Chapter 3
Mathematical Models Used for Hydrological Floodplain Modeling

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ABSTRACT

There are several methodological approaches to model floodplains. The selection of the appropriate methodology is a matter of the required results and is very dependent on data availability. In fact, data availability is the crucial parameter especially when working in ungauged basins or ephemeral streams. The goal of this chapter is to evaluate methodologies used to floodplain modeling in small watersheds. An overview of the principal models used in floodplain modeling is presented here in terms of their relative advantages as compared to each other. The chapter provides the results obtained with different models applied to a small watershed situated in the Romania and concludes with a discussion about the various recommendations and solutions on flood modeling methodology.

INTRODUCTION

Floods in Europe and especially flash floods in all the Mediterranean countries pose a serious threat to human life, property, infrastructure and block sustainable development. The problem has been recognized by the EU which has funded numerous research projects, has established bodies and Organizations and has issued the 2007/60 "Flood" Directive.

Reports of relevant European organizations as EEA (2012), show that global warming has led to an increase in the hydrological cycle and consequently, to the occurrence and frequency of extreme events in large parts of Europe. Temperature has risen by approximately one degree over the last century, higher than the global average. And as a result, evaporation has increased too. The effect is a change in atmospheric circulation. For this reason, annual precipitation has been generally

DOI: 10.4018/978-1-4666-9619-8.ch003

increasing across most of northern Europe countries, most notably in winter, but decreasing in parts of southern Europe. At the same time, a serious increase in the aggressiveness of the rainfall has been recorded. There are cases in which, in a few hours, rainfall exceeded the monthly rainfall, leading to flood events, especially flash flood events. All over the world have been reported damages caused by flooding. According OFDA/CRED international data bases, during the last period (2000-2007), the number of floods has increased reaching almost 200 events in 2007. For the period 1998-2010 the most affected European countries in terms of economic damages were Germany and Italy. The flood damage costs for Germany only, during 2002, reached 11,600,000bn US$. Disaster statistics and additional data related to damages produced by natural disasters during the period 1980-2010 both for Romania and other European Countries, are given in the PreventionWeb project's Web Site (http://www.preventionweb.net/english/). According to PreventionWeb, during the studied period more than 50% of the disasters recorded were floods. Moreover, the greater losses in economic terms are also due to flooding (3,536,618x1000US$). Flood and storm disaster are those that affect a large number of people. During the aforementioned period, 96,4% of the population was affected by floods and storm. Fatalities caused by floods cover around 50% of the total losses in life.

Within this context, the European Council approved the Flood Directive in September 2007. The Flood Directive demands that all hazard/risk assessment and planning should be conducted on a watershed basis providing a respective management plan. A good example of the implementation of the "Flood" directive is the Danube FLOODRISK project (http://www.danube-floodrisk.eu/). The main goal of this project was to harmonize data and methodologies in order to find a way to delineate the flood risk in the Danube river basin considered as a whole. The project has provided valuable results regarding the flood hazard mapping which has set the base for flood management plans and even the design of preventive measure.

As far as the flood prediction activity is concerned, modeling activities can play a very important place, because they can provide the expected flood extent.

In this context, research presented here helps to improve the knowledge on flood modeling. In this respect, the overall objective is to identify the proper methodology to floodplain modeling. To achieve the objective purposed in this chapter, the following specific objectives are proposed:

- The basic principles underlying the most commonly used model are reviewed in order to investigate the ability to incorporate flood modeling techniques into a GIS for generating flood hazard maps
- Basic criteria for the model evaluation are set.
- A pilot implementation of all selected models is carried out in the same river basin in order to provide comparable results.
- The results of the application of the different types of models used are compared.

The structure of the present chapter comprises the following parts.

The introduction includes an overview of the problem which justifies the necessity of flood modeling, objectives of this research and a detailed description of the study area including physical, geomorphological, hydrological, soil conditions and existing land use conditions. Additional information regarding rainfall and runoff data are also presented.

A brief overview of methodologies and procedures used to model floods is presented with an emphasis given to comparing their requirements and their results in terms of reliability and accuracy. A classification of these models is shown as well.

Flood modeling methodologies were applied in a test area in Voinesti, Romania. In particular, ANSWERS and TOPOG as physical-based dis-