WATER RESOURCES MANAGEMENT IN THE CENTRAL RIFT VALLEY: MODELLING FOR THE WATER POOR

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Abstract

Achieving a sustainable development is crucial, but is even more important in developing countries, where a wide number of people does not have a safe and secure access to water and relay on the environment to sustain their lives. The Ethiopian Central Rift Valley basin is already a degraded basin from the environmental point of view: ecosystems are endangered due to human activities there developed. Moreover, poverty is widespread all over the basin, with population is mainly living from agriculture on a subsistence economy. In order to achieve sustainable development to increase population incomes without affecting lives of those who are highly dependent on the environment and Integrated Water Resources Management approach shall be applied. First step has been to model the basin water resources, using the Soil and Water Assessment Tool (SWAT), which, after calibration and validation of the model, has given correct results. In order to follow deepening in the IWRM approach, more information on actual and future water demand and specifically water applied to agriculture will be needed.

Key words: Integrated Water Resources Management, Water Poor, Modelling, Central Rift Valley

Introduction

Target 1 of the 7th goal of the Millennium Development Goals states that country policies and programmes shall "integrate the principles of sustainable development and reverse the loss of environmental resources". This target is more significant in developing countries, where there are still too much people without a safe and secure access to water who relay on the environment for water and food provision. According to the Global Water Partnership (2003) the 'water-poor' are, among other conditions, those whose natural livelihood base is persistently threatened by severe drought or flood; and those whose livelihood depends on cultivation of food or gathering of natural products, and whose water source is not dependable or sufficient.

The Ethiopian Central Rift Valley (CRV) is part of the East African Rift, and is located in the administrative regions of Oromiya and the Southern Nations Nationalities and Peoples Region (SNNPR), covering an area of approximately 10,000 km2. In 2007, estimation of the population living in the Central Rift Valley Basin was around 1.9 million people, among them 1,600,000 were living on rural areas, although projections of the population on 2035 for the basin range inbetween 4.0 and 4.8 million people, from whom inbetween 3.1 and 3.7 million will be living in rural areas. The area encompasses a chain of four large lakes (Ziway, Langano, Abyata and Shala), which are highly productive, harbouring an indigenous population of edible fish and support a wide variety of other aquatic and wild life. But most ecosystems around the four lakes are becoming degraded as a result of human activities (Ayenew, 2007). Being a closed basin, relatively small intervention in land and water resources can have far reaching consequences for ecosystems, goods and services, and potentially undermine the sustainability use of the area. In this respect, water resources in the basin are used for irrigation, flower industry, soda abstraction, fish farming, domestic use and recreation, and also support endemic birds and wild animals.

Poverty is widespread all over the basin. The regional Gross Domestic Product (GDP) per capita is about 910 Birr per capita (or 105US$ using 2005 exchange rate), which is a low GDP per capita even compared to Ethiopian standards. Agriculture production and its related activities is the main pillar that sustains the Central Rift Valley economy. According to the Rift Valley Lakes Basin Integrated Resources Development Master Plan Study Project (Halcrow Group Limited and Generation Integrated Rural Development Consultants, 2007), it is estimated that about 67% of GDP is on the agricultural sector while industry and service sectors account for 10% and 24% respectively. But main production on agriculture is still produced on a subsistence basis, using traditional techniques and depending on rain-fed agriculture: just 120 km^2 are being irrigated, representing less than the 2% of the cultivated land.

Forecast of future climate change from Global Change Models shows that precipitation may vary: while during dry season precipitation may increase, on the small rainfall season, it will decrease, and will maintain similar values during the rainy season. The average monthly maximum temperature, as also average minimum temperature may rise, diminishing the water flow into lake Ziway inbetween 19% and 27% in 50 years time (Zeray et al., 2006) and also groundwater recharge.

In view of the future global threats to water resources, the best approach for water management in the basin is to focus on the Integrated Water Resources Management (IWRM) based in modelling tools. IWRM can be defined as a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (Global Water Partnership, 2000). IWRM includes all actions and projects aimed at increasing water use efficiency and water conservation and must be developed at river basin level district.

Methodology and results

For hydrology modelling, the code ArcSWAT has been applied. The software includes the SWAT (Soil and Water Assessment Tool, Arnold et al., 1998) model developed for the USDA Agricultural Research Service into ArcGIS (ESRI®). SWAT is developed to assess the impact of land management practices on large complex watersheds with varying soils, land use and management conditions over long periods of time. SWAT is physically based; although it can study complex processes is computationally efficient (Neitsch et al., 2005).

Data input includes, land use, type of soils, climate data and river flow. Surface elevation was obtained from a 90mx90m grid DEM provided by the USGS from SRTM data. Ten different types of land use based on satellite images (Jansen et al., 2007) and nine different type of soils have been identified were used. Meteorological data set includes daily meteorological precipitation and temperature values for the 1996-2005period from five different meteorological stations and relative humidity, wind speed and temperature from one station. Calibration period was from the 01/01/1996 until 12/31/2001 meanwhile the validation period was from 01/01/2002 until 12/31/2005. Calibration has been done using daily data of the runoff in three different points of the basin, and validation results show that SWAT has been successfully implemented.

Conclusions

Modelling is an important tool to be considered for the IWRM implementation, and semi-distributed models, such as SWAT code, may help. Although being a data intensive hydrological model, it can be useful for basins where not much information exists, such as the Central Rift Valley basin. Recompilation of existing data was not an easy task, and uncertainty around some of the data was high, but calibration and validation of the model has given correct results.

In order to follow deepening in the IWRM approach, more information on actual and future water demand and specifically water applied to agriculture is needed. Development has to consider all possible impacts on society and environment, and try to avoid the negative ones. Although further research is needed in order to know the resulting impacts on environment of different water and land use practices in the CRV, the use of models on reproducing possible future scenarios impacts allows to start working on mitigation measures.

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