

Urban Resilience - Tools and methods for analyzing flood problems in the city of TebessaTALBI Sarra ^{*1}, GHERZOULI Lazhar ², FEZZAI Soufiane ³

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Abstract: Now more than ever, many cities around the world are exposed to the inescapable phenomena of natural or anthropic disasters that exceedingly lead to fatal consequences. Human activities, particularly vulnerable urban tissues, anarchic urban development, and massive and rapid urbanization, are the principal purposes of the catastrophic accelerating climate crisis and global warming, consequently, the earth is more sensitive and seriously confronted with natural disasters as well floods and earthquakes.

Urban resilience (UR) is dedicated to developing solutions and methods to prepare cities for disasters and unexpected events caused by climate change-induced extreme weather; On the national scale, the flood risk is among the first risk that threatens the Algerian cities. In particular, the City of Tebessa is not spared from major hazards, with destructive effects, such as the floods of 2018. This study aims to provide an overview of UR by examining some of the literature reviews in this regard.

This paper focuses on the theoretical vision of defining UR and its specific components focusing on urban flood risk management through the review of recent research in the field, as well as highlighting the problem of Tebessa's flood vulnerability as a statement of the current situation, and providing a platform for the next work. The research method that is used in the main body of the paper is a literature review as a state of the art according to the data collected from online databases, and data analysis for the UR concept according to the classification of publications. As a result, the paper ends with a discussion of how UR as a concept might solve the problem of Tebessa's vulnerability and the necessity to enable serious thinking for this notion as a theoretical solution to the city's flood problem.

Keywords: Urban resilience; flood; vulnerability; Tebessa city; tools and methods.

Introduction:

Nowadays the world faces a major challenge against harmful shocks and mutations according to the increasing variability of climate, the warmer atmosphere increased the evaporation of water surfaces and held more water that increases the intensity of the rainfall, and the frequency of extreme events has been more aggressive in cities; as a result, these changes increase the effectiveness of natural hazards already been observed: the frequency of great floods has increased during the twentieth century (Foudi & Osés, 2014).

The large-scale natural disasters provoke security and stability, and sustainability of cities and cause serious human and economic losses according to several causes in this decade that complicate

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the management of major risks in cities, because 50% of the global population lives in urban areas(Lak et al., 2020; Meerow et al., 2016), that's why cities and urban systems need to be able to quickly bounce and to be more resilient from climate-related shocks and stresses(Leichenko, 2011), and also disaster mismanagement in urban regions(Cutter et al., 2008).

In this regard, stability and preparedness are considered important keys to urban resilience, supporting urban areas and cities to be proactive in the face of reactive events(Lak et al., 2020), because the concept of urban resilience has developed in response to this situation, moreover, "resilience thinking" has become a necessary concept that brought a new perception as a solution to the vulnerable areas(Leichenko, 2011), as it allows us to recognize the behavior of the city as a complex system, it involves several factors such as social, economic, ecological ...and many processes and objects are interdependent in space and time, this complex system becomes vulnerable when one of these subsystems is not functioning, damaged or unable to adapt to new challenges(Narieswari et al., 2021; Zhang & Li, 2018), if this situation is not properly solved it can be devastating or fatal(Narieswari et al., 2021; Zhang & Li, 2018).

The Algerian cities like all the cities of the world are exposed to the major risks resulting from the effects of climate change, and according to the Law N° 04-20 of December 25, 2004, on the prevention of major risks and disaster management in the context of sustainable development(Official Journal of the Algerian Republic N° 84, 2004) especially the article N°10 which includes the following risks: floods, earthquakes, and geological hazards, climatic risks...etc.

Tebessa is one of the Algerian cities facing a great challenge against some of the natural hazards and climatic risks mentioned above, such as floods that are considered the major danger that provokes and threatens Tebessa City, as an example is the flood of 2018; this city is characterized by a dense hydrographic network consisting mainly of ravines and gullies (wads) that cross the existing urban fabric of the city, which makes it more vulnerable to this type of hazard, in particular, the flood risks.

This paper focuses on the theoretical review of urban resilience with its specific components, also describes the problem of the vulnerability of the city of Tebessa to floods as a statement of the current situation, and provides a platform for the next work. The research method that is used in the main body of this study is a literature review as a state of the art from online databases, and data analysis for the subject of urban resilience by examining the classification of publications in this regard.

As such the paper concludes with a discussion on how urban resilience as a concept can address the problem of the vulnerability of the city of Tebessa, with the need to enable the necessary thinking for this concept as a theoretical solution to the problem of floods in the city of Tebessa. So how we can solve the flood problems in Tebessa City by using the concept of urban resilience? What are the methods and tools that can be used in this case?

1. Research method:

The study was held in the city of Tebessa, specifically in the municipality of Tebessa in the disaster aspect. In this paper, we try to : (1) Data collection to identify the state of the art of urban resilience from online databases; (2) Data analysis for the urban resilience concept according to the classification of publications; (3) Case study: Describing the statement of Tebessa City as a platform for the next work. To understand the problem of floods, as well as the available solutions, and to achieve urban resilience as a theoretical solution for the vulnerability of urban fabrics of Tebessa City. The research method is detailed in (Fig.1).

a. Data collection:

The use of data collection in this study is to identify the state of the art of urban resilience from online databases were used in the literature on this concept such as Scopus and ScienceDirect which have been used to research journal articles by selecting specific keywords related to our topic and were used in the research process e.g.: "urban resilience", "resilient city", "resilience assessment", "spatial resilience", "vulnerability", "floods".

b. Data analysis:

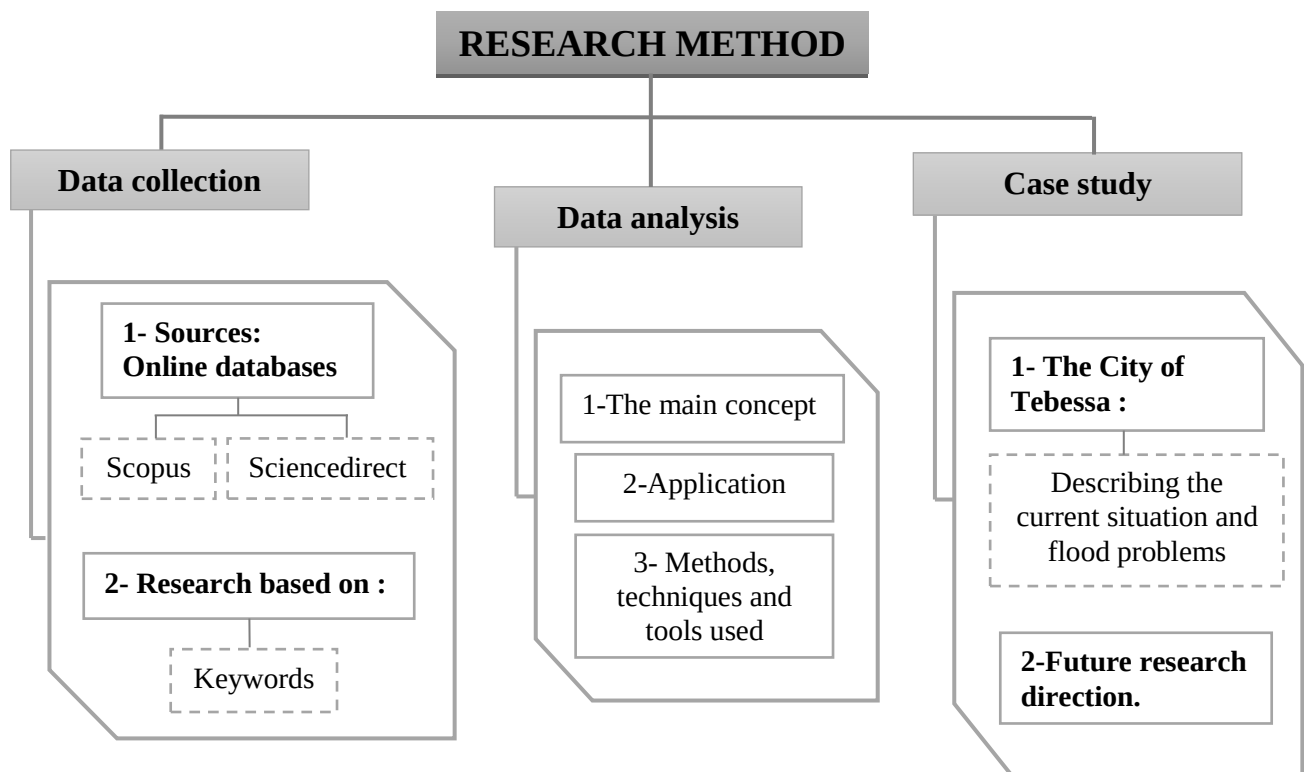
After collecting and examining these studies, the data analysis provides a roadmap to tackle challenges by identifying the various parameters that accelerate and worsen flood problems faced by cities and also filtering out available tools and methods on this issue to increase the resilience of cities according to the literature reviews.

c. Case study:

Tebessa city is our case study which is suffering from many problems, especially floods. In this part, the paper describes the current situation of this city according to the field data that the local administrations of the city are working on, such as Administration of civil protection, Administration of urbanism, architecture, and construction ...

In addition, this part shows the available tools and methods that could prepare this city for unexpected events; In particular, flood disasters.

Fig.1. Research method of the literature review.



Source: The author,2022.

2. Urban resilience:

Urban resilience as a concept is too large and wave to clarify; Recently several publications have provided many definitions of this concept, which makes it an adaptive concept according to changing the field and time; In this context, we try to collect and review the most common

definitions in many fields about this concept in chronological order from oldest to newest beginning in 2000 and ended in 2021, to understand it more.

First, In ecological systems, it is not easily observed, because the resilience of an ecological system is interconnected to the use of the system, rather than the stability of its subsystems, or even the ability to adapt to a diversity of ecosystems(Adger, 2000; Pimm, 1984), also, the resilience can be defined as “the ability of a system to resist the perturbations or to absorb the magnitude of the hassle that can be absorbed before a system changes its structure by changing the processes, parameters, and variables that control behavior.”(Adger, 2000); In the agricultural and biological sciences; environmental science, “Resilience is the capacity to which cities and environments tolerate alteration before identifying around a new condition of processes and structures.” (Alberti et al., 2003)

In the environmental science, “To maintain a certain dynamic system, urban governance also needs to build a transformative ability to face change and uncertainty”(Ernstson et al., 2010), and in social science; “Degree of adaptation to climate change stresses, effective internalization of climate-related risks, and rapid recovery from negative impacts”(Henstra, 2012). In earth and planetary sciences, “Resilience is the ability of the environment to absorb disturbance and recover its functions after a disturbance.”(Meerow et al., 2016). Thus resilience is a concept that “revolves around the capacities of urban environments to absorb, disrupt, recover from shocks, self-organize, adapt and transform.” (Zhang & Li, 2018), and according to (Reu Junqueira et al., 2021) defined the urban resilience as:” The capacity of an urban region to withstand a wide range of shocks and pressures, as well as to adapt to new environmental situations.”

After all these collections of resilience definitions, we can summarize the Urban Resilience considered as a positive concept revolving around the resistance, flexibility, and equilibrium system to solve many perturbations in the system of the city.

The city's ability to withstand and adapt to the effects of flood hazards is gradually becoming more attractive and developing. Even when such risks are identified, risk reduction and vulnerability are often not a prominent concern until after such events have occurred.(Xu et al., 2021).

To manage future flooding, it is important to uniformly embrace the idea of resilience as a positive concept that contributes to sustainability, which is a widely accepted trait.(Brown et al., 2012). The real meaning of urban resilience is the ability not only to fix basic functions but also to develop and thrive. Urban resilience is understood to mean the capacity to return to a” normal” or steady-state after a disturbance.(Campanella, 2006). But if certain conditions could be more undesirable, they are fully resilient to manage future damage from flood risks and mitigation and adaptation measures now. Recently, improving flood resilience has become one of the most important ways to deal with climate change and natural hazards, hence quantitative assessment of flood resistance has emerged as a priority.(Xu et al., 2021)

As a consequence, the connotation of resilience in the context of flood risk management relates to when an urban water system experience flooding:

- a- Ability and capacity to withstand floods; the ability to protect against floods.
- b- Flexibility when events occur; the ability to minimize damage and support rapid recovery.
- c- Self-regulation, learning, and adaptability of the system. (Xu et al., 2021)

The vulnerability of urban fabrics has a significant role in assessing the severity of risks, because there is a relationship between vulnerability and exposure to the risk of flooding, and according to this case of the city vulnerability is the measure of the capacity to weather, resist, or recover from the impacts of a hazard in the long term as well as the short term.

“You cannot manage your disaster risk if you are not measuring your losses” as mentioned by *Mami Mizutori (2009), UN Special Representative of the General Secretary for Disaster Risk Reduction.*”

Vulnerability depends on many factors such as ground use, type and state of construction, use and contents, the nature and the diversity of populations (mobility, age, health), warning of an impending hazardous event, and preparedness and ability to take responsive reactions. This means that within an identified flood hazard area there may be the same exposure or risk of flooding, but a wide range of vulnerability to the hazard. This will be examined in more detail in subsequent course topics. Floodplain managers and programs need to recognize and account for ranges of vulnerability to flood hazards. (Foudi & Osés, 2014)

Similarly, vulnerability is the measure of how sensitive an item is, the more it is exposed to risk the more it is susceptible to its forces and effects. (Messner & Meyer, 2006) And the degree to which an element behaves is when it is faced with a flood hazard and includes preparedness before the flood (proactive), adapting during the flood (reactive), and recovery after the flood (post-active) capabilities (Foudi & Osés, 2014). The flood hazard depends on its characteristics as duration, velocity, and depth.(Foudi & Osés, 2014).

Vulnerability analysis for each of the items at hazard allows estimating flood damages (tangible and intangible, direct and indirect) for different periods. As an example, in residential buildings, the vulnerability analysis shows the duration of the flood, the depth of water, the state, and the type of building that determine the direct damages of flooding(Penning-Rowell, 2005). There is a relationship between damage (losses) and water depth per square meter in residential properties. This damage contains the impact of flooding in building tissues, on household inventory, and the costs of unavoidable cleaning. (Foudi & Osés, 2014). In this case, the vulnerability analysis should be considered for each type of construction and equipment, summarize all damages, direct and indirect, tangible and intangible, and the negative consequences of floods are estimated. (Foudi & Osés, 2014)

2. Flood hazard:

Floods are among the hazards that provoke the cities, the American Planning Association defines a hazard as: "a physical condition or event that has the implicit to beget economic and human losses, fatalities, infrastructure damage, agricultural loss, damage to the area and territories, interruption of service and business, or other types of harm or loss." (*chapter 4 - flood risk assessment.pdf*, s. d.)

Flooding has become the most frequent natural hazard posing significant environmental, social, and economic damages across the globe, especially in urban environments. with a high degree of vulnerability(Xu et al., 2021)

The flood hazard is the potential for the inundation that involves hazards to life, health, property, and resources and functions of a natural floodplain. Its physical characteristics consist of the following elements: severity (duration, magnitude, and flood extent), probability of occurrence and frequency, locations or areas affected, and speed of flood onset. (Department of Environmental Protection - State of New Jersey, 2009), and the causes of flood hazards differ from one region to another it depends on the geographic situation and the characteristic of the weather ...so the types of flood hazards are represented in 3 cases :

a-Rainfall floods: Risk of flooding from the water surface and small watercourses.

Surface water flooding happens when rainwater does not drain away through the infrastructure and the normal drainage systems or soak into the ground, but lies on or flows over the ground instead.

b- River floods: Risk of flooding from rivers.

River flooding happens when a river cannot cope with the amount of water draining into it from the surrounding land.

c-Coastal floods: Risk of flooding from the sea.

Sea flooding happens when there are high tides and stormy conditions.

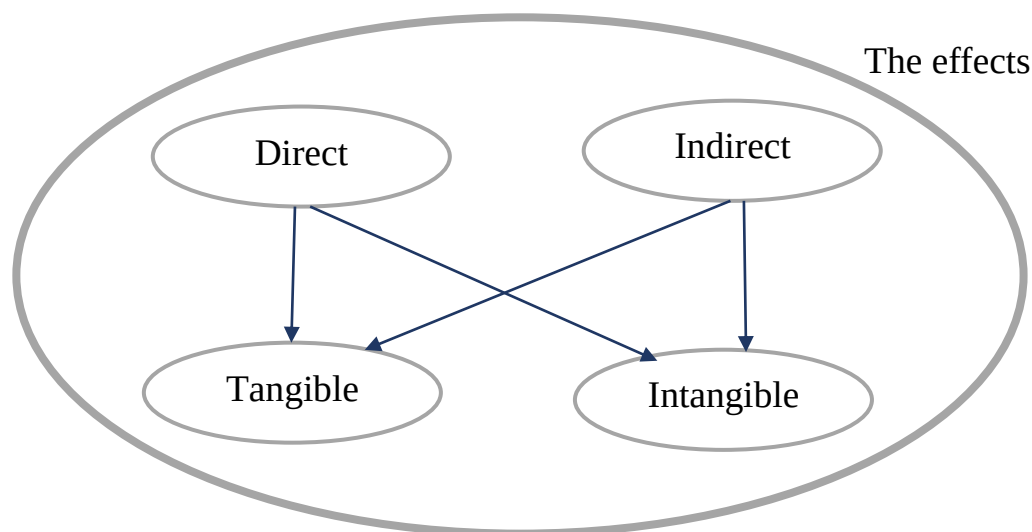
The effects of floods are classified into direct and indirect effects. The assessment of the damage and losses also classifies the effects into tangible and intangible effects. This classification is the most common in the literature (Rose, 2004), but interpretations and identification of what is considered direct or indirect may vary.

- The result of the physical contact of water with the items exposed is the direct effects, and the consequences of the direct effects which therefore occur at different scales – spatiotemporal- are the indirect effects. Also, the effects that can be easily measured in monetary terms are the tangible effects, and the effects that refer to the items that are not traded in the market or for which a value is difficult to determine are the intangible effects (Fig.2) (Foudi & Osés, 2014). For example:
- Direct and tangible: the damage of buildings and equipment, property, cleaning costs, infrastructures such as sanitation systems and roads, also cuttle and agricultural production...
- Direct and intangible: human losses, injuries, damage to cultural heritage ...
- Indirect and tangible: Disruption of public services including transportation, flows of public services, electricity, and water ...
- Indirect and intangible: the post-active stress, acquisition of experience in flood prevention, modification of preferences or risk perception,... (Rose, 2004)

The function of ecosystems affected by the flood hazard, and as a result, the effects are not necessarily negative effects on well-being. Because the way that functions will be affected by the characteristics of the flood and what the society values the services (Foudi & Osés, 2014).

Further, flow procedures are more representative of disaster costs than inventory procedures. Thus, the flow values enable the capture of outage time and recovery of activity (Foudi & Osés, 2014).

Fig.2. Classification of flood damage.



Source: The author, 2022 and (Foudi & Osés, 2014).

Following the previous studies in the field of urban resilience, it is important to understand the different attempts that have been exploited in these studies to distinguish between conceptual and analytic works, which can help future research provide a roadmap for the next steps. And to synthesize some of the most recent literature reviews, we use the table below (Table.1) to extract the following points: Subject, Method, Tool, the Area of applications according to the author of the research.

Table 1. Analytical urban resilience in recent literature reviews.

Reference	Subject	Method	Tool	Application area
(Beceiro et al., 2022)	Nature-Based Solutions / Resilience assessment framework	Statistics	1D-2D modeling	Porto
(Xu et al., 2021)	Flood resilience	Analysis method (ISM-ANP)	evaluation network model (ISM-ANP model)	03 Chinese cities (Wuhan, Nanjing, and Hefei)
(Ghouchani et al., 2020)	Urban resilience	Statistics	Exploratory Factor Analysis	/
(Feofilovs & Romagnoli, 2020)	Disaster Risks	Modeling, MCDM	SD Model, multi-criterion analysis	Latvia
(Li et al., 2020)	Policymaking	Modeling	SD Model, Simulation, Sensitivity Analysis	Beijing, China
(Li et al., 2020)	Green Infrastructure	MCDM	AHP	Ghent, Belgium
(Xun & Yuan, 2020)	Urban resilience evaluation	MCDM	Intuitionistic trapezoidal fuzzy numbers, TOPSIS, sensitivity analysis	Dalian city, China
(Iturriza, Labaka, Hernantes & Abdelgawad, 2020)	Climate Change	Modeling	Delphi, SD model, pilot test, simulation	Kristiansand, Norway
(Feofilovs & Romagnoli, 2020)	Urban Flood Resilience	Modeling	System dynamics (SD) model	Latvian Municipality
(Moghadas et al., 2019)	Urban Flood Resilience	MCDM	AHP, TOPSIS	Tehran, Iran
(Zhang, Song, Peng & Wu, 2019)	Disaster Risks	MCDM	Delphi Method, AHP	Shenzhen, China
(da Silva et al., 2019)	Sustainability	Statistics	Descriptive Analysis	Sao Paulo, Brazil
(Iturriza, Hernantes & Labaka, 2019)	Urban Resilience	Modeling	Delphi method, SD model	Norway, Spain, UK
(Brunetta & Salata, 2019)	Disaster Risks	Statistics	Clustering analysis, sensitivity analysis	Turin, Italy

Source: The author, 2022 and (Büyüközkan et al., 2022).

Despite all the recent definitions; Urban resilience is considered a key concept in preparing cities for disasters and unexpected events brought on by climate change-induced extreme weather. In particular, flood disasters provoke the stability of the cities according to many factors (BENSON, 1964); That can be divided into two parts:

1st / Accelerator factors: these factors accelerate the event of floods in cities such as:

- Climate change.
- Hydrologic characteristics.
- Topography characteristics: Drainage area, Main-channel slopes, Altitude, Length of the basin, Shape factor, Storage area, Channel geometry, Stream order, Soil and geology, Orientation, Forested area, and Basin rise.
- The meteorologic characteristics: Rainfall, Snow, Temperature, Wind, and Evaporation.
- Runoff and runoff/precipitation ratios.
- Location.

2nd / Exacerbating or aggravating factors: these factors worsen the event of a flood in cities and provide the event more aggressive as:

- Urban design.
- Fast urbanization in flood zones.
- Vulnerability of urban fabrics.
- Land use.

3. Tebessa City:

The city of Tebessa is a border city, it suffers from many problems affecting the economic growth and sustainable development of the city, in the first place, we will present the city of Tebessa in its context in the frame of flooding risk.

Tebessa city is located in the extreme east of Algeria and occupies a remarkable location between the Tell and the south of the highlands to the pre-Saharan regions. It is 16 km as the crow flies, but 45 km by national road 10, from the Algerian-Tunisian border. It is located 130 km south of Souk Ahras by National Road 16, 233 km from Annaba, 200 km from Constantine, and 634 km southeast of Algiers. (URBA-BA, 2018)

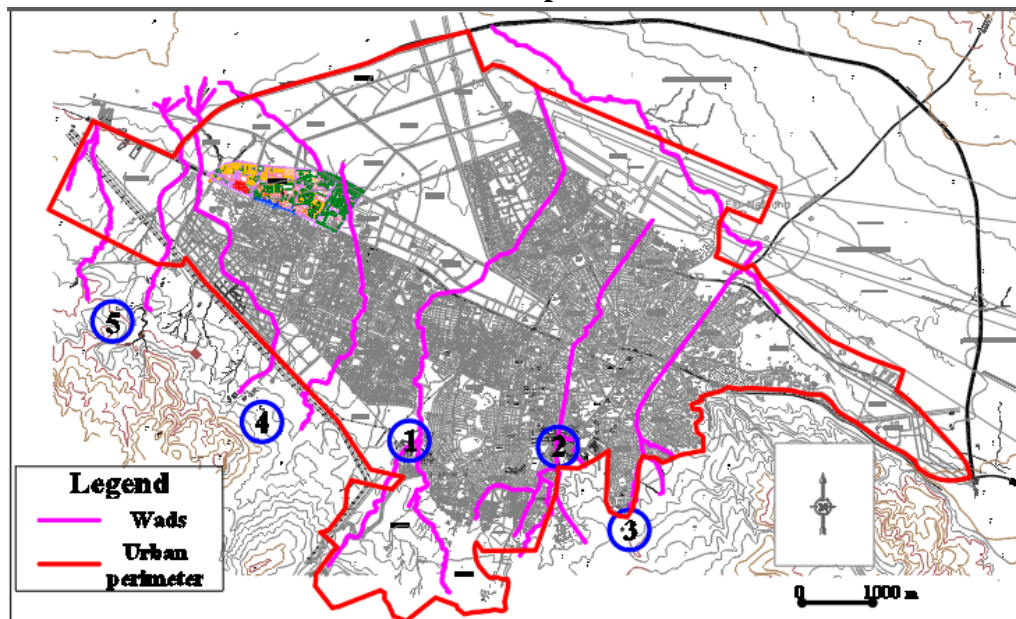
Map.1. The administrative location of Tebessa city.



Source: The author, 2022.

Tebessa as all cities in the world faces a great challenge against shocks, harmful changes, and major risks that cause the security and sustainability of the city; Because this city is characterized by a dense hydrographic network consisting mainly of ravines and gullies (wadis) that cross the existing urban fabric of the city (URBA-BA, 2018), (Map.2 and table 2).

Map.2. Intercommunal PDAU Tebessa-Hammamet-Elkouif-Bekkaria-Boulhaf Dyr the final phase



Source: The Direction of urbanism, architecture, and construction of the wilaya of Tebessa, 2018

Table 2. The existing wadis in the study case (the city of Tebessa)

N°	Wadis	Length (Km)
01	RAFANA	19
02	NAGUES	12.5
03	ZAAROUR	9
04	SEGUI	9
05	EL ANBA	7
06	EL GNATER SOUD	/
07	CHABROU	/

Source: The direction of civil protection of the wilaya of Tebessa, 2021.

The location of the city or the place on which it is based plays an important role in determining the types of natural hazards, and according to (HADJLA, 2016) The positional compounds of the city of Tebessa are represented by:

- **Topography:** The city of Tebessa occupies an area of 184 Km² and rises 850 meters above sea level (URBA-BA, 2018), which is characterized by its southern mountains such as Awal mountain, and Dokkane mountain...etc, and its plains, which are represented in the Marjah Plain extending from East to West of the city, with an average altitude of about 800 m above sea level. The study of topographic features at the urban perimeter level is included in the following: Altitudes, Slopes.
- **Geology:** The geological structure of the area determines the directions of the city's expansion, the distribution of buildings, their type, and their height according to Geological structure, soil geotechnical, hydrographic network, and vegetation.

Table 3 below, which presents, by wilaya, the number of constructions built in flood-prone areas, provides an idea of the seriousness of the situation that can generate

the dual phenomenon of flooding and urbanization in the cities.(Conseil National Economique et Social, 2003).

Table 3. The number of constructions built in flood-prone areas.

Wilaya	Number of constructions
Chlef	2248
Laghouat	3083
O.E.Bouaghi	1999
Batna	16261
Béjaia	500
Biskra	763
Bouira	1438
Tamanrasset	1159
Tebessa	17236
Tlemcen	375
Tiaret	13
Alger	14545 + neighborhoods Merdja and Baraki
Djelfa	784
Jijel	47 (05 zones in very high risk)
Setif	1261
Saida	976+09 neighborhoods
Skikda	4009
S.B.Abbes	576+04 in the downtown
Annaba	30 neighborhoods
Guelma	360
Constantine	620
Medea	3075
Mostaganem	1633
M'sila	1185
Oran	06 neighborhoods
Boumerdes	561
El Tarf	2370
Tissemsilt	1340
El Oued	766
Souk Ahras	The majority of municipalities
Tipaza	2710
Mila	1663
Ain Defla	7772
Naama	4924
Ain temouchent	14 zone adjacent to different wadi
Relizane	350

Source: The National Economic and Social Council, 22nd edition.

The city of Tébéssa occupies the first place in terms of the number of constructions built in floodable areas, 17236 constructions. (According to the National Economic and Social Council, 22 edition). And according to the latest statistics on the direction of civil protection of the wilaya of Tebessa, in the year 2021; The flood is the natural risk classified as the first dominant phenomenon that threatens the city of Tebessa.

According to (HADJLA, 2016) most Algerian cities suffer from natural hazards, especially the city of Tebessa, where the risk of flooding occurs repeatedly, and this is due to natural and other human causes, which made this phenomenon attract the attention of studies related to the urban field and become problematic in it.

The world today knows climatic changes that are characterized by the occurrence of floods and the infliction of human and material losses. Based on the topographic and climatic characteristics, the rainfall is distinguished by irregularity at the Spatio-temporal level, which results in irregular rainfall and sometimes in large quantities that lead to the occurrence of major disasters such as flood hazards.

Besides, the fast urbanization of the city is a response to the population increase, especially during the 70s, which represented the stage of the demographic explosion, where the city population moved from 62,639 to 200256 people between 1977 and 2018. As for the urban fabric, its area increased to 4843.65 hectares in the year 2018 after it was 1637 hectares in 1988. (URBA-BA, 2018)

In addition, the absence of adequate preparation for the city related to networks or preparation related to correcting watercourses, as the city lacks an effective network for rainwater drainage, on the one hand, and adequate preparation for wadis that pose a danger to the city (such as the absence of afforestation in the slopes to stabilize the soil and reduce erosion processes and reducing the current load...).

Addressing the issue of urban resilience in the city of Tebessa is an interesting task we find that there are efforts to protect this city against the threat of flooding through several attempts such as

a- The general flood prevention plan according to the Law n° 04-20 of 13 Dhou El Kaada 1425 corresponding December 25, 2004, relating to the prevention of prevention and disaster management within the framework of sustainable development:

This plan fixes the whole of the rules and procedures aiming to attenuate the vulnerability to the hazard concerned and to prevent the effects induced by the occurrence of this hazard.

above shall include :

- A national flood map specifying all the floodable areas, including the wadi beds and the perimeters located downstream of the dams and exposed to as such in case of dam failure,
- The reference height for each zone declared to be floodable, below which the perimeters concerned are subject to the non-aedificandi easement.
- The thresholds, conditions, modalities, and procedures for alerts and alerts for each of these hazards, as well as the of these hazards, as well as the procedures for the suspension of alerts.

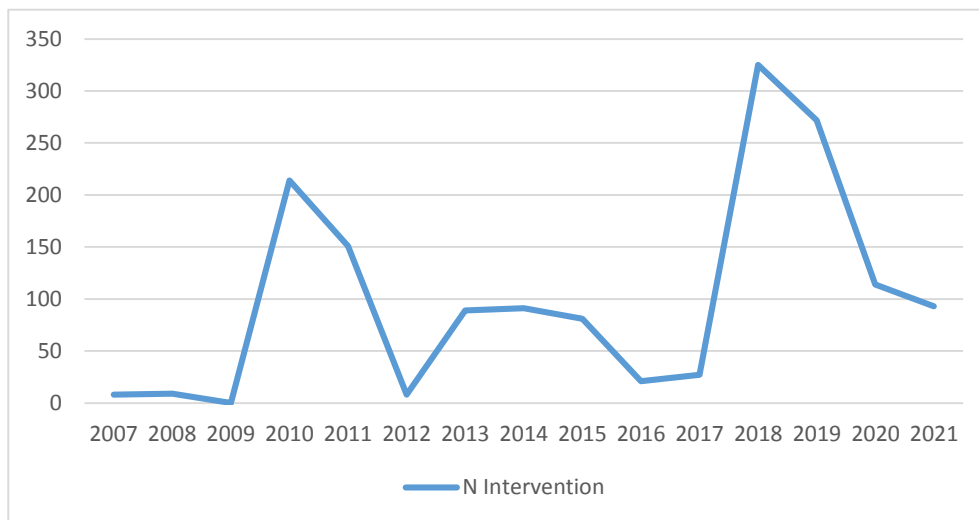
b- The emergency organization plan according to the Executive decree n° 19-59 of 26 Joumada El Oula 1440 corresponding to February 2, 2019, fixes the modalities of elaboration and management of the plans of organization plans:

Emergency preparedness is vital to ensure a disaster response is not impeded by disorganization or miscommunication. Remaining calm and moving confidently through the wilds of a crisis is much easier when you have a map. And that is exactly what an emergency operation plan (EOP) is a mapping of the best course of action during an emergency.

Protective actions for life safety include:

- Evacuation.
- Sheltering.
- Shelter-In-Place.
- Lockdown.

Fig.3. Census of the number of civil protection interventions against flood risks in the city of Tebessa



Source: The author, and The direction of civil protection of the wilaya of Tebessa, 2022.

However, all these exploited attempts by the Algerian government to achieve the resistance for our cities against the flood problems, the direction of civil protection of the wilaya of Tebessa still registering year after year an important number of economic damages and human losses due to monsoon rainfall that causes frequent floods according to the figure that shows the census of the number of civil protection interventions against flood risks in this city (Fig.3).

Hence, the Algerian government reviewed this defect through a general review of its laws, thus the adoption of the concept of resilience became necessary to preserve its cities. As an example: reviewing the Law relating to urbanism. The purpose of this Act is to enact a new urban planning regime and to create a special regime of urban domanial. The general rules on land use and management contribute to the application and respect of the fundamental rights guaranteed by the Constitution, among the objectives of this law is “Affirm the resilience of urban spaces to the risks of natural and technological disasters.” And these objectives include environmental preservation; ecological waste management; improving urban resilience; reducing social disparities and strengthening social cohesion; ecological management of green spaces; ecological management of stormwater and wastewater; reducing vulnerability to flooding, and reintroducing nature into the city. (Caisse Nationale du Logement, 2020)

Discussion :

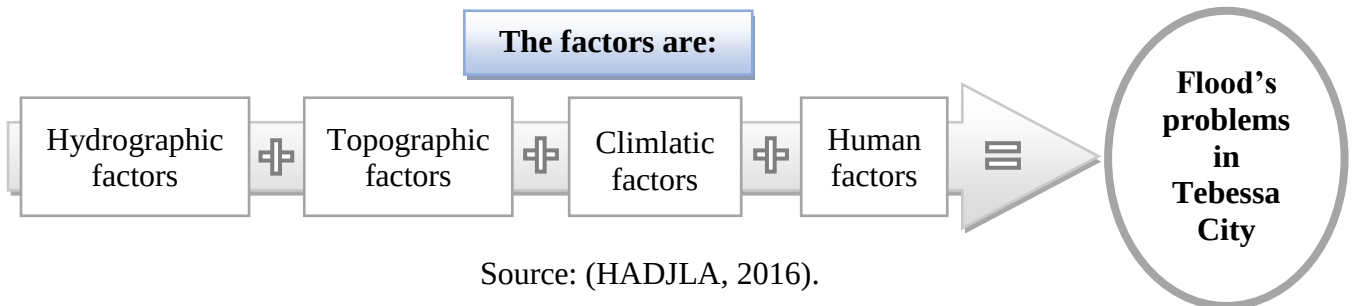
The process of identifying flood-prone areas depends primarily on a good knowledge of the boundaries that water covers during a flood. With the help of aerial photographs and fieldwork in parallel, to assess flood risks in the city of Tebessa. The morphological study of the area or the city's location shows what helps in facilitating surface water runoff; But under the influence of the nature of the semi-arid climate, heavy rains lead to the exit of water from the valley basins easily, causing natural disasters in the parts that are exposed to this or those crossed by the valleys. The problem of flooding arises from a combination of several factors (HADJLA, 2016), including (Fig.4):

- Topographic factors: are represented in the steep slopes located in the south of the city, with weak slopes in the north, and in general the flatness is the dominant feature of the place of the city.
- Hydrographic factors: are represented in the dense water network that penetrates the city and consists of 07 Wadis are mentioned above.
- Climatic factors: are represented by the semi-dry climate and semi-cold winters, which are often heavy and irregular rains, in addition to the type of climate and the nature of the soil

reflected on the vegetation cover, and these factors combined affect and exacerbate the problem of floods in the city.

- Human factors: are factors related to overpopulation, the process of legal urbanization, and human intervention, positive or negative, on the field: Fast urbanization; Lack of proper city setup related to networks or setup related to watercourse rectification...

Fig.4. Factors of the occurrence of floods in the city of Tebessa



Source: (HADJLA, 2016).

According to previous theoretical studies on urban resilience at different levels, each of them can be applied in our case study, but on the other hand, each of them can lead to different results.

On the one hand, the first study by (Beceiro et al., 2022) included the resilience assessment framework RAF for Nature-based solutions NBS; In our case study, it can be used to identify the consolidated characteristics and chances to increase the NBS contribution to urban resilience; by using the statistical method to aid in the diagnosis, decision-making, implementation, planning, and administration of the NBS, as well as to identify solutions that have the greatest potential to help cities overcome their resilience challenges.

On another hand, in the study (Xu et al., 2021); Analysis method models (ISM-ANP) were used to evaluate and analyze the following factors: Rescue capacity, the distribution of waters, spatial planning and spatial structure of land use, and infrastructure, and the level of public resources occupy that could help us to determine the key urban flood resilience indicators for the Tebessa City.

As well as, the study (Feofilovs & Romagnoli, 2020); The use of modeling method with Multi-criteria analysis and system dynamics models to create a dynamic Urban Resilience Index on the subject of flood risk to test an urban resilience assessment tool through a local case study which shows that the model is suitable for both short term and long-term resilience assessment by the model simulation.

But, the study (Li et al., 2020), Method of Multi-criteria decision-making (MCDM) including two parameters of landscape metrics and runoff coefficient was used to provide a better understanding of the spatial characteristics and capabilities of current green infrastructure in the core region to reduce stormwater flows, also to show the contribution of the grasslands and its impact for helping urban planners and decision-makers.

Conclusion:

The concept of urban resilience has emerged as a "new perspective on thinking". It was applied to planning at the end of the last century as a concept that encourages policies to cope with stressors such as flood risk and to respond by renewing and innovating cities. Resilience becomes instrumental in addressing both the causes and impacts of major global challenges. It is considered a solution to the problems of the city because Resilience is an approach that encourages a holistic view of an urban system understanding the links between a city's spatial plan, physical assets, functions, and socio-economic dimensions.

Resilience is a central theme in urban development, serving as the basis for a wide range of strategic interventions and investments in key development institutions around the world, and it is as much a quality of sustainable urban development as it is a driver of development itself.

Resilience at the city level equates the metropolitan area with a dynamic and complex system that must constantly adapt to different challenges in a comprehensive and integrated way.

In this context, attention to the concept of resilience has become a necessity, and according to the recommendations of experts in “from the challenge of resilience the requirements of the emergence of the Algerian economy” under the direction of the National Economic and social council in 2015, which encourages the adoption of the concept of resilience as a positive trait in our cities to resist against this kind of hazard, also the Algerian government has also started to update its laws to go along with the flow of the world to maintain the concept of the resilience as an effective solution for our cities and to motivate the potential of transforming vulnerable cities into resilience cities, by reviewing the Law n° 04-05 modifying and completing the law n° 90-29 related to the development and urbanism and replaced by the project of the First Draft of the law relating to the urbanism “Consultancy contract n° 13 / CNL-DG / 2020 of August 2” by the Algerian National Housing Fund. That adopts urban resilience as a necessary concept to preserve its cities. And reviewing the Law relating to urbanism. The purpose of this Act is to enact a new urban planning regime and to create a special regime of urban domainial. The general rules on land use and management contribute to the application and respect of the fundamental rights guaranteed by the Constitution, among the objectives of this law is “Affirm the resilience of urban spaces to the risks of natural and technological disasters.”

To study the concept of urban resilience in the city of Tebessa, there is a variety of methods, and according to the previous studies mentioned above, we can summarize it:

- a. Statistics method: The tools that can be used in this method are: Exploratory Factor Analysis, Variational Bayes, latent Dirichlet allocation...etc.
- b. Modelling method: The tools that can be used in this method are: SD Model, GIS, SD Model, Simulation, Sensitivity Analysis AHP...etc
- c. Analysis method: The tool that can be used in this method is: the evaluation network model (ISM-ANP model).
- d. Multi-criteria decision-making (MCDM): The tools that can be used in this method are: Delphi Method, AHP, TOPSIS...etc.

For a better understanding and mastery of the concept of urban resilience; This study determined several parameters for evaluating urban flood resilience and constructed an evaluation framework based on the 3 levels:

1. Legislative level:

This level treats urban resilience only from the legislative side by examining an extensive study to detect the gaps in the legislative statement as executive decrees, laws, instructions...etc., that are issued by the Algerian government over the years including some of the exploited attempts such as

- The executive decree No. 85-231 of 25/08/1985 fixed the conditions and modalities for the organization and implementation of interventions and assistance in case of disasters.
- The executive decree N°19-59 of 02/02/2019 set out the terms and conditions for the preparation and management of emergency organization plans.
- The law No.83-03 of 05/02/1983 relates to the protection of the environment.
- The law No. 04-05 of 25/12/2004 relating to the prevention of major risks and the management of disasters within the framework of sustainable development.

This study provides how we can enhance the urban resilience in Algerian cities especially the city of Tebessa against flood risks to achieve Tebessa as a resilient city.

2. Urban design level:

This level treats urban resilience from the field of designing Algerian cities in general, and the city of Tebessa in particular, by analyzing the current urban design and its instruments that are used to design the urban perimeter of the city, also to detect the gaps of the exploited attempts to reduce human and economic losses caused by floods through several parameters such as city scale, buildings, runoff water, planning process and strategy, infrastructure, orientation, land use, drainage area, urbanization, structure, frame of the city...etc., that can affect on stormwater flow, and help to

find solutions that reduce the negative impact of the flood risk to improve the resilience of Tebessa City.

3. Natural level:

This level treats urban resilience from the natural aspect as the most threatening factor to the stability of cities, especially flood risks which consider a frequent natural hazard posing significant environmental, social, and economic damages across the globe, especially in an urban area.

This level provides a comprehensive analysis of flood problems and detects its gaps through many parameters such as soil and geology, forest area, rainfall, grasslands, altitude, evaporation, precipitation, topography...etc, This study provides how we can solve the flood problems and improve urban resilience in the city of Tebessa against flood risks to achieve Tebessa as a resilient city.

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