The Association of Academies of Sciences in Asia (AASA)

TOWARDS A SUSTAINABLE ASIA

NATURAL RESOURCES

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With 27 figures

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Author
The Association of Academies of Sciences in Asia (AASA)
KAST Building, 7-1, Gumi-Dong
Bundang-Gu
Seongnam-Shi
Gyunggi-Do, 463-808
Republic of Korea
E-mail: aasa@kast.or.kr

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Project Team of “Sustainable Development in Asia” of the AASA

Project Co-Chairs

Yi Wang	Institute of Policy and Management, CAS
Namık K. Aras	Turkish Academy of Sciences

Group Coordinators

Energy

Luguang Yan	Institute of Electrical Engineering, CAS
Seung Mo Oh	Seoul National University

Environment and Climate Change

Gensuo Jia	Institute of Atmospheric Physics, CAS
Woojin Lee	Korea Advanced Institute of Science and Technology

Natural Resources

Lei Shen	Institute of Geographic Sciences and Natural Resources Research, CAS
Cahit Helvacı	Geology Department, Dokuz Eylül University

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Baichun Zhang	Institute for the History of Natural Science, CAS
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Thematic Report of the AASA Project "Sustainable Development in Asia"

TOWARDS A SUSTAINABLE ASIA: NATURAL RESOURCES

Coordinating Lead Authors

Lei Shen	Institute of Geographic Sciences and Natural Resources Research, CAS, China
Cahit Helvacı	Geology Department, Dokuz Eylül University, Turkey

Lead Authors

Lei Shen	Institute of Geographic Sciences and Natural Resources Research, CAS, China
Jiyuan Liu	Institute of Geographic Sciences and Natural Resources Research, CAS, China
Litao Liu	Institute of Geographic Sciences and Natural Resources Research, CAS, China
Tao Dai	Institute of Geographic Sciences and Natural Resources Research, CAS, China
Hongqiang Li	Institute of Geographic Sciences and Natural Resources Research, CAS, China
Yang Zhao	Institute of Geographic Sciences and Natural Resources Research, CAS, China
Lan Fang	Institute of Geographic Sciences and Natural Resources Research, CAS, China

Contributors

Cahit Helvacı	Geology Department, Dokuz Eylül University, Turkey
Christopher C. Bernido	The Central Visayan Institute Foundation, Philippines
Nikolay P. Pokhilenko	Institute of Geology and Mineralogy, Siberian Branch of the Russian Academy of Sciences, Russia
Gaohuan Liu	Institute of Geographic Sciences and Natural Resources Research, CAS, China
Zhijun Yao	Institute of Geographic Sciences and Natural Resources Research, CAS, China
Yao Lv	Institute of Geographic Sciences and Natural Resources Research, CAS, China

Luguang Jiang	Institute of Geographic Sciences and Natural Resources Research, CAS, China
Zengrang Xu	Institute of Geographic Sciences and Natural Resources Research, CAS, China

Reviewers

Namik K. Aras	Turkish Academy of Sciences, Turkey
Anna Stabrawa	UNESCAP-Thailand
Alper Baba	Izmir Institute of Technology, Turkey
Ashfaq Ahmad Chattha	University of Agriculture, Pakistan
Harsh Gupta	National Geophysical Research Institute, India

Foreword

Asia is not only the largest and most populated continent in the world, but also the region with the most diverse development models and most dynamic economies. In the past half century, Asia has been witnessing rapid economic growth and playing an increasingly more important role in world's political and economic arena. At the same time, Asia has developed the commonly-called "Asia Model", which has attracted worldwide attention. The Asia Model shows a new way for the developing nations or late-development countries on how to realize industrialization and modernization. All these achievements are made by Asian countries with a focus on the advantages of their late development, re-examination of their internal cultural values, active absorption of modern S&T and management experiences and constant exploration and innovation.

These social progresses have made great contributions to the realization of the UN Millennium Development Goals and have played a pioneering and demonstration role on what can be accomplished in today's world. However, Asia is facing big challenges. The most prominent one is that the rapid development of Asian economies is based on large input of production factors at the huge expense of natural resources and environment, which has been sharpening the conflicts in population, resources, environment, socio-economic development. The sustainable development in the region is being severely threatened and challenged. The rethinking and questioning of the Asia Model in the international community is growing especially in the era of post Asia Financial Crisis and Global Financial Crisis.

It is not only a common challenge for the governments of Asian countries, but also a common task for the Asian scientific communities to cope with the resources and environment crisis and to seek a new way of sustainable development in Asia. AASA, as a non-governmental and regional international scientific organization with 26 member academies, is mandated to initiate and conduct investigation on issues concerning S&T, economic and social development. As early as April 2007, AASA proposed to initiate a project on "Sustainable Development in Asia" (SDA) within AASA framework in the hopes to provide consultation and advice for national and regional governments in Asia and relative international organizations. This study proposal was approved at AASA board meeting held in Russia in August 2007 with the Chinese Academy of Sciences as the initiator. The project covers environment, energy, resources and culture with the establishment of four working groups among AASA member academies.

Soon after, the SDA project was officially launched and implemented at different levels. The efforts include the clarification of the research content, emphasis, structure and division of tasks. Various meetings at the working level and international workshops have been held to coordinate the research activities and project progress: the first international workshop under this project was held in February 2008; the AASA Workshop on Sustainable Energy Development in Asia in November 2008; the AASA Workshop on Agricultural Culture and Asian Sustainable Development in August 2009; and the AASA Workshop on Environment and Resources in September 2009.

With the joint efforts of AASA member academies, the SDA project has now come up with a series of studies including four thematic reports, namely, "Towards a Sustainable Asia: Energy", "Towards a Sustainable Asia: Environment and Climate Change", "Towards a Sustainable Asia: Natural Resources", and "Towards a Sustainable Asia: The Cultural Perspectives" . Based on these four reports, a synthesis report has also been written entitled: "Toward a Sustainable Asia: Green Transition and Innovation". All these reports have looked deeply into the common issues and challenges for the Asian sustainable development from different perspectives.

The synthesis report is an integration and extension of the four thematic reports. It aims at the major resource and environmental challenges and issues in Asia in the general context of the challenges of financial crisis and climate change, and in line with green transition and innovation in Asia. Of its major findings, it includes: the diagnosis of key resource and environmental issues in Asia, such as water, minerals, land resource, environmental pollution, eco-degradation, energy and environment and climate change, the revelation and reflection of the diverse, different, complicated and severe nature of resource and environmental issues in Asia, the systematic analysis of the main driving forces and future trends of resource and environmental changes in Asia, the empirical analysis and discretion of current evolution of the relationship between environment and development in Asia with the establishment of theoretical and conceptual models, the initiation of principals, strategic framework, focus and advice for promoting the green development of Asia on the basis of summarizing Asia's advantages and disadvantages.

The synthesis report differs from other similar reports. It focuses more on the combination of theoretical and empirical research in the evolution of environment and development, on the combination of trends analysis in time series and comparative study at spatial scale, and on the combination of Asia's integrated analysis and regional and national differences. Besides, attempts have been made here on the innovative modeling of the evolutionary and theoretical relationship between environment and development, analysis of the driving forces in environmental evolution, and utilization of newly developed composite index to conduct empirical research of Asia's environment and development relation in the evolution.

We hope the reports will be of good value to the facilitation of the green development in Asia, providing advice on dealing with the shortage of conventional resources, environment pollution and climate change, fostering new economic growth and enhancing Asia's competitive advantages. This is the first time that AASA has ever undertaken such a study, and it surely leaves grounds for more detailed study and analysis of various issues and challenges that Asian countries face in the future.

The SDA project is sponsored by AASA. I want to give my special thanks to all AASA member academies for their consistent support, advice and assistance, without which, the accomplishment of such an internationally interdisciplinary scientific project would be impossible. My thanks also go to all the members in the working groups, especially Professors Namık Aras and Yi Wang, co-chairs of this study, without whom, efficiency and quality of the study would not be guaranteed. I also need to thank United Nations Environment Programme (UNEP), InterAcademy Council (IAC) and InterAcademy Panel (IAP) etc. for providing us the references and various advice and inspirations. Last but not the least, I want to express my thanks to all friends and the institutions that have rendered us encouragement and assistance all the way along.

The SDA project features with a wide range of fields and a huge amount of data, some of which are still in their early stage of development. Any comments or suggestions from our friends and various international institutions are warmly appreciated.

Prof. Jinghai Li

President

The Association of Academies of Sciences in Asia (AASA)

September 20, 2010

Preface

Asia is an important continent with population of 3.8 billion and concentrates most developing countries in the world. Over the last several decades, many nations in Asia have seen quick economic development, while some strategic resources needs in Asia increase simultaneously. In the next 20 years and even long terms of the 21st century natural resources demand in Asia will increase largely. Asia occupies the important position of the resources supply and demand in the world. It has not only some key resources producing countries in the world, but main resources consuming countries as well. Unfortunately, Asian economic progress in general has been achieved at a high cost. Under combined pressure of climatic change and human disturbances, the natural environment in Asia has been steadily degrading, which compromises the future development and the livelihood of its huge residents. Impacts of climate change are especially visible in Asia on various sectors including agriculture, forestry, biodiversity conservation, water resources, human health, air quality, energy security, and others. Climate change related environmental deteriorations in Asia are already serious, and will very likely further worsen in future which is continuously challenging the sustainability of natural resources.

In 2008 the Association of Academies of Sciences in Asia (AASA) initiated a project of "Sustainable Development in Asia" which includes four research groups of energy, natural resources, environment and culture. In regard to the task of natural resources, it is required to take grasp of the status of natural resources in Asia, identify some common problems and challenges, summarize successful efforts that some countries in Asia have made, and propose several major projects and policy recommendations for sustainable use of natural resources in Asia.

To implement this task appointed by the whole project framework, we carried out large amounts of desk survey of literature review, data and information production, translation and dissemination of case studies that documented some so-called "best practices and models" of effective and sustainable use of resources in each country of Asia. A final policy report has been created and circulated among some limited scholar community.

This book is completed based on the final report of the sub-project entitled as "Sustainable Use of Natural Resources in Asia" under the whole project of AASA. This sub-project aims to bring together a wide range of experts and scholars involved in development and management of natural resources in Asia, within the context of sustainable use of natural resources and effective improvement of resources use. We consider that there is a good opportunity of cooperation on the sustainable use and management of natural resources in Asia. Strengthening the cooperation is a demand for resources safety and environmental sustainability that guarantees Asian environmental health and promotes socio-economic development in all countries of Asia.

During 2008 and 2009 two workshops were organized in Beijing and Izmir. The first workshop was held on February 25-26 2008 in Beijing of China and devoted to the whole project, including four groups of energy, environment, natural resources, social development and culture, 27 experts from 10 countries attended. On September 24-27 2009 the second workshop in particular regard to “Environment and Resources in Asia” was held in Izmir of Turkey and aimed to highlight on interactions among these two major issues of environment and natural resources in the context of sustainable development in Asia, where 34 representatives from 10 AASA member countries and one observer contributed to the discussions.

At the first workshop, Prof. Dr. Lei Shen and Prof. Christopher C. Bernido as the group leaders hosted the discussion and Prof. Dr. Cahit Helvaci, Prof. Nikolay P. Pokhilenko, Prof. Yi Wang, Prof. Gaohuan Liu, Dr. Luguang Jiang, Dr. Zengrang Xu, and Dr. Tao Dai also joined the workshop. We concluded that the research on natural resources and sustainability should focus on issues relating to land, water, mineral resources and biodiversity and their common challenges and diversified features were also identified. We acknowledged that the following perspective issues, tendency, needs and problems should be included in the context of natural resources. First, database establishment and data sharing in AASA should be priority action to be carried out. Second, natural resource assessment, exploration and mapping are needed to cooperate among all countries of AASA. Third, future consumption and demand based on population profile (structure, growth rate, education, and employment) should be estimated. Fourth, active cooperation on natural resource management within AASA is encouraged. We also identified some basic opportunities for the role of science and technology, pilot projects are recommended to be implemented, including education and training of young generation, community participation capacity building, and improvement of research and technology innovation in natural resource exploration and development. We recommended that a science foundation in AASA be established and supported by member countries. AASA should establish a database of natural resources for all countries in Asia and select urgent problems within member countries and find some solutions to work out.

The second workshop, Prof. Gensuo Jia, Prof. Lei Shen, Prof. Cahit Helvacı, Dr. Alper Baba and Prof. Namık Aras as co-chairs, was organized by AASA and Turkish Academy of Sciences (TUBA), hosted by Turkish Academy of Sciences and Dokuz Eylul University (DEU), sponsored financially by Inter Academy Panel (IAP), Inter Academy Council (IAC), TUBA, AASA, Dokuz Eylul University (DEU), the Graduate School of Natural and Applied Sciences (DEU – FBE), Izmir Institute of Technology (IYTE) and Turkish Chamber of Geological Engineering (JMO). Participants shared information about resources situation, discussed interlinks with the environmental issues in their own country, and addressed the common challenges in Asia. Recommendations were also made on how to prepare a consultative report on sustainable use of natural resources in Asia. Some academic articles and viewpoints of attendees were presented in its conference proceeding and final suggestion report. The experts emphasized the following points in terms of resources use in Asia:

First, resource efficiency is cross-cutting and applicable to the use of all resources. Therefore it needs to be investigated in all resources contexts. Second, water availability with appropriate quality and water use efficiency in the region are among the key issues in Asia and should be given high attention. Third, impact of climate change on agricultural resources development and food security should be given high priority. Strong support should be given to research in genetic engineering to increase the production of rice, wheat and corn; as well as control of erosion and natural hazards should be paid urgent attention to be controlled. Fourth, coal mining and its consumption is one of the core issues that concern the natural resources management, environmental quality, and climate change. Problem-solving oriented projects should be promoted and cooperation between member countries should be supported. Fifth, about 60% of the coastal areas of the world are in Asia-Pacific region. Coastal resources, however, have not been effectively developed. Sixth, establishment of technology and information-sharing platform and mechanism would contribute to the advancement of the collaboration and sustainable development in resources utilization in Asia. Last but not least, resources and environment are linked on the basis of all types of ecosystems. Biodiversity conservation is not only very important for the sustainable development of Asia but can also contribute a lot for our world.

Except two workshops mentioned above, we have undertaken a large amount of literature reviews and data analysis. These works are mainly attributed to some of my colleagues, doctoral and post doctoral students, including Profs. Jiyuan Liu, Gaohuan Liu and Zhijun Yao, Dr. Yao Lv, Ms. Litao Liu, Mr. Tao Dai, Mr. Hongqiang Li, Ms. Yang Zhao and Ms. Lan Fang.

Since Asia is undergoing a dynamic transition process, this book is inevitable to be imperfect due to the limitation of knowledge and time of the research group. We acknowledge that some major references might be omitted and forgotten but any comments and corrections are warmly welcomed.

Study Group on Natural Resources

August 2010

Executive Summary

Under current trends of economic globalization and regional economic integration, as well as increasing urbanization and industrialization, Asia's natural resources landscape has changed dramatically. The protection, development, processing and consumption of natural resources, and the socio-economic and environmental issues associated with them have aroused great concern of countries in Asia and the world. Over-exploitation and over-consumption of some natural resources, and the resulting environmental damage, social instability, single economic structure, are all facts that cannot be ignored. These require us to better understand the status of various natural resources in Asia, its existing problems, sustainability, and measures which might be taken by some countries in the region.

This book attempts to systematically analyze the status of natural resources in some major Asian countries, identify some common problems and challenges, summarize successful efforts that some countries in Asia have made, and propose several pilot projects and policy recommendations for sustainable use of natural resources in Asia.

The book is drawn from the major research report of "Sustainable Use of Natural Resources in Asia", the sub-project of "Sustainable Development in Asia", which is a consultancy project of the Association of Academies of Sciences in Asia (AASA). The book covers 48 countries in Asia (excluding Pacific region). For better analysis and discussion, we divide Asia into 5 sub-regions, namely, Northeast Asia, South Asia, Southeast Asia, Central Asia and West Asia. The major points and core contents of the book are drawn as follows:

1. Asia is in shortage of fresh water and land resources, and rich in mineral resources with very low utilization efficiency, in additon, biodiversity conservation is subject to many shocks

In this book, study on status and trend of resources use in Asia is mainly based on four aspects of natural resources, that is, water, land, minerals and biodiversity.

One of the major challenges facing Asia is the shortage of freshwater resource. Asian water resource pressure is mainly caused by extraction of surface water and underground water, pollution of freshwater resource made by industrial development, and inefficient utilization of water resource. Spatial and sector differences are significant in water resource distribution and allocation, average annual fresh water consumption of the South Asia and Northeast Asia accounts for 75% of the total, while agriculture is the largest sector of water consumption. The reverse relationship between water consumption and economic development in Asia is noteworthy.

Nearly 65% of the world's population is raised by less than 25% of the world's land in Asia. Land use in Asia can be divided into three parts: agricultural land, woodland and the other, of which the largest share is agricultural land, accounting for more than 50%; minimum share is woodland, accounting for 19%; and other use of land is just 30%. Agricultural land mainly consists of arable land, perennial crops, grass and pasture. Spatial variation is distinct in agricultural land. Nearly half of agricultural land comes from the Northeast Asia, followed by that of South and Central Asia, and Southeast Asia has the smallest agricultural land. Cereals crop production is dominated in harvested area in Asia, the past 50 years saw the biggest change amplitude. Since 1961, cereals production in Asia has grown rapidly but could not fully meet the consumer demand yet, with the growing gap between supply and demand and the rise of external dependence.

Mineral resources of Asia take an important position in the world. Asian non-ferrous metals and precious metals reserves account for 25%-50% of the world's total; ferrous metal such as manganese, chromites reserves are more than or close to 50% of the world's total reserves; and there are some sylvite resources reserves in non-metallic mineral resources. Countries in Asia can be divided into three categories in this book based on their different proportions of mining economics, namely, pillar mining countries (the share of mining economic output in total GDP is more than 10%), mineral-driven countries (the share between 1%-10%), mining auxiliary countries (the proportion <1%). Strong growth trend in mineral production and consumption is also an important feature of Asia's mineral resources.

Biodiversity conservation is subject to various shocks. Due to the rapid changes in land use, rich irrigation water with poor management, overloading utilization of mountain resources and rare species resources, blindly construction of water facilities, and fuel-wood harvesting have been serious threats to biodiversity and ecosystem services in Asia. 50% of the left mangrove resources in the world are scattered in Asia (including the Pacific Region, Australia and New Zealand), but these resources are severely damaged by industrial development and infrastructure constructions. 60% of coral reefs are at risk because of exploitation and destructive fishing. In addition, as a result of water shortage, increasing demand for agricultural land and accelerated development of urbanization, the forest area in West Asia is under considerable pressure and the quality degradation occurred in a large forest area of West Asia in recent years.

2. Problems and challenges coexist for sustainable use of natural resources in Asia

Resources use in Asia is faced with many problems and challenges in fresh water, land, mineral resources and biodiversity. At present, the major issues of resources use in Asia include: first, the shortage and declining quality of fresh water resource; second, food security threatened by desertification and degradation of land resources and ecosystem in Asia, in which China and Mongolia are particularly serious in land degradation and desertification; third, biodiversity loss of mountain and marine regions; fourth, inefficient use of mineral resources. The consumption elasticity per ton of steel and non-ferrous metals in Asia are both more than 1, in which the use efficiency and the rate of recovery of mineral resources in Asia are far lower than that in the developed countries, and even worse than that in Africa.

It is clear that future sustainable development in Asia would face more difficult challenges in natural resource management. On the one hand, countries in Asia should effectively protect precious natural resources and environment, on the other hand, the majority of countries in Asia are relying on the limited natural resources to eradicate poverty and improve living standards. There are constraints to the above-mentioned challenges at both domestic level and sub-regional level. The major challenges come from: first, high dependence on natural resources, which has become a serious constraint on economic and social development; second, lack of funds and technology deprivation, which is serious impeding efficient and sustainable resources use; third, lack of public awareness in sustainable resources use; and fourth, resource management capacity building and sub-regional resource development cooperation should be strengthened.

3. There are some successful experiences towards sustainable resources use in Asia

Despite many problems still existing in the current sustainable use of natural resources in Asia, it is worth noting that, in order to solve these problems or mitigate the negative impact, some countries in Asia have accumulated a lot of successful experiences as well as lessons in resources use. In this regard, five typical cases are identified in this book: First, taking China and West Asia as typical regions, water resource model on demand side management is introduced; their layer use pattern of arid desert land is a particular pattern for better land use. The achievement of Keerqin Prefecture, which is in China's Inner Mongolia, is worth learning. Second, the mulberry-embankment fishpond, the three-dimensional comprehensive development model of agriculture, forestry and fisheries, in southern China has been proven to be an effective multi-level model of comprehensive use of resources. Third, comprehensive utilization and recycling mode of mineral resources is one of the recommended use types, which was applied at Baiyun'ebo, Dexing and Panzhihua deposits in China and played an important exemplary and leading role. Fourth, in regard to the quantitative use of biological resources, the total allowable catch (TAC) in management of fisheries resources in Japan is specifically introduced in this book.

4. Asia could achieve sustainable resources use through conservation policies, technology and management innovations, and capacity-building

This book argues that Asia could realize its sustainable use of natural resources by ways of five aspects of policy recommendations below:

First, regional policies of resource conservation in countries and regions of Asia should be encouraged. The resources use and economic development of countries in Asia have many advantages, including associating interaction, complement and gradient development. Therefore, a mutually beneficial system for regional resources cooperative development and security can be established on the complementary characteristics of geographical, market, financial strengths, which can be expanded gradually into areas such as water resource, land degradation and desertification.

Second, policies of technology sharing and transfer in resource development and utilization should be placed onto the highest priority. The formation and perfection of policies of technology sharing and transfer can be achieved by the establishment of information-sharing website on resource development and use in Asia. The establishment of organizations would focus on resource development and use, and technology transfer and promotion, carry out academic exchanges, and improve the resources development and use, technology sharing and transfer policy.

Third, policies of cross-border resources use and management should be highlighted. Spatial dislocation in resource distribution, production and consumption bring the cross-border resources development and use of essential sense. The resources development and use should take strategy such as "go outside and bring in", in which financial, tax and fiscal policies should be established to service the "going out" resource development strategy, and the joint venture mechanism for overseas geological survey and exploration should be strengthened to reduce the risk. Some preferential policies for investment, taxation, import and export should be set up and a sound service system should be helpful for the cross-border resources use.

Fourth, establishment of technology and information-sharing platform and mechanism would contribute to the advancement of the collaboration and sustainable development in resources utilization in Asia. The establishment of the Asia resources technology sharing networks and domestic resources technology communication mechanism may facilitate this development.

Fifth, capacity-building for sustainable resource consumption should be highlighted. On the one hand, the concept of consumer savings need further promotion; on the other hand, the sustainable consumption of resources should be carried out over the whole Asia.

5. Priorities for future implementation of resource sustainability projects should be placed on the agenda of action in Asian countries

This book aims to propose some operational major projects. To this end, we brings up five major project proposals in the fields of land degradation, urban sewage treatment, tourism resource development, biodiversity conservation, small and medium-scales of city wastewater treatments and local capacity-building.

First, monitoring and assessment of technology development could be implemented in the fields of land degradation and desertification in Asia. Through this project, land degradation and desertification monitoring in various countries and regions in Asia can be monitored and evaluated, some financing mechanisms and institutional building can be improved, a united action programs of countries and regions in Asia combating land degradation and desertification can be promoted, and the collaborative mechanism between domestic and regional action programs can be established.

Second, technology development could be realized at cost of return wastewater treatment plants in small and medium-scales of cities. In this project, we recommend that small and medium-scales of municipal wastewater treatment plants could be introduced by cost recovery mechanisms, together with sewage and sewage recycling system, taking some sub-regional cities as pilot targets followed by a promotion.

Third, capacity-building could be carried out in sustainable tourism development and biodiversity conservation. Sustainable tourism resources development and biodiversity conservation building would be promoted by eco-tourism, combined with biodiversity survey, feasibility of the evaluation of eco-tourism, scenic spots' tourism planning and construction, scenic spots' dynamic environmental monitoring, tracking evaluation of biological diversity and so on.

Fourth, technology development and demonstration could be tested in the fields of resources recycling and land reclamation in small and medium-sized mines. This book takes Guiyang of China as a typical area, analyzing its resource recycling system model based on phosphorus chemical system, the coal chemical industry system, chlor-alkali industry system, thermal power construction and by-product system, with a view to carrying out follow-up project as reference.

Finally, local capacity-building could be enhanced in resource development and use. Four aspects should be improved, that is, human capital development projects, social capital development projects, capital system development projects, and economic capital development projects.

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1 Introduction

This book is completed based on the major research report of "Addressing Challenges of Natural Resources Use in Asia", the subproject of "Sustainable Development in Asia", which is a consultancy project initiated by the Association of Academies of Sciences in Asia (AASA). The book attempts to systematically analyze the situation of natural resources use in major countries in Asia, noting that they are facing common problems and challenges in terms of resources development and use, while summarizing some successful experiences of the typical countries towards sustainable natural resources use, and coming up with some pilot projects and policy recommendations for sustainable use of natural resources in Asia, on the basis of reviewing, summarizing, analyzing and referring loads of literature with statistical analysis of data and other forms of expert interviews, and workshops.

The scope of Asia mentioned in this book covers 48 countries in Asia (excluding Russia). For better analysis and discussion, the book divides Asia into 5 sub-regions, including Northeast Asia, South Asia, Southeast Asia, Central Asia and West Asia, of which 12 countries in West Asia can be divided into two sub-regions, namely, the Arabian peninsula (including the Gulf Cooperation Council and Yemen) and the Arab Oriental (Mashriq, including Iraq, Jordan, Lebanon, the occupied Palestinian and Syrian). Mashriq and Yemen are agricultural-based countries and their contribution of agriculture to GDP account for over 30% on average, occupying over 40% of the workforce; while the Gulf oil-producing countries are petroleum-based countries with 40% of its GDP and 70% of government revenue coming from oil (UNESCWA and API, 2002).

This book summarizes the four key problems of sustainable resources utilization in Asia (Table 1.1), including deterioration of freshwater and marine resources, desertification, land degradation and deforestation, biodiversity loss, poverty and resource security (involving food safety and security of mineral resources). The major challenges facing Asia are: development of renewable resources, monitoring and assessment in resource development and utilization, clean production.

Table 1.1 Common challenges and regional differences

Category	Common Challenges	Regional Differences
water resource	water shortage, water pollution, allocation of transboundary water resource, inefficient utilization of water resource	shortage of fresh water and agricultural water, partial drought
mineral resources	low mineral recovery, fluctuations in mineral prices, shortage of industrial raw materials of mineral, low treatment rate of tailings	lack of mineral resources exploration, frequent mining disaster, pollution from mercury, arsenic and other heavy metal, conflicts between mining and community, struggle in interests of game between enterprises and governments
biodiversity & biological resources	changes in biological habits, extinction of endangered species	loss of marine resources, excessive production in marine resources

2 Current Status and Trends

In theory, the world's natural resources can produce sufficient food, medical, housing and other conditions of life supporting for more people. However, due to uneven distribution of some important resources such as fertilizers, water-rich land, forests, wetlands and genetic resources, the reality is not the case (UNEP, 2007a). For the reasons of land degradation, water pollution, climate changes, desertification, loss of biodiversity and others, the ability to support earth's life system continues to weaken. As a result, differences in natural resources and production level in countries of Asia bring in great varieties in resource supply and demand, with surplus in some areas and acute shortage in the others.

Overall, there are rich and varied natural resources and socio-economic resources in Asia, in which the length of the coastline accounts for 2/3 of the whole world and there is larger mountain area in Asia than that in any other region on the world. There are both the poorest countries and the most affluent countries, not only China but also India which both in rapid economic growth. 60% of the world's population lives in Asia. The past 30 years saw the rapid growth of total population in Asia, from more than 3 billion in 1987 to more than 4 billion in 2007. In general, there are also different religious beliefs, a variety of regional cultures and languages in Asia.

Countries in West Asia are highly dependent on various natural resources and the development and utilization of natural resources is the major factor to maintain the economic growth and urban development. In the East Arabia and Yemen, agriculture is the major economic sector, agricultural output accounting for an average of 30% of the countries' GDP, occupying 40% of the workforce; and in Gulf oil countries, the value of oil-producing countries accounts for 40% of GDP, and provides countries with 70% of government revenue (UNESCWA and API, 2002).

2.1 Water resource

Most prominent and important issue in Asia is water resource utilization. The intertwined water-related problems, such as water crisis, water pollution, water conflicts, water politics and others make the tense situation of water resource in Asia. All the roots of Water-related problems are: ① the rapid growth of food production and energy development lead to largely increased water demand of Asia countries in the last 40 years; ② Over-extraction of surface water and groundwater; ③ global warming lead to reduced precipitation, increased evaporation and frequent climate disasters; ④ Changing water-use patterns have serious negative impacts. These four factors constitute the complex relationship among "people-water-nature-ecology" and Asian countries must pay great attention to them.

Water availability continues to decline in Asian countries. From 1955 to 1990 year, total water availability per capita dropped 40% to 60%. The space distribution and availability per capita of water resource among Asian countries vary significantly (Figure 2.1). Western Asia, Central and Southern Asia are a typical arid region, while the tropical rain forest, such as the Ifugao region in Philippines is the world's most humid areas. Total water availability per capita of Pakistan is the least and it also has one of the highest dependency ratios among the major Asian countries at around 77%. Central Asia is rich in water resource. However, more than 90% of the water in this vast region is concentrated in Kyrgyzstan and Tajikistan; Uzbekistan and Kazakhstan are the region's main water consumers, with Uzbekistan alone consuming more than half of the region's water resource, largely for agriculture(Leadership Group on Water Security in Asia, 2009).

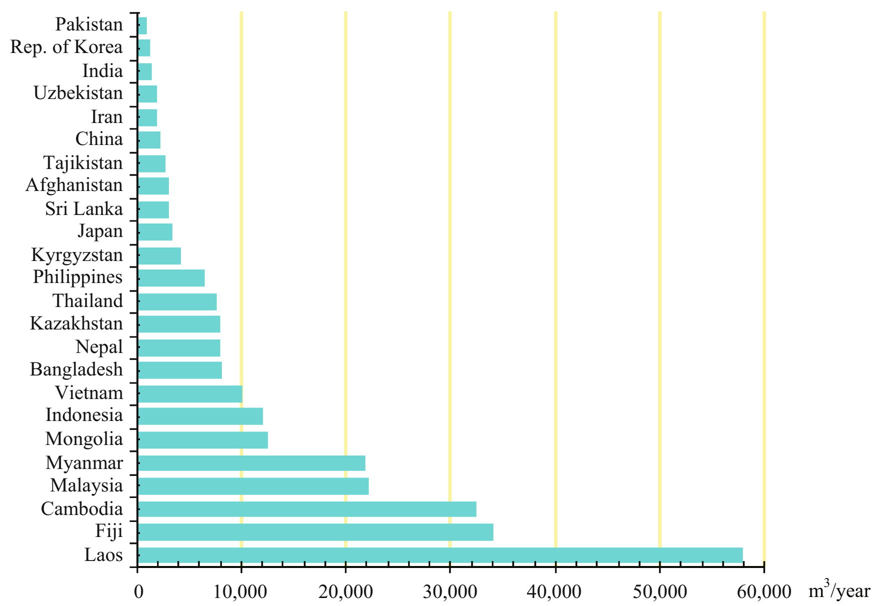


Figure 2.1 Water availability per capita of major countries in Asia in 2008

Source: Food and Agricultural Organization, Aquastat Database, 2008

Shortage of freshwater resource among Asian countries is very prominent. Asia is home to more than half of the world's population but per capita fresh water availability is only 3920m^3 which is much lower than the rest of the world. According to the statistics of the Pacific Institute, there are Asian countries those fresh water resources are less than 60%, such as Afghanistan, Cambodia, Laos, Tajikistan and others. Over-pumping of groundwater for living, industrial and agricultural production contributes to salinization in India, Pakistan, Bangladesh and other countries. In addition, the utilization of water resources in western Asia, Indo-Gangetic Plains of Southern Asia, the North China Plain has greatly exceeded its average annual natural recharge capacity. With rapid population growth and urbanization, Asia will present a new set of water shortage challenges in the coming decades. By 2015, the percentage of the global population living in Asian megacities (those with population of 10 million or more) and large cities (those with population of 5-10 million) is expected to grow to 4.7% and 3.7%, respectively (Asian Development Bank and Asia-Pacific Water Forum, 2007). Within the next 10 years, Almost two-thirds of global population growth is occurring in Asia, where the population is expected to increase by nearly 500 million. Asia's rural population will remain almost the same between now and 2025, but the urban population is likely to increase by a staggering 60% (Leadership Group on Water Security in Asia, 2009).

Water pollution remains a serious problem in Asia. Destructive development and inappropriate use of water resources may lead to water pollution and thereby causing degraded water quality, reduced water availability and even harm human health. According to the report of the International Rice Research Institute, over farming and fertilizing lands along both sides of rivers in Asia lead to forest destruction, serious soil erosion, and water pollution. In addition, after soaking by sewage, large tracts of land downstream are easy to become saline and cannot be cultivated. Groundwater distributing in some parts of Myanmar and its adjacent region to India contains arsenic concentrations in excess of the Environmental Protection Agency standard, besides, there are still many places have groundwater with excessive fluoride. Major point-source pollutants are microbial pathogens, nutrients, oxygen-consuming materials, heavy metals and persistent organic pollutants (POPs). And non-point-source pollutants are suspended sediments, nutrients, pesticides and oxygen-consuming materials. The Amur-Heilong River flowing through China, Russia and Mongolia is one of the world's three major river basins without any water infrastructure and home to over 70 million reside. In addition, it's one of the Global 200 Priority Ecoregions for Global Conservation. In recent years, there is a water crisis in the lower reaches of the Amur River and cause water and fish with strong smelly odor. Meanwhile, the river water composition is directly related to the upstream Khabarovsk Krai and the dirt abandoned by this region. According to statistics, in the last 6 years, during August and September, cholera pathogen can often be found in Amur River and its tributaries in the section of Khabarovsk region. 23% water samples extracted from Khabarovsk's city tap-water found Intestinal pathogen and 10% of the water samples had viral antigen. The amount of pollutants discharge through Amur River into the Okhotast and Japan Sea is more than 230 thousand tons per year.

Water quality has a direct bearing on the health. Research by the Pacific Institute suggests that even under the most optimistic scenario in achieving the Millennium Development Goal (established in 2000) of halving the number of people worldwide who lack access to safe drinking water and adequate sanitation facilities by 2015, some 34 million to 76 million people will perish by 2020 as a result of waterborne ailments (Gleick, 2002). As some of water resource specialists explain that water crisis in the future is not come because of actual physical scarcity of water, but because of continuing neglect of proper wastewater management (Table 2.1). On the whole, water conditions in Asia have been improved greatly. The population with access to improved drinking water infrastructure increased from 72% in 1990 to 87%. However, in some Asia countries, water-related diseases still represent up to 16% of all causes of death. Such as Diarrheal disease alone accounts for 865 deaths across Asia every year, and a significant share of these could be prevented though achievable interventions in water and sanitation (Chan, 2009).

Pollution of Asia's water supplies from inadequate wastewater management is another hidden danger. Pollution of Water sources is particularly acute in Asia's urban slums, and many countries have not been able to meet the growing demand for sanitation services. In Indonesia, for example, the UN Children's Fund found that only 53% of the country's population obtained water from sources that were more than 10 meters from a waste disposal site. And in Jakarta alone, fecal coliform was found in all but 16% of shallow well samples (UNICEF, 2009). The country is regarded as having high health risks with respect to waterborne diseases, especially among children (Central Intelligence Agency, 2007). Industrial pollution also poses a grave threat to human health and livelihood. Like Tai, located in China's southeastern coast on the border between Jiangsu and Zhejiang provinces, are the nation's third-largest freshwater body and its ancient "land of fish and rice." Now home to 2800 chemical factories, Lake Tai has been devastated by agricultural and industrial pollution. As a result, 2 million people have lost access to their primary freshwater source, and fish yields, rice production, and tourism-all significant sources of local income-have declined (Leadership Group on Water Security in Asia, 2009). In parts of Asia, groundwater pollution is very serious. Such as Bangladesh, water quality from underground sources is naturally impaired as a result of infiltration from mineral deposits of poisonous compounds. As groundwater pollution is often difficult to identify and treat, usually it's more dangerous.

Table 2.1 Fraction of population with access to improved drinking water (1970-2004) (%)

Region and Country	Urban							Rural							Total						
	1970	1975	1980	1985	1990	2000	2004	1970	1975	1980	1985	1990	2000	2004	1970	1975	1980	1985	1990	2000	2004
Cyprus	100	94		100	100	100	100	92	96		100	100	100	100	95	95		100	100	100	100
Israel							100							100							100
Japan							100							100							100
DPR. of Korea						100	100						100	100						100	100
Lebanon						100	100						100	100						100	100
Qatar	100	100	76		100		100	75	83	43				100	95	97	71				100
Singapore			100	100	100	100	100										100	100	100	100	100
United Arab Emirates			95				100			81				100			92				100
Malaysia	100	100	90	96	96		100	1	6	49	76	66	94	96	29	34	63	84	79		99
Thailand	60	69	65	56		89	98	10	16	63	66	85	77	100	17	25	63	64		80	99
Jordan	98		100	100	100	100	99	59		65	88	97	84	91	77		86	96	99	96	97
Turkey			95			82	98			62			84	93			76			83	96
Iran	68	76	82		100	99	99	11	30	50		75	89	84	35	51	66		89	95	94
Syria	98		98			94	98	50		54			64	87	71		74			80	93
Armenia							99							80							92
Gaza Strip							94							88							92
Rep. of Korea	84	95	86	90	100	97	97	38	33	61	48	76	71	71	58	66	75	75	93	92	92
Pakistan	77	75	72	83	82	96	96	4	5	20	27	42	84	89	21	25	35	44	55	88	91

Continued

Region and Country	Urban							Rural							Total						
	1970	1975	1980	1985	1990	2000	2004	1970	1975	1980	1985	1990	2000	2004	1970	1975	1980	1985	1990	2000	2004
Nepal	53	85	83	70	66	85	96		5	7	25	34	80	89	2	8	11	28	38	81	90
India	60	80	77	76	86	92	95	6	18	31	50	69	86	83	17	31	42	56	73	88	86
Kazakhstan						98	97						82	73						91	86
Philippines	67	82	49	49	93	92	87	20	31	43	54	72	80	82	36	50	45	52	81	87	85
Vietnam				70	47	81	99			32	39	33	50	80				45	36	56	85
Maldives			11	58	77	100	98			3	12	68	100	76			2	21		100	83
Georgia							96							67							82
Iraq	83	100		100	93	96	97	7	11	54	54	41	48	50	51	66		86	78	85	81
Sri Lanka	46	36	65	82	80	91	98	14	13	18	29	55	80	74	21	19	28	40	60	83	79
Myanmar (Burma)	35	31	38	36	79	88	80	13	14	15	24	72	60	77	18	17	21	27	74	68	78
Azerbaijan							95							59							77
China					87	94	93					68	66	67					73	75	77
Indonesia	10	41	35	43	35	91	87	1	4	19	36	33	65	69	3	11	23	38	34	76	77
Kyrgyzstan						98	98						66	66						77	77
Bangladesh	13	22	26	24	39	99	82	47	61	40	49	89	97	72	45	56	39	46	81	97	74
Turkmenistan							93							54							72
Yemen A R	45		100	100		85	71	2		18	25		64	65	4		31	40		69	67
Bhutan			50		60	86	86			5	19	30	60	60			7		32	62	62

Continued

Region and Country	Urban							Rural							Total						
	1970	1975	1980	1985	1990	2000	2004	1970	1975	1980	1985	1990	2000	2004	1970	1975	1980	1985	1990	2000	2004
Mongolia					100	77	87					58	30	30					82	60	62
Tajikistan							92							48							59
East Timor							77							56							58
Laos	97	100	28		47	59	79	39	32	20		25	100	43	48	41	21		29	90	51
Cambodia						53	64						25	35						30	41
Afghanistan	18	40	28	38	40	19	63	1	5	8	17	19	11	31	3	9	8	17	23	13	39
Bahrain	100	100		100	100		100	94	100		100	0			99	100		100			
Brunei Darus			100							95											
Kuwait	60	100	86	97						100					51	89	87				
Oman		100		90		41			48		49		30			52		53		39	
Saudi Arabia	100	97	92	100		100	97	37	56	87	88		64		49	64	90	94		95	
Uzbekistan						96							78							85	
Yemen Dem	88		85			85		43		25			64		57		52			69	
Source	UNEP 1989, WRI 1988	UNEP 1989, WRI 1988	UNEP 1989, WRI 1988	UNEP 1989, WRI 1988	UNEP 1993	WHO 2000	WHO/ UNI-CEF 2006	UNEP 1989, WRI 1988	UNEP 1989, WRI 1988	UNEP 1989, WRI 1988	UNEP 1989, WRI 1988	UNEP 1993	WHO 2000	WHO/ UNI-CEF 2006	UNEP 1989, WRI 1988	UNEP 1989, WRI 1988	UNEP 1989, WRI 1988	UNEP 1989, WRI 1988	Calcu-lated from UNEP 1993	WHO 2000	WHO/ UNI-CEF 2006

Source: Pacific Institute (2009)

2.2 Water resource allocation

Shortage of freshwater resource is one of the major challenges in Asia. Asia (including the Pacific region) occupies 32% of the world's freshwater resource, but support 58% of the world's population (Shiklomanov, 2004). The Asian economy is mainly irrigated agriculture, so the demand for water resource is very large.

Water-pressure in Asia is mainly caused by excess extraction of surface water and ground water, industrial development of freshwater resource, pollution and inefficient utilization of water resource (WBCSD, 2005). At the same time, to some extent, global climate changes also increase the pressure on water resource in Asia. Reports show that: over the past decades, there was an unprecedented back in the Himalayan glaciers (WWF, 2005). In recent years, climate change and natural disasters also posed a threat to water quality, resulting in the destruction of water facilities and groundwater pollution (WBCSD, 2005).

Nonetheless, the impact of human activities influenced a number of basin hydrological cycle, such as land-utilization change, water storage and inter-basin water transfer construction, agricultural irrigation and groundwater extraction and so on(Mirza et al., 2005).

At present, there are many people in Asia, to whom safe drinking water is not available. Lots of organic pollutants from urban emissions are the major reason for the decline in quality of fresh water. With the pollution of water resource, the water quality has been seriously affected, and available clean water is in reduction. There are significant regional differences in the volume of available fresh water and average annual fresh water availability continues to drop in Asia, 7000m^3 per capita in world average annual amount of available freshwater, but only 4200m^3 per capita in Asia (including the Pacific region), about 2348m^3 per capita in China(UNEP, 2000).

2.2.1 Agriculture

The agricultural sector occupies the majority share in the sector average consumption of fresh water in Asia. Based on the study of the average consumption of fresh water for the industrial sectors, we find that in the past 10 years, the average annual total consumption of freshwater resource in Asia was about 2492.0×10^9 m^3, of which the industrial sector occupied 323.5×10^9 m^3, the agricultural sector occupied 1977.5×10^9 m^3, civilian freshwater occupied 190.9×10^9 m^3, respectively accounting for 12.98%, 79.36% and 7.66% of the total amount (Figure 2.2).

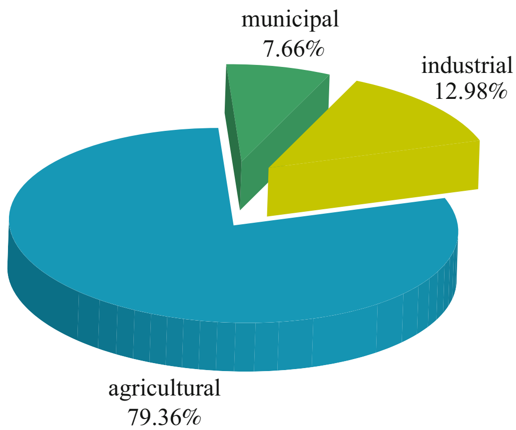


Figure 2.2 Average consumption of fresh water in Asian sectors, 1998-2007

Source: According to FAO AQUASTA (2007)

There is the largest annual consumption of fresh water in agricultural sector in Asia, accounting for 80% of annual consumption of fresh water in Asia, followed by that of the industrial sector, while that of the civil sector is the smallest. Freshwater resources in various sectors show significant distribution differences, and agriculture becomes the major fresh water consumption sector in Asia.

2.2.2 Water resource spatial distribution differences

There are significant differences of freshwater resource not only among the various departments but also in spatial distribution, showing a non-equilibrium state. In absolute volume terms (Table 2.2), there are 1032.01×10^9 m^3/a in South Asia, which is the largest, 823.45×10^9 m^3/a in Northeast Asia, 319.08×10^9 m^3/a in Southeast Asia, 177.35×10^9 m^3/a in West Asia, 140.03×10^9 m^3/a in Central Asia, accounting for 41.41%, 33.04%, 12.8%, 7.12% and 5.62% (Figure 2.3) respectively. The average annual total fresh water consumption of South Asia and Northeast Asia is up to 1855.46×10^9 m^3/a, nearly 75% of that of Asia. But the average annual total fresh water consumption of Central Asia, Southeast Asia and West Asia is less than 26% of that of Asia. So the conclusion can be drawn that the average annual freshwater resource consumption in Asia shows a non-equilibrium situation.

Table 2.2 Average consumption of fresh water by region and sector (10^9 m^3/a)

	Northeast Asia	Central Asia	Southeast Asia	South Asia	West Asia
agriculture	509.83	127.45	273.01	926.95	140.23
industry	231.87	8.04	24.89	40.58	18.14
civilian	81.75	4.54	21.18	64.38	19.03
total	823.45	140.03	319.08	1032.01	177.35

Source: FAO AQUASTA (2007)

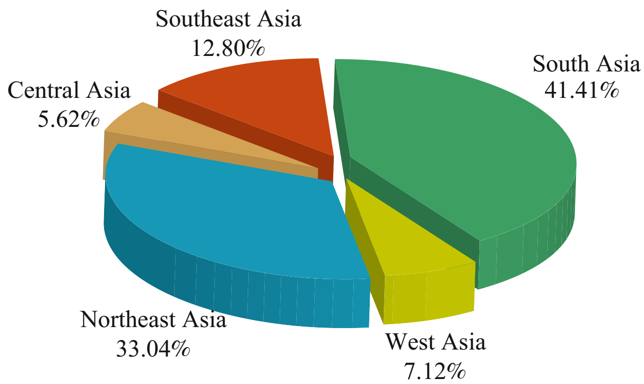


Figure 2.3 Average annual consumption of fresh water in Asia, by region

2.2.3 Water allocation differences between sectors

There are uneven distribution of freshwater resource not only in various spaces and sectors in Asia, but also in three departments involving agricultural, industrial and municipal water departments in different regions by average annual consumption of freshwater resource. Specifically, proportion of fresh water resource of the three departments is 61.91 : 28.16 : 9.93 in Northeast Asia, 91.02 : 5.74 : 3.24 in Central Asia, 85.56 : 7.8 : 6.64 in Southeast Asia, 89.82 : 3.93 : 6.24 in South Asia, 79.07 : 10.23 : 10.73 in West Asia. The proportions of agricultural water in Central Asia, Southeast Asia and South Asia are all more than 85%, and that of Northeast Asia is the lowest, followed by that of West Asia. The highest proportion of industrial water is in Northeast, 28.16%, followed by 10.23% in West Asia. The proportions of industrial water in Central Asia, Southeast Asia and South Asia are generally lower than the average consumption of fresh water for the industrial sector, in which the proportion of industrial water in South Asia is the lowest, only 3.93% (Figure 2.4).

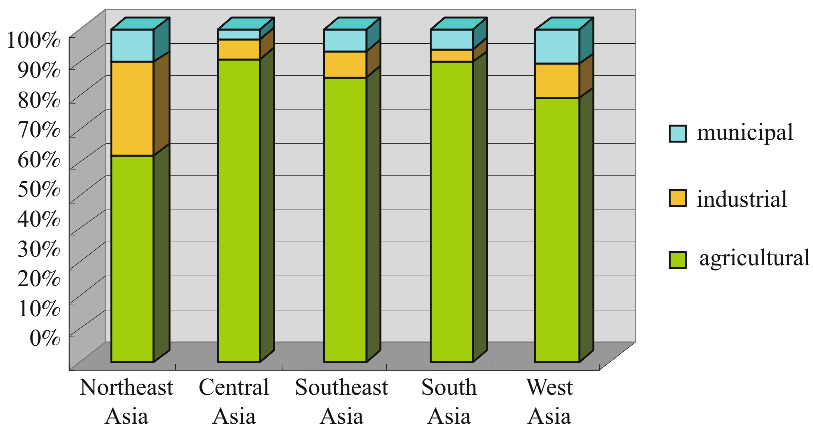


Figure 2.4 Average annual consumption of fresh water in various sectors and regions of Asia

2.2.4 Water consumption and economic development

1) To some extent, water resource consumption and economic development are reverse to each other from region to region

In five Asian sub-regions, the highest water consumption per GDP is in Central Asia region, amounting to 41,144.2 tons/10 thousand dollars; followed by that in South Asia, 9660.5 tons/10 thousand dollars; the third is in Southeast Asia, 6042.3 tons/10 thousand dollars; the fourth is in West Asia, 2809.9 tons/10 thousand dollars; the lowest one is in Northeast Asia, 1382.3 tons/10 thousand dollars, nevertheless, which is still higher than that of the world average, 952 tons/10 thousand dollars. On the contrary, the lowest two regions in water consumption per GDP, Northeast Asia and West Asia, occupy the highest GDP per capita, 14,592.9 and 8795.9 dollars respectively, while the highest two, Central Asia and South Asia, occupy the lowest GDP per capita, 1053.5 and 1213.5 dollars respectively, Southeast Asia is in the middle position by GDP per capita as 5902.8 dollars (Figure 2.5).

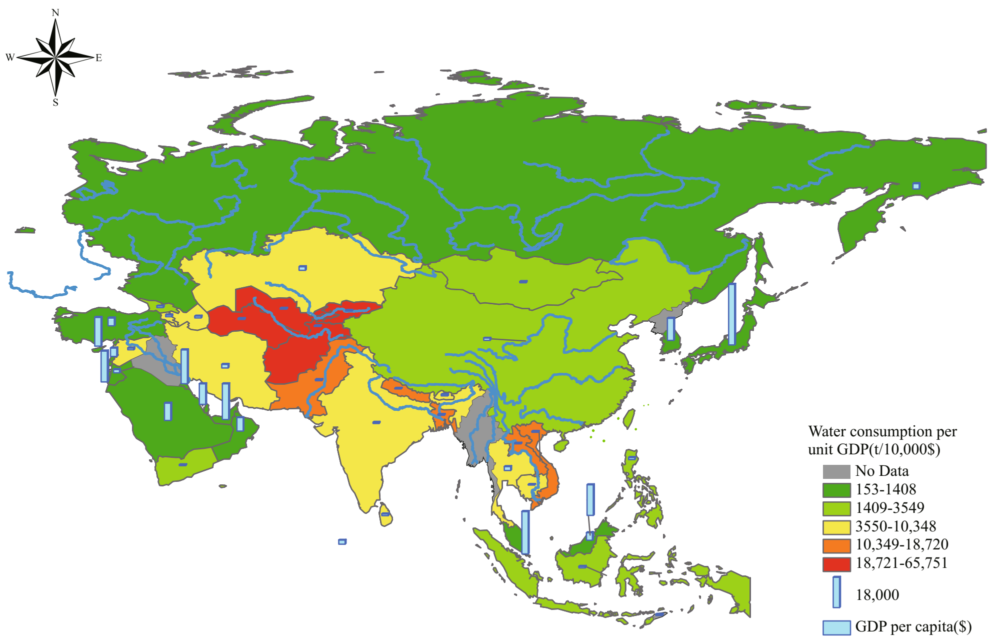


Figure 2.5 Distribution of water consumption per GDP and GDP per capita

2) High water consumption per GDP and wide gap of economic development

Average water consumption per GDP of Asia is 8897.7 tons/10 thousand dollars, far exceeding that of the world average, 952 tons/10 thousand dollars. There are about 10 countries whose water consumption per GDP are higher than that of the Asia average, and 29 countries whose water consumption per GDP are higher than that of the world average. Countries of excessive water consumption concentrate in Central Asia and South Asia while more effective ones in West Asia and Northeast Asia.

GDP per capita of Asia is 6402.9 dollars, slightly higher than that of the world average, 5975.7 dollars, but there are only 11 countries whose GDP per capita are higher than that of the world average, 1/4 of the countries included in the Census and Statistics, and the remaining ones, close to 75%, are lower than that of the world average. At the same time, higher GDP per capita of the 11 countries, with seven located in West Asia, and the remaining four countries are in Northeast Asia Japan and Rep. of Korea, Southeast Asia, Brunei and Singapore.

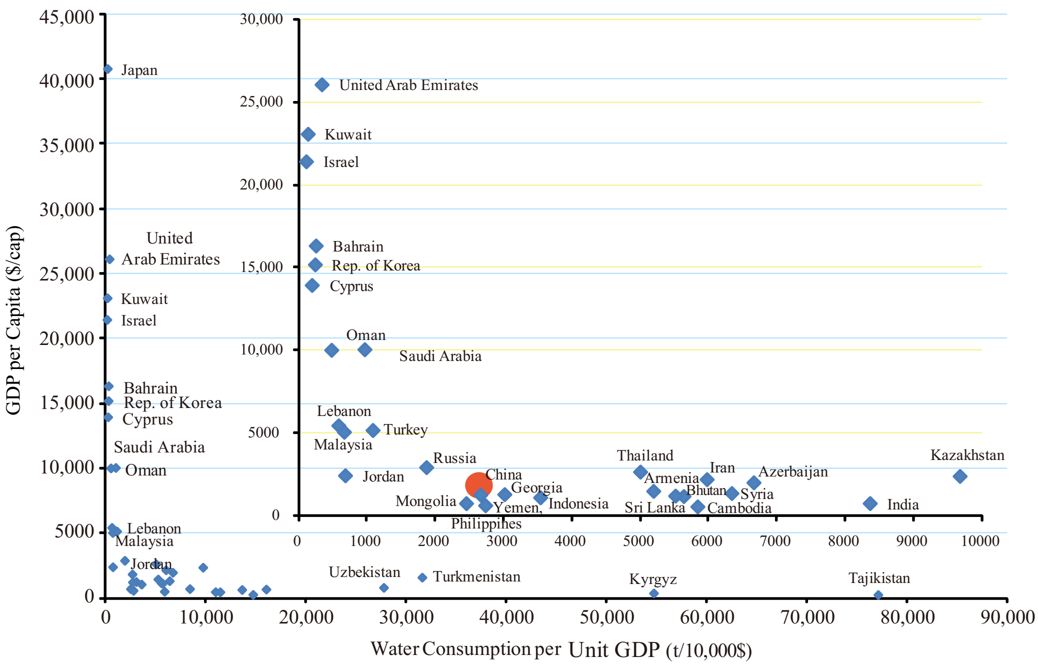


Figure 2.6 Scatterplot of water consumption per GDP and GDP per capita, by country

Overall, the water consumption per GDP of Asia is too high, and the gaps of economic development between countries in Asian region are also too wide in the uneven geographical distribution. The water consumption per GDP of vast majority of countries and GDP per capita are less than 10,000 tons/10 thousand dollars and 6500 dollars respectively (see enlarged map in upper right corner of Figure 2.6).

2.3 Land resource usd and environmental impacts

Human activities may have negative impact on the quality of land. Poor land management may lead to soil erosion and desertification, overgrazing may result in degradation of grasslands, large-scale utilization of fertilizers and pesticides may result in a decline in the quality of soil, some industrial activities or military activities may have a landfill resulting in land contamination.

2.3.1 Land utilization structure

2.3.1.1 New developments

In 2007, the Asian land area was 30.94 ha[1], only 23.8% of the world. However, at the same time, Asia's total population accounted for 64% of the total world population. Asia supported nearly 65% of the world's population by less than 25% of the world's land.

Figure 2.7 The distribution map of Asian land use structure

Source: World Reference of Atlas, Philips (2007)

The majority of the land in center of the Asian hinterland continent is desert or desertified land cover, especially in West Asia and Central Asia (Figure 2.7). Due to the barrier of Southern Iranian Plateau-Qinghai-Tibet Plateau, the East Asian monsoon and the southwest monsoon are inaccessible, so there are the scarcity of precipitation and dry climate. Especially, the unreasonable land utilization and water utilization since the 1930s destroyed the original water, soil and vegetation patterns, resulting in the spread of increased desertification, dust storms and frequent disasters. In the arid climate zone in North China, a Eurasian temperate steppe zone, alpine grassland and cold desert and grassland and agro-pastoral transitional zone form takes its shape (Figure 2.8). With more population, the farming-pastoral, the disturbance of human activi-

1 Not including inland water bodies covered by land area

ties on the surface intense, it becomes a sandstorms area with the most fragile ecology, the most prominent people to the contradictions, the most serious problem of desertification(Yue et al., 2006). These dust storms in the center of Asia have severely affected South Asia, Northeast Asia, Southeast Asia and other regions, and even farther, the Northwest Pacific Ocean, affecting the lives and health of the people(Zhuang et al., 2001). In particular, the desert located in Northwest China, Mongolia in the Asian continent center and Central Asia is the world's largest temperate desert, named known as "scar of the earth".

There is little change in the structure of Asian land utilization in recent 15 years (see the two upper parts in Figure 2.6). Asia land utilization, mainly composed by three parts including agricultural land, wood land and the other, of which the largest share is agricultural land, more than 50%; minimum share is woodland, 19%; other land-utilization, almost 30%.

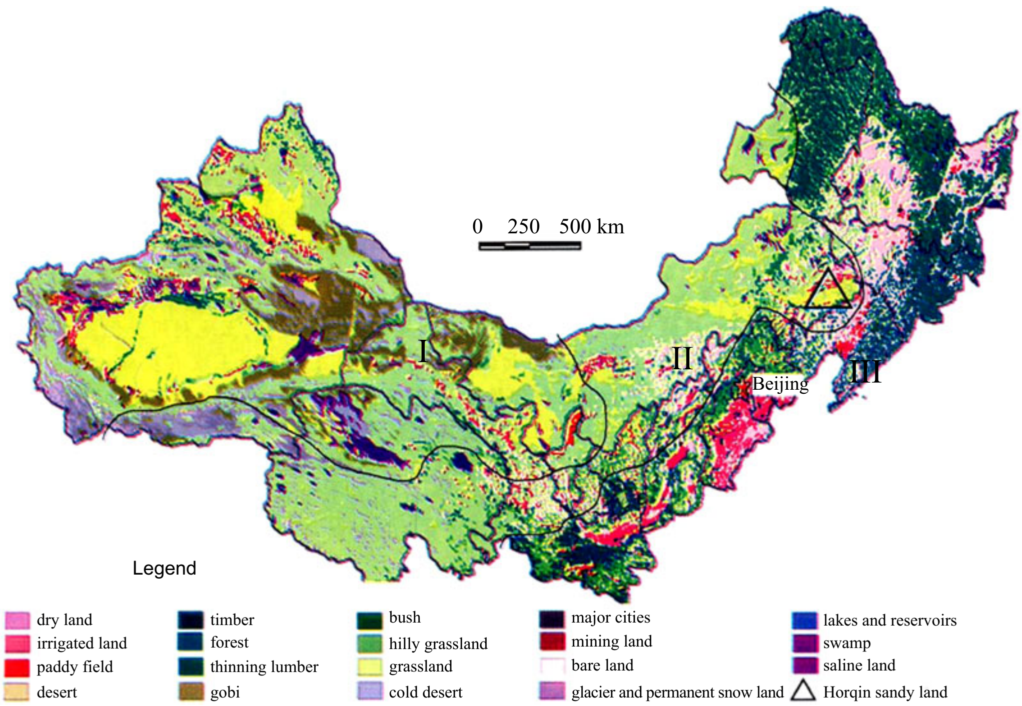


Figure 2.8 Land use in North China, 1999

Source: Yue Y J, Zhou H J, Wang J A (2006)

Agricultural land, however, is mainly composed by arable land, perennial crop, grassland and pasture [see the two lower part of Figure 2.9, Land utilization. Patterns (1992-2007) in Asia (Russia excluded)]. From 1992 to 2007, the grassland and pasture had more changes, with increase in relative weight by one percentage point; the relative proportion of arable land and perennial crops remained unchanged.

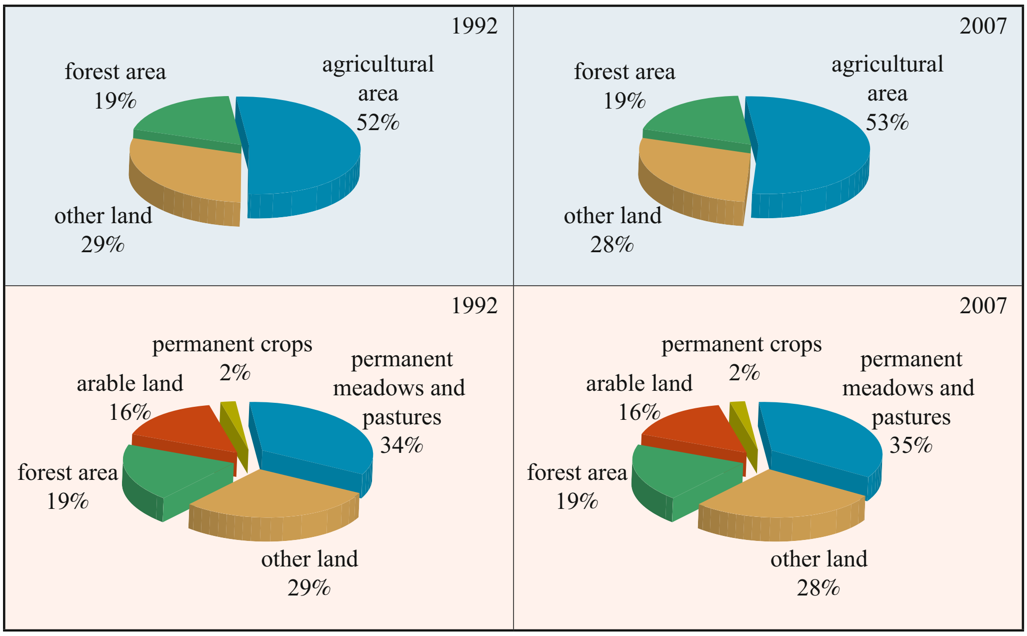


Figure 2.9 Asian land use patterns (excluding Russia), 1992-2007

2.3.1.2 Forest trends

Over the past 10 years, woodland in Asia has showed "V"-shaped evolution trend (Figure 2.10), and the changes in the calendar year could be divided into two phases:

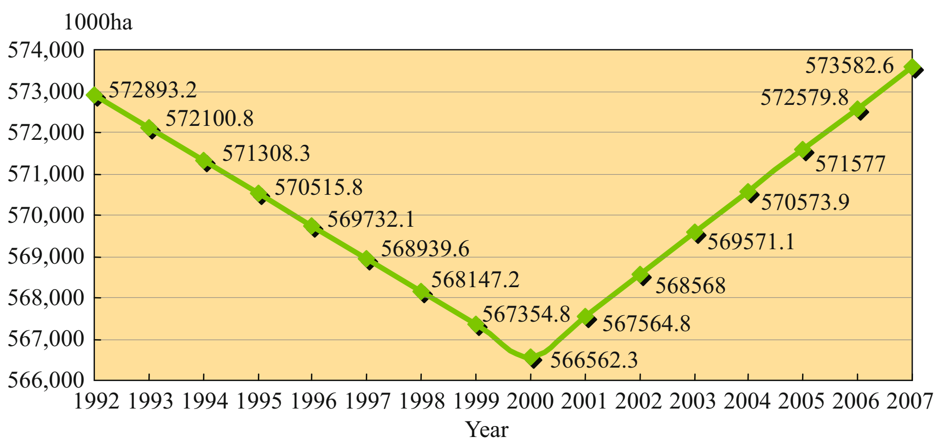


Figure 2.10 Annual change of Asian woodlands, 1992-2007

The first phase (1992-2000) is at uniform decreases. Since 1992, woodland in Asia has decreased uniformly by 0.14% and fell to trough 566.6Mha in 2000. In the first phase, as to the five Asian sub-regions, there were significant reductions in woodland in Southeast Asia and increases of various magnitudes in the other four regions. The largest increase was 14.3Mha in Northeast Asia; 1.5 Mha in South Asia; 0.4 Mha in West Asia; 0.1Mha in Central Asia; and the largest decrease was 22.3Mha in Southeast Asia. As to the change in woodlands of various countries, the largest growth was 15.9Mha in China and the largest drop was 15.0Mha in Indonesia respectively.

The second phase (2000-2007) was at uniform increments. In 2001, after declining for 8 years, Asian woodland grew for the first time, by an increase of 1Mha. From 2001 to 2007, woodland area maintained uniform growth by 0.18%. In 2007, Asian woodland increased to 573.6Mha (Figure 2.11), excesses that of 1992 unprecedentedly. At present, Asian woodland is still increasing. It is inferred that there would be further growth of woodland in Asia.

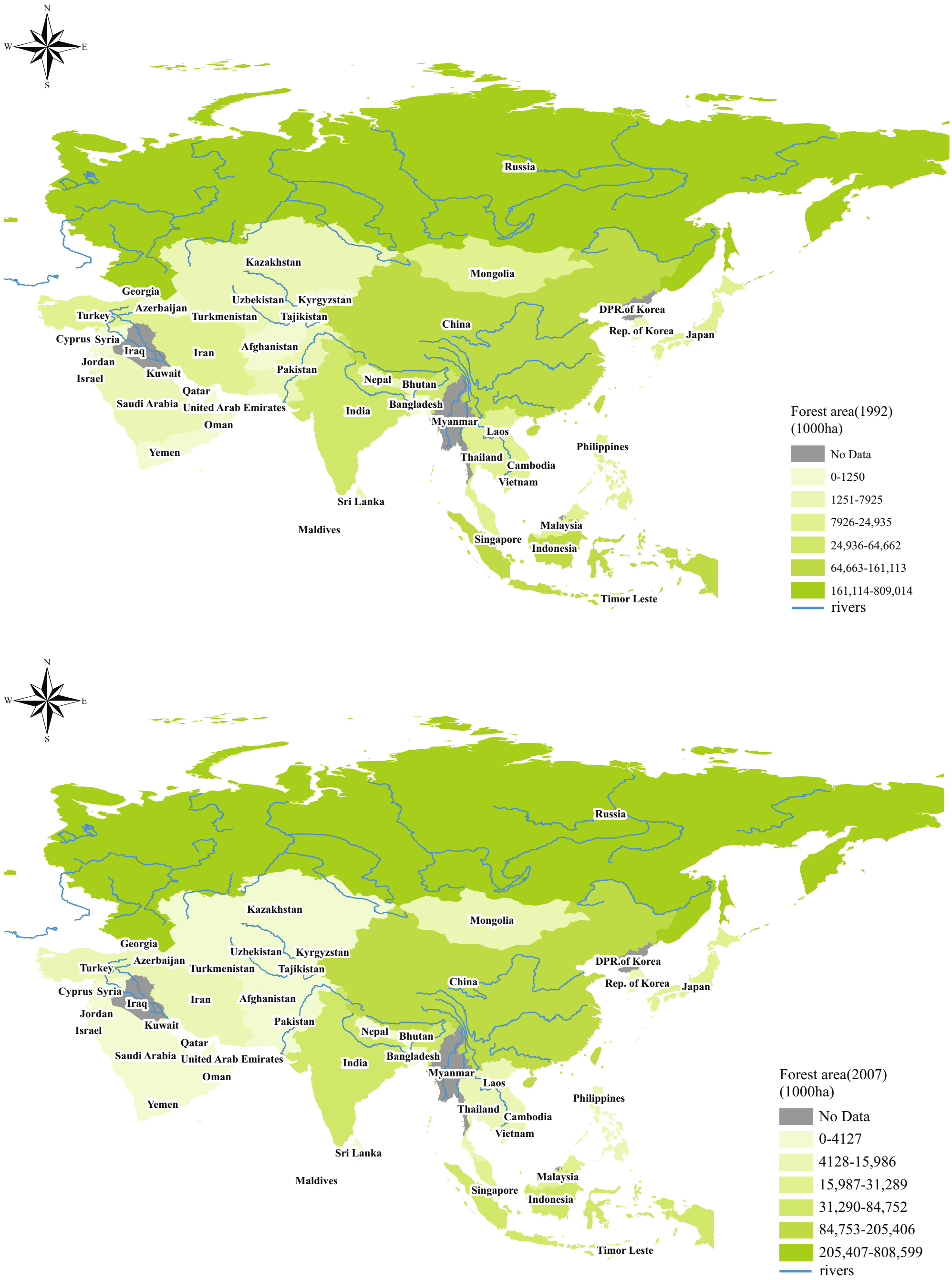


Figure 2.11 Changes of woodland density in Asian countries, 1992 and 2007

In the second phase, as to the five Asian sub-regions, there were growths in woodland areas in Northeast Asia, West Asia and Central Asia (Figure 2.12). The largest increase was 22.3Mha in Northeast Asia; 0.2 Mha in West Asia, 0.01 Mha in Central Asia. Both South Asia and Southeast Asia declined in varying degrees: Southeast Asia fell to 16.6 Mha and South Asia fell to 0.7 Mha. For the changes in woodland, the largest increase and decline showed 24.3 Mha in China and 11.2 Mha in Indonesia respectively.

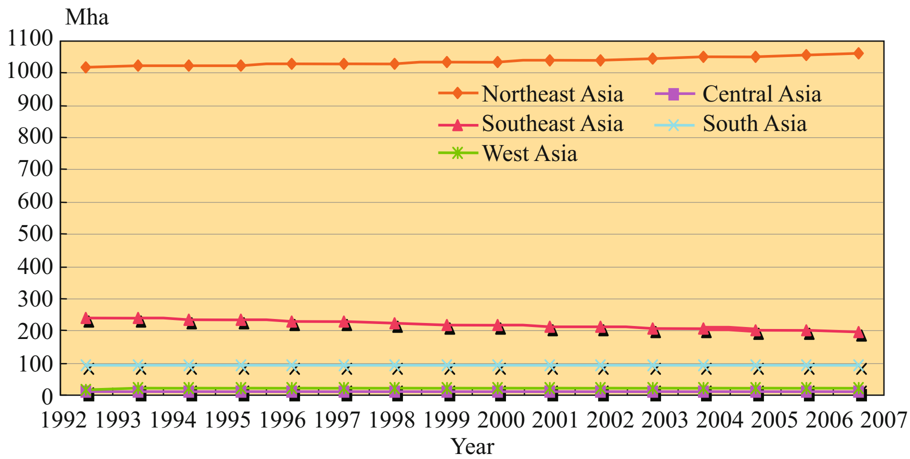


Figure 2.12 Annual changes of woodland area in various regions of Asia, 1992-2007

2.3.2 Agricultural land

2.3.2.1 Rapid growth

The total amount of agricultural land[1] has grew rapidly, from 1062.2Mha in 1961 to 1683.5Mha in 2001, just got the peak. Accordingly, the share of agricultural land increased from 39.6% to 54.4%. The net increase of Asian agricultural land area was 621.3Mha in 40 years, proportion of the Asian agricultural land to the Asian land utilization rose up by nearly 15%. From 2001 to 2007, total amount of Asian agricultural land has fluctuated between 1662.9-1683.5Mha, the proportion almost remained at 54%. Agricultural land utilization has become the major land utilization. in Asia, from 1961 to 2007, average growth rate of Asian agricultural land was 1.03%, 0.81% higher than the average growth rate of Asian agricultural land, 0.22%. (Figure 2.13).

1 Asia as the research object without including Russia while Northeast Asia as the research object including Russia, the following are all in the same

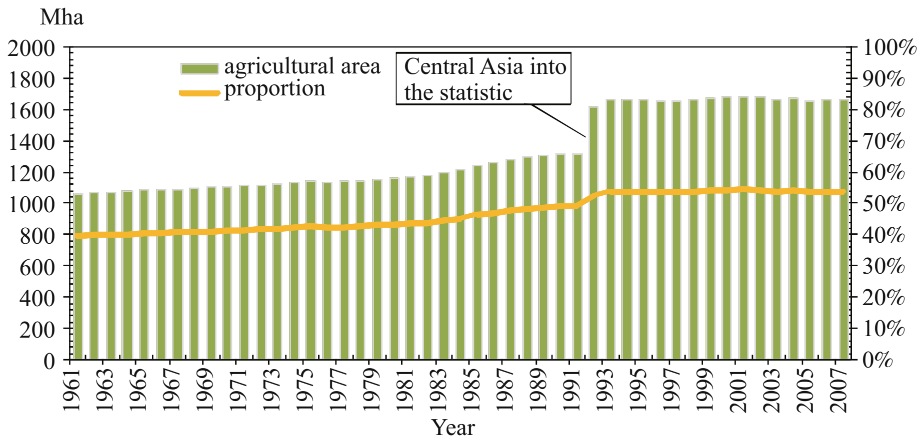


Figure 2.13 Annual change of Asian (Russia not included) agricultural land area, 1961-2007

2.3.2.2 Spatial variation

The spatial distribution of the total amount of agricultural land in Asia differs significantly. The relative proportion of agricultural land in sub-regions (Northeast Asia, Central Asia, South Asia, Southeast Asia and West Asia) was : 47.6 : 15.0 : 16.5 : 6.3 : 14.6 in 2007, as the result of evolution, which was 48.3 : 16.1 : 17.7 : 5.7 : 12.2 in 1992. Nearly half of agricultural land in Asia concentrated in Northeast Asia, followed by South Asia and Central Asia, and the smallest agricultural land was in Southeast Asia (Figure 2.14).

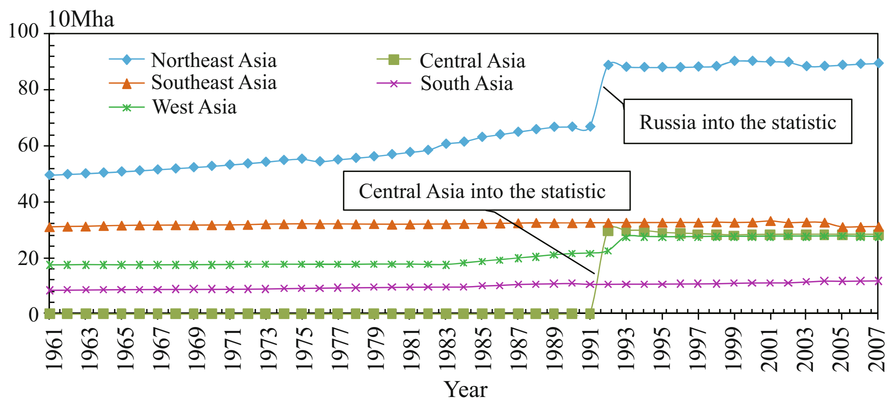


Figure 2.14 Annual agricultural land-utilization changes in various regions in Asia, 1961-2007

Nearly 50 years, the agricultural lands in other Asia regions, with the exception of Central Asia, have expanded in varying degrees (Figure 2.15). In particular, the agricultural land in Northeast Asia, South Asia, Southeast Asia and West Asia increased to 893.8 Mha, 310.1 Mha, 117.7 Mha and 274.3 Mha in 2007 from the 495.5 Mha, 308.9 Mha, 84.2 Mha and 173.6 Mha (10^6ha) in 1961 respectively, but that in Central Asia decreased to 282.5 Mha in 2007 from 296.0 Mha in 1992.

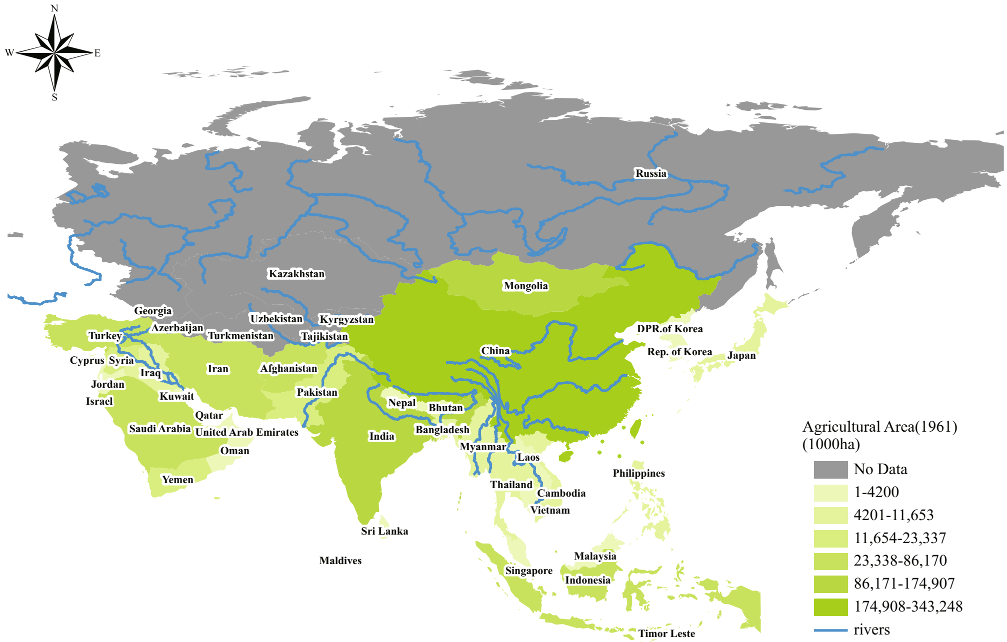


Figure 2.15 Changes of agricultural land in Asia, 1961 and 2007

2.3.2.3 Crop structure

Since 1960s, crop structure[1] has been changing quietly accompanied by the rapid expansion of agricultural land and tremendous growth of harvested

1 Primarily through the analysis of changes in the composition of crops harvested area to reflect the changes of crop planting structure in Asia

area.

Total crop sown area[1] increased from 411.33Mha in 1961 to 545.93Mha in 2007. Accordingly, cereals, fiber crops, oil crops, pulses, roots and tubers, as well as the acreage of fruits and vegetables also showed growth of varying degrees, which increased to 326,976,200 ha, 23,701,083 ha, 101,622,595 ha, 37,170,237 ha, 18,378,327 ha, 38,084,999ha in 2007 from 271,850,598 ha, 17,846,645 ha, 53,269,850 ha, 38,810,654 ha, 17,192,914 ha, 12,358,205ha in 1961 respectively. At the same time, the internal constitute of the crop sown area was also changed dramatically.

Proportion of the six major crops sown area changed to 60 : 4 : 19 : 7 : 3 : 7 in 2007 from the 67 : 4 : 13 : 9 : 4 : 3 in 1961 (Figure 2.16). In less than 50 years, the proportion of cereals declined by 7%, major beans dropped by 2%, roots and tubers dropped by 1%; while the major oil-bearing crops rose by 6%, vegetable melon fruit rose by 4%; the major fiber crops maintained a relatively constant proportion.

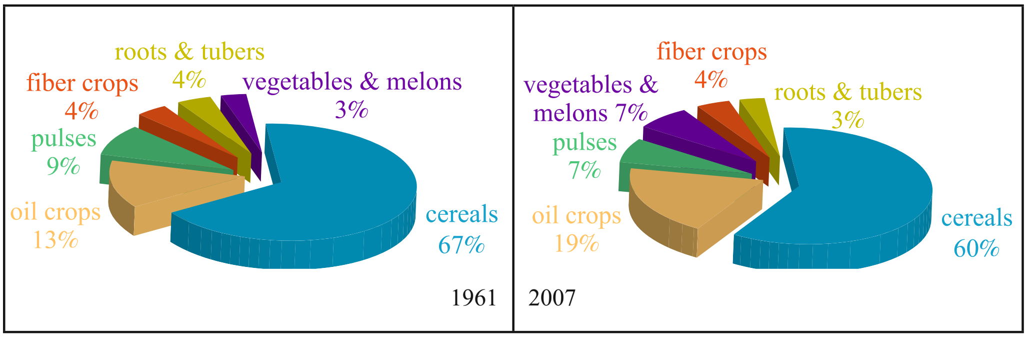


Figure 2.16 Sown area shares in Asia (excluding Russia)

Based on the above analysis, it is known that in the past nearly 50 years, the proportion of cereals harvested area declined mostly in Asia, correspondingly, the major oil-bearing crops got the largest increase.

As the harvest of cereals crops is dominated in the Asian harvested area, and has made the biggest change in the past nearly 50 years, it is chosen for study and through the analysis on cereals supply and demand, and impact of annual changes in cereals production and consumption in Asia can be revealed.

2.3.3 Cereal crops

2.3.3.1 Dramatic growth

Dramatic growth of cereals production in Asia is the result of harvested area and yield, and the rapid promotion of yield is the key of tremendous growth in production.

Cereals sown area in Asia showed the trend of slow growth (Figure 2.17).

1 Study on six categories such as cereals, main fiber crops, main oil-bearing crops, main legumes, roots and tubers, as well as vegetables and fruits

Cereals harvested area gradually increased to peak of 333.2 Mha in 1992 from 271.9Mha in 1961, followed by a slight decline. As of 2007, cereals harvested area in Asia was 327 Mha. Nearly 50 years, annual cereals harvested area has grew at an average rate of 0.4%.

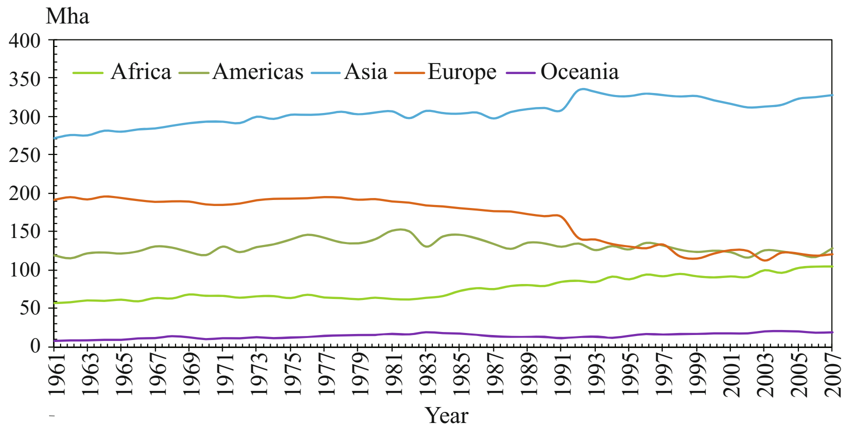


Figure 2.17 Cereal sown area annual change of five continents, 1961-2007

The level of cereals yields in Asia increased rapidly (Figure 2.18, Figure 2.19). In 1961, cereals yield in Asia was 12,122 hg/ha, lower than 19,121 hg/ha of Americas, 13,798 hg/ha of Europe, slightly higher than 11,146 hg/ha of Oceania and 8101 hg/ha of Africa. As of 2007, cereals yields in Asia was 34,896 hg/ha, beyond the 32,722 hg/ha of Europe, second only to 49,607 hg/ha of Americas. Cereals yield in Asia grew at an average annual rate by 2.4%.

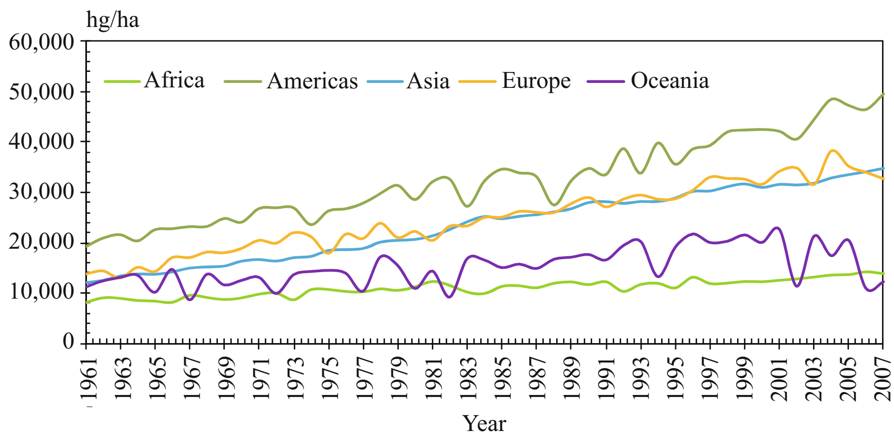


Figure 2.18 Cereal yield annual changes of five continents, 1961-2007

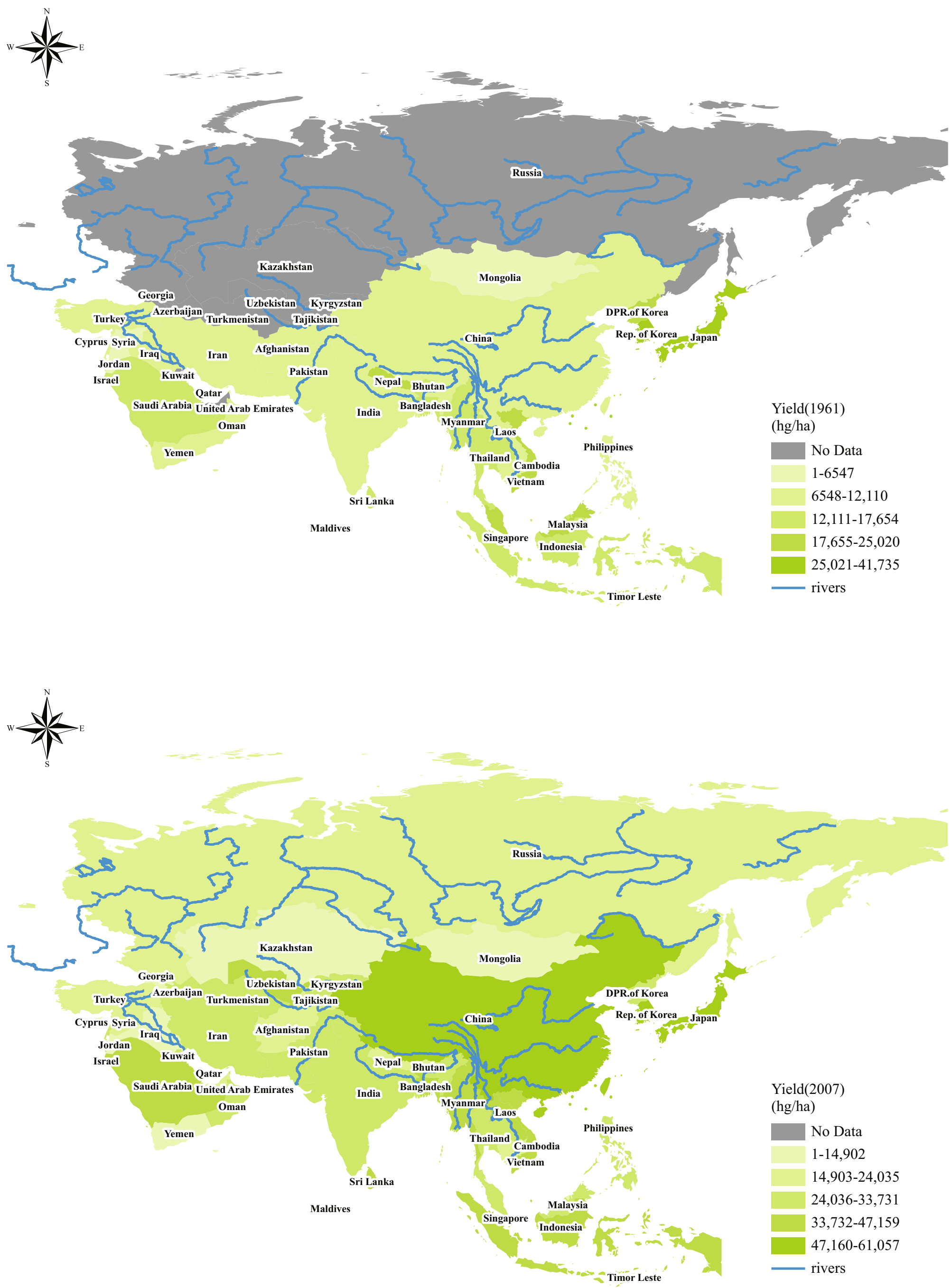


Figure 2.19 Changes in Asian cereals yield, 1961 and 2007

Cereals production grew substantially in Asia (Figure 2.20), from 329.5Mt of 1961 to 1141Mt of 2007. In less than 50 years, net cereals production in Asia has increased by 811.5Mt, becoming the largest cereals production area in five continents, followed by the 408.4Mt of Americas, 131.8Mt of Europe, 100.2Mt of Africa, 13.6Mt of Oceania. Cereals production in Asia grew at an average annual rate by 2.8%.

Judging from the average annual growth rate, the rapid promotion of yield was the key to the tremendous growth of cereals production, at the contribution rate of 84.5%. In addition, the expansion of harvested area of cereals also contributed to output growth by the contribution rate of 15.5%.

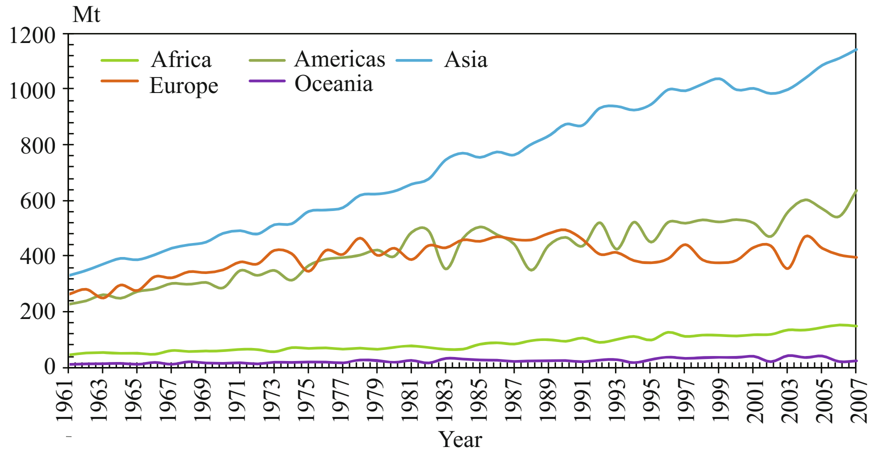


Figure 2.20 Cereals production and annual changes in five continents, 1961-2007

2.3.3.2 Supply and demand

Since 1961, although cereals production in Asia grew rapidly, it could not fully meet the consumer demand, and gap between cereals supply and demand was expanding (Figure 2.21). Asia's net imports of cereals were at the peak of 97.0Mt in 1995 from 21.4Mt in 1961. Asia's net imports of cereals have declined since 2000s, but as of 2006, net imports of cereals in Asia were still up to 85.2Mt. Judging from the evolution of trends of net imports of cereals, the curve of net imports of cereals in Asia is in the stage of a new round of rise.

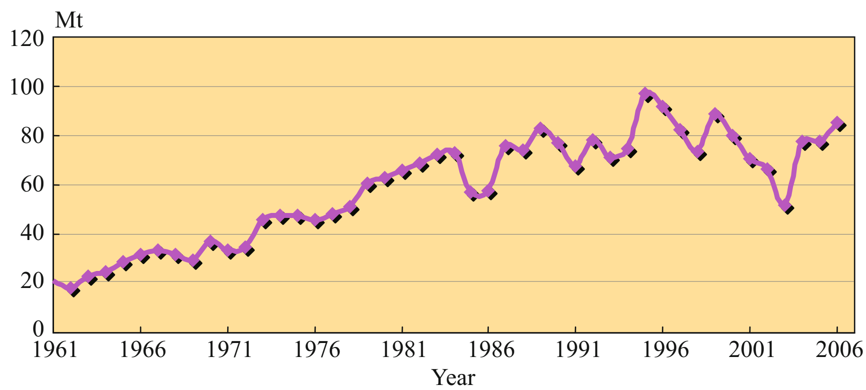


Figure 2.21 Cereal net imports annual change in Asia (excluding Russia), 1961-2006

2.3.3.3 Import trends

Particularly studies were carried out on kinds of representative cereals, rice, wheat, barley and corn, of which harvested area were the top four in Asia, 2007.

According to the study on imports and exports of the above four crops from 1961 to 2006, we found that their net imports grew in varying degrees. The net imports of rice increased to 127,575 tons in 2006 from 11,905 tons in 1961, wheat rose to 38,907,353 tons from 14,224,697 tons, barley increased to 13,263,098 tons from 1,288,847 tons; corn rose to 40,629,084 tons from 2,273,927 tons (Figure 2.22).

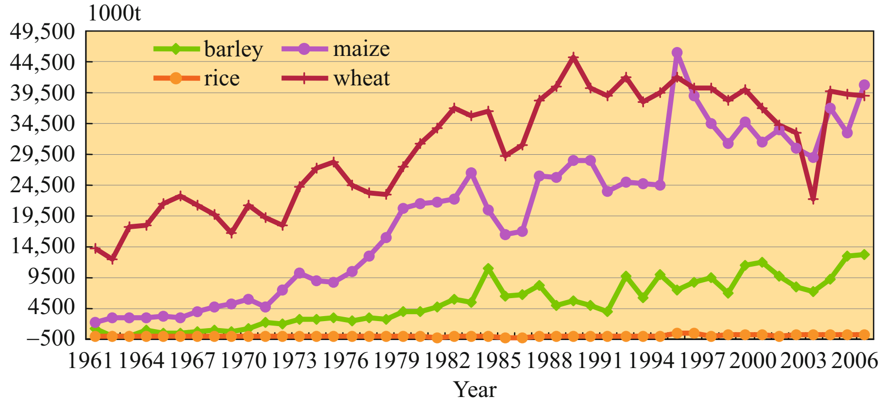


Figure 2.22 Annual changes of net imports of major cereals in Asia (excluding Russia), 1961-2006

The external dependence on foreign cereals refers to in a certain period of time and in a country (region) context, the ratio of the net imports of cereals to demand, which could be used to measure the degree of the cereals self-sufficiency of a country (region), the higher ratio, the more intense, on the contrary, the lower ratio, the weaker.

As of 2003, Asia's rice, wheat, barley and corn consumption were 454,110,291 tons, 242,232,351 tons, 2,647,166 tons, 9,306,421 tons respectively. Rice was still the dominant food in Asia, followed by wheat.

On the basis of a preliminary understanding of net imports of major cereals in Asia, the annual changes of the ratios of external dependence on foreign the mentioned four cereals were taken in to further study(Figure 2.23), which was 0.01%:29.49%:13.73%:9.88% in 1961 and 0.06%: 9.16%: 278.48%: 63.47% in 2003 respectively(Figure 2.23).

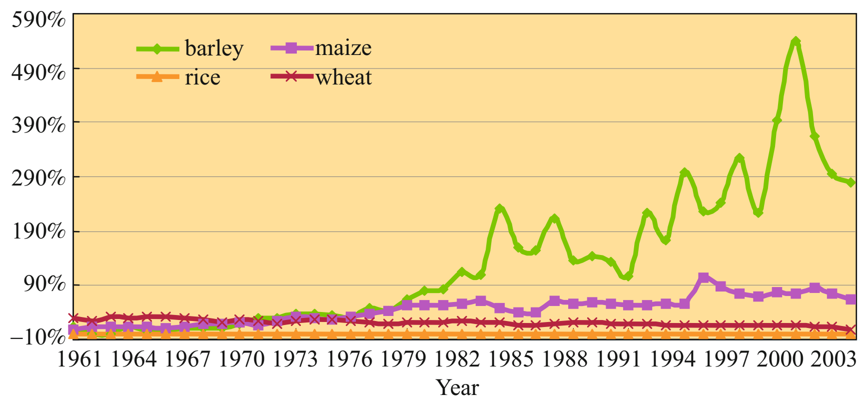


Figure 2.23 Annual external dependence on foreign major cereals (excluding Russia), 1961-2003

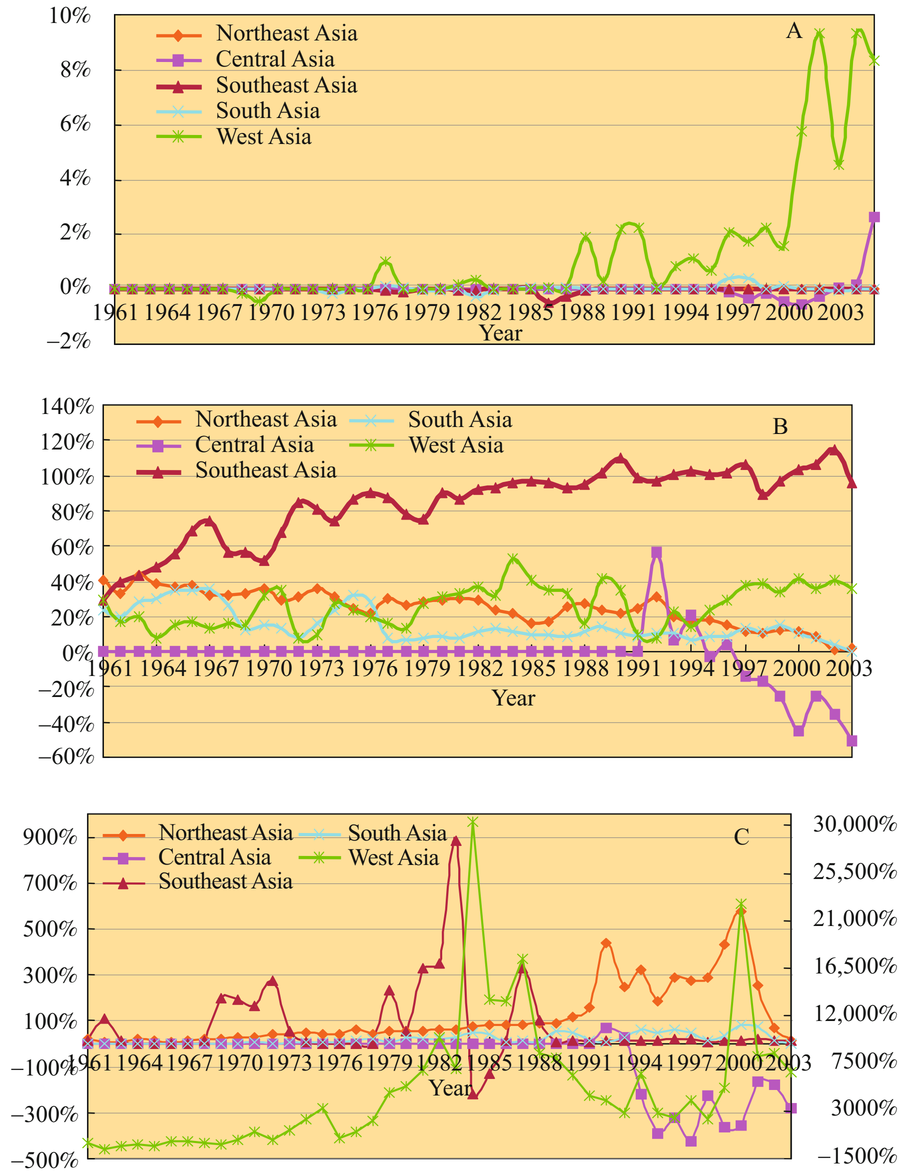
The above analysis shows that, in addition to the external dependence on foreign wheat in 1961 based on the decrease, the other three types of cereals were external dependence with varying degrees of increase. Of these, the greatest degree of dependence on foreign barley reached 278.48%, followed by corn, a net increase of 53.6%, rice is also a net increase of external interdependence of 0.05%.

2.3.3.4 Regional import differentiation

1) Northeast Asia

Nearly 40 years, rice in Northeast Asia has remained self-sufficient state.

The ratio of external dependence on foreign barley in Northeast Asia has experienced "M"-type evolution. The ratio oscillated up since 1961 with two peaks in early 1990s and early 2000s, followed by rapid decline, fell to 12.7% in 2003.



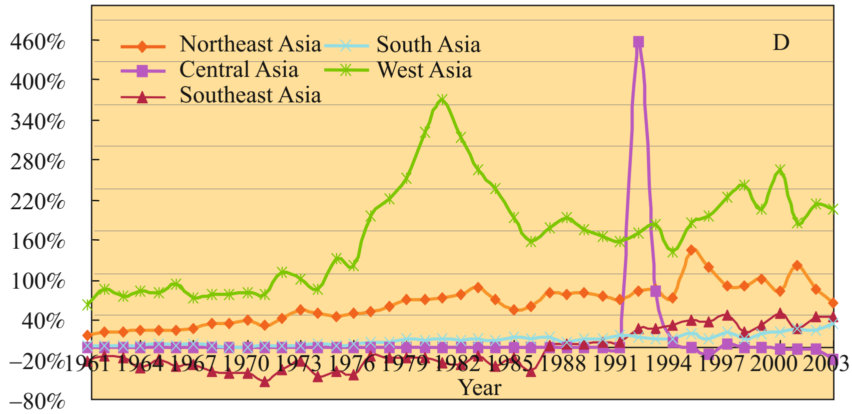


Figure 2.24 Cereal imports in Asian regions

Note: Figure A: Dependence on foreign rice;
Figure B: Dependence on foreign wheat;
Figure C: Dependence on foreign barley, the percentages on the right in Figure C are for West Asia;
Figure D: Dependence on foreign corn.

External dependence on foreign corn increased initially and then decreased, from 16.7% in 1961, oscillated up to 144.9% in 1995, and then gradually dropped to 64.7% in 2003.

External dependence on foreign wheat showed a steady downward trend. In particular, the ratio of external dependence gradually declined from 40.3% in 1961 to1.9% in 2003. In more than 40 years, wheat has achieved essential self-sufficiency from heavily relying on imports in Northeast Asia (Figure 2.24).

2) Central Asia

Central Asia is in hinterland of the Eurasian continent, rich in light and heat resources, land resources, animal and plant resources, as typical irrigated agriculture and grassland areas of animal husbandry region (Wang et al., 2009).

By the study on rice, wheat, barley and corn in Central Asia region, we found that in addition to the rise in external dependence on foreign rice, the other three ones were all declined. The ratio of external dependence on foreign wheat dropped to -50.5% in 2003 from 56.7%in 1992; barley decreased to -282.7% from 66.3%; corn rapidly dropped to -19.4% in 2003 from 457.7% in 1992; and the same time, external dependence on foreign wheat in Central Asia rice rose to 2.6% in 2003 from 0% in 1992 (Figure 2.24).

In a short span of ten-year timeframe, Central Asia has changed to a net exporter from a net importer of wheat, barley and corn, while a net importer from being self-sufficiency with a small surplus in rice.

3) Southeast Asia

The rice maintained self-sufficiency.

External dependence on foreign barley in Southeast Asia tended to be stabilized in the shock, after two turbulent periods at the end of the 1960s and early 1970s, late 1970s and early 1980s, increasingly smoothed since 1990s and always maintained small shocks by 10% -20%. The rice declined to 12.7% in 2003 from 15.9% in 1961.

Judging from the external dependence on foreign corn, Southeast Asia was a net exporter of corn from the beginning of 1960s to the mid-1980s. After the end of 1980s, the ratio of external dependence on foreign corn increased rapidly, to 46.4% in 2003, that is, Southeast Asia region has transformed into a net importer and nearly half of the corn consumption need to meet by imports.

External dependence on foreign wheat steadily increased in Southeast Asia, the ratio of which rapidly grew to 95.9% in 2003 from 29.3% in 1961. Southeast Asia almost all changed to relying on imports from mild dependence on imports gradually lost its ability to self-sufficiency in wheat (Figure 2.24).

4) South Asia

The rice in South Asia has always maintained self-sufficiency.

External dependence on foreign barley was in a small stable fluctuation, which was basic self-sufficient before 1970s, but the ratio was increasing after entering 1970s, breakthrough by 50% for the first time in 1989, 60% in 1994, 80% in 2000, followed by rapidly fell, dropped to about 0.6% in 2003.

External dependence on foreign corn in South Asia increased year by year, which achieved basic self-sufficiency from early 1960s to mid-1970s, and the ratio increased steadily from late 1970s, more than 20% in late 1990s and early 2000s, achieved 35.2% in 2003, changing from self-sufficiency to net importer.

External dependence on foreign wheat in South Asia declined rapidly. The ratio fluctuated around 24% from the beginning of 1960s to mid-and late 1970s, declined rapidly after entering 1980s, fallen to around -0.3% in 2003. South Asia achieved the change from a net importer to a net exporter of wheat (Figure 2.24).

5) West Asia

The rice in West Asia has maintained self-sufficiency with a small surplus from the early 1960s to the mid-1980s. At the end of 1980s, external dependence on foreign rice imported rice began growing, gradually rose to 8.3% in 2003 from the 0% in 1961.

External dependence on foreign barley in West Asia was in severe concussion. Judging from the ratio in 1960s, West Asia was a net exporter of barley, however, since 1970s, the ratio rose rapidly, reached the peak at 30,305.6% in 1984, although reduced subsequently, still grew up to 6724.9% in 2003.

External dependence on foreign wheat was slightly higher in West Asia. The ratio increased after decreased initially, from 29.7% in 1961 to 7.4%, at the bottom in recent nearly 40 years, followed by shock in 1984, rose to peak of 52.9% (Figure 2.24).

2.4 Mineral resources

2.4.1 Asian mineral resources in international markets

China's lead, zinc, tungsten, molybdenum, tin, antimony, rare earth metals, silver, phosphorus, magnesite and other minerals, Kazakhstan's copper, gold, lead, zinc, chromium and other minerals, as well as India's iron ore, manganese, chromium, rare earth, barite and other minerals, all play vital roles in Asia. In addition, Indonesia's copper, gold, nickel and tin, Mongolia's copper, gold, fluorite and phosphorus, the Philippines' gold, copper and nickel, as well as Thailand's gypsum and potassium, Turkey's boron, barite, chromite and others occupy important positions in the world.

The non-ferrous metals and precious metals reserves in Asia account for 25%- 50% of world's total reserves, with lead, zinc, tungsten, tin, antimony ore reserves taking more than or close to half of the world's total reserves; black metal as manganese and chromite reserves are more than or close to 50% of the world's total reserves. As to non-metallic mineral resources, potassium salt, there are certain reserves although not rich. Proved potassium salt reserves in Asia is 11.92×10^8t, mainly found in Israel, Turkey, China, Laos and other countries (Table 2.3).

Table 2.3 Reserves of major mineral resources

State	Iron (ore) (10^8t)	Bauxite (ore) (10^8t)	Copper (Copper metal) (10^4t)	Lead (lead metal) (10^4t)	Zinc (zinc metal) (10^4t)	Gold (gold metal)(t)	Potassium salt (K_2O) (10^8t)	Boron (ore) (10^4t)
China	118.36	5.39	1,847.08	814.10	2,518.40	1,434.65	1.06	2,500.00
Mongolia	9.00		382.00			140.00		
Japan			4.00	60.00	320.00			
DPR. of Korea	4.00		220.00	600.00	1,200.00	350.00		
Rep. of Korea	1.28		5.67	160.00	323.00	71.20		
Vietnam	10.00	40.50	59.20	63.40		400.00		
Indonesia	0.30	0.35	3,500.00		50.00	1,800.00		
Philippines	1.80	0.80	700.00			254.00		
Laos							0.20	
Thailand							1.00	
India	66.00	7.70	580.00	560.00	1,830.00	85.00		
Pakistan	5.00	0.74	138.00					
Kazakhstan	83.00	3.00	1,400.00	500.00	3,000.00	1,500.00	3.80	
Uzbekistan							4.00	
Turkmenistan							1.06	
Iran	18.00		2,054.00	132.00	220.00	200.00		100.00
Turkey	5.65	1.34	300.00	60.00	550.00	28.00		6,000.00
Jordan							0.40	
Israel							0.40	
total Asia (excluding Russia)	332.00	59.82	12,968.95	3,057.00	10,117.50	10,410.85	29.92	8,600.00
world total	1,600.00	230.00	47,000.00	6,700.00	22,000.00	42,000.00	83.00	17,000.00
reserves proportion of Asian to world's (%)	20.75	26.01	27.59	45.64	45.99	24.79	14.36	50.50

Source: U.S Geological Survey, 2000-2005

2.4.2 Mining economic differentiation

Mining industry provides domestic economic construction with raw materials, which is the important foundation to protect sustainable growth of economy. Accordingly, the mining industry occupies an important position in economy-structure of many countries in Asia. However, due to the various conditions of mineral resources, the proportions of mining industry to the economic (GDP) constitution differed dramatically.

Table 2.4 lists the proportion of the mining industry to domestic GDP in some Asian countries. Despite statistical data are different as to the year they were statistic, the contribution made by mining industry to domestic economy was still relatively clear. Accordingly, the Asian countries can be roughly divided into three categories: the first category, the proportion is more than 10%, such as Kazakhstan, Mongolia, Uzbekistan and so on, which are rich in mineral resources and mining is the domestic economy pillar industry; the second category, the proportion is between 1%-10%, such as DPR. of Korea, Kyrgyzstan, Malaysia, Vietnam, India, China, Indonesia, Thailand and the Philippines and so on, where mineral resources are relatively abundant and the mining industry in the proportion of GDP is not high but cannot be ignored mining in the role of domestic economic development; the third category, the proportion is less than 1%, such as Pakistan, Japan, Rep. of Korea and Cambodia, which are relatively poor in mineral resources. In particular, with the proportion less than 0.5%, Japan and Rep. of Korea is developed but still lack of domestic resources, mainly relying on foreign resources and domestic technical, economic strength to achieve their own development.

Table 2.4 Proportion of mining industrial output to domestic GDP

Country	The Domestic Gross Product (GDP, 100 million U.S dollars)	Growth (%)	The Proportion of the Mining Industry to Domestic GDP(%)	Year of Data
Kazakhstan	246.3	9.8	26.9	2002
Mongolia	18.2	10.6	17.3	2004
Uzbekistan	137.6		10.0	2000
DPR. of Korea		2.2	8.7	2004
Kyrgyzstan	13.7		7.7	2000
Malaysia	607.1	5.2	7.1	2003
Vietnam	325		6.6	2001
India	7,009.2	6.9	4.8	2004
China	19,316	9.5	4.0	2004
Indonesia	1843	4.1	3.0	2003
Thailand	818		2.2	2003
Philippines	866.3	4.6	1.6	2004
Pakistan	2,953	4.4	0.9	2002

Continued

Country	The Domestic Gross Product (GDP, 100 million U.S. dollars)	Growth (%)	The Proportion of the Mining Industry to Domestic GDP(%)	Year of Data
Rep. of Korea	6,050	3.1	0.5	2003
Laos	25.1	5.7	0.3	2004
Cambodia	53.1	37.7	0.3	2004
Japan	43,000	7.5	0.2	2003
Turkey	5,300	9	1.4	2004

Source: ① Word Bureau of Metal Statistics, 2002-2005;
② World Bank statistics.

2.4.3 Growth of mineral production, consumption, and shortages

Judging from the steel resources, in recent years, the Asian steel production and consumption of resources were both in a rapid growth trend and the proportion of which to total global production has increased year by year. Asia's production of raw iron, crude steel production and consumption of crude steel increased to 5,654,390,000 t, 6,755,890,000 t, 6,414,100,000 t in 2006 from 2,476,670,000 t, 3,086,330,000 t, 3,033,840,000 t in 1998. Asia's output of raw iron, crude steel production and consumption accounts for the world production in 1998 increased from 45.91%, 39.70%, 39.10% in 1998 to 64.17%, 54.05%, 51.76% in 2006 and then the production and consumption were both more than 50% of the world's total (IISI Committee on Economic Studies-Brussels, 2007).

Judging from the non-ferrous mineral resources, mineral resources in Asia's major non-ferrous metal production have grown rapidly, the proportion of which in global production has also increased year by year. Among them, Asia's refining aluminum, refined copper, refined lead and zinc production changed from the board in 1998, 4,285,800 t, 3,809,000 t, 1,667,800 t, 3,154,900 t in 2007 to 16,538,600 t, 7,774,800 t, 3,856,200 t, 6,065,100 t. Asian refining aluminum, refined copper, refined lead and zinc production accounted for the proportion of world production in 1998 from 18.92%, 26.98%, 27.80%, 39.22% to 43.42%, 43.09%, 47.55%, 53.97% in 2007 respectively, the major non-ferrous mineral production has earned a market share of the world's total production of about half (Table 2.5).

At the same time, consumption of Asian major non-ferrous mineral resources increased rapidly, the proportion of it to global consumption has increased year by year. The consumption of Asia's primary aluminum, copper, lead and zinc plates increased to 19,523,800 t, 9,634,500 t, 3,999,200 t, 6,221,300 t in 2007 from 7,025,500 t, 4,834,600 t, 1,745,300 t, 3,077,000 t in 1998. Asia's primary aluminum, copper, lead and zinc plate consumption accounts for the proportion of world production in 1998 from the 32.10%, 36.21%, 28.73%, 38.53% increase in 2007, and 52.42%, 53.63%, 48.74%, 54.99%, By 2007 the total consumption in Asia to the world's total consumption was of more than half (Table 2.5).

Table 2.5 Production and consumption of Asia's major non-ferrous mineral resources (10^4 tons)

Minerals	Category	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
production of bauxite	subtotal	1,784.64	1,946.1	2,144.94	2,205.71	2,892.16	3,169.41	3,555.05	3,676.52	3,946.17	4,847.74
	world total	12,303.42	13,015.82	13,891.52	13,904.39	14,731.21	15,831.5	16,803.5	17,636.28	18,316.86	19,165.49
	percentage of world total(%)	14.51	14.95	15.44	15.86	19.63	20.02	21.16	20.85	21.54	25.29
production of refined aluminum	subtotal	428.58	471.38	515.73	576.5	675.06	818.43	965.74	1,126.78	1,368.54	1,653.86
	world total	2,265.39	2,370.71	2,441.81	2,443.6	2,607.6	2,800.06	2,992.17	3,202.08	3,396.51	3,808.73
	percentage of world total(%)	18.92	19.88	21.12	23.59	25.89	29.23	32.28	35.19	40.29	43.42
production of secondary aluminum	subtotal	124.77	125.07	130.26	125.93	132.89	135.04	110.38	112.75	121.91	123.43
	world total	759.42	813.24	819.7	762.36	764.87	765.61	763.56	776.19	786.5	880.37
	percentage of world total(%)	16.43	15.38	15.89	16.52	17.37	17.64	14.46	14.53	15.50	14.02
consumption of primary aluminum	subtotal	702.55	817.64	907.47	880.19	966.08	1,144.82	1,296.75	1,421.57	1,600.54	1,952.38
	world total	2,188.93	2,335.55	2,505.91	2,372.15	2,537.23	2,760.65	2,996.06	3,170.93	3,399.46	3,724.64
	percentage of world total(%)	32.10	35.01	36.21	37.11	38.08	41.47	43.28	44.83	47.08	52.42
production of refined copper	subtotal	380.9	411.95	460.28	493.76	505.1	532.57	573.94	643.17	715.39	774.48
	world total	1,411.99	1,446.52	1,481.58	1,567.53	1,534.98	1,522.06	1,585	1,661.03	1,732.45	1,797.21
	percentage of world total(%)	26.98	28.48	31.07	31.50	32.91	34.99	36.21	38.72	41.29	43.09
production of secondary copper	subtotal	384.1	386	404	388.8	367.2	366	356.1	350.5	355.7	352.3
	world total	597.6	588.3	602.8	574.7	542.7	536.7	548.4	555.8	575.5	574.5
	percentage of world total(%)	64.27	65.61	67.02	67.65	67.66	68.19	64.93	63.06	61.81	61.32

Continued

Minerals	Category	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
consumption of copper	subtotal	483.46	538.41	602.52	616.85	695.94	731.31	803.48	824.96	833.79	963.45
	world total	1,335.26	1,405.67	1,519.19	1,468.56	1,505.14	1,531.7	1,666.44	1,663.24	1,698.8	1,796.36
	percentage of world total(%)	36.21	38.30	39.66	42.00	46.24	47.74	48.22	49.60	49.08	53.63
production of refined lead	subtotal	166.78	188.04	215.48	218.86	234.36	261.4	284.87	345.24	379.84	385.62
	world total	599.84	636.33	671.42	661.33	670.23	681.25	681.25	771.93	806.42	811.02
	percentage of world total(%)	27.80	29.55	32.09	33.09	34.97	38.37	41.82	44.72	47.10	47.55
production of secondary lead	subtotal	70.17	76.52	77.41	80.66	85.58	90.63	94.57	116.3	137.49	137.58
	world total	324.62	329.22	345.91	348.69	357.11	360.91	364.78	404.53	427.02	433.13
	percentage of world total(%)	21.62	23.24	22.38	23.13	23.96	25.11	25.93	28.75	32.20	31.76
consumption of lead	subtotal	174.53	181.66	202.67	212.85	242.33	269.01	302.95	349.62	377.05	399.92
	world total	607.42	618.03	641.5	656.05	658.93	668.3	723.76	777.39	812.35	820.46
	percentage of world total(%)	28.73	29.39	31.59	32.44	36.78	40.25	41.86	44.97	46.41	48.74
production of electro-galvanized plate	subtotal	315.49	339.52	379.25	394.5	420.72	445.87	467.48	500.78	552.22	606.51
	world total	804.34	842.07	906.39	922.24	964.6	993.11	1,016.04	1,015.48	1,058.98	1,123.79
	percentage of world total(%)	39.22	40.32	41.84	42.78	43.62	44.90	46.01	49.31	52.15	53.97
consumption of electro-galvanized plate	subtotal	307.7	337.1	366.65	375.64	410.5	447.21	506.46	559.68	578.32	622.13
	world total	798.55	839.03	886.52	886.64	935.51	943.5	1,020.51	1,043.37	1,081.75	1,131.42
	percentage of world total(%)	38.53	40.18	41.36	42.37	43.88	47.40	49.63	53.64	53.46	54.99

Source: USGS. Minerals Yearbook (1998~2007)(Volume III)<Arailable at: http://minerals.usgs.gov/minerals/pubs/country/index.html#pubs.>(last accessed 28/8/2009)

2.5 Biodiversity conservation

2.5.1 Coastal zones

Asia's marine ecosystems play an important role in the interaction between land and sea. There are long coastlines and more than half of the population are living on or living by the sea in Asia, directly depending on some important marine resources such as mangroves and coral reefs to survive. In the landlocked countries in Central Asia, as a result of the large-scale utilization of natural resources, the ecosystem has suffered severe damage. Due to the rapid changes and poor management of various natural resources, different forms of irrational land use, huge irrigation water, overloading utilization of mountain resources and rare species resources, blind construction of water facilities, and fuel-wood harvesting have been serious threats to biodiversity and ecosystem services in Asia.

Mangrove is a kind of rare resources on earth, essential to coastal ecosystems. Mangrove resource can provide timber and non-forest products and play a major role in the protection of the coast, providing various fish and shellfish with biological habitats and rich nutrients. 50% of Mangrove of the world left in Asia (including the Pacific region as well as Australia and New Zealand), severely damaged by industrial development and infrastructure (FAO, 2003; UNESCAP, 2005a). Mangrove in Northeast Asia and Southeast Asia has suffered serious damage as the result of the development of the coastal transition (Table 2.6).

Table 2.6 Mangrove distribution

Sub-region	1990(km^2)	2000(km^2)	Annual change(%)
Northeast Asia	452	241	−6.1
South Asia	13,389	13,052	−0.3
Southeast Asia	52,740	44,726	−1.6
total	66,581	58,019	−1.4

Source: according to UNEP (2007a), p221

Fragile coral reef is a kind of ecosystems, very sensitive to climate change, human activities, especially tourism and natural disasters. It is estimated that there is an area of about 118,000 km^2 coral reefs in Asia, of which mainly distributed in South Asia, Northeast Asia and Southeast Asia regions (Figure 2.25). accounting for 41.5% of the total area in the world, of which about 60% is in bacteralization, suffering from exploitation and destructive fishing at risk (UNESCAP, 2005b).

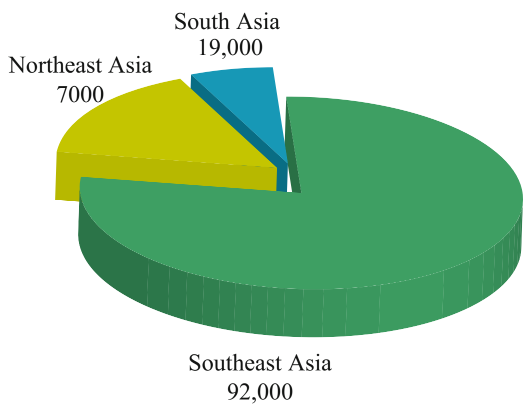


Figure 2.25 Coral reef distribution, 2004

Source: Wilkinson (2004)

Marine resources have high dependence on coral reefs. Therefore, the ultimate result of serious damaged coral reefs near densely populated areas in Asia, rising sea-surface temperature, lots of white coral in coastal areas was that the habits of coral reef are degraded and destructed; posing a threat to important rare species, bring out the loss of biological diversity (Table 2.7). In West Asia, coastal erosion is everywhere, if we do not take effective measures to protect and strengthen the management, coral reefs in Jordan, tidal coral reefs in Lebanon and Syria, as well as local biodiversity in coast countries including Yemen and so on would be threatened. The rise of shrimp farming industry in some regions is also a kind of hazard in a certain degree to the growth of mangroves.

Table 2.7 Threatened species

Sub-region	Mammals	Birds	Reptiles	Amphi-bians	Fish	Inverte-brates	Other Invertebrates	Plants
Southeast Asia	175	274	55	125	153	28	32	541
South Asia	207	204	64	128	110	2	78	538
Southeast Asia	455	466	171	192	350	27	49	1772
Central Asia	45	46	6	0	19	0	11	4
total	882	990	296	445	632	57	170	2855

Source: adopted according to IUCN (2006)

2.5.2 Forest resources

There are 51 million hm^2 forests in West Asia, only 1.34% of its land area, less than 0.1% of the world's woodland(GEO Data Portal, 2007a). Dense forests are mainly distributed in Mashriq countries, and pine woodland are scattered in the dry areas of the river and mountains in the Arabian Peninsula. As a result of deforestation in some areas while afforestation in the other places, the total area of west Asian forest had not shown significant change over recent years. The forest cover in Arabian Peninsula even increased at an average annual rate of 60 km^2 from 1990 to 2000, but tended to stabilize from 2000 to 2005. In Mashriq, as a result of the implementation of the afforestation plan since 1990, forest cover has been growing at 80 km^2 / year (GEO Data Portal, 2007a).

Box 2.1 Impact of ecosystem services and functions on humans

On the one hand, deforestation may cause the rapid reduction of timber production, and wood resources depletion in some specific areas of natural depletion especially, affecting the lives of local residents. On the other hand, reasonable protection and management of useful ecosystems can bring more benefits to mankind. For example, Phang Nga of Thailand is the area most affected by tsunami, but a large number of mangroves effectively eased the huge impact of Indian Ocean tsunami in 2004 (UNEP, 2005).

As a result of water shortages, increasing demand for agricultural land and accelerated development of urbanization, the woodlands in West Asia are under great pressure. In recent years, the degradation of quality of forest in West Asia occurred in a large area, which was mainly due to forestland cautilization, illegal logging, overgrazing, fire and the development of tourism. For example, only a fire occurred in Syria in 2004 destroyed almost 0.4% of total woodland in the country (UNEP, 2007b). In Arabian Peninsula, hundreds of hectares of Juniper forest had withered branches and leaves have emerged (PME, 2005; UNEP, 2007b) (Box 2.1).

More than 70% of the forest in West Asia is located in the Arabian Peninsula. Juniper forest in Arabian Peninsula, particularly those in low-latitude forests, are showing signs of recession, with the growing trees gradually weakened, and many young shoots and branches dead (Box 2.2). Juniper is the only native coniferous species in Arabian Peninsula, living in the northern mountainous area of Oman, Asir Mountain in Saudi Arabia and northwestern mountainous areas of Yemen. In a relatively humid weather, the leaves can juniper mist condenses into water drip from the branches to create a microclimate for the continued growth of other species. The forest here plays an important role in the maintenance of rich flora and fauna, as well as provides products and services to local residents. Woodland in Southwest Arabian Peninsula was the habitat for a lot of endangered species of birds (Jennings et al., 1988; Newton S F and Newton A V, 1996; Birdlife International, 2003). This region is not only the habitat of many birds of prey, or the only way for migratory birds. In addition, it is believed that the endangered Panthera pardus and the rare Canis lupus are often found in woodland. Juniper is a kind of major species in West Asia agroforestry, which can be used in traditional medicine.

Box 2.2 Juniper on the brink of extinction on the Arabian Peninsula

These signs are all related to high mortality of trees and poor natural regeneration capacity. Over the past 20 years, Asir Domestic Park and Raidah Domestic Park in Saudi Arabia have found widespread degradation of barbed Berlin phenomenon, the coverage were 450,000 hm^2 and 900 hm^2 respectively. No conclusion has been drawn on Juniper's withered branches and leaves. However, the weak renewable capacity of this species has relationship to invasive group of magnanima hitting berries. At the same time, human disturbance, overgrazing, air pollution, drought and climate change are also continuing incentive. Juniper was removed for the development of agriculture, building roads, housing and recreational facilities, which changed natural drainage systems in many areas. In addition, these acts and over-exploitation, overgrazing, the utilization of fuelwood and creation of charcoal made the microclimate here is not conducive to tree growth. The phenomenon of withered juniper branches in the region is a serious problem to the affected country in this area. It is silent resource degradation, likely to exacerbate desertification. West Asia was in an urgent need for a new action plan to save deading Juniper.

3 Challenges

3.1 Major problems

There are many common problems in sustainable utilization of natural resources in Asia, mainly in the following aspects:

3.1.1 Quantity and quality of freshwater resource

Global climate change has a great influence on rain and heat distribution in Asia, causing more severe droughts and floods, soil degradation as well as salt water intrusion and other marine disasters caused by sea-level rising(IPCC, 2007). Because most countries of the Asia distribution of precipitation changed and temperature rose, a substantial decline would occur in agricultural productivity.

West Asia is one of the most stressful areas in water resource utilization.

The natural environment is extremely arid. Rainfall changes dramatically during the quarter and water resource is especially valuable, for drought and little rain. For several decades, poor management of water resource in this area has caused quality degradation in large areas of land and sea. From 1985 to 2005, annual available fresh water per capita of the entire West Asia decreased from 1700 m^3 to 907 m^3, due to population growth in future, which is expected to decrease to 420 m^3 by the year 2050(UNESCWA, 2003). Mashriq countries mainly rely on surface water and a small amount of groundwater, while the Arabian Peninsula relies on ground water and desalinated seawater. The two subregions have made use of treated wastewater increasingly. 60% of the region's surface water comes from outside, therefore, the sharing of water resource has become one of the important factors in West Asia regional stability. However, the first water-sharing countries have not reached a consensus agreement on equality in water sharing and management. As a result of the small total amount of water resource and continuous worsening water quality due to over-exploitation of groundwater, emissions of industrial and agricultural, human health and ecosystems are seriously affected in West Asia.

Rapid industrialization and urbanization process, as well as limited water and sewage treatment facilities, make the situation of water scarcity in West Asia increasingly serious. There is enormous pressure for Mashriq and Yemen, agriculture-based countries in West Asia, to meet the increasing water demand by limited funds. In the area, urban water rapidly grew, from 7.8 billion m^3 in 1990, to 11 billion m^3 in 2000, by an increase of 40% (UNESCWA, 2003). Although majority of people can make utilization of treated drinking water, low-income areas have poor water services; number of large cities like Sana'a, Amman and Damascus are facing the more serious water shortages. Poor water quality affects health, which has aroused great concern, and the key reason is that large amount of untreated water was used in irrigation, poor sanitation, and poor waste management. In addition, over-exploitation of groundwater has led to a lot of dry springs, damaging the surrounding historical and cultural heritages. Typical example is Palma Oasis in Syria; large number of the historical fountains in the area dried, and had a significant impact on the surrounding historical Kingdom of Zambia.

Inefficient water resource management and utilization resulted in more water scarcity. In the Gulf countries, with an average consumption of 300-750 liters/capita/day they rank among the highest in the world (IUCN & WESCANA, 2007). The reason is in the lack of proper demand management mechanisms and price signals. Government policies focus on the supply side of water production management, with low water fee averaging less than 10% of the cost, not conducting consumers to save water.

Although cities in West Asia have high demand on water resource, the major water consuming sector is agriculture, accounting for more than 80% of water consumption. Over the past few decades, food self-sufficiency and socio-economic development-oriented economic policies have stimulated the prior development of irrigated agriculture. Agricultural water consumption in West Asia (UNESCWA, 2003) increased to 85 billion m^3 in 1998-2002 from 73.5 billion m^3 in 1990, have tremendous pressures on limited water resource of the region. In recent years, many countries in West Asia started to give up the above-mentioned economic policies, but agricultural water was still increasing, allocation conflicts between agricultural water, domestic water and industrial water were getting worse.

Water demand in West Asia is mainly attributed to the rapid expansion of population, which increased to 97.7 million in 1972 from 37.3 million in 2000 (2001 United Nations report on population distribution). Mashriq areas' population growth rate was greater than 3% per year so that water availability fell to 1574 m^3 from 6057 m^3 in 1950 m^3 (Khouri, 2000) (Table 3.1).

Table 3.1 Available water and supply pressure index in West Asia

	Mashriq Area	Arabian Peninsula	West Asia Total
surface water (million m^3/ year)	68,131	6,835	74,966
ground water (million m^3/ year)	8,135	6,240	14,375
desalinated water(million m^3/ year)	58	1,850	1,908
re-utilization of agricultural emissions (million m^3/ year)	3,550	392	3,942
water availability (million m^3/ year)	79,874	15,317	95,191
Water Supply Pressure Index			
population (million, 2000)	50.7	47.0	97.7
water consumption (million m^3/ year)	66,500	29,600	96,100
water supply pressure index (%)	83.3	193.5	101.0

Source: Water resource is according to Khouri (2000). Water stress index is based on ACSAD (2000) and United Nations Population Division (2001).

As a result of the increase in per capita consumption, domestic demand for water is increasing. Many countries restrict the demand by water distribution system. For example, Amman, Jordan, provides water only three days a week. In Damascus, provides water less than 12 hours a day.

Agriculture is the major water consumption sector in West Asia, accounting for 82% of the total water consumption, followed by water consumption for domestic and industrial sectors, accounted for 10% and 8% respectively. In the Arabian Peninsula, agricultural utilizes about 86% of the available water resource, and about 80% in the Mashriq (Khouri, 2000). In the past 30 years, in order to meet water demand, especially irrigation water demand, groundwater extraction has increased significantly.

As to the member states of Gulf Cooperation Council (GCC), the total annual water supply increased from 6 km^3 in 1980 to 26 km^3 in 1995, of which 85% was used for agricultural purposes(Zubari, 1997). In 1995, the member countries of Gulf Cooperation Council had water resource equivalent to 466 m^3/year per capita and a per capita water use of 1020m^3/year, producing an average annual water deficit of about 554 m^3 per capita, provided mainly by mining groundwater reserves (Zubari, 1997).

In the West Asia water pressure indexes (expressed as the ratio of water consumption to available water resource) in the seven countries in the Arabian Peninsula; five were more than 100%, while the remaining two were at the critical statement. These countries have already exhausted their renewable water resource, and are now mining non-renewable resource reserves. In Mashriq, in addition to Jordan, the water pressure index is still relatively low (Table 3.1). When the 9 of 12 countries in West Asia have per capita water resource in the 1000 m^3/year, 7 of the 9 countries have per capita water resource less than 500

m^3/year. West Asia's total water supply pressure index is greater than 100% (Table 3.1).

In the past 30 years, the policy of food self-sufficiency has encouraged the expansion of agriculture, and government provided subsidies and incentive systems of the system led to the development of large-scale animal husbandry, which have increased the demand for water resource, it was only through the exploitation of deep groundwater to meet those needs. In addition, the uncontrolled pumping of irrigation water, no charge or only a small amount of the taxes and fees on irrigation water, lack of governance to illegal drilling, bad irrigation habits, as well as farmers' inadequate knowledge of the issue, all resulted in excessive water utilization.

Intensive agriculture and excessive utilization of agricultural chemicals also aggravated the pollution of water resource. For example, in Gaza, water nitrate concentrations exceeded the guidance standard of World Health Organization (WHO) (10 mg / L), and the concentration rate of nitrate was increasing by 0.2-1.0 mg /L per year in coastal wells. Adherence to WHO standards would place half of these coastal wells off limits as drinking water (PNA, 2000).

In West Asia, the subsidies system and incentives system expanded private agricultural sectors in large scale, and also led to additional irrigation in areas farming relying on rainfall. For example, the total irrigated area in Syria in the past 30 years almost doubled, from 625,000 hectares in 1972 (accounting for 10.9% of arable land) to 1,186,000 hectares in 1999 (arable land accounting for 25.2% of arable land) (FAOSTAT, 2001). In Iraq, the percentage of irrigated land increased to 67.8% in 1999 from 30.3% in 1972 (FAOSTAT, 2001). Irrigation efficiency-percentage of actually water arriving at crop - not more than 50% in the area, sometimes even down to 30%, which led to serious waste of water resource (ACSAD,1997).

In Saudi Arabia, in the 15 years from 1980 to 1995, the amount of water used for cultivation of wheat was about 254 km^3 (Al-Qunaibet, 1997), equivalent to 13% of the country's total groundwater reserves (1919m^3) (Al- Alawi, et al., 1994).

3.1.2 Desertification and food security

China and Mongolia in Asia are particularly serious in land degradation and desertification. It is estimated that in 2000 land affected by desertification in China's reached 2,622,300 km^2, roughly 27.32% of the land area, or equivalent to 79.1% (CCICCD, 2000) of its semi-arid and semi-humid areas. About 30% of Mongolia's pasture had been damaged by unreasonable conduction, such as deforestation and livestock grazing. In the past 40 years, Mongolia's sand area has increased by 380 km^2, 78.4% of Mongolia's pastures suffered the degradation. As a result of poor management of forest resources, a large number of shrubs have been used for fuel-wood, desertification has been a serious threat to many Mongolians lives (Government of Mongolia, 1999).

West Asia is poor in land quality. About 64% of the 4,000,000 km^2 land in

West Asia is dry land (Al-Kassas, 1999). Only 8% of the arable land provided people with adequate food in the past without adverse environmental impacts. Over the past 20 years, the population increased by 75%, and the demand for resources also increased dramatically (GEO, 2007b). In addition, the widely utilization of inappropriate technologies, poor management of public resources, ineffective agricultural policies, as well as the rapid but unplanned urban development, land resources of West Asia suffered from a lot of pressure, which led to massive land-utilization change, land degradation and desertification in many countries of West Asia. The major threats to land in West Asia are wind erosion, salinization, followed by soil flooding, compaction and soil fertility declining. In the early 20th century, about 79% of land of West Asia became degradation, 98% of which are caused by human activities (ACSAD et al., 2004). These man-made causes included lack of land resources policies, highly centralized management, shortage of public input and professionals, single and rigid planning and management methods.

Soil degradation is increasingly threatening the food security in some Asia areas. In West Asia, the arable land and water land are expanding, and agricultural mechanization and modernization are being enhanced, with the massive utilization of herbicide, pesticide and fertilizer, promotion of greenhouse utilization and aquaculture, agricultural production has been greatly improved. For example, from 1987 to 2002, the water land increased from 4.4 Mha to 7.3 Mha (GEO Data Portal, 2007a) in West Asia. However, trade deficit also increased when the cereals production increased, which posed a serious threat to food security. The irrational utilization and poor management of irrigation water caused salinization in large areas of West Asia, affecting 22% of arable land in the area, resulting in huge economic losses(ACSAD et al., 2004).

3.1.3 Mountain and marine biodiversity

Asia is rich in biological resources and most of the 12 high-diversity countries of the world are in Asia. China ranks third in the world abundance for its biological diversity, with more than 30,000 kinds of higher plants, 6347 kinds of vertebrates, accounting respectively for 10% and 14% of the world's total. Asia's rich biological resources are being used by all kinds of human activities, for example, direct collecting and exporting timber, fish and other natural products, expanding agricultural production to the primeval forest, wetlands and grassland, constructing various dams, as well as growing high yield alien species instead of the traditional local crops. The above-mentioned activities accompanied by other socio-economic activities such as urbanization, industrialization, mining, tourism, the illegal trade in endangered species and the lack of proper management have resulted in substantial loss of biological diversity. In Mongolia, DPR. of Korea and China, due to the increasing export to surrounding profit-aiming markets by poaching and illegal collection, a number of medicinal plants and animals are rampant. Such as the Crested Ibis lived in Japan and the Korean Peninsula are now suffering from the threat of extinction, so does

China's Tibetan Gazelle.

More than half of Asia's land area is mountain, especially in West Asia, Central Asia and South Asia. The capacity of mountain resources changed in accordance with the distribution of rainfall year-on-year. In Jordan, the annual production of animal dry feed is less than 47kg/ha, while in Lebanon it is up to 1000 kg / ha(Shorbagy, 1986). Accordance to the standard sheep unit remaining unchanged since 1987, 250 kg, and annual feed gap in West Asia could be as high as 14.6 million kg(FAO, 2005). West Asian drought, cold and heat, grassland plant diversity plays an important role in enhancing coverage flexibility, but due to the huge pressure of mountain forests and grassland, West Asian biodiversity is declining.

Over husbandry, early husbandry, as well as other mountains reclamation and leisure activities had serious impact on and reduced the species diversity and density, resulting in soil erosion and a large number of sand dunes, taking up some farmland (Al-Dhabi et al., 1997). Observation results of vegetation cover change showed that (Tucker, et al., 1991): the vegetation in arid areas had more extension about 150km in rain year than in drought year. From 1985 to 1993(ACSAD, 2003), sandy area of Al-Bishri region in Syria increased 375 km^2, north to Jubail in eastern Saudi Arabia, in 15 months, the area of sand dunes expanded 1 more times(Barth, 1999). It is estimated that from 1998 to 2001, grazing and fuel-wood collection had reduced the mountain of productivity by 20% in Jordan and 70% in Syria respectively (ACSAD et al., 2004).

Forests have multiple functions, which can provide not only lots of timber, protection of soil and water conservation, but also opportunities to recreational, educational, cultural activities, and the conservation of biological diversity, making a contribution to reduce global warming. Northeast Asia is the world's non-tropical forest-rich region; preventing Northeast deforestation and forest degradation are of great significance in improving the environment of Northeast Asia and the world.

Loss of biodiversity caused the variation and fall of species structure, caused the local and global species extinction, influenced the production of the domestic economy as well as dietary and life of mankind. The international community protects it through the development of treaty such as "Treaty on Biological Diversity". At the domestic level, China, Japan, Mongolia, DPR. of Korea have developed their own domestic strategies and priority action plan, making efforts to protect biodiversity and reduce further losses. In order to effectively supervise management and biodiversity, the joint participation of Asian governments, organizations and the public should be encouraged.

3.1.4 Mineral resources

Since 2008, credit crunch and financial market turbulence caused by the U.S sub-loan crisis has posed a threat to the sustained growth of global economy and the global economic growth slowed down. IMF (International Monetary Fund) reduced the expected global economic growth rate of 2009 from 5.2%

to 4.8%. Despite the economic slowdown in the United States, Asian economy would continue to grow steadily by rapid economic growth in China and India. The economic growth of Asian developing countries (regions) is expected to be more than 8.3% this year and 8.2% next year.

The major of Asian countries are developing countries, still in a relatively economy backward state on the whole, China and India, the world's two most populous countries, as representative. In the process of economic development, for the population, technological backwardness, the quick development speed and other factors, the consumption of mineral resources are high in volume, in growth rate of extinction. Restricted by capital, technology and concepts, the elasticity of minerals consumption in Asia is greater than 1, showing that the growth rate of mineral consumption is greater than the speed of economic growth, and the Asian utilization of mineral products is inefficient.

As to the resource consumption of the steel, the steel consumption growth rates in 2006 compared with the same period last year of Europe, Africa, Asia, Americas, Oceania and the World were 5.2%, 13.9%, 6.3%, 7.3% −1.0% and 7.8% respectively, while GDP[1] growth rate were 3.2%, 5.2%, 5.5%, 3.3%, 2.9% and 3.9% respectively, by calculation, the elasticity indexes of steel consumption were 1.6, 2.7, 1.1, 2.2, −0.3 and 2.0,respectively. It is clear that Oceania's elasticity index of steel consumption is negative indicating a negative growth rate of resources with the highest utilization rate of steel resources; in contrast, the elasticity indexes of Africa is the largest about 2.7 implying its resources efficiency is the lowest among the five regions. Furthermore, on the whole, except Oceania, the other regions' elasticity indexes of steel consumption are all more than 1, this fact indicate that overall resource utilization of steel is still not high in this stage (Table 3.2).

Table 3.2 Elasticity indices of steel consumption, by continents

Intercontinental	Resource Consumption (10 thousand tons)			GDP (100 million U.S dollars)			Mineral Consumption Elasticity Index
	2005	2006	Growth rate(%)	2005	2006	Growth rate(%)	
Europe	21,470.8	22,591.6	5.2	9,866	10,178	3.2	1.6
Africa	2,559.9	2,915.4	13.9	730	767	5.2	2.7
Asia	60,343.4	64,141.0	6.3	10,887	11,482	5.5	1.1
Americas	19,013.5	20,407.6	7.3	14,071	14,532	3.3	2.2
Oceania	8,700	8,612	−1.0	542	557	2.9	−0.3
world total	113,121	121,908.3	7.8	36,096	37,517	3.9	2.0

Source: ① U.S Geological Survey, Steel minerals Yearbook 2006;
② Central Intelligence Agency, The World Factbook.

1 Source: World Bank database WDI GDP(constant 2000, U.S$)

From the point of view of non-ferrous metals consumption, the consumption of non-ferrous metals in Europe, Africa, Asia, Americas, Oceania and the world was 7.2%, 7.6%, 7.4%, 1.3%, −6.0% and 5.1% higher in 2006 than that in 2005 respectively; and GDP growth rate of Europe, Africa, Asia, Americas, Oceania and the world was 3.2%, 5.2%, 5.5%, 3.3%, 2.9% and 3.9% in 2006 compared with the same period last year respectively; by calculation, the elasticity index of major non-ferrous metals consumption of Europe, Africa, Asia, Americas, Oceania and the world was 2.3, 1.5, 1.3, 0.4, −2.1 and 1.3 respectively. It can be seen that the elasticity index of major non-ferrous metals consumption of Oceania is negative, indicating a negative growth rate of resources and the highest utilization rate of non-ferrous metals resources; in addition, except Americas, the value of elasticity indexes for other regions such as Europe, Africa and Asia are all more than 1, this fact implies that the efficiency of mineral resources of the whole world are still very low (Table 3.3).

Table 3.3 Elasticity consumption indices of major non-ferrous metal mineral products by continents

Intercontinental	Resource Consumption (10 thousand tons)			GDP (100 million U.S dollars)			Mineral Consumption Elasticity Index
	2005	2006	Growth rate(%)	2005	2006	Growth rate(%)	
Europe	1,774	1,902.1	7.2	9,866	10,178	3.2	2.3
Africa	93.7	101	7.6	730	767	5.2	1.5
Asia	3,239.2	3,478.7	7.4	10,887	11,482	5.5	1.3
Americas	1,581.3	1,602.2	1.3	14,071	14,532	3.3	0.4
Oceania	89.7	84.4	−6.0	542	557	2.9	−2.1
world total	6,820.2	7,168.4	5.1	36,096	37,517	3.9	1.3

Note: The statistics of the major non-ferrous metals aluminum, copper, lead, zinc, nickel and tin-6 in non-ferrous metals

Source: ① World Bureau of Metal Statistics 2008;

② Central Intelligence Agency, The World Factbook.

On Asian mineral resources waste recycling, consumption of mineral resources in Asia grow strongly, especially, China and Japan have become the two major consumer markets in ore and mineral products of the world. Although the utilization of mineral resources waste recycling showed a growing trend in Asia, while the consumption grew rapidly, resulting in waste recycling efficiency of mineral resources in Asia was decreasing year by year. Waste recycling efficiency of aluminum, copper and lead dropped to 6.32%, 12.09%, 34.40% in 1998 from 17.76%, 39.69%, 40.21% in 2007(Table 3.4).

Table 3.4 Mineral waste recycling efficiency (10^4 tons)

Minerals	Types	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
aluminum	recovery	124.8	125.1	130.3	125.9	132. 9	135	110.4	112.8	121.9	123.4
	consumption	702.6	817.6	880.2	880.2	966.1	1144	1296.8	1421.6	1600.5	1952.4
	the waste recycling efficiency(%)	17.76	15.30	14.80	14.31	13.76	11.80	8.51	7.93	7.62	6.32
copper	recovery	191.9	194.2	220.3	205.3	204	213.2	114.4	113.4	115.1	116.5
	consumption	483.5	538.4	602.5	616.9	695.9	731.3	803.5	825	833.8	963.5
	the waste recycling efficiency(%)	39.69	36.07	36.56	33.28	29.31	29.15	14.24	13.75	13.80	12.09
lead	recovery	70.2	76.5	77.4	80.7	85.6	90.6	94.6	116.3	137.5	137.6
	consumption	174.5	181.7	202.7	212.9	242.3	269	303	349.6	377.1	399.9
	the waste recycling efficiency(%)	40.21	42.12	38.20	37.90	35.32	33.69	31.22	33.26	36.46	34.40

Source: According to World Bureau of Metal Statistics 2008

Compared with other continents, the waste recycling efficiency in Asia is very low. According to statistics (Table 3.3), aluminum waste resources utilization of the world, Europe, Africa, Asia, Americas and Oceania is 23.64%, 31.07%, 6.80%, 6.32%, 59.24%, 31.81%. Asia aluminum recycling efficiency is the minimum, specifically, 0.48% lower than that of Africa, 17.32% lower than that of the world average. Copper waste resources utilization of the world, Europe, Africa, Asia, Americas and Oceania is 32.32%, 41.14%, 12.01%, 27.08%, 36.14%, 40.84%. Asia Copper recycling efficiency is only higher than that of Africa, 5.24% lower than that of the world average. Lead waste resources utilization of the world, Europe, Africa, Asia, Americas and Oceania is 52.79%, respectively, 63.19%, 71.57%, 34.40%, 75.53%, 158.98%. Asia lead recycling efficiency is the minimum, 28.79% lower than that of Europe, 18.39 % lower than that of the world average (Table 3.5).

Table 3.5 Non-ferrous mineral waste recycling efficiency (2007) (10^4 tons)

Non-ferrous mineral	Recovery	World	Europe	Africa	Asia	Americas	Oceania
copper	consumption	880.4	284	3.2	123.4	457.2	12.6
	the waste recycling	3724.6	914	47	1952.4	771.7	39.6
	recovery	23.64	31.07	6.80	6.32	59.24	31.81

Continued

Non-ferrous mineral	Recovery	World	Europe	Africa	Asia	Americas	Oceania
lead	consumption	580.6	194.4	2.8	260.9	116.5	6
	the waste recycling	1796.4	472.6	23.3	963.5	322.3	14.7
	recovery	32.32	41.14	12.01	27.08	36.14	40.84
aluminum	consumption	433.1	123.5	8.1	137.6	159.3	4.7
	the waste recycling	820.5	195.4	11.3	399.9	210.9	3
	recovery	52.79	63.19	71.57	34.40	75.53	158.98

Source: World Bureau of Metal Statistics 2008

To sum up, Asia's efficiency of first utilization and duplication recovery in mineral resources is far lower than that of developed regions, and even less than that of Africa. The lower utilization rate of resources caused Asia's mineral consumption increased substantially year by year, affecting the sustainable development of Asian economies. Therefore, it is necessary to further improve the level and the development of high-technology industries, to improve the utilization of mineral resources, and to change the rough-based economic development model to address the growing shortage of mineral resources situation.

3.2 Major challenges

It is clear that the future sustainable development in Asia would face difficult challenges in natural resource management. On the one hand, Asia should effectively protect precious natural resources and the environment, on the other hand, most countries in Asia need relying on the limited natural resources to eliminate poverty and improve living standards. The challenges above-mentioned are constrained by factors at both the domestic level and the sub-regional level.

3.2.1 Natural resources dependence

Many countries in Asia depended on natural resources and were very sensitive to international price fluctuations and economic shocks, the performance of which is the state of flux in domestic economic growth, employment, social stability and the environment. One of obvious examples was the oil prices decline of 1980s in 20th century, resulting in more than 10 years of macroeconomic instability, increased debt, higher unemployment and serious difficulties solvency in West Asia. From 2002, with the sharp rise in oil prices, the economies of Gulf countries have grown up again, a large number of international capital inflow and investment increased.

The high development speed, the population density and the resource consumption proportion growth speed of Asia, especially of East Asia, South Asia and Southeast Asia, with highlighted resource and environmental problems, are causing threats to and hindering sustainable development in Asia. Excessively rapid increase of the economic development of resources and environmental damage, such as land resources, water resource, mineral resources, forest resources, biological resources are in the development of predatory and destruction, coming up with tropical rain forest reduction, soil erosion, land desertification land water and marine pollution.

3.2.2 Financial and technical resources

West Asian countries have taken domestic action plans in response to the desertification, clearly defines various measures of mitigation of land degradation and protection of threatened areas(ACSAD et al., 2004), which have been completed by Jordan, Lebanon, Oman, Syria and Yemen, and are also being implemented by other countries. West Asian countries have also joined the international protection of biodiversity, and most countries have ratified the convention on biological diversity and biological security provisions, joined the international agreements on Food and Agriculture on Plant Genetic Resources by UN Food and Agriculture Organization. In West Asia, land degradation and poverty are often intertwined, but the intrinsic link between the two was often overlooked. Despite the efforts of governments to prevent and reduce the land degradation on domestic level and regional level, the effect is limited, more extensive international cooperation and public participation is in urgent need. So far, the successful practices of the improvement of degraded land included the introduction of water-saving irrigation and agricultural technology, improvement of degraded mountain areas and increase of the protection area. However, these schemes covered only 2.8% and 13.6% of degraded land in Arabian Peninsula and Mashriq region respectively. The size of protected areas in West Asia got a relatively large increase in 1990-1995 but has remained the same from then on(ACSAD et al., 2004).

The major constraints on sustainable development of forest in West Asia are: weak management system, lax enforcement, unclear land ownership, and restriction of climate and water resource, inadequate technical personnel and agricultural extension services, limited financial resources, lack of a clear policy of forest management. In recent years, the West Asian countries began to realize the ecological significance of the forest and started to protect forest ecosystems and biological diversity, improve forest reserves and develop eco-tourism. Syria, Jordan and Iraq stored a lot of water to provide new living environment for the habitat of species and alien species, especially birds. The Eden Again Project was implemented in Iraq in 2004, effectively restored Mesopotamian marshes (Charkasi, 2000; ICARDA, 2000; Iraq Ministry of Environment, 2004; UNEP / PCAU, 2004); the protection of local wheat varieties in Jordan and Syria also made important achievements(Charkasi, 2000; ICARDA, 2000; Iraq Ministry of Environment, 2004; UNEP /PCAU, 2004). At present, the West Asian countries are in the process of amending the development of domestic forest law and forest management policies and strategies. These policies and strategies have emphasized on combining the domestic plans as protecting biological diversity, combating desertification and eradicating rural poverty, to ensure that forest land can get long-term conservation and sustainable utilization. This requires clear socio-economic valuation of forest and woodland and the provision of environmental services, setting evaluation indicators goals for certain goals and progress, periodic revision of forest laws and regulations, institutional capacity-building to ensure the effective participation of local communities.

Asia's coastal zone and marine resource management is also facing severe challenges. Coastal and marine areas in West Asia have been threatened by the rapid development of construction of coastal residential, leisure and entertainment projects, and by the coastal land reclamation, oil pollution and harmful chemicals, as well as the impact of over-fishing. In some cities, a large number of lands are excavated by the construction of urban development and transport, resulting in lots of shoreline changes. In the early 1990s, 40% of the coastlines in the Gulf countries were developed (Price and Robinson, 1993). Bahrain coastal areas (ROPME, 2004) increased the land area by about 40 km^2 in less than 20 years. Since 2001, about 100 million m^3 of rock and sand were used for the coastal areas development of the Dubai Palm Island construction in United Arab Emirates (ESA, 2004), increased the coastline up to 120 km^2. Saudi Arabia's Jubail Industrial City consumed 200 million m^3 of excavated sediments (IUCN, 1987), embankment connecting Bahrain and Saudi Arabia spent 60 million m^3 of sand (UNEP, 2007a). In addition, there are a large number of industrial and agricultural waste and household waste discharged into the marine environment. Desalination plants discharge wastewater containing bromines, chromium as well as bacterial and viral pathogenic micro-organisms directly into the oceans. Countries along the Mediterranean frequently spill oil, a large number of the tanker through the Strait of Hormuz Coastal refineries every year, and there are refineries and petrochemical processing enterprises, which pose a serious threat to the marine water resource and water environment. War and military conflicts in some areas can also lead to oil spills and chemical pollution.

Coastal development also poses a greater threat to fishery resources. Many countries in Asia continued to decline in the amount of fishing, which has affected the regional food security, especially marine pollutants, high temperature and pathogens led a large number of fish deaths occurred from time to time. Although the Asian countries in the management of fisheries resources have corresponding laws and regulations, most are in inadequate implementation.

In recent years, many countries in Asia took the implementation of environmental impact assessment, integrated coastal zone development plan, signed regional and international marine conservation agreements before the coastal development, a variety of protective measures and regional plans being implemented. In the recent 5 years, in the Red Sea, a lot of projects have been taken to protect mangroves (PERSGA, 2004), as well as habitats and biodiversity. In Yemen, a regional environmental information center was established. In 1986, Saudi Arabia, Bahrain and the United Arab Emirates launched cooperation to investigation of the manatee globally threatened (Preen, 1989; ERWDA, 2003).

3.2.3 Public awareness

Lack of public awareness of sustainable resources utilization made human activities imposing a heavy burden on the environment. Extensive utilization of natural resources brought about resource pollution depletion or quality decline in many Asian countries. In the large-scale industrialization and urbanization process, the inefficient utilization of resources, serious pollution caused by a large number of coal-fired power plants, over-exploitation of agriculture and forest resources, and pasture grazing and policy failure in land utilization have caused serious degradation of local land.

To raise public awareness of resources anxiety is an important prerequisite to achieve sustainable resources utilization in Asia. Therefore, public awareness of the sustained resources must be connected with the practical activities closely.

3.2.4 Resource capacity and utilization cooperation initiatives

The supply-oriented water management approach has not brought about positive sustainable development of water resource or security. In recent years, many countries in West Asia turned to a more integrated water resource management and protection. Policy reforms of water sector focused on decentralization, privatization, demand management, water conservation and improvement of economic efficiency, strengthening its legislative and institution-building and fair participation (UNESCWA, 2005). A small number of countries also led these strategies into the framework of domestic socio-economic development, but still lacked of institutional capacity. To achieve the sustainable management of water resource, population policy and agricultural policy must be strengthened. The greatest challenge facing water resource in West Asia is the lack of sharing of water resource management in a number of West Asian countries where the development of surface water and groundwater going ahead, together with a shortage of funds in agriculture countries.

4 Successful Case Studies

4.1 Demand side management of water resource

In recent years, demand side management of water resource is a kind of international advanced management concepts and models of water resource gradually emerging. This management of water resource aimed at curbing water conflicts, ecosystem destruction and attenuation capacity of the water environment caused by the growth of demand for water resource, promoting fair and reasonable allocation and efficient sustainable utilization of water resource, the integrated systematical acting on comprehensive utilization of legal, administrative, economic, science and technology, publicity which carried out a series of measures related to the three major groups of water administrators, water consumers and water operators. The first country requesting for analysis of water demand, strengthening management is the State of Israel in the Middle East (Tao and Fang, 2006). Now we take Israel and China as the cases of demand side management of water resource.

Israel is a semi-arid country founded in 1948 with a population of 650,000, GDP of $ 300 per capita, and annual consumption per capita of water close to 300m^3. In 2003, population of Israel rose to 6.8 million and GDP per capita rose to $ 15,000. Despite the significant improvement of income per capita, the average annual water consumption per capita remained at about 300 m^3 (Arlosoroff, 2004).

Israel began to implement demand side management at the core of water conservation from the second half of the 20th century. To sum up, Israel achieves domestic water demand management goals mainly through the tools of the following eight aspects:

- laws, pricing and economic policies
- reutilization of sewage and wastewater
- protection of water resource and enhancing utilization efficiency

- allocation of water resource between agriculture and industrial production
- urban water measure, replacement of old pipes, electronic monitoring, as well as reform of water facilities
- virtual water policy
- internal and external water market
- seawater desalination

In the international tenders in 2001 and 2002, Israel ROSWDP cost significant declined, as the result of long-term in-depth study on the transformation of water. This decision also included a comprehensive domestic sewage treatment and wastewater recycling systems (tertiary and secondary waste water or sewage treatment), and efficient distribution market of fresh water. Although Israel's population and standard of living had been improved, the policy and investment would ensure the country's sustained socio-economic growth; In addition, the open water solution was also conducive to resolve the conflicts between Israel and its neighbors.

The first region implementing the demand side management of water resource in China is Shanxi Province, where is an important energy and heavy chemical industry base in China with the relative scarcity of water resource. From 1980s, Shanxi Province has strengthened the demand side management of water resource, and taken the lead in the establishment of provincial and municipal committees of water resource management, formulating laws and regulations, accumulating experience in water management. Demand side management model of water resource in Shanxi Province optimized water resource configuration among the various departments in Shanxi Province, enhancing the utilization efficiency of water resource in Shanxi Province, making tremendous contributions to support sustainable socio-economic development in Shanxi Province.

4.2 Arid desert strategies

In recent years, Chinese scholars proposed the "three-circle" eco-production paradigm against desertification in Northwest China, where was seriously affected by desertification, and it was not only the new structure of optimization-arid ecosystems and reconstruction, but also typical pattern of arid desert land layer utilization.

"Three-circle" eco-production paradigm is based on the mechanism of the spatial pattern of arid zone ecosystems and landscape and distribution and flow of trends of ecology and environmental factors, optimizing the eco-management and eco-design as eco-production paradigm. Although it is derived from the Ordos Plateau Maowusu Sandland, on the whole, it follows the law of the layer structure of geographical zone in arid areas (Zhang, 1992), follows the ecological planning rule of taking "water" as the core and based on the bio-climatic conditions, follows the principle of rich biological diversity giving priority to shrubs, and follows the configuration of shelterbelt system and semi-fixed sandy land as well as comprehensive management (Ci, 2005).

According to the macro scale and function, the "three-circle" paradigm could be divided into the "big three-circle" and the "small three-circle" in the spatial scale. "Big three-circle" controls intercontinental expansion scope of desertification and dust storms spread while "small three-circle" controls the activities of the regional wind, dust storms and sand hazards from the spot. "Big three-circle" is a large-scale protective circle of desertification, solving desertification, dust storms and eco-production and construction in domestic macro-pattern from the national scale, mainly consists of desert, grassland and agro-pastoral transitional zone. The "small three-circle" is the design pattern that control regional desertification and sustainable development of agriculture and animal husbandry. The "small three-circle" resides in the "big three-circle". The desertification control and ecological construction of a geographical unit, watershed or oasis can be based on different geographical areas and protection objectives to build the "mini three-circle" (Ci et al., 2007).

Natural landscape structure and complex system of integrated forestry, animal husbandry and the pattern of ground water in Ordos Sandland, due to geological features and the distribution of the configuration, shows the pattern of circle layers, which is the most prominent and essential characteristics of Sandland(Zhang, 1994). The structure of Ordos "three-circle" paradigm is agro-forestry, animal husbandry (grass) system under the protection of the first lap belt, with the soft beam and low dune as the second circle, in which high-quality high-yield agriculture, forestry, grass circle layers with oasis beaches (third circle) as the cores take shape, distributed in an orderly manner in arid, semi-arid ecosystems background, roughly in the ratio 3:6:1(Figure 4.1).

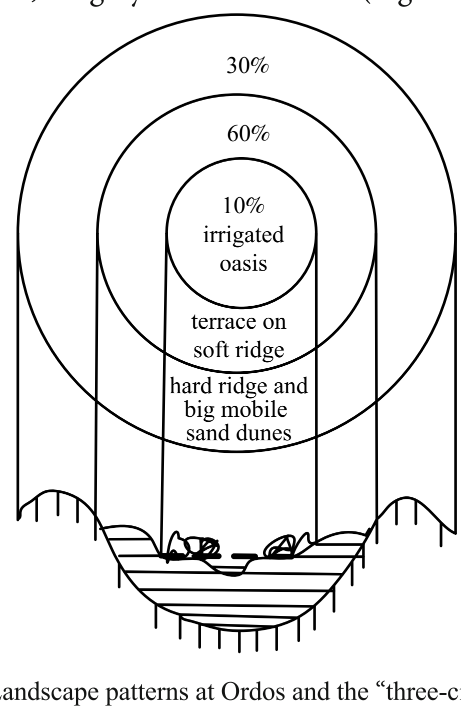


Figure 4.1 Landscape patterns at Ordos and the "three-circle" paradigm
Source: Ci et al. (2007)

The first lap is hard beam and large group of mobile sand dune, to restore and conserve natural shrub (or grassland), forming a protection zone and water source, located in the outer circle of sand, accounted for about 30% of the total area. The second circle is non-irrigated or semi-artificial “fruit shrub-grass” circle, located in the soft beam platform and low sand belt surrounding oasis beach, accounted for about 60% of the total area, with various geomorphology and landscape types, but lack of irrigation facilities currently and not suitable to carry out high-intensity agricultural development, and should be protected by wind and sand control, soil and water conservation, taking moderate artificial grass, feeding livestock and garden industry, as the direction of development. The third circle is high-yield agriculture and animal husbandry for inner circle oasis. Oasis beach accounted only 10% of the area, but with the advantages such as relative labor concentration, transportation and power convenience, so high-input and high-yield comprehensive sideline including agro forestry, animal husbandry and industry can be taken, with the integrated management and utilization of modern technology: shelf temperature, plastic, organic manure and chemical fertilizer efficiency, solar energy, wind power generation.

The establishment of the “three-circle” paradigm in China’s Ordos Sandland formed a circle of protective layers of tight security of production systems, effectively controlled desertification and erosion rate, improved small climate, played an important role in economic development and improvement of people’s living standards in Ordos. The “three-circle” paradigm is the correct understanding of human the law of natural, environmental and ecosystem structure, is also an effective way to scientific rehabilitation, reconstruction of ecological environment in arid areas, promoting the harmonious development of human society and natural environment.

4.3 Three-dimensional development model of agriculture, forestry and fishery

Mulberry-embankment fishpond in southern China is a typical three-dimensional development model of agriculture, forestry, fishery resources, its structure and function fully reflected edge effects of water-land interaction on freshwater ecosystems and terrestrial ecosystems (Zhong, 1993).

“Mulberry-embankment fishpond” system formed in Taihu Lake basin in the 9th century, rapid developed in the 14th century, typical distributed in Linghu Huzhou of Zhejiang Province, Dongshan Wuxian of Jiangsu Province, followed by Deqing, Changxing, Tongxiang, Wuxi, Wujiang and so on, into the boom at the late Ming Dynasty in the Pearl River Delta region, Guangdong Province, as the result of increasingly acute contradiction of more people on less land in the region. On the one hand, the model can absorb more labor, create more economic benefits; on the other hand, it can maintain strong anti-disaster abilities and efficient production systems. In addition, in forest and agricultural relations, it paid attention to water forests in water conservation, and solid the role of agro-ecosystem (Luo and Shu, 1995). Eventually, it went beyond other traditional forms of agricultural production, became an ideal three-dimensional integrated development model of agriculture, forestry, fishery resources.

Mulberry-embankment fishpond is constitutive of two parts, base and pond, the base surface is the terrestrial ecosystems, with the primary productivity of crops, and fish pond is freshwater ecosystem, with both primary productivity (phytoplankton) and secondary production (fish). Mulberry lived on base, silkworm ate mulberry leaves, and fish ate silkworm excrement and the pond scum fertilized mulberry. By the material circulation and energy flow in the mulberry leaves, silkworm excrement, the pond scum integrated agro-ecosystems, mulberry-embankment fishpond system was founded, which constitute a artificial ecosystem of land and water resource, consisted of terrestrial ecosystems in mulberry embankment with sericulture of and the aquatic ecosystems in fishponds, by interactions with suitable agriculture, fisheries, animal husbandry for different biological growth and development of multi-level ecological space(Chen et al., 1995).

At present, mulberry-embankment fishpond is in continuous improvement and development on the original basis. The silkworm excrement, human and animal feces are put into biogas digesters to produce gas as a fuel, and then the biogas is used to feed the fish, thus the traditional agricultural structure of “mulberry-silkworm-fish” is transformed into the new agricultural structure of “mulberry-silkworm-gas-fish”. In addition to planting mulberry, feeding silkworm and fish, part of the fishpond surface is used to crop floating lotus as pig feed, pig manure fertilizers mulberry, which improves the production of mulberry-embankment fishpond. At the same time, mulberry-embankment fishponds are transformed into sugarcane-based fishponds, fruit-based fishponds, grass-based fishponds, flower-based fishponds and other miscellaneous based fishponds, which interrupted past simple small circle in mulberry-silkworm-fish and built a new larger and more complex circle.

4.4 Comprehensive recycling techniques for mineral resources

A key feature of China’s mineral resources is many symbiotic mines and less single mines. For example, more than 85% of non-ferrous metal ores are comprehensive, total and associated with the total iron ore reserves is about 31%. More than 50 years, with China’s large-scale mineral resources exploration and development, some achievements have been made in comprehensive utilization of mineral resources, especially in significantly comprehensive utilization of three symbiotic deposits in Baiyun’ebo, Dexing and Panzhihua.

Baiyun'ebo Mines is world-renowned super-sized titanium, rare earth, niobium-based multi-component multi-metal symbiosis deposit. Beneficiation tailings contained many useful components, including (iron content 16%-18%), rare earth, niobium, thorium, scandium, apatite, barite, fluorite and other components. In recent years, Baotou Iron and Steel Company put forward a series of research work on comprehensive utilization of tailings, and achieved encouraging results. In 1998, Baotou Iron and Steel Company used the flotation concentrator tailings (magnetic iron content 16.7%) for the recycling of magnetic iron, got ore 36,000 tons at the total iron grade of 62.38%, the total iron recovery increased 0.75 %, and the annual profit arrived at 1.52 million. In 2001, Baotou Iron and Steel Company carried out research on rare earth oxide recovery experiments in weak magnetic mines and magnetic mines tailings, accessed to rare earth concentrate with rare earth oxide grade of 50.32%. The experiments recovering iron, niobium and other useful components from magnetic separation tailings had also been streaming the preliminary results. In addition, barite, fluorite, rare earth oxides also can be recovered from the oxidation of magnetic series tailings. Now, the recovery research of scandium from rare-earth mineral processing is embarked on.

Baiyun'ebo iron ore containing rare-earth effectively recovered iron ore concentrate and some rare earth concentrate by magnetic separation-flotation-high intensity magnetic separation. Baotou Steel Company has become the world's largest base of rare earth raw materials, but the overall level and efficiency of utilization is still low. At present, only iron and a small amount of rare-earth are in the real utilization, even if the reserves ranked second in the world has not been got recycling. The comprehensive utilization of vanadium and titanium resources in Panzhihua Vanadium-titanium Magnetite Mines has made our country from importing countries of vanadium into the world's fourth largest vanadium-producing country. However, due to resource characteristics, Panzhihua Iron and Steel Company has produced a large number of industrial waste emissions in resources dealing, and it is more difficult in secondary utilization. Jinchuan Copper-nickel Mines gained scientific and technological achievements after research for many years, got nickel, copper, diamond, sulfur, as well as gold, silver, platinum, harrow, osmium, iridium, nails, rhodium and other products by joint mineral separation-smelting innovation process, became an important production base of copper, nickel, diamond and precious metals, still facing the depleted resources, tailings resources utilization problems.

Dexing Copper Mines is the largest open copper mines in Asia, the largest copper mines in China, and the second-largest copper mines in Asia, characterized by large and concentrated mineral reserves, buried shallow, small-stripping ratio, ore optional, and comprehensive utilization of multi-elements. The comprehensive utilization of recovery of the associated valuable elements in Dexing copper has undergone three stages: the first phase was prior to 1978, by primary grinding, one time of roughing, one time of scavenging and two times of cleaning, single dissociation degree of useful minerals is only about 48%, recovery utilization of copper and the associated valuable elements are low efficient, recovery of the associated valuable elements are all by-products. The second stage was during the "Sixth Five-Year Plan", countries scientific and technological research projects 24-5-5 special "research on large-scale copper mines in Dexing Plant enhancing economic efficiency" provided technical conditions for comprehensive recovery of the associated valuable elements. "Duplicate improvements" process, grinding crude-rough concentrate-reelection of the separation technology of copper-sulfur minerals succeeded, and was applied in the first expansion, second and third phases of construction. The third stage was "Seventh Five-Year Plan", in order to adapt to the expansion of production scale and further improve the indicators of the need for sorting, and constantly explore ways of making recovery rate of the associated valuable elements steadily increased, to reach the international advanced level of similar mines, there were internal restructuring carried on production process in 1999-2003. Structural adjustment of selective grinding was carried out in 1999. New technology of selective grinding was selecting tailings to return to re-grinding, thus two operations, grinding and flotation, constituted a floating mineral grinding cycle, in continuously progressive cycle of grinding useful minerals, achieving best fossil monomer dissociation degree by grinding some aggregate mineral, fossil monomer dissociation degree got 96.19%, with further recovery of associated valuable elements. In order to enhance the concentration of valuable elements in the copper concentrate, the process structure has been adjusted in 2001-2003 by the utilization of existing equipment, from twice to three times in select sorting. At present, the Dexing Copper Mines has reached an annual output of copper 116,000 t, gold 5.3 t, Ag 21.5 t, equivalent to the amount of sulfur concentrate 120,000 t, molybdenum 2000 t (of which containing 45% of molybdenum metals and 600-700g / t of rhenium metal).

Panzhihua Vanadium-titanium Magnetite Mines is the second-largest iron ore base in our country, second only to Anshan-Benxi region, and nearly 100 million ton of tailings accumulated in the tailings dam currently. By technical research, Panzhihua Iron recovered vanadium, titanium, cobalt, scandium and other rare metals from the tailings. The value of iron ore accounted for only 38.6% of total value, but vanadium pentoxide, sulfur cobalt ore, titanium ore, scandium oxide integrated from the tailings recovery accounted for more than 60% of total value.

4.5 Quantitative conservation strategy of biological resources

In 1997, Japan carried out the Total Allowable Catch (TAC) system, which played a significant role in the maintenance of sustainable use of marine fishery resources. There were 7 fisheries of Japan regulated by the TAC system. The "Fisheries Act" and "Law on the protection of fisheries resources" were also developed to match the regulations. In addition, Japan fishermen have also taken various measures to join in the voluntary management of resources, greatly enhancing the awareness of sustainable utilization of Japan fisheries resources.

Quantitative utilization of biological resources is to clarify the utilization limit of biological resources in a certain period of time in a particular region and give efficient allocation, the more typical of which is Japan's total allowable catch mode in fisheries resources management.

In fact, Japan's total allowable catch in the fisheries resources management is based on the "resource-based fisheries management awareness". As early as in the 1970s, Japan has put forward the concept of "resources-based fisheries management". In 1983, the Japan Senate Agricultural and Fisheries Committee unanimously adopted "Resolution on the establishment of fisheries resources management-type". Since then, the fishery production began the qualitative changes from the past hunting-type or agricultural-type to the objective of sustainable resources utilization.

Total Allowable Catch is defined as the administrative decision to catch the ceiling of total allowable fishery catch due to social situation and economic conditions. Avoiding over-fishing, protecting biological resources and sustainable resources utilization is the core of TAC in Japan. According to United Nations Law of the Sea, Japanese established Exclusive Economic Zone and implemented the management of TAC (Figure 4.2).

As early as in the research-meeting on the Law of the Sea held in 1995, the Japanese established the following three criteria as a set of species TAC selection criteria: ① large catch and high economic value; ② varieties that fisheries resources management must be implemented immediately; ③ varieties that Japan's neighboring countries are also fishing. In 1997, six kinds of objects were set up for the TAC, that is, narrow blue whiting, horse mackerel, Pacific saury, sardine fish, mackerel, and snow crab. In 1998, sword tip squid loligo edulisin was added, so there are seven kinds in total. Fishermen took their respective fisheries by Olympic competition way (the quicker, the better) and must report to government about the catch, the government would disclose the actual catch, when the catch is likely to exceed the quota, the immediate guidance, recommendations or advice should be given, who fishes in violation of the provisions would be punished by 3 years penal service or fined by less than U.S$ 2 million.

However, fisheries management by TAC alone is not enough, in order to ensure compliance, avoid over-fishing competition, implement effective TAC management, self-management of fishermen by the conclusion of the agreement is necessary. It is clear that the agreement enacted in accordance with TAC in the TAC system has played a very significant role. The specific content of the agreement are:

(1) The measures on resource protection and management by restrictions of body length;

(2) Must report the catch of each other for rational management of quotas;

(3) The quota in each region in every period must be allocated;

(4) Operating ships and operating time must be limited during the fishery concentration period;

(5) Each fisherman's catch quotas must be carried out.

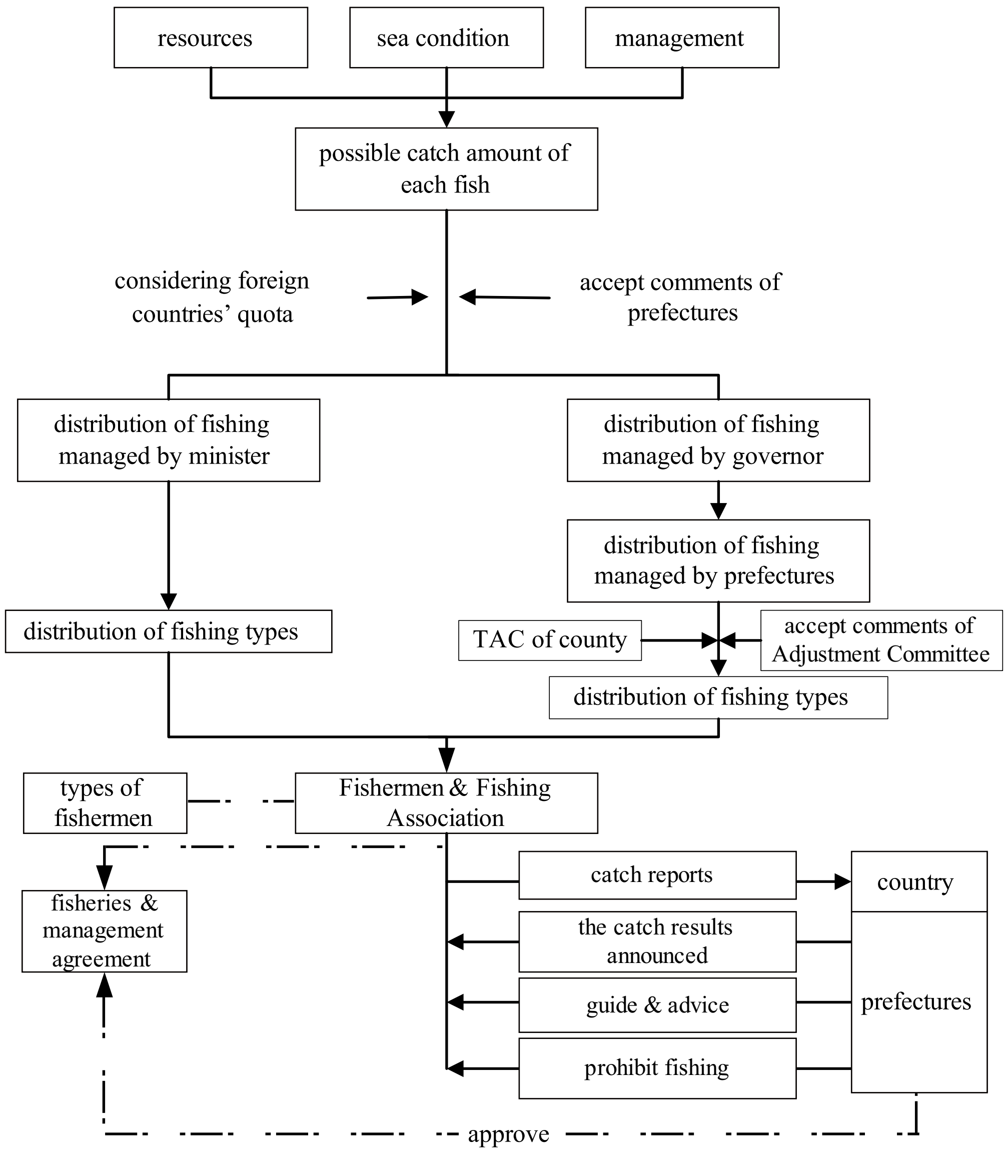


Figure 4.2 The distribution of TAC
Source: Based on Huang (2001)

Recently, all types of fisheries agreements are signed, except for small-scale tuna squid fishing industry.

From the implementing results of TAC, in 1997 fishery catch of TAC objects, the domestic mackerel catches was more than the allowable fishery catch, of which the amount was up to 104% while the actual catch of sardines were only 37% of the volume as a result of resource reduced, the others were all in the amount of allowable catch limits. In 1998, in accordance with the agreement of large and medium-sized purse seine fishery, fishing periods were divided into three stages to adjust the catch. The actual catch of 7 types of fish in 1998 was in the scope of the TAC.

5 Policy Recommendations

5.1 Regional policies

There are economic systems at different levels, of different types, and in different stages of development of countries and regions in Asia, with the characteristic of internal vertical and horizontal in mutual interaction and penetration. Therefore, there are associated interaction, complement and gradient development relationships between resources utilization and economic development in Asian countries, which is intrinsic motivation to promote sustainable development in Asia. To this end, Asian countries can make utilization of the complementary strengths in geographic, market, financial area for the establishment of mutually beneficial cooperation in regional resources development and security system.

For sustainable management of freshwater resource, cross-boundary water resource management plan should be vigorously developed and implemented. To solve the water shortage and water quality deterioration, it is also necessary to promote the cleaner production in industrial and service sectors. For the development and management of marine resources, coastal countries in Asia must be consistent with FAO and other regional or international organizations.

In order to deal with land degradation and desertification problems, Asian countries must join together to carry out monitoring and evaluation of the situation, to investigate its root causes, to manage land use reasonably, and to guide people to the sustainable use of land and forest resources. In order to enable domestic and sub-regional efforts to be effective, a variety of information resources must be effectively shared.

In order to solve the deforestation problem, Asian countries must resolutely implement the actions initiated by the UN, implement some of the principles and indicators (such as the Montreal Process), to achieve sustainable management of forest resources. Illegal logging is an international problem. In the

"Enforcement and management of forest law: the East Asian Council of Ministers" held in September 2001, the Ministerial Declaration agreed to require all importing and exporting countries should take action to resolve illegal logging by bilateral, regional and multilateral cooperation.

5.2 Technology sharing initiatives

There are significant differences in the level of resources development and utilization in intra-countries and regions in Asia due to the differences in their geographical and regional environment, economic development and comprehensive domestic strength heterogeneity, etc, of which the specific performances are: shortages of fresh water and agricultural water, local drought in some countries or regions in Asia; land utilization and cover change, with over-development of coastal land and expansion of urban construction land; lack of mineral resources exploration, frequent mining accident, heavy metal pollution such as mercury and arsenic, conflicts between mining and community; rapid loss of marine resources and over-exploitation of marine resources.

It is the inevitable choice for Asia's countries and regions to construct the technology-sharing platform for resources development and utilization, continuously improve economic and legal policy of technology transfer in the resources development and utilization in Asia, reduce the gap of resources development and utilization, enhance the efficiency of resources development and utilization in Asia as a whole, and promote sustainable resources development in Asia.

Construction of the technology-sharing platform. First of all, co-funded by Asian countries or regions, the information sharing website in Asian resource utilization and development is to be created, experts and scholars from research institutes in the field as the major body, providing the technical and management practices of new effective resource development and utilization to Asian countries or regions. Second, the transferring and promotion organizations in technology of resources development and utilization is to be created, with the establishment of offices in research and technology applications and intermediary structures in education and training, information services, to accelerate the sharing of technology in resources development and utilization. Third, wide academic exchanges in resources development and utilization between countries and regions in Asia is to be encouraged, which is conducive to the spread of the latest research results of the resources development and utilization.

Improvement of the technology transfer policy: the intellectual property law of resources development and utilization in Asia is to be improved, which can effectively stimulate the creation and invention of the technology in resources development and utilization; at the same time, the clear property rights help to promote the technology transfer in resources development and utilization, and the rapid and orderly development of technology transfer market.

5.3 Cross-border cooperation

Asian resource distribution shows the characteristics of relative concentration. Resources are often concentrated in a particular area to form a world-class mining and mineral deposits, such as Erdenet copper-molybdenum mines in Mongolia, bauxite mines in Danong areas of Vietnam, Baladila iron ore in India, Muruntau gold mines in Uzbekistan and Baiyun'ebo rare earth mines in Inner Mongolia of China. These large and super-large mineral deposits are of great significance in Asia and the world. This uneven distribution of resources led to the cross-border resources utilization in Asian countries, in order to achieve the complementary resources of the Asian region.

Asia is rich in resources with large potential exploration, but its cost-effectiveness has not yet been brought into full play. Asia accounted for 29.4% of the world's land area, but only attracted only about 10% of the world's investment in non-fuel solid mineral exploration (Shi and Li, 2006). To solve the issue of sustainable development, Asian countries improved their investment environment and increased cross-border investment of resources cross-border utilization, which brought the steady increase in resources reserves in Asia. In recent years, the exploration and investment in resources development has been steady growth in Asia, ensuring the sound development of resource industries.

Asian countries strongly encouraged resource development "going out" strategy to make up for the shortage of domestic resources, that is, to establish financial, taxation and fiscal policy serving the characteristics of the resource development "going out"; to improve overseas pre-geological survey and exploration mechanism reducing risk of resource development "going out"; to design investment, taxation and progressive export-import policy for resource development "going out" strategy; to provide a sound service system to cross-border utilization of resources.

High-tech applied to resource development is currently a trend in Asian resources utilization. Cross-border resources utilization brought resources development to a new era, which was conducive to the extensive application of high-tech. To address the issue of sustainable resources utilization, new technologies should be researched and developed continuously in resources exploration, mining, beneficiation and smelting, through technical innovation, achieve efficient resources utilization. In resource exploration stage, technology should be made full use of, and in resource exploration development stage, industrial structure should be actively adjusted, development and utilization of resources should be promoted in quality and efficiency, the introduction of high-tech modern equipment would significantly increase resource extraction, recovery and comprehensive utilization, reducing the grade of usable resources and improving resources utilization.

As the accelerating process of economic globalization in resource development, cooperation of resources development in Asia is greatly enhanced. The current cooperation between the countries and organizations has been gradually matured, and the cross-border resources investment environment improved significantly. Under the framework of free trade, mutually beneficial cooperation in resources field is an important way to a harmonious and stable external environment for economic development, which is beneficial for countries to establish a joint resources development platform, to achieve complementary of resources, capital and technological advantages in regional resources development, to promote regional resources trade, and to promote common development of Asian economies.

5.4 Technology and information sharing platforms

As the rapid development of Asian population and economies, accelerating consumption of natural resources, comparative advantages coming from the natural resources are gradually disappearing, and the bottleneck of natural resources becomes increasingly prominent. It is an issue of common concern that how to support high-speed development of countries and regions in Asia by increasingly scarce natural resources, how to reduce the gap in resources utilization between countries and save the consumption of natural resources for improving the efficiency of the utilization of natural resources, how to achieve sustainable natural resources management in Asia. The creation of technology and information-sharing platform and improvement science, technology and information-sharing mechanism is the prerequisite and basis for countries and regions in Asia to enhance the utilization efficiency of natural resources achieve sustainable natural resources development.

The creation of technology and information-sharing platform: on the one hand, to build a website on sustainable natural resources utilization in Asia, with the relevant research institutions as the major body, publishing the latest advanced technology and information about natural resources timely to various countries and regions in Asia; on the other hand, to establish the center for the sustainable natural resources utilization in Asia, with the countries and regions in Asia as the major body, defining the sustainable natural resources utilization of countries and regions in Asia through monitoring and evaluation of natural resources utilization, promoting the sustainable natural resources utilization, technology and information exchange and interaction of countries and regions in Asia.

Improvement of science, technology and information-sharing mechanisms: first, to strengthen protection of intellectual property rights, and to promote the healthy development of information and technology market; second, to smooth channels of technical assistance and service, to help countries and regions with lower efficiency of natural resources utilization play "late-development advantage", narrowing the gap.

5.5 Capacity-building strategies

In Asia, economic development and resource consumption kept growing, at the same time, more sustainable resources consumption patterns of the whole society and government should be promoted vigorously. In addition to the traditional measures solving the industrial pollution problem, Asian countries have promoted new policy of cleaner production, which aimed at reducing waste from the original source rather than the terminal in the production process, reducing pollution and environmental impacts. ECO-2 project of Rep. of Korea enhanced technology development, resource efficiency and environmental benefits. China strengthened the management of paper, pulp and steel production industries, set the standards, policies and regulations of cleaner production and carried out a large number of demonstration projects.

Many Asian countries have difficulties in the necessary investments in improving the efficiency of resources utilization and environment conditions. Some international cooperation projects focusing on financial assistance and technology transfer have been widely promoted in Asia, such as Japan's assistance to developing countries in Asia, which accounted for 30% of Japan's official aid. Nevertheless, in recent years, Japanese development investment on foreign aid has been in steady decline. Technology and investment is another constraint of Asian sustainable resources utilization. Recipient countries are relatively backward in the technical management, leading to more difficult technology transfer and cooperation. Strengthening capacity-building of Asian countries has been included in the "Agenda 21", but the capacity-building still need to be strengthened when governments and research institutions, enterprises and NGOs implement sustainable development projects, to ensure the technical cooperation meet the diverse needs and aspirations of local residents in future.

6 Project Proposals

6.1 Monitoring land degradation and desertification

Land degradation and desertification are important environmental problems in Asian countries and regions. Over the past 45 years, due to rapid urbanization and industrialization, large-scale deforestation and overgrazing, close to 20% of grassland and forest land in the Asia-Pacific region was affected by land degradation and desertification, which was more significant in Northeast Asia, especially Mongolia and China. In recent years, influence of frequent dust storms has spread to the Korean Peninsula and the Japanese Archipelago. A growing number of Asian countries have recognized the urgency and importance of combating desertification, actively accepted the United Nations Convention to Combat Desertification. In addition, some countries have begun to develop domestic action programs, such as China, Mongolia and so on. Therefore, accelerating technology development of monitoring and assessment of land degradation and desertification is both the premise and basis of scientific response to land degradation and desertification, and the inevitable choice of effective controlling land degradation and desertification.

The project aimed at monitoring and assessment of land degradation and desertification in Asia, thereby contributing to create a database and information exchange of land degradation and desertification in Asia (Kamiyamaguchi et al., 2001). Based on the monitoring and assessment strategies launched by China and Asia-Pacific region in 1999, the project is to build a network, including all countries and regions in Asia, to carry out integration and unified management of the relevant data and analysis method in land degradation and desertification, of capacity-building experience of countries and regions in Asia, of the research and utilization of new information technology and space technology. The project is to monitor and evaluate land degradation and desertification of countries and regions in Asia based on satellite data (MODIS Moderate Resolution Imagining Spectrometer). At the same time, a variety of international and local organizations would be involved in the evolution of land degradation and desertification trends, forecasting and creating the corresponding statistical data sets.

1) Targets

- to promote the implementation of the United Nations Convention to Combat Desertification (UNCCD) in Asian countries and regions
- to monitor and evaluate the land degradation and desertification of the countries and regions in Asia
- to provide technical assistance and advisory services for the action plans of all countries and regions in Asia combating land degradation and desertification
- to provide assistance to the capacity-building of land degradation and desertification monitoring and assessment for countries and regions in Asia, at the same time, to provide technical assistance in the creation of information exchange platform and database

2) Implementation

- to monitor and evaluate land degradation and desertification of other countries and regions in Asia
- to strengthen the implementation of the United Nations Convention to Combat Desertification (UNCCD) and its related theme in the countries and regions in Asia
- to improve the financing mechanisms and institutional building, and to promote the implementation of action programs combating land degradation and desertification of countries and regions in Asia
- to promote networking and information exchange on land degradation and desertification of countries and regions in Asia, and to establish collaborative mechanisms between the domestic and regional action programs

6.2 Increased development of small and medium-sized municipal wastewater treatment plants

In recent years, with the rapid growth of agricultural, industrial and domestic consumption demand for water, pressure on fresh water sources (including rivers, groundwater, lakes and reservoirs) has been increasing, with competition and conflict of water resource between the sectors escalating. Water shortages and deteriorating quality become the general trend of development in Asia at the present stage.

At present, countries and regions in Asia are faced with different water issues. China faces industrial wastewater, pollution of domestic sewage emission, drought and flooding problems caused by uneven distribution of water resource in the geographical space; acidification of lakes in Japan, as well as deterioration of water quality, poses a serious threat to aquatic organisms surviving; Mongolia limited water resource is often affected by the mining and long-term drought. How to increase access to clean fresh water is the severe challenge that Asian countries are facing.

1) Action program

Regional action programs of environmentally sustainable development was considered and adopted in the Ministerial Conference on Environment and Development of Asia-Pacific Region in 2000, determined the next course of action(Kamiyamaguchi et al., 2001):

- to introduce cleaner production and innovative technologies into the agricultural, industrial and other water sectors, to achieve economical utilization of water resource, at the same time, to promote utilization of treated waste water in industrial and other sectors
- to increase the sewage treatment, avoiding of any environmental pollution
- to introduce cost recovery mechanisms into enterprises concerned with sewage treatment and private sectors involved in their construction, operation and maintenance

2) Objectives

Based on the regional action program, to introduce cost recovery mechanisms into small- and medium-sized municipal wastewater treatment plant is proposed, together with sewage disposal system and recycling system, taking the key pilot cities in sub-region as targets, followed by a promotion.

Planning, monitoring and management activities:

- to determine the major sources of pollution in selected cities
- to designate municipal plans and guidelines or the major treatment of industrial wastewater pollution sources
- to formulate laws and regulations on the local water quality protection
- to explain the development mechanism of major pollution sources from the funds and facility operation
- to establish water pollution emission detection system according to the pollution sources
- to establish water quality monitoring database
- to manage and monitor capacity-building
- to determine the facilities required for technology development, to evaluate local capacity and to identify means of access to foreign technology

Infrastructure development program:

- to establish an environment-friendly city sewage system
- to establish municipal wastewater treatment plants in selected sites
- to establish industrial waste water recycling systems

Projects should be funded by joint venture of the local government, cooperative enterprises and international organizations. Specific planning, monitoring and management activities should be based on the situation of the selected city.

6.3 Sustainable tourism development and biodiversity conservation

1) Meaning of the project

Sustainable tourism resources development is important to promote sustainable utilization of tourism resources and reduce the negative impact of tourism resources development. Eco-tourism, as an important model of sustainable tourism resource development, can significantly promote biodiversity conservation and construction. In the biodiversity destruction and inadequate investment in biodiversity conservation, the steadily eco-tourism development would improve the situation. In this study, we believe that the steady development of eco-tourism is a good model and means for sustainable tourism resource development and biodiversity conservation building.

2) Principles of implementation

Based on ecological principles, with ecological environment-oriented and the natural environment-oriented, eco-tourism is a kind of marginal ecological engineering and tourism activities, both accessing to social and economic benefits, and promoting ecological and environmental protection(Liu et al., 2001). At present, the concept of ecotourism is accepted by policy-makers and managers, with eco-tourism rapidly developing. However, eco-tourism would have an impact on biological diversity without orderly planning and rational arrangement. For example, ① as a result of a large number of tourists, the breeding habits of animals and plants were destroyed; ② scenic tour route traffic brings habitat fragmentation, resulting in animal migration; ③ some scenic spots carry on hunting animals, picnic, barbecue buffet, as well as travel products such as animal and plant specimens, so that animals are hunted, vegetation cover are destructed; ④ some scenic spots create single animal sanctuary protected areas and sanctuary, leading to the development of the imbalance between species and the destruction of the original ecological balance(Xiao, 2008).

In order to effectively promote the sustainable tourism development and biodiversity conservation building, the following principles should be followed in the implementation of eco-tourism projects:

Priorities for biodiversity conservation building. The value of biological diversity has get deep understanding, conservation and building of biodiversity should be placed in the primary location. By China's practical experience, the establishment of nature reserves for biodiversity conservation is an effective way. Eco-tourism can be carried out within a specific area of natural reserves on the premise of biological diversity.

Appropriate and graduate development of tourism resources. Due to the vulnerability and non-renewable of biodiversity, moderate and steeply development should be focused on when promoting eco-tourism. Moderate development means better development conditions, which does not affect the regional development of biological diversity, and pays attention to the ecological environment protection in developing process. Steeply development is the process of gradual tourism resources development, improving the overall effectiveness of tourism resources by developing tourism resources step by step.

Win-win situation of economic benefit and ecological benefit. From many abroad successful examples, the economic benefits of eco-tourism is significant, putting tourism economic benefit into biodiversity conservation in some tourist areas can increase protection, which is so-called "those living on a mountain live off the mountain, those living near the water live off the water ". Obviously, only putting economic benefits gained from the tourism resources development into the conservation of biodiversity effectively can promote a win-win situation between the two.

3) Implementation of the program

In order to carry out eco-tourism steadily and promote sustainable tourism development and biodiversity conservation building, the following six steps should be carried out in the concrete implementation.

Survey of biological diversity. Familiar with the biological diversity of countries in the overall trend, a thorough investigation is to be carried out on biological diversity, to determine the areas with fragile biological diversity and severely destruction as well as the endangered species, and to delineate the scope of nature reserves.

Carrying out the feasibility evaluation of eco-tourism. According to the findings of biological diversity, by the evaluation method of tourism resources development, the feasibility evaluation of eco-tourism is conducted. Through the evaluation, the potential eco-tourism areas are determined, as a basis for further planning and construction.

Planning and construction of tourist areas. Before carrying out eco-tourism, tourism planning with multi-participation and inspection for the community impact is needed. And the planning need to take full account of tourism capacity and carrying capacity, strictly control the scope and tourism project. In building tourist spots, the damage of ecological environment should be minimized.

Dynamic environment monitoring of the tourist spots. By monitoring the quality of atmospheric environment, water environment, soil environment and noise, the number of visitors is reasonably adjusted in protected areas, to ensure the sustained and stable quality of the overall environment.

Follow-up evaluation of biological diversity. In view of the potential impact of eco-tourism on biological diversity, follow-up evaluation of biological diversity is needed, and the protection program of biological diversity is to be optimized. If the eco-tourism has a negative impact on biological diversity, tourism projects and spaces could be considered to reduce. If there is no significant effect, in accordance with the tourism market, tourism projects could be maintained and even expanded.

6.4 Recycling programs at small and medium-sized mines and further development of reclamation technology

In recent years, with rapid growth of mineral production and consumption in Asian countries, the mining waste and land occupied is very serious. Shortage of resources and land conflicts in mineral resources development is increasing; sustainable mining development has become an urgent problem in Asian mining.

At present, countries and regions in Asia are faced with different issues of mineral resources utilization and land reclamation. Asian countries are also actively seeking resources recycling of mines and land reclamation technology. China, India, Japan and Indonesia, on behalf of the mining countries in Asian region, have made many achievements and breakthroughs in mining development and governance.

In 2004, Guiyang Municipal Government implemented project named "Planning of Kaiyang chemical model base of phosphorus and coal with circular economy in Guiyang", to promote local economic development by leaps and bounds, in order to deepen the circular-economic eco-city building and promote the upgrade transformation of traditional industries as phosphorus and coal chemicals.

1) Meaning of the project

Taking full account of carrying capacity of the environment, resources and ecology, maintaining harmony development between man and nature, the project implement geological disasters repair of ecological environment damage and geological disasters caused by mining. It backfills by the utilization of mining waste and solid waste phosphogypsum, restores vegetation and land reclamation in the mining area, to avoid the rocky desertification and geological disasters. It carries out the resettlement of local residents in seriously damaged ecological environment, carries out technical training, to realize farmers out of poverty and urbanization, to strengthen ecological protection and construction, and to build heat, water, electricity, road transport and wastewater treatment infrastructure.

2) Facilities construction program

Base includes the construction of following four core industry as well as by-product system:

(1) Phosphorus chemical system. Based on high-quality phosphate, it includes two process lines as thermal-process phosphoric acid and wet-process phosphoric acid. Phosphoric acid process for the thermal route would focus on the development of fine phosphate and organic phosphorus products on the basis of the original yellow phosphorus production, fine phosphate would be refined from industrial grade, feed grade to the food-grade, pharmaceutical-grade and electronic grade; wet-process phosphoric acid process line would take 1.2 million tons ammonium phosphate as the initial goal, and compound fertilizers, efficient fertilizers, specialty fertilizers as the follow-up development goals.

(2) Coal chemical system. Qianxi anthracite chemical is high-quality chemical raw materials. Taken coal gasification as a starting point, co-production system can be developed with synthesis of many chemical products, so that coal chemical industry become new economic growth point of Kaiyang County. Recently, it is focusing on 400,000 tons/year of synthetic ammonia project, support for the ammonium phosphate production; in the long-term, it would expand the size of gas, with methanol (or dimethyl ether) as the major products. On the one hand, it can be used as clean fuels for direct sale; on the other hand, ethylene and propylene can be synthesized, laying the foundation of organic chemicals and chlor-alkali industry development. In addition, the synthesis gas can also supply for urban residents living as city gas.

(3) Chlor-alkali industry system. With the utilization of advanced technology of ion-exchange membrane caustic soda electrolysis, it takes caustic soda and chlorine as the major products in the near future, and focuses on PVC and organic chlorine in the long term.

(4) In the near future and long term, a power plant of 125,000 KW is built respectively, as development basis of energy security.

(5) By-product system. With the rapid development of the major products such as yellow phosphorus, phosphate, organic phosphorus, ammonium phosphate, and polyvinyl chloride and resources utilization of wastes such as phosphorus slag, gas, phosphogypsum, fly ash, the high-value by-product system is formatted.

3) Benefit analysis

The project has greatly improved the overall economic benefits of the base through the four industries such as phosphorus, coal, energy and chlor-alkali as well as an extension of industry chain, increase of value-added products, improvement of the resources utilization efficiency, product expansion. By 2008, the industrial output value of the base was RMB 6 billion Yuan; by 2020, the GDP would reach RMB13 billion Yuan. The base also put the ecological environment building in a prominent position. Through the construction of product chain and ecological chain, by-products and waste generated are in full utilization, reducing missions of phosphorous slag 1 million tons, phosphorus more than 3 million tons, fly ash about 0.3-0.5 million tons per year. At the same time, comprehensive management of geological disasters and land reclamation is also strengthened, good environmental benefits is achieved. Social benefits of the base would be very significant, providing 20,000 job opportunities for the local labor force. The construction of ecological social systems promotes phosphorus, coal chemical industry to upgrade and transform, achieves high-effective and sustainable resources utilization as well as steady economic development, greatly promote the building of cities and towns to promote circular mining economy. At the same time, the implementation of eco-social systems building project would have a positive role in adjusting the local industrial structure, increasing revenue, speeding up the construction of small towns, solving local "three rural issues". More importantly, it could effectively improve watershed ecological environment in the scope of the Three Gorges reservoir area, has a very positive meaning to protect the water environment in the Three Gorges reservoir area.

6.5 Local capacity-building of natural resources

1) Meaning of project

Public goods attributes of natural resources and the multi-sector and multi-character characteristics in the development and utilization make local capacity-building play a very important role in resources development and utilization. In fact, the direction, structure, scope, level and efficiency of the resources development and utilization can not be separated from the local capacity-building. From the practice of resources development and utilization in countries, to strengthen local capacity-building resources would not only be in favor of the effective development and efficient utilization of resources, but also avoid the resource curse phenomenon. To this end, this study takes local capacity-building of the resources development and utilization as major part of project proposals for sustainable resources utilization in Asia.

2) Principles of the implementation

Local capacity-building of resource development and utilization is related to a number of interest subjects, a number of sectors, as well as a number of directions. Obviously, the overall clear principles are very important for the formulation and implementation of project. From the successful experiences of countries, the following two points are essential.

(1) Overall advancement with clear focus. Local capacity-building should note the resources types and coordinate economic, social and environmental aspects. Therefore, the local capacity-building should be promoted as a whole in the resources development and utilization. At the same time, on the basis of the overall care, clear focus is needed. Especially for a certain period of time in a particular aspect, it should be trade-offs.

(2) Focusing on the long term situation while taking current situation into account. The resources development and utilization is a long-term process, so capacity-building should be strengthened from the perspective of sustainable development. Thus, in capacity-building of resource development and utiliza-

tion, we should focus on the long term situation and take current situation into account.

3) Implementation of the program

According to the current understanding of capacity-building, local capacity-building of resource development and utilization covers mainly four aspects (Table 6.1) including human capital, social capital, institutional capital and economic capital. Concrete implementation in all aspects is as follows.

Table 6.1 Framework for local capacity-building in resource management

Types of Capacity	Human Capital	Social Capital		System Capital	Economic Capital
		Cognitive (Social norms)	Structural (Network)		
building content	knowledge, skills, experience	trust and mutual values values, attitudes and behavior commitment motivation pursuit of status	network relationship	governance structure	infrastructure, financial resources

Source: according to Robins (2007)

(1) Human capital development projects. Human capital development projects mainly enhance the level of participants in resources development and utilization through the teaching of knowledge, skills and experience. Priority actions include: ① to carry out professional training in the resources development and utilization, especially the training of grass-roots participants, such as farmers, miners and so on; ② resource management for high-level talents. As to current overall low level of resource management, series projects of high-level resource management training may be established.

(2) Social capital development projects. Social capital can be divided into two parts, cognitive and structural. The development of cognitive social capital is mainly through changing and adjusting the concept of resources, correct mentality and behavior in resource development and utilization. The development of structural social capital is mainly improvement of related organizational networks. Priority actions include: ① to further implement the concept of resource sustainable development and utilization, and to enhance consciousness of conservation and sustainable resources utilization; ② to improve the communication network at all levels of resources development and utilization, so that the demands of different levels can be directly expressed and displayed smoothly.

(3) System capital development projects. The development of system capital is embodied in perfection of policies and regulations and optimization of institutional mechanisms. Priority actions: ① to establish a good policy environment for water resource sustainable development and utilization, to eliminate all implicated obstacles in the policies and regulations as soon as possible; ② to establish and improve good resource management institutions and systems, to

overcome the fragmentation of resources management as well as the situation of each shift; ③ to establish multi-format, multi-level monitoring mechanisms and oversight institutions, to explore and establish mechanisms for public participation.

(4) Economic capital development projects. The development of economic capital takes perfection of infrastructure investment and financial system as an important breakthrough. Priority actions: ① to further promote investment in infrastructure construction, to form a better infrastructure conditions and optimize the basic conditions for the resources development and utilization; ② to attract social funds to invest in the resources development and utilization through economic levers including investment, subsidies and prices, and to raise the level of the resources development and utilization.

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