Chapter 12
Modeling Hydrological Functioning of a Drainage Basin With Relation to Land Use Change in the Context of Climate Change:
Ourika Watershed Case Study

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ABSTRACT

Ourika basin in Morocco has very steep slopes with impermeable ground favoring water flows and flooding. History has shown deadly flood events. Floods are becoming recurrent and exacerbated not only by human activities that degrade soil and vegetation cover, accelerating erosion and quick water flows, but also by climate change. In fact, the basin has experienced a very strong dynamic of its vegetation cover, during the last 30 years, and has been subject to climate change impacts. This study is devoted to evaluating the impact of land cover change, mainly vegetation cover, on hydrological functioning of the basin. The HEC-HMS model was used to simulate basin hydrological response, according to two scenarios of land cover change. The first scenario simulates deforestation and urbanization impacts on peak flows, showing an increase of the peak flow by 31.68%. The second evaluates the impact of both reforestation actions and proscription of forest harvesting in the region. The simulated results showed a decline of 17.25% in peak flows, except for heavy precipitation events.

DOI: 10.4018/978-1-5225-5939-9.ch012

INTRODUCTION

In semi-arid areas, in general, precipitation is concentrated in time and is often torrential leading to river floods (Sibari et al., 2001). Climate change is likely to produce more frequent and more intense extreme events (Allan and Soden 2008; Driouech, 2010). Indeed, possible amplification of extreme events in Morocco associated to a decrease in total precipitation, could lead to an increased probability of occurrence of events inducing floods and droughts (World Bank, 2013).

Indeed, Morocco is confronted with recurrent rainfall events that can generate flooding likely to cause significant damage. In the past, the country has already experienced recurrent floods (e.g., Ourika in 1984, 1987, 1995, 1999 and 2014; Oued El Maleh in 1996, 2001 and 2002) which have affected both human and animal lives and infrastructures. On the other hand, an increasing aridity, which is manifested by a negative water balance and a reduction in plant activity, is considered as an amplifier factor of forest degradation in fragile environments, which will lead in the future to a migration of some species and their replacement by the desert (World Bank, 2013) exacerbating flood risks.

In this climate change perspective, Morocco, as a Mediterranean country, is expected to be more exposed to flooding; thereby rational management of water levels is a key factor for the safety and security of inhabitants and human wellbeing (Aldosari, 2006). Such management requires a holistic approach to address the various components of the water system (Letcher and Gioppini, 2004).

Unusual floods remain and become stressful with respect to a climate change context in which adverse climate conditions are recurrent and will reflect a structural component to be taken into account for natural resources management. Extensive care should be given in the operation and management of river basins and dam reservoirs used for water supply, flood control or both, so that they are able to overcome the water related problems (Yener et al. 2007). These activities include physical intervention and other soft practices in order to maintain and enhance a forest cover. Even if this later choice is largely adopted and accepted by local managers and the scientific community (Andréassian et al., 2001; Andréassian, 2002; Andréassian, 2004; He, 2003; Choi and Deal, 2008; Gerrits, 2010; Ohana-Levi et al., 2015), the question of how a forest cover contributes to moderate floods remain stressful for natural resources manager.

In order to address that question in a Moroccan environament, the Ourika basin is a good case study. It is known for alarming storms characterized by heavy precipitation localized in space and time (El Alaoui El Fels and Saidi, 2014) with a frequent and brutal flows of the main river and tributaries. e,g, in 1995, such phenomena lead to more than 200 lives lost (Said et al. 2003). Furthermore, vulnerability of this basin to climate change has been shown by many studies (Babqiqi and Messouli, 2013; Salama and Tahiri, 2010; Rochdane et al., 2014). Projected trends show an increasing frequency of extreme events and flooding.

On the other hand, the forest cover has been reduced during the period 1984 to 2000, then, due to the past events and prohibition of forest harvesting starting on the year 2000, the forest cover has been fairly restored (Rihane, 2015). In addition when using climate data from the MPI model (the fifth generation of the European Community Hamburg general circulation model developed at MPI, Germany (Roeckner et al. 2003), it is estimated that the basin biome will shift to bare land by 2070 to 2099. Nonetheless, impacts of forest cover on flood moderation in Ourika basin has not previously been assessed.

This work aims to assess forest cover change on flood moderation through modeling the hydrological behavior of the Ourika basin. Thus, floods have been simulated according to forest cover change scenarios using HEC-HMS solution.