URBAN RESILIENCE TO FLOODS : APPLICATION MODEL DS3 A CASE STUDY OF THE CITY OF BERKANE .

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Abstract

Is an important parameter in assessing the sustainability of a city, urban resilience has become subject of several studies to operationalize the term as it is polysemic.

In this context, we will apply two different approaches for assessing urban resilience to floods in Berkane, a city in the east of Morocco, well classified in term of vulnerability to flooding.

In this context, we will apply a very recent model named DS3 for assessing urban flood resilience of the roads of Berkane, a city in the east of Morocco, well classified in terms of vulnerability to flooding.

In this paper, we apply the approach of spatial analysis techniques of networks based on graph theory, using GIS software.

The ultimate goal is to diagnose the weaknesses of this vital network so we will can assess the adequacy of facilities projected by the Moulouya Water Basin Agency to cope with floods.

Keywords: Floods , GIS , Graph Theory , Networks, Urban resilience

1 INTRODUCTION

Due to the complexity of factors contributing to the worsening of material and human flood damage (accelerated climate change , excessive and non studied urbanization) , risk management , which was almost exclusively limited to technical solutions to reduce hazard , resorted to other promising concepts like resilience which is the most recent one [1].

Being a multidisciplinary concept not fully operationalized , it remains the subject of several research across all fields of science dealing with systems (ecosystem, psychological system , ...)

Regarding the "City" system , enough research continues to define and implement urban resilience to hazards , including the hazard treated in this paper : the floods.

In order to increase the effectiveness of measures taken in urban planning to deal with flood risk , we started in the assessment of the level of urban resilience to flooding by the evaluation of the resilience of technical networks which represent the vital component of each City. Indeed, floods seriously affect the lives of the inhabitants of the city , damaging their transport ,water, electricity, telecommunication and sewage networks.

This method is based on the philosophy saying that we must strengthen its immunity before talking about confronting any type of risk, a philosophy that reigns today positively on several scientific fields.

For this, we chose to apply the methodology that aims to calculate performance indicators applied to graphs representing the network infrastructure of the city , which remains a vital component of this system . This methodology proposed recently [2] can be considered helpful because it is based on well-founded mathematical concepts such as graph theory [4] , but which cannot be described as perfect after taking consideration of all other parameters complexity of the " city" system.

However, it remains a good way to highlight the ineffectiveness of the simple risk management facilities planned for our study area flooding.

Being a geographical problem, the obvious choice was to use Geographic Information System software. In this case we chose the famous open source Quantum GIS.

2 STUDY AREA

Berkane is a province located in the north-east of Morocco in the Rif oriental region. It has an area of 1985 km ². Its altitude varies between 200 and 1532m .

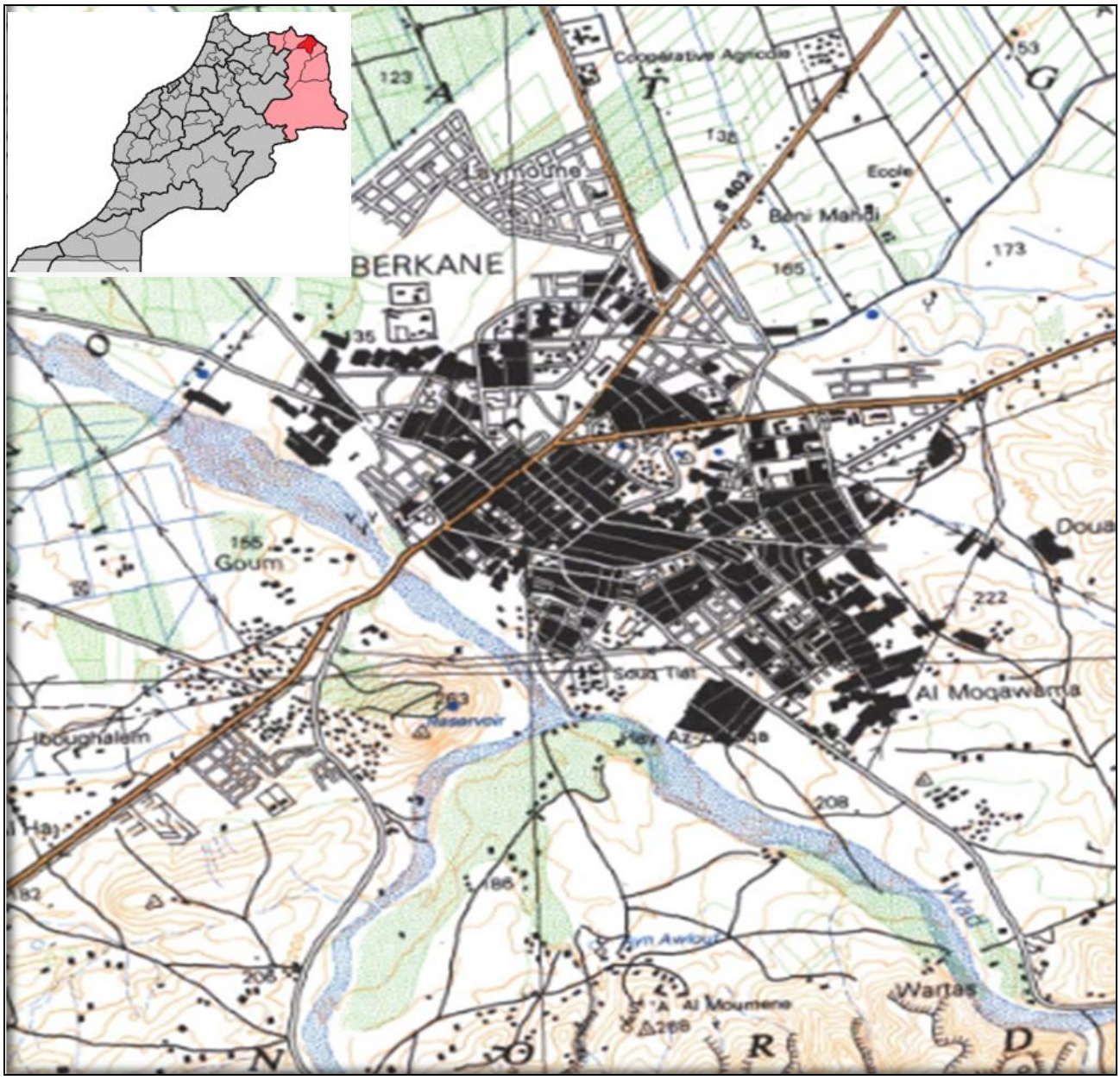

Fig 1: Location of the Berkane City

The climate of the study area is Mediterranean , characterized by an average of annual rainfall of 350 mm. The average of annual temperatures vary between 17.6 ° C and 20.5 ° C.

It is a well ranked in term of floodability. Each year the city live with floods which paralyze the city activity for some time.the last one is very recent as demonstrated by the following photo:

Fig 2:Flooded area in Berkane city ,09/09/2013

The flood area in Berkane city is concentrated in Bouhdila district which is located beside the oued of Cheraa,without the suffisant insfrastructure to deal with the rise in the wáter level after consisting precipitation.

Fig3: Panoramic view of Oued Cheraa and Bouhdila district

The Moulouya Hydrological Basin Agency classified this area at the head of the most vulnerable areas face to flooding as shown in the extracted table below:

Tab1:Degree of flooding risk in different sites of the study area [5]

Nom	Oued	Note	Risque d'inondation					
			Humain	Construction	Infrastructure	Economie	Environnement	Agricole
Berkane	Ouertrass	94	Elevé	Elevé	Elevé	Elevé	Moyen	Faible
Berkane	Cheraa	94	Elevé	Elevé	Elevé	Elevé	Moyen	Faible
Outat	Moulouya	87	Moyen	Elevé	Négligeable	Moyen	Moyen	très élevé
Jrada	Jrada	87	Elevé	Elevé	Moyen	Elevé	Moyen	Faible
Hassi Blal	Hassi Blal	87	Elevé	Elevé	Moyen	Elevé	Moyen	Faible

(Elevé= High,Moyen=medium,Faible=Low,Négligeable=negligible)

3. METHOD

The method used in this paper is to apply the recent model called DS3 [3], which do the diagnosis of the three capacities formulating urban resilience, ie the capacity of resistance, absorption and recovery .

Its application will be made initially on the urban transport network of the city of Berkane , and through the use of a plugin which analyze the graph corresponding to the studied technical network .This plugin is installed on the famous open source software Quantum GIS. The GIS software Open Jump will help to generate the graph in the required structure for the purpose of implementing the plugin of DS3 model.

This method is one of the relevant graph theory applications, through the selection, adaptation , and improvement of formulas describing the characteristics of the graph that are within its type and structure.

3.1 Analysis of urban technical networks by applying the DS3 Model

It is evaluating three qualitative capacity on the graph structure corresponding to the studied technical network:

- Resistence capacity : simply expresses the capacity of resisting to the disturbance during the crisis situation.
- Absorptive capacity : expresses redundancy and all possible alternatives in the situation of crisis.
- The recovery ability : expresses the accessibility of entities damaged during the flood.

3.2 Data preparation

The data required for the application of DS3 model are essentially the network technical subject of the study (transport), composed of its nodes and arcs (corresponding to major roads)

To generate them , we tried to have the most updated version of the data as possible , given the rapid changes experienced by this region (in the positive and negative sense!) . We so digitized the roads from different available base maps , mostly those of OpenStreetMap and Bing Roads.

After that, we used the produced data layer (shapefile) as input file to the function of graph generation available on OpenJUMP which also allowed to assign to each node its degree in the graph generated.

Finally, we have imported the graph of the road network QGis 1.8.0 (Lisboa) in Shapefile format to apply the plugin implementing the DS3 model.

The plugin allows to compute for each node three parameters and their combination thus representing the degree of vulnerability of the node.

4. RESULTS AND DISCUSSION:

The result of applying DS3 Model to the transport network of Berkane city is showed in the following map:

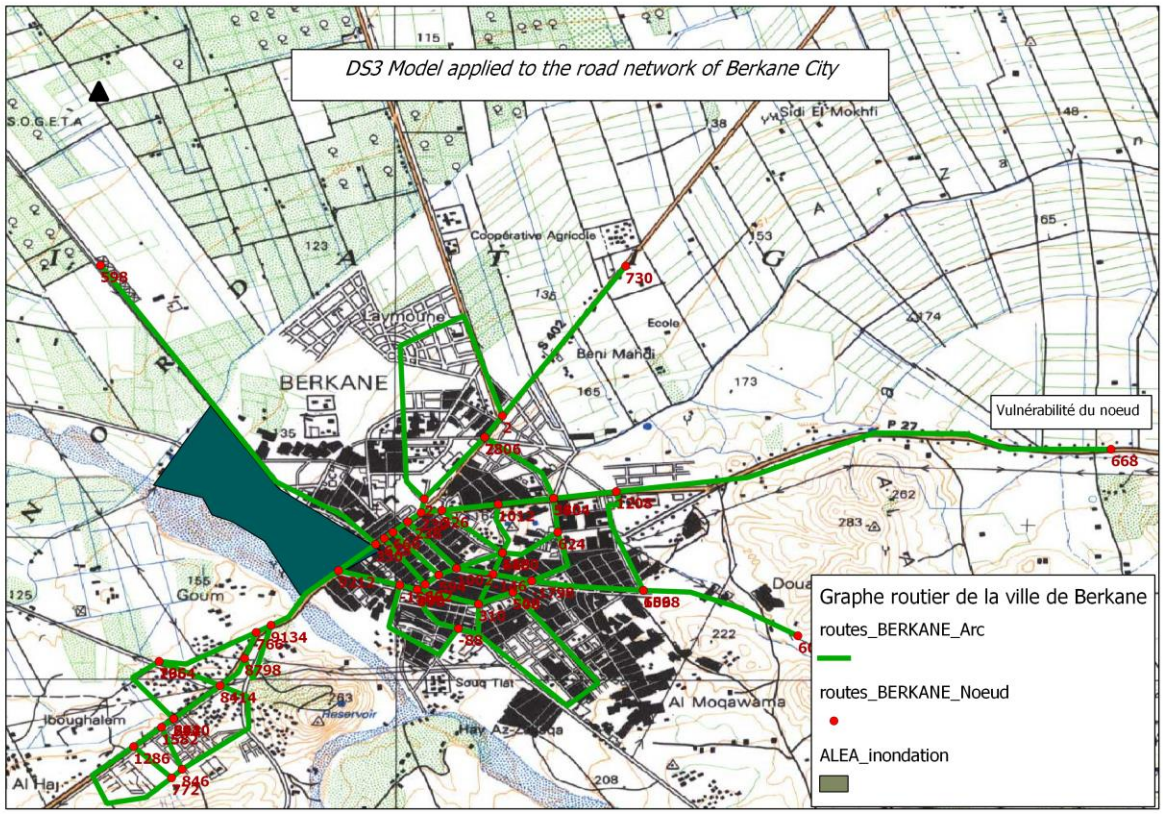

Fig 4 : Map of Road graph of the city of Berkane after calculating vulnerability indicator per node

Model DS3 shows high levels of vulnerability at almost all nodes of road network of Berkane city , which is due to the state of the network influenced by the state of sewage network .

That said, we are working on applying the model DS3 on all technical networks of the city of Berkane , in order to make a more detailed and information-rich diagnosis regarding the limits of urban resilience of the city towards floods .

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