平成 31 年 4 月 10 日（水）
国総研　水害研究室　板垣
生江

仏国「PLAN DE PREVENTION DES RISQUES NATURELS D'INONDATION COMMUNE DE BOUJAN-SUR-LIBRON Rapport de présentation」（ PLAN FOR PREVENTING NATURAL RISKS OF FLOODING COMMUNE OF BOUJAN-SUR-LIBRON Introduction Report）仮英訳

原文：http://www.boujansurlibron.com/wp-content/uploads/2018/05/PPRI_rapport_presentation.pdf（参照：2019. 03. 29）

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表紙

Freedom, Equality, Fraternity

France Republic

Prefect of Herault

Departmental Direction of
Territories and Sea Service Water,
Risks and Nature

PLAN FOR PREVENTING NATURAL RISKS OF FLOODING

COMMUNE OF BOUJAN-SUR-LIBRON

Introduction report

Procedure	Prescription	Public Inquiry	Approval
Preparation	06/12/2011	from 07/03/2016 to 07/04/2016	31/05/2016

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LIST OF ACRONYMS AND ABBREVIATIONS

AZI: Flood Zone Atlas

CAR: Regional Administrative Committee

CATNAT: Natural disasters regime

CD: Departmental Council
CNPF: National Center for Forest Property
CR: Regional Council
DDRM: Departmental Dossier on Major Risks
DDTM: Departmental Direction of the Territories and the Sea
DI: Flood Directive
DICRIM: Communal Information Document on Major Risks
DREAL: Regional Directorate for the Environment, Planning and Housing
DUP: Declaration of Public Utility
EAIP: Envelope Approached to Potential Floods
EPCI: Public Institution of Intercommunal Cooperation
EPRI: Preliminary Flood Risk Assessment
ERP: Institution Receiving Public
FPRNM: Major Natural Risk Prevention Fund
HLL: Light Houses of Leisure
IAL: Information Buyers Tenants
NGF: General Leveling of France
PCS: Municipal Protection Plan
PHE: Higher Waters
PLU: Local Urbanism Plan
PLUI: Local Local Urbanism Plan
POS: Land Use Plan
PPR: Risk Prevention Plan
PPRI: Flood Risk Prevention Plan
RSD: Departmental Health Regulations
SAGE: Diagram of Development and Management of Waters
SDAGE: Master Plan of Development and Management of Waters
SLGRI: Local Flood Risk Management Strategy
SNGRI: National Flood Risk Management Strategy
SPC: Flood Forecasting Service
TN: Natural Land
TRI: Important Flood Risk Territory

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Glossary
Alea: probability of occurrence of a given natural phenomenon, intensity and occurrence in

a given territory. The hazard is low, moderate, strong or very strong, depending on the water depth, the flow velocity and the submersion time compared to the reference phenomenon.

Landing: alluvium (sediment such as sand, silt, clay, silt, gravel) transported by running water, and settling in the stream bed or accumulating at break points.

Watershed: territory drained by a watercourse and its tributaries.

Cofferdam: removable flood barrier.

Flood expansion field: non-urbanized or poorly urbanized sector allowing the temporary storage of flood waters.

Change of destination: transformation of a surface to change its use.
Change of destination and reduction of vulnerability: in the regulation, it is sometimes indicated that work is allowed provided that it does not increase vulnerability. Will be considered a change of destination increasing vulnerability, a transformation that increases the risk, such as the transformation of a rebate into housing.

Article R 123-9 of the urban planning code distinguishes nine classes of buildings grouped in this document into three classes according to their vulnerability:

> a / housing, hotel accommodation, buildings and installations required for public services or of collective interest including sleeping quarters at night, b / office, commerce, crafts, industry, constructions and installations necessary for public services or of collective interest not including overnight accommodation, c / farm buildings or forest, buildings warehouse function (by extension garage, shed, shed, annex), constructions and installations necessary for public services or of collective interest strictly assigned to agricultural, forestry or warehouse uses.

The following hierarchy, in descending order of vulnerability, can be proposed: a> b> c
For example, the transformation of a commercial re-launch from an office to a home is in line with increasing vulnerability, while the transformation of a home into a home reduces this vulnerability. The distinction of building types is based on the vulnerability to flood risk of the people occupying them, and is part of the management of the crisis with a view to potential evacuation.

To note :

- in terms of vulnerability, hotel-type accommodation is comparable to housing, while a restaurant is a commercial activity.
- the transformation of housing into multiple dwellings increases vulnerability.

NGF rating: altimetric level of a land or submersion level, attached to the General Leveling of France (IGN 69).

PHE rating (highest water level): NGF rating reached by the reference flood.

Flood: a rapid and temporary increase in the flow of a watercourse that results in an increase in the water level and its flow velocity.

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Reference flood: it serves as the basis for the development of the PPRI and corresponds to the calculated centennial flood or the highest known historical event, whichever is greater.

Centennial Crude: A statistical flood that has a 1 in 100 chance of occurring each year.

Crude except it: raw determined by hydrogeomorphological method, likely to occupy the entire major bed of the watercourse.

Historical flood: highest known flood.

Flow rate: volume of water passing at a given point in one second (expressed in m^3 / s).

Footprint: trace on the ground or vertical projection of the volume of the construction, including overhangs and overhangs.

Issues: people, goods, activities, means, heritage likely to be affected by a natural phenomenon.

Equipment of general interest: infrastructure or superstructure intended for a public service (drinking water supply including boreholes, sewerage, sewage treatment, networks, public passenger transport equipment, protective dike close to densely urbanized places, ...). Are not considered as equipment of general interest the equipments receiving from the public, even carried by a collectivity and / or destined to a public use (swimming pool, gymnasium,

school building, ...) nor the operations of urbanization when well even they would have been the subject of a declaration of public utility.

Extension: increase of the footprint and / or floor area.

Water Height: The difference between the PHE rating and the TN rating.

Hydrogeomorphology: study of the hydraulic functioning of a watercourse by analysis and interpretation of the valley structure (photo-interpretation then field observations).

Flooding: temporary submersion by water of land that is not submerged in normal times. This concept covers floods caused by river floods, mountain streams and intermittent Mediterranean rivers, as well as floods from the sea in coastal areas.

Mitigation: action to mitigate the vulnerability of existing assets.

Modification of construction: transformation of all or part of the existing surface, without increase in footprint or floor area. This assumes not to touch either the building volume or the floor area, otherwise the project will be expanded.

Open: any surface through which water can enter a building (door, window, bay windows, etc.).

Habitable floor: all living spaces or arranged to accommodate commercial, craft or industrial activities. It excludes warehouses, garages, forestry or agricultural exploitations.

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Risk Prevention Plan: a document worthy of public utility, it is annexed to the Local Town Planning Plan in order to guide the urban development of the municipality outside the flood zones. It aims to reduce damage during disasters (natural or technological) by limiting urbanization in risk areas and reducing the vulnerability of already urbanized areas. It is the state's essential tool for risk prevention.
For example, there are:
-The Flood Risk Prevention Plan (PPRI)
-The Forest Fire Risk Prevention Plan (PPRIF)
-The Ground Movement Risk Prevention Plan (PPRMT): landslides, falls of blocks and

landslides, shrinkage-swellings of clay, subsidence or collapse of cavities, mudslides.

Prescriptions: local rules to be applied to a construction to limit risk and / or vulnerability.

Prevention: all the measures to be implemented to prevent, if not reduce, the impact of a foreseeable natural phenomenon on people and property.

Project: any new construction, including extensions, but also existing intervention projects such as changes or changes of destination.

Property: all contiguous parcels belonging to the same owner.

Floor area: floor area closed and covered under a ceiling height exceeding 1.80 m.

TN (natural land): natural land before works.

Vulnerability: potential consequences of the impact of a hazard on issues (populations, buildings, infrastructure, etc.). An essential concept in crisis management determining the likely reactions of populations, their ability to cope with the crisis, evacuation needs, etc.
Zone refuge: habitable covered floor level accessible directly from the interior of the building above the reference elevation and provided with access to the roof for evacuation.

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PART ONE: GENERAL PRINCIPLES OF PPR AND RISK OF FLOODING

1. Introduction

1.1 GENERAL FINDINGS

With 17 million people potentially exposed to flood risk, 9 million jobs exposed to overflowing watercourses and more than 18,000 vulnerable communes, France is exposed to the natural risks of flooding. The storm Xynthia of 2010, the floods of the Var of spring 2010 and autumn 2012 and more recently the succession of bad weather and unusual floods from September to November 2014 and August to September 2015 in the Hérault have dramatically recalled.

In the Languedoc Roussillon region, about three-quarters of municipalities are subject to the risk of flooding, and 25% of the population are potentially impacted. The proven risks represent an average financial cost of € 500 million, paid each year by the insurances to indemnify the damages. Thus, 97% of the municipalities of Languedoc-Roussillon have been declared at least once in a state of natural disaster since 1982 for flooding by overflow of rivers, runoff or mudslide.

1.2 WHY A NATIONAL POLICY FOR NATURAL RISK PREVENTION?

For many decades, the coastal plains have been the site of massive population concentration. Indeed, the presence of rivers and the sea has long conditioned the development of multiple activities, from the supply of drinking water, to industrial processes, through crafts or navigation.

During the nineteenth and twentieth centuries, industrial development led to a proliferation of installations in these sectors. This development also reached its climax during the Thirty Glorious (1945-1975) with the completion of large industrial settlements and the expansion of agglomerations, both strongly attracted by land easily developable.

Large river and maritime developments have, on the other hand, developed the illusion of total control of flood risk. This has been further strengthened by a period of hydrological rest for nearly three decades. As a result, industrial and commercial zones as well as suburban housing estates have largely invaded floodplains and coastlines without any particular precaution due to numerous economic, social, land and/or political pressures. However, in the early 1990s in France and in the 2000s on the south-east quarter, a series of catastrophic floods reminded people and public authorities of the existence of a long-

forgotten risk (Nimes in 1988, Vaison-la-Romaine in 1992, flood of 1999 on Aude, Gard in 2002, Rhône in 2003, etc.).

Watercourses have too often been developed, dyked, covered or deviated, thus increasing the vulnerability of populations, goods and activities in these submersible areas.

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1.3 THE GLOBAL STATE PREVENTION APPROACH TO NATURAL RISKS

Since 1935 and the submersible surface plans, the State policy has moved towards a reinforcement of the prevention of natural risks: the law of July 13, 1982, reinforced by that of July 22, 1987 relating to the organization of the security has put preventive information at the heart of the prevention policy and has introduced Risk Exposure Plans (PERs). Following the catastrophic floods of the late 1980s and early 1990s (Grand-Bornand in 1987, Nimes in 1988, Vaison-la Romaine in 1992), the State decided to reinforce its overall forecasting policy and prevention of flood risks, by the law of 2 February 1995, by introducing the Natural Risk Prevention Plans (PPRN), then that of 30 July 2003.

It will also be specified, that even if the State and the communes have responsibilities in this area, every citizen also has the duty to protect themselves and diminish their own vulnerability. The objective of this policy is of course to ensure the safety of people and property by trying to anticipate the best natural phenomena while allowing sustainable development of territories.

1.4 CHRONOLOGY OF LEGISLATION CONCERNING RISK PREVENTION

Among the regulatory arsenal relating to the protection of the environment and natural hazards, it is useful - and without pretending to be exhaustive - to cite the main steps:

- The Act of 13 July 1982 (codified in Articles L. 125-1 and following of the Insurance Code) on "compensation for victims of natural disasters" set the objective of compensating victims on the basis of the principle national solidarity. Thus, a claim is covered under the guarantee of "natural catastrophes" from the moment when the natural agent is the determining cause and that it presents an abnormal intensity. This guarantee will be put into play only if the goods affected are covered by a "damage" insurance contract and if the state of natural disaster has been confirmed by an interministerial decree. This law is also at the origin of the development of Natural Hazard Exposure Plans (implementing decree of 3 May 1984) whose objectives were to

prohibit the construction of new buildings in the most exposed areas and to prescribe special measures for new construction in less exposed areas.

➢ The law of 22 July 1987 (as amended by Law No. 95-101 of 2 February 1995 - Article 16 and codified in Article R.125-11 of the Environment Code) on "the organization of security the protection of the forest against fire and the prevention of major risks' stipulates that all citizens have a right to information on the major risks to which they are exposed as well as on the safeguarding measures (means of protect yourself) (Articles L.125-2 of the Environmental Code). To do this, several documents of an informative nature (not opposable to third parties) have been elaborated:

• The Departmental Major Hazard Files (DDRM), developed by the State, aim to identify in each department, major risks per municipality. They explain the phenomena and present the general safeguarding measures.

• The Transmission of Information to Mayors (TIM), carried out by the Prefect. It consists in sending to the mayors the information necessary for the establishment of the communal information document on major risks drawn up by the mayor.

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• The Communal Information Document on Major Hazards (DICRIM) is drawn up by the mayor. This informative document aims to supplement the information acquired by particular measures taken in the municipality under the police power of the mayor.

➢ The law of 3 January 1992, also known as the "Water Law", Article 16 (Article L.211-1 and following and L.214-1 and following Of the Environmental Code) relating to the preservation of aquatic ecosystems, to the management of water resources. This law tends to promote a political will of global management of the resource (SDAGE, SAGE) and in particular, the installation of compensatory measures to the urbanization in order to limit the effects of the waterproofing of the grounds.

➢ The Law of February 2, 1995, known as the "Barnier Law" (articles L.562-1 and R.562-1 of the Environment Code) on the strengthening of the protection of the environment, encourages public authorities, and in particular municipalities, to specify their development projects and to avoid an uncontrolled extension of urbanization. This text emphasizes the need to maintain rivers and aquatic environments, but also the need to

further develop public consultation (consultation). The Barnier law is at the origin of the creation of a special funding fund: the Fund for Prevention of Major Natural Risks (FPRNM), which makes it possible to finance, within the limits of its resources, the protection of densely urbanized places and possibly the expropriation of highly exposed property. This fund is funded by a levy on the product of premiums or additional contributions relating to the guarantee against the risk of natural disasters, provided for in Article L.125-2 of the Insurance Code. This law also saw the establishment of Natural Risk Prevention Plans (PPRN), following an application decree dated October 5, 1995.

➢ The law of 30 July 2003 known as the "Bachelot law" on the prevention of technological and natural risks and the repair of damages was the subject of a first bill after the explosion of the AZF plant in Toulouse September 21, 2001. This project was completed only after a "natural risks" component to respond to the shortcomings and dysfunctions also noted in the prevention of natural hazards during the floods in the south of France. France in September 2002. The law is based on five guiding principles:

- Strengthening information and consultation around major risks: The mayors of communes covered by a prescribed or approved PPRN must issue periodic information to the population at least once every two years about the natural hazards and the preventive measures implemented to deal with them.

- The development of a conscience, a memory and an appropriation of the risk: Obligation since the decree of March 14th, 2005 to inventory and to materialize the markers of floods, in an essential objective of visibility and sensitization of the public the level reached by the highest known waters (PHEC).

- Controlling urbanization in risk areas

- Information on risks at source: Following the decree of 15 February 2005, notaries are obliged to mention to purchasers and tenants the flood character of property; this is the IAL, Information Buyers tenants.

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Article L. 125-5 of the Environmental Code provides that purchasers or tenants of real estate located in areas covered by a Technological Risk Prevention Plan (PPRT) or a Plan for Prevention of Natural Risks foreseeable (PPR), prescribed or approved, or in areas of

seismicity, be informed by the seller or lessor of the existence of the risks.

This information is issued with the assistance of the competent State services, based on the information brought to the attention of the mayor by the State representative in the department.

General information on the obligation to provide information is available on the website of the Prefecture of Hérault.

• Improvement of compensation conditions for the victims: Increased possibilities to use the resources of the FPRNM to finance the expropriation of goods exposed to certain natural risks that seriously threaten human lives.

➢ The law of August 13, 2004 on the modernization of civil security and its implementing decree of September 13, 2005, aim to broaden the action taken by the government in terms of prevention of natural hazards. It is a matter of civil security, everyone's business (need to inculcate and sensitize children from an early age to the prevention of the risks of everyday life), to give priority to local (the objective is to give the population all the useful instructions in the event of a major accident and to allow each municipality to fully support the action of the rescue services through the communal plans of safeguard (PCS) replacing the plans emergency and rescue, and to stabilize the institution of fire and rescue services within the department (this bill creates a national fire and rescue representatives of the State, local elected officials, firefighters and departmental fire and rescue services (SDIS) and to encourage solidarity (as soon as the situation imposes the reinforcement of external means in the affected department, the state will play national solidarity).

➢ Directive 2007/60 / EC of the European Parliament and of the Council of 23 October 2007 on the evaluation and management of flood risks, known as the "Flood Directive". It aims to reduce the potential consequences associated with floods with a view to competitiveness, attractiveness and sustainable development of flood-prone areas.

To implement this renewed flood risk management policy, the French State has chosen to rely on national and territorial actions:
• a national strategy for flood risk management, provided for by Article L. 566-4 of the Environment Code, which brings together the provisions in force to make sense of national

policy and to display priorities;
• Flood risk management plans (PGRI), provided for by Article L. 566-7 of the Environment Code, drawn up at the scale of the river basin district (scale of development of the SDAGE).

The ambition is to achieve an integrated flood risk management policy in each territory, shared by all stakeholders.

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To do this, the State first mapped the theoretical flood hazard on a large scale and then made a crossover with the impacted issues. Based on the analysis of this inventory, priority areas have been identified to prevent floods. In these sectors, flood risk prevention actions will have to be implemented.

3 territories with significant risk of flooding (TRI) were identified in Hérault and a flood risk mapping was carried out for each IRR for 3 types of events: low probability (extreme events), average (centennial), strong

- ➢ TRI of Béziers-Agde, gathering 16 municipalities,
- ➢ TRI of Sète, gathering 7 communes,
- ➢ TRI of Montpellier, Lunel, Mauguio, Palavas extending over 49 communes including 39 in the Hérault,

The cartography of the TRI carried out which is not intended to replace the hazard maps flood risk prevention plans (PPRI), when they exist on the territory allows to improve and homogenize the knowledge of the risk of flooding in the most exposed sectors.

In the end, a Flood Risk Management Plan (PGRI) for the Rhône-Mediterranean basin will be developed for each IRR in local strategies (SLGRI).

NB: for further information on the implementation of the flood directive on the Rhone-Mediterranean district, it is advisable to refer to the website http://www.rhone-mediterranee.eaufrance.fr/

- ➢ The law of 12 July 2010 on the national commitment for the environment known as "Grenelle 2 ", transposes the Flood Directive into French law and amends certain provisions of the Environment Code (Articles L 562-1 and following) Concerning the

preparation, modification and revision of Risk Prevention Plans.

NB: for more information on the various legislative supports (laws, decrees, circulars), it is advisable to refer to the website https://www.legifrance.gouv.fr/.

To take into account the local specificities and harmonize the approaches in Languedoc-Roussillon, the "Guide for the elaboration of PPRI in Languedoc Roussillon" validated by the Regional Administrative Committee (RAC) by the Regional Prefect in June 2003, sets out the general principles of thresholds, hazards and zoning,

1.5 PURPOSE OF THE PRESENTATION REPORT

The introductory report is a document that states:

- the objectives of the PPR and the reasons for its development,
- the principles of PPR development and its content,
- natural phenomena known and taken into account,
- how to qualify the hazard and define the stakes,
- the objectives sought for the prevention of risks,
- the choice of zoning and the applicable preventive measures,
- the reasons for the settlement inherent in each zone,
- application to the commune of BOUJAN-SUR-LIBRON (climatological, hydrographic and geomorphological context).

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2 Approach to develop a natural flood risk prevention plan

2.1 WHAT IS A NATURAL HAZARD PREVENTION PLAN?

Developed at the initiative and under the responsibility of the State, in consultation with the municipalities concerned, the PPR is a tool for decision support. This regulatory document makes it possible to locate, characterize and predict the effects of foreseeable natural risks with the dual aim of informing and raising public awareness, and to direct communal development towards risk-free areas with a view to reducing the vulnerability of people and property through preventive measures.

Risk prevention plans (PPR) can deal with one or more types of risks, and can be spread over one or more municipalities. At the beginning of 2013, more than 7,500 PPR had been approved and more than 3,600 prescribed in France. They are part of a global risk prevention policy of which they are the preferred tool.
The main lever of the RPP is the control of the occupation and the planning of the territory. Other preventive actions, carried out under the responsibility of the State, local authorities and private individuals, complete the system: preventive information, crisis preparation and management, forecasting and warning .....

PPR are governed by Articles L.562-1 and following of the French Environment Code. Article L.562-1 provides in particular that:

"I.- The State develops and implements plans for the prevention of foreseeable natural risks such as floods, landslides, avalanches, forest fires, earthquakes, volcanic eruptions, storms or cyclones.

II.- The purpose of these plans is, where necessary:

No. 1　To delimit the zones exposed to the risks, taking into account the nature and the intensity of the risk incurred, to prohibit there any type of construction, work, development or exploitation agricultural, forest, artisanal, in particular in order not to aggravate the risk to human lives or, in the case where constructions, structures, developments or agricultural, forestry, craft, commercial or industrial exploitations may be authorized, prescribe the conditions in which they must be made, used or exploited;

No.2 to delimit zones which are not directly exposed to risks but where constructions,

works, developments or agricultural, forestry, artisanal, commercial or industrial exploitations could aggravate risks or provoke new ones and provide for measures prohibition or requirements as provided for in No.1

No.3 To define the prevention, protection and safeguard measures that must be taken, in the zones mentioned in No.1 and No.2 , by the public authorities within the scope of their competences, as well as those which may be the responsibility of individuals ;

No.4 To define, in the zones mentioned in No.1 and No.2, the measures relating to the development, use or exploitation of constructions, works, spaces put in cultivation or planted existing on the date of Plan approval that must be made by the owners, operators or users.
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III.- The realization of the measures envisaged in No.3 and No. 4 of the II can be made obligatory according to the nature and the intensity of the risk within a period of five years, being able to be reduced in case of urgency. Failing compliance within the prescribed period, the prefect may, after formal notice not followed by effect, order the realization of these measures at the expense of the owner, the operator or the user.

IV.- The preventive measures envisaged in the No.3 and No.4 of the II, concerning the wooded grounds, when they impose rules of management and forestry exploitation or the realization of work of prevention concerning the wooded spaces put in charge public and private forest owners and operators are taken in accordance with Title II of Book III and Book IV of the Forest Code.

V.- Preventive works imposed pursuant to No.4 II to property built or developed in accordance with the provisions of the Town Planning Code before the approval of the plan and charged to the owners, operators or users cannot bear only on limited facilities.

VI. - Flood risk prevention plans are compatible or made compatible with the provisions of the flood risk management plan defined in Article L. 566-7.

VII. - Decrees in Council of State define as necessary the methods of qualification of the hazards and the risks, the general rules of prohibition, limitation and framing of the constructions, prescription of works of reduction of the vulnerability, as well as informing the population, in areas exposed to the risks defined by the plans for the prevention of

foreseeable natural risks. "

2.1.1 WHAT DOES THE NATURAL FLOOD PREVENTION P LAN CONTAIN (PPRI)?

Article R.562-3 of the Environment Code states that the project plan file includes:

- Note a presentation note indicating the geographical area concerned, the nature of the natural phenomena taken into account and their possible consequences, taking into account the state of knowledge;

- one or more graphic documents delimiting the zones mentioned in No.1 and No.2 of II of Article L.562-1;

- a regulation specifying, as needed:

(a) the prohibition measures and the requirements applicable in each of these zones under No,1 and No.2 of II of Article L.562-1;

(b) the prevention, protection and safeguard measures mentioned in No.3 of II of Article L.562-1 and measures relating to the development, use or exploitation of buildings, works, structures and spaces planted or planted existing at the date of approval of the plan, mentioned in No.4 of this same II. The regulation shall mention, where appropriate, those measures whose implementation is obligatory and the deadline fixed for it.

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Graphic documents include:

- the hazard map developed from hydrogeomorphological analysis and modeling of the reference hazard,
- the map of regulatory zoning obtained by crossing the hazard with the exposed issues, making it possible to establish the red, blue and gray zonation conventionally encountered in PPR

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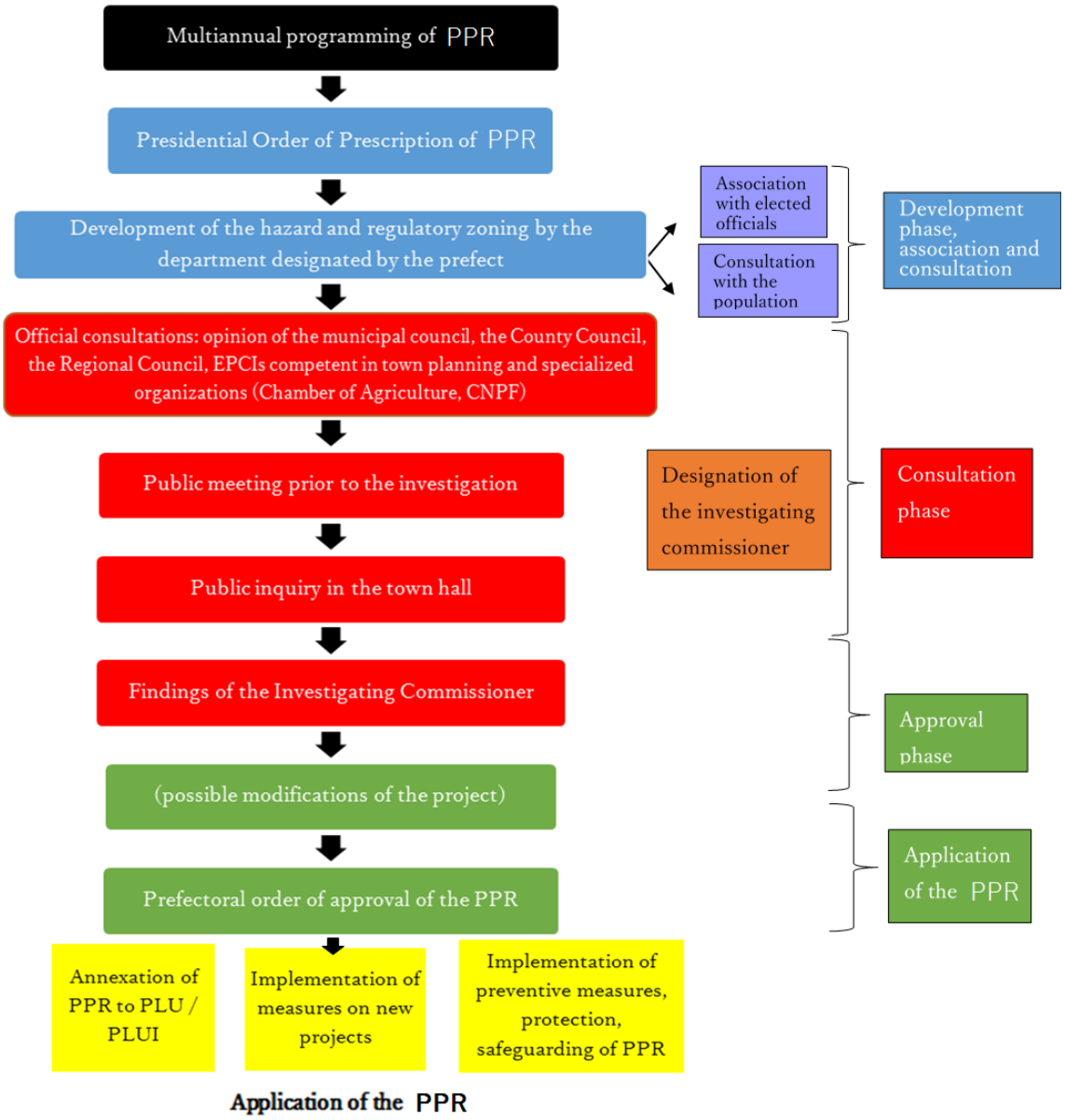
2.1.2 WHAT ARE THE PHASES OF DEVELOPING A PPR?

The preparation of PPR is conducted under the authority of the departmental prefect. The latter then designates the deconcentrated service of the State which will be responsible for instructing the project.



Application of the PPR

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）18 頁より作成。

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2.2 IMPACT OF PPR

2.2.1 SCOPE OF PPR

Once approved and published, the PPR is worthlessness of public utility. In municipalities with a PLU or PLUI, this servitude must be attached within three months. All regulatory measures defined by the PPR must be respected. These are essential for all existing and new constructions, installations and activities.

Existing goods and activities prior to the publication of this natural hazard prevention plan continue to benefit from the general guarantee scheme provided for by law.

For goods and activities created after publication, compliance with the provisions of the PPR conditions the possibility for the insured to benefit from compensation for material damage directly caused by the abnormal intensity of a natural agent, provided that the status of natural disaster is established by interministerial order.

The preventive measures prescribed by the PPR regulations and their conditions of execution are the responsibility of the contracting authority and the contractor responsible for the constructions, works and installations concerned.

In addition to the provisions imposed on new projects, the PPR also imposes measures, known as mitigation measures, on existing assets, in order to reduce their vulnerability.

2.2.2 PENALTIES FOR NON-COMPLIANCE WITH THE PROVISIONS OF THIS PPR

In the case of measures imposed by a PPR and integrated in the PLU or PLUI, pursuant to Article L. 480-4 of the Urban Planning Code:

- Natural persons recognized as liable may incur a fine of between € 1,200 and an amount that may not exceed € 6,000 per m^2 of built area, demolished or rendered unusable in the case of construction of a floor area, or 300 000 € in other cases. In the event of a second offense, in addition to the penalty fine, a sentence of imprisonment of 6 months may be imposed.

- Pursuant to Articles 131-38 and 131-39 of the Penal Code, legal persons can incur a fine of not more than five times the amount incurred by natural persons, as well as permanent or temporary prohibition of activities, temporary placement under judicial supervision, permanent or temporary closure of the establishment in question, permanent or temporary exclusion from public contracts and publication of the decision pronounced. A compliance of places or works with the PPR may finally be ordered by the court.

In the case of measures imposed by a PPR for the reduction of vulnerability of persons,

pursuant to Article 223-1 of the Penal Code:

- Defective natural persons may be found guilty of deliberately violating a particular safety or prudential obligation imposed by the regulation, directly exposing others to an immediate risk of death or injury, and this title one year imprisonment and 15,000 € fine.

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- Legal persons are liable for the same offense, in accordance with Article 223-2 of the Penal Code, to a fine not exceeding five times that incurred by natural persons, as well as the definitive prohibition or temporary activities, temporary placement under judicial supervision and publication of the decision pronounced.

In case of occurrence of a disaster causing damage to persons, pursuant to Articles 222-6, 222-19 and 222-20 of the Criminal Code:

- Defective natural persons may be convicted by reason of the mere negligence or manifestly deliberate violation of a particular safety or security obligation imposed by the regulation, of homicide or unintentional injury, and as such may incur one to three years' imprisonment and a fine of € 15,000 to € 45,000, depending on the seriousness of the damage and the offense.

- Legal persons incur a fine of not more than five times the amount of the fines incurred by natural persons for the same offenses, as well as the permanent or temporary prohibition of activities, temporary placement under judicial supervision, the publication of the decision pronounced and, in the case of manslaughter, the definitive or temporary closure of the establishment in question.

Article L.125-6 of the Insurance Code provides for the possibility for insurance companies but also for the prefect or president of the Central Reinsurance Fund, to refer the central charging office for the application of special allowances on the amount of natural disaster indemnities (franchise surcharges) up to 25 times the basic deductible amount for residential goods and up to 30% the amount of direct non-insurable material damage (instead of 10%) or 25 times the minimum of the basic exemption for goods for professional use.

When a PPR exists, the Insurance Code specifies that there is no possible derogation from the guarantee obligation for "goods and activities existing prior to the publication of this

plan", except for those whose compliance with measures made compulsory by this plan has not been carried out by the owner, the operator or the user. In this case, the insurers are not required to indemnify or insure the property built and the activities carried out in violation of the current PPR rules.

2.2.3 EFFECTS OF PPR

Preventive information

The general prevention, protection and safeguard measures referred to in the regulation concern the preservation of human life through protective devices, passive provisions, preventive information and the maintenance of existing structures.

Since the "Risk" law of July 30, 2003 (strengthening information and consultation on major risks), all mayors whose municipalities are covered by a prescribed or approved PPR must issue at least once every two years from the population periodic information on natural hazards. This procedure will have to be supplemented by an obligation to inform all the administrators every year by means of a relay left to the free choice of the municipality (municipal bulletin, public meeting, diffusion of a brochure) mandatory and recommended measures for future projects and for the existing frame.

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Municipal plan of safeguard (PCS)

Beyond the effects of the provisions issued in the regulation for new projects and for existing properties, the approval of the PPR makes it obligatory to draw up a communal safeguard plan (PCS), in accordance with Article 13 of the Law No. 2004-811 of 13 August 2004 on the modernization of civil security. Pursuant to article 8 of decree No. 2005-1156 of 13 September 2005 relative to the communal plan of safeguard and taken in application of article 13 of the law No. 2004-811, the commune must realize its PCS in a two years from the date of approval by the Prefect of the PPR Department.

Article 13 of the law No.2004-811 specifies that "the communal plan of safeguard gathers all the documents of communal competence contributing to the preventive information and the protection of the population. It determines, based on the known risks, the immediate measures of safeguard and protection of the people, fixes the organization necessary for the diffusion of the alert and the safety instructions, identifies the available means and defines the implementation of the measures accompaniment and support of the population ".

The municipal plan of safeguard is stopped by the mayor of the commune and its implementation falls of each mayor on the territory of his commune.

The municipal plan of safeguard is adapted to the means which the commune has. He understands :

- the municipal information document on major risks provided for in Article 3 (III) of the abovementioned Decree of 11 October 1990,

- diagnosis of local risks and vulnerabilities,

- the organization providing protection and support to the population, which specifies the internal measures taken by the municipality to be able to alert and inform the population at any time and to receive an alert from the authorities. These provisions include, in particular, an operational directory and a regulation for the use of the different means of alert that may be implemented,

- the procedures for implementing the municipal civil security reserve when the latter was set up pursuant to Articles L. 1424-8-1 to L. 1424-8-8 of the General Code of Territorial Collectivities.

It is eventually completed by:

- the organization of the communal command post set up by the mayor if necessary,

- the actions to be carried out by the municipal technical and administrative services,

- if applicable, the appointment of the deputy mayor or municipal councilor responsible for civil security issues,

(22 頁)

- an inventory of the municipality's own resources or that can be provided by private persons located in the municipality. This inventory includes the means of transport, accommodation and food for the population. This system may be supplemented by an inventory of the means likely to be made available by the intercommunal establishment of which the municipality is a member,

- the specific measures to be taken to deal with the foreseeable consequences on the territory of the municipality of the risks identified,

- the methods of exercise to test the communal plan for safeguarding and training actors,

- a census of the measures already taken in the field of civil security by any public or private person established on the territory of the municipality,

- how to take into account the people who volunteer for the victims,

- provisions ensuring the continuity of daily life until the return to normal.

22 頁

3 Methodology and Definitions

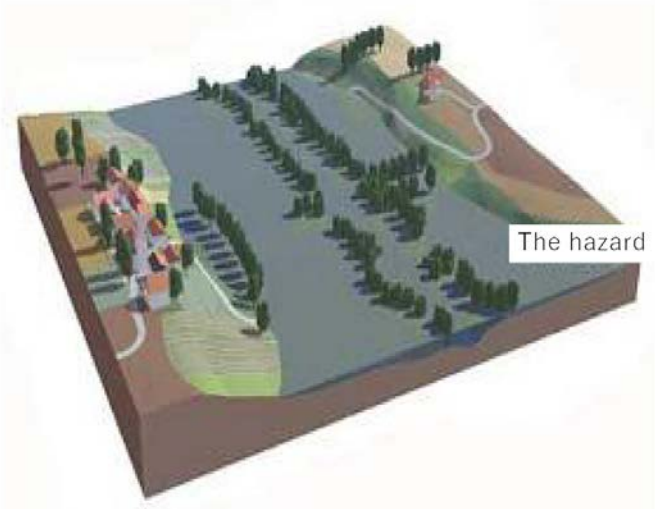
3.1 APPROACH TO EXTENSION OF KEY TERMS EMPLOYED IN RISKS

The risk is often defined in the specialized literature, as being the result of the crossing of the hazard and the stakes.

We thus have:
ALEA x ISSUES = RISKS

23 頁

Hazard is the manifestation of a natural phenomenon (potentially damaging) of occurrence and intensity.



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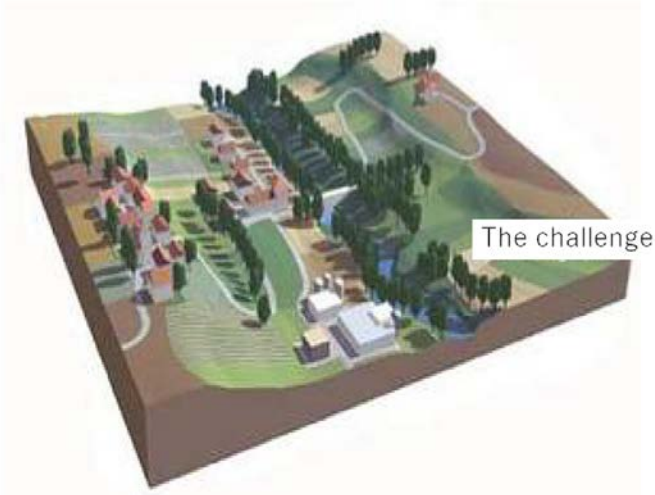
The issues presented correspond to all people and property (human, socio-economic and / or heritage issues) likely to be affected by a natural phenomenon.



※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）23 頁より作成。

The risk is the potential for brutal, random and / or massive damage following a natural event, the effects of which may involve human lives and cause significant damage. The term "risk" is therefore used only if issues (present in the area) can potentially be affected by a hazard (possible damage).

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）23 頁より作成。

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3.2 GENERAL PRESENTATION OF THE RISK FLOOD

The flood risk is thus the consequence of two components: the presence of the hazard (water) as well as that of the man (the stakes).

3.2.1 THE PRESENCE OF WATER: The FTAA

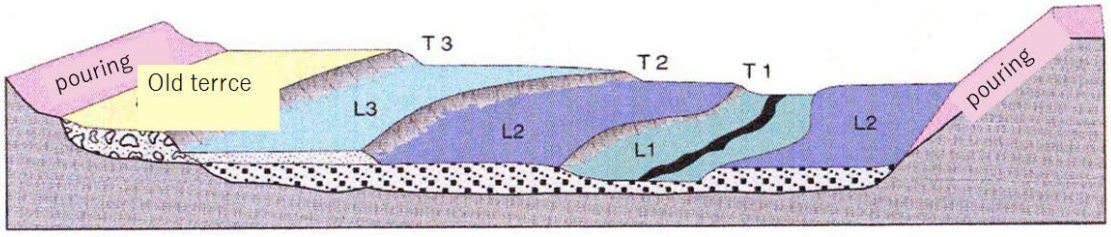
On the national territory, the majority of rivers (rivers, streams) have a morphology that is organized into three beds (see figure below):

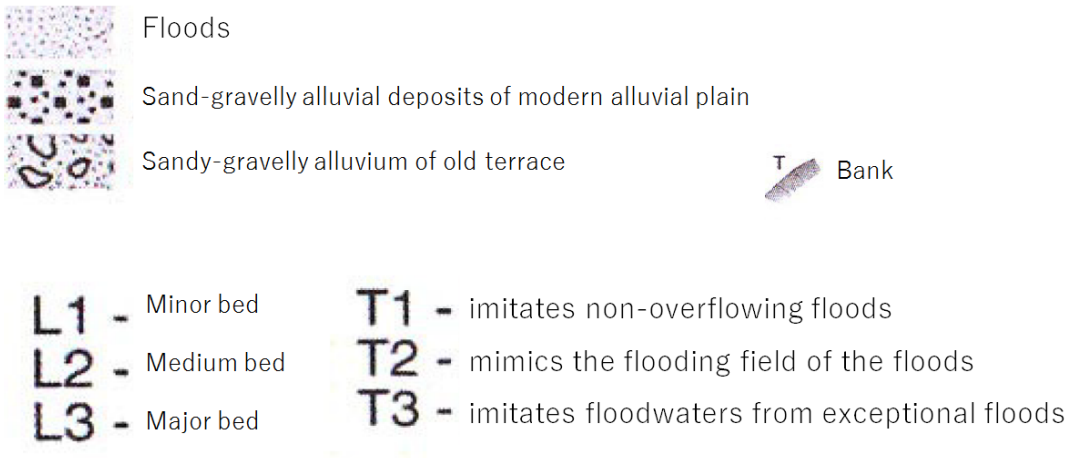
- The minor bed (L1) which is constituted by the ordinary bed of the watercourse, for the low water flow or for the frequent floods (annual floods: T1)

- The middle bed (L2), in certain climates, we can identify an average bed. For floods of 1 to 10 years, the flood submerges the lands bordering the river and extends into the middle bed. It corresponds to the alluvial space ordinarily occupied by the riparian forest, on which medium floods flow (T2)

- The major bed (L3) which includes the low areas located on either side of the minor bed, over a distance that ranges from a few meters to several kilometers. Its limit is that of exceptional floods (T3). We distinguish the flow zones, in the vicinity of the minor bed or flood channels, where the current has a high speed, and the areas of expansion of flood or water storage, where speeds are low. This storage is fundamental, because it allows the rolling of the flood (reduction of the flow and the speed of rise of water downstream).

- Outside of the floodplain, the risk of fluvial flooding is zero (which does not exclude the risk of flooding by rain runoff, particularly in urbanized areas). On the maps, we distinguish the ancient alluvial terraces, which no longer participate in the floods, but are witness to the disappearing hydraulic or climatic conditions. Their characteristics make it possible to consider a redeployment of sensitive land occupations outside the flood zones.





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This distinction of topographic beds of the river is possible by the hydrogeomorphological approach, recognized and developed since 1996, which aims at the study of the hydraulic functioning by analysis of the structure of the valleys. By various techniques such as photo-interpretation, photogrammetry and field observation, this is a method of interpretation of the natural terrain that identifies the structuring elements of the watershed likely to modify the flow of flood.

In densely populated urban area where the stakes are high, this approach may be complementary studies such as wired hydraulic modeling (or bidirectional) that is to model the Centennial calculated flow if high historic flood. Through this method, water levels, velocities and water flow directions can be established for a reference flood through profiles across the stream or successive traps. The crossing of these two criteria makes it possible to obtain the representative cartography of the different degrees of hazard.

3.2.2 THE PRESENCE OF MAN: THE CHALLENGES

By settling in the bed major, the man has settled in the river itself. But this occupation has a twofold consequence: it creates the risk by exposing people and property to floods and aggravates the hazard by changing the flow conditions of the water.

With regard to the risk of flooding, the issues to be taken into account are two types:

- areas with little or no urbanization,

- urban areas defined on the basis of the existing physical reality.

With the exception of existing campsites, areas with little or no urbanization are inherently vulnerable to human and economic vulnerability as few properties and people are exposed to them. However, to the extent that these areas are likely to allow the expansion of the flood and slow down dynamic flows, it should not open them to urbanization. On the other hand, it is essential not to expose in the flood zone new human and economic issues.

Urbanized areas include urban centers, communication routes, activities, sensitive or strategic equipment for crisis management.

3.3 PROCESS FOR FLOODS AND INUNDATIONS

3.3.1 DEFINITION AND TYPES OF FLOODS

"Inundations" and "floods" are frequently confusing terms. But the latter have very different characteristics. Indeed, a flood does not cause systematic inundations and vice versa!

(26 頁)

Flood is a rapid and temporary increase in the flow of a watercourse beyond a certain threshold. It is described from three parameters: the flow, the water level and the speed of the current. These parameters are conditioned by precipitation, the state of the watershed and the characteristics of the watercourse (depth, width of the valley). These natural features may be aggravated by the presence of human activities. Depending on the importance of flow rates, a flood can be contained in the minor bed or overflow into the middle or major bed.

Inundation is a rapid or slow submersion of an area outside the minor stream bed. There are several types of Inundations:

- We speak of plain inundation to designate the slow rise of water in the plain region. It occurs when the river slowly leaves its minor bed and floods the plain for a relatively long time. The river occupies its middle bed and possibly its major bed.

- The torrential flood corresponds to the rapid rise (usually within six hours after rainfall) of the water in the valleys and gorges following intense rains over a short period.

- Urban run-off flooding in urban and peri-urban areas, following intense and intense thunderstorms leading to saturation of drainage systems and then dripping onto impervious soils.

3.3.2 FLOODS AND INUNDATIONS TRAINING

Different elements contribute to the formation and the increase of flows of a watercourse:

- Mobilisable water, which may include snow or ice melt at a time of mild rains, repeated and prolonged rains or relatively short showers that may affect all small catchments of a few square kilometers. This case does not concern, or only very marginally, our Mediterranean rivers.

- Runoff depends on the nature of the soil and its surface occupation. It corresponds to the part of the water that has not been intercepted by the foliage, that has not evaporated and that has not been able to infiltrate, or that resurfaces after infiltration (saturation phenomenon of the soil).

- Concentration time is the time required for a drop of water with the longest hydraulic path to travel to reach the outlet. It is therefore a function of the size and shape of the watershed, the topography and the land use.

- Flood propagation (runoff) tends to congregate in a drainage axis where it forms a flood that spreads downstream. Propagation is further slowed down as the flow field is wider and the slope is smaller.

- Overflow occurs when there is propagation of a flow rate higher than that which can evacuate the minor bed.

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Our regions are obviously concerned by runoff, very strong in case of Cevennes episodes where infiltration is very low given the diluvian nature of the rains. The low concentration time makes the propagation fast and the prediction delicate.

Areas close to the coast (sea or pond) can also be flooded by the accumulation and interaction of extreme physical phenomena (atmospheric depression, wind, waves, etc.).

3.4 FACTORS AGGRAVING RISKS

Aggravating factors are almost always related to human intervention. They result in particular from:

- The location of people and property in the floodplain: not only is the risk exposure increased, but moreover, the waterproofing of soils due to urbanization promotes runoff at the expense of infiltration and increases the intensity of the flows. Land use also has an impact: the presence of vines (with rainwater drainage on slopes) or cornfields rather than grasslands contributes to a faster flow and decreases the time of water concentration towards the soil outlet.

- Potential failure of protection devices (dams, dikes, merlons, embankments, ...): the role of these devices is limited. Their effectiveness and resistance depend on their construction, management and maintenance, as well as the reference flood for which they were designed. In addition, breaking or submerging a dike exposes the floodplain to flooding more than if it was not protected. In the event of a break, for example, the wave effect generated is all the more devastating. In addition, natural structures such as dune ropes are not intended to serve as a protection structure and do not fall under the regulations relating to the safety of hydraulic structures. Their impact on the flows must be taken into account, but these cords cannot be considered as protective works resistant to the reference storm.

- Transport and dumping of unwanted products: Floods sometimes carry and then leave polluting or dangerous products on their route, particularly in urban areas. This is why it is essential that special precautions be taken regarding their storage.

- The formation and breakage of ice jams: the floating materials carried by the current (trees, bushes, caravans, vehicles ...) accumulate upstream of the narrow passages to the point of forming dams which greatly raise the level of the water and, in case of breakage, cause a powerful and devastating wave downstream.

- The raising of water upstream of the obstacles: the presence of bridges, embankments or walls in the flow field causes an elevation of the water upstream and on the sides which accentuates the consequences of the flood (increase of the duration of submersion, creation of eddies and currents, ...)

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3.5 THE CONSEQUENCES OF THE FLOOD

- Endangering people: The danger is manifested by the risk of being swept away or drowned due to the water level or the speed of flow, as well as the duration of the flood which can lead to the isolation of population centers. This is why it is essential to have a warning system (flood announcement) and organize the evacuation of populations especially if the time is very short, especially during fast floods or torrential.

- The interruption of communications: in the event of flooding, it is common for the communication routes (roads, railways, ...) to be cut, prohibiting the movement of people, vehicles or even rescue services. In addition, underground or surface networks (telephone, electricity, etc.) can be disturbed. However, all this can have serious consequences on the dissemination of the alert, the evacuation of populations, the organization of relief and the return to normal.

- Damage to property and activities: The damage caused by floods can reach various degrees, depending on whether the goods have simply been brought into contact with water (traces of moisture on the walls, mud deposits) or that they have been exposed to strong currents or flows (partial or complete destruction). Movable damages are more common, especially in the basement and ground floor. Activities and the economy are also affected in case of damage to the equipment, agricultural losses, production stoppage, impossibility to be supplied, ... In case of flood caused by the sea, the salinity of the water as well as marine sediments carried on normally emerged land cause additional damage, particularly on agricultural land. On the seafront, the mechanical effect of the breaking can cause significant material damage.

3.6 REFERENCE EVENTS IN THE FLOOD NATURAL RISK PREVENTION PLAN

Some small floods are frequent and do not lend or little to consequence. "Bigger" floods are also rarer. The establishment of a well-documented historical chronicle makes it possible to estimate, by statistical calculation, the probabilities of recrudescence of such flood intensity in the years to come. This establishes the probability of occurrence (or frequency) of a flood and its period of return. For example:

A decadal (or centennial) flood is a flood of such importance that it is likely to occur every 10 years (or 100 years) on average over a very long time. The 100-year flood is therefore

the theoretical flood, which each year has a probability of 1% (one "chance" out of 100) to occur.

As stated in the texts, the reference event taken into account in the context of a PPRI is the calculated centennial flood or the highest known historical flood if it proves to be superior.

Over a period of about thirty years (minimum life of a construction) the centennial flood has about one in four possibilities to occur.

If this is indeed a theoretically infrequent flood, the centennial flood is a predictable event that must be taken into account at the scale of sustainable development of a municipality: it is not in no case of a maximum flood, the occurrence of a higher flood can not be excluded, but the reference flood remains sufficiently significant to serve as a basis for the PPRI.

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3.6.1 THE DESCRIPTIVE PARAMETERS OF THE FAA.
The parameters primarily integrated in the study of the PPR hazard are those that make it possible to apprehend the level of risk induced by a flood or a marine storm:

- The submersion height currently represents the factor best describing the risks for people (isolation, drowning) as well as for goods (damage) by direct action (degradation by water) or indirect (pressure, pollution, short -circuit, etc.). This parameter is, moreover, one of the most easily accessible by direct measurement (field survey) or hydraulic modeling. It is considered that heights of more than 50 cm are dangerous for people (see graph in 3.6.2). Beyond 100 cm of water, damage to the building can be irreversible (destabilization of the building under pressure, soaked water, ...)

- The flow velocity is conditioned by the slope of the bed and its roughness, for the fluvial hazard. It can reach several meters per second. The danger of the flow depends on the height / velocity pair. For example, from 0.5 m / s, the speed of the current becomes dangerous for the man, with a risk of being carried away by the watercourse or to be hurt by objects carried with high speed. The flow velocity also characterizes the risk of transporting light or unsealed objects as well as the risk of

gullying of embankments or embankments. It is clear that, in the case of a dike break, this parameter becomes preponderant over the first tens of meters. In the case of marine submersion the flow velocity is considered to be less than 0.5 m / s.

- The submergence time corresponds to the duration of isolation of people or the dysfunction of an activity. When this time is important, health problems can occur, the water is often dirty, contaminated by sewers and a high degree of salinity in case of marine submersion. For fast kinetic fluvial floods, characteristic of Mediterranean climates, submergence time is not a parameter studied because of the rapid descent of the waters after the event.

3.6.2 THE QUALIFICATION OF THE FAA

It is determined by two distinct methods, depending on whether one is in an urban environment (hydrogeomorphology and wired or racked hydraulic modeling) or in a natural environment (hydrogeomorphology).

Depending on the values of the parameters studied, it results in flood zones of "moderate", "strong" and "residual" hazard.

Is classified as a "strong" hazard zone, an area flooded by the reference flood, and whose water depth is greater than 0.5 m or the speed is greater than 0.5 m / s.

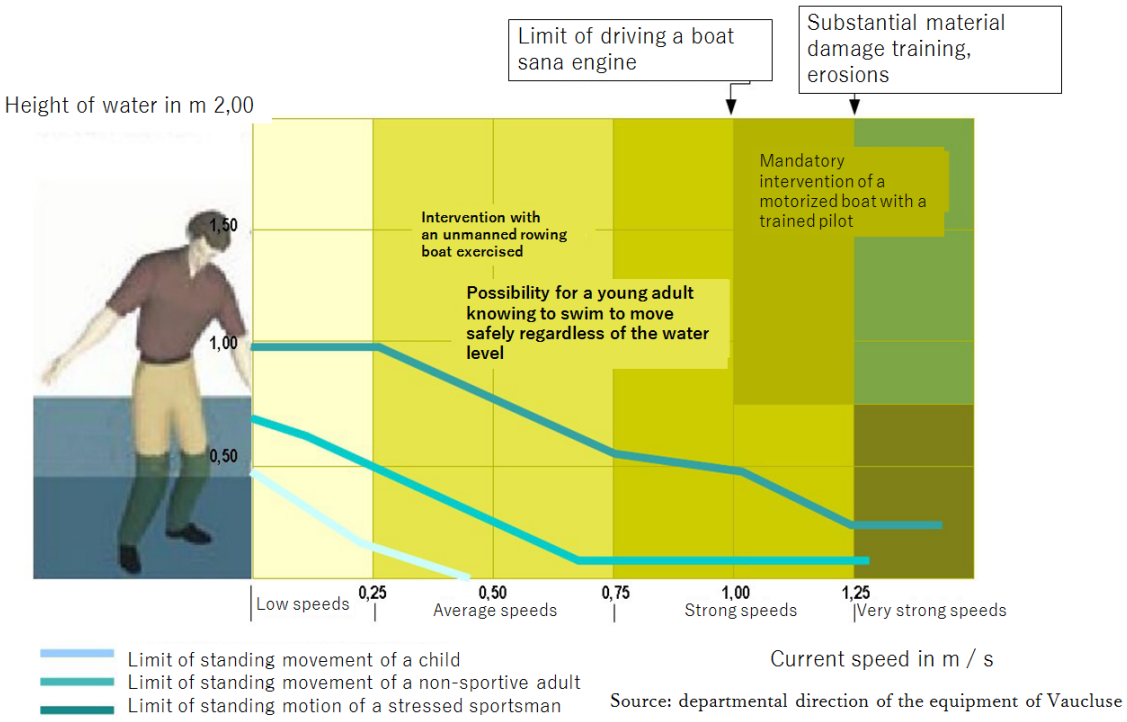
Is classified in zone of hazard "moderate", a zone by the flood of reference, and whose height of water is strictly lower than 0,5 m and the speed of flow is strictly lower 0,5 m / s.

It is classified as a "residual" hazard zone, an area that is not flooded by the reference flood, but that is likely to be mobilized for a higher flood.
(30 頁)
The threshold of 0.5 m is explained by the fact that the risk for people starts from this height of water:

➢ from this value, it has been shown by feedback from past floods, that an untrained adult and, even more so, a child, an elderly person or a person with reduced mobility encounters serious difficulties in displacements, reinforced by the total disappearance of the relief (sidewalks, ditches, open manholes, etc.) and increased stress,

➢ In addition to the difficulties of movement of people, this limit of 0.5 m of water characterizes a threshold for the movement of vehicles: a car can start to float from 0.3 m of water and can be washed away from 0 , 5 m by the current as weak as it is,

➢ A height of 0.5 m of water is also the limit of movement of conventional emergency response vehicles.



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Travel limits in case of flood

The limit of the speed parameter is more complex, depending on the location of the buildings, the height of dikes, their constitution, etc.

3.7 DEFINITION OF ISSUES

The issues are based on the current land cover analysis (review of current urbanization, location of sensitive, strategic, vulnerable, etc.). They make it possible to define the "natural" flood zone (moderate stakes) and the "urbanized" flood zone (strong stakes). (31 頁)

The moderate stakes cover the non-urbanized zones at the date of the elaboration of this plan and thus include, the agricultural zones, the natural zones, the forest areas, according

to the terms of the article R.123-4 of the code of the urban planning and urbanization areas not yet built.

Strong issues cover urbanized areas and areas to be urbanized already developed.

The delineation of urban areas (high stakes) is included in the hazard mapping of the PPRI.

At this stage, the aim is to meet the twofold objective set by state policy: to define and protect urbanized flood zones on the one hand, and to preserve non-urbanized areas on the other, particularly for the conservation of the field. flood expansion.

3.7.1 REGULATORY ZONING

Article L. 562-1 of the Environmental Code defines two main types of zones:

- areas directly exposed to risks, hereinafter referred to as "danger zones",
- areas not directly exposed to risks, hereinafter referred to as "precautionary zones".

3.7.2 AREAS AT RISK

Qualified in the PPR of danger zones, these are the areas exposed to a strong hazard, and in which most of the facilities are therefore prohibited.

These danger zones consist of:

- the Ru Rouge urban zone, flood areas subject to high hazard, where the stakes are high (urban areas),

- Natural Red Zone Rn, flood areas subject to a high hazard where the stakes are low (natural areas).

They serve two purposes:

- not to increase the population, the buildings and the risks by allowing, however, a minimal evolution of the building in urban area to favor the continuity of life and the urban renewal (all red zones),

- enable urban development that takes into account risk exposure by taking care not

to increase vulnerability (urban reds).

3.7.3 ZONES NOT DIRECTLY AT RISK

Areas qualified as precautionary in the PPR, they correspond to the whole of the municipal territory which is not located in zone of danger.

These are therefore areas where constructions, works, developments or agricultural, forestry, artisanal, commercial or industrial exploitations could aggravate risks or provoke new ones.
(32 頁)
They cover areas of moderate hazard and non-floodable areas by the reference flood.

They have several objectives:

- preserve areas of non-urbanized flood expansions,
- prohibit any project likely to aggravate the existing risk or to provoke new ones,
- prohibit any construction promoting isolation of persons and / or inaccessible to rescue,
- to allow a reasoned and adapted urban development in urban area of moderate hazard,
- allow urban development taking into account sea level changes due to global warming,
- allow urban development taking into account the potential risk in the event of a flood higher than the reference flood,
- allow urban development of non-floodable areas without aggravating the floodability of flood-prone areas.

They consist of:

- the Blue Bu zone, flood areas subjected to a moderate hazard, where the stakes are high (urban areas),
- Red Precaution Zone Rp, flood areas subject to moderate hazard, where the stakes are low (natural areas),
- Precautionary zones Z1 and Z2, areas not flooded by the reference flood, composed of the residual hazard zone Z1, potentially flooded by an exceptional flood, and Z2 zero hazard zone, which concerns the rest of the municipal territory, not subject to either the reference flood or the exceptional flood.

The following table and diagram illustrate these classifications of zones, resulting from the crossing of the hazard and the considered issues.

Alea	issues	Strong (urban areas)	Moderate (natural areas)
strong	Flood for the reference flood	Red Ru danger zone	Red Rn danger zone
Moderate	Flood for the reference flood	Buoyant Blue Precaution Zone	Precautionary area Red Rp
Exceptional	Hydrogeomorphological limit	Precautionary zone Z1	
No	Beyond the hydrogeomorphological limit	Precautionary zone Z2	

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）32頁より作成。

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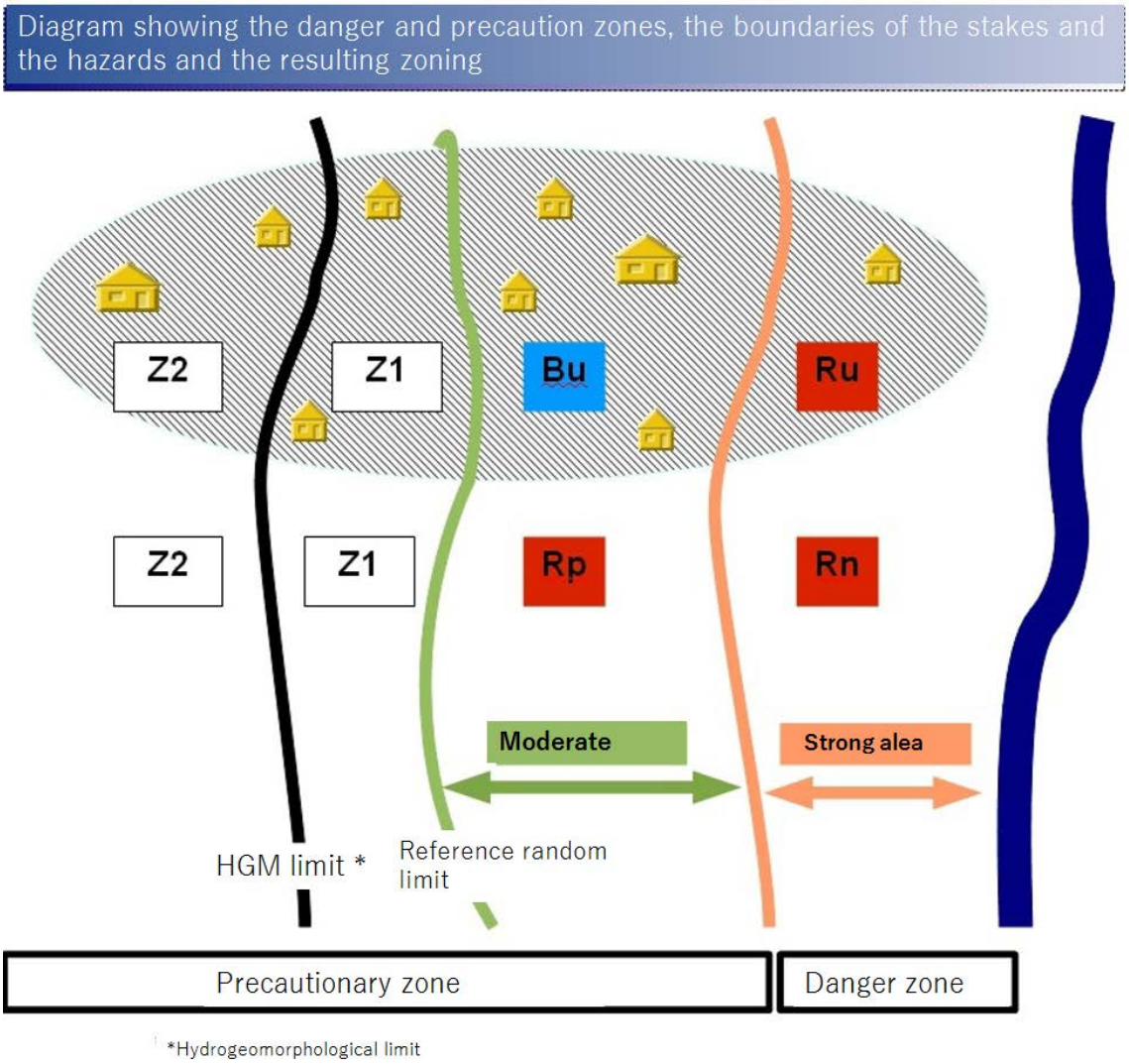

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4 THE MEASURES PRESCRIBED BY THE PPR

The PPRI Regulation incorporates prevention, protection and safeguard measures and measures on the existing which are briefly described below.

4.1 PREVENTION, PROTECTION AND SAFEGUARD MEASURES

These collective or specific measures, established by Article L. 562-1 II 3 ° of the Environmental Code, aim to preserve human lives by actions on the phenomena or the vulnerability of goods and people.

Some of these measures belong to the public authorities within the scope of their competences, others are the responsibility of the individuals.

They aim to reduce the impact of a phenomenon on people and property, to improve people's and elected officials' knowledge and perception of risk and to anticipate the crisis.

To this end, several provisions can be made such as:

• carrying out specific studies on hazards (hydrology, hydraulic modeling, hydrogeomorphology, atlas of flood zones, etc.),

• setting up a monitoring and announcement system,

• the development of a crisis management plan at the municipal level, the PCS, or even at the inter-communal level,

• implementation of public information meetings on risks, elaboration of information documents such as DICRIM, etc.

4.1.1 CONTROL OF RAIN FLOWS

The control of rainwater, including in the face of exceptional events of centennial occurrence, is a major challenge for the protection of inhabited areas. This rainwater management is the responsibility of the municipality. If it is not already realized, the municipality will have to establish a zoning of stormwater treatment, in accordance with the article L.2224-10 3 ° of the General Code of the Territorial Collectivities, within five years as from the approval of the PPRI.

In accordance with article 35 of the law No. 92-3 on water (codified in article L.2224-8 of the general code of the territorial collectivities), the communes or their groupings must delimit the zones where measures must be taken to limit the waterproofing of soils and to control flow and runoff of storm water and runoff and areas where it is necessary to provide facilities for collection, possible storage, and as needed, rainwater treatment.

In application of the SDAGE Rhone - Mediterranean, measures to limit runoff must be absolutely favored: limitation of waterproofing, retention on the plot and storm water storage devices (retention basins, valleys, tank roads, ...)

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4.1.2 PROTECTION OF URBANIZED DENSITY PLACES

In accordance with Article L.221-7 of the Environmental Code, local authorities or their group may, as part of a declaration of general interest, study and undertake flood protection works. In application of the SDAGE Rhone - Mediterranean, this work must be limited to the protection of densely urbanized areas. They must be subject, in the framework of authorization procedures related to the application of the Water Act, to a sufficiently comprehensive analysis to make it possible to understand their impact upstream and downstream, both in terms of hydraulics and the preservation of aquatic environments. Works that leave rivers with the greatest freedom should be preferred to narrow embankments bordering the minor bed.

If protection work is in most cases conceivable, it should be borne in mind that these protections remain in all cases limited. The occurrence of a flood exceeding the project flood cannot be ruled out.

When the basin is the subject of a flood prevention action plan (PAPI), the State is likely to contribute to the financing of such work as part of the fund for the prevention of major natural hazards (FPRNM dit Barnier fonds).

Existing dams protecting important stakes will be subject to rigorous management, maintenance, regular inspections, and if necessary, work of reinforcement, enhancement, etc.

4.1.3 PREVENTIVE INFORMATION

Article L125-1 of the Environment Code states that "Citizens have the right to information

on the major risks to which they are subject in certain areas of the territory and on the safeguarding measures that concern them. This right applies to technological risks and foreseeable natural risks.

The mayor must issue at least once every two years to the population periodic information on natural hazards. This procedure must be supplemented by an obligation to inform all citizens on a yearly basis through a relay left to the free choice of the municipality (municipal bulletin, public meeting, distribution of a brochure, exhibition, ...) on mandatory measures and recommended for projects and existing buildings.

4.1.4 SAFEGUARD MEASURES

The mayor, by his powers of police, must elaborate a communal plan of safeguard (PCS), in accordance with article 13 of the law No.2004-811 of August 13, 2004 relating to the modernization of the civil security, within a two years from the date of approval of the PPR. This article specifies that "the municipal plan of safeguard regroups all documents of municipal competence contributing to preventive information and the protection of the population. It determines, based on the known risks, the immediate measures of safeguard and protection of the people, fixes the organization necessary for the diffusion of the alert and the safety instructions, identifies the available means and defines the implementation of the measures accompaniment and support of the population. He may designate the deputy mayor or the municipal councilor responsible for civil security matters.

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The following provisions are made mandatory for communities in the context of the prevention, protection and safeguarding of existing and future buildings:

- the approval of the Flood Risk Prevention Plan opens a period of 2 years during which the town hall must draw up a Municipal Protection Plan (see above),

- Owners or managers, public or private, protection dikes in highly urbanized sectors must comply with the requirements of the current regulations on the safety of hydraulic structures (Decree No. 2007-1735 of 11 December 2007 on safety hydraulic works and decree No. 2015-526 of May 12, 2015, relating to the rules applicable to structures built or developed to prevent floods and the safety rules of hydraulic structures, applicable at the date of approval of the PPRI),

- According to their characteristics and the protected population, dikes and protection works for the protection of urbanized places must be the object of their owner of a complete diagnosis, a thorough technical visit, a report of inspection and report of monitoring at a frequency of 1 to 5 years.

4.2 MITIGATION MEASURES

These measures, introduced by Article L. 562-1 II 4° of the Environment Code, have resulted in the drafting of a specific part of the regulation attached to this PPRI file, in which all mandatory measures are detailed.

4.2.1 DEFINITION

The mitigation measures concern individuals (owners, operators, users) and apply to their existing property.

4.2.2 OBJECTIVES

Of very different natures, these measures pursue three objectives which allow to hierarchize them:

- Ensure the safety of people (adaptation of goods or activities in order to reduce the vulnerability of people: safe haven, consolidation works of protection works),
- Reduce the vulnerability of buildings (limit material damage and economic damage),
- Facilitate the return to normal (adapt the goods to facilitate the return to normal when the event occurred: choice of materials resistant to water, etc., mitigate the psychological trauma related to a flood by facilitating the waiting for rescue or recession, and possible evacuation in conditions of comfort and safety satisfactory).

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4.2.3 MEASURES APPLICABLE TO EXISTING GOODS

A diagnosis (or self-diagnosis) must first be developed by the owners, communities, businesses and individuals, to know their vulnerability and thus determine the necessary measures to reduce it. This diagnosis must establish the height of water likely to invade the building in the event of flood similar to that taken by reference by the PPRI.

For property built or developed in accordance with the provisions of the Urban Planning Code and prior to approval of this PPR, work relating to certain individual building measures is now mandatory. They are imposed only within the limit of 10% of the market value or estimated value of the property considered at the date of approval of the plan

(Article R562-5 of the Environment Code). These mandatory measures are described in the regulations of this PPRI.

Unless otherwise specified in the regulation, the implementation of these provisions must be carried out as soon as possible and within a maximum period of 5 years from the approval of this plan (pursuant to article L.562 -1 III of the Environmental Code, according to the terms of its implementing decree).

If these measures are not implemented within the prescribed time limits, the prefect may impose the implementation of these measures at the expense of the owner, the operator or the user.

Since the law of 30 July 2003 on the prevention of technological and natural risks and the repair of damage, all the work of safety of persons and reduction of the vulnerability of the buildings prescribed by an approved PPR can benefit from a State subsidy. This grant from the Fund for Prevention of Major Natural Risks, known as the Barnier Fund, aims to encourage the implementation of these measures and concerns:

- individuals (residential property) up to 40%,
- companies with fewer than 20 employees (professional use) up to 20%.

4.3 REFERENCES AND RESOURCES

- Portal for the prevention of major risks: http://www.prim.net
- Risk prevention portal of MEDDE: http://www.developpement-durable.gouv.fr/Enjeux-et-principes.html
- Risk component of MEDDE - DGPR: http://www.developpement-durable.gouv.fr/-Risques-naturels-et-ouvrages-.html
- Information portal on natural and technological risks: http://www.georisques.gouv.fr/
- Website of the Rhone Mediterranean Basin Water Information System: http://www.rhone-mediterranee.eaufrance.fr
- Website of the state services in the Hérault: http://www.herault.gouv.fr/

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SECOND PART: THE NATURAL RISK PREVENTION PLAN FLOODING OF THE COMMUNITY OF BOUJAN-SUR-LIBRON

The watershed of Libron covers 16 municipalities of the department: Faugères, Caussiniojouls, Cabrerolles, Laurens, Autignac, Magalas, Puissalicon, Puimisson, Pailhes, Lieuran-Les-Beziers, Corneilhan, Bassan, Boujan-Sur-Libron, Montblanc, Beziers and Vias.

In 2010, in response to the preparation of Flood Risk Prevention Plans (PPRi), the French government commissioned the engineering consultancy EGIS Eau to carry out a study of the areas flooded by overflowing water courses. Water, excluding rain runoff, on the perimeter of the communes of the watershed, scale relevant for the risk analysis.

The mission consisted of two phases. A first phase whose objective was to understand the functioning of the rivers present in all the communes of the watershed and to determine, for the realization of the second phase, the sectors requiring a more in-depth study with the implementation of place of a hydraulic model to characterize the hazard.

The knowledge of the functioning of the rivers relied mainly on the collection of historical data and hydrogeomorphological analysis:
- the historical data identified and analyzed emanated from different sources: data transmitted by the communes, data from the testimonies of residents, data owned by the DDTM or data present in existing studies,
- the hydrogeomorphological analysis allowed to determine the maximum expansion field of the flood and to retranscribe the hydrodynamism of the watercourse (minor bed, middle bed, major bed, secondary flow axes ...).

The meeting of the communes, the field expertise and the hydrogeomorphological analysis made it possible to determine the sectors treated by hydraulic modeling, the choice of the modeled sectors depending notably on the stakes located in the hydrogeomorphological flood envelope.

For sectors subject to modeling, a hydrological analysis has been carried out in order to determine the characteristic flows and the reference flow rate to be taken into account (centennial flow rate or flow rate of a historical flood in the event that the latter is greater than the centennial flow).

The municipal territory of Boujan-sur-Libron is mainly drained by the Libron and its tributary Ardaillou.

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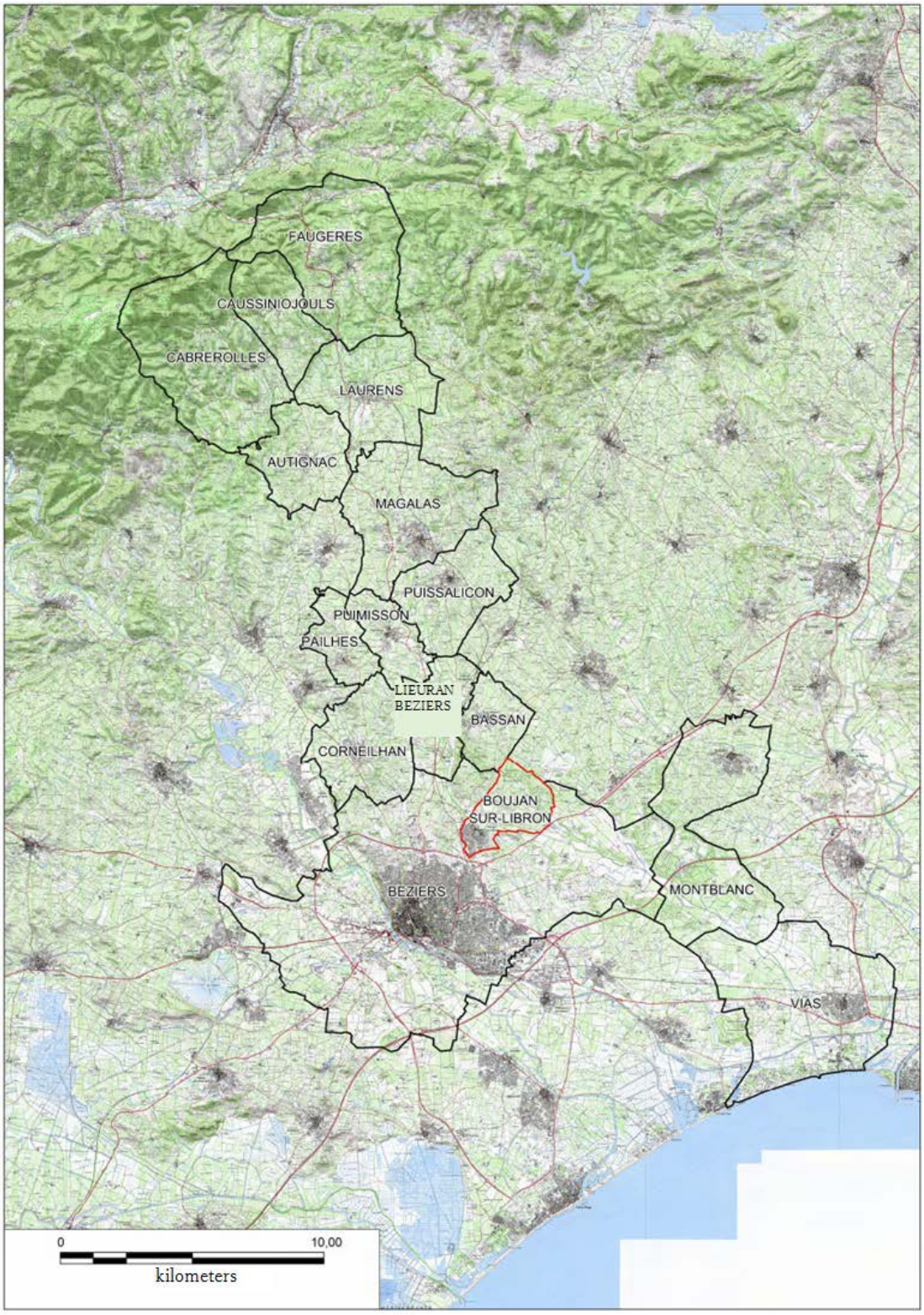

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）39 頁より作成。

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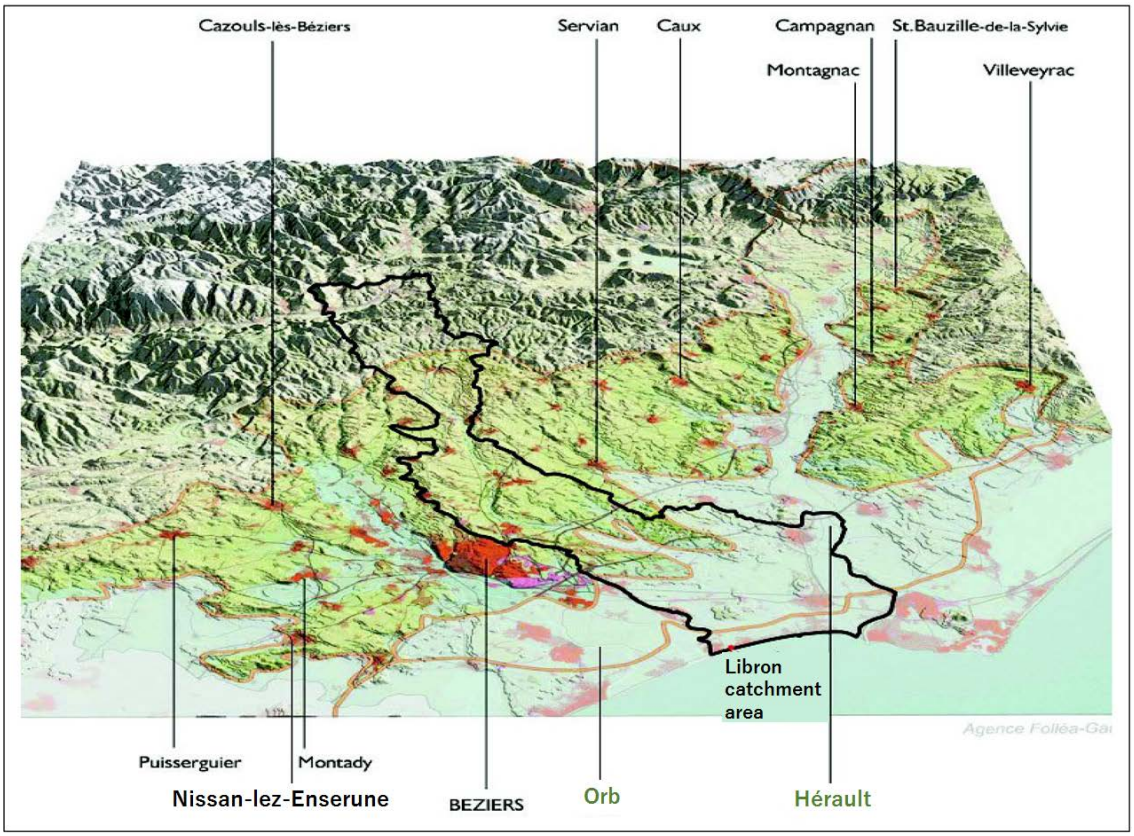
1. THE LIBRON

1.1. GENERAL PRESENTATION OF THE RIVER BASIN

1.1.1. GEOGRAPHIC CHARACTERISTICS

With a total area of 236 km², the Libron catchment area is oriented North-Northwest to Southeast. Its length is of the order of 40 km. The highest point of the watershed is located 500 m above sea level. With a relatively elongated shape, its slope is very steep up to Laurens (greater than 2%) and softens over the rest of the linear (approximately 0.4%) to the outlet at sea from the river at Vias. It is also from Laurens he takes the name of Libron and is fed by several tributaries.



※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）40 頁より作成。

Watershed of Libron

In its upstream end, the Libron crosses natural formations composed mainly of leafy trees (green oak, pubescent ...). Part of the rain is therefore intercepted by this relatively dense vegetation.

But very quickly the vegetation becomes less present. Only the middle bed of the Libron is occupied by dense vegetation, constituting the riparian forest of the river. The space is then

occupied by agricultural activities, mainly vineyards and orchards.

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1.1.2. WEATHER CONDITIONS

1.1.2.1. TYPE OF CLIMATE

The watershed is subject to a Mediterranean climate characterized by its summer drought. Summers are hot and winters are mild and lightly watered. The rainfall pattern is bimodal with rainfall distributed mainly in autumn and spring. However, there are important inter-annual variations between very dry years and very rainy years. The most intense rainfall events usually occur in autumn. These are brief and violent thunderstorms favored by the upstream reliefs that block the air masses concentrating on certain sectors very large quantities of water. Significant rainfall can also occur in winter, as evidenced by the floods of January 1994 and 1995, or spring (floods of May 1992, 1999 and 2008), or even in summer, during which time nearly 10% of Extreme rainfall (rains> 100 mm / day) was recorded in the Hérault for the period 1958-2012.

1.1.2.2. RAINFALL

It is relatively homogeneous throughout the watershed:

- in the upper basin, the annual rainfall is between 800 and 1000 mm,
- on the average valley and low plain, annual values are of the order of 600 to 700 mm (Source: Météo France)

1.1.3. GEOLOGICAL AND GEOMORPHOLOGICAL DESCRIPTION OF THE BASIN

The upstream part of the Libron watershed extends to the eastern end of the southern slopes of the Montagne Noire, within a formation called the scales of Cabrières.

At this point the limestone substrate dates from the Devonian. The stratigraphic series are:

- a dolomitic series,
- limestones with siliceous intercalations,
- versicolored limestones, which are massive and composed of very fine grains of very variable color,
- nodular limestones.

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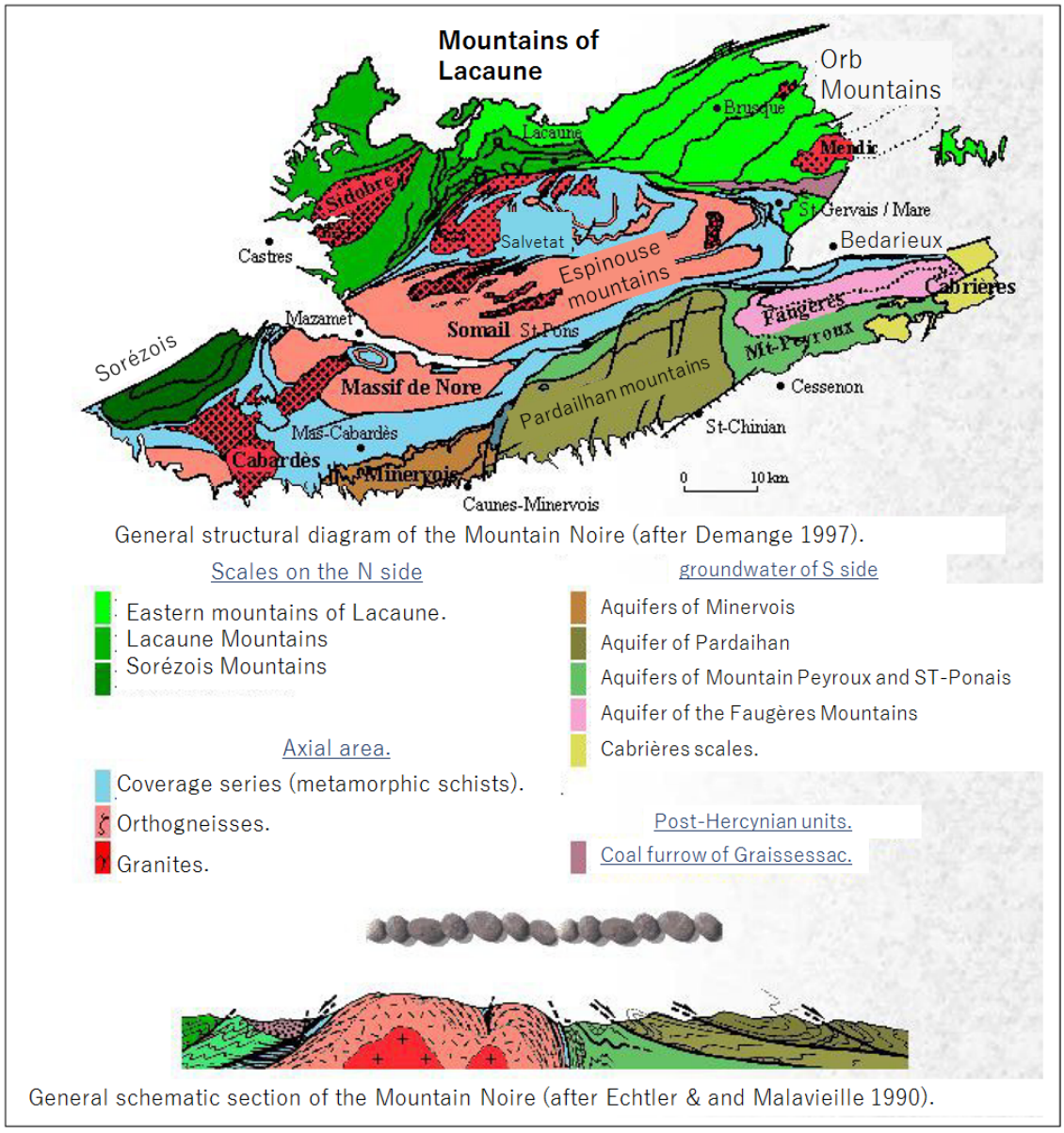

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）42 頁より作成。

Until Laurens, the Libron flows mainly in a formation of Flysch. These are syn-orogenic rock formations (formed at the same time as the mountain ranges) formed by alternating sandstone benches at the base and schists upward from the formation. They are formed by dissolving rock fragments torn from mountains in peripheral seas: they are turbidites.

Downstream of Laurens, and as far as Lieuran-les-Beziers, the Libron incises a substrate

composed of marine molasse (succession of sandstone at the base and clays at the top) dating from Middle Miocene.

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In its downstream section, the Libron abuts volcanic outcrops much less weatherable. A million years ago, the sea covered the entire littoral zone. The earth's crust, a little less thick at this place, lets out some gases and incandescent materials. And then, it is the explosion: the chimney of the volcano at 100-500 meters under the surface is invaded by the sea water that heats up and vaporizes creating a gigantic geyser. It is in a cloud of steam that lava fragments associated with a cloud of dust rise more than 1,000 meters away. Slag, lava dust exploded, agglomerate under the stratifying water found in both Cap d'Agde and Vias where they are called "Bosc cinerites ".
These volcanic reliefs have the impact of a narrowing of the alluvial plain to the right of Vias, playing a role of natural lock. The significant extension of the plain immediately upstream of this tightening would also be one of the consequences of this geological context.

The geology in the Libron watershed is characterized by a predominance of limestone. This type of substrate is particularly alterable (by dissolution) and permeable, the water interfering in the subsoil through numerous cracks. This partly explains the absence of exotic flows, in favor of inferred-flow (underground flows). The volcanic rocks in its downstream part are on the contrary very little alterable and constitute natural obstacles determining the route of the Libron. In addition, these formations are characterized by significant impermeability, favoring runoff.

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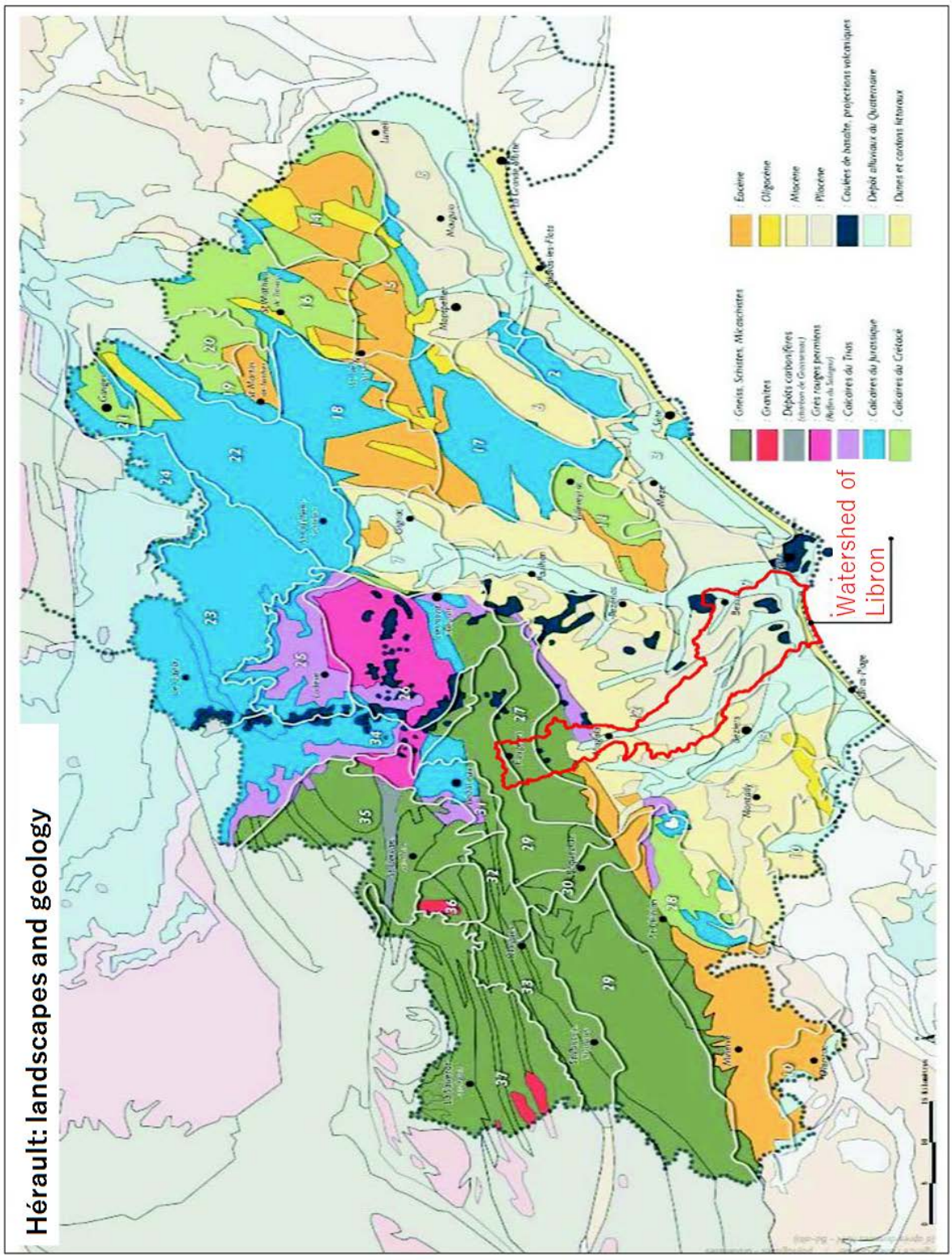

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）44 頁より作成。

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1.2. HYDROGEOMORPHOLOGICAL ANALYSIS

From its source to its outlet in the Mediterranean, 8 homogeneous sections can be observed on the line of about 44 km traveled by the Libron.

Naubine Creek, Gournautuc Creek, and Mas d'Azil Creek, Mayroune Creek, Badeaussou Creek, Riels Creek, Sèbe Creek, del Basth and Combes, Vinassac Creek, Garenne Creek, Aire Creek and Ardaillou Creek are the major tributaries of the Libron and have also been studied.

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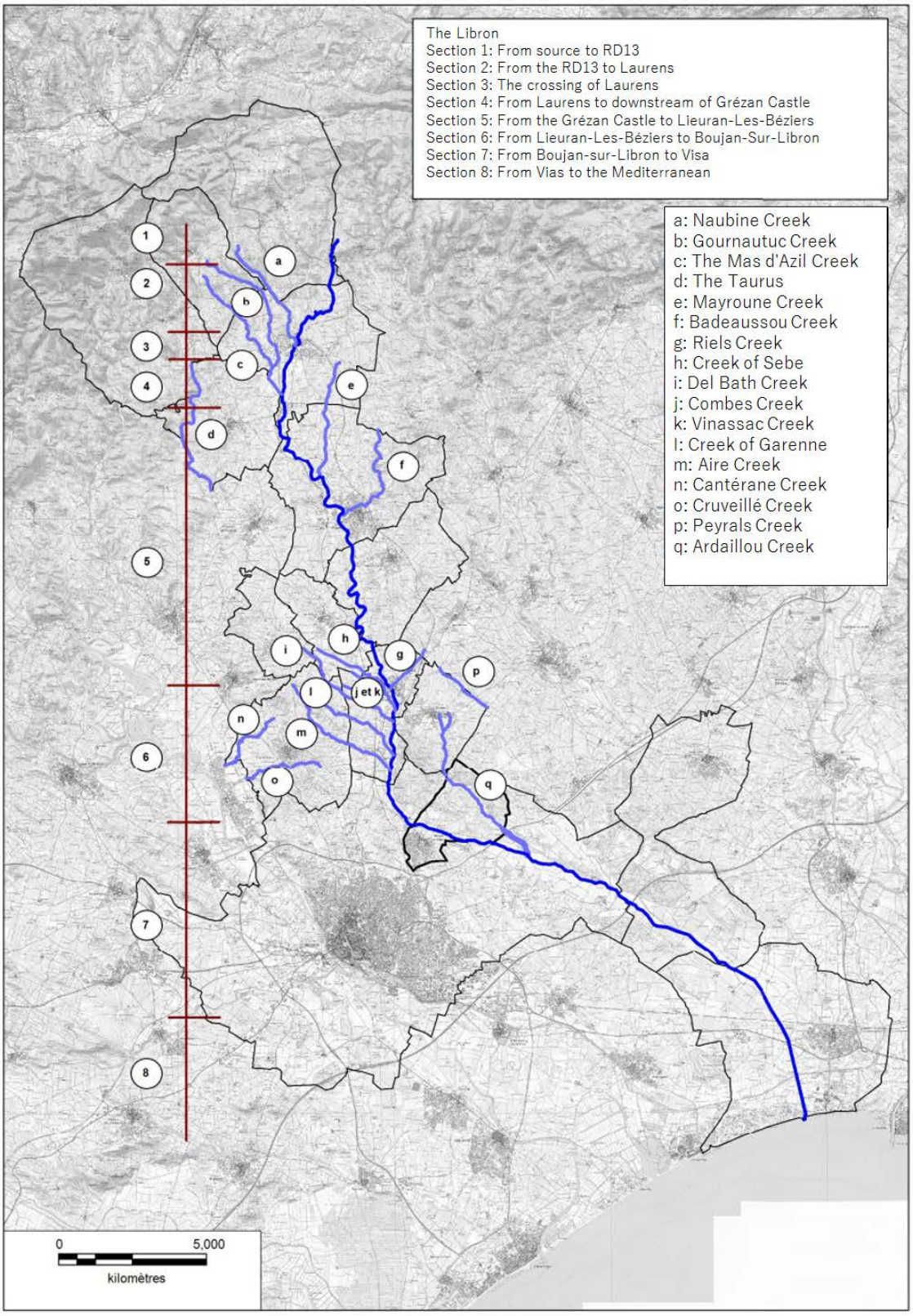

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）46 頁より

作成。
Hydrogeomorphological approach - watercourses analyzed

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1.2.1. SECTION No. 1: FROM THE SOURCE TO RD13 DEPARTMENT ROUTE (1 KM)
The Libron takes shape at 265 m altitude in the Regional Natural Park of Haut Languedoc; it is called Sauvanès and flows into a very narrow V valley where the slopes are very pronounced. The slopes structure the alluvial plain and bring more or less important materials into the bed.

At only one kilometer from its source, the Libron already encounters significant anthropogenic obstacles. Two huge infrastructure embankments support the RD13 road and the railway. The Libron is then forced to borrow a nozzle, certainly undersized for an extreme flood. The flows are thus strongly disturbed from the upstream.

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Busload of the Libron from its upstream part (upstream / downstream)

1.2.2. SECTION 2: FROM THE RD13 DEPARTMENTAL ROUTE TO LAURENS (3.4 KM)
Up to Laurens, a succession of slope breaks alternates between limited overflows and small areas of expansion. Globally, the plain of Libron widens significantly, fed by the contributions of many small tributaries. The minor bed is well marked, may be very wide in places, but still remains dry in low water regime.

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Libron minor bed in an area with poorly maintained slopes significant hold with formation of a small natural water reservoir and a desiccation crust

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About 1.5 km upstream of Laurens, the Libron changes radically orientation, blocked by a massive dolomitic barrier (The Causse). It then goes to the South-West by describing meanders inscribed before incising again to the village of Laurens.

Crossings of the Libron are of the type rafting on this section. Only a municipal road and an embankment can disturb the flow.

Few issues are identified in this sector. Some recent constructions on the right bank, resulting from the urban development of Laurens, are localized in bed major.

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Recent dwellings in floodplains upstream of Laurens

1.2.3. SECTION 3: LAURENS CROSSING (800 M)

The first urban area crossed is at the confluence of Naubine, Libron and a small tributary left bank. These streams are in the form of fully artificial channels. Their concrete bed promotes the rapid evacuation of floodwater which allows to reduce slightly the risk at the village level. On the other hand, floods will be more devastating downstream of this anthropised sector; in fact, these developments induce downstream higher velocities (because of a reduced roughness) and influx of water in greater quantities.

This relatively long concreted linear also has morphological impacts. The Libron's tendency

towards an equilibrium profile leads to regressive erosion upstream of the anthropised section, and progressive erosion downstream.

The streams are completely integrated into the urban landscape. The crossing structures are submersible and the minor beds act as parking (photo left below). The banks are artificial on most of the linear (rip-rap or retaining walls).

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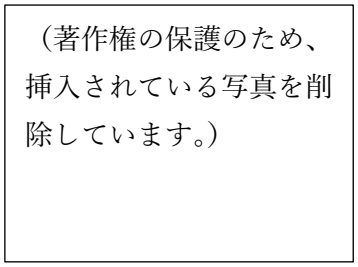
Many buildings are very vulnerable and limit overflows on the left bank, carrying them to the right bank. These homes are the first victims of the waves, which can be devastating and deadly as evidenced by past events ("In the village of Laurens, eight houses collapsed" September 26, 1857- Floods in France from the sixth century to the present day M. Champion, Paris, Dunod, 1858-1864). Some of them have been recently renovated and their first floor is now habitable (photo right below). The risk remains very important to Laurens given the multiplicity of issues present around the minor bed.



Minor bed serving as parking. Houses on the left bank very vulnerable.

Immediately downstream of the sector, the bed section is diminished by the presence of gardens and outbuildings established on embankments. These developments still disturb the flow, before the Libron flows more naturally. Once this urban crossing completed, an average bed stands out very clearly and the plain manages to be structured.

1.2.4. SECTION 4: FROM LAURENS TO THE BEGINNING OF GRÉZAN CASTLE (2.3 KM)

On this stretch the Libron valley is relatively well structured, with a clear demarcation of the different beds. The appearance of an average bed and bank erosion areas testify to a sustained hydrodynamism, resulting in part from the phenomena induced by the crossing of Laurens but also the presence of fine and mobilisable material. The route of the Libron is relatively straight, the casing being less restrictive.

The Libron perceives the contributions of the Gournautuc creek, an important tributary on the right bank. The confluence zone is disturbed by the presence of the RD909 road embankment which blocks the valley of this tributary at its outlet.

The stakes are very limited on this section. The presence of activities in major beds could lead to the mobilization of a significant amount of materials. Some vineyards are also vulnerable, some are bordered by low walls.

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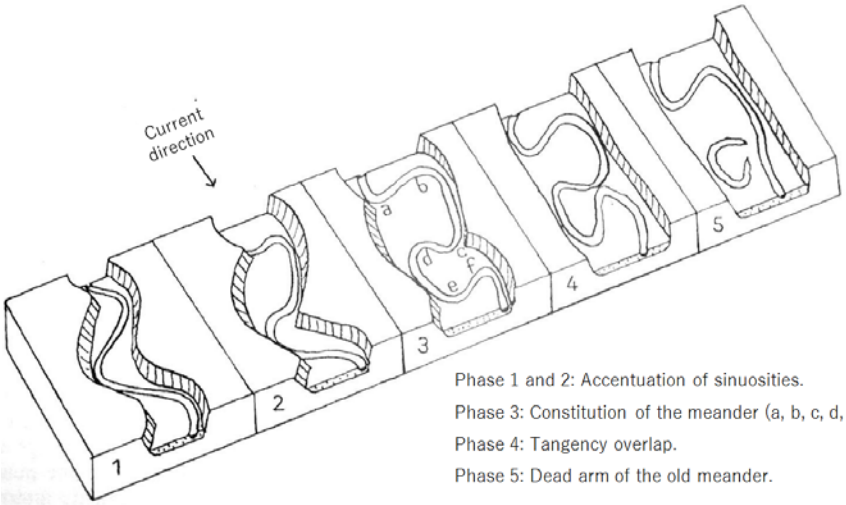
1.2.5. SECTION 5: FROM THE GRÉZAN CASTLE TO LIEURAN-LES-BÉZIERS (13.2 KM)

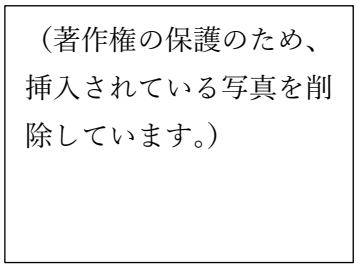
This homogeneous section is relatively long; it represents a linear of about 13 km. It is characterized by an alternation of sinuous paths (weakening of the slope) and straight lines (when the slope increases slightly). Thus, on certain sectors, the Libron describes meanders, sometimes inscribed, sometimes free, sometimes even intersected. These intersections favor an increase of the slope, which induces a more rectilinear layout. Old terraces line the main bed and show the past activity of the watercourse. These formations tend to evolve downstream, whether registered or free, as illustrated in the figure below.



※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）50 頁より作成。

Evolutionary dynamics of a free meander
(Source: Landform shapes, DERRUAUX, 1996)

At Puimisson's right, the different meander phases are clearly observable



1: Before crossover = overflow point and discharge arm that tend to short the meander. Erosion begins to increase inside the meander. In the long run the Libron will borrow what is today a preferential axis. Note that here the meander has already been intersected. It passed the limit of the current major bed, the former flow channel of Libron being today a discharge arm.

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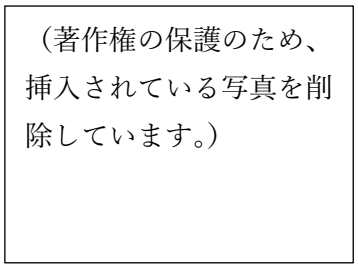
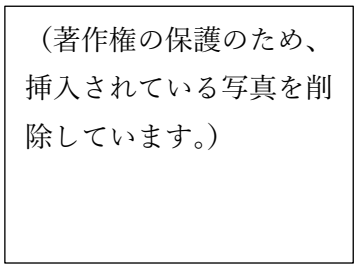


2: Meandering cut = the action of the man accelerated things in this place by the recalibration of the new bed and the reduction of the old bed (embankment). But the Libron would naturally cross this meander. The plots in the lobe are very vulnerable, judging by the number and size of pebbles on the ground.



3: The old channel is in the form of a cut meander called Ox-Bow (a form of beef collar). It is reactivated during extreme events.

Hydrodynamics is very strong throughout the section. The presence of overflow points, outburst arms, bank erosion ... testify to intense hydrodynamic activity in extreme

conditions. The average bed is very clear, well demarcated from the major bed by slopes several meters high (or even decametric in places). The dynamics of the Libron is very intense on this section.

In addition to the erosive dynamics, several accumulation zones are identifiable. Landings are formed where the slope decreases. These banks, if they are difficult to mobilize, can have consequences on the flows: modification of the layout of the minor bed, facilitated overflows, increased risks in case of stakes ...

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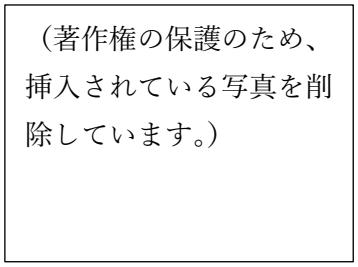

Bank erosion, landing formation and diversion of the Libron bed

The stakes are few on this stretch. In the municipality of Magalas, at the Villa Sainte-Paule right, two houses on the left bank are located at the edge of the middle bed and are thus vulnerable. Several other recent constructions are at the edge of a flood zone, located astride an old Libron terrace and its current alluvial plain.

The Magalas wastewater treatment plant is also vulnerable, located in a confluence zone where hydrodynamism is extreme during floods. The lagoon basin is also located in a flood zone but it was built on embankment.

Finally some drilling along the section is threatened, either directly by the overflows of the Libron, or indirectly by bank erosion and jeopardizing the works. Shore comforting was also necessary to limit the damage.

Upon arrival at Lieuran-les-Béziers, the Libron is less winding. A large expansion zone allows the water to be stored during extreme floods, and then the stream cuts 500 m upstream of the village, indicating a specific increase in the slope.

1.2.6. SECTION 6: FROM LIEURAN-LES-BÉZIERS TO BOUJAN-SUR-LIBRON (7.7

KM)

On this stretch the slopes are becoming weaker. The Libron then roams on an alluvial floor growing wider, reaching more than 400 m in places, and describes light meanders free. Upstream of Boujan-sur-Libron, it turns abruptly towards the East thanks to a more binding geological change.

Hydrodynamics remains very strong during floods. A minor / medium bed is delimited by high slopes all along the linear.

On this section the stakes are relatively numerous. Much of the village of Lieuranles-Béziers is very vulnerable, both by the overflows of the Libron and by the contributions of a tributary left bank Creek Riels. At this point, the alluvial plain widens abruptly but remains unclear, because of its interlocking in the formation of colluvium. Many homes as well as businesses and public buildings (town hall, local municipal, ...) are installed in flood zone on the left bank. At the village square, most dwellings have cofferdams more than 50 cm high, indicating frequent floods.

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On the right bank of the recent constructions, installed on embankments, as well as older buildings are also present in bed major. The crossing of the Libron is a bridge with several large arches, unlike the vast majority of works previously encountered which were submersibles or rafts. The importance of this one lets imagine the heights of water that can be reached at Lieuran-les-Béziers.

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Lieuran-les-Béziers Bridge and stakes located on the left bank

At the exit of the village, towards the road RD15, several buildings are also vulnerable. Some of them are flooded by a small tributary left bank channeled, whose flows are strongly disturbed by the presence of a transverse SNCF embankment. The football stadium and the tennis courts are present upstream of the same infrastructure embankment, at the

confluence with the small tributary which is again blocked by the embankment of the RD15.

The anthropogenic elements disturbing the flow begin to be very numerous within an alluvial plain more and more wide and flat. It is also a big break with the previous sectors upstream, and we will find this type of disruptive development until the outlet of the Libron.

At the exit of this urban area, an equestrian center and two properties are vulnerable. Two purification stations are too; one of them is located at the confluence between the Libron and the Vinassac, while the other seems less vulnerable, in limit of major bed.

The overflows can extend up to the area of the Castle of Ribaute, without affecting the buildings, built on the edge of the flood zone.

At the Arnoye domain, the physical context limits the overflows, which are then reported on the right bank. Only the lowest buildings in this area are vulnerable.

At the entrance to Boujan-sur-Libron, on the left bank, corporate buildings and dwellings have recently been built at the foot of a steep slope, to which the overflows of the Libron extend. To the right of this sector is the cooperative cellar, which is also vulnerable. The risk is increased in this sector by the presence of a huge transverse embankment, formerly built for crossing the Libron. Today the infrastructure is no longer used and buildings come to occupy the unsinkable space. The impact of this development is far from negligible. The section is greatly reduced and the overflows are larger upstream, making buildings recently installed on the right bank even more vulnerable.

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Globally, few issues are identified in Boujan-sur-Libron, the urban extension being mainly realized on the other side of the village. Nevertheless some sports facilities (stadium, tennis courts, sports facilities ...) have settled in the alluvial plain and new buildings are beginning to build (example: the cultural and sports center of the town hall under construction).

It is at the end of this section that the Libron begins to be dammed; the overflows are then limited by very high artificial slopes and its route is then completely anthropised. The risk remains nevertheless very present, in particular during break of dike.

1.2.7. SECTION No. 7: FROM BOUJAN-SUR-LIBRON TO VIAS (13.9 KM)

One of the characteristics of this section is the progressive widening of the alluvial plain of Libron, which reaches in places impressive proportions; overflows can indeed extend over a kilometer or even nearly 3 kilometers at Saint-Privat.

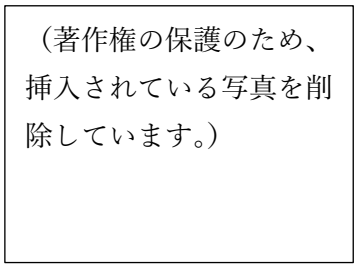
From the RN9 road, the Libron receives inputs from the Ardaillou stream and the Baume stream, two very important tributaries on the left bank that drain a significant area of the watershed and participate in the expansion of the Libron.

About 6 kilometers from its mouth, the Libron changes direction again. It then heads south to the sea, blocked in the east by reliefs where settled the Castle of the Gardie and the city of Vias. These formations, of volcanic nature and therefore little alterable, leave no other alternative to the Libron; the only outlet to reach the sea is then between Vias and Madeilhan (eastern end of the formation of Terres Nègres). These basaltic formations also form a tightening of the valley, which limits the overflows at this level but also is one of the causes of the extent of overflows upstream of this sector (dam effect).

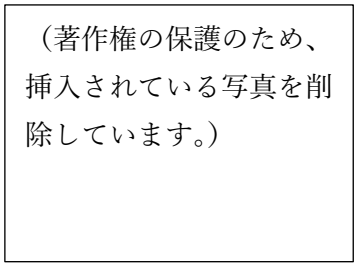
The extremely low slopes on this section explain the extent of flooding in this downstream sector, combined with an alluvial floor which is also very flat and has a very large drained catchment area. Many anthropogenic works are intended to contain the vagaries of the Libron (lateral and transversal dikes, embankments, channelization of major rivers, etc.). Nevertheless, traces of current or past floods are still visible. Many relief arms (left photo below), major bed depressions, erosion of banks or dykes ... show an increased flood intensity.

Many overflow points are present, mainly located on the right bank and identifiable by a weakening of the dike of Libron. Testimonies report that during breaks in this dike to the right of these overflow points, there may be a wave that takes the land and layer the vines or tears the fruit trees (photo right below). Overflows can also occur where the dyke is naturally cut, at confluences with some small streams (Montimas, Les Redonnières...) that do not allow a continuity of its lateral dike. These areas may be the weak spots where overflows will occur during extreme events.

55 頁



Secondary flow shaft and auxiliary discharge arm



Orchard affected by a dike break (trees washed away)

The alluvial plain is very important in this downstream section, but the stakes are very limited. They are mostly represented by crops: vines, orchards, cornfields or sunflowers ... Some buildings are vulnerable; the lower part of the domain of Saint-Jeandu- Libron, the domain of Saint-Bauzille, Saint-Privat, La Jourdane, and the buildings at the place called Médeilhan. Some of them are nevertheless elevated, or protected by a dike.

1.2.8. SECTION 8: FROM VIAS TO THE MEDITERRANEAN (1.8 KM)

This downstream section corresponds to the Libron outlet. Its alluvial plain is then confused with that of Hérault and Orb, making this part of the territory very vulnerable. The sector being very flat, and the mechanical actions of the sea being felt, the "major bed" extends on a broad band about 2 kilometers since the littoral. Water levels can be important locally.

The Libron is still dammed up to its outlet. This arrangement makes it possible to concentrate the flows and to evacuate the rainwater more quickly towards the sea. Before the construction of these lateral dams and the creation of an artificial outlet, the Libron was blocked by an important dune cord; the waters were then stored behind this natural barrier, forming lagoons, and then heading west to the old outlet east of Portiragnes Plage. The waters were evacuated to the sea by what is now called the old Grau du Libron, now a large hydromorphic area.

The Midi Canal and its embankment strongly disrupt the flow. A consequent structure, made up of several locks, allows the Libron to cross the structure without damaging it (photo below), and limits the sediment input upstream of the structure. The stakes are very numerous in this plain. downstream, mainly related to tourism activity.

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（著作権の保護のため、挿入されている写真を削除しています。）

Work for the crossing of the Midi Canal

1.2.9. MAIN TRIBUTARY OF THE LIBRON ON BOUJAN-SUR-LIBRON: THE CREEK OF ARDAILLOU

The Ardaillou stream has its source in the village of Bassan and flows south to open on the left bank of the Libron. The slopes are generally weak and the valley remains open on all the linear. The Ardaillou is in the form of a very deep bed (soft formations) and its alluvial plain is structured quickly, fed by many tributaries. Its major bed is relatively large mid-term, the overflows may spread over the entire alluvial floor. Hydrodynamism is particularly marked in the downstream section, downstream of the RN9 road. The plain is very clear in this sector, bounded by steep slopes on the left bank and by very incised colluvium (embankment more than 3 m high) on the right bank.

1.3. HISTORICAL ANALYSIS ON BOUJAN-SUR-LIBRON

In addition to the information collected from the commune, the analysis of various historical documents and hydraulic studies attest to the historical floods of Libron occurring in 1907, 1956, 1964, 1996, known as the most important of memory of man and 1999. In addition to these historical floods, that of November 2014, although not the subject of recognition of the state of natural disaster in the town of Boujan-sur-Libron.

In general, in case of flood, the Libron regularly overflows in the vineyards. During the flood of 1907, the water rose to the village houses on the right bank of the Libron. A house, located behind the stadiums, had between 50 and 60 cm of water (cellar on the ground floor).

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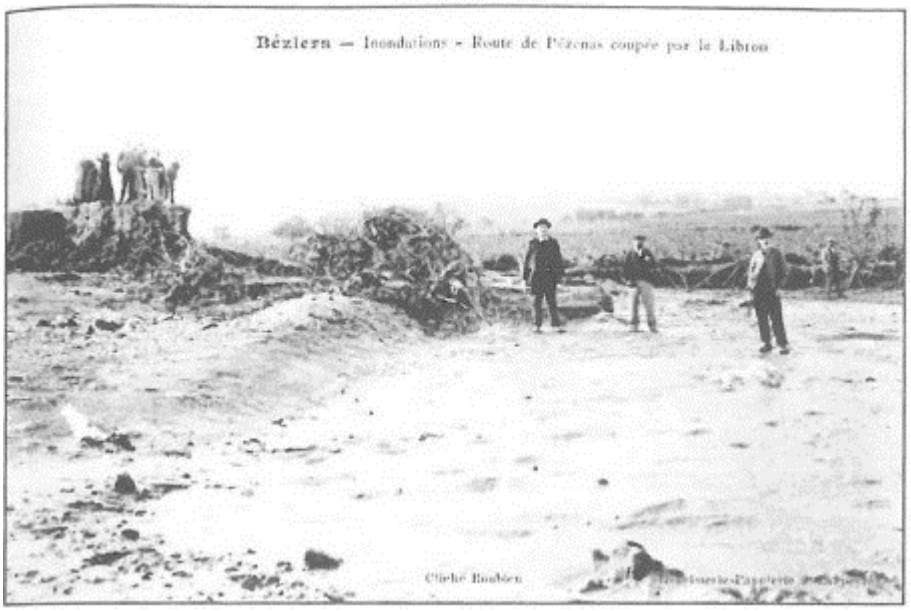
"[...] The floods are sudden and easily reach 6 meters and even 8 meters above the bed of the torrent. We will quote in modern times that of 1856, which caused 60,000 francs of damage to Lieuran. More recently, in 1907, the Libron caused 80,000 francs of damage to Laurens and 60,000 to Boujan. On that date he took the metal bridge of the Béziers railway at Méze, which was 31 meters long, however.

All the roads of the properties downstream of Boujan were covered, and some of them resisted the flooding. The castle of Saint-Jean-de-Libron was surrounded by water, although 600 meters separate the constructions of the river. The whole plain of Jourdanne and Vias was flooded. In October 1913, a new flood carried the national road from Béziers to Pézenas in two different points. One of the levees that channels the Libron around the Jourdanne was covered by water and half carried away. Our wadi creates an artificial bed in the vineyards of the Count of Cassagne. The last houses of Vias were invaded by the waters. [...] >> Geography Bulletin of Languedoc-Le Libron - J. COULOUMA Doctor of Pharmacy, Bachelor of Science, 1929



It is a landscape of desolation that stands at the Domaine de Libouriac: the vines are destroyed and the mutes cut

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）57 頁より作成。

Extract from the collection "The floods of 1907 in the Hérault" (Source: IPSEAU 2010 study)

Béziers, 26 septembre.

Au départ de Béziers, le terrain est presque sec, il a plu très peu aux environs de notre ville, mais à Boujan le Libron a débordé ; les plaines de Libouyrac et de Boujan sont submergées ; un limon épais recouvre les vignes, tout est presque perdu ; le plus éprouvé est notre ami M. Castelbon de Beauxhostes, notre sympathique Mécène.

La population est sur le talus qui longe la voie du chemin de fer ; bien des propriétaires se lamentent ; c'est une nouvelle ruine pour nos vaillants agriculteurs.

Sur la route, une charrette attelée de trois chevaux a été emportée par le torrent ; le conducteur a pu se sauver sur un arbre, les trois chevaux sont morts.

A BOUJAN

Boujan, 8 novembre.

Dans la nuit de mercredi à jeudi, un orage d'une violence inouïe s'est déchaîné sur notre localité, transformant rapidement nos rues en de véritables torrents et inondant, dans les bas quartiers du village, une partie des habitations.

Par suite de cette pluie torrentielle, les moindres ruisseaux ont grossi et débordé.

Le Libron est sorti de son lit et déverse ses eaux limoneuses dans les terres riveraines. La plaine n'est plus qu'un immense lac ; les souches sont entièrement recouvertes par la nappe liquide.

Le pont du chemin de fer de l'Intérêt local, construit sur le Libron, a été démoli par les eaux. Les trains ne circulent pas. On nous signale également que, sur une distance de 80 kilomètres environ, la route de Pézénas a été coupée par les eaux.

Ce matin la pluie continue à tomber, le tonnerre reprend ses terribles roulements et le temps reste menaçant.

La route de Pézénas ravagée

Le Libron a ravagé la route de Pézénas, près du domaine de Libouriac, sur une longueur de 80 mètres, le chemin a été creusé à une grande profondeur, avec d'énormes excavations.

Le pont a été emporté et le Libron s'est créé un nouveau lit.

A BOUJAN

Boujan, 11 novembre.

Samedi dernier, vers 6 h. du soir, le Libron est encore sorti de son lit pour la ...ième fois, occasionnant de nouveaux dégâts. On se demande avec anxiété quand finira cette période de mauvais temps.

Nous devons une rectification à notre article de samedi dernier. C'est sur un parcours de 80 mètres environ, et non de «80 kilomètres», comme il a été dit par erreur, que la route de Pézénas a été coupée près du domaine de Libouriac, par la trombe d'eau tombée dans la nuit du 6 au 7 novembre.

Nos lecteurs avaient déjà rectifié d'eux-mêmes.

The Little Southern - September 27, 1907

"Béziers, September 26, 1907

At the start of Béziers, the ground is almost dry, it has more little around our city, but in Boujan the Libron overflowed, the plains of Libouriac and Boujan are submerged, a thick mud covers the vines, everything is almost lost, the most experienced is our friend M. Castelbon de Beauxhostes, our friendly Maecenas. The population is on the embankment along the railroad track, many owners lament, it is a new ruin for our valiant farmers. On the road, a cart harnessed with three horses was swept away by the torrent, the driver was able to save himself on a tree, the three horses died. >>

The Flash – November 9, 1907

<< A BOUJAN

Boujan, November 8, 1907

On the night of Wednesday to Thursday, a storm of unheard-of violence unleashed on our locality, quickly transforming our streets into real torrents and flooding, in the low quarters of the village, a part of the houses.

As a result of this torrential rain, the smallest streams have swollen and overflowed.

The Libron is out of bed and pours silty waters into the riparian lands. The plain is no more than an immense lake, the stumps are entirely covered by the liquid layer.

The railway bridge of the Local Interest, built on the Libron, was demolished by the waters. Trains do not circulate. We are also told that, for a distance of about 80 kilometers, the road to Pézenas has been cut off by the waters. This morning, the rain continues to fall, the thunder resumes its terrible bearings and the weather remains threatening. >>

<<The road to Pezenas ravaged

The Libron ravaged the road to Pézenas, near the Domaine of Libouriac, over a length of 80 meters, the path was dug to a great depth, with huge excavations. The bridge was taken away and the Libron has created a new >>

The Lightning - November 12, 1907

<<A BOLJAN

Boujan, November 11th.

Last Saturday, around 6. from the night, the Libron is still out of bed for the second time, causing further damage. It is anxiously queried when this period of bad weather ends.

We need a correction to our article last Saturday. It is on a course of about 80 meters, and not 80 kilometers, as it was said by mistake, that the road to Pezénas was cut near the area of Libouriac, by the storm of water fell on the night of November 6th or 7th. Our readers had already corrected themselves. >>

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）58 頁より作成。

Articles of the Little Southern and Lightning - September 1907

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During the floods of 1964, some damage affect the infrastructures, breaks of bridges and dikes are noted.

In Boujan-sur-Libron

Here again, we had not seen it since 1907. The water went up to the cooperative cellar.

The pillars of the old railway bridge sunk 6 meters deep left like straw fetuses. In the vineyards, the stumps were torn out by hundreds and buried in the silt. Among the most affected properties are those of MM. Gaujal and Castelbon de Beauxhostes. At the Arnoy estate, the Guilhem family had to be evacuated, the waters reaching the first floor of their home.

The Free Midi - Friday, October 2, 1964

En haut : *Le camion de déménagement aérialement couché dans la vigne.* — En bas : *La « 4 » du docteur Magnien qui fut presque entièrement recouverte par les eaux, contre l'arbre auquel les automobilistes durent leur salut.* (Photo Villemagne).

The Free Midi - Friday, October 2, 1964

In Boujan-sur-Libron

Here again, we have never seen this since 1907. The water has risen to the cooperative cellar,

The pillars of the old bridge of road sunk at 6 meters deep are gone like straw fetuses.

In the vineyards, the stumps were ripped out by hundreds and spread under the silt.

Among the most affected properties are those of MM. Gaujal and Castelbon de Beauxhostes.

At the Arnoy estate, the Guilhem family had to be evacuated, the waters reaching the first floor of their home.

TAKEN IN THE OVERFLOW OF LIBRON ROUTE OF PÉZENAS

A motorist and his family had to spend two hours on a tree and a truck driver on the roof of his cabin

le Libron qui était sorti de son lit débordait sur la route de Pézenas. survenait, se dirigeant vers Béziers, une automobile 404 Peugeot, immatriculée 663 OL 32 et un camion de déménagement de l'entreprise Laurens de Perpignan.

La voiture franchit le pont de la R. N. 113-9, mais se trouva rapidement en difficulté devant la montée soudaine des eaux en face. Elle fut plaquée, une centaine de mètres plus loin, contre un arbre situé sur sa gauche.

Le chauffeur du poids lourd,

de la dégager en la poussant à l'arrière, mais il n'y parvint pas et le bref espace de temps ainsi perdu suffit à le mettre à son tour en perdition.

Le puissant véhicule ne put faire que quelques dizaines de mètres au bout desquels il se trouva projeté latéralement sur la gauche, à l'intérieur d'une vigne inondée en contrebas de la route, et se coucha sur le côté gauche.

M. Nogueira dut monter sur l'aile supérieur du toit pour échapper à une mort certaine.

Quant à l'automobiliste, M. Jean Magnier, docteur en médecine à Domazo (Hérault), il parvint grâce à sa grande taille à sauver sa femme et ses deux enfants, un garçonnet et une fillette de 7 et 5 ans, par le seul convable de la voiture pour les perdre dans les branches de l'arbre avant de les y rejoindre.

C'est transis et à bout de forces mais sains et saufs que M. Magnien et les siens ainsi que M. Nogueira purent être arrachés à leur dramatique position, quelque deux heures plus tard, par les sapeurs-pompiers de Béziers.

Ils ont été assistés transportés au Centre hospitalier pour y être réconfortés après ces longs instants d'angoisse passés sous la pluie et dans l'obscurité la plus complète.

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）59 頁より作成。

Article of the Free Midi of 02/10/1964

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TORRENTS OF WATER ON BITERROIS

The Marseillaise - Friday, October 2, 1964

Routes coupées et ponts emportés

Un camion de 5 tonnes emporté

Un médecin de Donzère et sa famille doivent se réfugier dans un arbre

A 5 ton truck carried away

[...]

On the road Béziers - Pézenas a heavy weight was carried away in a vineyard while four motorists had to take refuge in a tree where the firemen came to clear them [...]

A doctor from Donzère-Mondragon, Dr. Jean Magnen has known tragic hours not far from Béziers. On the road Pézenas-Béziers his <<404>> was stopped near Libron-Séjour, the engine drowned.

The flooded Libron was breaking on the road. The car was dragged by the waves. Fortunately, she stopped against a tree on the edge of the low side. The flood became so large that the water reached the inside of the car, threatening to drag it into the torrent. His occupants, the doctor, his wife and two children, a boy and a girl from 5 to 7 years, were able to operate the sunroof and take refuge on the bodywork. It was then that the driver of a truck company Laurent de Perpignan, tried to help them by pushing the car with his truck. He was in turn immobilized. The water reached the roof of the car. The doctor and his family had to take refuge in the branches of the tree where the firemen came to rescue them as soon as the alert was given. [..] >>

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）60 頁より作成。

Article from the newspaper La Marseillaise, 02/10/1964

During the flood of 1996, the water reached the RD15, north of the village, on the right bank of the Libron. There was about 10 cm of water on the road. The road was cut for about 10 days. The water was spread over a width of 500 meters. On the left bank, it reaches the dump The white bridge has never been submerged. Further downstream, on the right bank, the waters of the Libron arrived in the midst of vineyards. There were ravines in farmland, vineyards and fields.

The flood of 1999 is described as more modest than that of 1996, the Libron invading only agricultural land.

The following flood markings have been identified in the municipality of Boujan-sur-Libron:

Location	Raw dates	Source	Rating (m NGF)
Mazets upstream RD15E2	30/09/1964 ? - Mazet 1	PHE DDE	42.92
	04/09/1964 ? - Mazet 2	PHE DDE	42.66
	30/09/1964 ? - Mazet 2	PHE CG Hérault	42,96
	29/01/1996 ? - Mazet 2	PHE CG Hérault	41.96
Downstream treatment plant CD15E2 (right bank)	29/01/1996	PHE CG Hérault	42.42

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）60 頁より作成。

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Also worth mentioning outside but close to the municipal area of Boujan-sur-Libron:

- A benchmark of the 1996 flood (source: testimony of M COSTA, Director of SIGAL) is located at the intersection of the RD15 and the Servian road, on the tree trunk, at a coastline of about 45, 50 m NGF. The high level is explained in particular by the study carried out by the presence of the embankment of the old railway which blocked the flows.

- Flood marks on the pumping station building of the Domaine of Libouriac (commune of Béziers).

The various decrees of natural disaster recorded on the commune since 1982, year of establishment of the CATNAT system, are presented in the table below.

Type of disaster	Beginning on	End	Stop of	On the JO of
Storm	06/11/1982	10/11/1982	18/11/1982	19/11/1982
Floods and mudslides	13/10/1986	17/10/1986	27/01/1987	14/02/1987
Floods and mudslides	13/12/1987	14/12/1987	07/04/1988	21/04/1988
Landslide and ground	28/10/1993	01/11/1993	08/03/1994	24/03/1994

collapse				
Floods and mudslides	28/10/1993	03/11/1993	08/03/1994	24/03/1994
Floods and mudslides	17/10/1994	28/10/1994	12/01/1995	31/01/1995
Floods and mudslides	28/01/1996	30/01/1996	02/02/1996	03/02/1996

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）61 頁より作成。

1.4. HYDROLOGICAL ANALYSIS

1.4.1. SYNTHESIS OF PREVIOUS DOCUMENTS OR STUDIES

1.4.1.1. HYDRAULIC STUDY OF THE LIBRON VALLEY - SOGREAH – 1968

The purpose of this study is an analysis of flood flow conditions, an estimation of the characteristic flood flows and capacities of the minor bed, and proposals for hydraulic development.

The characteristic flows were estimated by comparison with the department's watersheds (Orb, Lez, Lirou, Bérange), taking into account the rainfall intensities observed on each of them.

The period of return of the flood of 1964 is estimated at 100 years, even superior to Magalas and Lieuran.

1.4.1.2. LAURENS LIBRARY VALLEY HYDRAULIC LAYOUT DIAGRAM – RN9 - BRL AND BCEOM – 1988

The study area is the Libron watershed. The linear studied extends from Laurens to the sea, about 45 km.

The rainfall data used are the available data for the Laurens and Béziers substations. At the Béziers substation, only the decennial daily rainfall is known, the other values are determined by applying the same ratios as those of Laurens.

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Characteristic peak flows were determined using three methods: the Crupedix method, the rational method using the gradex method to estimate the centennial flow rate, and the Soil Conservation Service (SCS) method. The results obtained were compared and criticized in

order to retain the most representative hydrographs of the hydraulic functioning of the watershed.

The method chosen is the SCS method, which takes better account of the damping effects of the flood wave especially downstream of Magalas. The hydrographs obtained for the upstream sub-basin (up to Magalas) and the downstream sub-basin (up to the sea) were composed and flattened from upstream to downstream to take into account the flood peak attenuation. Time offsets have also been applied to best represent flood propagation and concomitances on the watershed.

The flood of 1964 was analyzed during this study. The previous method was applied with the characteristics of the rainy episode of September 30, 1964. The period of return of this flood is therefore of the order of 100 years in Magalas and between 50 and 100 years on the downstream basin where the rains were less strong. The flows are close to those of the Sogreah study from 1968 to Magalas, but much lower downstream. The attenuation of the peak flow seems more in line with reality, particularly given the very long shape of the watershed.

1.4.1.3. STATISTICAL TREATMENT OF THE DATA OF THE PLUVIOGRAPHIC STATION OF BÉZIERS LA COURTADE - BCEOM - 1997

The purpose of this study is the statistical treatment of rainfall data from the Béziers la Courtade substation. Between 1980 and 1994, only 8 years of observations are complete.

Despite the small size of the exploitable samples, statistical adjustments of this station were calculated and compared with those of the Montpellier Bel Air stations (in service from 1920 to 1971) and Montpellier Fréjorgues (in service since 1957) on different time steps (30 minutes to 48 hours) and return periods.

The conclusions of the analysis of Béziers la Courtade are as follows:

- the observation period of the post is too low to draw specific conclusions about the rainfall in the Béziers region,
- the distortion within the sample makes adjustment by usual statistical laws difficult for periods of less than 12 hours,
- in conclusion, the quantiles calculated on this station do not allow to revise upwards the quantiles usually taken into account (quantiles of Montpellier Bel Air) in the hydrological calculations on the Béziers region.

1.4.1.4. HYDRAULIC STUDY OF THE A75 MOTORWAY - PÉZENAS / BÉZIERS SECTION - HYDRATEC - 2004

The purpose of this study is to design hydraulic structures for crossing the seven watercourses crossed by the future A75 between the Pezenas exit and the Béziers entrance, including the Libron and Ardaillou. Since none of the streams are equipped with a flow measurement station, flow estimates are made using empirical formulas.

The rainfall data used are those of the Montpellier-Fréjorgues substation for small time steps, corrected by the ratio of daily rainfall on the Pézenas, Servian and Gabian substations (+25%).

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The concentration times selected are the average of the results of the empirical formulas. The runoff coefficients are 0.6 for the decadal flood and 0.8 for the centennial flood.

The centennial flow is calculated by the rational method and the gradex method. The proposed flow is 460 m^3 / s. This value is greater than the value of the 1988 BRL study, but it is retained on the one hand to be placed in the high value of the gradex method range, in a safer way, on the other hand because it is consistent with the flows obtained on neighboring watersheds, notably the Thongue, whose values are close to those of the Sogreah study.

1.4.1.5. FLOODING ZONES OF THE LIBRON IN THE CROSSING OF BOUJAN-SUR-LIBRON - HYDRAULIC STUDY - AQUA CONSEIL / ENTECH - APRIL 2010

This study, conducted by the municipality of Boujan-sur-Libron, aims to determine the flow conditions and flood areas of the Libron to the right of Boujan-sur-Libron.

It is based on a hydrological study to determine the volumes and flows of the 100-year flood (rainfall-flow modeling) and on hydraulic modeling of the Libron valley at the right of the study area.

Topographic surveys were conducted as part of this study (cross-sections) in addition to those conducted as part of the PPRi study. The modeling of this sector was carried out using HEC-RAS software. The centennial flow of the Libron to the right of Boujan-sur-Libron is estimated at 473 m^3 / s.

1.4.1.6. SUMMARIES OF RESULTS OF PREVIOUS STUDIES

Watershed	Study name		Q10 (m^3/s)	method	Q100 (m^3/s)	method	Flood 1962
Libron	Aqua Conseil / ENTECH 2010	Boujan	216	SCS	473	SCS	
	HYDRATEC 2004	Downstream of Boujan	177.8	rational	373	rational	
			215.2	crupedix	468	gradex	
			94.6	SOCOSE	460	gradex	
	BRL 1988	Boujan			394	SCS	335
	Sogreah 1968	highway			295	SCS	280
			230		460		

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）63 頁より作成。

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1.4.2. EXISTING PLUVIOMETRIC AND HYDROMETRIC DATA

Several rain stations are located in or near the Libron catchment area and provide daily rainfall values. Statistical adjustments give daily rainfall values for characteristic return periods of 5, 10, 50 and 100 years:

Pluvio	Source	Years of measurement	P5	P10	P50	P100
Béziers	Météo France (GEV law) 2010	1970-2008	109.6	136.4	203.2	235
St Genies	Météo France (GEV law) 2010	1955-2001	106.3	127.2	175.3	196.5
Murviel	Météo France (GEV law) 2010	1990-2008	106.9	120.7	142.4	148.8
Bédarieux	MF synthesis (renewal law) 1999	1961-1998	130	150	197	216
Cazouls	MF synthesis (renewal law) 1999	1961-1981	133	158	215	239
Servian	MF synthesis (renewal law) 1999	1961-1998	108	127	168	186
Gabian	POS Lieuran (Gumbel) 2001 study	> 25 years old 1948		144		221

Pézènes	POS Lieuran (Gumbel) 2001 study	> 25 years old 1966		164		204

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）64 頁より作成。

Characteristic daily rainfall values for each sub watershed concerned by the modeling were calculated by performing a weighted average of the values of the nearby rainfall gauges, according to the distances and altitudes of the stations.

These stations do not provide data for durations of less than 24 hours. Since the concentration times of the watersheds studied are well below 24 h, we used rainfall data from the Montpellier Fréjorgues station to calculate the Montana coefficients over the required time steps. For each watershed studied, these coefficients were weighted by the ratio between the daily rainfall of the watershed concerned and that of Montpellier, in order to obtain values representative of the sector considered.

Montana formula: h = a * t 1-b, with:

h = height corresponding to the time step considered, in mm

t = no time in minutes

Rain duration from 6 minutes to 1 hour			Rain duration from 1 h to 6 h			Rain period from 6 am to 24 pm		
Duration of return	a	b	Duration of return	a	b	Duration of return	a	b
10 years	4.913	0.4	10 years	16.502	0.691	10 years	22.011	0.748
100 years	7.043	0.385	100 years	26.823	0.702	100 years	34.2	0.754

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）64 頁より作成。

Coefficients of Montana calculated at Montpellier Fréjorgues station

No hydrometric station is present in the Libron catchment area. It is therefore not possible to directly calculate reference flows by statistical analysis of hydrometric data. Only the Magalas station (St Paul) was commissioned between 1970 and 1973. Unfortunately, the results are unreliable (questionable validated flows) and the series remains too small to perform a statistical analysis.

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Empirical formulas were used to determine return flow rates Q5 (5 years), Q10 (10 years), Q50 (50 years), and Q100 (100 years) at each confluence point. For the sake of consistency, the methodology used here will be similar to that of the hydrological studies carried out under other PPRI in the department (Lirou watershed, Thau lagoon watershed, etc.)

（著作権の保護のため、挿入されている写真を削除しています。）

Location of the subwatershed studied on Boujan-sur-Libron

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1.4.3. HYDROLOGY OF WATERSHEDS UP TO 10 KM 2

1.4.3.1. METHODOLOGY RETAINED

The 5 and 10 year return period rates were calculated using the Crupedix method and the 50 and 100 year return period rates using the gradex method.

The gradex method is based on the assumption that for high return period rainfall, the basin is saturated with water and any supplemental rainfall causes an equal flow supplement. This method requires the determination of a pivot point, which corresponds to the return period in years of the value of the precipitation from which the flow deficit no longer increases. The pivot point will be taken equal to 10 years.

Decadal flow is calculated using the Crupedix method. From this pivot point, the gradex method is applied. The gradex, a gradient of the extreme values of the rainfall heights, is taken for a duration equal to the base time, the duration corresponding to the average time of the direct runoff hydrographs. Since this base time is not known for the small watersheds studied (no hydrometric measurements), we will evaluate it with the Socose formula.

Name BV	Area (km^2)	Slope (m/m)	Q10 (m3/s)	Q50 (m3/s)	Q100 (m3/s)	Specific Q100 (m3 / s / km^2)	Exceptional (m3 / s)	Q previous studies (m3 / s)
Libron	93.9	0.018	162	401.6	502.9	5.4	905.2	473/460/394

to Boujan								

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）66 頁より作成。

1.4.3.2. VALIDATION OF RESULTS

The specific flows obtained were related to the flows calculated in the neighboring catchment areas (Lirou, Haute Vallée de l'Hérault), for equivalent catchment areas and similar landforms.

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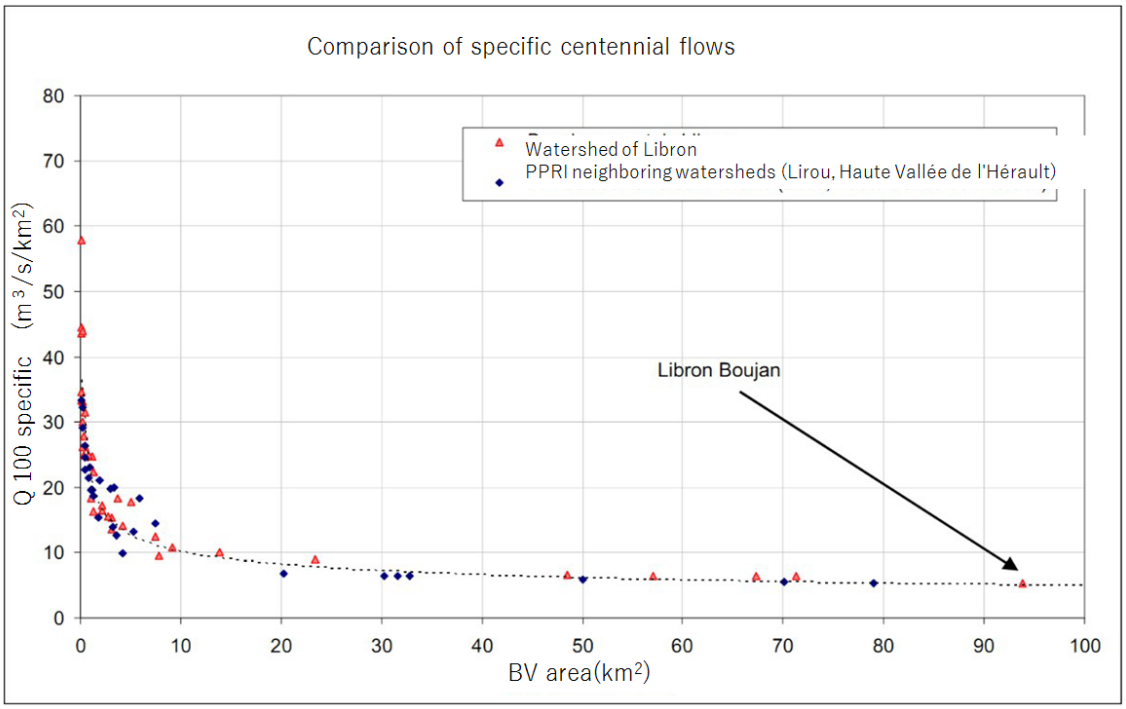

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）67 頁より作成。

Specific centennial flows for catchments> 10km²

1.4.4. CENTENNIAL DEBIT OF THE LIBRON TAKEN INTO ACCOUNT IN PPR I

As part of the hydraulic study "Floodplains of Libron in the crossing of Boujan on Libron, hydraulic study, April 2010, Aqua Council / ENTECH", a topographic survey and a hydraulic modeling were carried out on this sector for the centennial flood , using the HEC RAS model.

The centennial flow taken into account is 473 m^3 / s, which is significantly higher than that of the 1988 BRL study (Q100 = 394 m^3 / s, Q1964 = 325 m^3 / s), but close to the centennial flow rate of the study. Hydratec 2004 downstream from Boujan (Q100 = 460 m^3 / s) and consistent with the specific flows of neighboring watersheds.

This value is therefore consistent as a centennial rate. However, the water levels obtained in the Aqua Conseil / ENTECH study prove to be significantly lower than the existing PHEs in the municipality, particularly at the RD15E Bridge. The flood zone could therefore be underestimated compared to the levels reached in 1964 and 1996.

Thus, for the sake of consistency with the rest of the watershed and due to the inaccuracies of the historical flood lanes identified, the calculated centennial flow being greater than the flow of the historical floods, the PPRi in the municipality of Boujan-sur-Libron was carried out by modeling the 100-year flood. The peak discharge of the 100-year hydrograph retained under the PPRi is 502.9 m^3 / s.

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1.5. HYDRAULIC MODELING ACHIEVED UNDER PPRI

1.5.1. MODEL USED

The model used in this study is Infoworks RS. It is a mathematical simulation software that reproduces and analyzes the functioning of rivers, canals, rivers, floodplains and estuaries.

Infoworks RS is used to model flow and water levels in a river, over a long period of time or at a small time scale. It was developed by Wallingford Software.

1.5.2. SETTING MODELS

In the absence of a hydrometric station on rivers, historical flood data cannot be used to calibrate hydraulic models. Calibration of the models was therefore carried out thanks to the field expertise which made it possible to estimate the roughness coefficients.

The roughness coefficients retained on the Libron are generally 15 in a minor bed and comprised between 10 and 15 in a major bed consisting essentially of vine-type field / culture.

1.5.3. MODELING FLOWS

Modeling of the reference flood (100-year flood with a 100% Q100 flow rate of 502.9 m3 /

s) and field expertise enabled mapping of the flood zones for the reference flood. It allows the drawing of iso-heights and iso-velocities for this same flood with as a result the cartography of the hazard.

The calculated odds are infrequently lower than those recorded for the historical floods of 1964 and 1996. The EGIS WATER study carried out in the framework of the PPRI explains it by accidents and ice jams which occurred during these floods, which raised the water levels locally(pillars of the old railway bridge carried, breakages of embankments, ice jams). These phenomena are not quantifiable and therefore not taken into account in modeling.

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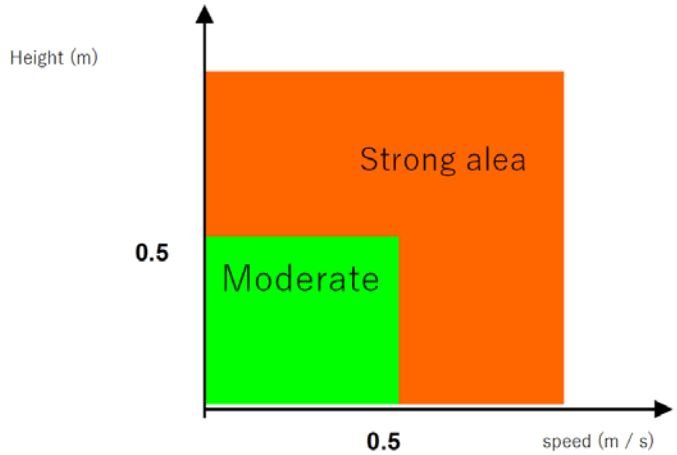
2. Map Results

The mapping of the hazard is carried out differently depending on whether one is on a modeled area (implementation of a model), or on a sector where the flood zone has been determined by the hydrogeomorphological approach supplemented by modelizations hydraulics to the right of the stakes strong.

2.1. MODELED SECTORS

The mapping of the hazard on the modeled sectors is based on the following hazard grid, resulting from the regional Languedoc-Roussillon doctrine of PPRI development.



※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）69 頁より作成。

On the modeled sectors, one thus sees appearing in the envelope of the centennial flood zones in moderate hazard and areas in strong hazard.

Beyond the envelope of the centennial flood but in the maximum extent of the flood defined by the hydrogeomorphological approach, the zone is in residual hazard.

2.2. NON-MODELED SECTORS

For the Libron catchment area, hydraulic modeling has been carried out in the areas of strong stakes. These vulnerable zones have in the past, often as a result of major floods, experienced changes in the bed (rectifications or recalibrations of the minor bed change the flow conditions) to limit the risks resulting in the presence of a residual hazard sometimes therefore.

The residual hazard is by definition the hazard that is greater than the reference hazard.

In addition, when the reference flood is a 100-year recurrence flood, based on a statistical analysis, there may be no consistency with the so-called rare flood determined by the hydrogeomorphological method. This method does not allow to precisely distinguish the recurrence of different ranges of floods. It only indicates different levels of hazards by focusing on the dynamics of flood flows.

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Conditions Explaining the Presence of a Residual

Hazard Several problem areas have been the subject of hydraulic modeling. The modeling was carried out for flow rates determined from rainfall data. These data made it possible to model the response of the watercourse to these rains and, coupled with topographic data, to carry out a zoning of the hazard. The modeled flows are then generally lower than the hydrogeomorphological flows. When accurate information on the water depths reached during historical floods were available (flood markings) the models were calibrated on these references.

Despite all the hydrogeomorphological envelope is in many sectors superior to these calculated hazards. This exceptional hazard corresponds to the maximum morphogenic flood, which has occurred several times during the last tens of thousands of years (contemporary period at the scale of the watercourse). This difference can be explained by various factors:

- human interventions on the conditions of water flows: acceleration of the flow rates by concreteization of the bed which limit the heights of water,
- surface embankments rendering some areas unsinkable,

- retention ponds to store runoff water,
- dams or thresholds having a significant impact on the flows and their dynamics,
- a tributary of a problem area that is part of the study area but has not been modeled.

On the other hand, some small tributaries have a valley with a flat bottom or on the contrary a very steep valley with steep slopes (torrential facies of the upstream parts). During heavy rainfall, the creek overflows over the entire functional alluvial plain. In fact, the hazard in these sectors will be considered strong.

3. Regulation

3.1. CONSTRUCTION OF THE REGULATORY CARD

3.1.1. HAZARDS

According to the methodology described in the first part of this report and explained above, the mapping distinguishes the high hazard sectors, the moderate hazard sectors, the residual hazard sectors and the non-hazard sectors.

3.1.2. CHALLENGES

According to the methodology described in the first part of this report, the issues taken into account in the municipality are of two types:

- areas with little or no urbanization,
- Urbanized areas defined on the basis of the existing physical reality.

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In the town of Boujan-sur-Libron, several issues were identified near the Libron, during meetings with the commune and the recognition of land. From upstream to downstream:

- the cooperative cellar, located on the right bank, behind the D15 road,
- the urban zone, made up of private dwellings, on the right bank, accessible by the Old Station road,
- sports facilities: Domenech sports stadium, bowling alley, tennis court, arena, located on the right bank of the Libron,
- a picnic area, on the left bank,
- a detached house, on the left bank,
- The dump, on the left bank,
- The treatment plant on the left bank.

（著作権の保護のため、挿入されている写真を削除しています。）

Vines on the right bank of the Libron, downstream of the RD15E2

（著作権の保護のため、挿入されている写真を削除しています。）

Bridge RD15E2 and picnic area on the left bank

3.1.3. REGULATORY ZONING

Regulatory zoning is one of the vectors of risk prevention policy, which must guide urban development outside risky sectors and reduce the vulnerability of existing or future buildings.

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The zoning must aim in particular to:

- prohibit or limit very strictly construction in hazardous areas,
- in urban areas, do not aggravate the stakes in areas of high risk.

By crossing the level of hazard and the nature of the issues, one obtains an estimate of the risk and the determination of zones of constraint useful to define the regulatory zoning.

3.1.3.1. CROSSING GRID OF THE FATE AND ISSUES

Alea	issues	Strong (urban areas)	Moderate (natural areas)
Strong	Flood by the reference flood.	Red Ru danger zone	Red Rn danger zone
Moderate	Flood by the reference flood.	Buoyant Blue Precaution Zone	Precautionary area Red Rp
Residual	Hydrogeomorphological limit	Precautionary zone	

	of the flood zone.	Z1
No	Beyond the hydrogeomorphological limit of the flood zone.	Precautionary zone Z2

※（COMMUNE DE BOUJAN-SUR-LIBRON, Préfecture de l'Hérault 2011）72 頁より作成。

3.1.3.2. SCOPE

As a preamble, it should be noted that the purpose of this paragraph is to synthetically explain the principles that governed the drafting of the Boujan-Sur-Libron PPRI Regulation, to which the reader is invited to refer in order to know in an exhaustive manner the rules applicable to each zone.

The urban planning rules applicable to new projects and to existing building modifications are mandatory and apply imperatively to new projects, to any use or occupation of the ground, as well as to the management of existing properties.

For each of the red, blue, gray and white areas, a body of rules has been established.

The regulation consists of several chapters relating to the different zones.

These chapters have two parts:

- ARE PROHIBITED that indicates prohibited activities and occupations,
- ARE ALLOWED to specify under which conditions activities and occupations may be permitted.

In each of these chapters, the rules are intended to meet the main objectives, which motivated the drafting of these requirements:

- safeguarding the inhabitants
- protection of existing goods

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Thus, according to the intensity of the hazards and the situation with regard to the stakes, 6 regulatory zones are distinguished. The prevention principles used are as follows:

➢ **Zone Rn, flood zone of high hazard in sector with moderate stake (non-urbanized sector):**

Due to the danger, it is important not to introduce new issues (population, activities, ...). The general principle associated in the regulation is the prohibition of any new construction.

➢ **The Ru zone, a flood zone of high hazard in a sector with high stakes (urbanized sector):**
Due to the danger, it is important not to introduce new issues (population, activities, ...) by allowing a minimal evolution of the existing building to promote continuity of life and urban renewal.
The general principle associated in the regulation is the prohibition of any new construction.

➢ **The Rp zone, flood zone of moderate hazard and moderate stakes (non-urbanized sectors):**
This flood expansion zone should be preserved and any project that could aggravate or cause new projects should be prohibited. The general principle associated with the regulation is the prohibition of all new construction, but with provisions to ensure the maintenance and moderate development of agricultural development or construction.

➢ **The Bu zone, moderate hazard flood zone in high-stakes sector (urban sectors):**
In view of the existing urbanization, urban development that takes risk exposure into account should be allowed through the implementation of constructive arrangements. The general principle associated with the regulation is the possibility of carrying out new developments and projects, excluding institutions of a strategic or vulnerable nature, under certain requirements and conditions, including floor level.

➢ **Zone Z1, zone not subject to the reference flood but potentially flooded by an exceptional flood:**
It is necessary to allow an urban development taking into account the exposure to risks, generated by a flood higher than the reference flood, through the implementation of constructive provisions.
The general principle associated in the by-law is the possibility of making new developments and projects, with the exception of buildings of a strategic or vulnerable character, under certain prescriptions and conditions of floor level (minimum 50 cm above the natural terrain) , and subject to compensate for the waterproofing of soils so as not to aggravate the risk downstream.

➢ **Zone Z2, zone not subject to either the reference flood or an exceptional flood:**

All new works and projects are authorized subject to compensating for the waterproofing of soils so as not to aggravate the risk downstream.

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4. Bibliography

- Guide for the elaboration of PPR in Languedoc-Roussillon - June 2003
- Study defining the floodplain areas of the Libron catchment area - Boujan-Sur-Libron Commune - EGIS Water - December 2012

5. Useful links

Website of the state services in the Hérault: http://www.herault.gouv.fr/

Website of the DREAL: http: //www.languedoc-roussillon.developpement-durable.gouv.fr/