

# **Water Resources Planning Practices and Future Trends in China**

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## **1. Function of water resources planning**

China is a country that suffers severely from flood and drought disasters. Being as a foundation for water resources development and management, water resources planning have played a very important role in water harness practice in China. The Chinese people have a long history and rich experiences in struggling against the flood and drought disasters and water resources utilization. The water resources planning concept and practices have been formulated along with progress of struggling with water conflicts. The functions and tasks of water resources development planning in China can be summarized as followings:

i) Being as a main component of land reclamation and regulation planning and part of the national natural resources and economic development strategy and policy formulation. The water resources planning traditionally dealing with the water conflicts and problems of flood mitigation, drought prevention, exploitation and utilization of water resources and relevant environmental/ecologic improvement. It has been recognized that the water is a strategic resources of the nation and the water problems is always an obsession to the government and the publics. Traditionally, the water resources development plan have been integrated together with the land resources development plans or as a major component of the land resources development plans. The planning of water resources have provided a fundamental bases for the land resources reclamation and economic development in China, but also serving as one of the constraints to providing the suggestions on the economic layoutting and structuring decisions-making, the cities and townships alignment on certain extent.

ii) Being as the major bases for the state and regional water resources development strategy and policies formulation. Since the water resources plans, particularly the comprehensive water resources development plans such as the national, river basin and regional comprehensive water resources development plans, always addressing the overall water resources issues and dealing with the strategic aspects of water issues. Therefore, water plans are always provide a fundamental basis to formulate the overall sector development strategy and policies.

iii) Being as the major bases of the state and regional water resources development activities. The water resources development plans always addressing the overall master plan of water resources development arrangement including the flood mitigation, water resources, hydropower, navigation development and other water related developments, corresponding measures as well as the phasing of the implementation of the key water works have been identified in the plans. Those water plans will also provide a basis for the follow up

feasibility studies and design of the main engineering works. In general, the preliminary justification of those projects have been always conducted for which may be possibly carried out in short term including the function and the major role of the projects in the river basin and regional water development strategy. Therefore the follow up actions on designing can be directed by the water plans and the investment and financial arrangement can be made and the development activities can be implemented accordingly.

iv) Being as a fundamental bases to formulate the policies for regulating the water related human development activities. Water system is an open system with close relations with the natural system and the human beings. It has been noticed that the human development activities have a strong impacts on the water system and consequently the ecologic system will be degraded by some of the negative activities. Water plans needs to address such issues and assess the consequences of such impacts by human development activities. Water conflicts between different sectors, different regions always existing, such as the water allocation among different users, flood prevention water levels and design standards of dykes and etc. Thus will require the water plans to address those issues from the overall point of views and to solve those conflicts on the basis of equity and most cost-effective principles.

## **2. History of water resources planning**

To dealing with water resources development and harnessing, the government at all levels has put on great efforts on water resources development planning for long times. A series of principles on water planning has been formed, on the basis of which a number of historic water works were constructed that still functions well at present, such as Dujiang Weir Irrigation Works on the Minjiang River in Sichuan Province. However, it was until 20<sup>th</sup> Century and 30<sup>th</sup> Century when modern and meaningful planning became a reality, and a relatively systematic concept on water resources planning was formed and river basin planning was conducted. The formation of planning theory, overall development of planning techniques and methodology as well as a large scaled planning practice started only since the founding of new China in 1949. Water resources planning and water development in China were undergone into four main stages as follows.

First stage was from the year of 1949 to 1956. Water resources development was focused on dyke construction, watercourses dredging for flood discharge, rehabilitation of production and flood and drought release. The main tasks were concentrated on flood mitigation and drought releases and rehabilitation of production infrastructures. Water infrastructure construction during this period greatly alleviated the damages caused by frequent flood and drought disasters, which played an important role for social stability and production recovery. Water supply capacity for irrigation increased 90 billion m<sup>3</sup> and irrigated area expanded to about 27 million ha. First round river-basin water resources planning was conducted during this period on a relatively general basis, which investigated the basic conditions of the river basins that greatly improved the basic works of water resources planning. Some key planning results were achieved by the completion of seven river basin planning and some main medium and small river planning. These achievements played a significant role in the reconstruction of new China. The main aim of planning was laid on river harness and disasters prevention in this stage.

Second stage was from 1957 to 1979, a period of combining development and utilization of water with river harness for fostering benefits and releasing disasters. Due to the quickening of rehabilitation of industry and agriculture, focus of river harness was transferred to the development and utilization of water resources in many rivers, many water storage and regulation works and water diversion facilities were built for controlling floods, developing hydropower energy resources and water resources utilization, in order to satisfy the aim of economic development. Water resources planning in this stage brought in the content of comprehensive utilization of water resources on the basis of focusing on disaster prevention. Water resources planning compiled in this period mostly addressed on improvement of water resources development and utilization, underlined that water resources should serve for economic and social development.

Third stage was from 1980 to 1989, a period of modification and transition of economic system. A transform from water resources development and harness to strengthening of management was gradually realized along with the changes of economic system and mechanism of investment input. The economy was developed very fast in this period, water shortage and pollution became an intruding issues together with the rapid increase of water demands. The service objective of water sector had gradually turned to an all-range service to the national economy from mainly agriculture. The key areas in river harness were development and utilization of water resources and distribution of water resources. The issue of Water Law and Management Regulation of River Courses and so on in this period established a legal basis for the work of river harness and water resources management. In most of the river basins, a second round and more systematic water resources planning was carried out in the period. A significant progress was made on planning concept and methodology, especially on comprehensive planning and coordination of water planning with land governing and economic development. The contents of water resources planning became richer that not only considering the harness and development of water resources, but also water resources protection and management.

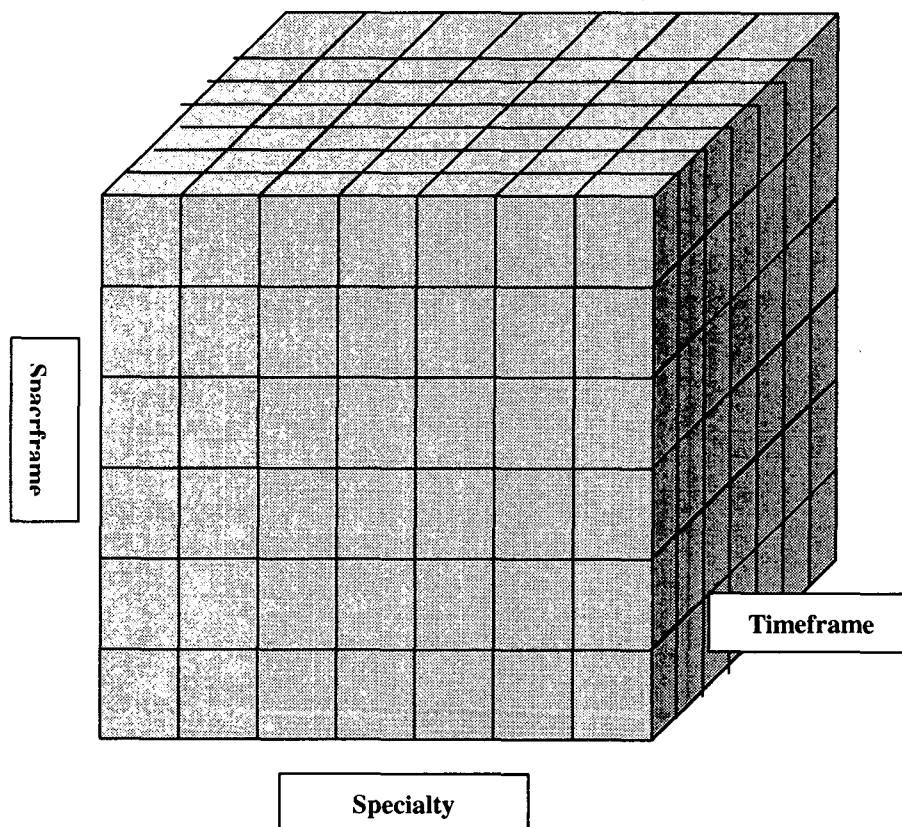
Fourth stage was from the year of 1990 till now. Along with the rapid development of society and economy and improvement of people's living standards, the requirements to flood control of the rivers, comprehensive development and utilization of water resources and ecological and environmental protection tend to be higher and higher. The scope of water undertaking is expanded and sustainable development has gradually been a concept of providing guidance for water resources development and management. The content of planning also makes some alternation, which gradually from engineering oriented planning practices in the past to resource oriented planning practices. Construction and management are considered equally important in planning. Those planning content many respects of development, utilization, harness, distribution, conservation, protection and management and lay more emphasis on sustainable social and economic development, as well as protection and improvement of ecological environment.

### **3. Framework of water resources planning system**

According to the Water Law of the People's Republic of China, Law of the People's Republic of China on Flood Control, Law of the People's Republic of China on Soil and

Water Conservation and Law of the People's Republic of China on the Protection and Control of Water Pollution, the relevant plans must be worked out so as to set up a base for water construction and management.

Through many years of practice on water resources planning, a framework of water resources planning is formed as shown in Fig. 1.



**Fig.1 Sketch of the framework of water resources planning system in China**

Water resources planning may be divided into national planning, river basin planning and regional planning on the basis of scale and space-frame; comprehensive planning, professional planning, specific planning and engineering planning on the basis of professional field and specialty (in which comprehensive planning refers to an overall plan on water resources development in various fields, professional planning refers to plans on flood mitigation, water resources utilization and environment protection, and specific planning refers to special content of water construction and management with particular purposes, engineering planning refers to the project planning); long-term, medium-term and short-term plans on the basis of time-frame. The above-mentioned three-dimensional composition of the various plans makes up the framework of water resources planning system in China. Coordination and linkage of the plans not only define and dispose layout and measures of water construction, but also regulate and define human activities so as to reach the target of giving support to sustainable development of economy and society by a sustainable utilization of water resources.

In line with Chinese laws and regulations connected to water affairs, comprehensive planning and professional planning for major rivers and lakes defined by the government shall be worked out by the responsible department together with other departments concerned and people's governments of relevant provinces, autonomous regions or municipalities, then report to the State Council for approval. Comprehensive planning and regional comprehensive planning of other rivers and lakes that across provinces, autonomous regions or municipalities shall be made by the River Basin Commissions together with water departments of the people's governments of provinces, autonomous regions or municipalities where the rivers and lakes are being located, and be appraised and commented by the people's government of relevant provinces, autonomous regions or municipalities, then reported to the responsible department of water of the State Council. After seeking comments from the relevant departments of the State Council by the responsible departments of water, it shall be reported to the State Council or its authorized departments for approval.

#### **4. Trend of water resources planning**

##### **4.1 Main issues existed in current planning**

Water resources planning has played a significant role in guidance of water resources development and management in the country by looking back of planning practice in the last 50 years, since the founding of new China. Nevertheless, the requirements for water resources planning have been demanding highly along with the social and economic development. In the light of actual situation of present water resources planning, main issues in China may be summarized as follows:

- i) Various planning are existed at present, but planning system is in disorder. Currently, relationship between administrative levels and relationship between various planning tends to be in chaos, in particular the division of forced planning of resource oriented managed type that reflecting governments' functions with directive type of planning that reflecting the needs of market is unclear. As a result, the definition of planning is in confusion, which caused overlapping of various plans, on the other hand, there are still gaps existed during these planning.
- ii) Legal status of these plans needs to be reinforced. Although most of the water related laws define the scope of relative plans and also establish legal status of the plans, safeguard measures tend to be weak during the implementation of these plans, so as the supervision system, thus it weakens forceful impact of these plans to water resources development and management.
- iii) Management system and mechanism of planning is incomplete. Incomplete management system has caused inconsistent of planning and unclear of management right, as no precise interpretation has been given to the responsible parties for compiling, coordination, approval and supervision of these plans.
- iv) Contents of planning are too old to meet the modern requirements, since it is short of resources oriented planning but more engineering oriented planning, short of comprehensive planning but more specific planning, short of forceful planning but more directive planning,

short of non-engineering measures but more engineering contents, paying less attention on social and economic issues, but more on water issues, emphasizing less on conservation and protection of resources but more on development and utilization of water resources.

#### **4.2 Driving force of water planning**

China as a large developing countries, the current social and economic development levels are still far away from the demanded ambitious plans and targets by the state and the people. Therefore there will be lots of the changes to be going on along with the developments. The water sector as the basic public sector is in the same situation with the nation as a whole. At present, because of the natural conditional and lagging behind water infrastructures development and poor water resources management, China is still suffering from serious water problems. Comparing with the future demands of social and economic development to the current situation, there are still great needs for the water sector developments. The driving forces for water resources planning are the driving forces from the stress of natural condition, the external environmental and the internal environment.

i) The driving force of water resources planning from the stress of the natural condition. China is and will still be suffering from the frequent and serious water related disasters such as flood, drought and pollutions, unless the basic infrastructure framework have been greatly improved. This will require a continuous efforts for the water resources planning to meets the needs for the sustainable development.

ii) The driving force of external environment of water sector. The social and economic situation in China has changed dramatically in the last two decades and those changes will still be significant happening in the future. Increased demands for water sector have provided strong driving forces for the sector development and water resources planning. Nether the less the development force of the sector, but more important are these mechanism and policy changes along with the economic development and improvement of market economy system will become more and more strongly in the overall environment of the sector, such as the development of marketing economy will leading to the changes of the water resources development and allocation mechanism, the re-structuring of the government will leading to the changes of the government roles adjustment in the water resources development and management, the relationship between the sector and the public and etc. It is clearly observed that this will require a continuous improvement of the water resources planning practices to address those changes.

iii) The driving forces from the internal environmental situation of the water sector. Although the water sector have been set up its basic framework in terms of the both institutional and infrastructure frames. But the sector itself is still at a quite low level and standards regarding to its coordination capacity among different stokeholds, basic facilities condition and services level provided to serve the publics, the regulating capacity both for water and human water related activities and the techniques aspects for conducting the better water resources planning, development and management.

The above mentioned driving forces will requires the continuous improvement of the traditional water resources planning practices. This will require the water resources planning to address the following aspects:

i) Water is desirable? – This will require the planners to re-study the mission of the water resources planning and study the demand for the social, economic development and the environmental protection, to identify and assess what are the goals and priorities for water.

ii) What is available? – This will require the planners to analysis the natural conditions and the current situations of water sector to assess the current capacity to provide the service for the public, to identify and assess what are the potentials and the weakness to be address.

iii) What are the possible options? –This will require the planners to analysis all possible options and alternatives to solve the water conflicts including the measures to reduce the demand, increase the services and guarantee the quality of service.

iv) What are the achievable goals? –This will require the planners to analysis and assess the reliability and feasibility of the options through the balance analysis for the demand and availabilities, which will require not only the technical feasibility, but also the economical and political feasibility and the environmental soundness.

v) What are the actions? –This will require the planners to formulate the implementation program and to identify the measure and actions recommended to address the problems for the decision makers.

v) What are the consequences? –This will require the planners to provide the full sets of the results to examine the results for different chooses including the recommended actions and provide the basis for the decision-making justification.

#### **4.3 Direction of water resources planning**

For sake of fulfill the gap of water resources planning and meeting the requirement of a sustainable social and economic development to water sector, the water resources planning should:

i) Consist on a close combination of water resources planning and social and economic development, by defining tasks and key areas based on the requirements of social and economic development, so that the planning can be made on the basis of local conditions of water resources and social and economic development.

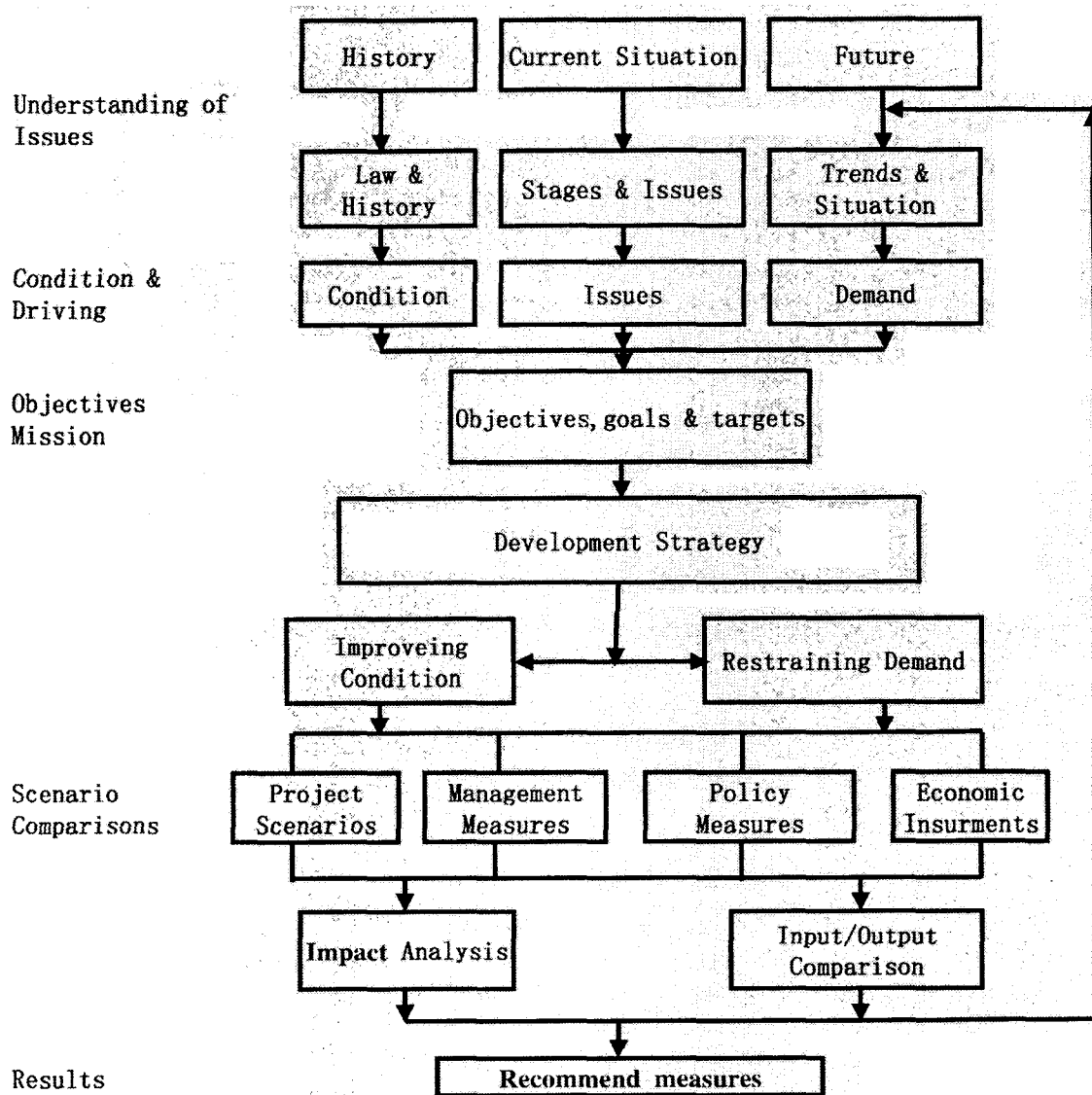
ii) Formulate countermeasures of water resources development and utilization according to natural and geological conditions, characteristic and problems related to water resources situations.

iii) Direct target and aims of development according to the requirement of a sustainable water resources development for it will support and safeguard the sustainable development of economy and society.

iv) Determine a scale and procedure of development based on national finance capacity and the market.

v) Combination of engineering measures with non-engineering measures when dealing with water resources planning, not only set up boundaries for water resources development and utilization, but also the framework to regulate the human development activities.

General framework and concept of modern water resources planning are shown in Fig. 2.



**Fig. 2 General framework and concept of water resources planning**

### 5. Basic framework of on-going national comprehensive water resources planning

After the founding of new China, two rounds of water resources planning were carried out on water resources development and utilization. The first round was a plan of water resources development and utilization resulted in the first round and second round of river basin comprehensive planning. Second round was plans on national water resources assessment, development and utilization planning, as well as plans for long-term and medium-term water supply and demand. These two round of planning established a basic framework for the present water resource development and management.

However, significant changes have been happened in eternal environment as well as internal conditions on national water resources. One reason is that there are considerable changes in the formation mechanism of water resources and interaction due to the impact of intensive human development activities. Those changes of global climate, environment and underlying



surface, recharge conditions of water resources, over-exploitation of ground water and water pollution make considerably alternation to the quantity, quality, availability and supply capacity of water resources, as well as its time and space distribution, Especially in Northern part of the country, the changes has resulted in aggravation of resources scarcity. Second reason is that relationship of water supply, use, drainage and consumption and water use structure have been changed dramatically during water resources development and utilization owing to the development of economy and society and structure adjustment. Consistent increase of water use and changes of water use structure caused a severe competition over water use by various regions and departments, hence the contradiction of water demand over supply becomes increasingly intruding. Third reason is the restructuring and changes of distribution and allocation model of water resources, water resources development and utilization system, and mechanism and government functions along with the establishment of market economy. Because of the above reasons, existed water resources assessment and planning results cannot reflect the real situation at present. New assessment of water resources is needed urgently for answering the question raised by new conditions and issues, and to make plans based on it for making overall arrangement for domestic, industrial and ecological water use and meeting the requirements of water undertaking in the new age. For this reason, a comprehensive water resources planning will soon be initiated in a country base.

This comprehensive water resources planning shall confront the following targets: i.e. through making water resources planning, to make a further examination of current water resources. It shall proposes a layout and action plan for a reasonable water resources development, high-efficient utilization, optimized relocation, all-respect conservation, effective protection, comprehensive development and scientific management based on analysis of bearing capacity of water resources, which shall be an foundation and guideline for the activities of water resources development and management, so as to promote and ensure a harmonious development of population, resources, environment and economy, to stand for a sustainable development of our economy and society by a sustainable development of water resources.

The on going planning will be conducted in four levels of nation, river basins, provinces or regions and cities. The planning at all levels will coordinate accordingly and form a complete system of water resources planning of the country. The main contents shall include: investigation and assessment of water resources and situation of water resources development and utilization, prediction of water demand, water conservation planning, water resources protection planning and water pollution control planning, analysis of water supply potential and prediction of water supply, study on a reasonable water resources allocation, layout of water resources development and its implementation plan, evaluation of implementing results of the plans, safeguard measures for a sustainable water utilization and so on. The contents and relationship of these plans are illustrated in Fig. 3.

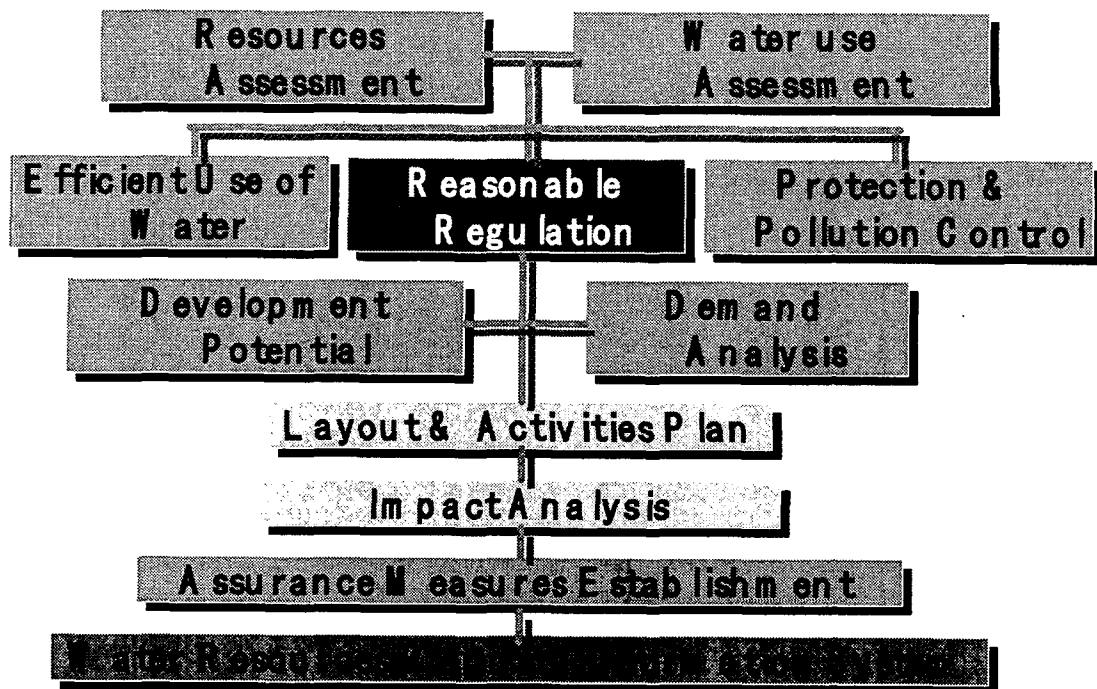


Fig. 3 Contents and relationship of on-going plans