INTEGRATED NATURAL RESOURCES MANAGEMENT FRAMEWROK IN SEMI-ARID REGIONS

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Arid and semi-arid regions are generally characterized by water scarcity and low per capita water allocation. In such areas, intensive agricultural activities associated with high population growth cause a further exacerbation of this problem. The Faria watershed located in the northeastern part of the West Bank, Palestine is one of these semi-arid regions where the lack of proper management of natural resources has negatively affected the existing obtainable surface water and groundwater resources including springs water which supplies more than 50% of the water supply to agriculture. Integrated watershed management provides an interdisciplinary framework that links physical, social and economical sciences into planning, policy and decision making.

The Faria watershed constitutes a major part of the Jordan Valley which is considered as the only potential area for agricultural development during the coming years, in addition to its current importance as the largest agricultural production area in the West Bank (PWA, 2000). Faria watershed is located in the northeastern part of the West Bank with a total area of 330 km^2. The predominantly rural population in the watershed, estimated at about 21000, faces a series of environmental threats and poor economic conditions. The rapidly growing rural population, about 3.5 percent annually, has resulted in increased demand for natural resources, mainly land and water. Lack of proper management of water and land resources causes over abstraction of the scarce water resources and ineffective use of land. Discharge of untreated wastewater and unbalanced use of fertilizers and pesticides cause pollution of the scarce water resources, both groundwater as well as surface water. Unbalanced abstraction of groundwater has increased salinity to unaccepted levels (ARIJ, 1998).

The objective of this paper is to develop an interdisciplinary approach to an integrated natural resources management framework that involves diverse modules of surface water and groundwater models, a planning model for economic evaluation, a multi-criteria decision analysis model, and a GIS technology to facilitate processing and visualization; and the data from the Faria watershed in West Bank in Palestine will be used as a case study.

The study starts off by the collection of available data followed by an assessment and analysis of the collected data to identify and evaluate the system behavior historically and provide where future work needs to be done. The amount of available surface water will be simulated using GIS based rainfall-runoff model namely Geomorphologic Instantaneous Unit Hydrograph (GIUH) model (Lee and Chang, 2001). The MODFLOW (Harbaugh and McDonald, 1996) software package will be used to estimate the amounts

of groundwater that could be safely extracted under different management options and climatic change scenarios. A long-term statistical analysis of spring yields in the watershed is essential to better understand the behavioral trends in spring yields in the area, to comprehend the uncertainty associated with spring yields and the influential explanatory parameters, and to enable the development of optimal water allocation policies and management option measures under drought conditions such that the economic revenue is maximized. Thereafter, assessment and modeling of the sustainable-yield limits of water resources within the watershed including groundwater and surface water will be carried out considering possible climatic changes. Based on this assessment, management options (scenarios) with the involvement of stakeholders will be formulated and tested through the AGSM (Fisher et al., 2005) planning model. Assessment and evaluation of different scenarios from different perspectives, considering different decision criteria will be conducted to choose the best management option.

The paper presented an interdisciplinary approach to a conceptual framework for an integrated management system that involves diverse modules of surface water and groundwater models, statistical analysis correlations, a planning model for economic evaluation, a multi-criteria decision analysis model, and a GIS technology to facilitate processing and visualization. Such an approach typically addresses integrated management of agriculture-dominated watersheds in arid and semi-arid regions with application to Faria watershed. This application in turn can be generalized to similar areas in the region and worldwide. The study concentrates on developing management options that sustain the available water resources both in quantity and quality, optimize the use of low quality water including treated effluent and brackish water, and maximize both the irrigated areas and the income of the local farmers. Since the decision criteria involve conflicting objectives, a multi-criteria decision analysis is employed using the importance order of criteria (IOC) method Yakowitz et al. (1993).

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