CONTRIBUTION OF GEOGRAPHIC INFORMATION SYSTEM TO IMPROVE THE INSURANCE MANAGEMENT OF NATURAL DISASTERS IN ALGERIA CASE STUDY: THE CITY OF BATNA

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EXTENDED ABSTRACT

La frequenza dei disastri naturali è aumentata in tutto il mondo, e per la particolare posizione geografica, l'Algeria è tra i paesi più vulnerabili alle calamità naturali.

Negli ultimi decenni su questo Paese si sono abbattute numerose catastrofi naturali di grande portata: le inondazioni di Bad El Oued nel 2001, di Ghardaïa nel 2018, di Sétif e di El Taref nel 2012 e i terremoti di Boumerdes nel 2003 e di Mila nel 2020, che hanno causato la perdite di numerose vite umane, oltre ad ingenti danni economici.

Le autorità pubbliche hanno quindi deciso di istituire uno speciale sistema assicurativo (CatNat), che introduce l'obbligo di assicurarsi contro gli effetti delle catastrofi naturali, al fine di alleggerire l'onere dello Stato in termini di risarcimenti. Questa assicurazione è stata creata nel 2004, a seguito dei danni causati dalle inondazioni a Bab El Oued e dal terremoto a Boumerdes, rispettivamente nel 2001 e nel 2003.

Pertanto per il settore assicurativo le calamità naturali rappresentano il maggiore rischio strategico da affrontare: l'aumento della frequenza dei disastri naturali e l'elevata domanda di risarcimento dei danni in termini economici, ha incoraggiato il comparto assicurativo a partecipare al recupero e alla riduzione dei rischi naturali, migliorando la stessa gestione assicurativa.

Il presente lavoro illustra il ruolo degli enti assicurativi nel controllo dei rischi naturali e come promuovere una migliore gestione assicurativa attraverso l'integrazione del sistema informativo geografico (Geographical Information System -GIS) nella città di Batna.

Il GIS è lo strumento tecnologico che fornisce funzionalità quali:1) astrazione: modellazione delle informazioni; 2) cquisizione: recupero delle informazioni esistenti, alimentazione del sistema con i dati; 3) archiviazione: memorizzazione dei dati in modo che possano essere facilmente recuperati e interrogati; 4) analisi: risposte alle interrogazioni, il cuore del GIS; 5) visualizzazione: restituzione grafica.

Le applicazioni dei sistemi informativi geografici (GIS) alla gestione assicurativa sono quindi numerose e consentono, tra l'altro, agli assicuratori di segmentare la tariffazione e di specializzare la vulnerabilità dei loro portafogli assicurativi. Gli assicuratori supportano la gestione dei rischi naturali, e la loro mappatura. Le informazioni geografiche diventano pertanto strumentofondamentale per gli enti assicurativi: il GIS consente l'interrogazione, l'analisi e la mappatura dei dati nel corso di un processo decisionale che mira ad essere preciso e coerente.

Per una analisi più dettagliata dell'*iter* gestionale, nel presente lavoro sono stati sviluppati tre punti: in primo luogo, è stata fornita un'introduzione per comprendere il problema, in una seconda parte spiegato il metodo per risolverlo e, infine, un'ultima parte è stata dedicata alla presentazione dei risultati ottenuti dalla gestione delle assicurazioni nella città di Batna.

In conclusione il tasso medio di adesione all'assicurazione contro le calamità naturali, obbligatoria in Algeria dal 2004, rimane molto basso sia su scala nazionale (solo il 10%) che su scala locale, nell'area di studio, a causa dell'assenza di una cultura assicurativa tra i cittadini: attualmente gli assicuratori algerini sono quindi chiamati a svolgere il loro ruolo nella gestione dei grandi rischi naturali, sensibilizzando la popolazione sull'importanza di stipulare un'assicurazione CatNat e promuovendo una migliore gestione assicurativa attraverso l'integrazione di nuove tecniche, come il sistema informativo geografico GIS.

Una buona gestione assicurativa consente di ottimizzare le misure per migliorare la prevenzione dei richi naturali ed i relativi risarcimenti.

ABSTRACT

In recent years, the frequency of natural disasters has increased all over the world, including in Algeria.

In the last decades Algeria has been marked by very large-scale natural disasters: floods, landslides and earthquakes, which have caused considerable material damage and loss of life in view of the extent of the damage caused by natural disasters, the public authorities have decided to set up a special insurance system (CatNat) based on the obligation to insure against the effects of natural disasters, in order to lighten the burden on the State in terms of reparations.

This insurance was created in 2004 following damage caused by the floods in Bab El Oued and the earthquake in Boumerdes in 2001 and 2003 respectively.

The increase in natural disasters and thus in the cost of claiming compensation encourages insurers to participate in the recovery and reduction of natural risks by improving their insurance management.

The applications of Geographic Information Systems (GIS) to insurance management are numerous; and they allow, among other things, insurers to segment their pricing and to specialise the vulnerability of their insurance portfolios. Insurers support their management on natural risk, exposure and liability cards. Geographic information becomes crucial for insurers.

This paper talks about clarified the role of insurers in the management of natural risks and how to promote better insurance management through the integration of geographic information system in the city Batna.

KEYWORDS: *CatNat, insurance, natural disasters,GIS,management, Batna*

INTRODUCTION

In recent years, the frequency of natural disasters has increased worldwide. Natural catastrophes are the most important strategic risk for the insurance sector (KOUSKY, 2019).

Between 1970 and 2020, the total cost of natural disasters in the world is estimated at 3,810 billion dollars of losses, (the United Nations (UN, 2020) and the World Meteorological Organization (WMO, 2021) of which almost a third were covered by insurance and reinsurance companies.

Given its geographical position, Algeria is among the countries most vulnerable to natural disasters. Thus, over the last decade, it has been marked by very large-scale natural disasters such as the floods of Bad El Oued in 2001, Ghardaïa in 2018, Sétif and El Taref in 2012 and the earthquakes of Boumerdes 2003, and Mila in 2020.

The consequences of these natural disasters are visible on the ground (photos 1, 2, 3, 4).

The increase in natural disasters highlights the problem of compensation for victims and property.

This is provided in Algeria by an insurance system that was born in 2004 after the Bab El Oued floods and the Boumerdes earthquake.

Photo 1 - The Boumerdes earthquake 2003 (Algerian TV)

Photo 2 - The Mila earthquake 2021 (Algerian TV)

Photo 3 - The floods of Bab El 2001(Algerian TV)

Photo 4 - The floods of Constantine 2018 (Algerian TV)

Year	Type of disaster	Location	Declaration State of disaster	Cost of disaster
10/11/2001	The floods	Bab El Oued	Before the (law Ordinance 03-12 of 26 August 2003 on the obligation to insure against natural disasters and to compensate victims	544 Million dinars
21/05/2003	Earthquake	Boumerdes		5 Billion dollars
08/10/2008	The floods	Ghardaïa	Insurance CatNat	250 Millions dinars
07/02 /2009		Adrar		250 Millions dinars
02/11/2011		El Bayadh		6 Billion dinars
19/03/2012		Sétif, El Taref		193 Million de dinars
19/092018	The floods	Constantine	Disaster areas	25 Million dinars
07 /08/2020	Earthquake	Mila		25 Million dinars

Tab. 1 - Natural disasters in Algeria from 2001 to present (Source: CAN, 2009 and author's treatment)

This insurance system is a hybrid based on insurance coverage and a solidarity system (HADDAD, 2018), (REDOUANE *et alii*, 2020).

It has been thus since 2004 that natural phenomena are covered by the CatNat insurance. (Insurance against the effects of natural disasters) (RAMOUL, 2010, 2021)

Currently, in Algeria, only damage caused by floods, mudslides, earthquakes, mass movements, storms and high winds is insured following Ordinance 03-12 of 26 August 2003 on the obligation to insure against natural disasters and to compensate victims (Official Journal, n° 52 of 27 /08/2003).

The natural disaster guarantee only applies if an Interministerial Decree (Ministry of the Interior, Local Authorities and Town and Country Planning) are published in the official gazette stating the state of the disaster.

The state of the disaster is declared on the basis of a detailed report drawn up and transmitted to the minister in charge of local authorities by the Wali of the wilaya affected by the natural disaster and after the opinion of the competent technical services according to the nature of the disaster (Executive Decree n°04-268 of 13 Rajab 1425 corresponding to 29 August 2004).

The state of natural disaster has been declared four times for floods by CatNat insurance (2008,2009,2011,2012) (Table 1).

For the Constantine flood and the Mila earthquake, the Interministerial Decrees declaring the disaster areas by Article 7 of Executive Decree n° 90-402 of 15 December 1990, on the organization and operation of the natural disaster and major technological risk funds.

Algerian insurers are similarly obliged to provide coverage for CatNat risks, and must replace the public authorities in the organization of compensation.

The insurance system benefits from the financial support of the State in case of capacity exhaustion (State guarantee granted to the CCR (Central Reinsurance Company).

In particular in Algeria, there is an increase in the cost of disasters. Floods and earthquakes represent the first perils both in terms of the number of natural disaster decrees and the events caused by floods, which have cost 1262 Million dinars since the beginning of the CatNat regime in 2004 (Table 1).

The increase in the cost of disasters is reflected in an increase in the number of claims (Figure 1).

This is indicated by the that amount of claims paid to the market between 2008 and 2020 is 260 million. They are at their highest levels in 2009, 2012 and 2014.

Given the increase in claims, there has been an increase in the financial consequences for insurance companies (CCR, 2011, 2021) since the beginning of the CatNat regime between 2004 and 2020.

This increase encourages insurers to participate in the recovery and reduction of natural risks to improve their insurance management (PICO, 2007a).

A prevention management policy is based on the geographical distribution of natural risks (LETREMY, 2014) (ARNAUD, 2012).

Insurers estimate the various parameters of their management and assess their financial commitments in the event of a claim. They are increasingly basing their management on cartographic data.

From a simple illustration such as the map, it is now becoming a real instrument of insurance management (PICO, 2007 b).

The diagram in Figure 2 illustrates the need for insurers to assess natural risks (CatNat insurance).

Better insurance management needs to incorporate new technologies such as Geographic Information Systems (GIS) (ARNAUD, 2012).

GIS is the technology tool that provides the five functionalities known as the "5*A*'s": *A*bstraction: modelling of information, *A*cquisition: retrieving existing information, feeding the system with data, *A*rchiving: storing data so that it can be easily retrieved and queried, *A*nalysis: answers to queries, the very heart of GIS,
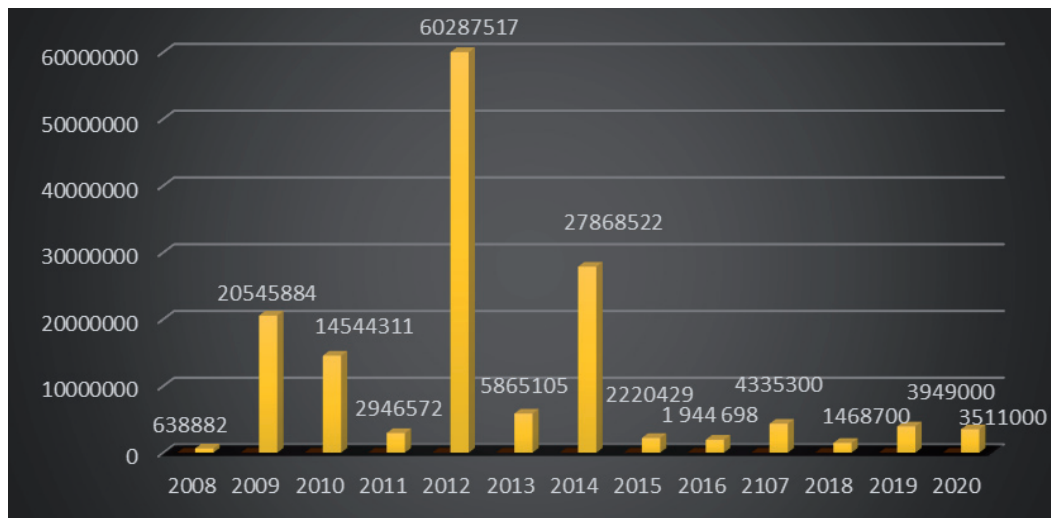
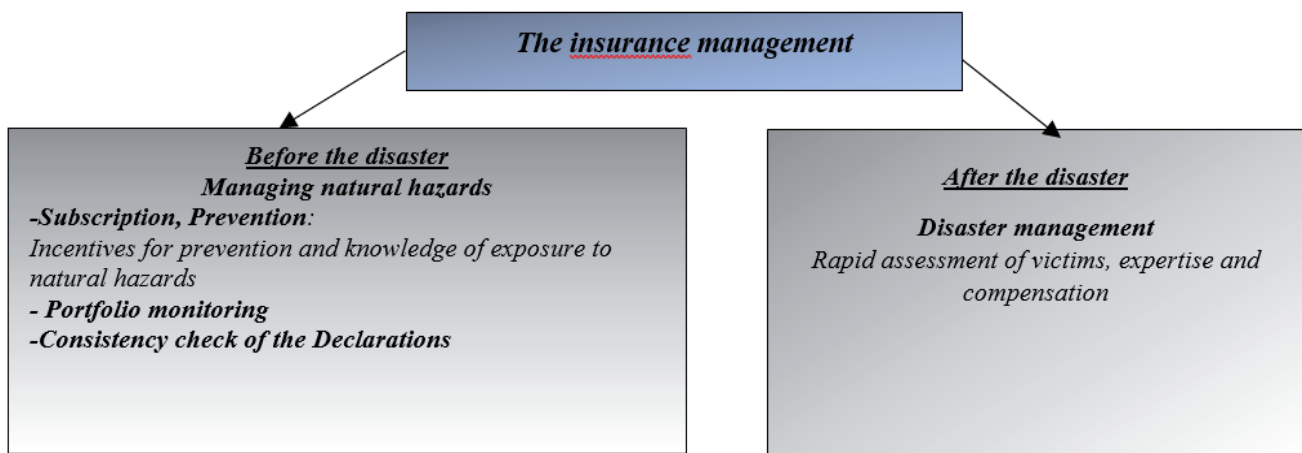*Fig. 1 - Claims settled by the market from 2008 to 2020 in Algeria (unit DA) (Source: CCR, 2011, 2021)*

Fig. 2 - The need for insurers to assess natural risks (CatNat insurance)

Display: graphic restitution (LONGLEY *et alii*, 2001).

GIS is a tool for querying, analyzing and mapping data throughout a decision-making process with the main objective for the user to make the best decision.

The objective of this paper is to answer the following questions.
- What is the role of geographic information systems (GIS) in natural disaster insurance?
- How can this technique be used in natural hazard management and insurance management?

To better understand this problem, three points will be developed successively:
1. firstly, an introduction will be given in order to understand the problem;
2. in a second part, the method of solving it will be explained and
3. finally, a last part will be devoted to the presentation of the results obtained.

LOCATION OF THE STUDY AREA

The city of Batna is strategically located (Figure 3), at the intersection of two main roads, the North-South axis, and the axis linking the East to the West through the high plateau. (Figure 3). It is the chief town and administrative center of the wilaya of Batna, at the national level, the city is located approximately 435 km southwest of the capital Algiers, its territory geographically limited by five communes, it is located between 35.55° of attitude and 6.17° of longitude.

The city of Batna is characterised by the passage of several river; the main river El Gourzi and its main tributaries; Tazoult river, and Azzab river (Figure 3) (the hydrographic network is presented by the color blue). Given its geographical position, the city is vulnerable to the risk of flooding (Photos 5, 6).

The city centre sectors are the heart of the city which is always affected by floods, and affects the economy and daily
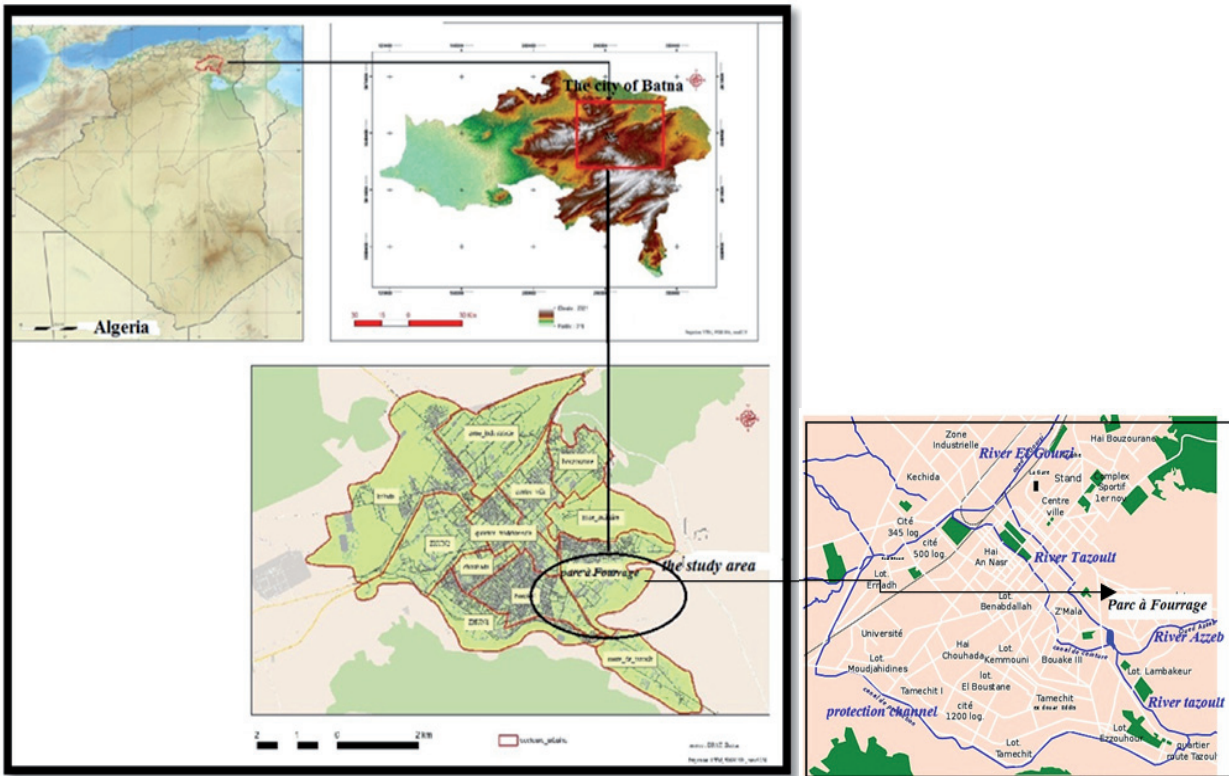
Fig. 3 - Location of the study area (Source: DPAT Batna) - Plan of Batna with its districts

activities of the city (SLIMANI, 2019).

Also the Wilaya Risk Analysis and Coverage Scheme (SWACR) has classified the Parc à Fourrage district, due to its population density, it is one of the most vulnerable areas of the city and consequently the flood-damaged (Figure3).

The damage caused by the floods and their cost for the citizens in the city, made us ask the following question: what is the CatNat insurance situation for the citizens of the city of Batna?

The answer to this question can be found in Figure 4, which shows the evolution of property insurance premiums in the city.

It can be seen that there was an increase in the number of contracts up to 2016, but from 2017 onwards there was a decrease in the amount of premiums, especially in the years 2000-2022, due to the epidemiological situation in the world (COVID -19 pandemic).

The floods are the most threatening natural risk in Batna for the insurance sector (SLIMANI, 2019, BATNA insurance agencies). Concerning the balance sheet of the insurance companies, an increase in the financial consequences can be observed. This increase provides an incentive for insurers to participate in the recovery and reduction of natural risks to improve their insurance management.

Photo 5- The effects of flooding in the city of Batna

Photo 6- The effects of flooding in the city of Batna (source civil protection 23 August 2015)
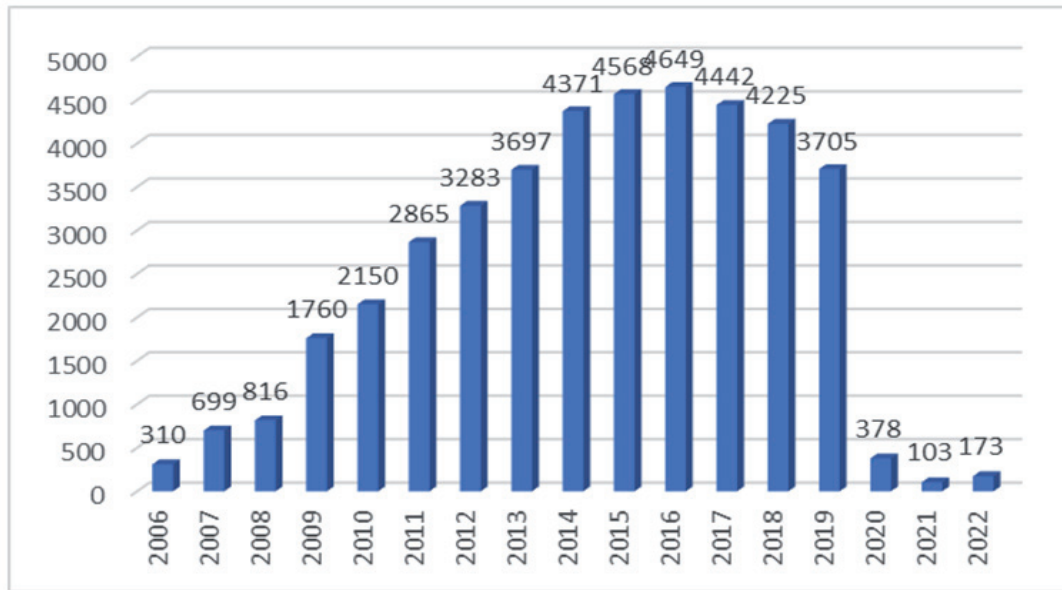
Fig. 4 - Evolution of property insurance contributions in the city of Batna (X: years - Y: number of contracts)

METHODS AND TOOLS

In this article we have studied the pre-loss insurance management, it is about prevention measures: incentives for prevention and knowledge of exposure to natural risks.

In order to improve insurance management, we took an example of a district most exposed to the risk of flooding in the city of Batna. This is the Parc à Fourrage district: and we showed the role of GIS in each phase of insurance management.

We started with natural risk management measures (preventive measures), first locating the prevailing risk in the area, then determining the typology of insured assets and finally pricing and specialising the vulnerability of their covered insurance portfolios, it is about the sum of the premium.

First phase flood risk mapping

The flood risk is estimated by crossing thematic maps related to the stakes exposed to flooding and the flood hazard (ANH, 2014). Geographic Information Systems play an essential role in flood risk mapping. GIS is used to establish and combine the hazard map and vulnerability map to extract the flood risk map.

$$Flood\ risk = Hazard \cdot Vulnerability$$

The mapping of risk areas and the typology of the insured property provide insurers with the possibility of adapting their pricing to the vulnerability of the assets covered. The risk map allows insurers to check the adequacy of their pricing practices with the composition of their insurance portfolios (PICO, 2007a).

The reliability and precision of risk maps is of paramount

importance to insurers. This depends on the quality of the database containing information on the insured property. The constitution of this database should not be neglected because the more precise the information collected, the more rigorous the evaluation of the insurance parameters will be.

According to the studies and the civil protection services of the wilaya of Batna, the Parc à Fourrage district is classified as a medium-risk or high-risk area (Figure 5).

The steps for the creation of the flood maps are: elaboration of the hazard map and the vulnerability map and grouping the two in the same interface to extract the flood risk map.

Second phase monitoring and spatial allocation of the portfolio

Insurers have a great deal of information on the insured property; location, type of occupation of the insured property, number of rooms, etc. This data allows them to draw up a useful map for insurance management: the exposure map.

In the Figure 6 the exposure map shows the spatial distribution of an insurance company's portfolio. This map shows the distribution of the property that must be insured by a CatNat insurance. CatNat insurance covers any owner (individual or legal entity) of a property or commercial facility built in the district.

We try to put an estimate of the insured property in the district, this is the equipment for housing (collective and individual) and all types of equipment (industrial, commercial, administrations, etc.).

Neighbourhood facilities are concentrated in flood-prone areas which makes it even more vulnerable, especially for equipment located on the banks of the river Tazoult.
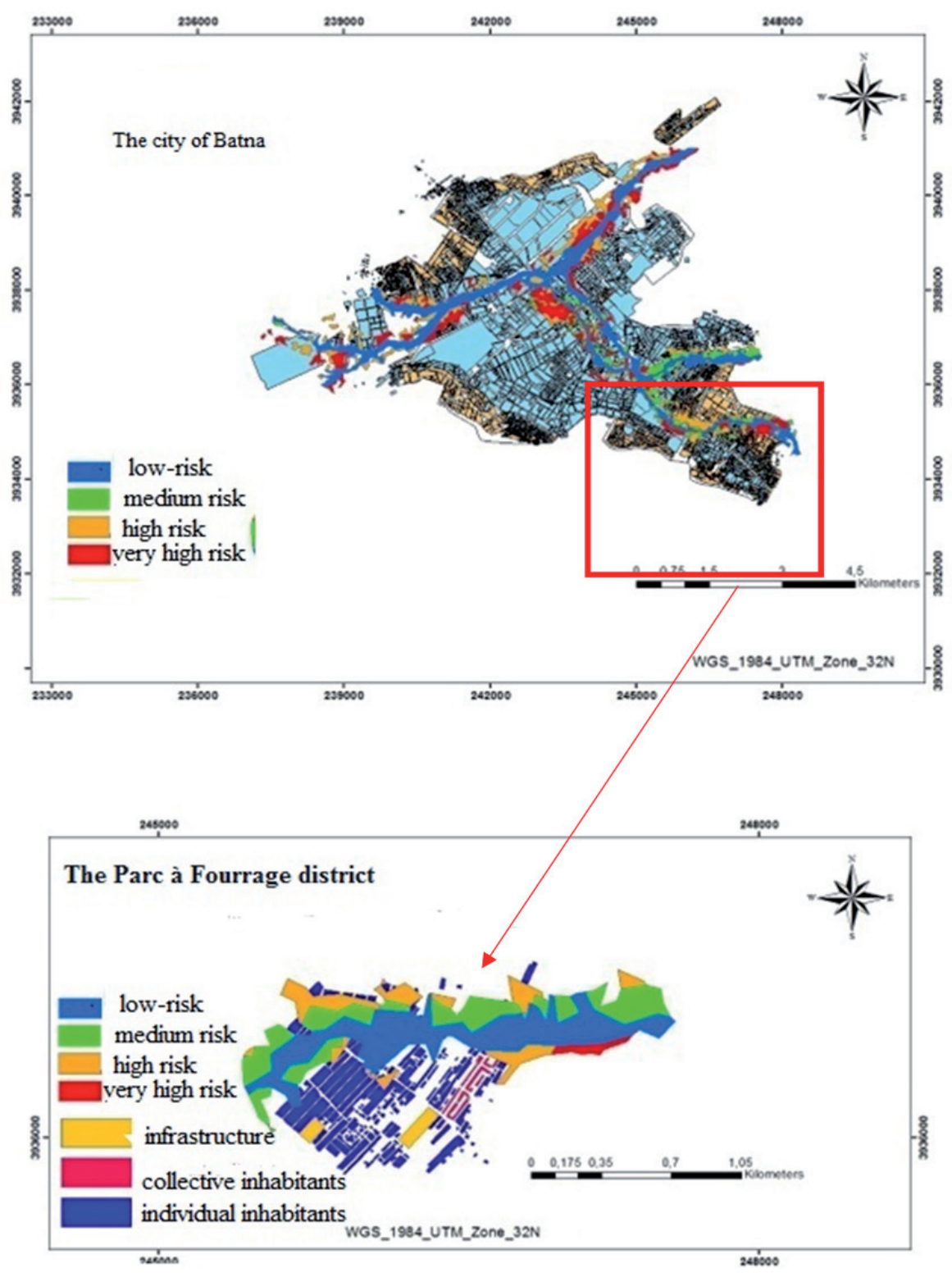
Fig. 5 - Flood risk mapping in the city of Batna (Source: Civil protection of the wilaya of Batna & treatment)
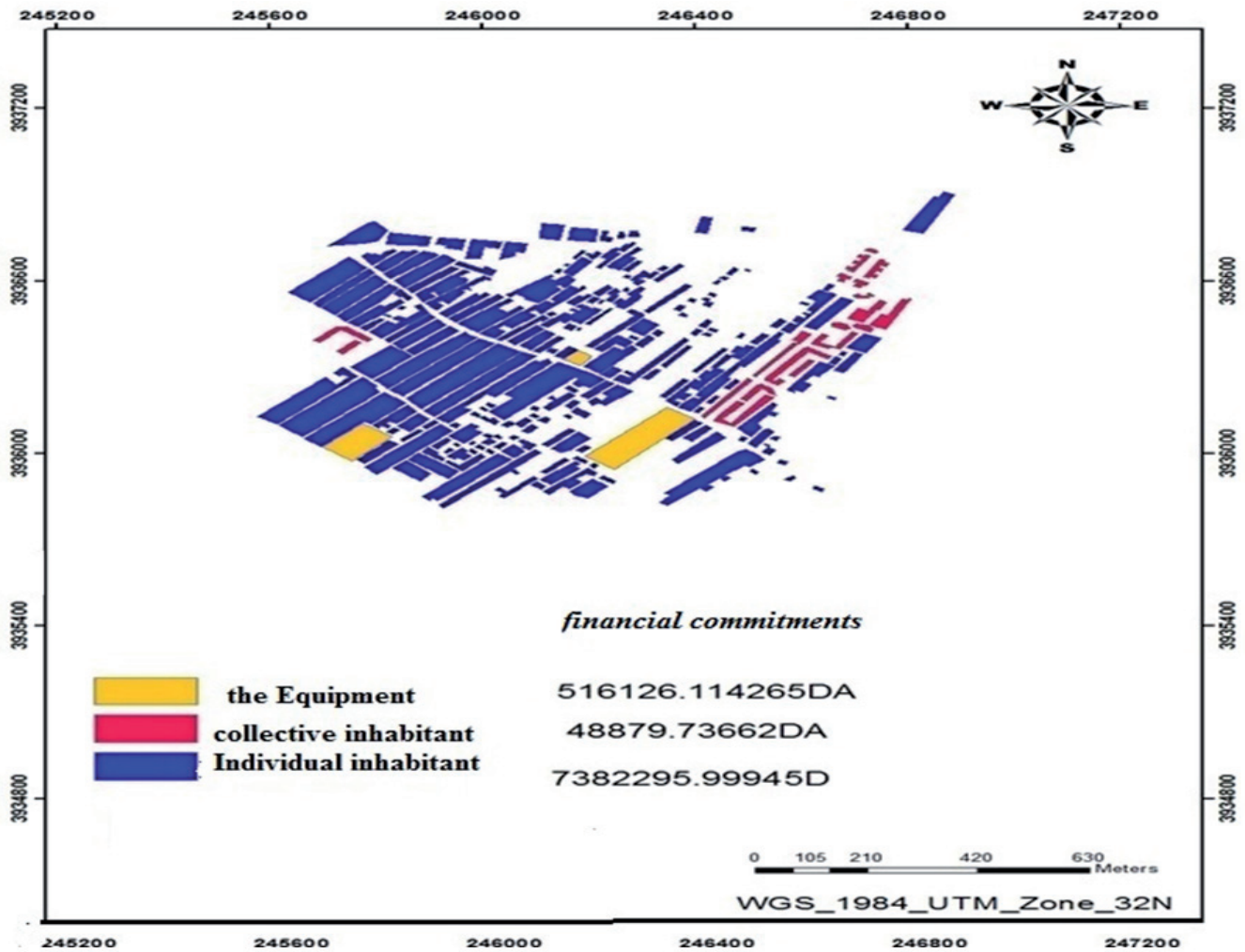
Fig. 6 - *Spatial distribution of the portfolio and of financial commitments in the Parc à Fourrage district*

Here the geographic information system allowed us to superimpose the physical layer related to the level of flood risk and the layer that contains the urban components of the city; the habitat and the facilities to realize the exposure map.

Third phase Estimation of CatNat insurance premiums

From map of the figure 6 (number of insured properties), we calculated the contribution rates from the price per square meter fixed by the Algerian state (Order of 20 Joumada Ethania 1438 corresponding to 19 March 2017 modifying the order of 17 Ramadhan 1425 corresponding to 31 October 2004 fixing the parameters of pricing, tariffs and deductibles applicable in terms of insurance against the effects of natural disasters) and estimated the contribution premiums for CatNat insurance:

$$P = \zeta \, Max \, (Vd \, (S \cdot Pn)$$

where:

ζ: the base rate to be applied

Vd: declared value

S: total building area

Pn: normative price per square meter.

If the insured does not have a building permit, a surcharge of 20% should be applied to this premium.

RESULTS AND DISCUSSION

The results obtained by processing the two layers: the physical layer related to the level of flood risk and the distribution of insured property are necessary to determine the map of financial commitments.

The financial commitments are a picture of the insurer's financial commitment. It can be the average financial commitments of the insurer over a year as shown in Figure 6.

We were able to estimate the financial consequences of CatNat

District	Area (in ha)	Number of homes	Number of dwellings threatened (2019)	Built-up area (in ha)	Number of contracts in 2019	Number of contracts in 2022
Parc à Fourrage	1,6	9435	2358	1,2	68	94

Tab. 2 - State of insurance in the Parc à Fourrage (Source: Batna Civil Protection Directorate and insurance companies)

insurance in the Parc à Fourrage district, which are estimated at between 516126.11 DA and 7382295.99 DA (Figure 6).

The mapping of financial commitments allows insurers to optimise their management.

To show the real state of CatNat insurance, at the level of this the district, we contacted Insurance company, where data on the state of insurance at the district level (number of contracts) were collected, the results are presented in Table 2.

The value of CatNat insurance (premiums and contributions) in the Parc à Fourrage district remains low in relation to the number of houses endangered and in relation to the estimated financial consequences of insurance (between 516126.11 DA and 7382295.99 DA) (Figure 6). According to a survey carried out by SLIMANI (2019) where it shows the absence of the insurance culture in this district because of the lack of experience and confidence as well as the long procedures and the too expensive costs of this insurance (the answer of the citizens of the district).

Therefore :
- Insurance companies need to address the need to create and manage new knowledge about natural hazards in order to improve cohesion between the different actors in the insurance system against the effects of natural disasters, and thus their prevention.
- The insurers of the city of Batna are called upon to play their role in the management of major natural risks, by increasing the awareness of the population on the importance of taking out Cat-Nat insurance, especially in vulnerable areas.

- Each company must be able to manage and prevent losses as well as possible, to be able to ensure itself against one or more catastrophic events and to be able to optimize the underwriting policy with the insured (JULIEN, 2009)

CONCLUSIONS

The results obtained from this research in insurance management in the city of Batna, allowed us to show the role of GIS in the management of natural risks and the improvement of insurance management of insurance agencies.

Geographic Information Systems (GIS) play an essential role in improving insurance management. It starts with the mapping of flood risk, the estimation of insured property and ends with the mapping of financial commitments.

Insurance against natural disasters has been compulsory since 2004, but the overall average rate of intrusion remains very low either on a national scale (only 10%) (DJAZAIRI, 2013) or on the local scale of the study area, due to the absence of an insurance culture among Algerian citizens.

Today, Algerian insurers are called upon to play their role in the management of major natural risks, by increasing the population's awareness of the importance of to contract a CatNat insurance; and by promoting a better insurance management through the integration of new techniques such as the geographical information system.

Good insurance management makes it possible to anticipate and optimise measures to improve prevention and compensation.

A good knowledge of natural risks is essential to protect oneself physically and financially through insurance: geographical information is therefore becoming crucial for insurers and policyholders.

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