Chapter 16
Sustainable Land Use and Watershed Management in Response to Climate Change Impacts:
Overview and Proposed Research Techniques

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ABSTRACT

With the changes in climatic, biophysical, socio-cultural, economic, and technological components, paradigm shifts in natural resources management are unavoidably and have to be adapted/modified to harmonize with the global changes and the local communities' needs. This chapter focuses on sustainable land use and watershed management in response to climate change impacts. The first part covers some definitions and background on sustainable land use, watershed management approach, and sustainable watershed management. The second part describes the use of the Geographic Information System (GIS) and Spatial Decision Support System (SDSS) model focusing on the framework for a planning and decision making, computer-based system for supporting spatial decisions. The mathematical programming has been reviewed focusing on optimization algorithms that include optimization modeling and simulation modeling for decision making. Finally, the example of methodology development for sustainable land use and watershed management in response to climate change in Dong Nai watershed, Vietnam is presented.

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1. INTRODUCTION

Current climate change estimates indicate that major environmental changes are likely to occur due to climate change, in practically every part of the world, with a majority of these changes being felt through modification of the hydrological cycle, e.g. floods, droughts and storms. Climate change impacts are also estimated to be particularly severe in many developing countries of the world and especially in Vietnam. The recent studies (Dasgupta *et al*., 2007; IPCC, 2007) have concurred that Viet Nam will be one of most vulnerable countries to climate change in the world. Gradual changes, such as sea level rises and higher temperatures, more extreme weather such as drought, and more intense typhoons are all on the horizon and will have a potentially devastating impact on the country's people and economy. According to the latter study, 10.8% of Vietnam's population, mostly those people living in the two river deltas (Red & Mekong river deltas), would be affected by sea level rise (SLR) of just 1 meter (Dasgupta *et al*., 2007). According to the IPCC (2007), a 1 meter SLR in Vietnam would lead to flooding of up to 20,000 km^2 of the Mekong River delta and 5,000 km^2 of the Red River delta. In the Mekong River delta alone, more than 1 million people would be affected directly.

The above statements do not only reflect the importance of watershed resources in natural resources management but also imply for the integrated management, which all stakeholders must consider where developing management activities from the beginning of a project establishment. Hence, this chapter focuses on sustainable land use and watershed management in response to climate change impacts. A broad understanding of various topics in sustainable land use and watershed science and modeling technology is required to complete the studies presented in this chapter and it is important to thoroughly review each of them. The first part covers some definition and background to sustainable land use, watershed management approach, and sustainable watershed management. The second part is concerned with the Geographic Information System (GIS) and Spatial Decision Support System (SDSS) model focusing on the framework for planning and decision making, and the computer-based system for supporting spatial decisions. The mathematical programming system has been reviewed focusing on optimization algorithms that include optimization modeling, and simulation modeling for decision making. Finally, an example of methodology development for sustainable land use and watershed management in response to climate change in Dong Nai watershed, Vietnam is presented.

2. DEFINITION AND BACKGROUND OF WATERSHED MANAGEMENT APPROACH

If one asks why we need to manage natural resources based on watershed boundary, the answer would be to recognize that sustained land or resource based development depends on the interaction of all the activities that take place in the watershed. Uplands and lowlands are physically linked in a watershed via the hydrologic cycle. Upstream activities affect downstream opportunities and problems by influencing the flow of water, sediments and other waterborne materials through the system. For recognizing this fact, one has to merely look at the numerous examples where poor upstream land use practices result in disaster downstream. Upland erosion not only leads to long-term losses of upland productivity, but also loss of storage capacity in reservoirs which in turn leads to loss of hydropower production, increased flooding, or loss of irrigation capacity downstream. Soil loss brings adverse downstream impacts even when reservoirs are not present. More frequent over bank flows and flood damages will likely result. In addition, lack of adequate water to dilute wastes and general water quality deterioration