

# Surface Water Management and Modelling in the Sakia El Hamra Hydraulic Basin (Southern Morocco)

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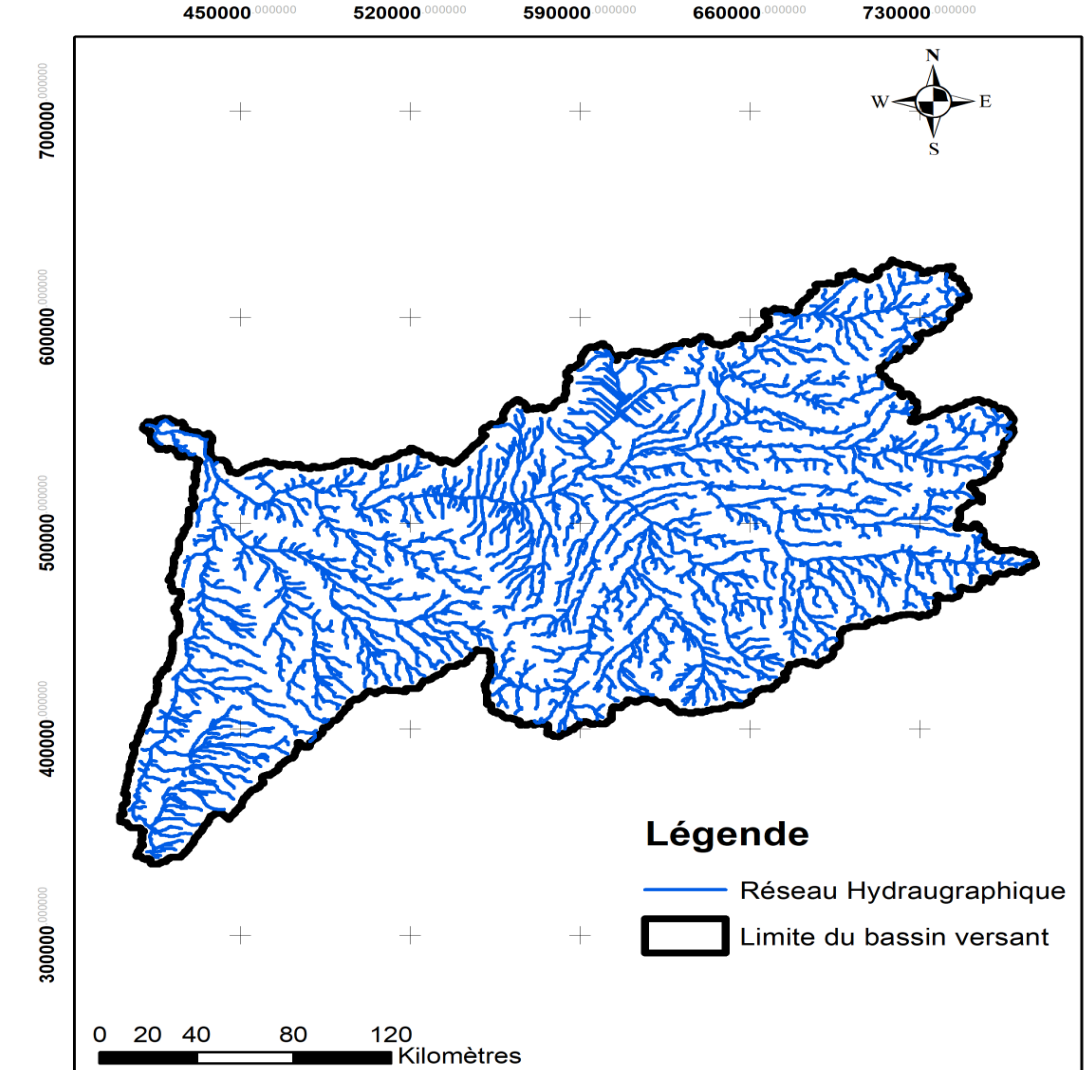
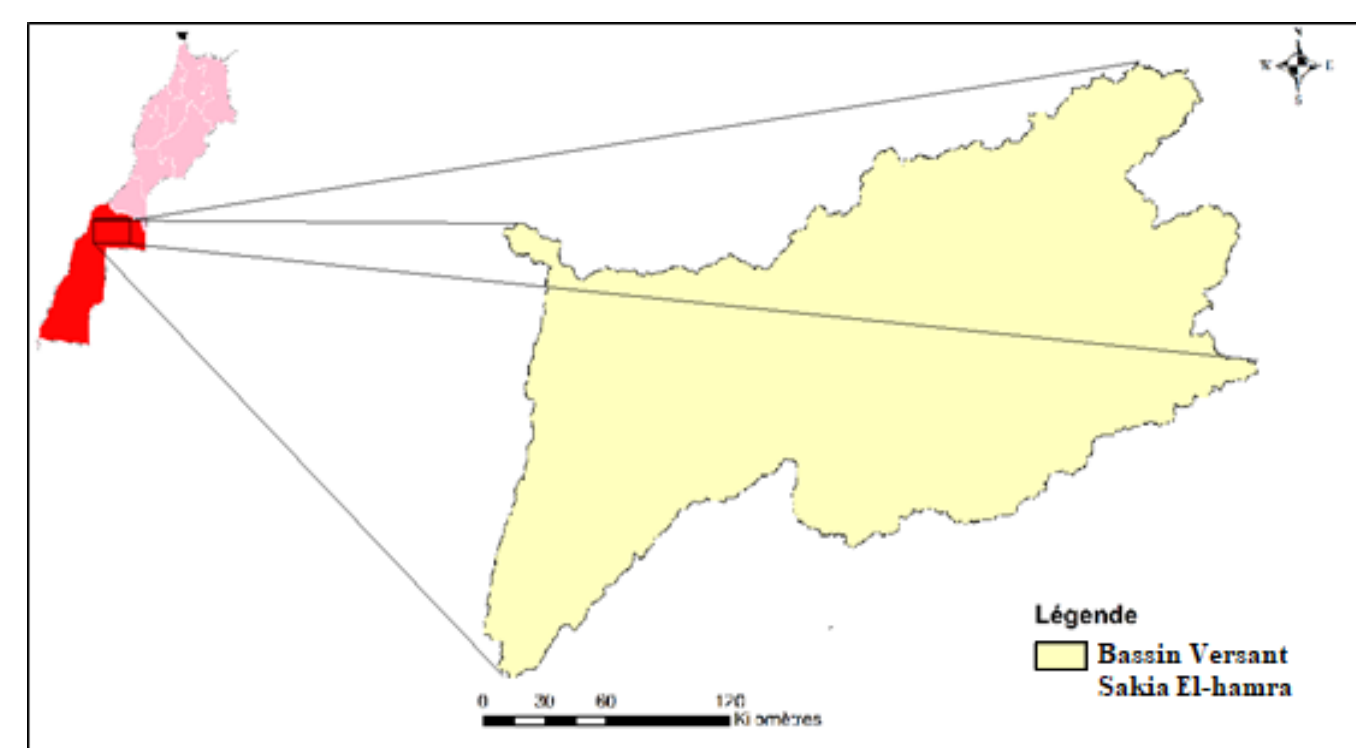
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## Introduction

The watershed of Sakia El Hamra covers an area of 52000 km<sup>2</sup>, that drains to Sakia El Hamra wadi, a stream of about 447 km long, crosses the basin in its northern part in the East-to-West direction, to discharge into the Atlantic Ocean at the outlet called Fom El Oued. This zone often experiences dangerous torrents of water and violent flash floods, specifically in the northern part of Laayoune city. For example, a flash flood has occurred at the end of October 2016. The peak flow was far in excess of the average (3000 m<sup>3</sup>/s against 410m<sup>3</sup>/s). This river flood, lasted for about 10 h, caused damage to the infrastructure and destruction of agricultural lands near Fom El Oued. The objective of this study is to investigate the hydrological regime of SAKIA EL HAMRA catchment to prevent the floods in the future and improve warning systems. The present work consists of three parts: the first part concerns the description of the watershed area through its hydrological parameters. The second part is about the modeling of the hydrological regime using the HEC HMS software. The last task was to simulate the floods in the area and vulnerable regions based on the flow recorded during the last flood.

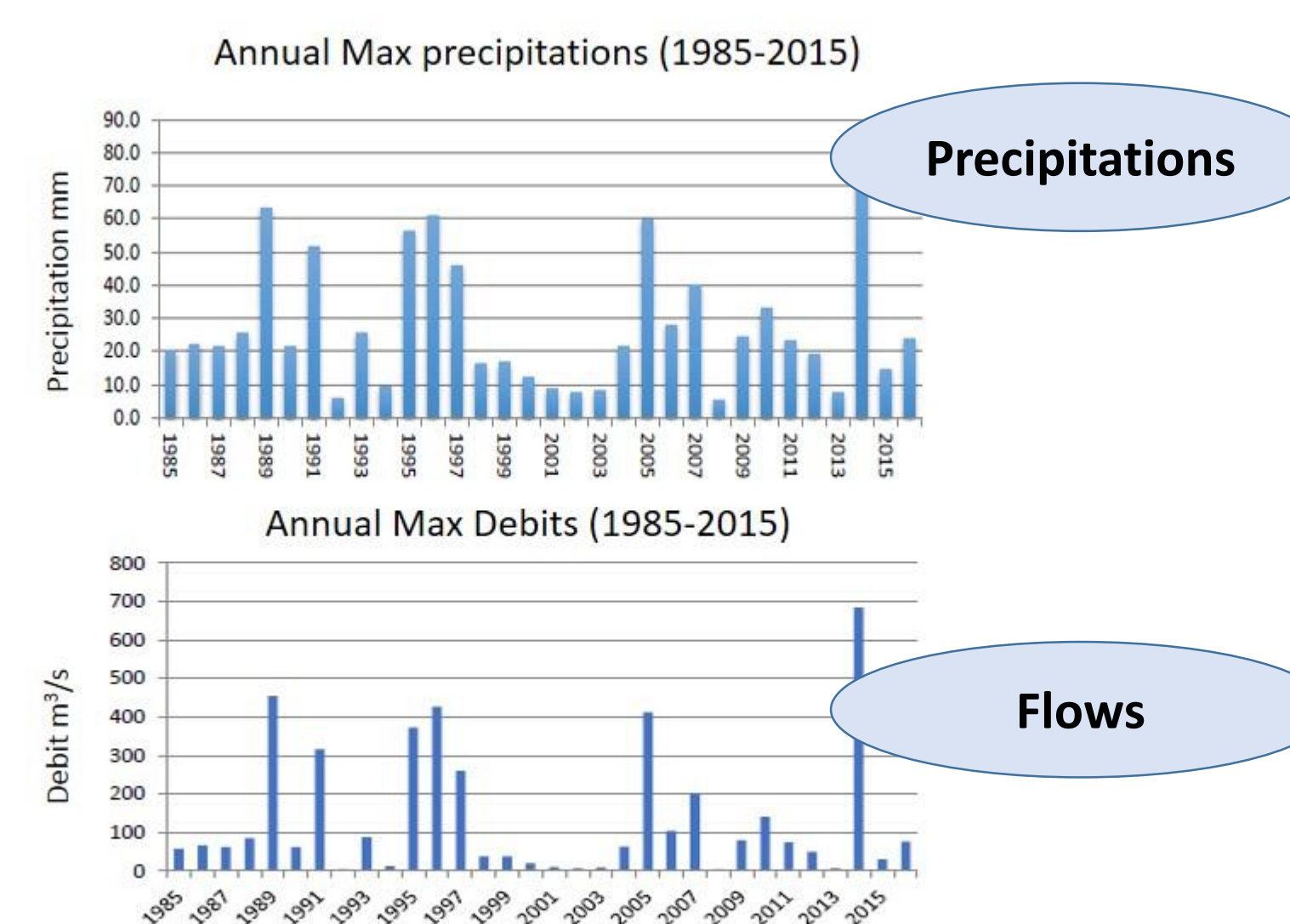
## Study area

- The watershed of Sakia El Hamra is located in south of Morocco;
- It covers an area of 52000 km<sup>2</sup>;
- Arid to semi-Arid climate;
- Mean annual precipitation 60 mm;
- It's an area characterized by flash floods.



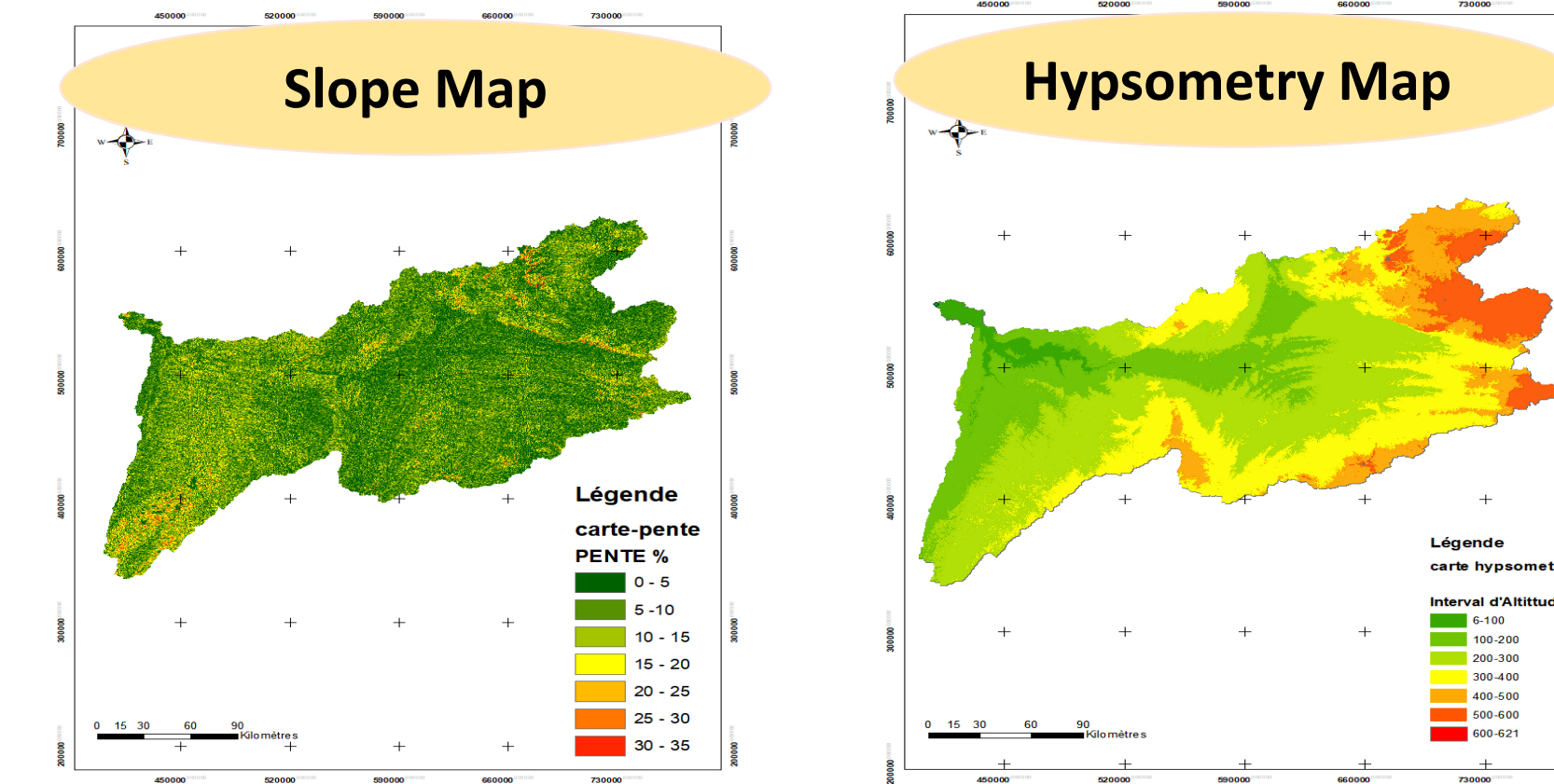
## Materials and experimental data

### Climatologic data



- The Laayoune Airport Meteorological station, provided for us the max annual precipitations and flows during 30 years ; from 1985 to 2015.

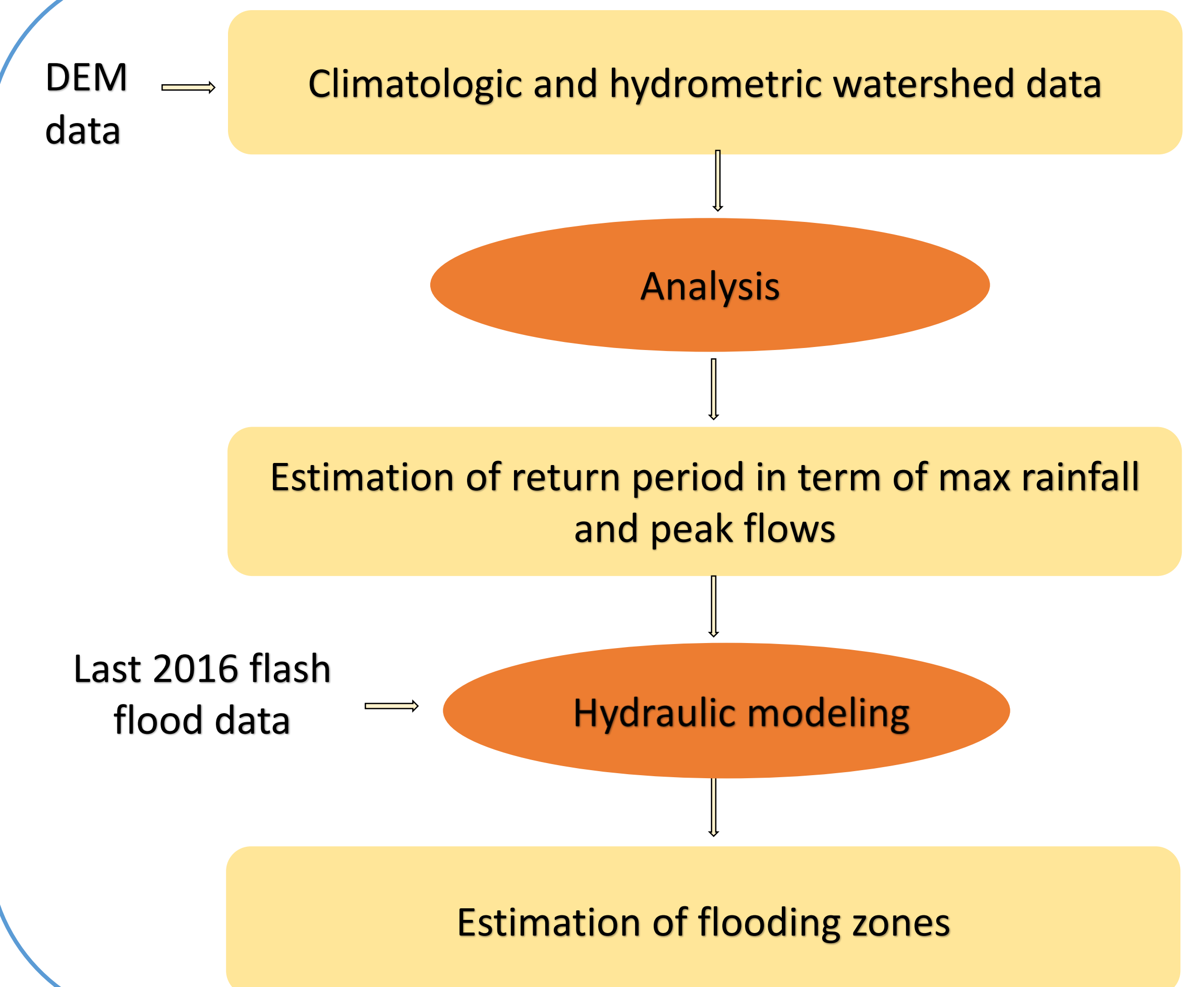
### Watershed characteristics



The characteristics of watershed were mainly extracted from DEM, acquired from ASTER satellite :

- The relief of the watershed;
- Slope indices;
- Drainage density;
- Calculation of concentration times.

## Methodology



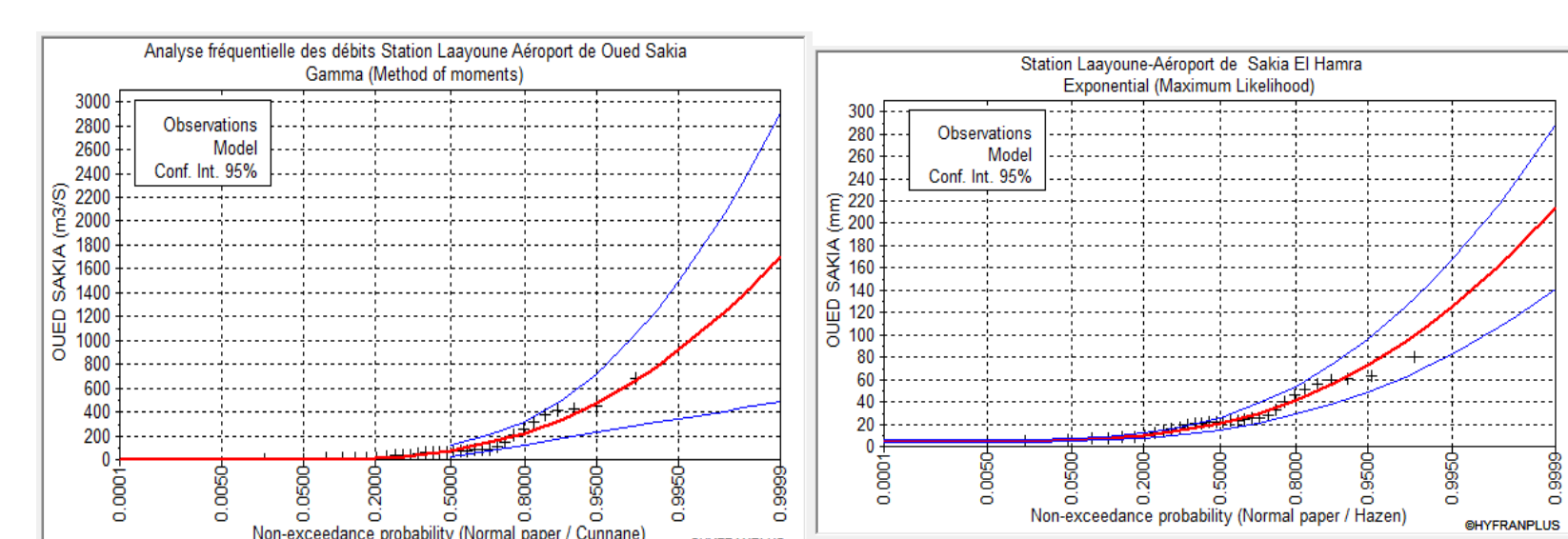
## Conclusion and perspectives

The results showed that during flash floods with known flows, water level can reach up to 13 meters, with high flow velocities flooding hundreds of hectares of surrounding plains at the northern part of the city of Laayoune and agricultural lands near Fom El Oued. In addition some perspectives are highlighted:

- ✓ To refine the results ground topographical companies are needed;
- ✓ The estimated flooding areas must be declared as hazard zones and prohibit construction of either houses or future projects;
- ✓ The use of SAR data to improve floodplain mapping.

## Results and recommendations

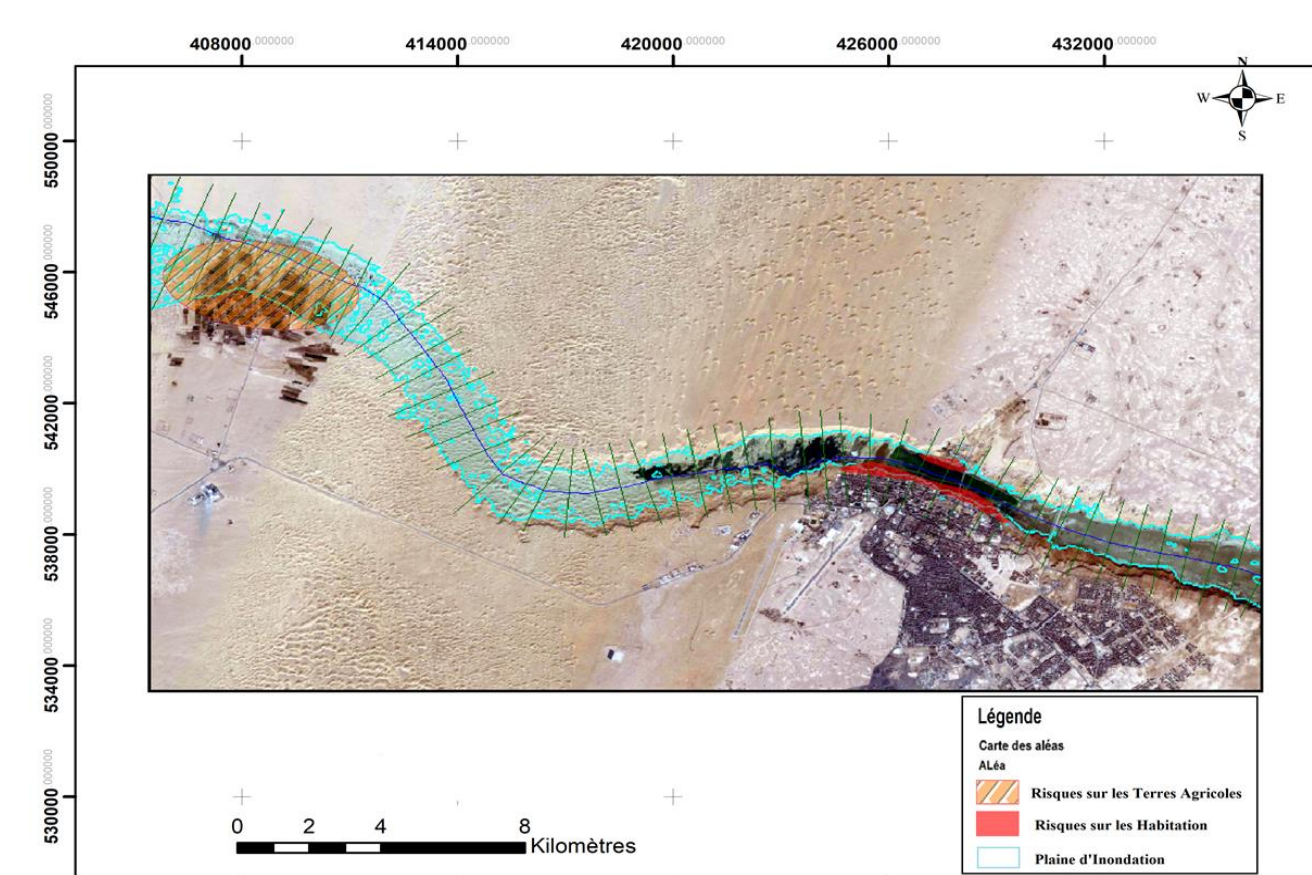
### Frequency analysis



The analysis showed that:

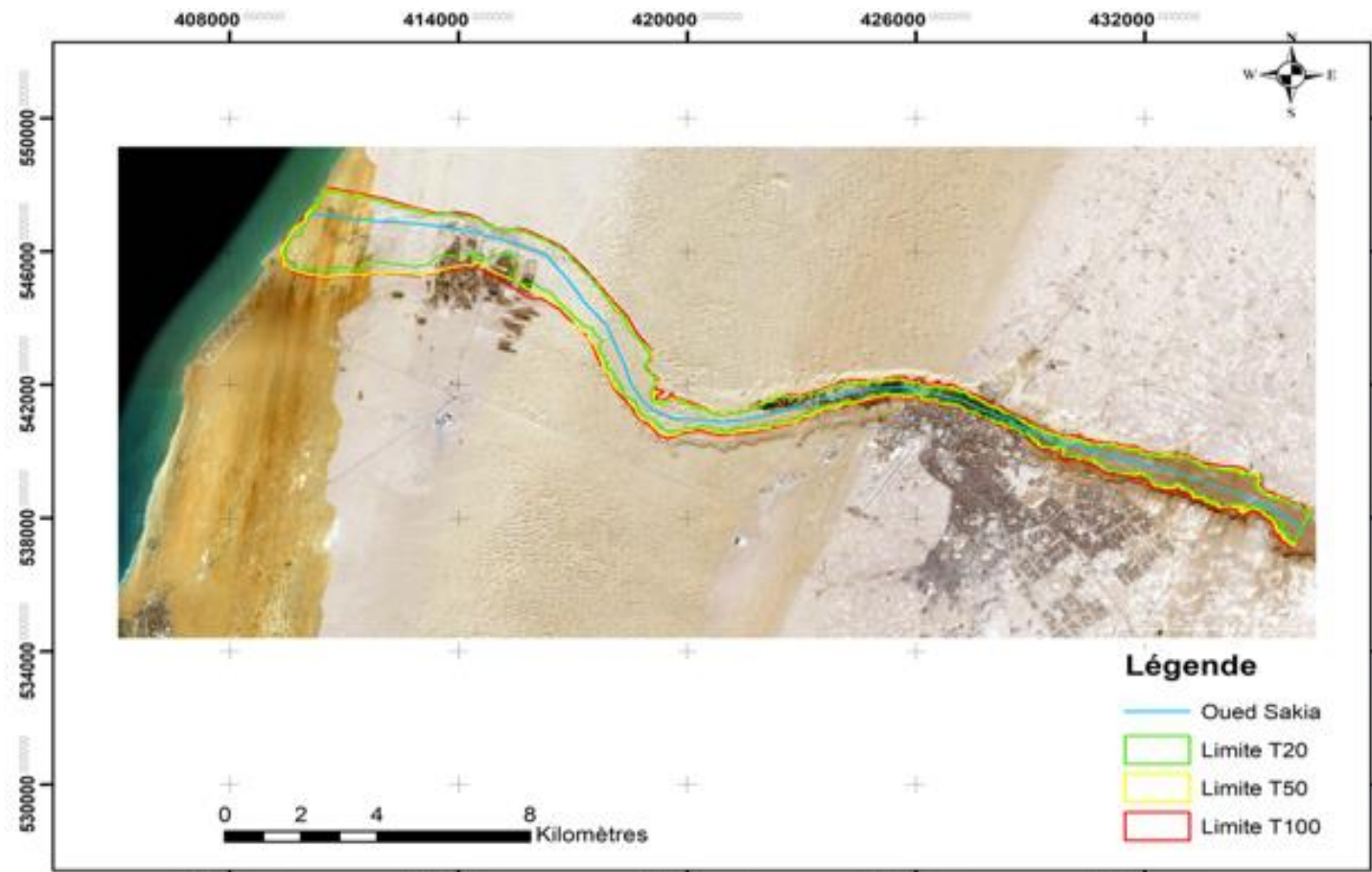
- the Gamma distribution is best model for estimating annual maximum flows;
- the exponential distribution is best model for estimating maximum annual rainfall.

### Hazard Map



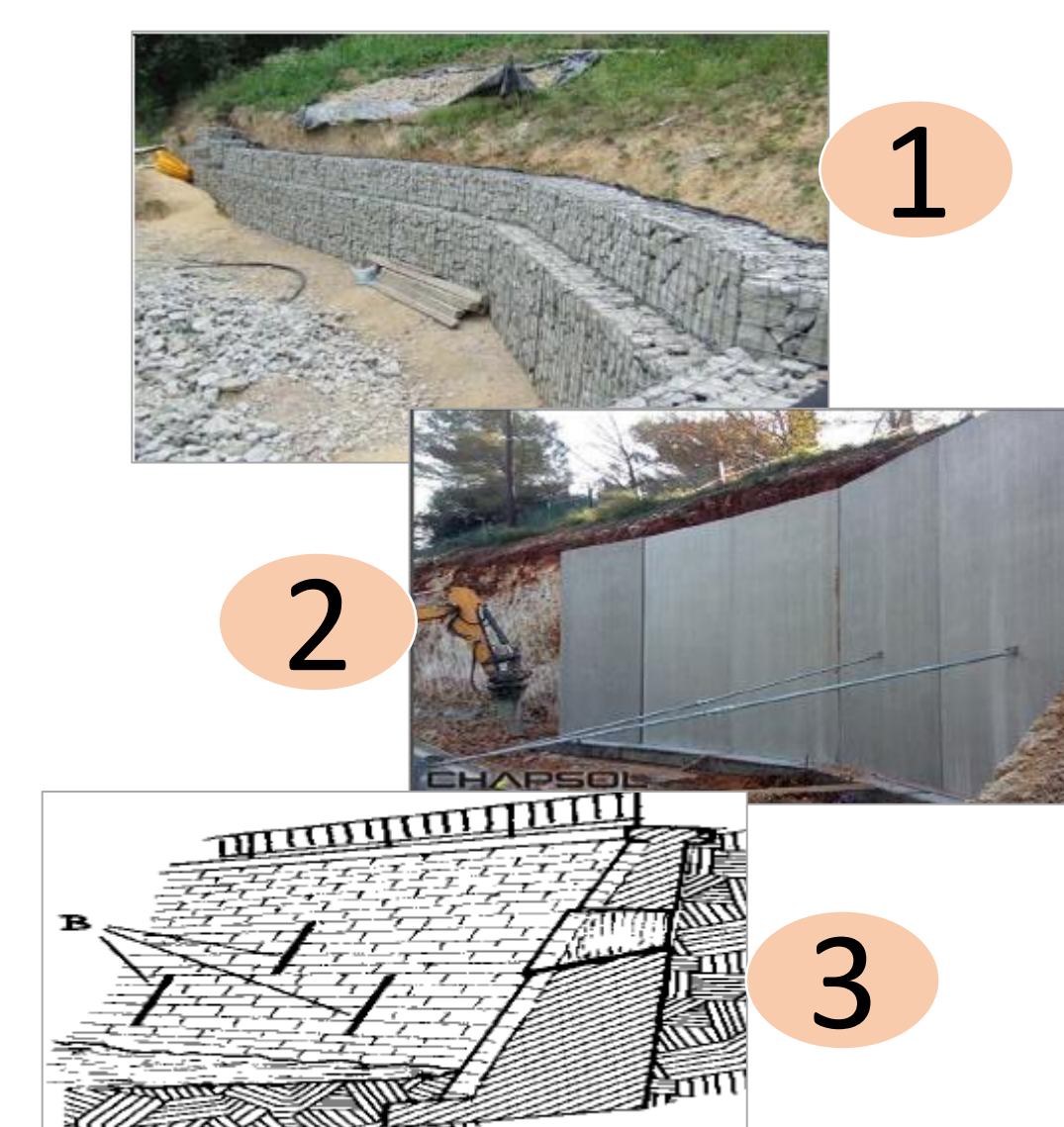
- The hazard Map illustrated the flooded area during last flash flood on October 2016, mainly: destructed built-up area and affected agricultural lands

### Estimated flooding areas



- The estimated flooding areas for period of 20 years, 50 years, 100 years.

### Recommendations for protection against floods



## Aknowledgement

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