Impact of Climate Change on Water Resources in Seyhan River Basin

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1. Introduction

The water resources of Seyhan River Basin were investigated within the framework of the ICCAP Project. Upstream of the Seyhan Dam was considered as the study area. This part of the basin covers about 21750 km^2. Three main tributaries make the Seyhan River; namely, Cakit, Zamanti and Goksu. The Zamanti sub-basin requires a special attention due to its relatively complex hydrological structure. The average elevation of this sub-basin is about 1250 m, and karstic discharges supply the main contribution to the river flow. The pervious lithological units are generally made of carbonate rocks most of which are extensively karstified.

The response of the basin hydrology to any changes in the climatic and inherent vegetative and land-use conditions will be studied by the MIKE-SHE model (Turkish group) and the SiBUC-HydroBEAM model (Japanese group).

2. Activity of Turkish group

2.1 Preparation of relevant data

The available data were designated, digitized and transferred to a GIS software. Hydro-meteorological data such as flow rates, rainfall and snow cover were input to the database, topographical, geological maps, soil map, vegetation, and leaf area index (LAI) were digitized and given as separate layers. The basin boundaries were defined according to the topographical divide.

2.2 Numerical model of the Seyhan basin

The basin was discretized into 216 x 299 grids of 1 km^2 each. Because the subsurface water is a main factor that controls evapo-transpiration rate and the infiltration, the vadose zone was taken into account in the model. The soil map was re-arranged so as to define the soil type and some model parameters were defined for two major types of soil in the basin. The vertical dimension of the vadose zone was taken as 50 m. and divided into 80 finite-difference layers of thickness varying between 0.125 and 5 m. The evapo-transpiration is computed by Penman-Monteith method for potential and LAI approach for actual evapo-transpiration.

The surface runoff was simulated by finite difference solution of the Saint Venant equation. Runoff occurs whenever the overland storage exceeds a certain threshold (6mm). Channel flow component was simulated using the geometry of the river bed defined by finite difference nodes. This required measurement of width and depth of the river at sections where flow rate was observed.

2.3 Calibration of the model

The model was calibrated using the flow rate data at different sections available/ derived for the period between 1980 and 1992. As seen in Fig.1, correlation between observed and calculated flow rate is poor. The lack of adequate meteorological stations to represent the spatial distribution of precipitation and evapo-transpiration and the significant contribution of karstic discharges into the river flow are regarded as the major factors responsible for this poorness. However, adjustment in the water budget components was realized to better understand the role of karstic effluents in the basin.

2.4 Calibration of the Model

The model was calibrated using the flow rate data at different sections available/derived for the period between 1980 and 1992. As seen in Fig. 4, correlation between observed and calculated flow rate is poor. The lack of adequate meteorological stations to represent the spatial distribution of precipitation and evapo-transpiration and the significant contribution of karstic discharges into the river flow are regarded as the major factors responsible for this poorness. However, adjustment in the water budget components was realized to better understand the role of karstic effluents in the basin.

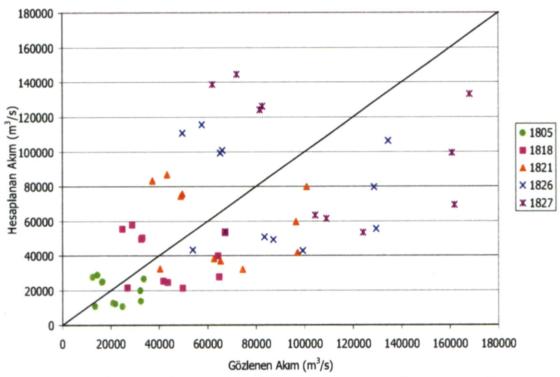

Fig.4 Correlation between observed and calculated flow rates

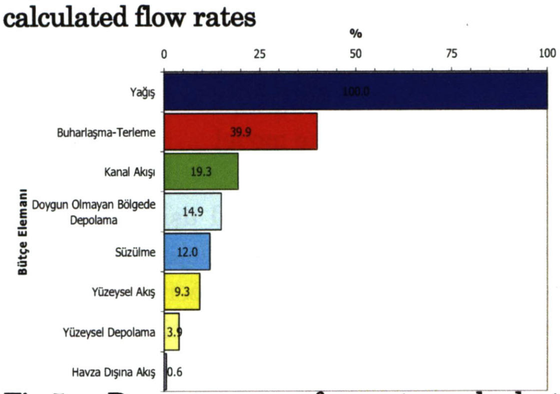

Fig.5 Percentages of water budget components for the period 1980-2000

2.5 Water Budget

The water budget components calculated by the model for the period between 1980 and 2000 are tabulated in Fig.5. According to this calculation, about 40 % of the precipitation is lost by evapo-transpiration. This rate corresponds to a volume of 15.89Gt. About 12 % of the total precipitation (4.76Gt) is infiltrated to form the groundwater. About 3.71 Gt is the surface runoff. About 0.24 Gt is lost through outflow from the basin, and this amount is the inflow to the Adana Plain groundwater system.

3. Activity of Japanese group

Based on the field survey and NDVI time series analysis (different phenological characteristics), landcover dataset of the whole Seyhan river basin was improved and utilized in the numerical simulation.

The 2nd product of RCM is utilized as forcing of land surface model. Seven meteorological components are available in hourly time interval. The simulation domain (E34.25-37.0, N36.5-N39.25) is divided into 5 min grids. The simulation period for the present climate condition is from 1994 to 2003, and future climate condition is 2070's. Unfortunately, there was some mistake in the initial soil moisture setting of RCM simulation, and it resulted in significant systematic biases. Thus, model biases were removed based on observation for the quantitative use. As a first step, the projection of the climate change impact on the regional hydrological cycle is attempted to start the discussion on the vulnerability of agricultural production system in this basin. In terms of basin average annual water balance, precipitation is projected to decrease about 140mm (690mm to 550mm), and evapo-transpiration decreases about 50mm (430mm to 380mm). As for the details of the bias correction and simulation results, please refer to the personal research report (Tanaka et al. in this volume).