

Principles and Measures of Watershed Management in China

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Abstract: China has only 7% of the world's arable land, but feeds 22% of the world population. The country ranks 88th in the world in per capita water availability, and an imbalance exists between population and availability of land and water. In order to protect, improve and rationally use the water, land and other natural resources, the Chinese Government pays great importance to integrated watershed management. This paper presents the concept, principles and measures of watershed management in China, as well as the achievements and experiences gained since the founding of the People's Republic of China. Watershed management policies are the basis of watershed management. Yet, the economic policies and laws and regulations of watershed management in China have major problems. Several effective counter-measures in watershed management have been discussed, including: (i) perfection of management systems of watershed; (ii) maintenance of long-term stability of various management systems; (iii) annual fund allocation by the central and local governments to support watershed management and make detailed financial support policies; and (iv) establishment of social service systems for watershed management.

Key words: Watershed management, soil and water conservation, watershed management policies, China.

Land and Water Resources in China

General situation

The total area of China is 9.6 million km², making up about 1/15th of the land area of the world. However, due to large population, per capita land area is only 0.8 ha, less than 1/3rd of per capita area of the world. At present China has 95.3 million ha of arable land, which is and the per capita arable land area is 0.087 ha only 1/4th of that in the world. China has 7% of arable land of the world, but feeds 22% of the world population.

A large population and small arable land constitute the basic problem. The salient features of China's land resources are as follows:

- Shortage of reserve resources of arable land: Out of 33.33 million ha of existing wasteland only 11.33 million ha can be reclaimed as arable land.
- A sharp decrease of arable land: Between 1957 and 1986 the total arable land in China decreased by 40.67 million ha, or an average annual decrease of 1.405 million ha.

The pollution of soil by industrial wastes and pesticides, deterioration of land quality, shortage of nutrients P and K, shallow soil depth and soil compaction are also adversely affecting land productivity.

China is rich in total amount of water resources, but poor in terms of per capita water availability. The amount of river water annually available in China is 2,711.5 billion

m³ ranking sixth in the world, but the annual per capita water resource is only 2,474 m³, which is 1/4 of the world annual per capita water resources (9360 m³), giving the country a rank of 88th in the world.

Water resources are unevenly distributed in the country, both in terms of area and season. In the south, the rainy season is longer, and the rainfall occurs from March to June. About 50 to 60% of the annual rainfall is received between April and July. In the north, the rainy season is shorter, and the rainfall from June to September accounts for about 60 to 70% of the annual total. Often it occurs in the form of rain storm, leading to flood and waterlogging. Drought occurs when rains are inadequate. Pollution of water further aggravates the shortage of water resources. According to statistics, 80% of the unprocessed waste water is drained directly into rivers, lakes, streams and reservoirs, polluting more than 1/3rd of river courses and other water resources from where water supply to some cities and towns threaten the people's health and normal life.

Damages of soil erosion

China is not only suffering from degradation of land and water resources, but is also suffering from soil erosion. According to a survey through remote sensing in 2000, the area degraded due to soil erosion in China was 3.56 million km², 37.1% of the total area of the country, of which, 1.65 million km² was eroded by water, and 1.91 million km² by wind. At least 5 billion tons of soil is lost annually by water erosion.

Soil erosion not only degrades land resources, but also the environment, deteriorates agricultural production and

causes ecological imbalance, adversely affecting national economy. The main consequences of soil erosion are as follows:

- Increased threat of flood, drought.
- Poorer land in sloping areas, that leads to low and unstable grain production, or even no harvest.
- Increased silt deposition in channels and ports, obstructing shipping and creating berth problems at the port.

Concept and Principles of Watershed Management

Concept of watershed management

Watershed management is also called integrated watershed management, mountain watershed management, upland watershed management and catchment management. The objective is to make the most of the ecological, economic and social benefits of water, land and other natural resources, taking watershed as a unit. It also calls to rationally categorize the lands for agriculture, forestry, animal husbandry, etc., and protect, improve and rationally utilize water and land resources by taking appropriate measures. Mountain watershed management is, the water and land conservation in mountain areas.

Principles of watershed management

During the periods of Seventh and Eighth Five Year Research Plans the state initiated the national project on "integrated watershed management" and summed up the following principles of watershed management.

Principle of ecological economics: Based on ecological economics, guided by the theory of economics, taking man's economic

activities and ecological environment, it deals with the ecological economic compound system formed by the interaction between ecological and economic systems, and with the ecological economic problems occurred in their movement of contradiction, and expounds the theoretical principle of the causes and resolution of ecological economy produced by them, thus revealing the objective law of ecological economic development. The analysis, assessment, adjustment and management of watershed as an open ecological economic system are the specific applications of ecological economics theory in watershed management.

Principle of system theory: This theory takes system and its mechanism as an object of study. It is the science dealing with the types, general character and movement laws of system. System theory provides theoretical basis of the knowledge of character and features of watershed ecological economic system to make scientific design, management, forecast and policy in the reformation and establishment of different watershed systems, according to people's needs.

Theory of great system control: This is a new branch of control theory, and deals with the common laws of methods of the process system control in different fields (biological ecology, social economy and engineering techniques). Based on the combination of system science (control theory, operational research, system engineering, etc.) and computer science (artificial intelligence, mould distinction, knowledge engineering, etc.) as well as their relevant subjects, the theory is formed into an interdisciplinary science, a study of the

method of analysis and synthesis and the control, management and decision-making of great system.

How to apply "great control system" to "man-watershed" ecological economic system is a new field to be developed. There are many subjects worthy to be studied in it, for example:

- "Controllable character" of "man-watershed" system: The application of the theory of "controllable character" to the study of "man-watershed" system contributes to the control and management measures for controlling water and soil losses and improving the environment, such as the number, rational distribution and conduct of the measures of water and soil conservation as well as the corresponding measures of techniques, economy, law, etc.
- "The most economic control" of "man-watershed" system: Under the conditions of ensuring improvement of environment and satisfying the requirements for the set quota of environmental quality, the application of "the most economic control" theory to "man-watershed" system contributes to designing the most economic anti-erosion control system so as to minimize the investment and run time expenses (such as consumption of energy and materials) for water and soil conservation; the greatest social and economic benefits and the best improvement of the welfare of people's living quality are obtained as a result of watershed control.
- "Observational character" of "man-watershed" system: The application of

“observational character” theory to “man-watershed” system contributes to determining the monitoring measures of environment for making comprehensive assessment of environmental quality, such as the number and rational distribution of the stations of environmental monitoring as well as the ability to handle monitoring data, etc.

- “The most economic observation” of “man-watershed” system: Under the conditions of satisfying the requirements of comprehensive assessment of environmental quality, the application of “the most economic observation” theory to “man-watershed” system contributes to designing the most economic environmental monitoring network so as to minimize the investment and run time expenses for monitoring equipment and the number of monitoring stations, and the greatest social and economic benefits are obtained as a result of the establishment of environmental monitoring network.
- “Stabilization” of “man-watershed” system: The application of “stabilization” theory to the analysis of “man-watershed” contributes to finding out the causes of vicious cycle and destruction of ecological balance, and seeking the conditions of favorable cycle and the rehabilitation of ecological balance.
- “Harmonization” of “man-watershed” system: The application of “harmonization” theory to “man-watershed” system contributes, on the basis of the partial-system improvement of the environment and ecological balance, to the realization of environmental

improvement and ecological balance of the whole system (regions, countries, global, etc.), and to the solution of the problem of comprehensive management of environment on the basis of the pollution control of atmosphere, water body, soil, crops, etc.

- “Intellectualization” of “man-watershed” system: “Man-watershed” system is an active system of intellectualization. The application of the control and management and decision-making of intellectual faculties in the theory of the “great system control”, and of the methods of analysis and design of the active system contributes to making the most of man’s intellectual faculties and initiative, effectively utilizing self-balance and self-purification ability of environment itself and economically realizing stabilization and harmonization of “man-watershed” system.

Principle of landscape ecology:

Landscape ecology takes the entire landscape as an object of study and pays special attention to the study of the heterogeneity of natural resources in the landscape. The word landscape implies the region with heterogeneity of space, appearing in repetition in the similar forms, and made up of interacting blocks ecological system. It is composed of ecological system of geomorphologic types. Its basic principle consists of structure and functions of landscape, biological diversity, species flow, re-distribution of nutrients, energy flow, changes and stability of landscape, etc.

The essence of watershed management is the preservation and sustainable management of landscape. Thorough analysis

of the space structure, functions, heterogeneity of watershed and changes occurring after watershed is disturbed has significance to the scientific management of watershed, and to the determination and assessment of the heterogeneity and quality of watershed ecological system.

Principles of sustainability: Sustainability has become the criterion of the exploitation and utilization of all natural resources as well as all the economic activities of mankind, and, of course, the criterion of the activities of watershed management.

To judge whether the activities of watershed management follow the criterion of sustainability or not, we suggest referring to some index system of sustainable watershed management.

Measures for Watershed Management

To attain the objective of sustainable development, a number of measures for comprehensive management of watershed must be adopted. Following are the the main components:

Land use planning for soil and water conservation in the watershed

On the basis of detailed survey of land resources, land types are classified. Local socio-economic conditions as well as the state policies are taken into consideration to rationally determine the land utilization pattern of each plot in the watershed. The proportion and specific position of land used for productive agriculture, forestry, animal husbandry and fishery, and the place and time (where and when) to carry out different measures of soil and water conservation are also considered. To improve the quality and efficiency of land utilization planning in

the watershed, the techniques of aerial and space remote sensing and geographic information system should be applied and the principle of ecological economics should be implemented.

Appraisal of soil erosion

In order to prevent and control soil erosion, it is necessary to assess the extent and nature of soil erosion of each plot in the watershed. In the zones of hilly slope, the intensity of erosion and the distribution and nature of mass wasting should be surveyed. In gully channels, the stage of gully development and the impacts of mountain torrents and debris flow should be surveyed. In the zones of alluvial cone, a hazard map of mountain torrents or debris flow and classes of danger should be drawn.

Conservation system integrating biological and engineering measures

Biological measures mainly refer to forest and grass planting and protection, while engineering measures are mainly carried out on slope (can be further divided into engineering for soil and water conservation on farmland, grassland, and forest land), gully channels, and zones of alluvial cone.

Measures of Supervision and Administration

In addition to the natural factors, human activities like indiscriminate cutting of forest, reclaiming wasteland on steep slopes and ignoring adoption of soil and water conservation measures during mining and road repairs, are also important factors contributing to serious soil erosion. In view of illegal activities leading to worsening of soil erosion and aggravating ecological

environment, the legal system of supervision and administration must be strengthened. People causing damage to soil and water resources must be punished according to the law.

Achievements of Watershed Management

Through efforts made since the middle of 1950's, China has achieved remarkable success in watershed management. Watershed management has played an important role in improving the basic conditions of agricultural production and farm yields, promoting the development of rural economy, accelerating the eradication of poverty and building up a fortune in poor mountain areas, and raising the living standard of the people. Watershed management reduces the sediment in the rivers, and protects the national territory and improves ecological environment. Over the past 50 years, soil erosion from over 780,000 km² area has been effectively controlled. On 40.0 million ha area forest trees and on 3.67 million ha area economic forest tree species were planted. About 3.4 million ha area was preserved by planting grasses, and on 11.9 million ha area crops were planted and soil and water conservation measures were taken. Over the past 50 years, a total of 35.5 billion tons of sediment have been blocked by dam, 1.56 million ha of land, soil have been sedimented and more than 63 billion yuan of output value have been accumulatively increased. The existing facilities of soil and water conservation can conserve over 18 billion m³ of water and prevent loss of over 1.1 billion tons of soil each year. Lots of counties, towns and villages have effectively controlled soil erosion, changed their

poverty status and led to remarkable ecological, social and economic benefits. Rich experience has been gained in mountain watershed management. The main terms are the following:

1. The government must pay great attention to the watershed management, and the decision makers of counties should earnestly practice what they advocate.
2. The importance of the watershed management must be well publicized and the awareness of watershed management among the broad cadres and masses must be constantly strengthened.
3. A practical and feasible plan of watershed management should be made.
4. Funds may be raised in every possible way.
5. Integration of control measures with management is required.

Models and benefits of watershed management

Over the past 50 years watershed management has proved that all management practices carried out in accordance with the technical specification of the state has achieved remarkable successes and many successful models have emerged. The main benefits are as follows:

- The structure of land utilization is improved and the rate of land utilization raised.
- Watershed management promotes the development of productive undertakings of agriculture, forestry, animal hus-

bandry and fishery, and improves the structure and rate of land utilization. According to a survey of 20 nationally representative mountain watersheds (5 in the Yellow River Valley, 6 in the Yangtze River Valley, 1 in the Pearl River Valley, 1 in the Haihe River Valley, 3 in the Huaihe River Valley and 4 in the Songliao River Valley), data indicate changes have been positive during implementation of the management program (Table 1).

- In the course of watershed management the measures for quick economic benefits have been taken for overall development of agriculture, forestry, animal husbandry and fishery, thus laying a foundation for commodity production.
- The 20 watersheds with proper management practices have expanded the area of basic farmland and increased the grain yields. The changes are shown in Table 2.
- Watersheds are distributed in vast hilly areas, rich in natural resources. The establishment of comprehensive management and development system of watersheds has created favorable conditions for the development and utilization of natural resources and for

setting up of a production base of such commodities as grain, cotton, oil, livestock, fowl, fish, melon, fruit, vegetable, timber, medicinal herbs, etc. Thus, resources in watersheds are transformed into commodities of economic value.

- In the 20 watersheds mentioned above, soil erosion measures were attempted in 569.55 km² area. Forest-grass coverage increased from 31.2 to 54.7%. In addition, a vast quantity of rainwater is retained, soil erosion is decreased, micro-climate has been improved, and animal and plant communities are increasing gradually.

Economic Policies, Laws and Regulations of Watershed Management

Economic policies

With the economic reforms in the countryside of China, the family contract system of watershed management has been developing very rapidly. In 1989, 3.15 million families were involved in this contract system in only seven provinces and regions in the middle and upper reaches of the Yellow River. About 250 thousand watersheds were contracted and managed, the total area of which amounted to over 3.9 million ha.

Table 1. Changes in land utilization in the 20 watersheds

Land type	Area before management (km ²)	%	Area after management (km ²)	%
Total area	1012.91	100	1012.91	100
Farmland	347.76	34.3	302.31	29.8
Forest-grass land	315.84	31.2	553.95	54.7
Waste land	222.54	22.0	47.22	4.7
Non-productive land	126.77	12.5	109.43	10.8
Rate of land utilization		65.5		84.5

Table 2. Changes in the basic farmland and grain yield

	Before management	After management	% change due to management
Arable land area (km ²)	31,467	29,993	-4.7
Basic farmland (km ²)	16,347	23,727	45.1
Per capita arable land (km ²)	0.136	0.124	-8.8
Per capita basic farmland (km ²)	0.07	0.098	38.7
Total grain yield (10 ⁴ kg)	8,896.91	11,762.93	23.2
Per capita grain (kg)	384.2	468.1	26.5

Under the family contract system, basic production materials such as land, forests and other natural resources in a watershed are publicly or collectively owned. The relevant government organizations distribute them to individual family or group of families for management. Thus, farm families become independent economic units in the watershed and can manage the contracted land over a long period. The contracted land can also be inherited by their offspring or transferred by payments. By contracting the watershed, farm families have more extensive management rights over the land than by contracting only individual fields. The agricultural, forest, animal husbandry, and fishing products from the watershed are completely owned by the contractor. As a result, the enthusiasm of farmers to properly manage the watershed is greatly enhanced.

Relevant economic policies of family contract and family group contract systems for watershed management are discussed below:

Contract policies: Contract policies aim to define who will contract, manage and benefit under the contract system for watershed management. The policies are as follows:

- A small watershed is contracted by one individual family, or by a group of families if one individual family is unable to manage the entire watershed. Reasonable circulation and co-operation of capital, technologies and labors, are allowed. Capitals, technologies and intellectuals from other regions are permitted to be introduced and cross-regional joint contracting and development are encouraged.
- Key engineering projects involving large areas are jointly managed by the state, commune and household. The economic benefits are allocated to each family according to its share.
- With regard to wastelands in mountains and gullies that are managed collectively in a watershed, individual families contract and manage and share the economic benefits.
- Contracting waste mountains and wastelands by local people and labors from other regions is permitted, and obtaining management right by bidding is implemented.
- The prices of watershed units are determined by the local farmer committees, and the management rights over a long-term are sold to farmers by public bid-

ding. The contracts are signed under the supervision of judicial departments and certificates for managing the watershed are issued.

Policies of rights and ownership: The principles of family contract system of watershed management are based on long term stability of relevant policies so that farmers can dispel their worries and regard the watershed as their own. Accordingly, they participate actively and the watershed is managed and developed carefully, which contributes to the prosperity of the whole watershed economy. The main contents are as follows:

- The collective ownership of the land remains unchanged. The contracting period ranges from 30 to 50 years, in some cases even 100 years. The benefits acquired by contracting and managing the watershed can be inherited, leased and transferred by payments.
- Forests and grasslands in the range are managed by individual contractors. The proprietary rights of forests and grasslands are collectively owned. Tree prices are determined and registered, and added values are allocated by shares. Individual young trees and sparse forests can be evaluated and allocated to contractors to manage. Grasslands are distributed to contractors to manage after they have paid cost price.
- The cutting of forests in the contracted areas should be approved by relevant departments according to regulations. All forest and subsidiary products are handled by contractors themselves.

Preferential policies: The principles of preferential policies are to encourage and

motivate contractors to manage the watershed actively and with creativity. The preferential policies implemented currently in all watersheds are summarized below.

- With regard to the newly built terraces, reservoir beds, etc., in the contracting areas under the integrated planning, proprietary rights of the land are collectively owned and management rights of the watershed belong to contractors themselves. In a certain period during contract additional burdens not imposed on contractors, e.g., agricultural taxes are exempted, grain procurement quotas are not increased and some subsidiary products are completely owned by contractors.
- Some contractors give up sloping lands because they develop agricultural fields to increase yields per unit area. In this case, they can be relieved of agricultural taxes, grain procurement quotas and some subsidiary products on their former sloping lands, under the approval of county-level government.
- Without causing detrimental effects on growth of tree saplings and conservation of soil and water, contractors are allowed to plant crops for grain, oil, melon, vegetable, etc., on their contracted forest lands. The yield and income are owned completely by the contractors.
- The government gives appropriate financial support to those contractors who attempt to manage the remote gullies, as well as mountain and other wastelands.
- The government gives financial and material support to contractors for

expanding farmlands and to plant cash trees on priority.

- To enterprises contributing to the economic development of the whole watershed, taxes are exempted for three years.

Protection policies: The principles of protection policies are to dispel the contractors' worries and protect their legal rights. The main contents include:

- The government issues 'Certificate of Watershed Management' to contractors. If a contractor transfers his land to others during the contract period, reasonable compensations should be given according to the results achieved by him.
- The contractors' legal rights are protected by the state. The actions which violate the contractors' management and benefit rights should be severely punished according to prevailing laws.
- Encouragement and protection should be given to those who have become rich by contracting and managing the watershed. Extortion, encroachment and sharing should be prevented.
- Contracted lands are allowed to be transferred by payments and lease among contractors.
- Comprehensive services are provided to contractors in pre- or post-production activities to relieve them of worries and difficulties so that they may contribute to the development of watershed economy. Some typical services include assistance in planning, selection of optimal approaches of development and management, provision of better

varieties, teaching of breeding and planting techniques, pruning and management techniques of fruit trees, prediction of market, services of buying, transport and sell of products, etc. All these aim to ensure that contractors obtain good economic returns.

Constraint policies: The principles of constraint policies are to ensure that contractors obey relevant laws and regulations, avoid short-term activities and illegal management.

- Contractors who obtain Certificate of Watershed Management and sign relevant contracts are obliged to manage watershed according to the requirements of contracts. The tax collection department has the right to withdraw the contracted land from those who fail to fulfil their obligations and transfer it to other interested contractors.
- Within the contracted land, illegal activities like deforestation, destruction of existing hydrology, traffic and water/soil conservation structures, are strictly forbidden. Violators are punished according to relevant laws and regulations.

Laws and regulations

Relevant laws and regulations in watershed management: In China, existing laws and regulations of watershed management mainly include:

- Law of soil and water conservation
- Forestry law
- Law of combating desertification
- Water law
- Land management law

- Environment protection law
- Fishing law
- Grassland law
- Mineral resource exploitation law
- Wild animals protection law
- Flood control law, and
- Law enforcement of watershed management

The contents of supervision and law enforcement of watershed management are lengthy. Based on laws, regulations and policies of watershed. They can be classified into the following categories:

- Supervision of agricultural activities in a watershed
- Supervision of forestry activities in a watershed
- Supervision of traffic, water engineering, industrial and mineral enterprise activities
- Supervision of soil-taking, sand-excavating, stone-quarrying and sloped and waste land reclaiming activities:
- Supervision of exploitation and usage of soil and water resources
- Supervision of pollutants discharged by enterprises in a watershed
- Supervision of subsidiary production activities in a watershed
- Supervision of special areas in a watershed

Problems in Watershed Management

Problems in policies

Problems in policies include the inadequacy and instability of contract systems of watershed management, the lack of proper understanding of the importance of these problems by local leaders, worries about existing contract systems and lack of enthusiasm to adopt watershed management. The farmers worry about the instability of the family contract system promoted by the government.

Problems in science and technology

This includes inadequate involvement of science and technology, insufficient applications of research results, and inadequate role played by technical staff in the watershed management.

Problems in investment

Problems include the inadequacy of investment systems and uncertainty of benefits by investment. In general, the enthusiasms of investment by all concerned departments are not fully motivated, the capital accumulations are not accelerated and the investment benefits are not raised. Thus, there is a lack of self-accumulation and self-development ability in watershed management.

Problems in supervision and management

This includes the inadequacy of supervision and management of situations, violation and relaxation of law enforcement in many regions. Thus in some areas soil erosion and environment degradation continue.

Suggestions

Management systems of watershed should be perfected

Contracting by households, family groups and joint groups should be encouraged. Management systems of multi-channel, multi-form and multi-department should be encouraged. Some suggestions are as follows:

- *Watershed management company, jointly-established by state watershed management stations and farmers:* Lands are shared, the management and administration are carried out by local stations of soil and water conservation, and yields are allocated according to shares. Lands and labors are allocated by 40% and 60%, respectively. Contracts are signed, the valid term ranging from 20 to 30 years. The fruit orchards could be owned by contractors or jointly managed after the initial terms terminate.
- *Joint contracting of watershed management by state-owned and collective enterprises:* In the process of comprehensive management, production bases of forests and fruits are also constructed and collective economy is continuously improved.
- *Establishment of watershed management company by family groups:* The contracted mountains and forests are priced and shared by farmers and management is implemented jointly. Besides, special households can jointly establish real institutions and implement dimensional and intensive management so as to raise the production and commodity rate in the watershed.

- *Joint management by state institutions and villages:* For example, fruit orchards can be jointly established and managed by forestry or hydraulic bureaus of the county-level with villages.
- *Implementation of stock system:* Stock system is an effective way to separate property rights from management. It eliminates the direct control of managers by stock-holders.

Maintenance of long-term stability of various management systems of watershed

Making long-term stable policies to ensure that contractors, relevant organizations and individuals dispel their worries, invest actively in watershed management, expand management scopes and scales and take full responsibilities in the watershed management.

Degraded watershed areas are generally in economically disadvantaged regions and need economic support to reverse the tendency of environment degradation. It is suggested that the central and local governments allocate funds annually to support watershed management and make detailed financial support policies. The financial support standard is decided according to the ecological-economic conditions of the watershed.

Establishment of social service systems of watershed management

Social service systems of watershed management include:

- Assistance in planning, management and development, by economic organizations of the village; providing services in machine for ploughing, drainage and

irrigation, plant protection, harvesting and transportation.

- Providing seeds of improved plant strains, market and meteorological information, management techniques, and promoting technologies, etc. All these are implemented by relevant soil and water conservation stations, agricultural and forestry stations and management and administration stations at the county-level.
- Providing production and living materials; assistance in buying, processing, transportation, selling, exporting, capital raising and insurance. These services are provided by relevant selling stores and departments of commerce, material, foreign trade and finance.
- Technical advice, personnel training and transformation of scientific research results are to be provided by relevant scientific and educational departments,

which set their local branches in the watershed areas.

- Special services may be provided by farmers' specialized associations, specialized cooperative societies and specialized households.
- Establishment of two comprehensive service series: (i) integrating planting, breeding and processing, and (ii) integrating production, buying and selling.

Conclusions

The essence of watershed management is the protection, improvement and rational use of the eco-economic systems of the watershed. Its ultimate goal is to realize the sustainable management of the watershed and reconcile the development of economy and environment. In order to achieve these goals, policies, science and technologies, investment and social service systems are indispensable and need to be perfected.