



River flood modelling for the integrated management of flooding risk.

Application to the Tahaddart watershed. North-western Morocco

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Contents

- **Problem and justification**
- **Study Area**
- **Objective**
- **Methodology**
- **Expected results and impacts**

Problem and justification

The World

The negative impacts of climate change on freshwater systems outweigh its benefits :

- ❖ Areas in which runoff is projected to decline face a reduction in the value of the services provided by water resources.
- ❖ The beneficial impacts of increased annual runoff in some areas are likely to be tempered by negative effects of increased precipitation variability and seasonal runoff shifts on water supply, water quality and flood risk.

The resulting increased flood risk poses challenges to society, physical infrastructure and water quality. It is likely that up to 20% of the world population will live in areas where river flood potential could increase by the 2080s.

Increases in the frequency and severity of floods and droughts are projected to adversely affect sustainable development. Increased temperatures will further affect the physical, chemical and biological properties of freshwater lakes and rivers, with predominantly adverse impacts on many individual freshwater species, community composition and water quality.

Problem and justification

Morocco

In 2020, it is expected that Morocco knows :

- ✓ Increasing temperatures of about **0.7 to 1 C °**
- ✓ decrease in rainfall of about **-7 to 0%**
- ✓ shrinking snowpack to higher altitudes
- ✓ the water sector will experience a decline in resources evaluated **10-15%**

This will have negative repercussions on the national economy

Agriculture
19,2% of
GDP
(2009)

Problem and justification

Morocco

Like all the Mediterranean countries, Morocco is subject to major floods can be very damaging for public and private infrastructure, agriculture and causing numerous civilian casualties.

For example :

- ✓ Event of the Ourika Valley in August 1995
- ✓ Events in 1996, 2000, 2001, 2002, 2003 in particular, have affected the northern regions (Martil river in Tetouan, Taza ...) or the region of Casablanca (Mohammedia, Settat, Berrechid)
- ✓ October 2008 in the region of Nador, Al Hoceima, and Zaio



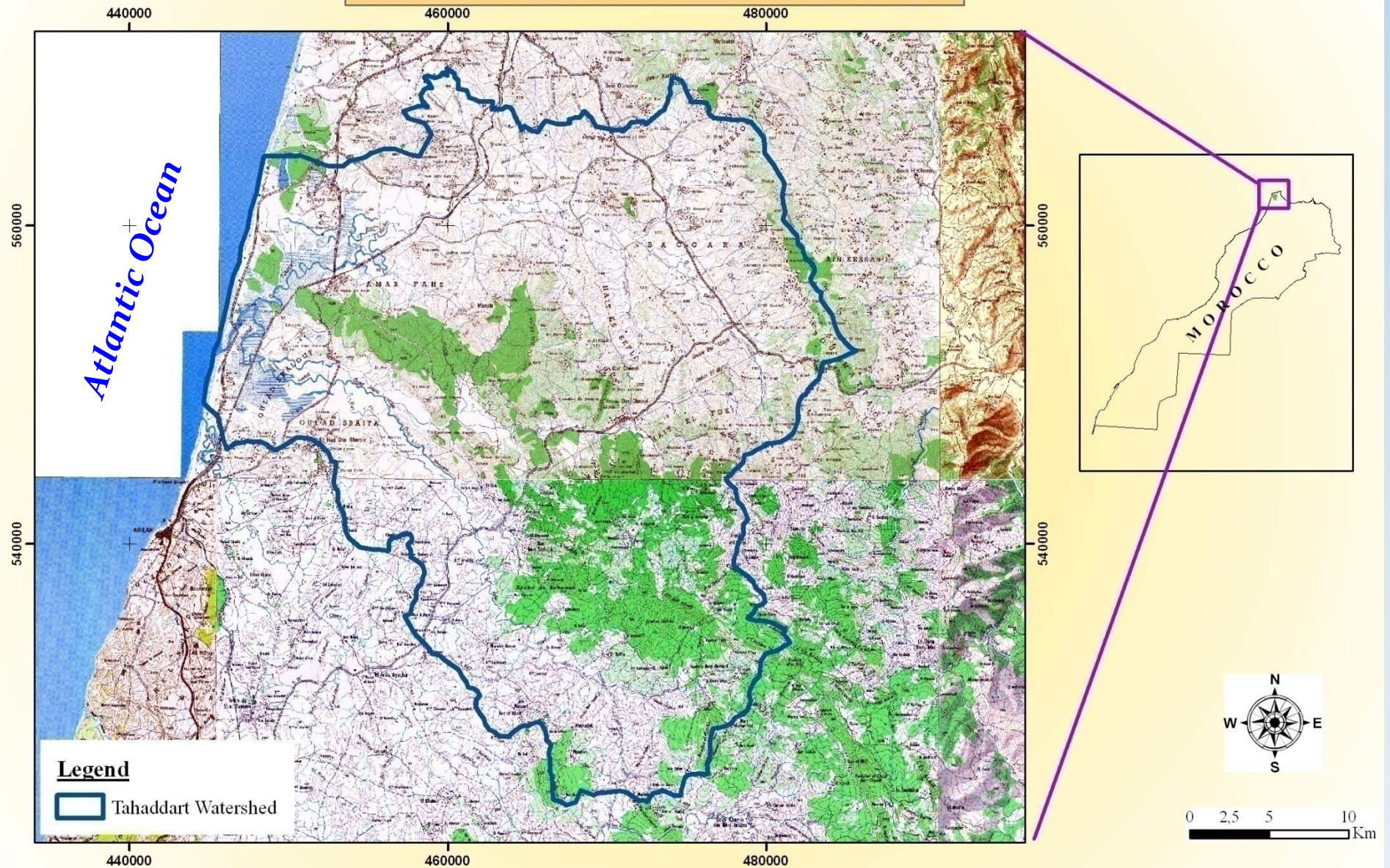
Nador



Mohammedia

Study Area

Location Map of the Tahaddart Watershed



Study Area

Characteristics

- ✓ location : northwest of Morocco
- ✓ area : 114 560 hectares
- ✓ administrative situation : between Wilaya of Tangier, Wilaya of Tetouan, province of Larache and Province of Fahs-Anjra
- ✓ reliefs : predominance of mountainous land and hills
- ✓ climate : Mediterranean, with a seasonal variability of rainfall, (average about 750 mm / year), temperatures not less than 0°C and do not exceed 40°C

Objective

The overall objective of this study is to develop data elements that allow local actors to establish a strategy to guard against adverse effects of climate change, especially floods and mitigate their adverse impacts.

The specific objectives are :

- ✓ Assess the vulnerability of the study area to flooding;
- ✓ Develop the map of flood zones, the sensitivity and potential damage of flood;
- ✓ Determine the causes and impacts of floods;
- ✓ Evaluate the cost of flood damage;
- ✓ Propose adaptation measures to mitigate adverse effects of climate change;
- ✓ Compare the cost of action and inaction against climate change;

Methodology

This study will be released on the following steps :

1. Mapping land

By using aerial photographs, satellite images as well as other cartographic materials, different land uses in the Tahaddart watershed will be mapped (Agriculture, Forest, Beach, Water ...) as well as all infrastructure and equipment (Roads, Railways, dams ...). To study the impact of flooding on the natural environment and socio-economic facilities of the study area.

2. socio-economic analysis

To determine the factors responsible for the current state of the land, we will conduct a socio-economic analysis will be based on the most recent surveys in the area, meetings with many local actors and surveys with the local population. Thus, this analysis will include: demographic characteristics of the population, social characteristics, the main economic activities, the state of urbanization and housing, public facilities, basic infrastructure, the state land and valuable sites present on the territory of the study area.

Methodology

3. Flood Hazard Mapping

To map areas at risk of flooding, we will use the method developed by CEMAGREF “INONDABILITE”(National Center for Agricultural Mechanization, Rural Engineering, Water and Forest, France). This method has been developed through extensive research put forward in the wake of damage caused by floods in Western Europe especially in France. It was designed to provide a framework for analysis of flood risk. This method has been used in Morocco as part of the national study of protection against flooding .

❖ **Flood risk**

The risk of flooding due to two fundamentally different parameters that are VULNERABILITY (sensitivity to flooding, it depends on the land use) and the HAZARD (areas where flooding may occur). Flood risk is assessed by the intersection of vulnerability and hazard. Vulnerability refers to the land use. It reflects the fact that a region is more or less sensitive to the risk of flooding. Hazard refers to hydrometeorological phenomena and their impact on the drainage.

Methodology

❖ **Vulnerability**

The vulnerability map was obtained using the map of land use area, and grid transformation developed in the framework of the national study on protection against flooding constituting a standard for Morocco.

❖ **Hazard**

The Hazard is the map that identifies the areas where floods are likely to occur, more or less extensive and frequent. It includes the areas of depression and overflow areas of rivers.

The determination of areas of depression is based primarily on the development of digital elevation model (DEM), determining the direction of water flow, the filling of internal drainage of the DEM.

The overflow areas will be identified using the DEM and extension HEC-GEORAS designed specifically to treat geo-spatial data. It creates a database that contains the geometric data and hydraulic structures.

HEC-RAS (Hydrologic ENGINEERING Center's River Analysis System), which allows for simulations of floods.

❖ **Identifying causes and flood damage**

To identify the causes and flood damage, we will conduct an investigation near the institutions affected or concerned by floods.

Methodology

❖ **Estimated cost of flood damage**

The evaluation of the cost of flooding is useful for associate a price on adaptation needs. But it is important to note that the estimated economic loss of infrastructure is a very complex task. However, in this study these values will be estimated on the basis of market prices.

4. Proposed adaptation to climate change

The proposed adaptation measures that are to come from local actors through targeted surveys. The proposals will incorporate reflect concerns and experiences of the population in the design of adaptation.

We also be based on the listing of accommodations that are in other countries by selecting only those measures that are more adapted to the context of the study area.

We try also to estimate the cost of adaptation to flooding in comparison with the cost of damage in case of inaction to deduct the **gross profit of adaptation**.

Expected results and impacts

The main results of this work are: evaluation of the vulnerability of the flood zone, the precise determination of flood zones, agglomerations, equipment and infrastructure in flood risk very high, estimated the cost of flood damage on the watershed.

The study of susceptibility to these risk factors would provide information that can develop strategies to prevent the adverse effects which would be exposed populations and their socio-economic activities and promote adaptation measures developed and adopted by local actors.

This action of adaptation to climate change is necessary to prevent damage and minimize potential threats to economic development, infrastructure and ecosystems.

**Thank you for
your attention**