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Flow Modeling Test and Flood Risks in the North-East Piedmont of Aureas: A Geosystem Approach

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Abstract

Khenchla city is among the regions of the country most threatened by the risk of flooding, which prompted a social interest in risk management due to the magnitude of the material and human damage that can be caused due to Extreme flows, mainly by floods. That is why we have chosen the modelling approach; the models implemented have been validated and allow us to consider efficient risk management of flooding in the localities of the Northeast Aurès piedmont.

Key words: Frequent, floods, risk management, damage, dynamic, floods, modeling, flow.

INTRODUCTION

The river's proximity is always considered an advantage for the development of human activities. However, with the rapid development of urban areas, industry and commerce are directly involved in the hydrological process of the watershed and, particularly, in their extreme manifestations. In this situation, the increased vulnerability of our societies to floods deduced to strong social demand interest to anticipate and prevent these natural disasters, which pose significant human and economic problems (Hassan EL MACHKOURI 2004)

Today, there are several models in hydrology that help to reduce the complexity of the relationship between falling and flowing water. However, reducing the damage caused by floods first requires thorough identification of the regions presenting the risk of flooding by drawing up a map of vulnerable zones, which would be a valuable tool for assessing socio-economic issues at risk.

GENERAL CONCEPTS

The north-eastern piedmont of the Aurès consists of a corridor dominated by a mountain range of the Aurès massif. Their originality relies on the permanence of the phenomenon of endorses, which is reflected in the development of a multitude of Sebkhas (Garaâs) occupying the centre of the plains, which constitute their basic level geomorphology and their hydrological outlet. Thus defined and delimited, the north-eastern piedmont of the Aurès is part of the catchment of the «High Plates Constantinos» (ANRH 2002)figure 1.

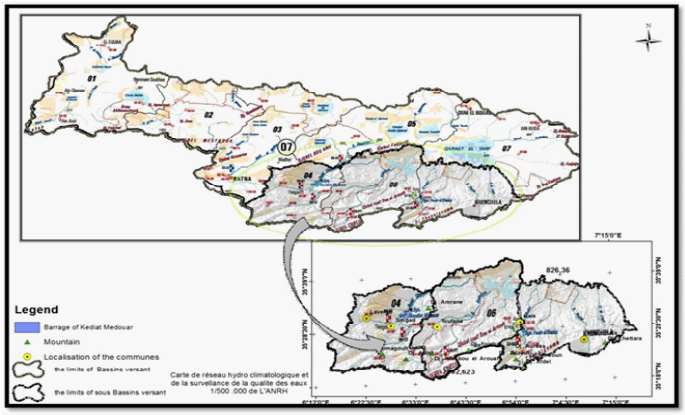


Figure 1. Map of the situation of the Piedmont North-East of Aurès in the Basin Versant of the Constantine Highlands

Two distinct stratigraphic and structural point of view characterizes the study area: to the north, the low zones constitute the extension towards the east of the basin Miocene from Timgad Toufana to Kais, which corresponds to the border south of the Great Depression Garaât Et-Tarf. On the other hand, the southwest mountains constitute the north-eastern corner of the pleated quadrilateral Aurès with two main structures: In the North, the anticline, the mountain of "Chélia", and the khenchela syncline.

Geological Features

Structurally, the peaks correspond to open anticlinal ridges in the Cenomanian, separated by synclinal valleys where tertiary sediments are conserved. The Timgad-khenchela depression is filled with folded Miocene sediments; the folds here also have a mean E-W orientation. Towards the North-East, the folds are interrupted laterally by NW-SE orientation faults, the main ones (Medina and Bouhmama fault) roughly aligned on the western limit of the Timgad-Khenchela depression. Stratigraphically the reliefs that border the Timgad-Khenchela depression are formed of Miocene outcrop (figure 2).

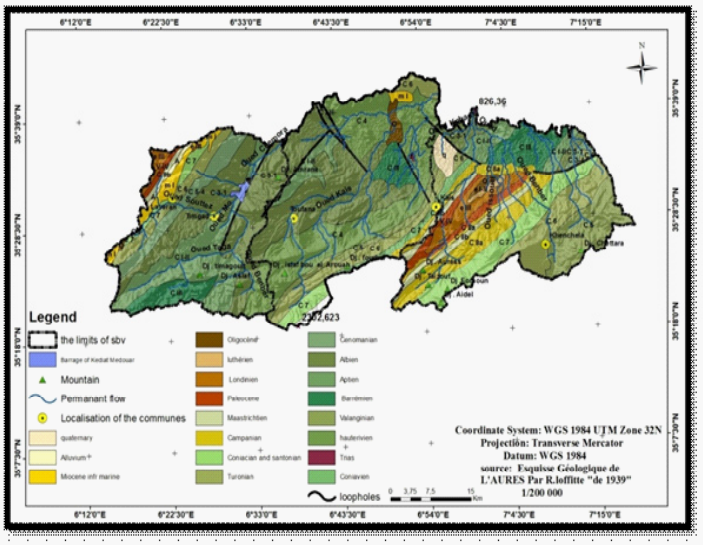


Figure 2. Geological map of the Piedmont North-East of Aurès

Soil Characteristics

The study of the soil characteristics of the study area is very important in our work for this purpose; the map represents the spatial positioning of the different types of soils in the Northern Aegean Piedmont: Saline soil; Alluvial soil; Calcimagnesic soil; Unsaturated Soil (figure 3).

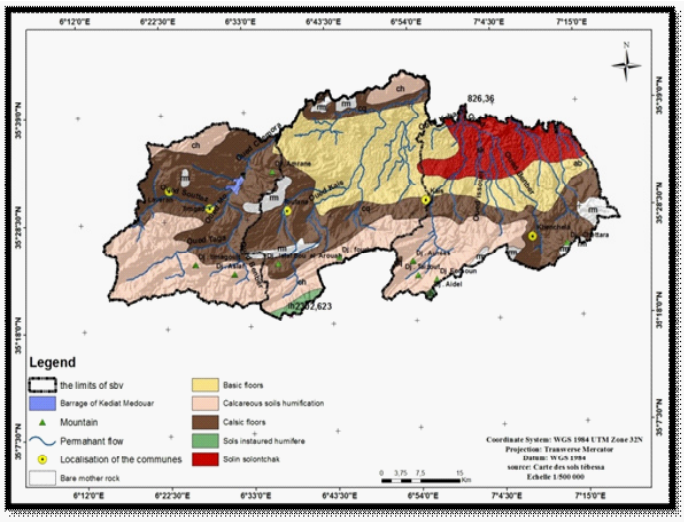


Figure 3. Soil map of the Piedmont North-East of Aurès

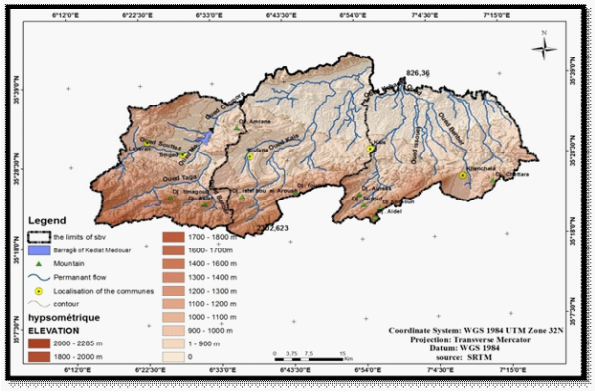


Figure 4. Elevation map of the Piedmont North-East of Aurès

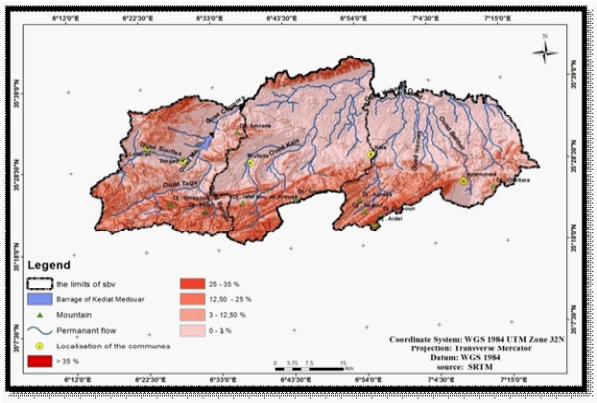


Figure 5. Slope map of the Piedmont North-East of Aurès

The Morphometric Characteristics

This study focuses on three watersheds in the north-eastern Aurès piedmont, the Oued Chemorah watershed, the watershed of Foum el-Gueiss and the watershed of Oued (figure 4).

Kais watershed of Oued Chemorah and Oued Kais are instead lengthened, while the watershed of Foum El-Gueiss tends towards a more or less picked up (figure 5).

The watershed of Oued Chemorah presents a strong relief catchment of Foum El- Gueiss an extreme relief and the Oued Kais watershed a relatively strong relief. The drainage density is generally high for the three watersheds, characterised by semi-dry regions (figure 6).

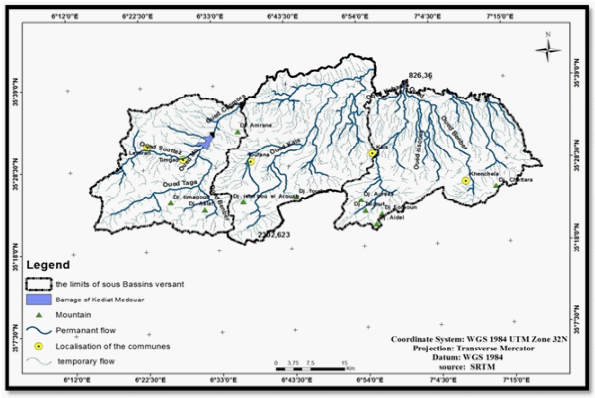


Figure 6. Hydrographic network map of the Piedmont North-East of Aurès

RELIABILITY OF THE MAP OVERLAY (GIS APPROACH)

The analysis of the urban structure made it possible to understand the current situation and the urban space's consumption rate.

Growth Diachronic of Khenchela City

Before 1954:

Like all cities created during the colonial period of Algeria, the city of Khenchela was founded by creating a European district. This period is characterized by slow urban development and low densification.

1954-1965:

Before independence, the city did not experience a large volume of growth in this period. This extension is exhibited by a mass of construction on the southeast and south part of the checkerboard.

1966-1976:

The city has experienced exciting growth in this period, represented by an urban variation between planned tissues in a regulatory framework and spontaneous tissues representing a traditional habitat.

1977-1987:

A slight extension of traditional neighbourhoods, the enlargement of the neighbourhood. Echabord and the proliferation of another spreading point are at the extreme north of the (city Moussa Reddah). The most significant event of this period was the creation of industrial establishments (industrial zone, S.N.L.B., Prometal ...). they are constituted to the north, and in the juxtaposition of the city, they occupy important surfaces.

1987-1997:

In this period, we can see significant growth in the state of evolution of the urban fabric.

The allocation of this vital growth was oriented globally, towards the south. As a result, voluntary operations in the north are relatively limited.

2005-2014:

The city's evolution is remarkable. This period the exploitation of the land reserves in the city and the continuity of growth to the south. The five-year programs and private extensions are mostly carried out in the regulatory framework. Furthermore, the state's intervention was affected by the radiation of the illicit district Echabord in the northern part of the city (P.D.A.U. 1016) figure 7.

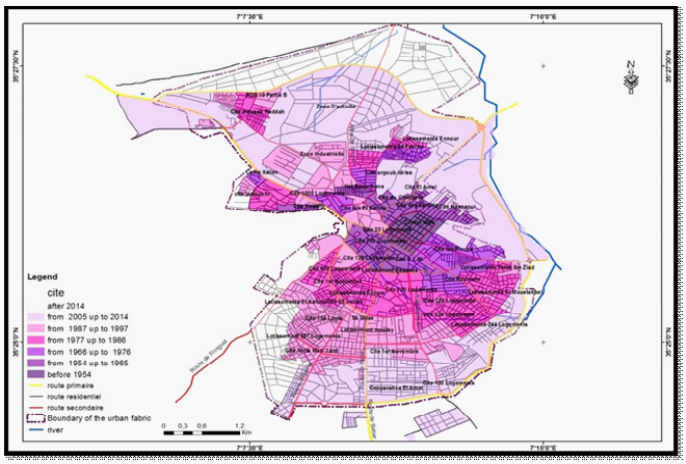


Figure 7. Urban development of Khenchela city

The Anthropic Effect on Vulnerability

Urbanization plays mainly on hydrological processes through increasing impervious surfaces (habitats, equipment, roads. etc). The consequences of urbanization are manifested mainly by the reduction of rainwater infiltration. The increase and the acceleration of runoff lead to the aggravation of the flood's peak. At the same time, it increases the overall flow of water.

The Vulnerability of Urban Space (City Of Khenchela)

The development of the flood vulnerability map requires the prior determination of a reference hazard which must be the highest known flood or submersion or the flood or 100-year submersion if this is higher.

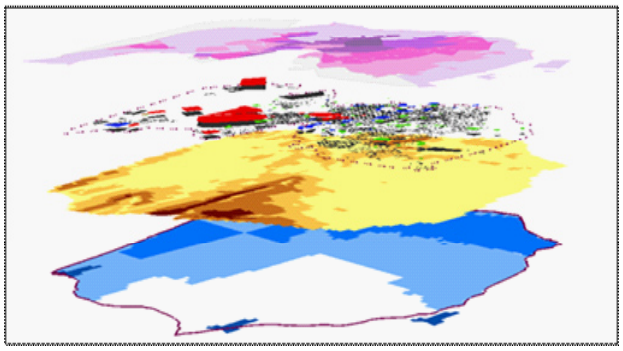


Figure 8. Layering cards

Through the Risk Zoning Map, Four Types of Vulnerability is Identified

Methodological approach. Knowledge of the submersion hazard assessment Water level reached for a centennial occurrence Topography. Overlay of lithological maps, hydrographic network natural and anthropogenic land occupation Delimitation of floodplains.

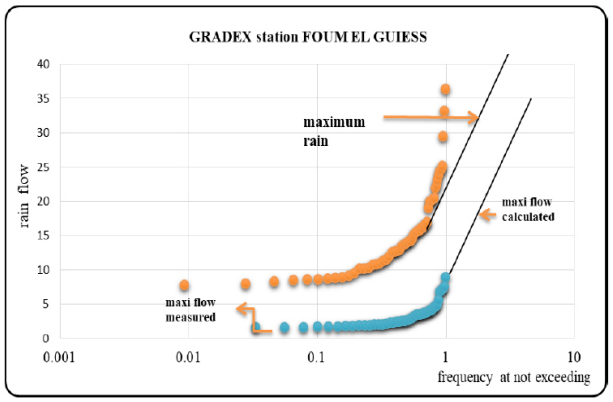
METHODOLOGY AND MATERIAL

Different Flood Estimation Methods

A. Empirical Formulas (MG, ANRH)

$$Q_T = \gamma_T . S . K . \ln(1 + A\overline{P}) . \left(\frac{S}{L^2}\right)^{0.25}$$

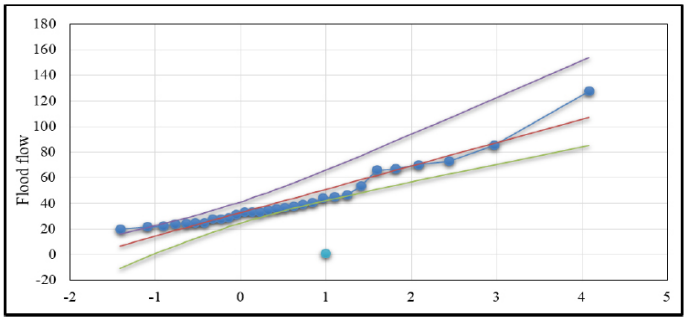
b. Gradex method Station FOUM EL GUIESS



The method assumes that when the flow rate exceeds a certain value, the soil is saturated.

This value, called threshold flow (or pivot point), can vary from the ten-year flow to the fifty-year flow, depending on the soils and the characteristics of the watershed. Thus, during the base time of runoff (assimilated to the characteristic duration), any increase in rainfall induces the same increase in increase in flow.

c. Adjustment to a Gumbel law of flood EL GUEISS



RESULTS AND DISCUSSION

Return period	10	20	50	100	200	500	1000
Empirical formulas MG	/	/	172.05	189.64	205.73	225.25	238.95
Analyzes statistics (renewal) S ≥20	84.22	98.62	117.77	132.58	147.75	168.46	184.70
Gradex method	/	/	/	206.87	240.78	303.57	345.21
Regional method (ANRH)	129	/	/	228	/	/	350

The empirical (M.G) and regional method (ANRH) give high results compared to the values resulting from the analysis Statistics (renewal) beyond a selected threshold equal to Qmax ≥ 20 m3 / s. As a result, the Gradex method, the vagueness is due to the very rough estimate of the saturation frequency of the watershed (visual determination from the Gradex.

Highly Vulnerable Areas

The highly vulnerable areas in our study area are mainly the areas located in the outlet of the wadi, essentially to the north where is the industrial zone, which occupies more than 68 ha and contains more than 43 production units and 08 companies, and densely populated neighbourhoods (concentration of different habitat programs over time).

The Vulnerable Zones

Vulnerable areas are located on both sides of the river in the north and southwest of a population density that varies between high and medium.

Areas of medium vulnerability

The areas of medium vulnerability are those located near the tributaries and the very low areas, representing the new extensions to the north and south.

Areas of low vulnerability

Areas of low vulnerability characterize older neighbourhoods and future extensions.

All areas designated as vulnerable have an important river system consisting of fairly deep ravines, and ground slopes are classified as 0 - 8%: these conditions favour flooding and reliable transport. The important erosion causes strong transport and increases the risk of flooding, especially in the urban space.

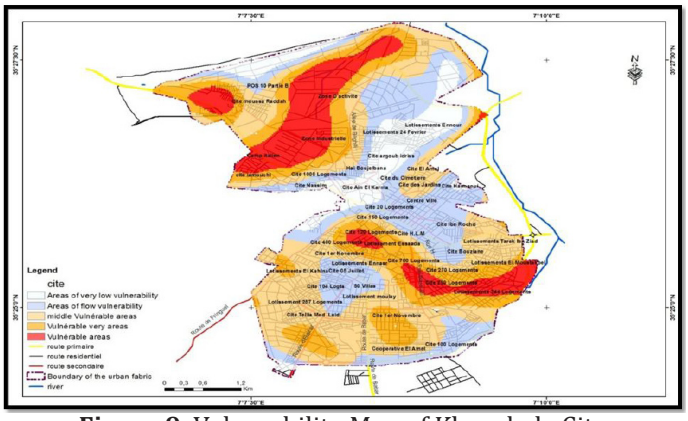


Figure 9. Vulnerability Map of Khenchela City

CONCLUSION

The topographic surfaces that constitute the impluvium of the Northeast foothills of the Aures have hydrological and morphometric properties that make them particularly sensitive to flooding.

Rainfall in this region is characterized by a high intensity and significant spatial and temporal heterogeneity.

The estimation of floods by different methods consists in not being concerned with the date of extreme hydrological events. But to look for the probability for which these events occur during a given period.

It is a pre-global analysis for the dimensioning and the realization of flood protection measures.

The development of a reliable and efficient flow forecasting tool is a major human and economic challenge

prediction of flows by these models is an important research axis in hydrology, it defines how to evaluate the flood phenomena in the near future, this estimation taking into account the existence of hazard and uncertainties.

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