THE DEVELOPMENT AND APPLICATION OF WACM

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Abstract This paper is about the necessity of developing the WACM (Water Resources Allocation and Cycle Model), its developing process, basic frame and application. WACM couples generalized water resources rational allocation model with water cycle model affected by nature and human. The former model is based on the simulation of water supply, water use, water consumption and drainage, whose target is to minimum water deficit in research region. The latter model sets up water balance model and water dynamics model from the perspective of water balance and water dynamics, which includes the chains of evaporation, precipitation, exchange between soil water and ground water, runoff and converge. The water balance model mainly simulates cycle, change and conveyance of water quantity, but the dynamics mechanism is not considered. The dynamics model is based on water dynamics mechanism, which supplies timely water cycle response information of generalized water resources allocation, to achieve the dynamic allocation and simulation on the water resources allocation and water cycle process. The WACM can couple with economy and ecology models to study and analyze the effect of water resources development and utilization on economy and ecology. WACM is developed and improved in the practice, which has been successfully applied in generalized water resources rational allocation of economy ecosystem, efficient utilization of regional water resources, the management and control of water resources, the analysis of regional water saving potential and threshold, the quantitative relationship of water saving between resources and irrigation, the check computation of water resources on water utilization and the determination of its threshold, etc. The application effect of WACM is satisfying.

Key words WACM; generalized water resources rational allocation; water cycle simulation

1 NECESSITY OF WACM DEVELOPMENT

Water resources allocation model is an important method applied in reasonable regional water allocation while water cycle simulation model is a basic tool for studying the law of water cycle. Traditional water allocation lays more emphasis on surface and ground water but less on soil water that affects the economic-ecosystem significantly. Meanwhile, ecological water use process is not taken into account in traditional water allocation. On the other hand, traditional water allocation is independent from water cycle system. As a result, water resources evolution in association with the allocation process could not be reflected and water allocation scheme could not be evaluated scientifically. At present, frequent human activities make great effects on external environment as well as structure and mechanism of water cycle process. Accordingly, water utilization following the law of
water cycle is necessary to allocate water resources between economic system and ecosystem effectively and reasonably. Therefore, considering the changed water resources and eco-social system, new methods and ideas should be applied in the research of modern water resources and new model that aims at the requirement of water resources problem should be developed. So the water resources allocation and cycle model (WACM) is established and modified gradually to achieve those goals.

2 FOUNDATION OF WACM DEVELOPMENT

2.1 WATER RESOURCES ALLOCATION

Rational water allocation and water cycle simulation are the foundation of WACM building. In general, the development of rational water allocation experienced four stages. Firstly, water resource optimization dispatch focused on single project (e.g., flood control, irrigation, power generation). Secondly, optimal water allocation was based on quantitative macroeconomic analysis. Interrelationship between water system and economic system was the hotspot of this stage. In addition, the research work extended to multi-source, multi-user, multi-objective and multi-region as well. The integration of decision-making theory with practice in water resources planning also promoted the formation of the optimal water allocation with multilayer, multi-objective and group decision making. Thirdly, rational water allocation was oriented to ecosystem. After analyzing the natural water cycle and artificial water cycle, ecological water demand and its process were studied. In the rational water allocation, water resources system, economic system and ecological system were considered as a whole and the interactions between them were explored. That means the rational water allocation expanded the boundary of optimal water allocation based on macroeconomics. Fourthly, rational water resources allocation was founded on full attributes. In this stage, five attributes (i.e. natural, environmental, ecological, social and economic) of water resources were studied comprehensively and appropriate methods were employed to coordinate their relationship. Moreover, the decision variables involved in multilevel. The allocation goal should meet not only the basic requirement of single attribute but also harmonize the overall layout.

2.2 WATER CYCLE SIMULATION

The distributed hydrological model is a powerful tool to solve water resources problems, which was proposed by Freeze and Harlan in 1969, develops rapidly and is widely used in water cycle simulation. Its core mechanism is rainfall-runoff process. By analyzing the physical mechanism of water cycle, the distributed hydrological model puts runoff yield and concentration, soil water movement; groundwater movement and evaporation process together and studies the spatial variability of hydrologic variables. However, the distributed hydrological model is usually applied to simulate the natural hydrological process in short duration and small scale (particularly in mountain) because of the limitation of data materials as well as boundary conditions. In order to reflect the law of water cycle in large basin scale, a distributed hydrological model incorporated with water and energy transfer processes (WEP) model, is developed by Yangwen Jia from IWHR to simulate water and energy processes in watersheds with complex land covers and the model is successfully applied in Heihe River, Yellow River and Haihe River.

Climate change has significant effects on water cycle. By generalizing the cycle fluxes and the cycle path, water cycle elements (e.g., precipitation, runoff, evaporation) response to climate change under large scale was brought into model consideration but practical application was rare.