute of Agricultural Environment, Energy Research and Sustainable Development of Chinese Academy of Agricultural Sciences are applying it to the scenario research of greenhouse gas emissions and pollutants emissions and other field. The Geosciences Center of Tsinghua University and the International Institute for Applied System Analysis of Austria (IIASA) are conducting an international cooperation project named "The development and application of GAINS - City model in Chinese cities". The project, taking GAINS as the chief source, develops the city version and applies it in China to quantitatively assess the greenhouse gases and air pollutant emissions in the course of urbanization and to look schemes of emission reduction. Li Yingchun⁵ and other scholars from the Institute of Agricultural Environment and Sustainable Development of

⁵ Li Yingchun. Agricultural nitrous oxide emissions and mitigation potential in China[D]. 2009. Institute of Agricultural Environment: Beijing

Chinese Academy of Agricultural Sciences have used GAINS model for studies of agricultural nitrous oxide emissions scenario and emissions reduction potential of China. Li use GAINS model to estimate the SO₂ emission of the manure management system. The research needed the factors as follows: (1) all kinds of animals in the solid waste treatment system and liquid manure treatment system; (2) nitrogen excretion rate; (3) the nitrogen volatilization rate of the manure indoor and outdoor storage; (4) the annual milk yield. The GAINS model includes the activity data and emission factors input module, method of reducing N₂O emissions, the leaching of N, computing module and result output module.

GAINS model can be used in the field of regional air pollution risk about health and ecology, and it can simulate the concentration and distribution of the pollutant, as well as the analysis of relationship between pollution emission and health and ecology damage. Recently, there are few institutions use GAINS in the field of air pollution and climate change simulation, it is necessary to carry out some training about GAINS in China, let more researchers know and use the GAINS model.

2.2.3.2 CGE model

The research of Computable General Equilibrium (CGE) model started relatively late in China. The main work is to analyze the transformation characteristics during China's economic reforms. Feng Shan⁶ in 1989 established the earliest multi-sectoral CGE model of China - C-CGE. In 1995, the Development Center of the State Council of China had an international cooperation with the OECD Development Research Center and developed a prototype of CGE model of China's economy containing 64 departments. Since then, the Chinese Academy of Social Sciences also had cooperation successively with Monash University of Australia and the Netherlands Central Planning Agency. Based on ORANI-G framework, they introduced the Chinese economic characteristics during the transition since the 1990s into the model, including the new changes of economic system (i.e., trade system) and development pattern and built a CGE model of the Chinese economy -- PRCGEM⁷. on the inheritance of Australia's Monash model, it also developed a general

⁶ Feng Shan. Computable general equilibrium model C-CGE of Chinese economy system[J]. System engineering theory and practice. 1989:4:32-39

⁷ Fan Mingtai, Zheng Yuqin. General equilibrium analysis of impacts of trade liberalization in Chinese economy[J]. World Economy. 2000:4:16-26

equilibrium model for China's economy trends. In the model, by simulating the influence to industrial structures and employment factors through labor supply increase and three different technology progress factors - intermediate input economical, labor saving, and capital saving technical improvement, China's economic growth and structural changes are analyzed on medium to longer terms. Duan Zhigang⁸ established a computable general equilibrium model reflecting commodity trade between regions, the Labor factor flow, the middle and secondary tax and expenditure system of local government at the Provincial level characterizing regional economy, Provincial Dual Region Computable General Equilibrium Model, (Hereinafter referred to as PDRCGE).

Fan Taiming and Zheng Yuqin used agriculture CGE to analyze the food security impact of China's trade liberalization. The static part contained production decision module, domestic final demand module, international trade module, price, market clearing, the total amount of definition, the supply of factors. And the characteristic of the agriculture CGE was the agricultural products classification, agricultural policy tools and its mechanism of action refinement, and rural independent distinguish.⁹ Fan's research supported the free trade negotiation.

Huang Yingna used Chinese environmental CGE to analyze the economic impact of cleaner production and pollution tax subsidies and the relationship between capital, labor and energy¹⁰.

At present, the Chinese scholars are using CGE model in the fields such as environmental protection tax and price policy making, environment pollution prevention and control policies concerning water, air and solid waste, emissions trading, reduction of greenhouse gas emissions, climate disaster impact assessment, water source pricing, water rights policy research, land resources and mineral resources price policy research.

But the hypothesis of the CGE model is still exist and the uncertainty of the model sometimes is hard to control, they are the difficult problems of carrying out the research

⁸ Duan Zhigang, Li Shantong, Wang Qiwen. Analysis of input coefficient change in Chinese input-output table[J]. China soft science. 2006: 8:58-64

⁹ Fan Taiming, Zheng Yuqin, Qi Shuchang, et, al. China's trade liberalization and its impact on food security- an application analysis of Chinese agriculture based on CGE model[J]. Agriculture economy. 2005: supplement: 3-13

¹⁰ Huang Yingna, Zhang Wei, Wang Xuejun. An econometric estimation and selection on the production function in an environmental CGE model[J]. Acta scientiae circumstantiae. 2003. 23(3): 350-354

result to decision making. Actually only few research by the CGE model can give support to simulate the scene of pollution control and other environmental regulation, but it still need more practice.

3 Research and Practice at Provincial and City Level

3.1 Jiangsu Province

Jiangsu is a province on the east coast of China, north of Shanghai, with a population of 79 million and an area of 102,600 km² (roughly the size of Iceland). The capital of Jiangsu is Nanjing (pop. 8.2 million). Jiangsu is an economically advanced province with one of the highest GDP per capita (68 347 RMB, 2012) and economic growth rates in China. Economic development is, however, primarily concentrated in the southern part of the province. Since 1949, Jiangsu has developed heavy industries such as chemicals industry and construction materials. Today, the most important industries are machinery, chemicals, electronics, automobiles and solar industry. The majority of the population in Jiangsu lives in densely populated urban areas where environmental risk factors are complicated and numerous, road capacity is relatively insufficient, and the access to space and natural and ecological lands is rare.

3.1.1 Environmental risk introduction and its characteristic analysis

3.1.1.1 Environmental risk introduction

Jiangsu Province now is in a rapid economic growth period and its economic development model is changing from extensive economy to intensive economy. As Jiangsu is a province with rapid urbanization, the majority of its population inhabits cities and towns where risk factors are complicated and numerous, population and buildings are very dense, open space and natural and ecological lands are rare and road capacity is relatively insufficient. This goes against taking emergency measures to evacuate population in case of sudden environmental events. Once a major environmental risk spreads to the cities and towns, it may evolve into an omnibearing crisis and brings the cities and towns to a standstill.

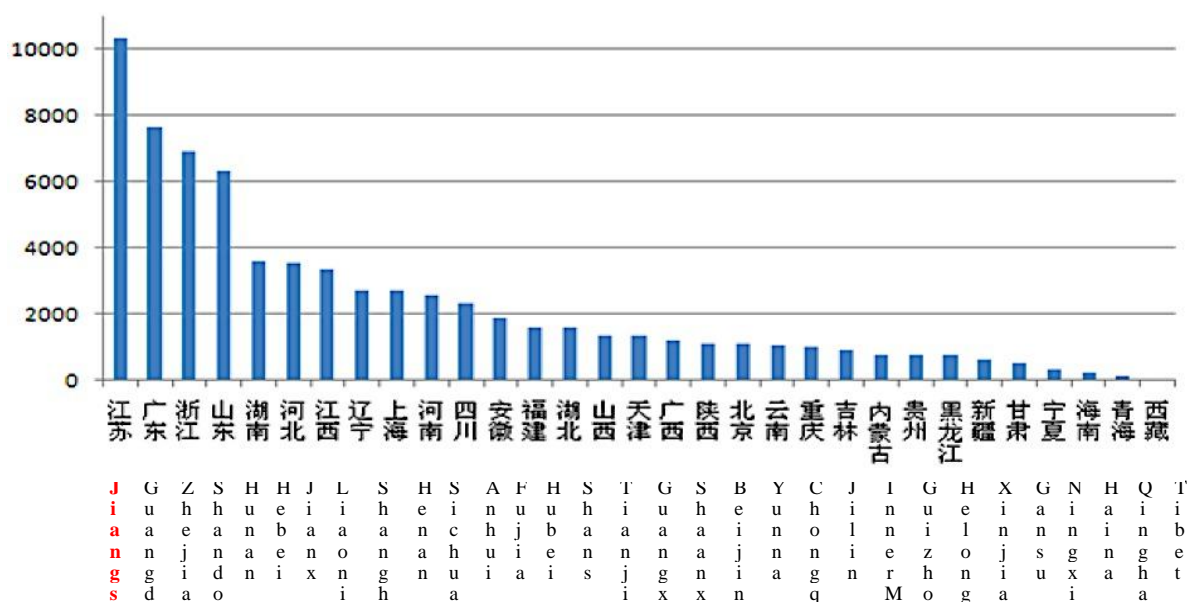
In such a great background, Jiangsu faces more environmental risk factors than ever and other cities. The data released by the Ministry of Environmental Protection¹¹ indicates that in 2004-2009, Jiangsu had totally 55 sudden environmental events, ranking the second in the country, and it included 3 extremely consequential events (totally 8 in the country) and 5 consequential environmental events.

3.1.1.2 Environmental risk characteristic

From the environmental safety event information handled by Jiangsu Environmental Emergency Response and Accident Investigation Center, check for environmental risks and chemicals for major industries and enterprises in Jiangsu, check for potential environmental safety hazards in the whole province and 100-day major environmental safety inspection, it is summarized that environmental risks in Jiangsu Province have the following characteristics in regional and industrial distribution, formation and breakout mechanism.

(1) Risk sources are large in total, small scaled and dispersedly distributed.

Jiangsu is a big chemical industry province and has totally 38,000 chemical enterprises¹². The Ministry of Environmental Protection carried out check work for environmental risks and chemicals for major industries and enterprises in the country in 2010.



¹¹ China Statistical Yearbook on the Environment 2004-2009.

¹² Report on the major industries environmental risk and hazardous chemical examination in Jiangsu province.

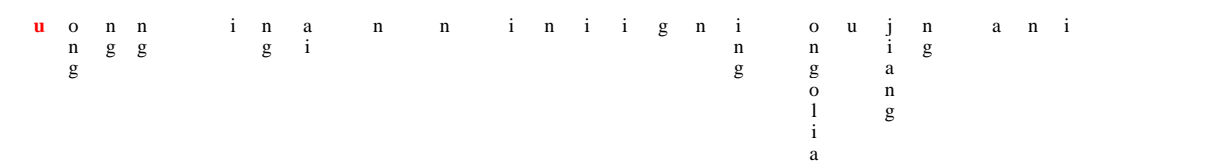


Figure 3.1 Number of Major Environmental Risk Source Enterprises in Provinces in China

According to the critical quantity of the chemical in the enterprise, Jiangsu have 10,332 enterprises which the quantity of chemical is higher than the critical quantity, accounting for 14.6% total number of enterprises checked in China and ranking the first among provinces and cities (see Figure 3-1). Environmental safety information statistical data¹³ shows that traffic accidents have become an important factor that induces environmental pollution events while supervision and control of mobile source environmental risks is difficult and urgently needs recognition and enhancement.

(2) Regional distribution of environmental risks is highly different

Due to different distribution factors and environmental risk prevention and control and emergency response capability among industries and trades, regional difference of environmental risk distribution in Jiangsu Province is high. From the statistical results of major risk source enterprises (Figure 3-2), it can be seen that Suzhou, Wuxi and Changzhou, three municipalities directly controlled by the provincial government, have the largest number of major risk source enterprises. Because of large quantities of major risk source enterprises and compact distribution, the environmental risk triggered by distribution is prominent. In addition, environmental safety event quantity and risk source distribution show a significant correlation. Statistical results in 2007-2010 indicate that Nanjing, Wuxi, Zhenjiang and Changzhou, four cities in south Jiangsu, had the largest number of environmental safety events while Xuzhou, Huaian, Lianyungang and Suqian Cities had the smallest number. As most chemical and petrochemical projects are distributed in South Jiangsu and regional economic development is rapid,

¹³ China statistical yearbook on environment 2004-2009.

the total number of environmental safety events is larger and the hidden environmental risk as a whole is greater in the South Jiangsu than in the central and North Jiangsu. Due to difference in environmental management and emergency response capability, however, environmental risk, if broken out in the North Jiangsu, is more liable to cause sudden consequential and extremely consequential events.

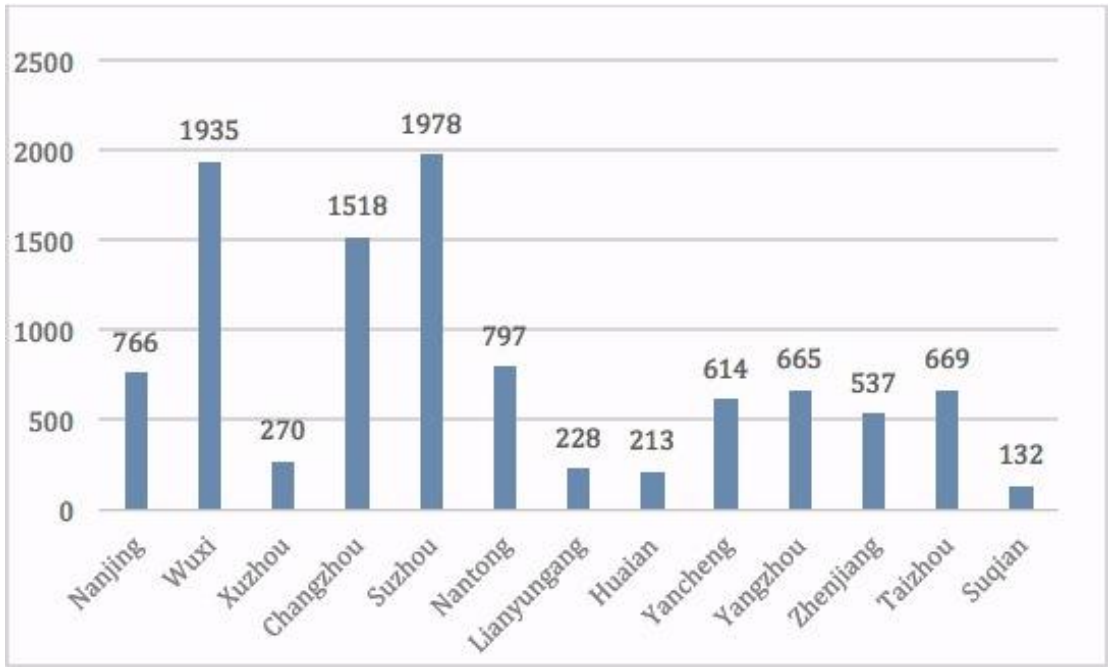


Figure 3.2 Number of Major Environmental Risk Source Enterprises in Municipalities Directly Controlled by Jiangsu Provincial Government

(3) Chemical raw materials and chemicals manufacturing industry has a prominent environmental risk

Chemical raw materials and chemicals manufacturing industry is an industry that involves the most environmental safety information and such enterprises use various chemicals in production and have a long process flow, many side reactions, complicated operating conditions and equipment and many various leak points and dangerous links. The waste discharged by them often contains chemical substances that are toxic and hazardous or difficult to naturally degrade and tends to cause leakage and further environmental risk accidents, thus environmental risk is relatively prominent.

Tabell 3.1 Environmental Safety Information Quantity for Major Industries(2010)

Name of industries involved	Environmental safety information quantity (piece)	Percentage (%)
1 Chemical raw materials and chemicals manufacturing industry	172	69.4%
2 Petroleum refining, coking and nuclear fuel processing industry	15	6%
3 Waste resources and waste and old materials recovery and processing industry	11	4.4%
4 Medicine manufacturing industry	6	2.4%
5 Water production and supply industry	4	1.6%
6 Other industries	40	16.2%

(4) Structural and distribution environmental risks keep emerging

Jiangsu Province has a large number of high-risk industries and enterprises whose production value is high and percentage is large. Such industrial structure leads to high overall environmental risk in Jiangsu. Some of them were built in 1980s and have backward production processes and aged equipment and some even have exceeded the scrapping year, thus having a great hidden environmental risk. The large number of such high-risk enterprises and high percentage of heavy chemical industry give rise to high frequency of sudden environmental events in Jiangsu Province. Furthermore, many heavy chemical enterprises are built along rivers, near lakes and adjacent to the sea and some even are distributed in the upper reaches of urban drinking water source protection zone or adjacent to concentrated residential areas. Once an accident occurs, it will directly threaten the safety of hundreds of thousands of people. Distribution hidden environmental risk and structural environmental risk will substitute individual pollutions and become the main environmental risk that is here to stay in Jiangsu Province.

3.1.1.3 Environmental event characteristic and genetic analysis

Environmental risk source is formed and characterized by many factors and new features keep emerging as the situation changes. For some environmental pollution events, the direct cause is enterprises' safe production or natural disasters and it reflects the problems accumulated by extensive and unplanned economic growth models at a deeper level.

(1) Heavy chemical industry percentage is high and high risk enterprise quantity is large

Due to undue emphasis on economic development and especially the growth of GDP, leaders in some places think that pure economic growth equals to economic development. In order to pursue GDP growth, they blindly introduce high input, high consumption, high emission and high environmental risk enterprises, which make the percentage of the heavy chemical industry grow continuously to increase regional environmental risk. Jiangsu is a big industrial province and a big chemical province and all cities along rivers choose the heavy chemical industry as the main industry for major development along the rivers.

(2) Some risk enterprises are located in environmentally sensitive areas and accident hazard is great

For many factors such as historical reasons and developing speed, risk source enterprises in Jiangsu are in large quantities and some enterprises are not reasonably distributed and are close to environmentally sensitive areas such as drinking water source areas and residential areas. Once a sudden environmental event occurs, the consequence will be very severe.

The inspection results of environmental risks and chemicals for major industries and enterprises in 2009 show that the number of risk source enterprises in the Taihu Lake, Changjiang River and Huaihe River basins is 72% total. Quite a few major rivers and lakes in these three basins are important drinking water source areas whose safety is much threatened by pollution discharge ports into the rivers. Following the blue algae event in the Taihu Lake, almost all water intakes of all cities along the river in Jiangsu are from the Changjiang River but in the same time a large number of heavy chemical enterprises and especially some enterprises that produce and use extremely toxic substances (chromic salt, sodium cyanide) are also distributed along the Changjiang

River. Pollution discharge ports and waterworks water intakes are staggered. More serious is that spare water sources for all cities are also in the Changjiang River and they cannot play a due role in case of emergency.

Secondly, in some cities and industrial development zones, due to lack of rational planning, disordered industrial distribution, mixed industrial areas and residential areas, energy pipe networks are spread underground all over cities and extensive construction of petrochemical and organic chemical areas leads to more and more frequent occurrence of environmental events. The consequences are more and more serious and mitigation measures are more and more complicated.

(3) Environmental emergency management force is weak and difficult to respond to the austere situation

In emergency materials, some enterprises lack environmental emergency facilities and equipment, park zones and administrative regions fail to reserve emergency rescue materials according to risk factors and environmental pollution accident types. After an accident occurs, pollution cannot be treated promptly and thus event influence becomes serious and the situation is further deteriorated. Presently in some regions in Jiangsu, an emergency rescue team has not been organized for accidents and pollutants and the emergency rescue team lacks professional knowledge and is not experienced. After an accident occurs, the emergency rescue team cannot be assembled and dispatched smoothly and cannot carry out emergency response work in an ordered and highly efficient way. Due to lack of guidance by knowledgeable experts with actual working experience, improper accident emergency measures will cause secondary pollution.

3.1.2 Present situation of environmental risk management in Jiangsu Province

3.1.2.1 Environmental risk evaluation and management

(1) Check hidden environmental risks

Jiangsu Province started to check environmental risks and chemicals for major industries and enterprises in the country in 2009 and now has completed basic environmental risk information entry for more than 7,000 enterprises and found out environmental risks for chemical industry enterprises. It has a comprehensive knowledge of raw materials, products, types and quantities for chemicals manufacturing

industry, petrochemical industry and medical industry, a comprehensive knowledge of distribution of environmental risk sources in basins, a comprehensive knowledge of enterprise environmental risk unit risk prevention situation, a comprehensive knowledge of enterprises' environmental emergency disposition and emergency rescue resources and a comprehensive knowledge of distribution of environmental protection targets around enterprises.

It comprehensively organized and carried out special check actions for potential environmental safety hazards and defined and rectified potential environmental safety hazards by checking on the spot, establishing archives, urging to handle by levels and supervising at provincial level. At the same time, Jiangsu Department of Environmental Protection (EPB), in accordance with the deployment of the State Council, organized and carried out a major check for land sourced oil spill risks in the coast area in the province jointly with six departments including the Department of Land Resources. They checked all land sourced oil spill risk sources in Nantong, Yancheng and Lianyungang Cities and have basically known the land sourced oil spill risk sources in Jiangsu.

By determining the environmental risk level evaluation methods for centralized drinking water source areas and chemical park zones, it organized and carried out environmental protection department self evaluation and expert on-the-spot evaluation to find out regional environmental risk level.

According to environmental risk check results, it formulates the major environmental risk enterprise rectification and prevention and control scheme in Jiangsu Province and carries out rectification and improvement actions. It establishes major environmental risk enterprise elimination mechanism and organizes and carries out the special rectification and check action for potential environmental safety hazards. It includes the annual special major environmental risk rectification and check in the local government's annual assessment and implements regional restricted approval for the regions that still have a relatively high environmental risk after rectification.

(2) Establish sudden environmental event emergency plan system

For the problems existing in Jiangsu's emergency plan such as low operability and practicability and that plan preparation becomes a mere formality, it includes plan contents in the routine environmental law enforcement range and carries out plan

management in five aspects of risk evaluation, professional compilation, professional audit, publication for operation and periodical check.

Push forward the standard compilation of emergency plans at enterprise, park zone, department and sensitive target levels. It issued the “Guidelines for Compiling the Emergency Plan for Sudden Environmental Events in Jiangsu Province” for risk sources and risk source concentrated areas, completed the “Guidelines for Compiling the Emergency Plan of Sudden Environmental Events for Environmental Protection Authorities in Jiangsu Province” and compiled the “Guidelines for Compiling the Emergency Plan of Sudden Environmental Events for Sensitive Protection Targets in Jiangsu Province”. In addition, it compiled the “Emergency Plan for Sudden Environmental Events of Jiangsu Department of Environmental Protection” (2009 revision) and printed and issued the “Emergency Plan for Sudden Pollution Events in Centralized Drinking Water Sources in Jiangsu Province” jointly with Jiangsu Department of Water Resources and Jiangsu Department of Health.

It carried out experimental spot work for whole process management including emergency plan compilation, evaluation, archiving and drilling. In plan compilation, it chooses chemical enterprises, dangerous chemicals warehousing organizations, waste water plants and papermaking and printing and dyeing enterprises to compile the emergency plan, which is very typical. In plan evaluation, environmental protection authorities, enterprises and scientific research institutes participate to a different extent. In archiving, environmental protection authorities play a leading role and have basically developed a unified archiving form and preliminarily summarized and made a whole plan process management model. In compilation, enterprises are the first responsible subject and depending on the actual conditions, implement the requirements of the “Guidelines” by self-compiling or entrusting the third party with compilation. In evaluation, enterprises’ internal audit and expert external audit are combined and the environmental protection authorities audit the elements and forms for the enterprises’ plan compilation. Archiving is made by class and level according to enterprise environmental risk levels. Major risk sources are archived in the provincial department, relatively large risk sources are archived in the municipal bureau and average risk sources are archived at the county and district level.

(3) Establish the early warning and monitoring system

Enhance scientific and technological early warning level. By relying on the “1831”¹⁴ ecological monitoring platform project, complete the experimental spot chemical park zone monitoring and early warning project and develop the remote monitoring and early warning capability for water and air environmental risks. Initiate the construction of the provincial environmental protection emergency monitoring center project, realize dynamic monitoring and early warning for major pollution sources in the Taihu Lake basin area, improve the environmental risk information release platform and quick release mechanism, periodically or aperiodically release various environmental risk information, strengthen early warning response capability building and standardize and refine various early warning response measures and coordination and interaction mechanism.

Regulate information reporting work. The “Notification on Further Strengthening Environmental Emergency Information Reporting Work” was issued to establish the “daily reporting” system for sudden environmental event information in the provincial environmental protection system and it requires environmental protection bureaus of all municipalities directly controlled by the provincial government to daily summarize and report the 24h sudden environmental event information to Jiangsu Department of Environmental Protection. In addition, several documents including the “Notification on Further Strengthening Sudden Environmental Event Information Reporting Work” and the “Notification on Further Regulating Sudden Environmental Event Information Reporting Work” were issued to clearly specify the range, time limit and format of sudden environmental event information reporting and the level of the provincial sudden environmental event information reporting work is thus enhanced significantly.

Strengthen the risk early warning work for environmentally sensitive protection targets like drinking water source area. Focusing on safety control work for drinking

¹⁴ 1831 means one ecological environmental monitoring platform, eight sub monitoring systems, such as drinking water sources, water environment, atmospheric environment and so on, there class ecology center at province, city, county, and one data management module.

water source areas, Jiangsu Province carried out drinking water source area patrol inspection and daily reporting work. It chooses the regions with low risk resistance ability to conduct potential environmental safety hazard pilot check for intra-regional drinking water source areas and prepares the provincial drinking water source area environmental risk resistance ability project construction scheme. It has completed the construction scheme for the system of environmental risk level evaluation for centralized drinking water source areas at county level and above and drinking water source area prevention and control and the eight cities along the river have formulated the emergency treatment implementation scheme for sudden pollution events in the Changjiang drinking water source area. Thus the environmental safety guarantee ability for drinking water source areas is further enhanced.

Increase environmental emergency attendance and dispatch force. The province has arranged a departmental general attendance (emergency attendance) room, established and improved the sudden environmental event information analysis, reporting and attendance special reporting system and realized a top-to-bottom 24h emergency attendance system in the province. Jiangsu Department of Environmental Protection revised and issued the “Measures of Jiangsu Province for Reporting Sudden Environmental Event Information” to quarterly report the situation of environmental safety information reporting and emergency attendance in the province and further promote the execution of the 24h emergency attendance system in all places. It exercises strict management and periodically carries out the provincial environmental emergency attendance dispatch to ensure smooth communication. It strengthens the emergency preparation work for personnel, vehicles, materials, instruments and equipment.

(4) Rapidly push forward the building of the emergency response system

In 2013, the provincial environmental emergency response team ability building is accelerated and with the “provincial level environmental emergency response team ability first class standard pilot creation” as an opportunity, the provincial, municipal and county level environmental emergency response and risk management organization system is built and improved. Construction of emergency command systems at all levels is quickened. The provincial level environmental emergency response mobile command platform optimization and upgrading project was smoothly completed and the advanced “space earth integration” concept and the mature technology of satellite communication

in statics were used to meet the all weather work need of the mobile command platform. Input of emergency vehicles and equipment was increased.

Environmental protection authorities in all places take the “five earliest-times” action to cooperate with the department concerned in handling and responding to the events under the unified leadership of the government. Perform emergency monitoring for the surrounding environment involved by the accidents and provide data support for judging pollution trend in a scientific way. Organize related experts to actively study and discuss and propose the technical scheme for promptly and effectively handling pollution events and report to the government for execution. Promptly collect pollution accident information and conduct information reporting work. Organize personnel to carry out environmental restoration work on the spot and make efforts to eliminate secondary pollution. Strengthen postmortem management. While handling the consequential and extremely consequential sudden environmental events, carry out pollution damage evaluation to provide basis for event classification, responsibility ascertainment and environmental rights and interests maintenance.

(5) Environmental emergency guarantee ability building

Establish and improve the socialized emergency team material reserve. In emergency rescue team building, organize all places to investigate and learn about the emergency treatment team and complete information collection and summarization work. Presently, Jiangsu Province has 88 various emergency treatment teams engaged in many rescue fields including water, air and solid waste. In emergency material reserve, the intra-regional circular emergency material reserve mode is summarized and realized. On the basis of purposely learning about the products and raw materials from the chemical enterprises in the region, the environmental protection authorities take the lead in building an emergency rescue material chain including manufacturers’ products and raw materials and develop an emergency material circulation network and corresponding transfer mechanism.

Enhance the environmental protection authorities’ emergency response team ability level. For the first time the province used the form of provincial environmental emergency response ability competition to promote environmental emergency management awareness and increase environmental emergency management skill. Every year, 40 emergency management persons are tested for skills in emergency

command car butt connection and sudden environmental event simulation. This has expanded environmental emergency management trainees, increased the emergency management training pertinence and successfully completed the training tasks for the provincial environmental protection authorities and enterprises' environmental emergency management personnel. Jiangsu Department of Environmental Protection actively grasps the opportunity of the country-wide environmental emergency ability standardization creation and has become the first demonstration organization in the country for the "provincial level environmental emergency response first class standard creation".

Improve emergency response expert participation mechanism. The provincial department issued the "Measures of Jiangsu Province for Environmental Emergency Response Expert Panel Management" (tentative) to further improve the expert participation mechanism. This further substantiates the provincial level environmental emergency response expert database and increases the coverage of experts in all industries and fields. Now provincial level expert database and city level expert database have been established.

All out push forward emergency response scientific research. The "Theory and Practice of Environmental Emergency Management" compiled collectively by staff from the provincial center and the "National Sudden Environmental Event Emergency Handling Evaluation System" and the Ministry of Environmental Protection topics of "National Environmental Emergency Ability Standardization Acceptance Method" undertaken by the provincial center.

(6) Progress of environmental risk emergency interaction work

Platform construction. All out push forward the emergency informatization work focusing on emergency command platform and advance the trans-regional and trans-sector emergency interaction platform construction work. According to the requirements of the Yangtze River Delta region environmental cooperation agreement, establish the trans-boundary environmental pollution dispute handling and emergency interaction platform with Shanghai and Zhejiang and organize and carry out the joint potential environmental safety hazard check action in the junction of Jiangsu, Zhejiang and Shanghai.

In 2012 it issued, jointly the provincial safety supervision bureau, the “Notification on Further Carrying out the Emergency Handling Work for Secondary Environmental Pollution from Production Safety Accident” and issued, jointly with the provincial public security department, the “Notification on Further Strengthening the Emergency Handling Work for Secondary Environmental Pollution from Traffic Accidents of Dangerous Chemicals Transport Vehicles on Expressways in Jiangsu” to preliminarily establish the joint response and information intercommunication mechanism for secondary environmental pollution from safety production accidents and dangerous chemicals and hazardous waste transportation accidents. It has strengthened the trans-regional emergency interaction to increase multi-sector joint prevention and control ability. Thirdly, it developed the trans-regional and multi-sector emergency interaction ability along the Yangtze River and successfully held the “Changan No.1” comprehensive drill for sudden environmental pollution event in drinking water source areas along the river.

(7) Demonstrative emergency drill

Presently it has been made clear to establish the drilling system on the basis of four types of sudden environmental event plans including environmental risk sources, risk source concentration areas (industrial park zones), sensitive environmental protection targets and environmental protection authorities.

To carry out drinking water source area emergency drill demonstration and aiming at drilling in responsibilities, procedures, technologies and coordination, the municipal government takes the lead and the safety supervision, public security, water resources, fire fighting and construction departments jointly participate. In 2012, environmental protection authorities in all places in Jiangsu jointly conducted more than 30 various emergency drills and major risk enterprises and chemical park zones conducted over 100 emergency drills. The practical emergency response ability was inspected and enhanced.

The enterprise-oriented emergency response concept emerges in the drills, the background of demonstrative emergency drills is more diversified and regional features of emergency drills are more prominent.

3.1.2.2 Prevention and control of environmental risks involved in environmental planning

Jiangsu attaches great importance to prevention and control of environmental risks and mentions the major fields and main tasks for prevention and control of environmental risks in several environmental plans. Jiangsu Twelfth Five Year Plan for Environmental Protection and Ecological Construction definitely requires that environmental supervision and management and risk prevention ability should be enhanced markedly in 2015. In this plan, county and township centralized drinking water quality compliance rate will reach 100% and 95%, the percentage of urban household waste and sewage safely handled should reach 100% and 90%, the annual pollutant emissions quantities of COD, NH₃-N, SO₂, NO_x will reduce to 112.80mt, 14.04mt, 92.50mt, 121.40mt. The annual Phosphorus emissions in Taihu Basin will reduce to 0.40mt.

It makes the main tasks in the plan to strengthen environmental risk source management, prevent and control environmental risks of dangerous chemicals, enhance environmental risk prediction and early warning, protect the safety of sensitive protection targets and increase environmental risk prevention guarantee level.

In the Twelfth Five Year Plan period, Jiangsu Environmental Risk Prevention and Control Plan proposes to preliminarily build the modern environmental emergency management system that tallies with Jiangsu's condition, improve the environmental emergency management system of classified management, graded responsibility, combination of central and regional system while giving priority to dependency, establish the environmental emergency management mechanism of unified command, sensitive response, ordered coordination and highly efficient operation and basically form the "full prevention and full control" environmental risk prevention and control pattern. Thus environmental emergency ability is comprehensively enhanced and various sudden environmental events can be effectively addressed. To the end year of planning, the document constructs rate of province key industries environmental risk source will reach 100%, and the environmental emergency plan record rate of national monitoring key enterprises, province key environmental risk sources and concentrating area will reach 100%, there will be 50% key environmental risk point should be monitored and emergency mechanism of all the city and 60% counties should be set up to 2 level, 14 provincial environmental emergency response team will be established

and 13 emergency response material storage will be built. It proposes more than 10 major projects such as environmental risk source investigation project for the major industries in the province, environmental risk monitoring point construction project and drinking water source area risk prevention and control project. The major projects are investigation of environmental risk source of major industry; construction project of environmental risk monitoring; risk prevention project of drinking water sources; Environmental emergency response planning project; provincial environmental emergency response standard construction; city, county environmental emergency response standard construction; typical region environmental emergency response capacity construction; environmental emergency platform of province; environmental emergency materials network and emergency response team construction. The pollutant emission reduction projects, water environment quality improvement project, air quality improvement project, city environmental comprehensive renovation project, rural environmental project, ecological protection and construction project and environmental regulation project are given with the plan.

Jiangsu province issued “River-shore Transformation 5 years Plan (2013-2017)” in 2013. It defined that the environmental protection investment to GDP ratio would achieve to 3.4% and the industrial sewage discharge compliance rate would rise to 100% in 2017. In order to improve the condition of air pollution, the total emission of SO₂, NO_x and the smoke dust would be controlled in the river-shore. The industries of the iron, steel, cement, printing and dyeing, as well as chemical and heavy metal will be the key industries to management, some factories which is high energy consumption, heavy pollution, and safety and environmental risk will be eliminated. The regulation about environmental impact assessment should be strictly implement, and the environmental law enforcement supervision should be strengthened.

3.1.3 Environmental risk management work faces a huge challenge and opportunity

3.1.3.1 Problems for prevention and control of environmental risks

Although Jiangsu has made some achievements in environmental risk management, it faces a huge pressure and challenge in environmental safety guarantee tasks as a whole. Presently the main existing problems are: traditional industrial development model

leads to ecosystem unbalance and regional environmental risk keeps enlarging. Industrial structure is not rational and environmental risk prevention and control difficulty is great. Some enterprises have backward production processes, discharge of pollutants is difficult to stably reach the standard and illegal pollution discharge cannot be stopped despite repeated prohibition. Environmental risk prevention and control awareness is weak and prevention work is not properly done. Environmental risk management system is still unsound.

3.1.3.2 Need of environmental risk prevention and control

(1) Adjust and optimize industrial structure layout

Environmental risk management is long term work and a complete system should be developed from macroscopic economic policy to industrial planning and further to enterprise individuals. Intensive development model should be established, industrial layout should be rationally planned and monitoring and control and management of existing risk sources should be enhanced. Admittance threshold for new enterprises should be increased and the strategy of administrative means and economic lever in combination should be used to actively control and reduce the environmental hazards caused by individual enterprises during economic development.

(2) Improve environmental emergency management mechanism

Improve environmental emergency management rules and regulations, strengthen environmental emergency management ability building, smooth environmental emergency management system and establish the sudden environmental event early warning and handling mechanism participated by all sectors.

(3) Move forward the environmental risk prevention and control threshold

Environmental risk management is not only a type of non-normal management and pre-prevention and mid-response are two inseparable parts. Risk management is based on normal management and plan, drill and risk source check and treatment work can greatly reduce risk prevention and control pressure. According to the principle of “focusing on prevention and combining prevention and emergency response”, strengthen risk prevention and control work, move forward risk prevention and control pass and minimize environmental risk breakout probability. Build an omnibearing and multi-level environmental emergency plan system, organize and carry out standardized environmental emergency response drill, push forward regional environmental risk

control construction project and increase environmental risk source check and treatment.

For the sudden pollution accidents in various conditions, formulate scientifically demonstrated, pertinent, rapid and highly efficient systematic prevention and control measures and especially strengthen the preparation work of emergency prevention and control plan for sudden pollution accidents. Build an omnibearing and multi-level environmental emergency plan system at government special project, sector, sensitive protection target, park zone and enterprise levels, define the subjects to which the plan applies, make clear the level and relations between plans, provide guidance on preparation and improvement of various plans and actively do emergency preparation work for various environmental accidents. Strengthen the whole process management including plan preparation, evaluation, archiving, drill and update and make efforts to improve plan quality and efficiency.

In recent years, although many places and organizations have conducted various emergency drills and obtained good effects, their drill types, scales, contents and procedures are different and some emergency drills are not pertinent or highly practicable. Also no evaluation is conducted after drill and the plan is not improved. Studying and issuing the environmental emergency drill guidelines can guide all places and organizations to conduct emergency drill work in a standardized way, clearly specify the definition, purpose, content, procedure, organization, implementation, monitoring and evaluation of environmental emergency drills and regulate evaluation and summarization of emergency drills and subsequent actions after them so as to provide a good guidance and standardization for emergency drills and increase the environmental safety level of all industries.

Aiming to guarantee the environmental safety of sensitive areas in the province, build the provincial sensitive area emergency response line of defense in the light of the regional environmental risk extent and push forward, by class, the building of intra-regional environmental risk resource emergency prevention and control ability. Conduct environmental risk source emergency prevention and control building action in the >10,000t centralized drinking water source areas and then gradually disseminate it and practically build several powerful lines of defense between risk sources and sensitive protection targets so as to ensure the water supply safety of centralized drinking water source areas and the people's life and health.

Carry out environmental safety production check periodically and aperiodically and especially check the important process systems, infrastructures, technical equipment, operation environment and prevention and control means and mainly prevent and remove accident potentials. Strengthen equipment service and maintenance, enhance operators' technical training and evaluation, implement stringent reward and punishment system and reduce equipment and human error rate. Strengthen routine management of enterprises qualified for transporting dangerous chemicals, improve safety and technical performance of transport vehicles and give them periodic check and maintenance. For the vehicles used for trans-regional transportation of dangerous chemicals, conduct pre-departure on-line test and perform remote monitoring and control by the satellite positioning system. Enhance management for transport personnel and transport escorts and strengthen training and examination for them and make them work by permit.

(4) Carry out theoretical and technical research for environmental emergency response

Presently, the technical support system corresponding to the three stages of “pre-prevention and control, mid-response and treatment and afterwards evaluation and restoration” of environmental emergency response has not been established. Due to lack of technical guidance and guide manuals such as preparation of environmental emergency plans, quick detection of typical pollutants and on-the spot treatment schemes, environmental protection authorities at the grass-roots level are unable to emergently treat environmental accident site in a scientific and efficient way and can only ask for help from the higher level departments and wait for treatment scheme from environmental protection experts, which misses the best opportunity of environmental emergency response. It is necessary to enhance theoretical research on environmental emergency response, build an environmental emergency management information system, study emergency treatment specifications for sudden environmental events and provide technical support for environmental risk prevention and control and environmental event treatment; use urban geological information system to establish environmental risk source database, build an environmental risk prevention and control system and provide effective technical support for emergency treatment of accidents.

(5) Strengthen environmental safety propaganda

Pay attention to propaganda and education of environmental safety knowledge, increase social risk awareness and emergency response ability and prevent and control environmental risks from the sources. Enhance risk prevention and control awareness education for enterprises having environmental risks, strengthen environmental accident potential education, increase the scientificness and effectiveness of accident emergency treatment, and improve the emergency response mechanism for handling environmental risk events. Conduct necessary education and training of environmental accident emergency treatment and prevention knowledge for residents, acquire risk awareness and emergency response knowledge and nip the risk in the bud.

3.2 Guizhou Province

Guizhou is a landlocked province in the southwestern part of China, with a population of 35 million and an area of 176 000 km² (roughly the size of Sweden). The capital of Guizhou is Guiyang (pop. 4.3 million). Guizhou is a relatively poor and economically underdeveloped province, but rich in natural, cultural and environmental resources. In 2012, Guizhou had the lowest GDP per capita (19 566 RMB) of China's provinces.

Anshun is a prefecture-level city in Guizhou province with a population of 2.3 million (of which about 800 000 in the city proper). Anshun City has been selected as a pilot region to develop environmental emergency response ability at prefecture city level.

3.2.1 Environmental risk introduction and its characteristic analysis

3.2.1.1 Environmental risk introduction

Guizhou is one of the major provinces that develop and utilize various heavy metal mineral resources in China and pollution by heavy metals (heavy metalloid) such as mercury, lead, zinc-cadmium, antimony, thallium, manganese, vanadium and arsenic is its main type of environmental risks. On the other hand, with the development of various industries and completion of various chemical parks in the province, the quantity of hazardous chemicals will increase enormously and regional environmental risk will increase markedly as a result. The statistical results of regional environmental risks for chemicals from the Ministry of Environmental Protection show that economic development does not correspond to the regional environmental risks in Guizhou very much in proportion, and high environmental risks and high frequency of the occurrences of environmental accidents will emerge in Guizhou's Twelfth Five Year Plan development period. Therefore, environmental risk sensitive industries in Guizhou are mainly chemical and heavy metal smelting enterprises.

Since 2010, totally 19 acute environmental events have occurred in Guizhou, including 2 consequential environmental events, 1 relatively consequential environmental event and 16 average level environmental event. Production safety accidents caused 5 environmental events, being 26.3%; traffic accidents caused 9 environmental events, being 47.4% and other accidents caused 5 environmental events, being 26.3%. Classified by accident types, 12 water pollution accidents, 4 air pollution accidents and 3 radiation accidents have occurred.

For Anshun City, the environmental risks exist in the aspects of water pollution, air pollution and solid wastes. Regarding water pollution, there are five waste water treatment plants, receiving urban and industrial waste water which includes smelting waste water, acid containing waste water, fluoride waste water and so on from more than 10 factories in Anshun City. Regarding air pollution, fluoride gas released from Huangguoshu Aluminum Corporation and ammonia gas from Hongsheng Chemical Corporation are the most concerned air pollutants sources. Regarding solid wastes, a large amount of fly ash, gangue, slag and smelting waste residues are produced by more than eight metal production plants and chemical plants in Anshun City.

3.2.1.2 Environmental risk characteristic and general analysis

According to the features of heavy metal resources and their development and utilization in Guizhou, pollution by such heavy metals (heavy metalloid) as mercury, lead-zinc- cadmium, antimony, thallium, vanadium and arsenic is prominent and typical. In terms of pollution sources, heavy metal pollution in Guizhou mainly comes from two aspects: heavy metal pollution left over in the history and pollution by heavy metal discharge from industrial enterprises.

Environmental risks of heavy metal pollution in Guizhou Province are mainly characterized by the following:

(1) Mining causes mill tailings and waste residues pollution

Wanshan Mercury Mine, for example, has discharged totally 126 million tons of waste residues and 20.2 billion m³ mercury containing waste gases in the half century since 1949; in Bijie Region, the total quantity of waste residues from zinc smelting is about 12 million tons and total floor area of waste residues is 11.335 million m²; in Liupan City, total quantity of waste residues from indigenous smelting method is 8.415 million tons and the floor area is 1.26 million m². Such waste residues are eroded and washed by atmospheric precipitation all the year round and pollute water body and soil. The pollutants are difficult to disappear in a short time and directly do harm to human bodies through food chain and are a type of persistent hazard. In addition, Guizhou is one of the provinces that have abundant antimony resources in China. In Dushan County, there are 104 abandoned antimony ore pits left over from many years' exploitation and mine water is leaking for long. There is also a great deal of deposited waste residues piled on the gully banks and there is not any environmental protection

facility. With unorganized and arbitrary piling, antimony goes along with interstitial water and waste residue washing rain water into the river when the rain season comes, and river water and sediments are heavily contaminated.

(2) Ecological environment is heavily damaged

Due to sustained development and utilization of mineral resources and the lack of subsequent reclamation, landscaping and slope reinforcing work, forest cover rate drops, soil and water loss in the mine fields is severe and soil erosion is high. As smelting waste residues are piled in large quantities on the river side, river water is polluted. At the same time, as no safety guarantee facilities are provided for the left over abandoned underground pits, serious potential environmental and geologic hazards exist.

(3) Human health is affected

Heavy metal pollution is both inhaled through atmospheric smoke dust and ingested through soil plant enrichment to cause grievous harm to human health and especially children's' growth and development. According to the investigation conducted by Guizhou Disease Prevention and Control Center and Wanshan Special Zone Disease Prevention and Control Center, more than 200 people have shown mercury poisoning symptom to a different extent over the past decades in Wanshan. Average mercury content of residents' hairs in the mercury mine contaminated areas in Wanshan is beyond the standard for 2.59 times and sick rate and incidence rate of mercury poisoning reach 4.3-5.8%. In Huilong Town, Xingren County, Qianxinan Prefecture, Guizhou Province, thallium deposit grows in Lanmuchang and coal mining history has exceeded 300 years. In this region over 400 people have had thallium poisoning since 1960s and it is one of the most typical thallium pollution regions. In Qianfeng Town, Magu, Haozhang County, environmental cadmium pollution caused by indigenous zinc smelting method is very severe. In Hejiachong area where indigenous furnaces are the most concentrated, soil cadmium content is 5.2 times that of contrast area and is very close to the soil cadmium content in the "itai-itai disease" region in Japan.

The cause of heavy metal pollution in Guizhou is manifested mainly by the following:

(1) Development and utilization of mineral resources

Development and utilization of mineral resources are the foremost sources of heavy metal pollution in Guizhou and their features are mainly numerous involved heavy metal elements, wide pollution range and high environmental impact. In addition, some mineral products have a low grade and development of associate ores is widespread. Mining causes pollutions to water, atmosphere, soil and agricultural crops, which poses a direct or indirect threat to human health.

(2) Heavy metal smelting industries

In addition to the heavy metal pollution problems caused by mineral exploitation, heavy metals in the discharged three wastes (waste water, waste gas and industrial residue) from industrial production have become another important source of heavy metal pollution in Guizhou. At the same time, since smelting technologies left over in the history is backward and environmental protection facilities are unsound, resource utilization ratio is low and ecological damage is serious. For example, the indigenous zinc smelting method concentrated in Bijie region has caused extensive destruction and pollution to local resources and environment.

(3) Wide distribution of chemical industries

Check of environmental risks and chemicals in major industrial enterprises in Guizhou shows that there are totally 414 environmental risk and chemical enterprises in Guizhou. Merely in Anshun City, there are several chemical enterprises such as Hongtai Chemical Co. Ltd, Hongsheng Chemical Co. Ltd, Hongda Aluminum Chemicals Co. Ltd and Huangguoshu Aluminum Co. Ltd. Hazardous waste such as barium residues, production waste water, smoke dust and waste gases discharged by these enterprises pose a big risk to local environment.

3.2.2 Current situation of environmental risk management in Guizhou Province

3.2.2.1 Environmental risk evaluation and management

(1) Investigation in hidden environmental risks

According to the requirements of the Ministry of Environmental Protection, a series of hidden environmental risk check works such as the “check for environmental risks and chemicals for major industries and enterprises” and “100-day major environmental safety inspection” were carried out, environmental risk enterprise database was

established, the problems found in the enterprise environmental risk check were in depth analyzed and promptly rectified, and monitoring and control of environmental risk enterprises were strengthened.

(2) Carry out warning and emergency response work in major regions

In the period of natural disasters such as freezing, mountain torrent and flood season in Guizhou Province, deploy environmental emergency management work such as in-advance prevention, active response and proper treatment in accordance with the requirements of the Ministry of Environmental Protection, provincial Party committee and provincial government, and carry out environmental emergency response work for major enterprises and major areas such as drinking water source area, nature reserves, radioactive sources and hazardous waste in special periods to strictly prevent occurrence of environmental pollution accidents.

Hongfeng Lake Reservoir area, a drinking water source area in Guiyang City, Guizhou Province, has been applied for being included in the first group of biological early warning pilot regions for major drinking water source areas by the Ministry of Environmental Protection and the biological early warning on-line monitoring system is built to provide vigorous guarantee for the environmental safety of the Hongfeng Lake drinking water source area.

(3) Strengthen departmental interaction and increase treatment efficiency

To further increase the ability of Guizhou Province to handle acute environmental events and enhance the building of emergency handling interaction mechanism jointly between environmental protection authorities and other sectors, the “Agreement on Emergency Interaction for Acute Events” is signed with the provincial bureau of safety supervision and the “Guiding Opinions on Strengthening the Building of Emergency Interaction Mechanism between Environmental Protection and Public Security and Fire Fighting Departments” (QHTZ[2012]No.14) was issued jointly with the provincial public security and fire fighting brigade to exert the advantages of all sectors, handle acute environmental events quickly, scientifically, safely and effectively and avoid and mitigate the possible environmental pollution during emergency treatment to the maximum extent.

On the other hand, emergency interaction among environmental protection authorities of all administrative regions in the province is strengthened. For instance, in order to

enhance the early warning and emergency response work of acute environmental events in the Chishui River basin in the province, the environmental protection bureaus of the 8 counties (municipalities, districts) in the Chishui River basin have been organized to sign the environmental emergency response interaction mechanism agreement.

(4) Prepare contingency plans and increase emergency response ability

Promptly revised the “Contingency Plan of Guizhou Province for Acute Environmental Events” and organized evaluation in the provincial government on January 15, 2013 to further improve Guizhou Contingency Plan for Acute Environmental Events and effectively address acute environmental events in Guizhou. At the same time, the environmental contingency plan management method for enterprises and institutions in Guizhou and the environmental response ability system building scheme for Guizhou were formulated.

Independent environmental emergency management agencies including Guizhou Acute Environmental Event Emergency Response Center and prefecture level city environmental emergency response centers were built but environmental response personnel are very limited and many staffs are registered but do not actually work for the purpose.

For independent configuration of environmental emergency response equipments, the funds are mainly from environmental management funds of environmental protection bureaus and the fund deficiency directly leads to a widespread low emergency equipment level. Except Guiyang City Environmental Emergency Response Center has a small amount of environmental emergency response equipment, other environmental emergency response agencies do not have any equipment and thus cannot meet the actual work need to a great extent.

(5) Current situation of environmental risk management in Anshun City

For the environmental risk problems, Anshun City has conducted related works, including strictly prohibit waste water plants, smelteries and chemical plants etc. from discharging heavy metal containing sludge, hazardous waste and exceeding-standard waste water to the environment; recover and recycle solid waste (e.g. high carbon content fly ash) or hazardous waste (e.g. barium residues); strengthen construction of associated pipe networks for waste water plants and push forward the reconstruction of

separating rain and wastewater and existing combined pipe network system in accordance with local conditions.

Another important task carried out in Anshun City to prevent environmental risk at river basin level is to improve the environmental protection work for the Sancha River basin in the city. The annual “Comprehensive Treatment of Water Environment in Sancha River” work plan was composed to ensure that major pollutants in the basin reach the standards both in pollution discharge concentration and total quantity control. Currently the characteristic pollutant of Sancha River is identified as “Suspended Solids (SS)” caused by more than 100 plants/factories in the river basin, most of which are collieries or mining related factories. The construction of weir/dam on the river to hold the sand and sediments has been conducted under the guidance of the plan. The protection work has been implemented since 2009.

3.2.2.2 Prevention and control of environmental risks involved in environmental planning

The “Guizhou Environmental Status Bulletin of 2010” reported that the percentage of urban concentrated drinking water sources with water quality higher than the standard is 82.3%, and the percentage out of 85 surface water monitoring sections in the province with water quality of Class V (and worse than Class V) is 20%. Aiming at the current environmental situation, Guizhou has compiled the related plans such as the “Special Plan of Guizhou Province for Ecological Construction and Environmental Protection in the Twelfth Five Year Plan Period” and “Plan of Guizhou Province for Comprehensive Prevention and Control of Heavy Metal Pollution in the Twelfth Five Year Plan Period”.

According to the Guizhou Twelfth Five Year Plan, the total discharge amounts of main pollutants including COD, NH₃-N, SO₂ and NO_x are targeted to reduce by 6%, 7.7%, 8.6% and 9.8% separately in 2015 compared to 2010. The percentage of national surface water monitoring sections in the province with water quality of Class V is planned to be lower than 20%. The percentage of urban concentrated drinking water sources with water quality higher than the standard is set to be over 90%.

The contents of environmental risk prevention and control involved in the plans mainly include:

(1) Strengthen prevention and control of environmental risks in major fields and maintain environmental safety;

(2) Make nuclear radiation, heavy metals and hazardous chemicals the major fields of environmental risk prevention and make efforts to solve the environmental safety guarantee issue in the industrialization course.

(3) Carry out environmental risk investigation and evaluation for the regions with high occurrence of environmental accidents and sensitive industries in the province: establish environmental risk source classification archives and information database mainly for the heavy metals, hazardous waste and persistent organic pollutants and the enterprises that produce and use hazardous chemicals.

(4) Improve environmental risk management measures: include environmental risks in the environmental management system and give definite requirements for environmental risk prevention in the approval process of planning environmental impact assessments and construction project environmental impact assessments so that environmental risk prevention facilities and the main part of the projects are designed, constructed and operated concurrently.

(5) Conduct environmental pollution damage investigation and research: basically know the situation of environmental pollution damage in Guizhou, carry out pilot work of environment and health comprehensive management, reduce environmental risks that affect human health and gradually perform works in environmental pollution damage evaluation.

(6) Determine the entity responsibilities for enterprises to prevent risks: find out high risk and heavy pollution enterprises and gradually establish the enterprise closedown system pursuant to related national policies and laws and regulations; establish enterprise acute environmental event reporting and emergency treatment system, strictly control enterprises for stable up-to-standard discharge and practically enhance enterprises' ability to prevent acute environmental events.

(7) Improve environmental risk emergency response system: according to the "Standard of Environmental Emergency Response Ability Building for National Environmental Protection Authorities", push forward the provincial, municipal and county environmental emergency response agencies three-level standard construction and drive the municipal (state and prefecture) level environmental protection authorities to gradually become standardized, institutionalized and normalized in environmental

emergency management agency, emergency management personnel, ability building and environmental emergency equipment works.

(8) During the plan preparation, attention is also paid to the risk prevention and control models such as “economic model of environmental characteristic by the Development Research Center of the State Council” and DRC-CGE model.

3.2.3 Challenges and opportunities

3.2.3.1 Main problems in environmental planning and environmental risk management

(1) Determination of planning targets and indices

- Determination of some planning targets lacks support of basic data and predication model and as a result, planning targets for some indices are slightly higher;
- Determination of planning targets fails to embody the analysis of some uncertainties or growth factors and accessibility is not interacted in many sectors and especially not determined under the precondition that financial funds can guarantee. For example, the dynamic grasp of macroeconomic trend, execution of desulphurization plans by existing and new thermal power plants, reduction and up-to-standard discharge of chemical oxygen demand and heavy metals for various industrial pollution sources such as coal chemical, phosphorus chemical and aluminum chemical industries;
- Determination of some targets directly cites the results of other special plans while all sectors compile their respective plans, which lacks interactions between sectors. At the same time, the target determination process of environmental protection plans and other special plans lack effective exchange and communication, which could also lead to the lack of a clear corresponding relation between indices and planning projects. Even if the key projects are pointed out, the implementation progress may be slow and planning targets couldn't be accomplished as scheduled as financial funds cannot be guaranteed.
- The methods to concrete planning indices are too simple and economic and social development level and basic environmental conditions are different for

all regions. Comprehensive consideration should be given to all regions' environmental qualities, environmental capacities, construction abilities of key construction projects and pollution reduction abilities etc.

(2) Linkup between environmental protection plans and economic and social development plans

Guizhou Twelfth Five Year Plan for Environmental Protection was initially compiled in 2009 and during its compilation, other provincial level special plans were initiated in succession. Due to time differences, it is somewhat difficult to link up environmental protection plans and other plans. In the implementation of various plans, starting time of projects is different and delayed approval of plans for implementation affects the accomplishment of plan schedule and determined targets. In addition, since the provincial national economic and social development plan is a macroscopic programmatic document, the fund sources needed for the primary tasks and key projects in environmental program plans often cannot be found correspondingly, and the tasks and key projects in the environmental protection plan are difficult to implement, which affects the accomplishment of plan targets and indices. Plan feasibility needs to be further strengthened.

(3) Linkup between key construction projects

- The corresponding relations between plan targets and indices and key construction projects are not apparent and pollutant reduction amount and implemented actual projects lack a corresponding relation;
- Information on construction project costs and investment proposals is very limited. The plan only gives the total cost and does not consider the social and even ecological cost of the project implementation as well as fund sources and the estimation of project implementation possibility and difficulty is insufficient;
- Due to lack of basic information, most construction projects are selected by using the qualitative analysis screening method. The plan mostly lists the possible construction projects and has not provided an all-round priority sequencing analysis for them.

(4) Problems existing in guarantee measures

As many sectors are involved, guarantee measures cannot be well established, improved and operated unless a powerful interaction mechanism is available. For the special environmental protection plan, it is difficult to have an all-around plan guarantee in one sector. Many guarantee measures still lack pertinence and operability.

3.2.3.2 Need of environmental plan and risk prevention and control

- Improve the emergency management system and speed up emergency response ability building. Define orientation and responsibility of emergency management agencies of all sectors at all levels and determine the building contents and scale of emergency management agencies at all levels in the province to provide guidance for the building of emergency management agencies at all levels in the province.
- Strengthen the emergency mechanism construction. Connect in series the related sectors involved in emergency management work dynamically, focus on emergency work through information intercommunication, coordination and interaction, comprehensive response and resultant force to establish and improve the environmental emergency response interaction partnership between environmental protection authorities and other related sectors, realize resource sharing, experience exchange and advantage complementation and increase the ability to prevent and handle acute environmental events.
- According to the environmental risk conditions of all regions in Guizhou, establish a multi-level and stereoscopic environmental emergency material reserve system. Build the provincial and municipal level environmental emergency material reserve system and establish the mutual aid mechanism of environmental emergency material equipment with major enterprises and institutions; grant support to major environmental risk enterprises in policies, technologies and funds to support them to improve environmental emergency materials and equipment reserve, establish transfer, expropriation and mutual aid mechanism with them and sufficiently exert their important functions of

enterprise materials and equipment in environmental emergency rescue.

- Develop environmental emergency response teams. The building of Guizhou acute environmental event emergency response system is still at a starting stage. Presently, only Guizhou Department of Environmental Protection and Guiyang City, Anshun City, Tongren City, Qiannan Prefecture, Qiandongnan Prefecture, Qianxinan Prefecture and Bijie City have established independent environmental emergency management agencies and Zunyi City and Liupanshui City have not. Many staffs are registered but do not work, staffing is very limited, ability is low and equipment is poor, which are the biggest bottleneck for environmental emergency response agencies in Guizhou. According to the “Standard of Environmental Emergency Response Ability Building for Nationwide Environmental Protection Authorities”, environmental emergency response ability of environmental protection authorities at all levels in Guizhou has not attained the requirements of the minimum standards and is difficult to meet the present need of environmental emergency response work in Guizhou.
- Strengthen risk prevention and prediction and early warning ability. The environmental risk source evaluation system and the classification standard have not been established, thus being unable to realize active prevention. Distribution, classification and grading of major environmental risk sources are not clear, significant environmental event prevention and control system has not been established and treatment of major hidden environmental hazards has no rules to follow. Environmental emergency equipment ability is far from satisfying the need of prediction and early warning and average equipment level of emergency monitoring instruments is much lower than the emergency ability building standard and its development is not balanced. The ability to analyze and evaluate risk information and monitoring data is deficient, thus being unable to timely and accurately determine the nature, development trend and sphere of influence of the risks and provide scientific and effective prediction and early warning information.
- More scientific, rational, feasible and operable technical methods that can support plan compilation are needed, e.g. simulation models usable to quantify plan targets and indices, to provide technical support for environmental plan

compilation and risk prevention and control.

- In order to strengthen the abilities at prefecture level to prevent and control the environmental risks of acute accidents and the emergency response abilities, Anshun City is selected as a pilot region to formulate the environmental emergency response ability building standard for city-level environmental protection authorities, including environmental emergency management agency and staffs, hardware equipment and operation rooms. At the same time, prefecture (city) level first class standard is established according to actual conditions to further enhance the ability-building standard.

3.3 Tongling in Anhui

3.3.1 Main environmental risk problems for Tongling City

3.3.1.1 Introduction

Tongling (pop. 742 000) is a prefecture level city on the Yangtze river in Anhui province (pop. 60 million), bordering to the east to Jiangsu and Zhejiang provinces. Anhui province has lagged behind in economic development compared to its more successful neighbor provinces to the east, with a GDP per capita in 2012 (28 792 RMB) less than half of those provinces. Economic development varies markedly within Anhui province and Tongling is among the most developed and prosperous regions in the province.

Tongling City governs 3 districts and 1 county with an area of 1,113km². Resource industries have been in the leading position of the city's national economy. After many years' development by relying on copper, sulfur and limestone resources, etc., Tongling has become an important industrial city in Anhui and an important basic raw material production base in China.

In 2012, the proportion of the three industries in Tongling was 1.9:74.7:23.4 and the proportion of value added in the regional total output value was 68.1%. In the secondary industry, heavy chemical industry is the primary and in the narrow land space, such urban pillar industries as nonferrous metal, cement, electric power, sulfur and phosphorus chemical, iron and steel, coking and electronic industries are concentrated. At present, copper smelting production capacity in Tongling has reached 1 million tons/year, cement production capacity reached 1.8 million tons/year, total installed capacity of thermal power reached 2.8 million KW, sulfuric acid production capacity 4.5 million tons/year and chemical fertilizer 2 million tons.

Heavy chemical industrial structure causes considerable production and discharge of pollutants and the resultant environmental risk problems cannot be ignored. Production and discharge of such pollutants as wastewater, waste gas, sulfur dioxide, nitric oxides, heavy metals and solid waste per unit national land area in Tongling City are higher than the average level in Anhui Province. Annual average values of sulfur dioxide and inhalable particulate matters in urban air in Tongling are close to national Grade II standard. Air environmental capacity is almost saturated and it is a national acid rain control area.

3.3.1.2 Risk characteristic and cause

Environmental risk of heavy metal pollution. Tongling is one of the nonferrous metal ore bases in China. Heavy metals are discharged in the nonferrous metal mining and processing. As heavy metals are not degradable, they accumulate more and more in the environment and thus cumulative environmental risk exists.

Environmental risk of chemicals. The hazardous chemicals in the use, production and transportation by smelting, chemical and mine enterprises have environmental risks.

Layout risk. Tongling City is built along mines. For historical reasons, urban function layout is irrational and protection distance between industrial zone and residential area is insufficient. Some heavy industrial enterprises are located in the urban prevailing wind direction and upper reaches of drinking water sources and pose risks to urban environmental quality, drinking water safety and public safety.

Hidden ecological environmental hazards. Prolonged mineral resource development has caused such ecological environmental problems as soil erosion, water pollution and ecological function deterioration, etc.

3.3.2 Related works already done

3.3.2.1 Environmental risk evaluation and management

For the environmental risk problems that Tongling City faces, the city has initially established the risk management system mainly based on prevention and emergency response.

(1) Environmental risk assessment for construction projects. Carry out environmental risk assessments for construction projects, increase environmental admittance conditions and construction criteria, make environmental risk evaluation an important item of environmental impact assessment for construction projects and strengthen the check of risk prevention and control measures' implementation when construction projects are completed and accepted to ensure that risk prevention and control measures are practically implemented. In addition, assessment is also conducted for the projects that have been completed and put into operation but have environmental risks.

(2) Enterprise environmental subject responsibility and government environmental safety supervision and management responsibility. Formulated the "Emergency Plan of

Tongling City for Environmental Pollution Accidents” and “Environmental Emergency Plan for Major Enterprises” and established the environmental emergency rescue system with unified government command and interaction of environmental protection, public security, fire fighting, traffic, health and safe production departments. According to the “five earliest-times” principle (i.e. report in the earliest time, arrive at the scene in the earliest time, monitor in the earliest time, release information to the society in the earliest time and ascertain the cause and take effective measures in the earliest time), highly efficiently handle sudden environmental events and reduce the people’s life and property losses and ecological environmental damages.

(3) Environmental risk source check. Enhance the check for hidden environmental hazards for smelting chemical enterprises, hazardous waste production and treatment organizations and the enterprises that discharge heavy metals and hazardous chemicals, establish the environmental management database for environmental risk sources and strengthen environmental safety guarantee measures.

(4) Building of environmental emergency management, technical support and handling rescue teams. Prepare necessary emergency rescue materials and equipment and periodically organize training and drills to increase environmental emergency monitoring and treatment ability.

(5) Environmental pollution liability insurance. Carry out environmental pollution liability insurance for trial in the nonferrous metal smelting industry.

3.3.2.2 Prevention and control of environmental risks involved in environmental plans

(1) Prevention and control of environmental risks involved in Tongling Twelfth Five Year Plan for Environmental Protection

“Twelfth Five Year Plan for Environmental Protection of Tongling” defines the key environmental protection works in the Twelfth Five Year Plan period: by focusing on reducing total quantity of major pollutants, improving environmental quality and preventing environmental risks, and making the change of economic growth mode as the main line, make efforts to solve prominent environmental problems and establish the full prevention and control risk prevention system, highly efficient environmental treatment system and complete environmental management system to comprehensively enhance ecological civilization level. It is proposed that in 2015, the compliance rate of

drinking water sources and water environmental function zone will be 100% and the number of days with ambient air quality better than Grade II (annual average of PM₁₀ is 76 ug/m³ in 2012, and will be 70 ug/m³ in 2015) will be greater than 330 days; discharge of major pollutants such as sulfur dioxide, nitric oxides, COD and ammonia nitrogen will be reduced by 15.2%, 11.2%, 9.1% and 8.7% compared with 2010; discharge of heavy metals from major heavy metal prevention and control areas will be reduced by 15% compared with 2007; safe treatment rate of hazardous wastes will be 100%; safety treatment rate of industrial solid waste will be ≥90% and centralized treatment rate of domestic wastewater and non-harmful treatment rate of domestic wastes will be ≥85%; environmental supervision and monitoring ability will accomplish the working objectives required for national standardized construction. The following measures are mainly taken to prevent environmental risks:

Strictly manage drinking water source areas. Protect drinking water sources, plan and construct spare urban drinking water sources and practically guarantee urban drinking water safety. Carry out ground water pollution investigation, implement protection works for rural centralized drinking water source protection areas and comprehensive environmental treatment works for water source areas, strengthen water quality monitoring in rural centralized drinking water source areas and eliminate potential environmental safety hazards in water source areas.

Enhance environmental risk source supervision and control. Conduct environmental risk investigation and evaluation. By focusing on the enterprises that discharge heavy metals, hazardous wastes, persistent organic pollutants and produce and use hazardous chemicals, comprehensively investigate major environmental risk sources and environmentally sensitive points and establish environmental risk source database. Enhance prediction and early warning of potential environmental risks and periodically carry out environmental emergency drills for hazardous chemicals enterprises to improve environmental risk prevention ability. In 2015, complete construction of the whole city's environmental risk monitoring points, build the emergency command system for sudden environmental events and comprehensive guarantee system for environmental emergency materials and equipment at municipal and district levels and enhance environmental risk prevention guarantee level. Optimize industrial layout and gradually move the enterprises that are situated in the upper reaches of drinking water sources or near other environmentally sensitive targets and

use hazardous chemicals or produce large quantities of pollutants to the industrial park zones or industrial concentration areas. Strictly carry out environmental impact assessment for construction projects and prohibit the enterprises that have potential environmental risks from entering the environmentally sensitive areas.

Push forward centralized treatment of hazardous wastes. Establish the solid waste management agency, implement systems such as hazardous wastes reporting and registration, accident emergency response and hazardous wastes manifests, and build the comprehensive information management platform for archives and records concerning production, storage, treatment and utilization of hazardous wastes. Build Tongling Hazardous Waste Centralized Treatment Center and push forward centralized treatment of hazardous wastes. In the Twelfth Five Year Plan period, the unified recovery and safe treatment system for pesticide wastes was established in the whole city.

Comprehensively prevent and control heavy metal pollution. Manage heavy metal-related enterprises as main pollution sources, establish production and discharge records of heavy metal pollutants and strengthen supervisory monitoring and inspection system. Focusing on lead, mercury, cadmium, chromium and metalloid arsenic, mainly prevent and control heavy metal pollution from industries and enterprises such as nonferrous metal ore (including associate minerals) mining and dressing, nonferrous metal smelting industry, acid production from sulfur iron ore, PCB printed circuit board and electroplating industries. Carry out major heavy metal pollution treatment projects for nonferrous metal smelting and processing, iron and steel, printed circuit board and comprehensive utilization of nonferrous metal wastes and take comprehensive treatment measures such as close down a group, move a group and treat a group to speed up industrial restructuring, develop hi-tech technological industries and promote the transformation and upgrade of resource type urban industrial structure. All out develop circular economy, continuously carry out cleaner production audit, improve comprehensive resource utilization level and industrial cleaner production level and reduce discharge of pollutants. Carry out pilot projects focusing on rehabilitation of site contaminated by heavy metals from industrial and mining enterprises, control over the discharge of atmospheric heavy metals from major industries and bed mud pollution treatment for major rivers and make efforts to solve the problems of heavy metal pollution that have significant effects on production, life

and human health. In 2015, establish a relatively complete heavy metal pollution prevention and control system, accident emergency response system and heavy metal pollution health hazard monitoring system.

Carry out soil pollution treatment pilot work. Conduct environmental risk evaluation for reutilization of contaminated soil and contaminated sites. Promote the establishment of soil pollution prevention and control and rehabilitation mechanism, carry out typical regions and typical types of soil rehabilitation pilot work, increase input in treatment and rehabilitation and mainly rehabilitate soils chemically contaminated by heavy metals. Establish soil use adjustment mechanism, complete safety division of soil for agricultural use and carry out farmland soil rehabilitation and comprehensive treatment pilot work.

Strengthen safety supervision and management of radiation environment.

Enhance safety permission and supervision for the organizations that use radioactive sources and ray devices, push forward radiation safety supervision and management informatization construction and establish the dynamic database for supervision and management. Strengthen collection and storage work of radioactive wastes and unused waste radioactive sources and optimize electromagnetic radiation source layout to ensure radiation environment safety.

(2) Prevention and control of environmental risks involved in Tongling Twelfth Five Year Plan for Comprehensive Prevention and Control of Heavy Metal Pollution

Tongling Twelfth Five Year Plan for Comprehensive Prevention and Control of Heavy Metal Pollution focuses on prevention and control of major pollutants, key regions, main basins, major industries and enterprises and adopts the treatment concept of promoting a group, treating a group, moving a group and eliminating a group to mainly prevent heavy metal pollution for the 8 major heavy metal-related industries including nonferrous metal smelting industry, nonferrous metal ore (including associate minerals) mining and processing industry, sulfuric acid industry, circuit board manufacturing industry, nonferrous metal processing industry, electroplating and metal surface treatment industry, comprehensive utilization of heavy metal-related hazardous wastes and dismantling of imported Class 7 wastes (Wastes from heat treatment containing

cyanide, one of the 49 catalogues of hazardous wastes from “National Catalogue of Hazardous Wastes”) .

Main tasks include: implement pollution treatment equipment upgrading and renovation projects for major enterprises, comprehensively clear and rectify the mining and dressing industry, eliminate the mining and dressing enterprises that do not meet admittance conditions and increase industrial concentration; adjust the layout of heavy metal-related enterprises and strictly control sanitary protection distance; fully conduct cleaner production audit work for heavy metal-related enterprises and enhance industrial cleaner production level; carry out heavy metal polluted soil remediation and restoration pilot work, make efforts to solve the heavy metal pollution problems that have significant effect on production, life and human health, promote further optimization of heavy metal-related industrial structure and layout and significant increase of comprehensive pollution source prevention and control level and make active progress in pilot treatment of leftover problems such as heavy metal polluted soil rehabilitation.

The plan shows that in 2015, the relative complete heavy metal pollution prevention and control system, accident emergency response system and environment and health risk evaluation system will be established. Main objectives: discharge of heavy metal pollutants in major prevention and control areas will be reduced by 15% compared with 2007, discharge in non-major prevention and control areas will not exceed the level in 2007 and compliance rate of heavy metal pollutants in centralized drinking water source areas in Tongling Section of the Changjiang River and towns will reach 100%; compliance rate of heavy metal pollutants in surface water of the primary and secondary branches of Tongling Section of the Changjiang River will be 100%; safe treatment and utilization rate of heavy metal containing hazardous wastes will reach 100%.

3.3.3 Problems and need

3.3.3.1 Problems existing in prevention and control of environmental risks

Presently, prevention and control of environmental risks in Tongling City mainly lies in emergency treatment of environmental risks and many problems exists in prevention and control of environmental risks.

(1) Fundamental research of prevention and control of environmental risks is weak

The key points of environmental risk management are traditional environmental problems such as sulfur dioxide, nitric oxides, smoke (dust), heavy metals and hazardous chemicals. Fundamental research on the environmental risks and health hazards of the “three effect” (teratogenic effect, carcinogenic effect, and mutagenic effect) pollutants, endocrine disruptors and persistent pollutants that enter the environment is insufficient and especially research on non-sudden long term and chronic health risks of pollutants is basically a vacancy and estimate of future potential environmental risks is insufficient.

(2) Environmental risk management lacks systematic design

Environmental risk management also lacks corresponding laws, regulations, specifications and standards and it is urgently needed to comprehensively consider such elements as subject, object, process and region of environmental risk prevention and control and management from an omnibearing angle of view, establish environmental risk management monitoring system, scientific research system, evaluation system, response system and law, policy and measure guarantee system and compile the environmental risk prevention and control and management plan to guide the environmental risk prevention and control work.

(3) Standardized enterprise environmental risk management mechanism has not been established

Different environmental management means have not been used for enterprises at different risk levels in accordance with environmental risk features, and for prevention and control needs of different industries and enterprises to establish enterprise environmental risk management standardization certification system, establish and improve enterprise environmental risk management standards and specifications or carry out graded management and take related policy measures.

(4) Environmental risk evaluation depth of construction projects is insufficient

Environmental risk evaluation for construction projects is mainly to evaluate the occurrence possibility of fortuitous environmental risk events and the postmortem effect on environmental quality. The evaluation contents of the impact of environmental risks on human health and ecological safety are too limited and comprehensive

environmental evaluation for enterprises, industrial park zones and regions is insufficient, thus being unable to meet the requirements for preventing and environmental risks from the source.

(5) Basic capacity to prevent and control environmental risks is not enough

Environmental emergency treatment also has the problems of incomplete environmental risk information, backward treatment technology and unsound emergency response mechanism.

3.3.3.2 Needs of environmental risk prevention and control

For the environmental risk problems and the current situation that Tongling faces, the following needs exist in environmental risk prevention system, method and capacity building:

- (1) Advanced international environmental risk management experience, including environmental risk management laws, policies, mechanisms and typical case analysis, etc.
- (2) How to build the whole process environmental risk management system including pre-evaluation, prevention, monitoring and control and response;
- (3) How to conduct by-class and by-level analysis and management system design for environmental risks and build the normalized and specialized environmental risk management model;
- (4) Identification research method for delayed type, cumulative and potential environmental risks from long term and low concentration pollutant discharge. Environmental risk management system design that is based on total pollution discharge-environmental quality-people's health;
- (5) How to build the public participation mechanism and regional cooperation mechanism for environmental risk management;
- (6) Main contents of environmental risk management ability building, etc.
- (7) Heavy metal wastewater, waste gas and solid waste treatment and disposition technology and rehabilitation technology of site contaminated by heavy metals, etc.

3.4 Summary

Jiangsu, Guizhou (including Anshun) and Tongling lie respectively in eastern, western and central China, and have different economic development level and characteristics, and face different environmental risk problems. Production, usage, storage and transportation of chemicals are main sources of environmental risks of Jiangsu Province; mining, smelting and chemical industries are main causes of environmental risk problems of Guizhou; heavy metals discharge from mining and processing of non-ferrous metals, and chemical industry are main environmental risk problems of Tongling. Environmental risk from layout of sources (such as chemical facilities) and receptors (such as residential areas) is a common problem facing by the pilot provinces and cities.

Although Jiangsu, Guizhou (including Anshun) and Tongling have taken measures of inspection, assessment, early warning and emergency response to reduce environmental risk, and many of them are reflected in the 12th five year plans of environmental protection under the guidance of national plan, there are still many management and technical problems and requirements needed to be solved and met. How to integrate environmental risk management into environmental planning efficiently and effectively is a common question raised by pilot provinces and city, based on which, technical methods such as simulation and assessment models of environmental planning and risk management are the important requirements.

4 Questionnaire survey result

4.1 Statistical result

The questionnaire survey conducted for this project aims at agencies of the Ministry of Environmental Protection and related working personnel of the Department of Environmental Protection of Jiangsu Province, the Department of Environmental Protection of Guizhou Province, Tongling Municipal Environmental Protection Bureau and Anshun Municipal Environmental Protection Bureau. Totally 93 questionnaires were issued and 84 returned, feedback rate being 90%.

(1) Questionnaire status

In this questionnaire survey, the target group accepts the questionnaire survey (Figure 4-1). Among them, 28 questionnaires were received at the central level (agencies and subordinate organizations of the Ministry of Environmental Protection), 48 received by the provincial (Jiangsu, Guizhou) environmental protection departments and 8 received at the municipal level (Tongling, Anshui).

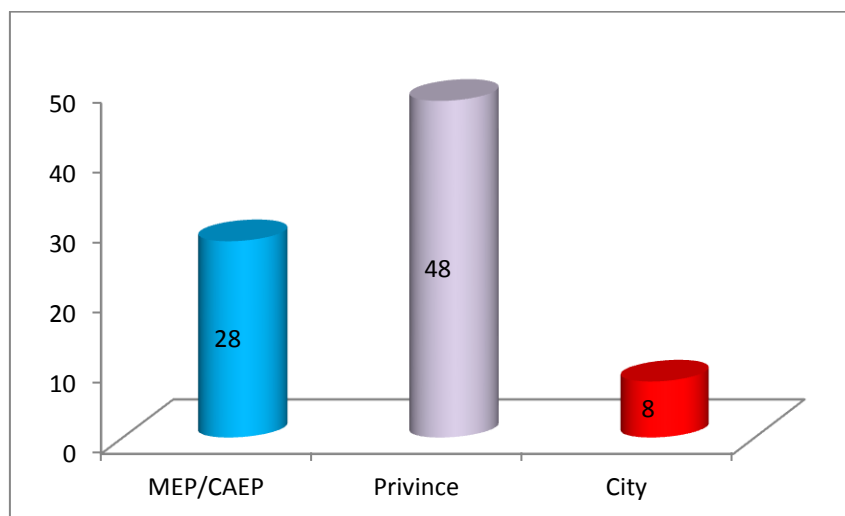


Figure 4.1 Completed questionnaires

There are 22 Questionnaires in Guizhou province at the provincial level, 26 in Jiangsu province.

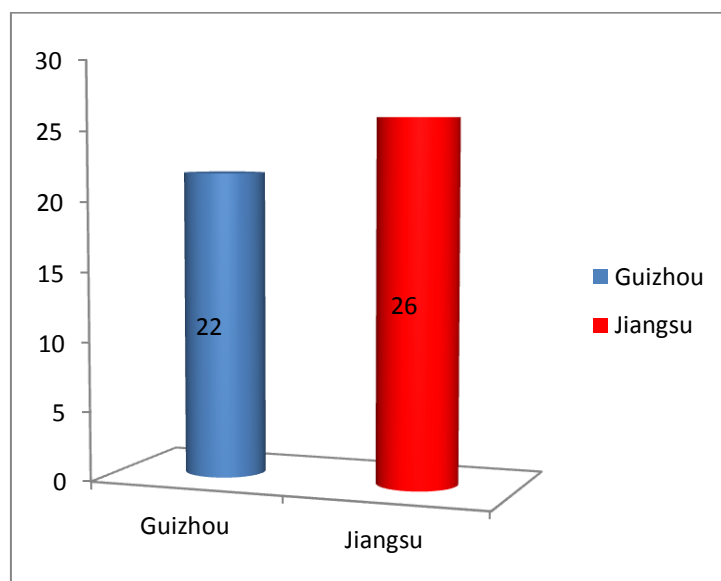


Figure 4.2 Number at the provincial level

(2) The number of respondents engaged in environmental planning study, formulation and implementation

General situation of the target group: 77% respondents are engaged in plan study, formulation and implementation work. The situation of those engaged in the above work at the central, provincial and local levels is shown in Figure 4-2.

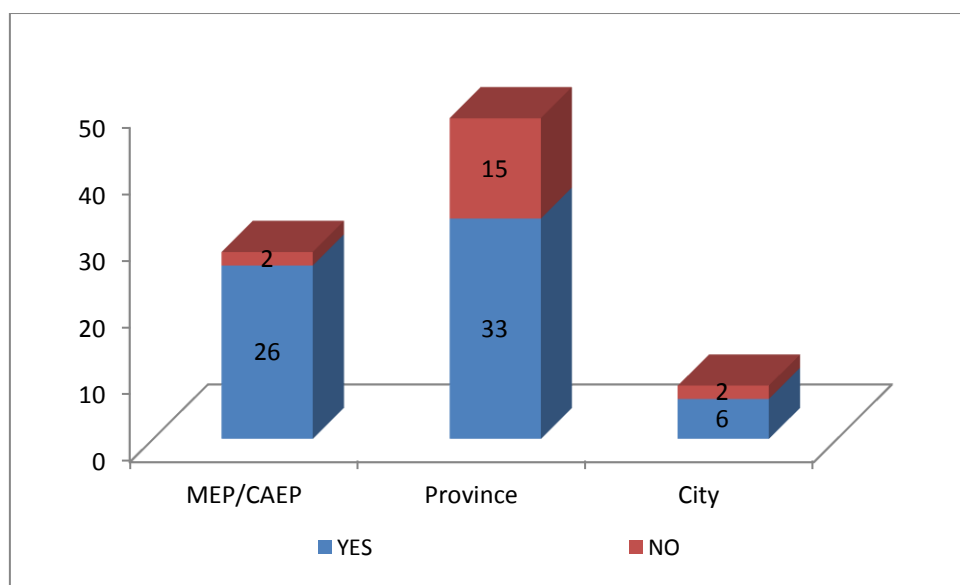


Figure 4.3 Number of respondents with job responsibility for environmental planning

It is known from the questionnaire that 77% respondents are engaged in plan study, formulation and implementation work. The development of this project plays a positive help role for the environmental protection working personnel in plan study, formulation and implementation. As the number of questionnaires decreases level by level, the proportion of central and local data is not of index significance and can not reflect the true proportion of the personnel engaged in plan study, formulation and implementation at the central and local levels but it can reflect the need of the target group for this project.

(3) The number of respondents engaged in environmental emergency response

General situation of target group: 45% respondents are engaged in environmental emergency response work and the proportion of persons engaged in emergency response work at the central, provincial and municipal levels is shown in Figure 4-3.

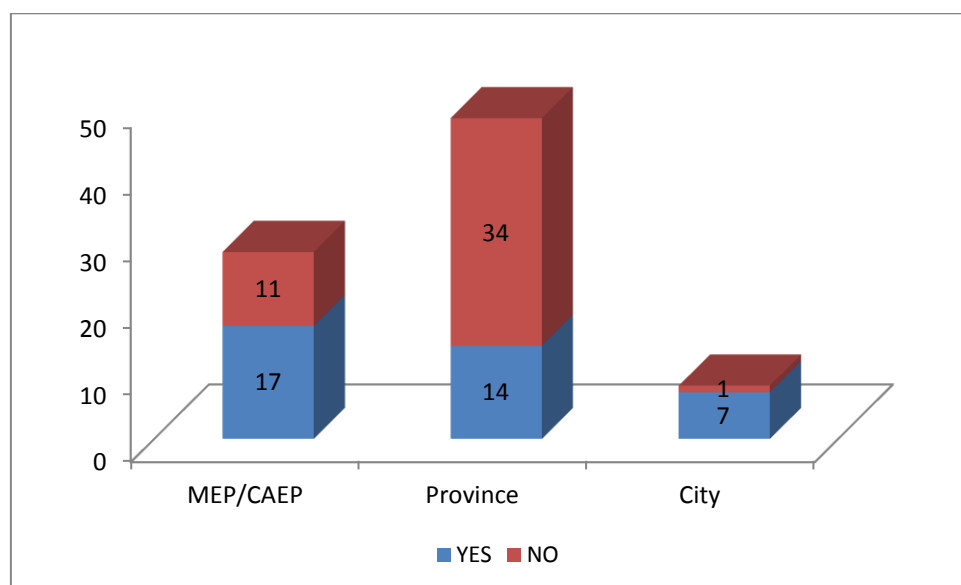


Figure 4.4 Number of respondents engaged in emergency response

45% respondents are engaged in environmental emergency response work and it is critical to emergency response work to have theoretical knowledge and practical experience in environmental risk prevention and control.

(4) Number of persons who use the Cost Benefit Analysis in work

General situation of target group: 53% respondents use CBA in their work and the proportion of persons using CBA at the central, provincial and municipal levels is shown in Figure 4-4.

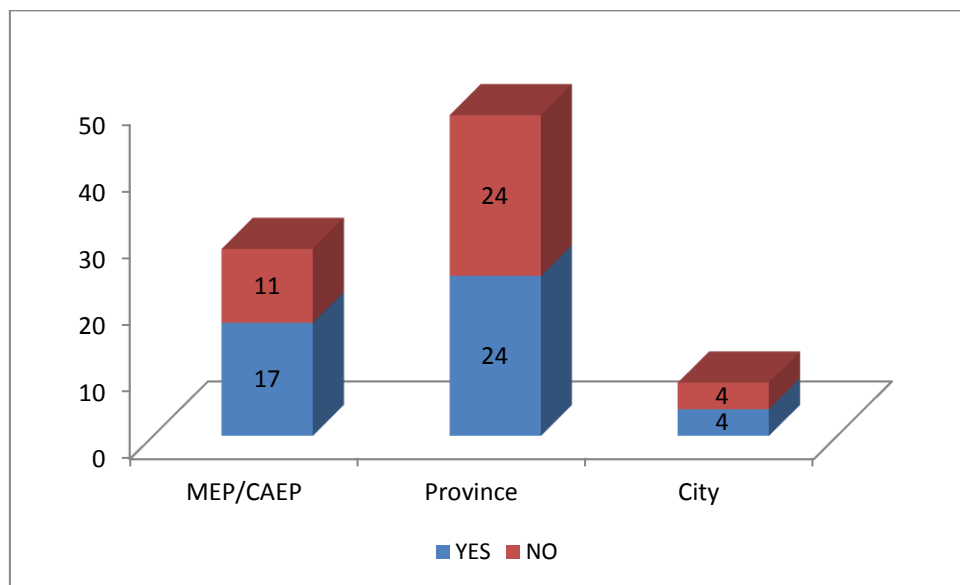


Figure 4.5 Application of CBA

(5) Application extent of Cost Benefit Analysis in work

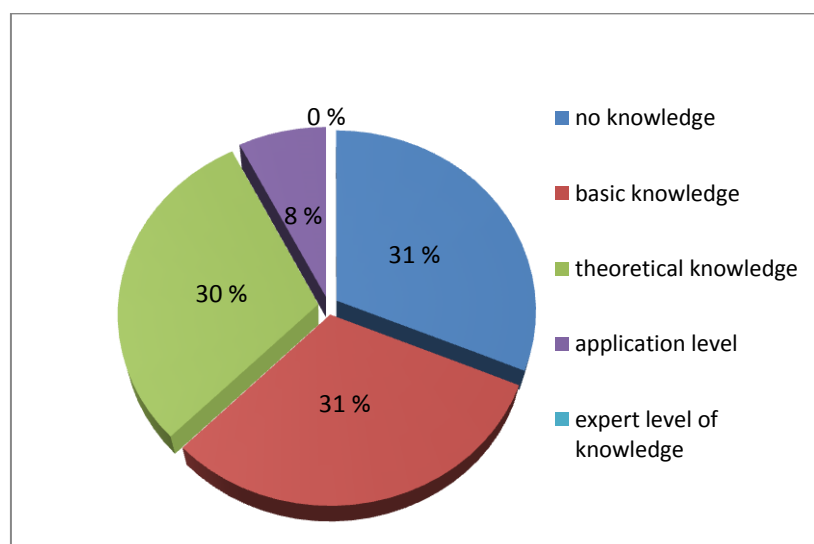


Figure 4.6 Familiarity with CBA

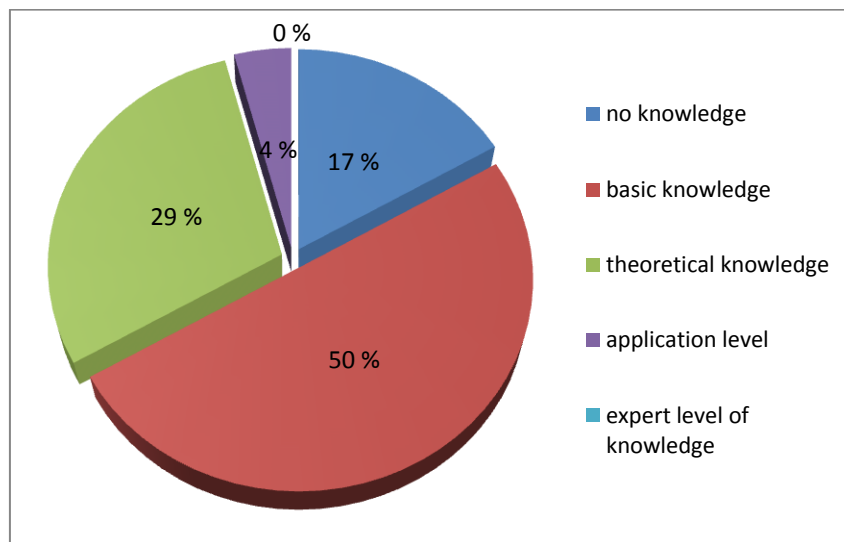


Figure 4.7 Familiarity with CBA (MEP&CAEP)

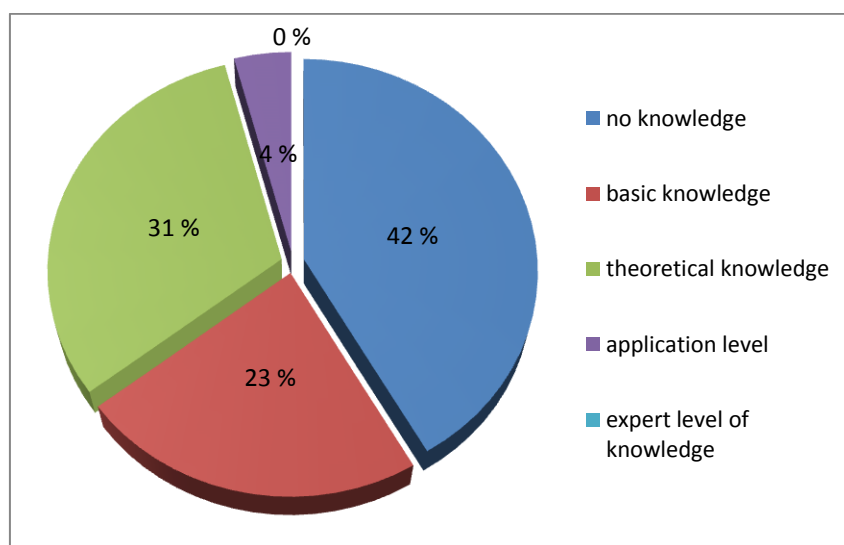


Figure 4.8 Familiarity with CBA (provincial EPBs)

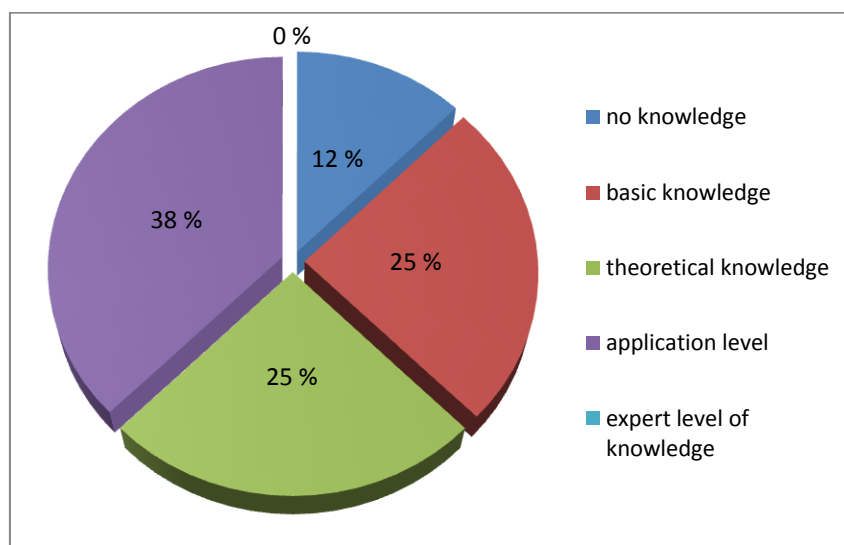


Figure 4.9 Familiarity with CBA (municipal EPBs)

It is known from the questionnaire survey that 53% respondents use CBA in their work. Use of CBA decreases level by level and it is used most by the environmental protection working personnel at the central level and used least by the working personnel at the municipal level. From the survey of CBA knowledge, “no knowledge” and “basic knowledge” are 31%, “theoretical knowledge” is only 30% and “expert level of knowledge” is none. Knowledge of CBA by the environmental protection working personnel at the central, provincial and municipal levels is reverse. CBA is used most in work but known less at the central level; the environmental protection working personnel at the municipal level use CBA least in work but know CBA most; and the environmental protection working personnel at the provincial level know CBA least.

It is suggested that CBA study by the environmental protection working personnel at the central and provincial levels should be enhanced through this project and training of all target groups in practical use should be strengthened.

(6) Number of persons who use the Strategic Environmental Assessment in work

General situation of target group: 36% respondents use SEA in their work and the proportion of persons using SEA at the central, provincial and municipal levels is shown in Figure 4-9.

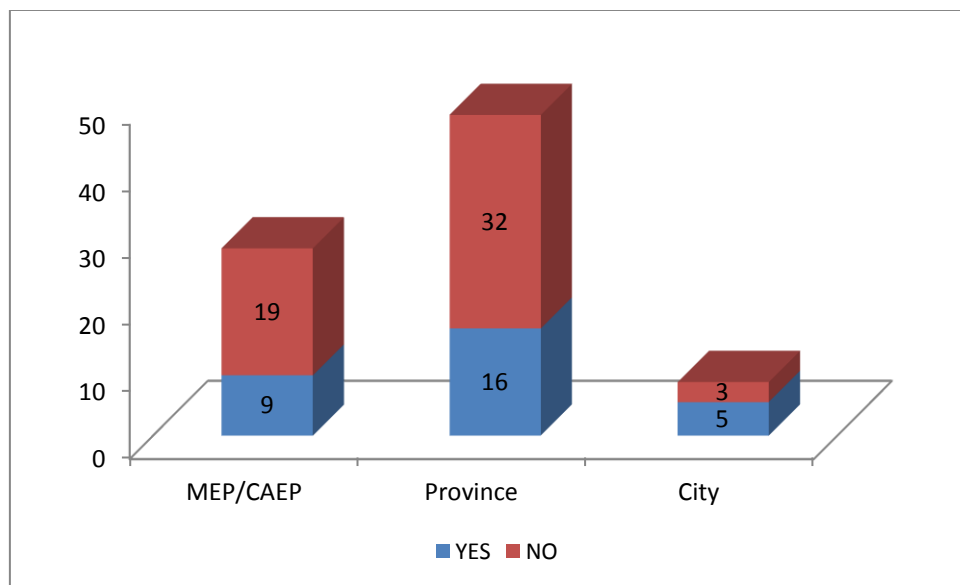


Figure 4.10 Application of SEA

(7) Application extent of Strategic Environmental Assessment in work

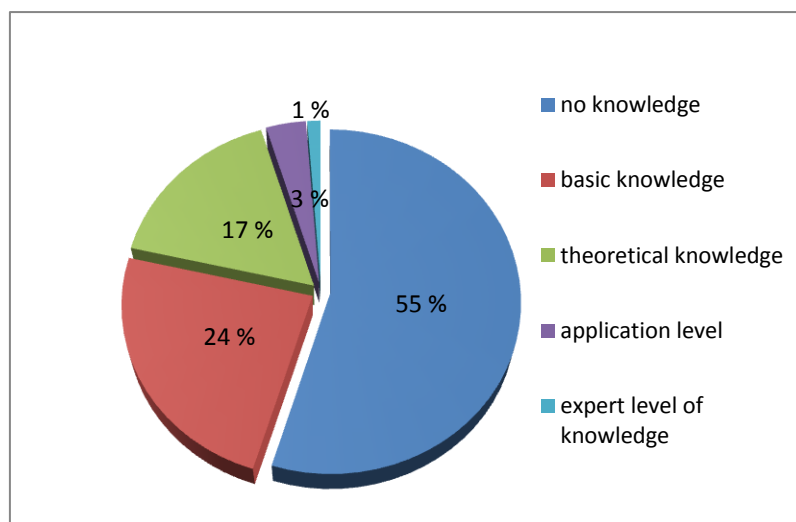


Figure 4.11 Familiarity of SEA

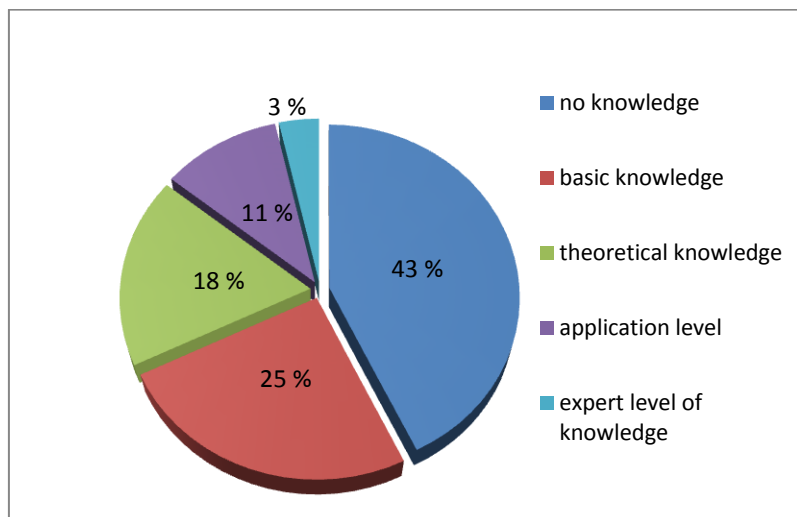


Figure 4.12 Familiarity of SEA (MEP&CAEP)

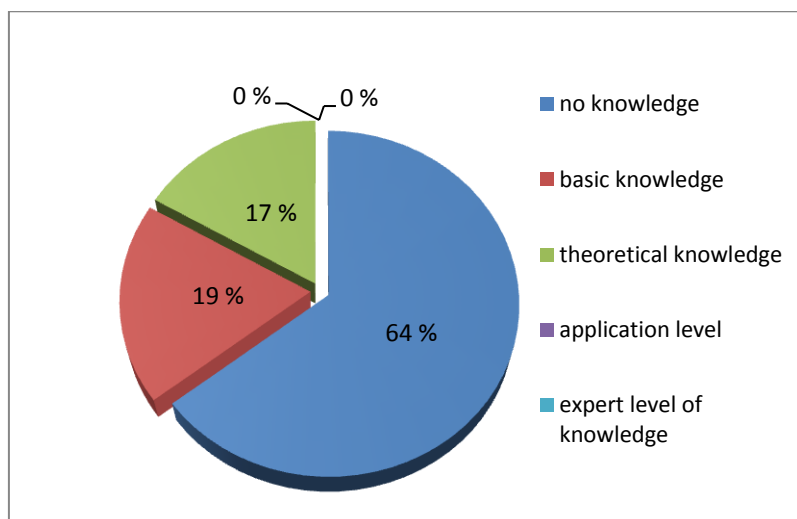


Figure 4.13 Familiarity of SEA (provincial EPBs)

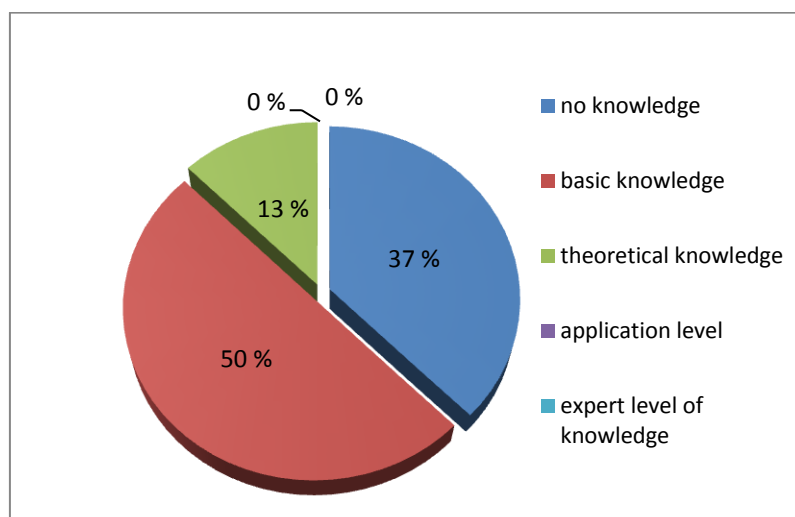


Figure 4.14 Familiarity of SEA(municipal EPBs)

It is known from the statistical data that 36% respondents use SEA in their work and 79% environmental protection working personnel do not know SEA. Only 17% know SEA theory and even less, only 3% , conducts practice but 1% fully know SEA. SEA familiarity decreases level by level and is lower at the more basal layer. There is no actual SEA use at local level.

It is suggested that practical case teaching should be introduced while theoretical training is carried out.

In order to analyze the application and familiar of CBA and SEA situation, the following according to the personnel engaged in environment planning work and the person engaged in both environmental planning and emergency response. Jiangsu province and Guizhou province for the CBA, SEA applications and familiar with statistical analysis respectively. It more suitable to train emergency staff and local staff differently and the training theory into practical teaching cases at the same time.

In this questionnaire survey, the target group 31 people are only responsible for environmental planning, formulation, implementation, 7 people are only responsible for emergency response, 31 people work there are both for environmental planning, formulation, implementation, and emergency response duty, 15 people work in the other aspects.

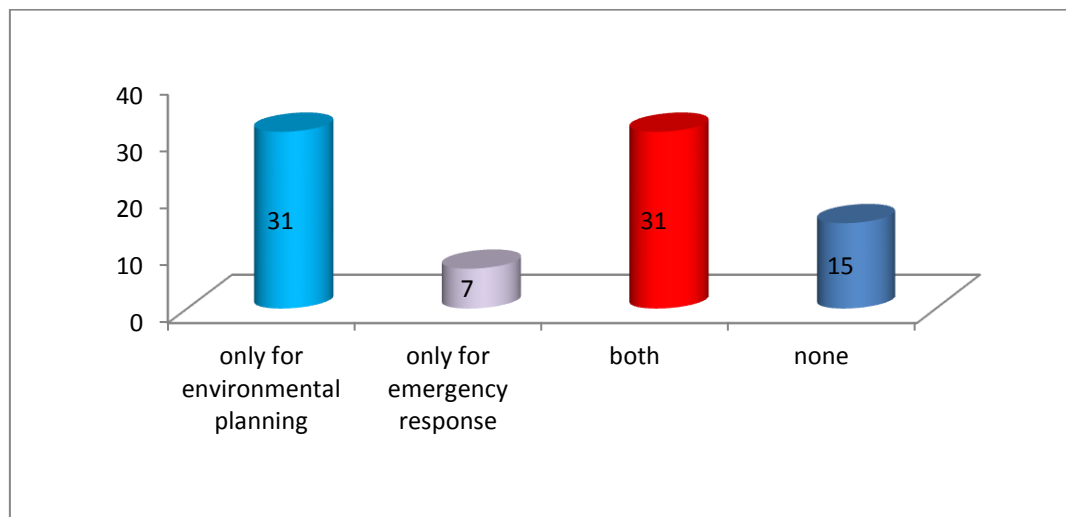


Figure 4.15 Type of Work

Because only 7 people engaged in emergency response, we merge them with the people engaged in both emergency response and environmental planning for analysis .

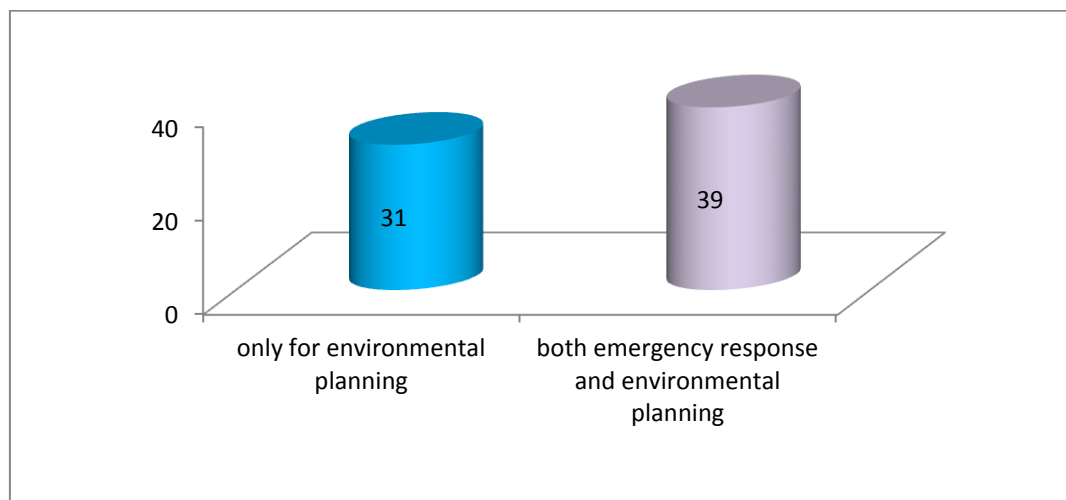


Figure 4.16 Type of work

It can be seen from the statistics, engaged in environmental planning is applied to the CBA accounted for 61%,to the SEA accounted for 35% and engaged in both emergency response and environmental planning is applied to the CBA accounted for 66%,to the SEA accounted for 39%.Overall CBA used in work is more, SEA need to strengthen training.

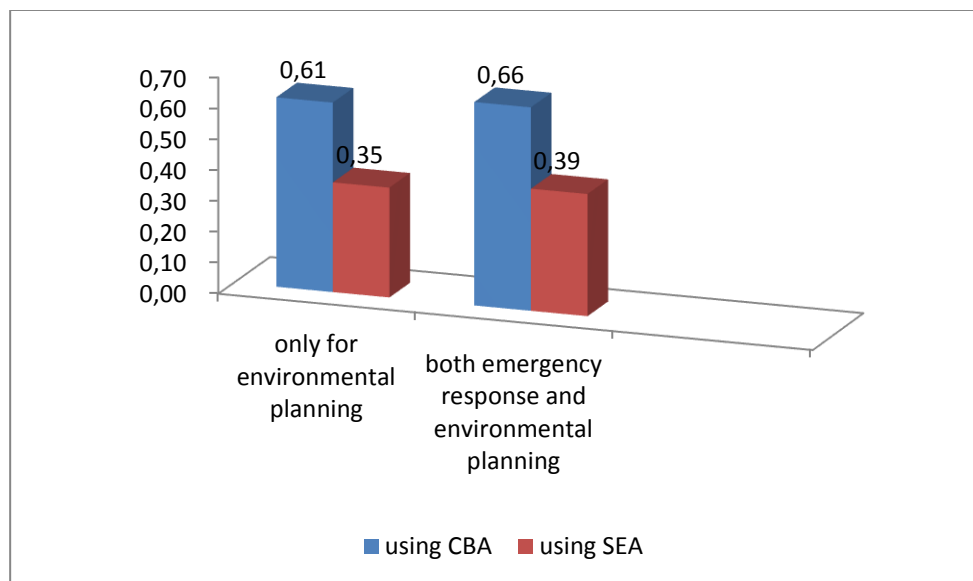


Figure 4.17 Applied condition of CBA and SEA

The knowledge of CBA level, the personnel engaged in environmental planning 26% do not know, a basic knowledge of 32%, 29% theoretical knowledge, 10% application level, 3% expert level of knowledge. Personnel engaged in both emergency response and environmental planning 21% don't know, a basic knowledge of 37%, 26% theoretical knowledge, 8% application level, nobody knows very well.

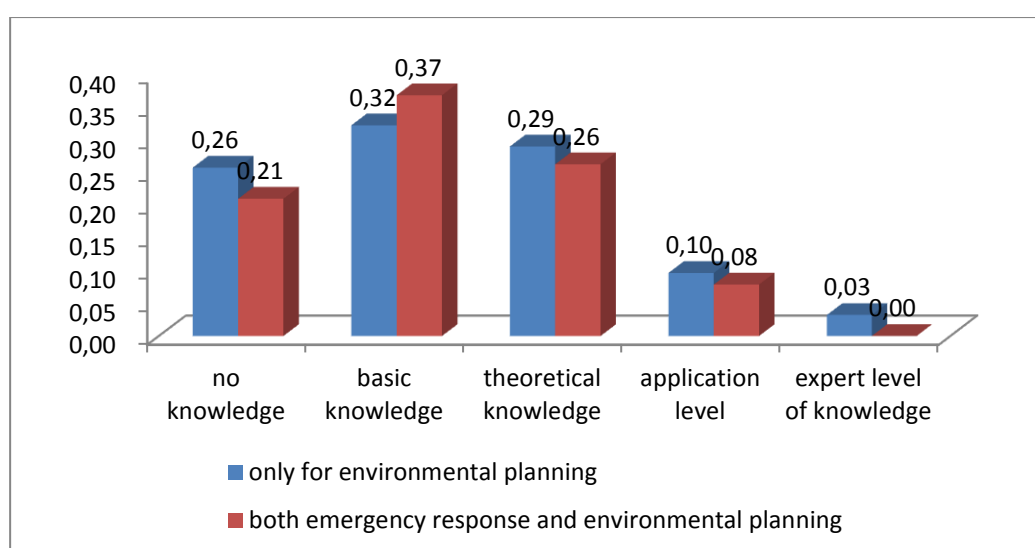


Figure 4.18 Knowledge of CBA level

The knowledge of SEA level, the personnel engaged in environmental planning 58% do not know, a basic knowledge of 16%, 16% theoretical knowledge, 6% application level, 3% expert level of knowledge. Personnel engaged in both emergency response and environmental planning 50% don't know, a basic knowledge of 29%, 16% theoretical knowledge, 5% application level, nobody knows very well.

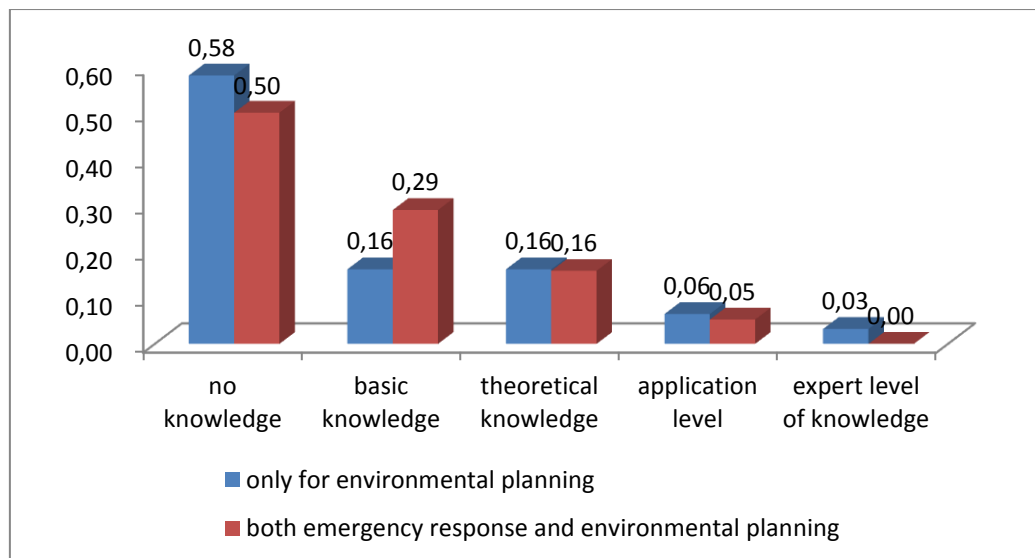


Figure 4.19 Knowledge of SEA level

Through the questionnaire can be seen work applied to the CBA accounted for 32%, the number of applications to the SEA accounts for 23% in Guizhou province. The number of work applied to the CBA, Jiangsu province accounts for 69%, the number of applications to the SEA, Jiangsu province accounts for 46%. It can be infer that the people of Jiangsu province have learned more about CBA and SEA knowledge of theory and practice than the people in Guizhou province.

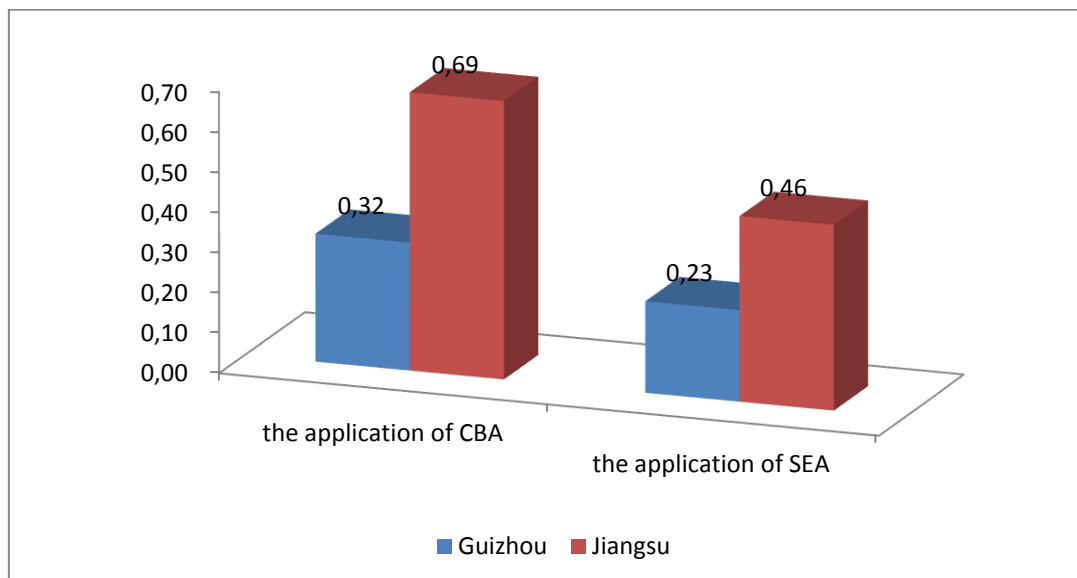


Figure 4.20 Application of CBA and SEA at province level

(8) Knowledge level of international environmental planning experience

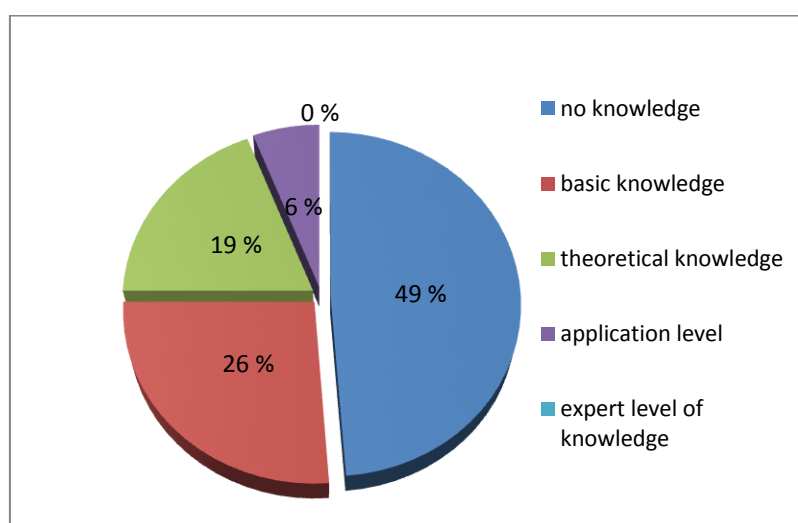


Figure 4.21 Familiarity of international experiences and best practice

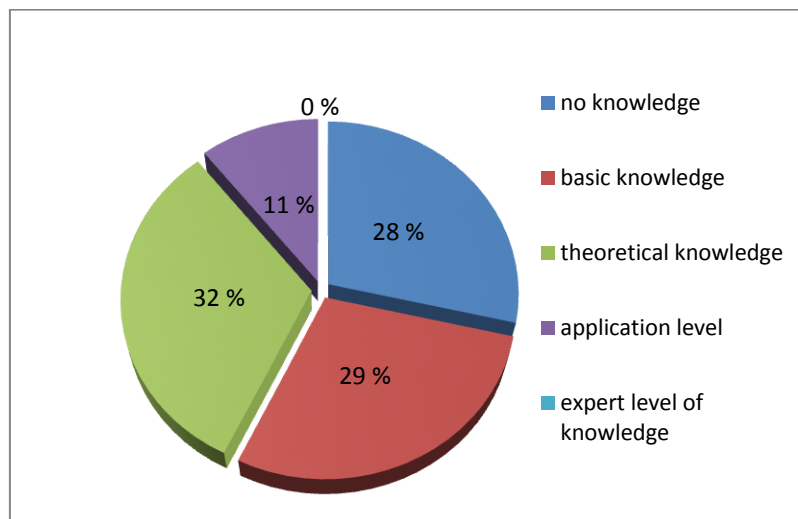


Figure 4.22 Familiarity of international experiences and best practice (MEP&CAEP)

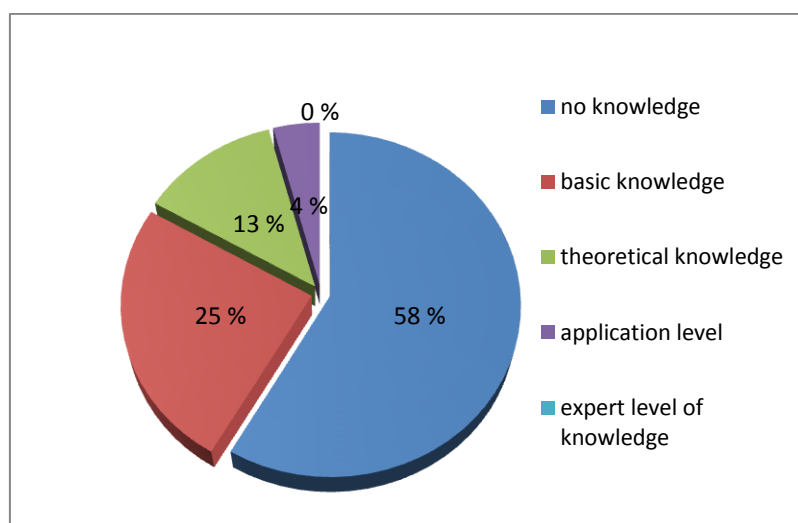


Figure 4.23 Familiarity of international experiences and best practice (provincial EPBs)

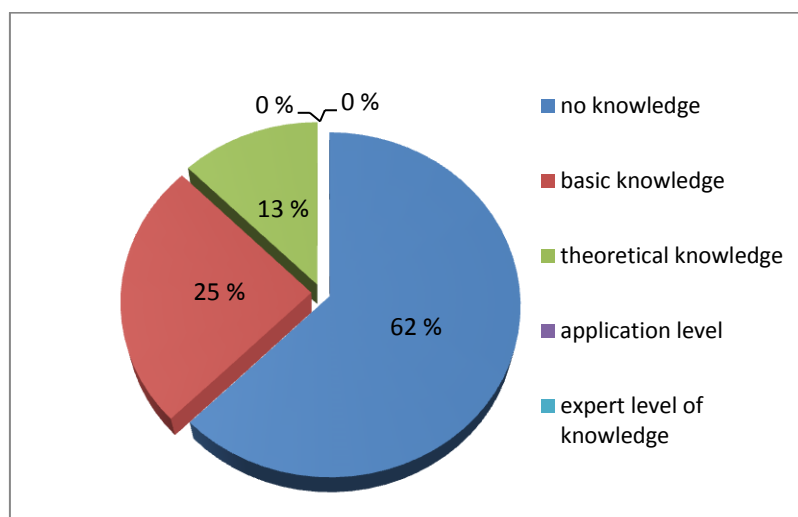


Figure 4.24 Familiarity of international experiences and best practice (municipal EPBs)

It is known from the statistical result of questionnaire that the knowledge of the respondents for international environmental planning experience is not high.

Approximately a half do not know international environmental planning experience and only 25% know theory and practical application. For environmental protection work at provincial and municipal levels, nobody knows practical application. The persons who know theory are also among environmental protection working personnel at the municipal level and its proportion is only 13%.

It is suggested that training of target group in international experience should be enhanced and attention should be paid to the combined systematic and topical training mode to have knowledge of international environmental planning and aim at the specific work of environmental protection working personnel at different levels.

(9) Knowledge level of environmental risk prevention and control method

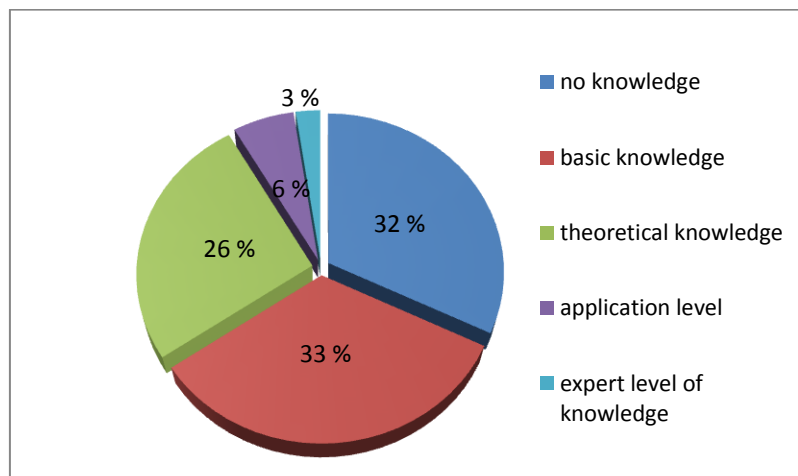


Figure 4.25 Level of knowledge and experience with environmental risk reduction methodologies

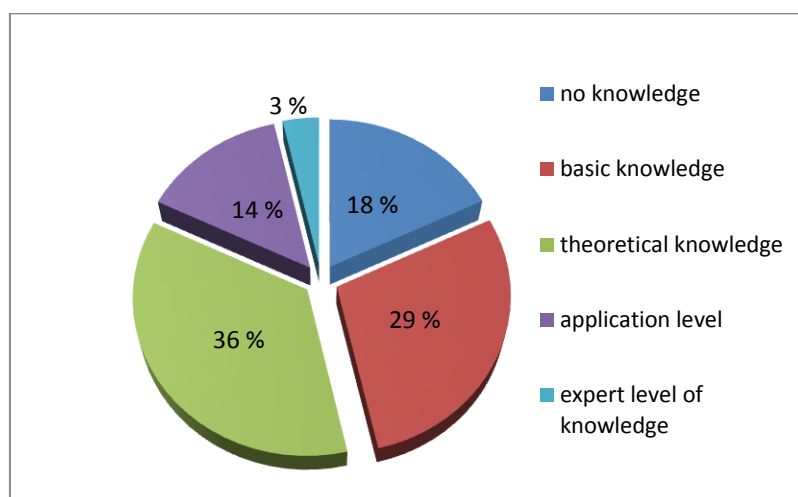


Figure 4.26 Level of knowledge and experience with environmental risk reduction methodologies (MEP&CAEP)

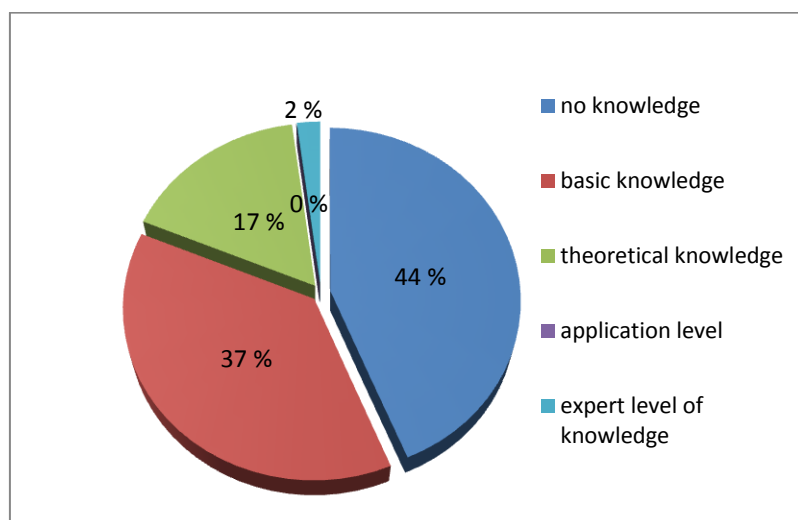


Figure 4.27 Level of knowledge and experience with environmental risk reduction methodologies (provincial EPBs)

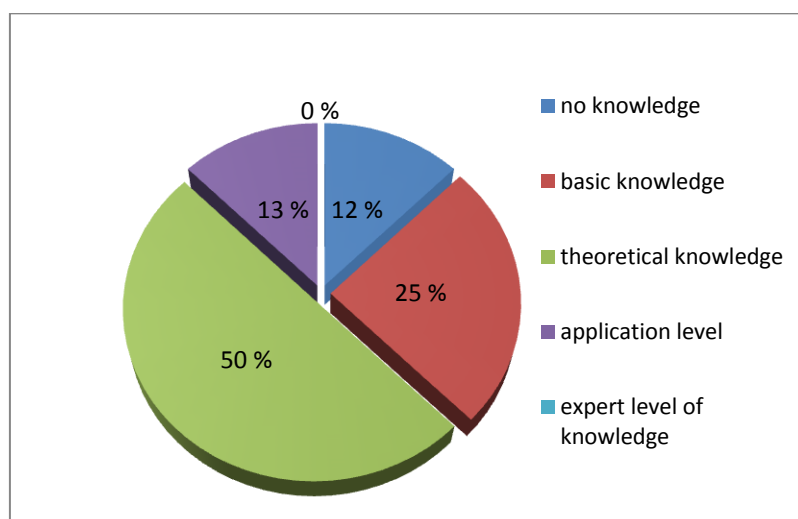


Figure 4.28 Level of knowledge and experience with environmental risk reduction methodologies (municipal EPBs)

It is found from the questionnaire survey that the knowledge of environmental protection working personnel at all levels for the environmental risk prevention and control method is like a dumbbell and the knowledge of environmental protection working personnel at central and municipal levels is higher than that of environmental protection working personnel at provincial level and more than a half personnel of both know or very much know the risk prevention and control method.

(10) Knowledge level of international environmental risk prevention and control experience

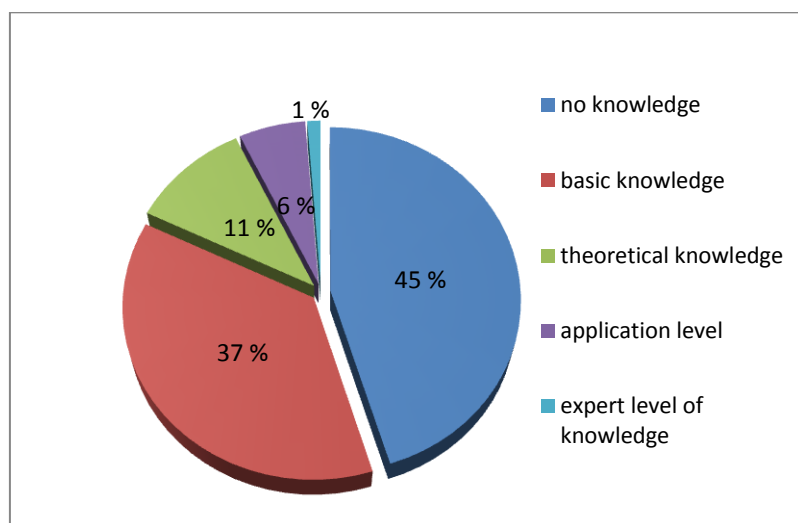


Figure 4.29 Level of knowledge of international experiences and best practice related to environmental risk methodologies

For the risk prevention and control experience and practical knowledge, personnel engaged in environmental planning 58% do not know, a basic knowledge of 26%, 3% theoretical knowledge, 10% application level, 3% expert level of knowledge. Personnel engaged in both emergency response and environmental planning 34% do not know, a basic knowledge of 45%, 16% theoretical knowledge, 5% application level.

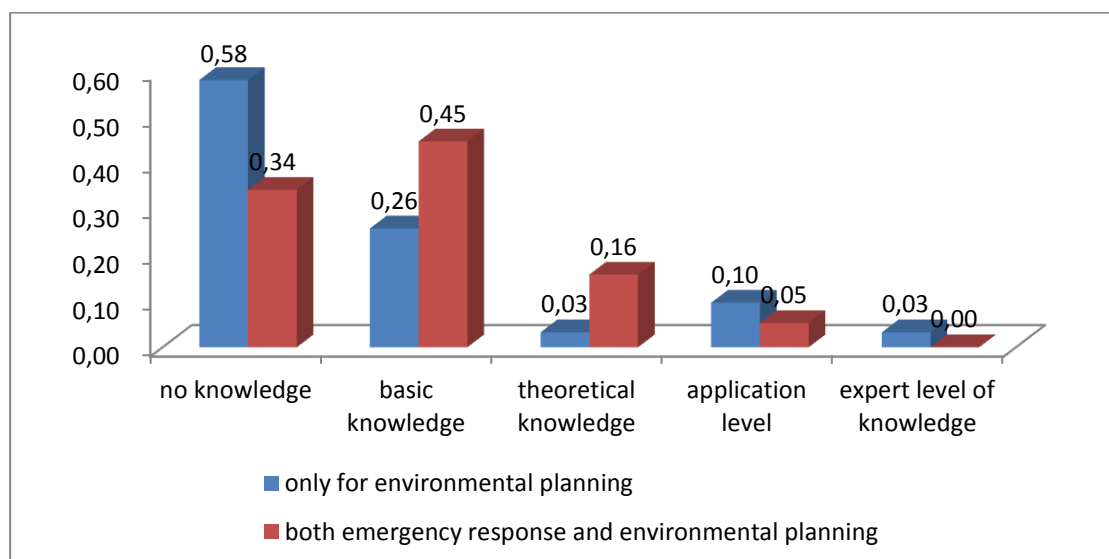


Figure 4.30 Knowledge level of international environmental planning experience

The questionnaire in Guizhou province, 50% people don't know, a basic knowledge of 23%, 18% application level. In Jiangsu province, 35% people don't know, a basic knowledge of 35%, 19% theoretical knowledge, 12% application level.

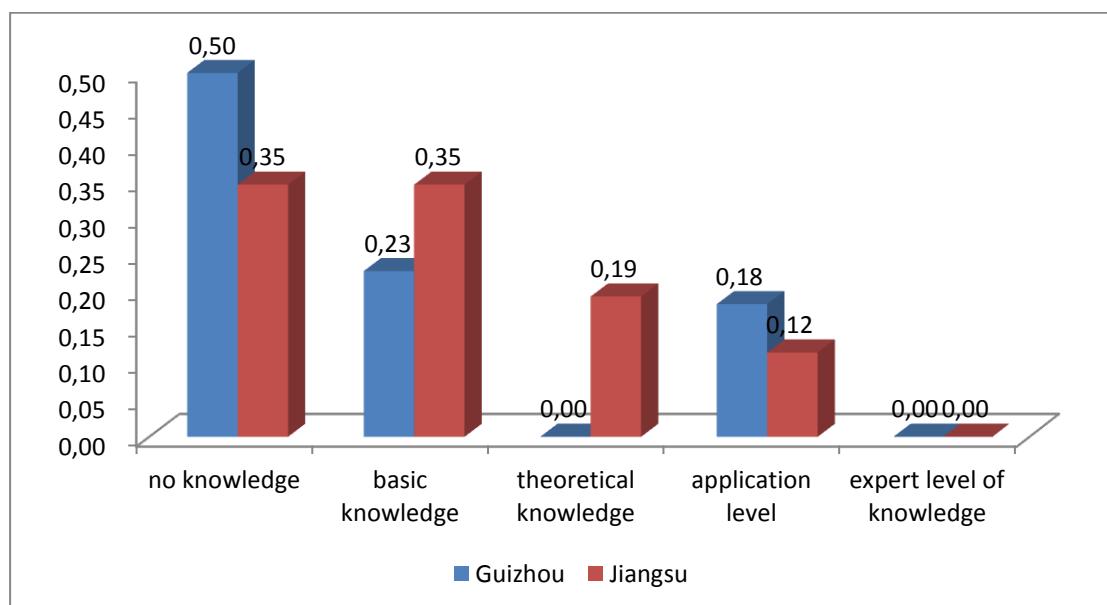


Figure 4.31 Knowledge level of international environmental planning experience

It is found from the questionnaire survey that presently environmental protection working personnel at all levels lack the knowledge of international environmental risk prevention and control experience and environmental protection agencies at municipal level basically do not know the international experience in environmental risk prevention and control. In general, the people of Jiangsu province in the international risk prevention and control experience and practice have higher degree than Guizhou province.

Theory and practice of combining work helps to improve people's awareness of risk defense and practice, and continue to acquire international about risk knowledge and practice of civil air defense. Therefore, introduction, training and study of international experience are the most pressing task for environmental protection working personnel at all levels at the moment and need major attention from this project.

(11) Knowledge level of GAINS, CGE and other integrated environmental impact assessment models

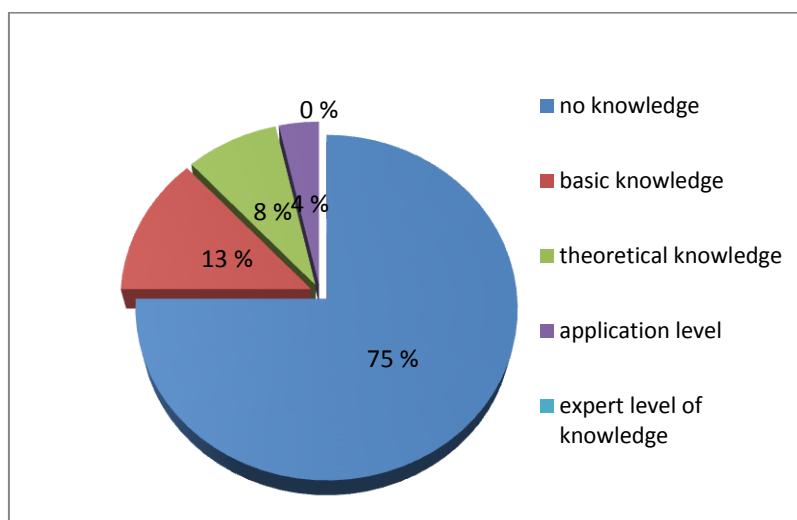


Figure 4.32 Level of knowledge about GAINS, CGE-models and other models for integrated evaluation of environmental impact

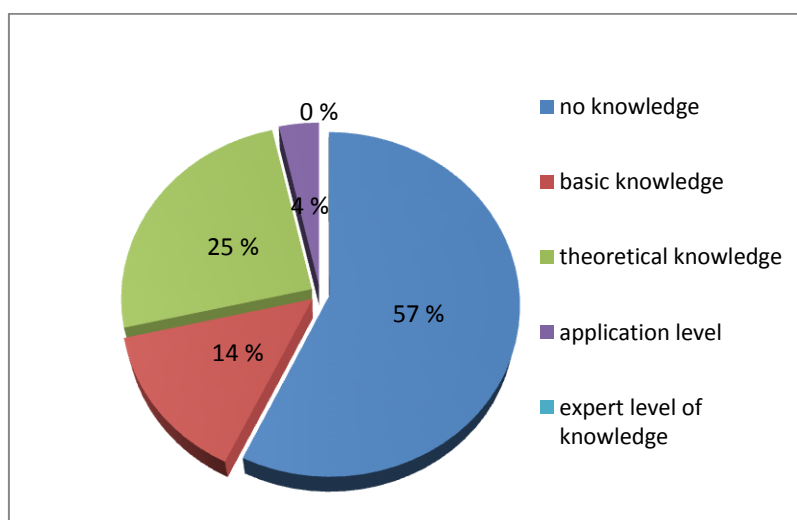


Figure 4.33 Level of knowledge about GAINS, CGE-models and other models for integrated evaluation of environmental impact (MEP&CAEP)

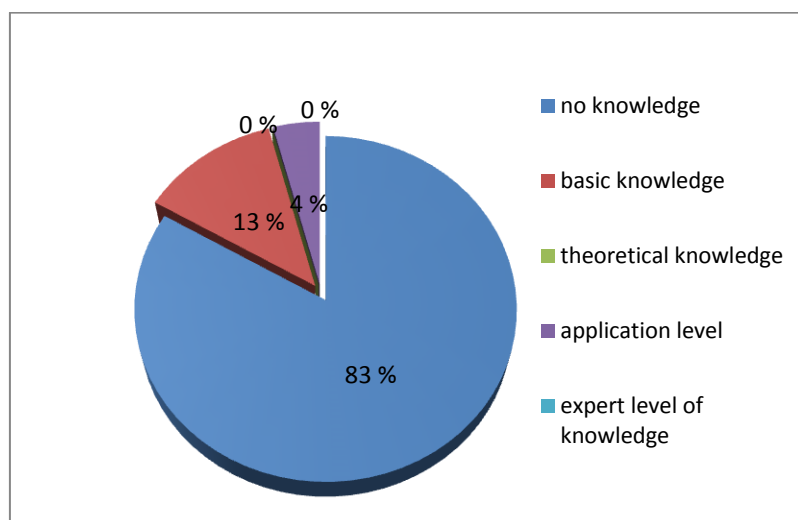


Figure 4.34 Level of knowledge about GAINS, CGE-models and other models for integrated evaluation of environmental impact (provincial EPBs)

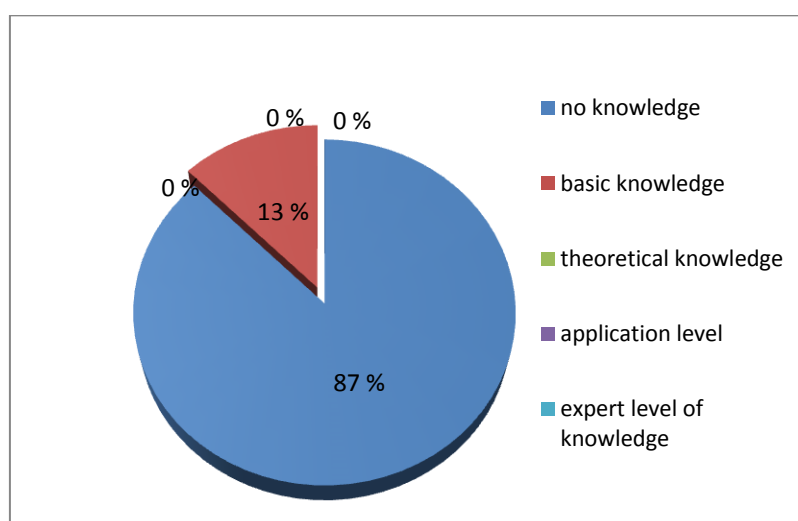


Figure 4.35 Level of knowledge about GAINS, CGE-models and other models for integrated evaluation of environmental impact (municipal EPBs)

Knowledge level of GAINS and CGE model, personnel engaged in environmental planning 74% do not know, a basic knowledge of 6%, 10% theoretical knowledge, 10% application level. Personnel engaged in both emergency response and environmental planning 76% do not know, a basic knowledge of 16%, 8% theoretical knowledge.

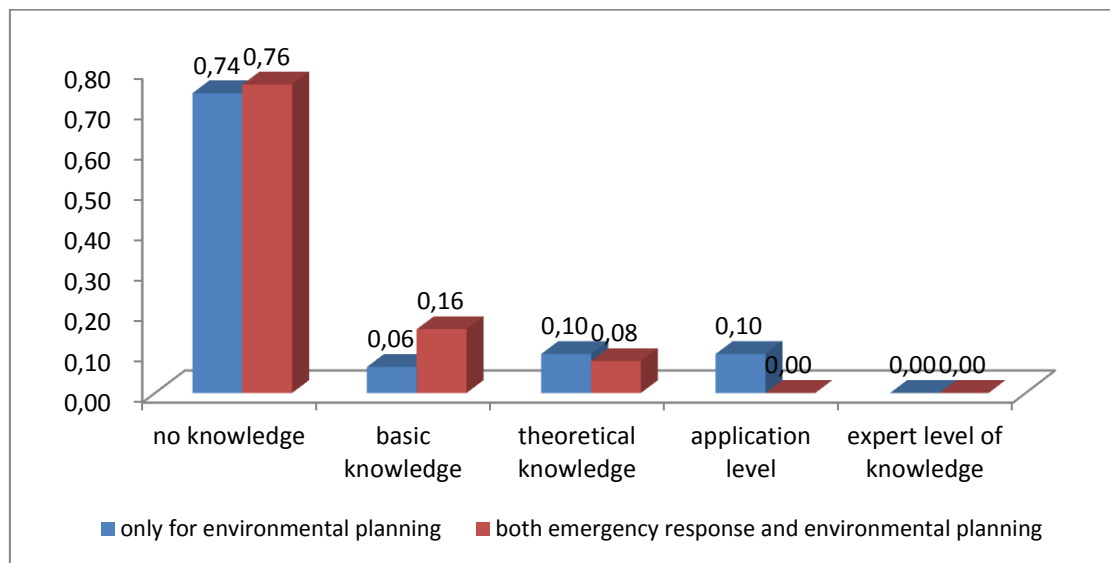


Figure 4.36 Knowledge level of GAINS, CGE models

Knowledge level of GAINS and CGE model, 82% people don't know, a basic knowledge of 14%, 5% application level in Guizhou province. 81% people don't know, a basic knowledge of 12%, 8% application level in Jiangsu province.

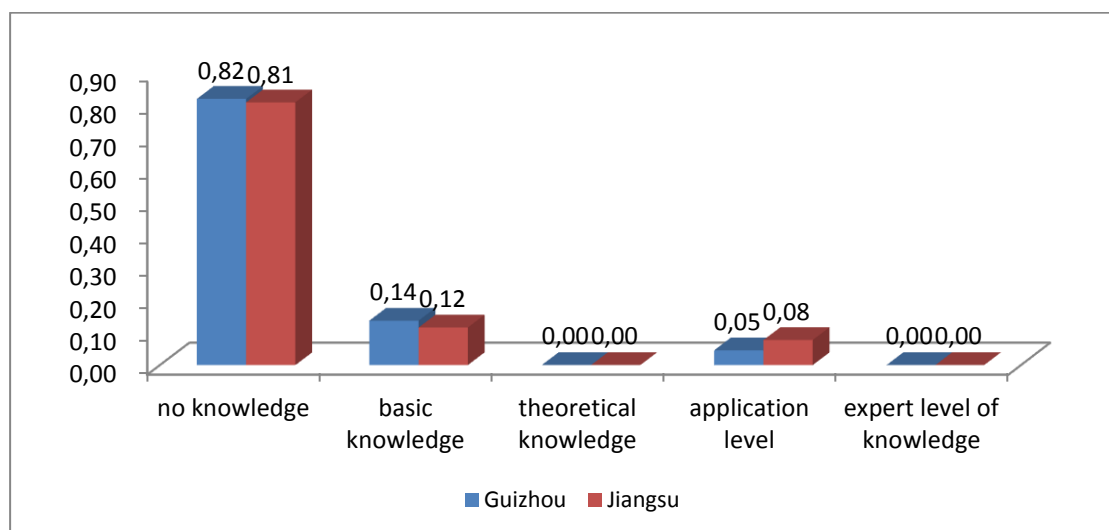


Figure 4.37 Knowledge level of GAINS, CGE models

All the respondents lack knowledge of international experience in environmental risk prevention and control. In general, only 30% know GAINS, CGE and other integrated environmental impact assessment models and the situation is even worse at local (provincial and municipal) level at which theory and practical application is basically unknown. Overall provincial administrative unit realized GAINS, CGE model for degree is not enough, need related training.

Therefore, introduction, training and study of international experience in environmental risk prevention and control need major attention from this project.

(12) Satisfaction of methods and tools concerning environmental planning and environmental risk prevention and control and used in emergency response work with the practical work

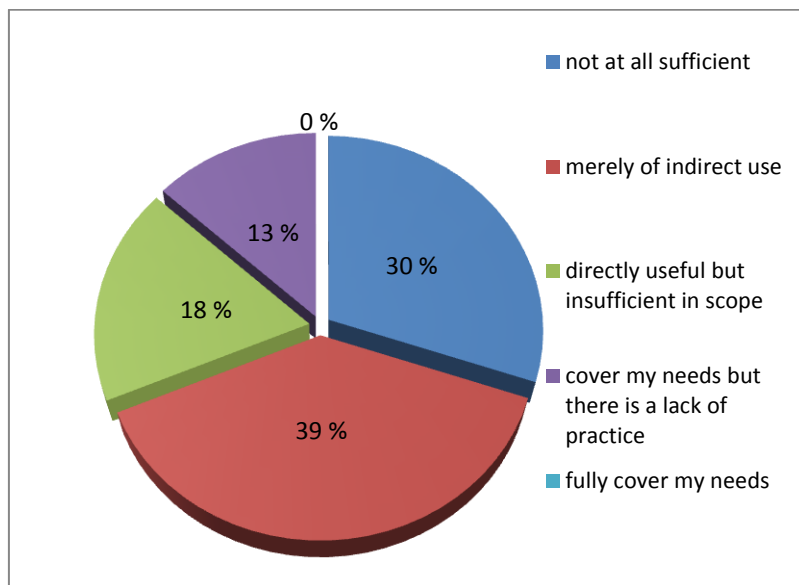


Figure 4.38 Conformance to its requirements of methods and tools

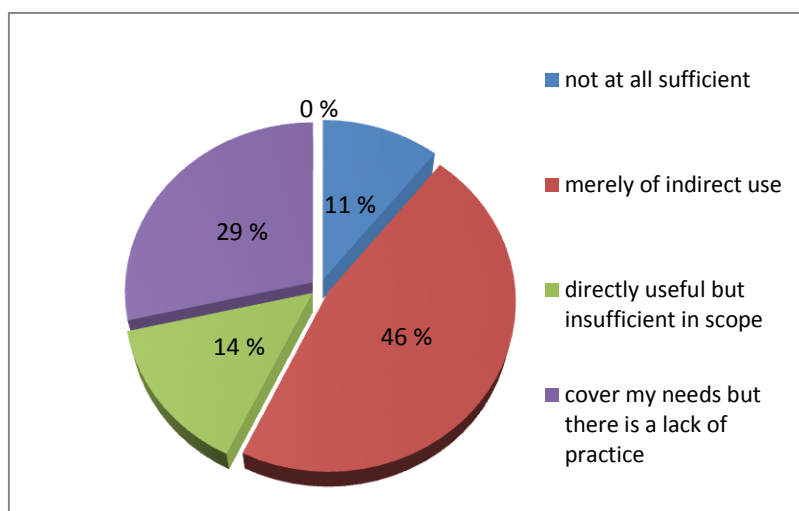


Figure 4.39 Conformance to its requirements of methods and tools (MEP&CAEP)

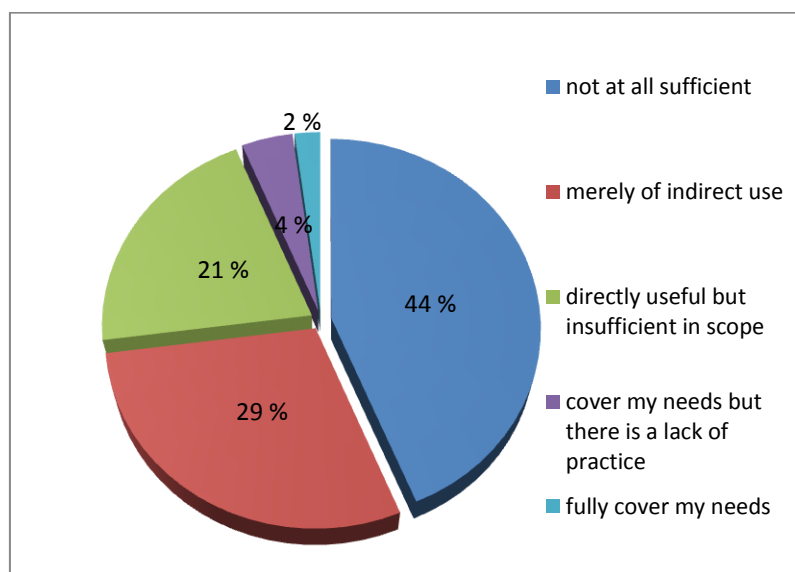


Figure 4.40 Conformance to its requirements of methods and tools (provincial EPBs)

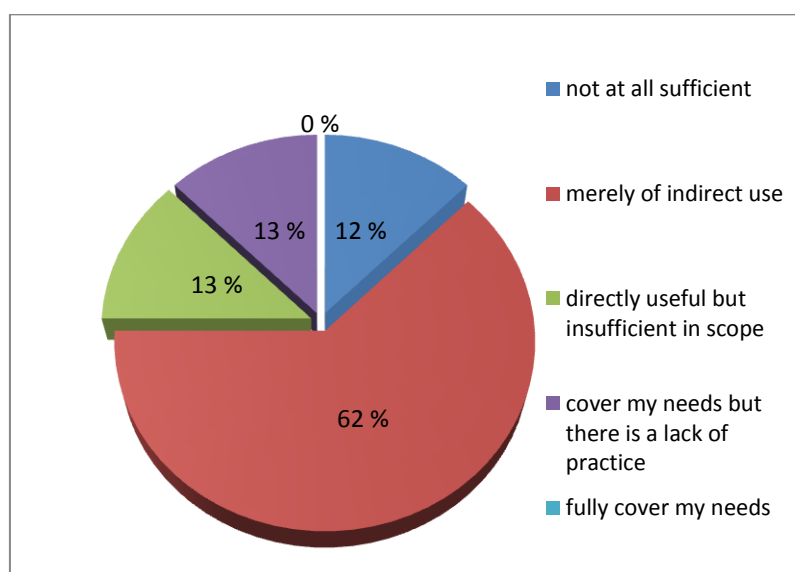


Figure 4.41 Conformance to its requirements of methods and tools (municipal EPBs)

According to the questionnaire survey data, presently it is common that the methods and tools used in environmental planning, environmental risk prevention and control and emergency response work are not highly practicable or very effective in actual environmental protection work. As a whole, 30% is unusable, 39% can be indirectly

referenced and 31% can be partially used and need to be verified in practice. It is seen from the above central and local proportion figures that these methods and tools are

more difficult to use at more basal level. It is suggested that this project can pertinently sort these methods and tools and carry out training in accordance with actual work to improve their operability and actual effect.

(13) Is it needed to further know the specific international experience in the environmental planning, risk prevention and control and accident emergency response field?

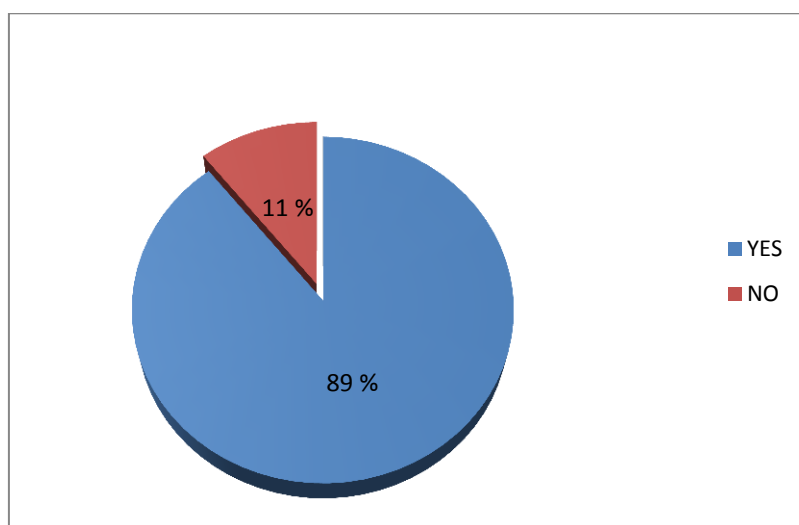


Figure 4.42 Demand analysis of specific type of international experience

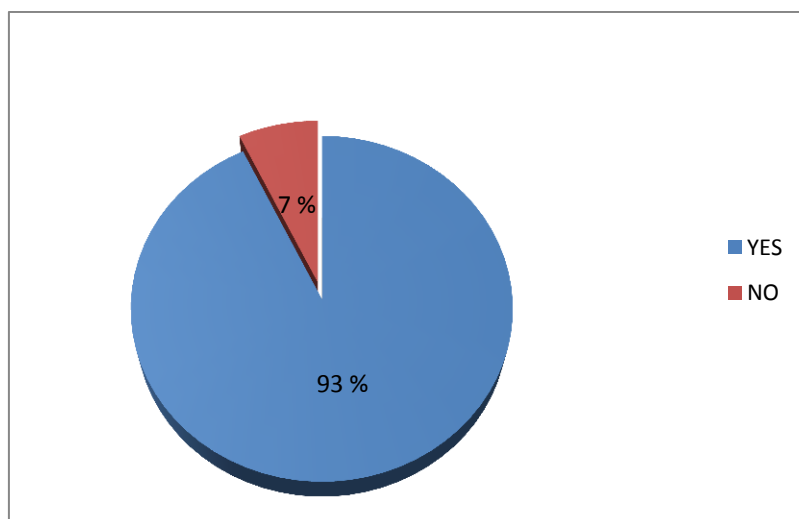


Figure 4.43 Demand analysis of specific type of international experience(MEP&CAEP)

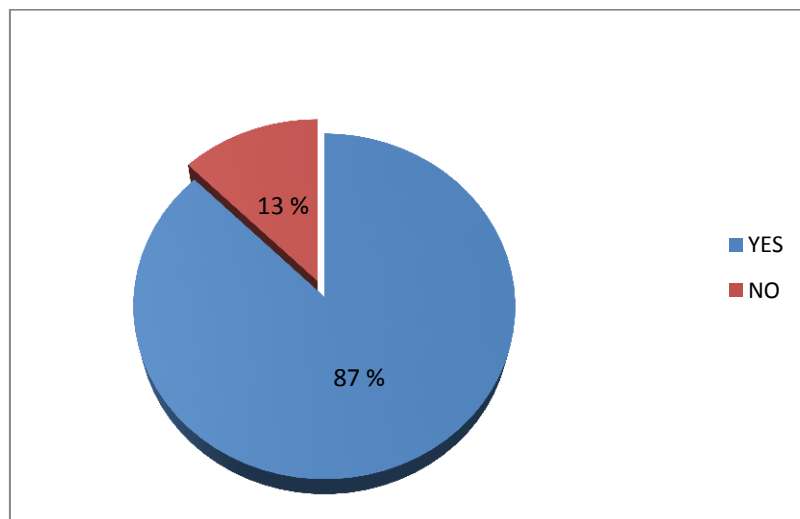


Figure 4.44 Demand analysis of specific type of international experience (provincial EPBs)

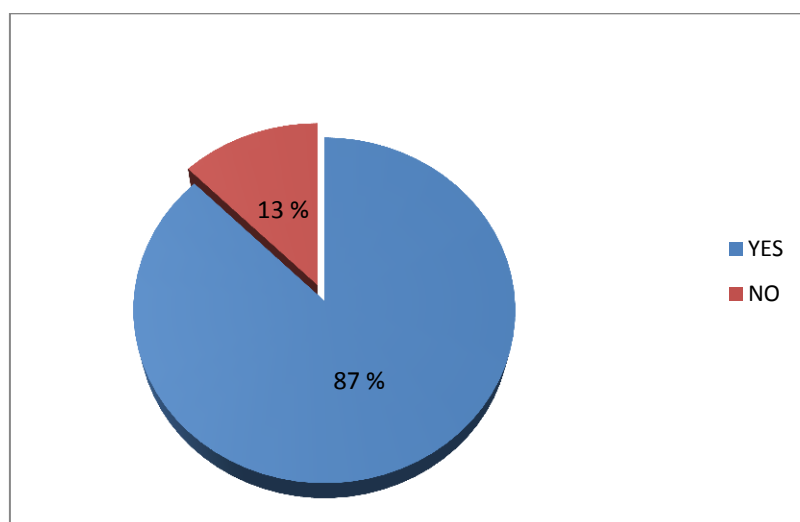


Figure 4.45 Demand analysis of specific type of international experiences (municipal EPBs)

According to the questionnaire survey, environmental protection working personnel at all levels think it needed to further know the specific international experience. They more concerned about international environmental planning experience, environmental risk prevention and control experience and accident emergency response experience.

4.2 Main conclusion

(1) Project necessity is strong.

In view of target groups for the questionnaire survey, the personnel engaged in environmental planning study, formulation and implementation work and in emergency response work need very much such international experience as “Cost Benefit Analysis (CBA), Strategic Environmental Impact Evaluation (SEA), international environmental planning experience, environmental risk prevention and control experience, GAINS, CGE and other integrated environmental impact assessment models and accident emergency response” and place their hope on the use of these empirical methods in the work. On the other hand, the working personnel engaged in environmental protection still have many deficiencies in theoretical mastering and practical operation of these international experiences, methods and tools and need this project to provide technical assistance and support.

(2) Project content has emphasis.

From the questionnaire survey situation, environmental protection working personnel at all levels do not know the international experience (environmental planning, risk prevention and control, GAINS, CGE and accident emergency response etc.) that needs to be used in work, therefore it is suggested that this project should increase training in international experience.

In addition, local environmental protection working personnel are more concerned about the practical use of various theoretical methods and how these methods adapt to work need is a critical problem that needs to be solved. Therefore, it is suggested that while teaching theoretical knowledge, this project can increase the introduction of specific policies and flow for the overseas application of the related technologies and methods in accordance with actual local conditions and conduct case analysis in the light of Chinese policy environment and actual local conditions.

(3) Training subjects are adjusted.

From the questionnaire, environmental protection personnel at central and local (provincial and municipal) levels have different points of interest and different work requirements. It is suggested that training should be carried out separately according to the familiarity of different subjects with theoretical contents in the questionnaire, training should be given mainly to those that have great need but lack knowledge other than to those that have the knowledge in order to avoid repeated teaching.

In response to local need of carrying out actual work, seek the training mode in agreement with the actual work.

5 Conclusion

5.1 Many efforts have been done in response to solve environmental risk problems in China

China is currently facing many environmental risks in air, water, soil, et al., sudden and cumulative environmental risk issues both exist, and because of regional economic and social development patterns and environmental endowment differences, local issues and environmental risks have the ability to solve environmental risk issues are different. As for the pilots,

- Jiangsu lies in eastern China, and is a comparatively developed province. As there are many chemical companies, the production, use, storage and transport of chemicals are the main sources of environmental risk. Environmental emergency response capacity is relatively good, but differentiates from different regions, such as the north and south.
- Guizhou Province and Anshun City, are located in China's western region, and are rich in mineral resources. Environmental risks mainly from mineral resource extraction, smelting and chemical production activities of enterprises.
- Tongling City in Anhui Province is in central China, heavy metals and other pollutants discharged from mining and processing of non-ferrous metal with copper as a representative generate environmental risks on populations and ecological systems.

Chinese government has realized the importance and urgency of addressing environmental risks, especially during the 12th five-year period, the environmental risk prevention have been unprecedentedly emphasized. In the "National 12th Five-Year Plan for Environmental Protection", environmental risk prevention is firstly written into the planning guidelines, and is taken as a one of the main tasks of environmental protection (with the total emission reduction, and quality improvement tied), under the guidance of national planning, environmental risk prevention are also taken as import contents in local environmental protection plans. At both of the national and pilot local level, the staffs in target groups have more or less knowledge and understanding on

environmental risk assessment and management. There already are some studies on international environmental planning, environmental risk assessment and management experience, some foreign models, methods (such as CBA, SEA, GAINS, CGE) also were introduced by papers and reports, and some of them are applied in practices. Generally, the work carried set a foundation for Chinese environmental risk management and planning.

5.2 There are still many problems in national and local environmental risk management

How to coordinate the relation between economic development and environmental protection is still an import issue for sustainable development in China. Many of the environmental risk problems derive from the prolonged tendency of "economic growth is important than environmental protection", the layout (industrial enterprises spatial layout), structural (proportion of heavy industries), composite (multi-kinds of pollutants) problems are significant, for example, the environmental risk caused by an irrational layout of risk sources (eg, chemical companies) and environment sensitive targets (eg, residential areas) is a common problem facing many places, this kind of problem is usually caused by past lack of industrial and environmental standards, or the standards were not strictly enforced, such problems can not be solved in short time, and require systematic planning and management.

Although the environmental risk prevention is taken as an main task of environmental protection during the 12th five-year period in China, and a lot work such as inspection, assessment, early warning and contingency have been or planned to be done to reduce environmental risks, many measures have been written into the plans at both national and local level, however, there are not clear, quantitative targets, qualitative descriptive requirements of environmental risk prevention policy measures can only play a role in guiding the implementation, but lack of actual binding. How to effectively integrate environmental risk prevention into existing environmental planning and management system, and play practical role is an key issue.

In practice, planning and management of environmental risks is still a relatively new concept, as an interdisciplinary region, it proposes more and higher requirements on planning, policy making and implementation, but there is a certain degree of divergence

between the theoretical research and practice management, many technical problems need to be solved. According to survey results, as important target groups of the project, environmental emergency management personnel and environmental planners have not enough theoretical and practical knowledge for each other, especially some emergency response agencies are just set up, the staff of which are lack of knowledge on environmental risk prevention and planning, and some environmental planners also lack technical basis of goal setting, method application of environmental risk reduction planning.

5.3 Improving technical methods application is critical to solve the current environmental risk reduction planning and management problems

Environmental planning is one of the import environmental management means, and is an import implementation carrier of environmental protection strategy. Efficient and effective planning and implementation is necessary to solve environmental risk problems . As mentioned above, there is gap between the demand of risk reduction and the supply of planning and policies, the awareness of environmental risk and methodologies mastered can not meet the practical requirements. Thus, it is necessary to study and apply existing mature and efficient methods to improve environmental planning and risk management system, and integrate the ideal and methods of risk reduction and prevention into the environmental planning system.

Based on the phase I project and the baseline study, the implementation of this project will be more targeted. We will summarize the experience of international environmental planning, environmental risk prevention and management, and carry out the training activities focusing on CBA, SEA, MSG-6 and GAINS other models and methods, improve trainees' cognitions and applicative capacity on environmental planning, environmental risk management, establish and test a framework for environmental risk prevention and planning framework of China, propose appropriate policy recommendations.

Appendix A

Table A-1 List of environmental risk assessment methods

No.	Description	Object	Content	Target
1	Health risk assessment	Chemicals and pollutants	Hazards identification, assessment of dosage effect relationship, exposure assessment and risk characteristics	Substance supervision and prevention of human health
2	Ecology risk assessment	Chemicals and pollutants	Question, analysis and risk characteristics	Substance supervision and ecology risk prevention
3	Comprehensive risk assessment	Chemicals and pollutants	Comprehensive assessment of health and ecology risk of substances	Substance supervision, health and ecology risk prevention
4	Assessment of construction project risk	Construction project	Risk identification, source analysis, result calculation, risk calculation and evaluation, risk management	Assessment of accidental environmental risk, judgment of project feasibility and risk acceptability
5	Division of environmental risk levels	Construction project, parks, regions and basins	Define the environmental risk level by index system, level analysis, scenario matrix, weight assignment	Daily environmental risk supervision to emphasize the key supervision points and increase the supervision efficiency

Table A-2 List of technical specifications for environmental risk assessment

No.	Description	Issued department	Supervised objective	Purpose
1	Technical guideline of environmental risk assessment of construction projects (HJ/T169-2004)	Environmental Impact Assessment (EIA) Department	Construction projects	Accident risk calculation and prevention measures proposal
2	Technical guideline of environmental risk assessment – method of classification of environmental risk for chlor-alkali enterprise	Department of Policies and Laws	Chlor-alkali enterprise	Insurance for environment pollution responsibility
3	Technical guideline of environmental risk assessment – method of classification of environmental risk for sulfuric acid enterprise		Sulfuric acid enterprise	Insurance for environment pollution responsibility
4	Technical guideline of environmental risk assessment – method of classification of environmental risk for lead bullion smelting enterprise (exposure draft)		Lead bullion smelting enterprise	Insurance for environment pollution responsibility
5	Technical guideline of risk assessment for polluted sites (exposure draft)	Pollution Prevention and Control Department	Polluted sites	Development and management of polluted site
6	Assessment method of classification of enterprises' environment risk (exposure draft)	Emergency Center	Enterprise related to environmental risk substances	Management of classification of enterprise environment risk

Table A- 3 Relevant institutions and policies of China's environmental risk management

Time	Promulgation unit	Policy name	Main content
1990	State Environmental Protection Administration	Request for Environmental Risk Assessment over Major Accident Potential of Environment Pollution	General environmental risk assessment requested in environmental impact reports of major projects in China.
1997	State Environmental Protection Administration, Ministry of Agriculture and Ministry of Chemical Industry	Notice on Further Strengthening the Supervision and Management of the Waste Water Discharge from Pesticide Production Units	The construction projects of new, expanded and revamped pesticide production must carry on risk assessment about water pollutants, especially about specific pollutants.
2004	State Environmental Protection Administration	Technical Guideline of Environmental Risk Assessment of Construction Projects	Levels, procedures, basic content, source item analysis, result computation and risk calculation of environmental risk assessment.
2004	State Environmental Protection Administration	Notice on Insuring the Environment Pollution Prevention in the Course of Enterprise Relocation (Huanban No. [2004]47)	Strengthening the environmental supervision of the moved enterprises, investigating in the pollution sources of the construction site in the moved industrial areas and monitoring the soil environment.
2005	State Environmental Protection Administration	Measure of Environmental Pollution Prevention on Discarded Hazardous Chemicals (Huanbaozongjuling	Prevention of pollution by discarded hazardous chemicals, recovery and disposal; unification of the supervision and management on the prevention of hazardous chemicals pollution.

Time	Promulgation unit	Policy name	Main content
		No.27)	
2005	The State Council	National Emergency Plans for Environmental Contingency	The events caused the adverse effects on environment and ecology are considered in emergency management for the first time.
2007	State Environmental Protection Administration	<p>Notice on strengthening the Management of Environmental Impact Assessment and the Prevention of Environmental Risk (Huanfa No.[2005]152)</p> <p>Notice on Developing Investigations in Environmental Risk for Chemical and Petrochemical Projects (Huanbanhan No.[2006]69)</p> <p>Notice on Checking about Environmental Risk of Newly-built Chemical and Petrochemical Projects (Huanban No.[2006]4)</p>	<p>Environmental risk source control, developing searching environmental risk sources by checking, being strict about the environmental protecting approval of construction projects and strengthening supervision and responsibility investigation.</p> <p>To carry out pertinent environmental safety check, search for hidden environmental risks of construction projects, put forward rectification measures and proposals and prevent environment pollution accidents from happening.</p>
2007	Ministry of Environmental Protection	Instructions about Environment Pollution Liability Insurance	To put forward the pilot work of environment pollution liability insurance in key industries and regions.
2008	Ministry of Environmental Protection	Opinions about Strengthening Soil Pollution Prevention (Huanfa	Principle regulations were made about the pollution prevention and environment supervision on industrial sites.

Time	Promulgation unit	Policy name	Main content
		No.[2008]48)	
2009	The State Council	Control Regulations of Transportation of Radioactive Substances	To specify the management of transporting radioactive substances in China and reduce the risk of transporting radioactive substances, to promote the development and application of nuclear energy and technologies and safeguard human health and the environment.
	Ministry of Environmental Protection	Management Method of New Chemical Substances (Buling No.7) Opinions about Strengthening the Work of Environment Emergency Management	To control the environmental risk of new chemical substances, safeguard human health and protect ecological environment. To put forward the overall promotion of the whole process management of environment emergencies, actively prevent and appropriately response to various acute environmental accidents and strengthen basic and guaranteeing work of environment emergency management.
2010	Ministry of Environmental Protection	Notice on establishing and perfecting emergency response mechanism jointly between environment protection and safety supervision departments (Huanban No.[2010]5)	To realistically promote establishing and perfecting emergency response mechanism jointly between environment protection and safety supervision departments at the levels of provinces, cities and counties.
		Management Measure for Safety Permission of Transporting Radioactive Substances	To strengthen the safety management of transporting radioactive substances and implement licensing system for transporting radioactive substances.
		Guideline for Compiling	To put forward the composing streamline of contingency plan for petrochemical

Time	Promulgation unit	Policy name	Main content
		Environmental Contingency Plan for Petrochemical Enterprises (Huanban No.[2010]10)	enterprises and the main content of the plan.
		Interim Management Measure of Contingency Plan for Acute Environmental Accidents (Huanfa No. [2010]13).	To specify compilation, evaluation, record, implementation, supervision and management of the contingency plan.
		Management Measure of Information Reporting about Acute Environmental Accidents (Trial) (Huanban No.[2010]141)	Content, standard and form to be used in the information report about acute environmental accidents

2011	Ministry of Environmental Protection	Registration Measure of Environmental Management on Hazardous Chemicals (Huanbanhan No.[2011]1212)	To strengthen the environmental management of hazardous chemicals, reduce the emission of hazardous chemicals into the environment and prevent environmental risks.
2013	Ministry of Environmental Protection	Guideline for Compiling Reports on Evaluating Environmental Risk of Key Hazardous Chemicals under the Environment Management	The content to be compiled in reports on evaluating environmental risks of hazardous chemicals and the technical methods of environmental risk assessment were specified.

Vista Analysis AS

Vista Analysis is a social science consultancy with its main emphasis on economic research, policy analysis and advice, and evaluations. We carry out projects to the highest professional standards, with independence and integrity. Our key thematic areas include climate change, energy, transport, urban planning and welfare issues.

Our employees have high academic credentials and broad experience within consulting. When needed we utilise an extensive network of companies and resource persons nationally and internationally. The company is fully employee-owned.

Vista Analysis AS
Meltzersgate 4
0257 Oslo

post@vista-analyse.no
vista-analyse.no