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The impact of flood risks on urban expansion areas in cities (Case study of M'sila, Algeria)

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Abstract. Natural disasters and their causes are so complex and difficult to classify that some types have sudden impacts while other types have slow impacts on urban expansion areas. Flood is one of the most serious natural disasters affecting the urban environment. On the physical side, flood causes destruction of buildings and cuts in the urban fabric. However on the environmental side, flood's impacts appear in the presence of swamps and ponds and which cause, in turn, the spread of bad odors, epidemics and diseases via running water. The latter may have a greater impact on infrastructure such as bridges, roads and the lives of residents. As for M'sila region, whenever there is heavy and sudden rain, the neighborhoods and residential communities located along El-Ksob valley, as well as the area of urban expansion, are exposed to torrential floods due to the high level of the valley water as well as El-Mwailha valley, which is located within the area of land occupancy plan (Hammam Dal'a Road). These floods have resulted in large losses in buildings and properties, and in some cases, victims. Therefore, this study discusses some risks caused by floods on the urban expansion areas in M'sila and tries to provide solutions to reduce the severity of this phenomenon.

Keywords. Urbanization, risks, floods, cities, urban expansion, Msila

Introduction

Floods are natural disasters due to the sweeping waters of carrying clay, sand and rocks, and covering trees, houses, and the like. Since most of the floods lead to disasters and destruction of urban facilities, concerns have been directed to predict their occurrence and to reduce the risks resulting from them. In addition, floods are the most complex natural phenomena, and we cannot identify the real reasons or reach accurate results while studying them because there are a variety of factors contributing to their happenings, including large amounts of rainfall in a limited time as well as the geological composition, which in turn affects the coefficient of soil permeability. In this regard, it is worth to mention the human cause in constructing buildings in areas exposed to natural dangers (floods) or urban expansion without considering the laws of construction which results in multiplying the size of the disaster if all these factors were not taken into consideration.

1. Definition of Flood:

Flood is a common phenomenon, especially in recent years. It results in mass losses of human, material, and economic losses. It is the accumulation or the increase of waters that flood

the land. Flood means "flowing waters", and this meaning can also be applied to the flow of tides and ebbs often because of heavy rainfall.

2. Studying the Flood Risks on M'sila:

2.1 Geographical Location:

Msila is located in the north-west of El-Houdna Basin, bordered on the north by El-Houdna mountains range and on the southern side by El-Houdna Basin. It is a crossroads for the 40 national road, the 45 national road, and El-Ksob Valley, which runs lengthwise (north-south); it crosses the neighborhoods in the north of the city, and it is adjacent to the center and east of the industrial zone. It continues its stream near to Mezrir, one of the most important reasons of M'sila's development in different phases. Its area is estimated at 233 km².

2.2 Administrative Location:

The Municipality of M'sila is located at the northernmost borders of the city, where it is bordered by:

- From the north: Bordj Bou Arreridj (El-Ashe municipality).
- From the south: Ouled Madi Municipality.
- From the east: Metarfa and Sewame'a Municipalities.
- From the west: Ouled Mansour Municipality.

3. Climate Data:

The field of study is a transitional area between two semi-humid and semi-dry biospheres in the south, due to its geographic location, which is a boundary between two different physical units from the morphological view: Setif's hills representing the Hill Atlas in the north and Ouled Nail Mountains representing the Desert Atlas in the south and Shatt El-Hudna, as we mentioned earlier. Therefore, the climate range of the study area is influenced by this geographical location, where we find it affected by the semi-humid air currents from the north, which often collide with the mountain range as a natural barrier.

The area of study is also affected by semi-dry air currents coming from the south. In general, the climate of the study area belongs to the Mediterranean climate which is characterized by cold wet winter and hot dry summer.

3-1 Heat:

According to the climatic data for the study of the INSID institute, the highest temperature recorded in July was 38 degrees Celsius and the lowest temperature recorded in January was 3.8 degrees Celsius.

Table 1: Monthly Heat Rates (1982-2022)

Month	January	February	March	April	May	June	July	August	September	October	November	December	Yearly rate
Thermal average	3.8	4.3	7.1	10	15.3	20.9	24.6	24.3	19.5	14.0	9.0	4.7	13.12
Maximum temperature	13.6	15.9	19.2	22.8	28.4	33.9	38.0	37.3	25.5	22.8	19.1	14.1	24.21
Minimum temperature	8.5	9.9	13.1	16.4	21.9	27.5	31.5	30.8	25.4	19.6	13.5	9.00	18.92

Source: Meteorological Service of the City of M'sila - October-2022

3-2 Wind:

The prevailing wind direction is the northeastern direction in winter, while in the summer the predominant wind direction is the southern one.

3.3 Rainfall:

The rainfall is between 170 and 300 mm per year, with a maximum of 400 mm and a minimum of 200 mm per year.

Table (02): Monthly Rates of Rainfall (1982-2022)

Month	January	February	March	April	May	June	July	August	September	October	November	December	Yearly rate
Rainfall ratio (mm)	22.3	11.7	17	18.3	25.1	9.4	2.6	6.8	22.4	24.3	24.2	20.2	20.43
Number of days	5.6	3.5	5.1	3.6	3.4	1.9	1.2	1.9	4.7	4.3	5.3	5.4	4.99

Source: Meteorological Service of the City of M'sila-October-2022

Here we refer to the city's drainage system, a common type where all wastewater and rainwater are collected in a single network from north to south, and all of them pour in El_Ksob Valley. Drainage was in poor condition due to lack of management and the lack of drains in many streets. They were often exposed to flooding, which required attention and intervention. However, it has been noticed in recent years that the municipality of M'sila was concerned with cleaning the network, but it was not only concerned with renewing it.

We also find that Algeria applied Article 76 of the Water Law N°17/83 of 16/07/1983, in which chapter 5, "Water-damaging effects", chapter I, "Flood control," states that the State, at the level of the hydrographic network, shall form the facility which regulates, adjusts, calibrates, seizes and smooths flood heights in order to protect the national economy and people and their properties against the risks and the damages caused by floods.

4 -Expansion Area in M'sila:

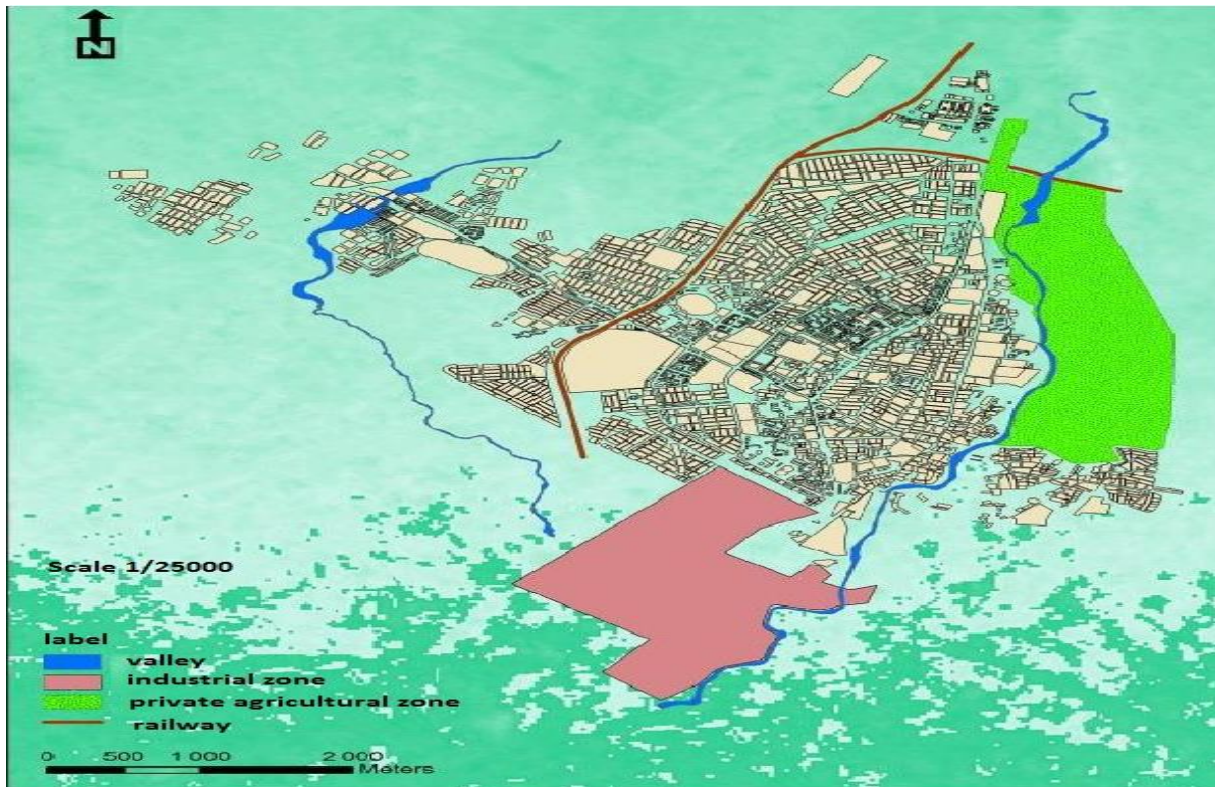
The expansion area is located west of the city of M'sila, which includes the land occupancy plan (Hammam El-Dal'a road) and the land occupancy plan N° 5, as well as Mouilha neighborhood. It is noted that this region has multiple waterways as well as Mouilha valley, which flooded on April 12, 2007 and resulted in significant losses at the level of collective housing workshops.

5 - Stages of Expansion and Flood Places:

The city of M'sila has witnessed a great leap in the extension and expansion of its urban fabric in different directions from one side to another, and in similar urban forms in terms of patterns subject to previous architectural studies in some places. In others, there is an unthinkable expansion beyond the rules of planning and urbanization. In all cases, the city of M'sila is suffering from several problems, including the existence of valleys and flood places in the expansion area, which made most of the construction projects exposed to dangers of valleys flooding.

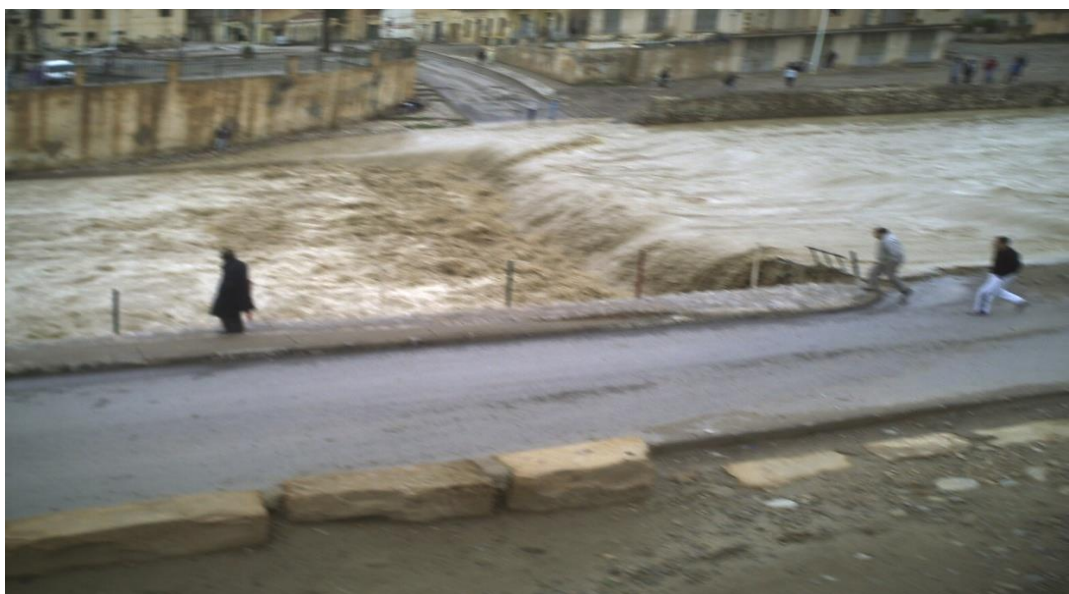
Plan N° 01: Obstacles in the Face of Urbanization in M'sila City

Source: Planfor Planning and Urbanization of M'sila Municipality + Researcher's Treatment

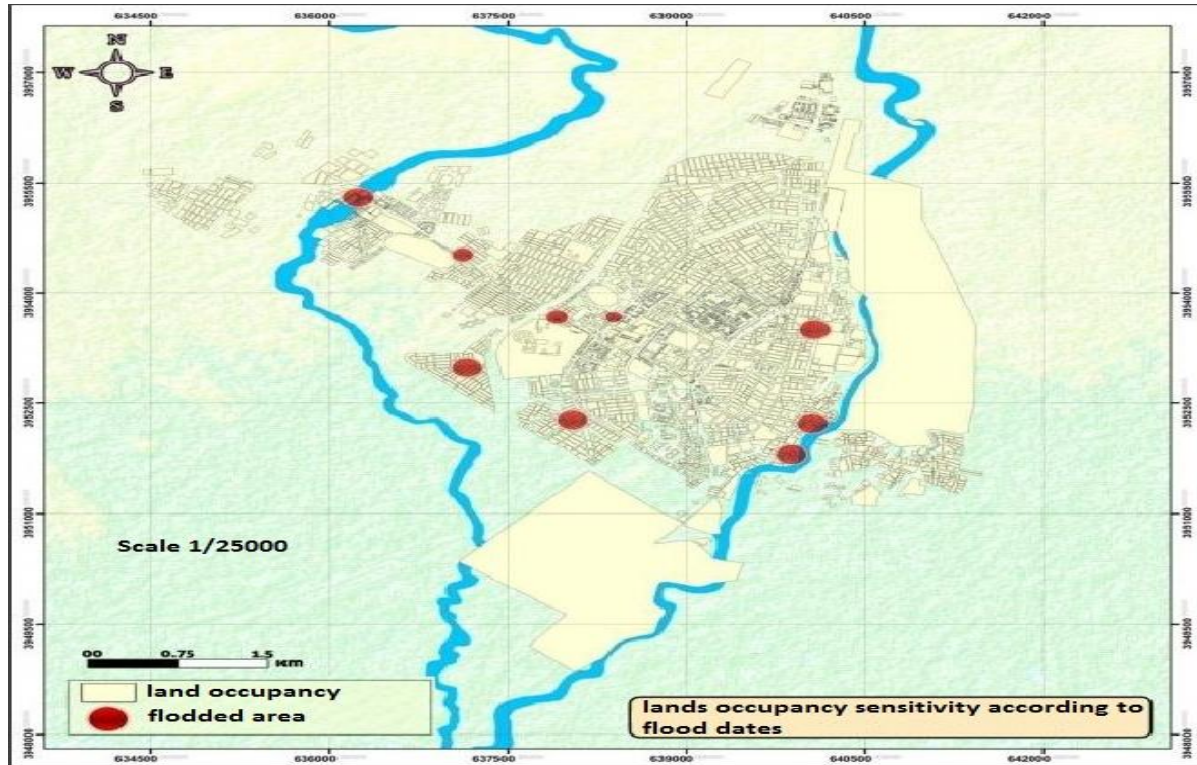


Source: Planfor Planning and Urbanization of M'sila Municipality + Researcher's Treatment / October 2022

Figure N° 01: Flood of El-Ksob Valley in October 2022



Source: Researcher's Treatment/October 2022
Plan N° 02: Flood Risk Sensitivity.



Source: Plan for Planning and Urbanization of M'sila Municipality + Researcher's Treatment /October 2022

6 –Zoningthe Risk

6-1 At the Level of the Urban Area of M'sila City

After studying the topographic map of the urban area of M'sila city, we noticed several valleys in the north and west of the city as we noticed that the land occupancy plan N°5 did not take into account the presence of these valleys. The risk of flooding is evident in this area of the city because of the heavy rain which took place in the city on April 12, 2007, where large areas of individual and collective housing were flooded, as a result of the flooding of valleys and waterways in the area of land occupancy plan N° 5.

The flooding of El-Ksob valley on September 23, 2007 led to material losses in the neighborhoods located at the level of its banks, especially El-Kush and El-Arqoub neighborhoods, so we propose a plan for the prevention of flood risks at the level of the urban area of the city of M'sila.

7- Achieving Flood Risk Prevention Plan

In order to control flood risks in accordance with a legal and regulatory framework, a flood risk prevention plan should be carried out to assess the risks and to identify flood prevention methods and approaches to the urban environment. Flood risk prevention plan comes to identify the expected flood risks on the municipal area which threaten:

- The urban environment
- Various establishments and equipment
- Agricultural areas, forests, etc.

- Areas of commercial and industrial activities
- Different and future expansion areas of the urban environment

This plan also shows us the areas that are directly at risk and those at least or indirectly vulnerable. Therefore, this plan should be implemented by all related bodies and stakeholders. It should also be integrated with the municipal planning and urbanization plans, as a supplementary law to planning and urbanization law.

7.1 Steps and Phases of Accomplishment

The method of completion of any flood protection plan is not different from the planning and urbanization plans (land occupancy plan and the planning and urbanization plan)

7.1.1 Achievement Phase and Deliberations

At this stage, the area allocated for the intervention and the concerned bodies with the plan shall be determined and the approval of the concerned bodies shall be obtained.

7.2 Study Phase

The study and implementation of the flood risk prevention plan shall be assigned to private or public studies offices and shall be committed to consult with the bodies and actors in the urban field.

7.3 Public Survey Phase

After the stage of achievement and the study of the plan by the institution in charge of achievement, this plan shall be presented to public survey in order to involve citizens and to let them know the possible transformations in the studied field while giving them the right of opposition and reservation.

7.4 Approval Phase

According to the studied plan and the reports of the involved bodies and departments in the achievement, as well as based on the records of public survey, ratification is done by the concerned body.

7.5 Content of the Plan

- A note indicating and analyzing the concerned area as well as showing the results of risks
- Plans and maps showing and identifying areas at risk with the integration of the plan within the planning and urbanization plans.

8 Recommendations in the Field of Planning

To prepare and protect the lands located along the valleys, which cut the urban area of the city of M'sila, and to enable the land to absorb the largest amount of water and to provide land and areas of good growth of vegetation, the hills and the banks with weak or medium slopes should be adjusted in order to exploit them in agricultural activities or to build stone barriers.

As for the hills or banks of valleys with high slopes, they must be supported by soil and stone barriers, which differ in shape and size depending on the slopes and land type.

8-1 – Preparing Valleys

- Making water barriers to correct the waterways and to isolate the solid parts that come from the floods.
- Building concrete walls to resist the power of water
- Planting the banks of the valleys with deep-rooted trees to help maintain the soil
- Building small dams to adjust water flow and to exploit rain water.

8-2 – Urbanization

- Creating of the urban environment by preventing dumping of garbage within the valleys and stopping urban expansion at the expense of places exposed to flooding.
- Building wastewater treatment plants.
- Making sewage sinks in the largest possible number and reviewing drainage networks, taking into account heavy rainfall.
- Cleaning valleys streams from garbage.
- Surrounding neighborhoods and establishments located at the level of the valleys with insulated walls.

8-3 Legal Recommendations

- Reviewing the planning and development plans for municipalities exposed to flood risks by integrating the risks into these plans.
- Monitoring the construction process on the banks of the valleys
- Establishing flood protection plans for flood-exposed municipalities.

Conclusion

In this study, we identified the areas at risk of flooding by producing a map showing the risk areas in M'sila city, based on geomorphological and climatic studies and based on field investigation, as well as after the assessment of the floods that hit urban communities located at the level of El-Houdna Basin.

We have also proposed recommendations in the field of planning for the area under study, and we have attached these suggestions to recommendations. These recommendations are as follows:

- Preparing the dam and valleys to resist erosion and maintain soil cohesion
- Accomplishing small dams to regulate the flow of water in valleys and to protect urban communities from the risks of flooding.
- Managing urban environment by taking physical data into account in order to reconcile the studies related to urbanization and natural obstacles.
- Enacting laws for the integration of flood risks within the planning and urbanization plans.

We have also made recommendations about flooding risks on inhabitants and local authorities' awareness for total control during risks and the way to manage them, which can be done through:

- Temporal and spatial monitoring of flood possibilities
- Complete readiness for rescue and intervention operations by preparing all available resources for the authorities concerned in case of floods
- Accomplishment of flood protection plans for municipalities at risk.

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• **The Bodies**

- The Directorate of Urbanization and Building of M'sila.
- Water Resources National Agency of M'sila
- The Directorate of Civil Protection of M'sila Municipality.
- The Directorate of Irrigation OF M'sila