DEVELOPMENT OF CALCULATION METHODS OF HYDROLOGICAL PARAMETERS FOR THE SUSTAINABLE WATER MANAGEMENT IN ARID RIVER BASIN

マクマドフ, クゥシュドベック

https://doi.org/10.15017/1543979

出版情報：九州大学, 2015, 博士（工学）, 課程博士
バージョン：

（様式２）

氏　　名　：クゥシュドベック　マクマドフ

論 文 名:　DEVELOPMENT OF CALCULATION METHODS OF HYDROLOGICAL PARAMETERS FOR THE SUSTAINABLE WATER MANAGEMENT IN ARID RIVER BASIN
（乾燥地の河川流域における持続可能な水管理のための水文特性値の算出方法の開発）

区　　分　：甲

論　文　内　容　の　要　旨

More than 85% of the area of Uzbekistan are in arid or semiarid conditions, including Kyzylkum desert, the largest desert of Central Asia. Uzbekistan is perhaps the most vulnerable of the Central Asian countries with respect to water resources and irrigated agriculture, because it has the largest irrigated area (4.3 million ha), the biggest rural population (more than 14 million) and the highest population density of 49.6 persons per square kilometer. Being an arid country, but a large consumer of water, derived from sources lying outside of its borders, Uzbekistan suffers heavy damages from water shortage. Most of the nation's water resources are used for farming, which accounts for nearly 84% of the water usage and contributes to salt damage. Heavy usage of pesticides and fertilizers for cotton growing caused soil and water pollution of the region.

This research indicates the development of computation methods to management and evaluation of the condition of the hydrological parameters for the sustainable water management in the arid river basin. As a research area has been selected the Chirchik and Kashkadarya River basins, where the management of water resources and land salinization is a continuing problem.

The Chirchik River basin is the largest right-hand bank tributary of the Syr-Darya River, and a population of more than 2.7 million of the Tashkent region depends on the sensitive water resources of the Chirchik River basin. No other viable alternative resources exist excluding the Chirchik River for providing potable water to residents in the Tashkent region.

The second largest and strategically important area of the country is Kashkadarya province, the driest region of the Uzbekistan, whose annual precipitation is 300-350 mm/year and evaporation rate is 1300-1700 mm/year. In the past 70 years, the river flow of the Kashkadarya River did not reach the Amu-Darya River, because of the huge amount of water intake for the agricultural purposes and the river water is completely lost in the Kyzyl-Kum desert. In this context, water resources of the Kashkadarya River basin are fully mobilized for the irrigation purposes. The water balance model development is considered to be an important part in the establishment of sustainable water management policies for the Chirchik and Kashkadarya River basins. The water balance model is developed by using the ArcGIS and MIKESHE commercial softwares.

The ArcGIS provides a wide reach of powerful spatial modelling and analysis capabilities for producing and applying maps, compiling geographic data, managing of the geographic information in a database and etc., and the MIKE SHE is an integrated hydrological modelling system for creating and assuming the entire land phase of the hydrologic cycle and allows portions to be used independently and customized to the roles.

The developed model enables analysis of the complex hydrogeological regime in the regions, and forecasting of the environmental impacts on the various management options. The model simulates all hydrological processes in the Chirchik and Kashkadarya River basins, including evapotranspiration of a watershed, precipitation, overland flow, unsaturated and saturated flow and infiltration for both calibration and validation periods.

Chapter 1 explains the general framework and the background of the problem, as well as the detailed plan and a brief introduction of the method employed in this study.

The MIKE-SHE model and ArcGIS tools require reliable information about all components of both river basins, such as: actual evapotranspiration (ET) of a watershed, precipitation, overland flow (OL), unsaturated (UZ) and saturated (SZ) flow, infiltration and etc. As can be seen, all detailed information on the natural characteristics of the Chirchik and Kashkadarya River basins are described with spatial distribution of the different components of the river basins have been shown in Chapter 2. As a consequence of the comparison of the spatial distribution, water balance results of the two river basins show that the both river basin's environment is depleted and water management systems are worse situation.

Regarding the importance of the climatic factors in the runoff formation of water resources, in Chapter 3, a new interpolation method of climatic parameters by using barycentre method has been introduced. Analysis and evaluation of scientific and practical data determined that the existing methods of interpolation of climatic parameters of the territory due to the significant variability of the landscape of the surface does not contribute obtaining the accurate climate data. Under these conditions, the proposed interpolation method can produce a mixed system of climatic factors at the midpoint (center) of the motion of each climatic parameter, with a unique centre (barycentre). The calibration results of the current interpolation methods and new developed method (including the similar asumptions) with observed results showed that the developed method has the most similarity to the actual observed data. By using the developed interpolation method have been calculated the water balance of the Chirchik and Kashkadarya River basins and has been obtained acurate water balance errors.

In Chapter 4, the method for forecasting groundwater level in an arid area according to climatic data has been described. In the territories with an arid climate, productivity of irrigated agriculture largely determines the condition of the moisture of territory and groundwater levels. The numerical implementation of the water balance equation and an integrated hydrological modelling system by using MIKE-SHE have been obtained the accurate hydrological water balance of the river basins to monitor the seasonal change of the spatial distribution of the groundwater levels. The monitoring of the ground water level in river basins can protect the soil from the salinization and erosion, which is the main problem in arid ares.

Moreover, in Chapter 5 have been presented the modeling of water and salt balance for sustainable water management in river basins for the sanitarization purposes. In arid areas the water and salt balance equations give the qualitative and quantitative management of the river basin and their sanitary protection. Development of the applicable formula for calculation allows forecasting and management of water quality in the rivers, especially in arid and semi-arid regions with crop irrigation systems.

In Chapter 6, all prepared conclusions according to the research findings has been summarized. The obtained results in the framework of the research are useful for arid and semi-arid areas and along with to solve various problems associated with the sustainable use of water of the territories, as well as to analyze and assess their impact on different processes in the environment.