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# Flood modeling with FLO-2D: Mersin / Lamas River

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**Abstract**

Floods are natural disasters that cause loss of life and property, when necessary, precautions are not taken. It is the first among meteorological disasters in our country, and it comes after earthquakes among all disasters. In order to prevent or reduce the losses caused by floods, flood models should be made and precautions should be taken. In this study, two-dimensional flood modeling was carried out for the Lamas River, which transfer its waters into the Mediterranean and is located in Mersin province. In the study, the FLO-2D model was carried out on the 5-meter resolution elevation model obtained from the General Directorate of Maps. In the study, $Q_{100}$ and $Q_{500}$ flow return periods were modeled, and flood maps were obtained. As a result of the study, it was determined that the study area within the city limits was affected by both floods and the agricultural greenhouses in this area were unprotected. In addition, it was stated that the DEM resolution used significantly affected the study results.

## Introduction

Flood is a major natural disaster that affects many places in the world, including developed countries. In addition to loss of life, billions of dollars of property losses are experienced every year due to floods [1]. With flood models, it is possible to prevent or reduce all these losses by informing the public where will be flooded. These models are also very useful in flood-related relief and rescue operations [2]. 2D flood modeling is a newly developing subject in our country. In order to prevent or minimize the loss of life and property, flood maps should be prepared, and measures should be taken before floods occur. In this study, flood modeling is carried out by using a package program capable of hydraulic modeling, high-resolution topographic data, and some flood return periods obtained with various statistical distributions.

The aim of this study is to perform flood modeling with the help of the FLO-2D package program, which can make two-dimensional hydraulic modeling by using different recurring flow rates (100 and 500-year return periods) of the Lamas River, which is located within the borders of Mersin central district and empties into the Mediterranean.

## Material and Method

Many input data are used in flood modeling [3]. As these parameters are detailed, the model can better express the real environment or the studied area. The main ones of these data are numerical surface or elevation model, flood recurrence rates or hydrograph and Manning roughness coefficient. For other data, the following source can be examined [3,4]. In this study, digital elevation model (DEM) data with a resolution of 5 meters was used. This data was obtained from the General Directorate of Mapping. The repeat flow rates were obtained from previous studies and the flow rates used in this study are given in Table 1 [5]. In the study, the Manning roughness coefficient was assumed to be a constant 0.04 like Demir et al. [6].

**Table 1.** Return period of flood flows [5]

| **Year** | **100** | **500** |
|---|---|---|
| **Peak Flows ($m^3/s$)** | 113.15 | 163.78 |

### FLO-2D

FLO-2D is one of the package programs produced/developed by O'Brien, where 2D hydraulic models are made [7] .FLO-2D has been widely used in flood modeling in recent years [8–10]. It models the flow of water in terms of time. This model represents a simplified version of the stream containing particles of various sizes, the main components of which are solid and water materials [11].

### Study Area

The surface area of Mersin is 15,853 $km^2$ and most of it is within the borders of the Eastern Mediterranean Basin. Mersin province, which is surrounded by the Mediterranean from the south, is separated from the inner parts of Anatolia by the high plateaus and peaks of the Western and Central Taurus Mountains from the north. Lamas River (Limonlu) is located in Erdemli district of Mersin. This river takes its source from Yüğlük Mountain and flow into the Mediterranean [6]. The study area and DEM are shown in Figure 1.

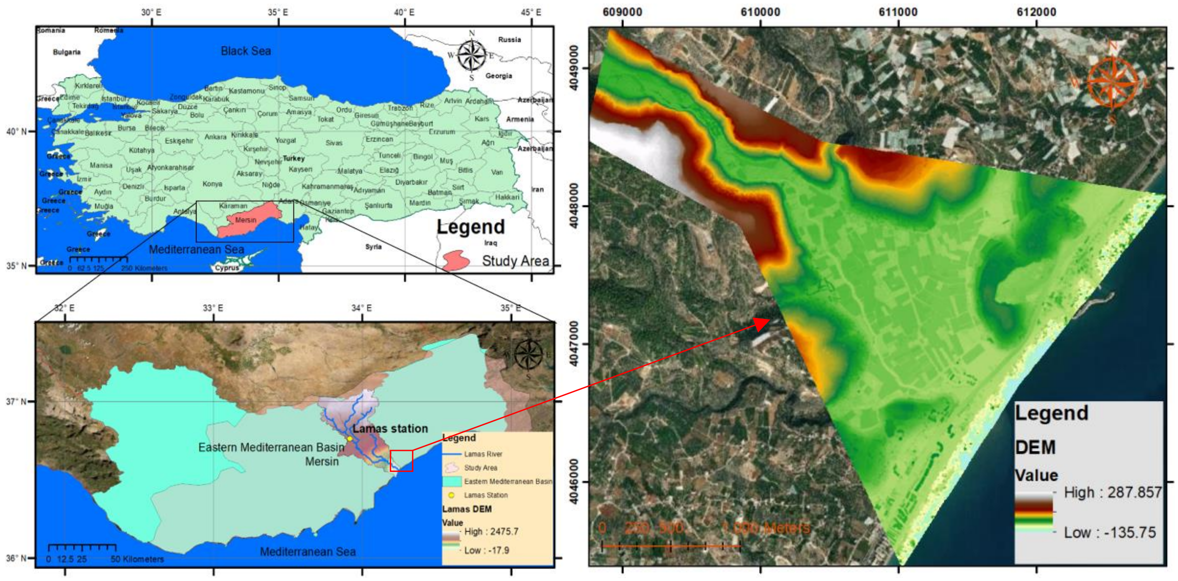


**Figure 1.** Study area and DEM, revised from [6]

### Results

Flood modeling basically requires a digital elevation model, the calculated flow rates for the different recurrent times of the Lamas River, the baseline map of the region, and the Manning friction coefficients [6]. In this study, a 5-meter resolution DEM obtained from the General Directorate of Mapping was used. Flood flow rates were obtained from the literature and the Manning coefficient was assumed to be a constant 0.04 for the entire study area. In the study, 2 different recurring flow rates $Q_{100}$ and $Q_{500}$ were modeled using FLO-2D and the results are given in Figure 2 and Figure 3.

When Figure 2 and Figure 3 are examined, water heights of 11 meters at the upper elevations where the flow first begins, and 3 meters to 5 meters in places, in the region where the flow ends or exits to the Mediterranean, have been determined. At $Q_{100}$ flow rate, the flow generally follows the riverbed, but cannot follow downstream and spreads out of the river. At the $Q_{500}$ flow rate, many greenhouse areas are affected by the flow and water levels up to an average of 3 meters are observed.

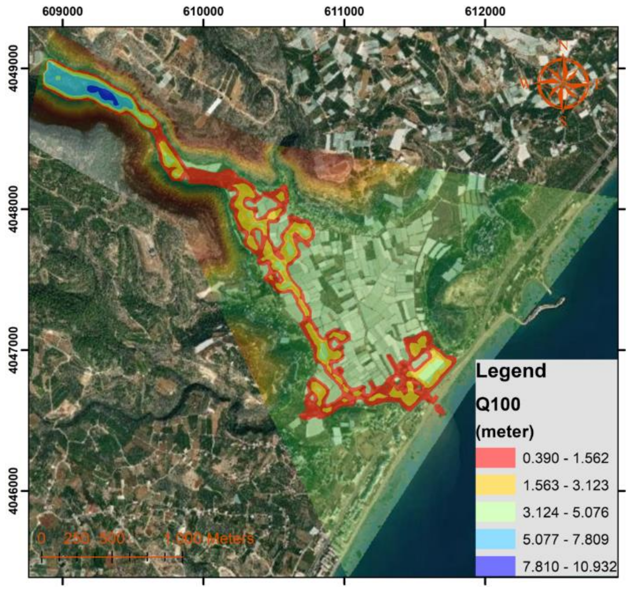


**Figure 2.** Flood propagation map for $Q_{100}$

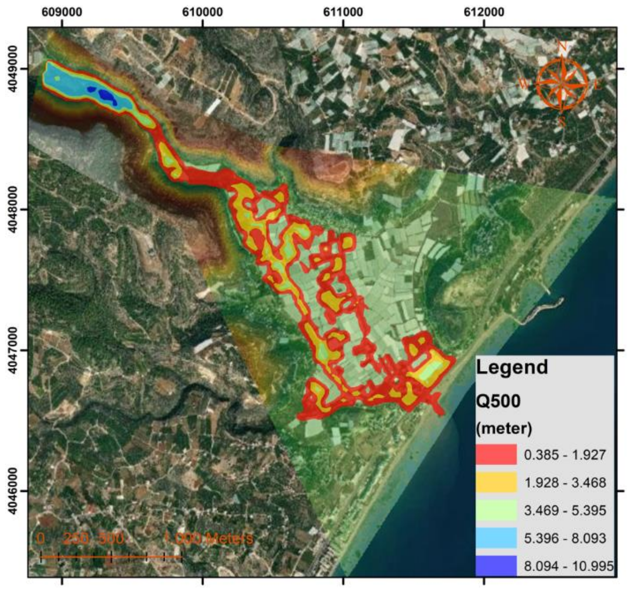


**Figure 3.** Flood propagation map for $Q_{500}$

## Discussion

Another aim of the study is to compare the results of the model performed using HEC-RAS in this area with some of the criteria of this model [6]. In this study, 10-meter resolution DEM, 25-meter size mash, 0.04 constant Manning friction coefficient and $Q_{100}$=36.3 m$^3$/s, $Q_{500}$=51.5 m$^3$/s flow rates were used. As a result of the study, it is seen that almost all of the upstream region is under water. It was also determined that the river flow could not follow the riverbed in any way. In the current study, 5-meter resolution DEM, 25-meter size grid, 0.04 constant Manning friction coefficient and $Q_{100}$=113.15 m$^3$/s, $Q_{500}$=163.78 m$^3$/s flow rates were used. As a result of the study, it was observed that a part of the upstream section was affected by the flood and the water flow followed the river bed. This result shows that the DEM resolution used in flood models can greatly affect the study. In addition, the fact that the flood flow rate has increased by about 3 times shows that there may be an increasing flood trend in the region with the updated data. In order to protect the greenhouses in this region, which is important for the economy of the region, from possible floods, it is recommended to raise the river sections and to clean the sections at regular intervals.

## Conclusion

In this study, two-dimensional flood modeling was carried out using FLO-2D and 5-meter DEM. In the modeling, 2 different recurring flow rates were used and the areas that would be affected by possible floods were determined in both flow rates. Contrary to the past records of climate change, serious floods are seen in some regions and extreme droughts are seen in some regions. For this reason, $Q_{500}$ flow rate should be used as a reference model flow rate, especially in flood models to be made in urban centers, and cross-section and bridge arrangements-designs to pass this flow should be considered. In addition, digital surface model should be preferred instead of digital elevation model in modeling, and 5 meter resolution DEM data or more sensitive data should be used in modeling as in this study.

In future studies, it is considered to use smaller model grits (dimensions) for the same region and to simulate the flood using at least 2 different hydraulic models by calculating various recurrent flow rates. Thus, calibration problems will also be investigated. In addition, it is planned to obtain the Manning coefficient according to the topography characteristics and the COWAN method instead of a fixed value.

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