NATURAL RISK IN THE CITY OF ALGIERS: FLOODING OF NOVEMBER 10, 2001

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Abstract
The objective of this work is to present a contribution for flooding hazard analysis and how to reduce the risk. The analysis concerns the expertise about the disaster induced by the flood on November 10/11, 2001 in the district of the city of Algiers.
During the urban design phase, the assumption of the risk is integrated in the standards and rules of construction related to each specific site. On existing urbanised sites, the reduction of the risks consists in making decisions to reduce the fragility of the environment using several artificialies. The identification of the existing correlations between the town management and the vulnerability of a site allows the implementation of preventive measures. The interactions between the urban management, the soil and the vulnerability of the site permit the presentation of recommendations to mitigate the risk in the future.
Key words: Algiers, fragility, Vulnerability, flooding, risk reduction, town planning, recommendations.

Résumé
Risque naturel dans la ville d’Alger : inondation du 10 novembre 2001

Mots clés : Alger, fragilité, vulnérabilité, inondation, risque, aménagement urbain, recommandation

ملخص
الخطر الطبيعي بالجزائر العاصمة: فيضان 10 نوفمبر 2001

تستهدف هذه الدراسة عرض إشكال الفيضان الذي عرفته الأحياء الهاشمية للجزائر يوم 10 نوفمبر 2010. حيث ناقشت
المواضيع والأسباب الخاصة بالموقع والمحيط وكذلك العوامل الخارجية المرتبطة بوضع السياسات المعموقة وخاصة في مجال التعبير
والجهيزات الأساسية والتنمية المحلية. تقدم الدراسة عددا من المقترحات العملية التي تستمكت من تقييم خصائص الفيضان في هذه
الأحياء مستقبلا. ومنها ضرورة مقارنة الإشكالية وفقاً للتطور الإشعاعي يستحضر الأسباب الاجتماعية والاقتصادية والسياسية وغيرها
وتجاوز النظرة التقنية القطعية التي كانت متصلة في السابق، وهي مقترحات تهم مقياس ترابي مختلف من المحيط والجهوي
والوطني.

الكلمات المفتاح: العطوبة، الفيضانات، الخطر، التهيئة الحضرية، التوصيات، الجزائر العاصمة.
Introduction

The population of the city of Algiers that was 800,000 inhabitants in 1962 grows to 2,500,000 inhabitants in 1998 and reaches about 3,000,000 inhabitants in 2001 (ONS, 2001). In its contemporary history, the city has never known such flooding, dramatic due to its consequent human losses and damage, although the precipitation rainfall has been getting decreasing since 1970 (M.O., 2001).

The yearly precipitation for Algiers region (A.S.H.A: Archives du service hydraulique de la ville d’Alger, 2001), was in the order of 700 to 800 mm in 1960/62, of 500 to 600 mm in 1975/80 and 400 to 500 mm in 2000. The urbanised surface of the Great Algiers has doubled and the zone of Bab El Oued and its West neighbourhood have tripled. The new urbanised zones were built on the catchments that nourish the river in Bab El Oued.

- This site, has been largely deforested, and presents a schistose soil of clay origin, a very damaged morphology and hilly topography on some places.
- The aspect of the urban produced is not characterised by a rational urban shape nor by an ordered spatial organisation.
- Some constructions are built against or inside cliffs, these actions permitted to enlarge the surface of their properties.
- The implantation of buildings and road networks do not follow the perpendicular tracing curves of topography levels and do not respect the authorised alignment. Gutters destined to collect the rainwaters along streets are very distant to each other and their grids are demolished in their majority.

The article presents the major characteristics of the flooding event and

1. Presentation of the context

The following figures present the location of the studied area within Algiers town and the schema of the site morphology of Bab El Oued District showing the impact of local factor in the flooding genesis.

![Figure 1. Location of the study area.](image1)

![Figure 2. Schematic morphology of the Bab El Oued zone.](image2)

2. General assumptions and identification of the risk factors

The factors that cause damages in the town are identified. The natural context and the characteristics of the urban site (density, economic activities and social structures, etc. increase risk opportunities and expose the city to floods in its lower parts when they are not mastered.
- The vulnerability

The great disasters in the past have marked the community for a long time. The natural elements are probably the principal causes. But at the same time, these disasters show precious indicators to approach problems of the future risk reduction. The historicity of the hazard and the disaster is approached based on the return-period.

The propensity of a space to suffer from damages characterizes its vulnerability. The relationship between these two notions: hazard and vulnerability, determines the level of risk. It supposes that the challenge is to reduce the risk in using suitable scientific knowledge, many subjects and an appropriate methodology.

The flooding risk is linked to the importance damages provoked by the flood and the land movement.

From a methodological point of view, the identification of the risk is obtained from a multidisciplinary analysis aspect that includes:

- A spatial approach to the physical and human environment interface;
- The historic dimension (conditions of the natural evolution, hierarchy of responsibilities, consequences of political decision) that oriented policies of the actual management;
- The perception and the level of awareness of the risk by the affected populations and decision-makers;
- Specificities and cultural diversities intervene as important element to be taken in account.

- The flooding

The inventory of flooding events, in Algeria and in Algiers particularly, confirms that the rainfall season concerns the period October to December. All rivers are susceptible to be the source of violent flow and dramatic accident but don't constitute necessarily a "major risk of flooding", except in the case of obstruction. The history of flooding and landslides in Algiers shows events occurred in 1955, 1962 and 2001 (A.S.H.A: Archives of hydraulic office of the Algiers city, 2001).

3. Description of the flood and its estimated damages

In the flooding event of November the 10th, 2001, the studied area was highly damaged because the main collector of the sewage system, which is located downstream the pouring basin and upstream of the district of Bab El Oued, did not get its diameter enlarged nor doubling the system. The two sub-catchments, in the district of Trolet, were full of sand, while the sewage systems, all categories, have not known any maintenance operation since a decade ago. The continuous rainfall that lasted 14 hours (all night and in the morning) was followed by the disaster. The recorded precipitations in the city of Algiers were evaluated by the weather services (M.O, 2001) to be about 210 mm during 24 hours. The rise of the water level was progressive and regular in a first time which was estimated at two hours, then suddenly a large wave evaluated to two or three meters of height surged in streets near of the Trolet district and the Maillot hospital at 9 a.m (local time) in the morning of October 10, 2001. The water tracing converged toward Maillot hospital from the west and the south and throw out at the seafront boulevard. The water speed has been estimated between 20 to 30 km/h. The water wave strength was such that reversed the persons and vehicles and carried away vehicles as corks. After the passage of the wave, the progression of mudflow with the solid blocs affected first floors of buildings on a height sometimes reaching two meters. The road traffic has not been stopped neither upstream nor downstream the damaged zone. The waters have carried away a large number of citizens, mainly those trying to help the drowned people in streets.

The first estimation of the flood was given by the government as following:

- 712 human lives lost, 350 injured persons and 116 missing persons,
- 1800 housing units suffered damage,
- 56 schools suffered considerable from damage,
- Many bridges, roads and public works were damaged,
- 1,000,000 M³ of mud in the streets,
- More than 350 vehicles (cars, trucks and buses with passengers) were buried under mud or throw out at the sea,
- Estimation cost of the damages: U.S. 250 million.
The Photos 1 to 6 illustrate the damages of the flooding disaster.

The following remarks were noted:

- The site is downstream a large pouring catchments, controlled by the massif of Bouzareha (in the west) and the El Biar zone (in the east), do not possess any hydraulic infrastructure facilities for protection against flooding.
- The high urbanisation of these catchments increase the impermeability of the soil.
- The site presents a hilly topography, which encourages the erosion of soil and the surface waters flow.
- The absence of an urban shape proves that the urban design is not sufficiently rational and is not adapted, considering the characteristics of the site.
- Banks of the oued are not being protected. This fact encourages the overflow and the change of tracing flow.
- The deterioration of the site morphology can provoke eventual landslides.
- The most damaged zone (Tripoli - Maillot hospital) situated in the entry of the funnel of the catchments should be reserved to green spaces, not to dwellings and commerce.
- The sewage system (that is unit type) being close to the seafront is certainly overloaded because historically the urban extension started from the seafront.
- The power of the water wave resides not in its height but in its kinetic strength. The water's mass came from a long distance.
- The water wave speed presents an enormous mass of water which has been blocked somewhere and then suddenly set free.
- The enormous quantity of water that surged on places of the disaster zone, proves that the hydraulic evacuation network was not functional because of an inadequate maintenance.

4. Discussion and recommendations for risk reduction

Damages caused by the 2001 Algiers's flooding have given the opportunity to launch a large discussion on the safety in the megacities. The narrowness of the space, the insufficiency of the infrastructure inherited in terms of road network, drinking water system, housing, have pushed since 1974 to the decentralization on several "wilaya" (administrative regions) that are Tipasa, Blida and Boumerdes. In spite of the realization of several new urban zones and the multiplication of new urban districts since the 1980's, the increased requirements of the high and middle social layers aggravated the housing deficit. The need of the habitat has already consumed well more agricultural space than didn't make the previous implantations of industrial activities.

The reduction of the risk is linked to the efficiency of policies (management) adopted in risk prevention. It is about determining what can be acceptable for the concerned community, not only on the economic and financial plan, but also, and maybe especially, on the social, political and cultural level (Belazougui, 1999a). Any proposition concerning risk mitigation aims in facto to modify behaviours, sometimes deeply anchored in the culture, the tradition, the social practices (those, notably, which assure a minimum capacity of subsistence to the poorest). The problem is to know how to modify these behaviours for risk reduction, while using to best the tradition and the existing social practices. Only the narrow association between the different disciplines can go in this direction and can clear on the efficient propositions leading to what is acceptable, adapted and lasting.

The consensus that it is accepted of the disaster management process, in the United Nations system, is to take simultaneously into consideration risk factors and vulnerability with the one of the risk management according to the relation (2) (Benouar, 2001):

\[
(1) \quad \text{Risk} = \text{Hazard} \times \text{Vulnerability}
\]
\[
(2) \quad \text{Risk} = \text{Hazard} \times (\text{Vulnerability} / \text{Policy})
\]

By comparison, to the old definition (1) that neglected the notion of the preventive management, the new approach defined the fragility like a science being a matter for the domain of the appraisal and the domain of sciences of the politics of the urban management prevention. A great effort remains to
achieve in the definition of the fragility. Indeed, the reference in terms of fragility leads directly to the today’s standards.

For the "possibilist" method, three scales are globally to be considered for the identification of conditions to reduce the factors of risk that will be able to realise concrete actions of prevention:

- The macro-scale (regional and national scales): structural factors and processes that contribute to generate risks may be apprehended, while increasing the vulnerability of populations and of the city as a whole, as poverty, phenomena of rural exodus, unemployment, the economic and political instability, etc. Researchers may very well propose solutions. However these factors or processes are not easily mastered and do not permit to propose sufficiently targeted solutions, efficient and aiming in the short term.

- The middle-scale (intermediate scale of the city) where general solutions to middle or long terms are foreseeable. It is notably about measures of urban preventive scheduling and to establish urban disaster management.

- The micro-scale where we find amplified risk, the very local forms of vulnerability and the common survey subjects between disciplines. According to the analysis of the risk and the weakness of technical design (technical approach of the vulnerability), earth sciences and the civil engineering may elaborate solutions, or even estimate the cost of it. The role of human sciences is to orient and to propose solutions by the identification of conditions of risk reduction.

These elements are constituting the urban system (populations, proprieties, functions, activities, modes of management and decision-making...) cannot be studied in an exhaustive and deepened manner in terms of risks and vulnerability. To be efficient the research must focalise on certain spaces and certain elements taking in account that the risk would constitute a major handicap for the community concerned, the urban functions and the development of the city (or even of the country). The problematic supposes to privilege the last two levels of geographical analysis; therefore, the first one at the level of the city, the second concerning the local scale and more precisely of spaces and elements (challenges) important within the city. The first level of analysis doesn't constitute an end in itself but stands to the service of the second level whose findings should be operational. The multidisciplinary studies should be therefore adapted to the needs of these two levels of analysis, so much in their nature that in their precision.

The "phenomenological" approach permits, once the challenges are identified, to reconstitute the causes of the damage. For this, the historical development of the urban system could be coupled with the physical process evolution in order to understand multi factorial interactions to the causes of the damage. Reactions of populations as the political decision of the public power facing the damage must be recovered and analysed, in order to value its induced effects. For example, structures built in preventing risks linked to water and earthquakes do not reduce the vulnerability systematically. The behaviour of the urban populations may have a significant impact on the perception of the risk. Only detailed case studies of some urban sites allow establish a diagnosis in order to propose measures that justify the recent evolution of the territorial organization under damage.

There are now opportunities to bring together earth scientists, engineers and social scientists from Algeria to propose a methodology for reduction risk using semi-empirical data and field surveys. As a result, various kinds of mitigation measures are being applied. These recommendations concern the urban policy of the city of Algiers after the flooding of November, 10, 2001.

To avoid a sectorial and segmented vision, the risk disaster must be considered in a global and integrated approach. Indeed taking into account simultaneously all factors of the risks goes in a rational and voluntary approach permitting to reduce the disasters impact on the city and on the territory. A methodology that permits to take the risk disaster in charge in the urban politics is necessary. Our study permits to underline the following propositions and recommendations:

- The creation of urbanism service to the intercommunity links for small cities having as mission to contribute to the technical plan of soil occupation and the director plan of urban planning, and carry technical free help to citizens. This service may collaborate with services of the land registering and services of the regional development in the scale of intercommunity.
- The unification of the technical services of the cities with the different ministerial departments for more coordination in action.
- The obligation to do impact studies for projects of important size in the cities.
- The creation of an institution charged for the prevention and the management of disasters. Its action must rest on the creation of database oriented toward knowledge of reasons, consequences and relative circumstances (conjunctions) to phenomena of disasters in a general manner. This approach permits to model disasters and to simulate scenarios. It may do comparisons between the local cases and the cases of disaster in others countries and establish rules for the urban risk reduction and create specific risk databases. These databases consist of the geological, geotechnical and structural engineering data provided by geographic information systems (King and Kiremidjian, 97). These databases are important in characterising the urban risk: earthquake source database, geotechnical hazard database, and vulnerability database.
- Adoption of a rational urban insurance policy (Kleindorfer et al., 1999) and urban planning. The urban design in the district is one component of the urban composition in the town. For the national policy, the town is one part of the region planning. The vision of the urban disaster must be taken in account during the urban process of the town planning, before and after the realization of the town. This approach associates the action of the technician actor with the action of the policy actor. The diagram represented by the figure 3 illustrates this vision.

**THE DISASTER RISK IN THE URBAN PLANNING PROCESS**

![Diagram of the disaster risk in the urban planning process.](image)

*Figure 3. The disaster Risk in the urban planning process.*

The aggravation of deficits, notably in drinking water services triggered riots in several cities of the interior and in the capital. The communication networks overloaded, will have consequences on the scheduling of the future zones of implantation urban and a structuring effect on the urban armature and the existing network of communication. The high standard residential zones of the city centre itself are de-localised more and more toward the southwest suburb where the urban density is low, the mechanical circulation is very fluid and the landscape is grassy and hilly. The rarity and the high cost of the land in the belt of the city centre will have for effects the popular district repression toward the less viable suburbs and predisposed to the violence and other social consequences. Applicable and sustained decisions must be taken to reduce the risk. Otherwise, Algiers could evolutes toward situations of fragility amplified by possible natural disasters.
Conclusion

To avoid a sectorial and segmented vision, taking into account the risk of disaster must be managed in a global and integrated approach. The risk of disaster for the inhabitants of Algiers has been aggravated by the lack of technical expertise in the domain of the prevention and mainly by social reasons linked to urbanized space. If the maintenance of some urban equipments and water network are not taken into account, thus the vulnerability of the city will increase. The management of the city cannot be divided in isolated segments. The city is a space system with a social and political
support, and of functions that assured by actors. The knowledge of these interactions permits to take preventive arrangements during the precocious phases of the conception of the urban plans. The preventive measures must be applied to the urbanism in all its aspects of use: occupation and organization of spaces, and to the urban planning in its infrastructure, equipment and management aspects. The disaster management, in its preventive aspect, essentially articulates on the mastering of the urban scheduling and management of urban composition and infrastructures.

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