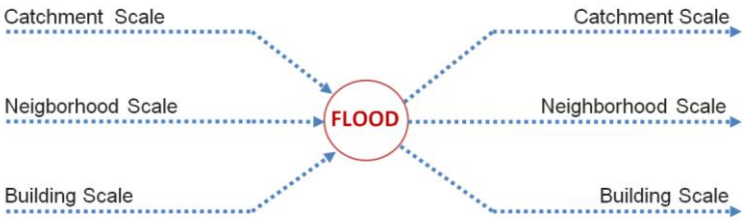
OUTCOMES

- In the urban plan but it is not clearly integrated in the urban form features related to parks, squares, parking, etc; dealing with flood risk. Mainly, this is actually one of the weaknesses that we found in *Le Havre.*

- Nowadays we can see as projects at catchment scale which has been adopted and implemented (Flood retarding basins) mainly in surrounding areas, and at the same time, projects at neighborhood (Waterways, dew pond, etc) and building scale (Temporary methods to protect as well as adaptation of waterproof materials at home)[51] which has been adapted but are still not implemented entirely.

- Taking previous into consideration in a way is necessary to create links among those three scales that are related directly with flood mitigation (See figure 17)

18A). Lineal way



18B). Comprehensive way

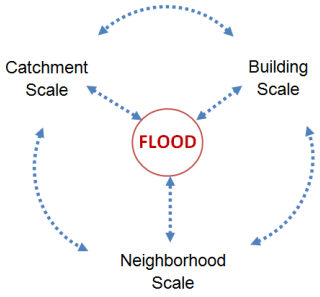


Fig. 18 Mitigation Measures Processes (Designed by the author).

Concerns flood mitigation measures there is not a clear links between different scales currently, It can be considered, due to each scale face flood risk in a lineal way (fig 17A); but what will happen if all of them facing flood risk in a comprehensive way?(fig 17B)

[51] See Figure 15

Hypothesis

Furthermore most of the authors included in the literature review have been focusing since few decades ago on the population growth issue which takes a relevant worldwide position on the political agenda. In this context, concepts such as renewal built-up and urban regeneration appear more and more in most of the studies/analyses about the cities. Referring to that, ongoing urban processes is going to suggest radical transformations including movement of people, changing habitudes, new views about the city, etc (B. Ginot 2010).

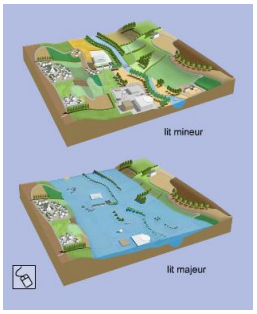
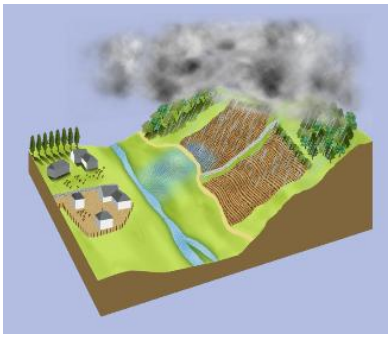
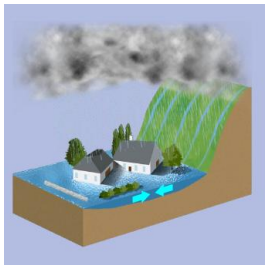
In this way our approach presents as hypothesis: if nowadays exits urban processes in terms of infrastructure of cities such as housing, buildings, runways, etc; where the aims are going to address mainly to adopt new construction material for instance. Concerns flood mitigation; it has a talent to producing considerable changes on the ongoing urban processes through the catchment, neighborhood and building scale working together on it.

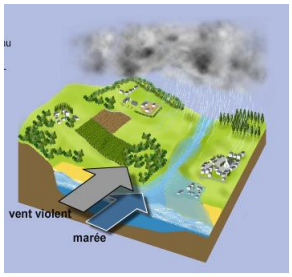
In this way, taking the previous argument into account, *Montivilliers* should be regarded as a city with a talent to produce innovative measures about regeneration of areas based on the resilience concept. This means that it can produce relevant changes in flood risk management related to the ongoing transformation of the city.

6. APPENDIX

Index 1

Types of Flood events in Le Havre, according to the *"Risque Majeur en Haute Normandie":*

TYPES OF FLOOD RISK IN *LE HAVRE*	
Overflows Stream overflows can understand as minor river beds (*lit mineur*) and it could increase until to occupy temporarily its major river beds (*lit majeur*). It progress is slow, and can be anticipated several hours even several days in advance.	
Runoffs and mud flows Rainfall can come along with runoff in slope areas. It become more often in the mountainous regions. Due to that, the plants which are acting as natural obstacles tend to disappear. In addition, the ground is often waterproofed in deforested surfaces due to the intensive agricultural practices which produce several amount of silt without allowing the infiltration of rainwater. Therefore, runoff tends to produce mud flows.	
Stagnation of water The stagnation is an accumulation of water in a low point. It due to non filtration capability, as well as slow evacuation of water, in a waterway during rainfall events.	
High water table levels In case of long rainfall events, the saturation of grounds can produce a flood due to rising in the water table levels. These ground-waters levels are affecting directly by the rainfalls event having as consequences differences of height. This type of flood can be several months while water table becomes low.	

Marine Submersion A strong tidal range and a steady wind coming from the sea, having as consequences an immersion which is going to opposite way to a natural evacuation of rainwater. The phenomenon disappears with the low tide.	

Source: CD-ROM sur la Prévention des Risques Majeurs en Haute - Normandie

Index 2

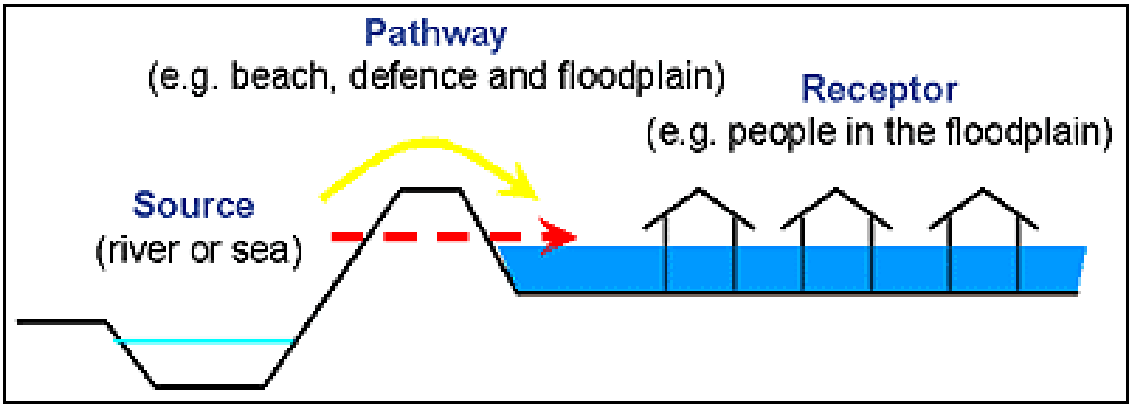
Definitions about flood events order:

Source - The origin of a hazard (for example, heavy rainfall, strong winds, surge etc).

Pathway - Route that a hazard takes to reach Receptors. A pathway must exist for a Hazard to be realized.

Receptor - Receptor refers to the entity that may be harmed (a person, property, habitat etc.). The vulnerability of a receptor can be modified by increasing its resilience to flooding.

Consequence - An impact such as economic, social or environmental damage/improvement that may result from a flood. May be expressed quantitatively (e.g. monetary value), by category (e.g. High, Medium, Low) or descriptively.

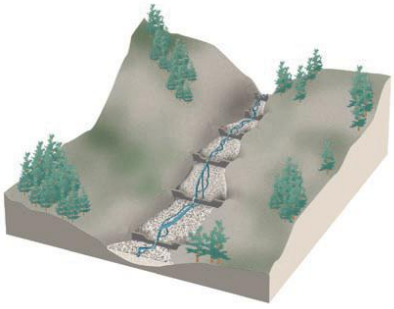


Source: *Floodsite* website.
Conceptual Model.

Index 3

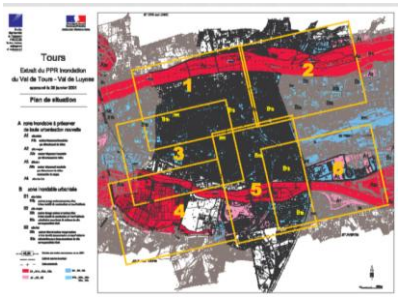
- *Structural Mitigation.*

Source: blog.cytrap.eu



Source: ministère de l'écologie et du développement durable

- *Non-structural Mitigation.*



Source :
http://www.prim.net/professionnel/documentation/guide_inond/page01.html

Index 4

Summary of the main actors / interventions:

Level / scale	Actor	Role	Intervention
Country (Government)	Ministry of Environment	Prevention	Documents of protection (Law), research
	Interior Ministry	Protection, management	Documents / Plans of management (Law)
Catchments basin	Basin council	Statutory	SDAGE, SAGE
	Public establishment	Information, research	Survey, scientific report
Regional	DREAL (DIREN)	Information, prevention	Survey, data bases, advices
Department	*Préfet*	Management	**PPRi**, DDRM
	DDT		
Commune	Mayor	Management	**PCS**
		Information	**DICRIM**
Others	Others: Associations, insurers, …	…	….

Source: FRM Actors M2RI 2013 Kamal Serrini.

ORSEC: “Organisation de la Réponse de Securité Civile”:

SDAGE: “Master plans of Water Management” (Schémas Directeurs d’Aménagement et de Gestion des Eaux)

SAGE: “Documents of Planning and Management of Water” (Schémas d’Aménagement et de Gestion des Eaux)

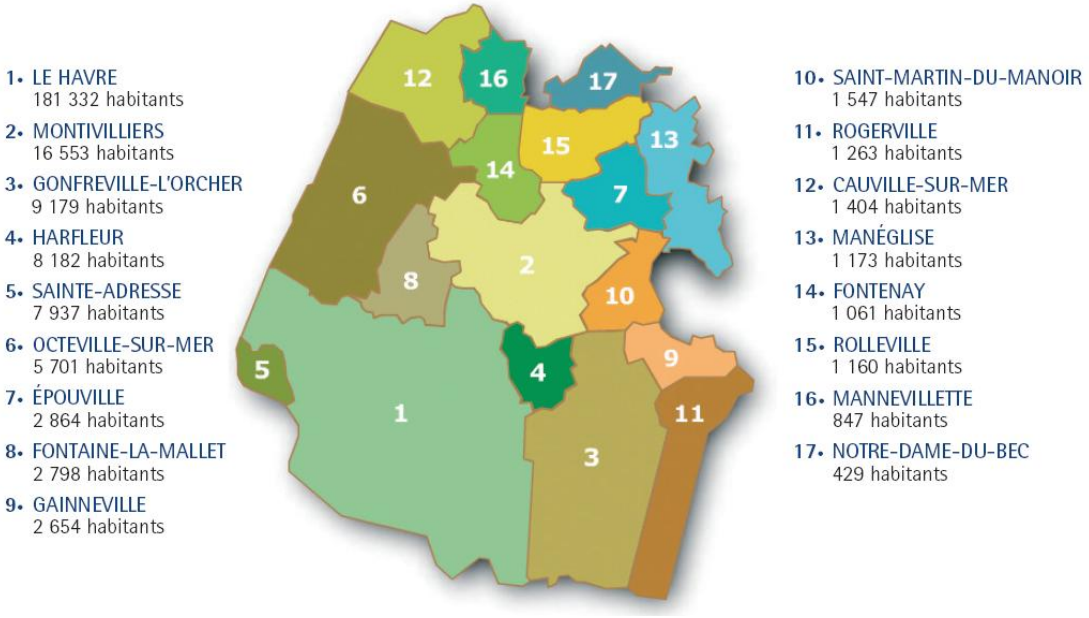
DREAL: Direction Régionale de l’Aménagement, de l’Environnement et du Logement (DIREN + DRE + DRIRE)

DDRM: “Departmental Report of the Major Risks” (*Dossier Départementale des Risques Majeurs)* Preventive Information & knowledge about all kinds of risk at the department level.

PPRi: “Plan of Flood Risk Prevention” (*Plan de Prévention du Risque Inondation)*

<u>Index 5</u>

Communes of the agglomeration of Havre:



Source: INSEE 2008

Index 6

The four majors steps in risk regulation in France- Inspired from N. POTTIER, 1998 in V. MORINIAUX, 2003.

In the field of flood prevention policies, different regulation systems succeeded since the beginning of the 20th century in France. One can consider 4 phases where both mapping tools and planning regulations were implemented. The following table summarizes those phases.

Phases	Flood events	Regulations	Mapping documents
1st phase (1930-1982): the first legal tools and maps dealing with flood are created 2 objectives: - to facilitate flows and preserve the open lands where floods can expand - to protect housing and the built environment against floods (R111-3)	**1930:** major floods of the rivers Tarn and Garonne ; about 400 people died	**1955:** the "Urban planning Code" and its article R111-2 and R111-3 restrict urban sprawl by Creating "*Périmètres de risque"*	**1935:** the "*Plans de Surfaces Submersibles"* are created
2nd phase (1981-1994): a new mapping tool to better take into account the issues at stake - new planning and mapping tool: the *PER* - objective to reduce damages by controlling urbanisation and Imposing prevention measures (on the existing and future issues) - information for citizens - objective of an integrated water management	**Winter 1981 - 82:**winter floods on the Saône, Rhône and Garonne Rivers **1983:** floods on the most river basins **Summer 1987:**flash flood in le Grand-Bornand (23 people died) **Autumn 1988:** flash flood in Nîmes (11 people died) **Summer 1992:**flash flood in Vaison-la- Romaine (34 people died) **Winter 1993-94:**massive floods in the North and Eastern parts of France	**1982:** new regulations concerning victims indemnification **1987:** law on the organisation of civil security, protection against forest fires and major risks prevention (the "Atlas des Zones Inondables" (Atlases of Flood-prone Areas) are created for public information) **1992:** Water Act (Loi sur l'eau)	**1984:** decree creating the "*Plan d'exposition aux risques naturels prévisibles"*, *PER*

3rd phase (1994-2003): **the PPRNP are created to clarify and reinforce the legal system** - The State clarifies the objectives of its prevention policy against natural hazards - The PPRNP are created and replace the former mapping documents (PSS, perimeters Art. R111-3, PER). They are the only legal document for prevention against natural hazards.	**Beginning of 1995:** floods in 43 districts (*départements*) and about 40 000 houses flooded in the northern part of France **Autumn 1999:** flash floods in Aude, Hérault, Pyrénéées-Orientales **Winter 2000-2001:** floods along the Somme river and in Brittany region	**1994:** circular on flood prevention and management of floodprone areas **1995:** Law on the reinforcement of environmental protection. **1995:** Decree on the possibility to expropriate owners when a natural hazard threaten human lives **1996:** Circular on specific dispositions for the built environment in flood-prone areas	**1995:** decree on the creation of the"*Plans de Prévention des Risques Naturels"* (PPRN)
4th phase (since 2003) The main objectives are: - the identification of areas where water retention could be done - a better information for the people - vulnerability reduction		**2003:** law on prevention against natural and technological risks and damages repair	

Source: AN INTERNATIONAL COMPARISON. M. Amalric, S. Bernier, M. Fournier, J. Serrano, L.Verdelli), 2008

Index 7

The four different levels of risk:

- LOW RISK: deepness of submersion <1m, no reference to speed
- MEDIUM RISK: deepness of submersion between 1 and 2m, with a speed from none to low or deepness of submersion <1m with a medium to high speed
- HIGH RISK: deepness of submersion >2m, with a speed from none to low or deepness of submersion <2m with a medium to high speed, completed by a particular danger zone of 300 m behind the dikes
- VERY HIGH RISK: deepness of submersion >2m with a medium to high speed, completed by a particular danger zone downhill spillways and others river works.

Index 8

Data related to *Grand Hameau "Eco-Quartier"* project.

Source: Town Hal of *Le Havre*,
Grands projets, Aménagement Urbain et prospective.

Gestion alternative des eaux pluviales

Toits végétaux, diminution de la minéralisation des espaces publics, stockage et utilisation des eaux pluviales : le dispositif de gestion des eaux de pluie mis en place au Grand Hameau répond aux techniques alternatives.

Il pleut ? On gère...

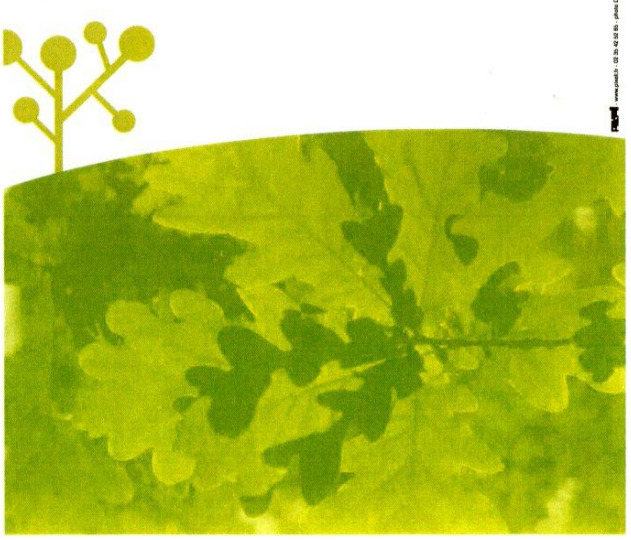
L'ensemble du réseau d'**évacuation des eaux pluviales est constitué de noues de stockage**, d'une profondeur maximum de 60 cm, et de **bassins tampon intégrés** au plan d'organisation générale du quartier et au plan paysager.

Ce système permet de **gérer le ruissellement des toitures et des différents aménagements** sur l'ensemble de la chaîne hydraulique, et sert également de mise en scène paysagère.

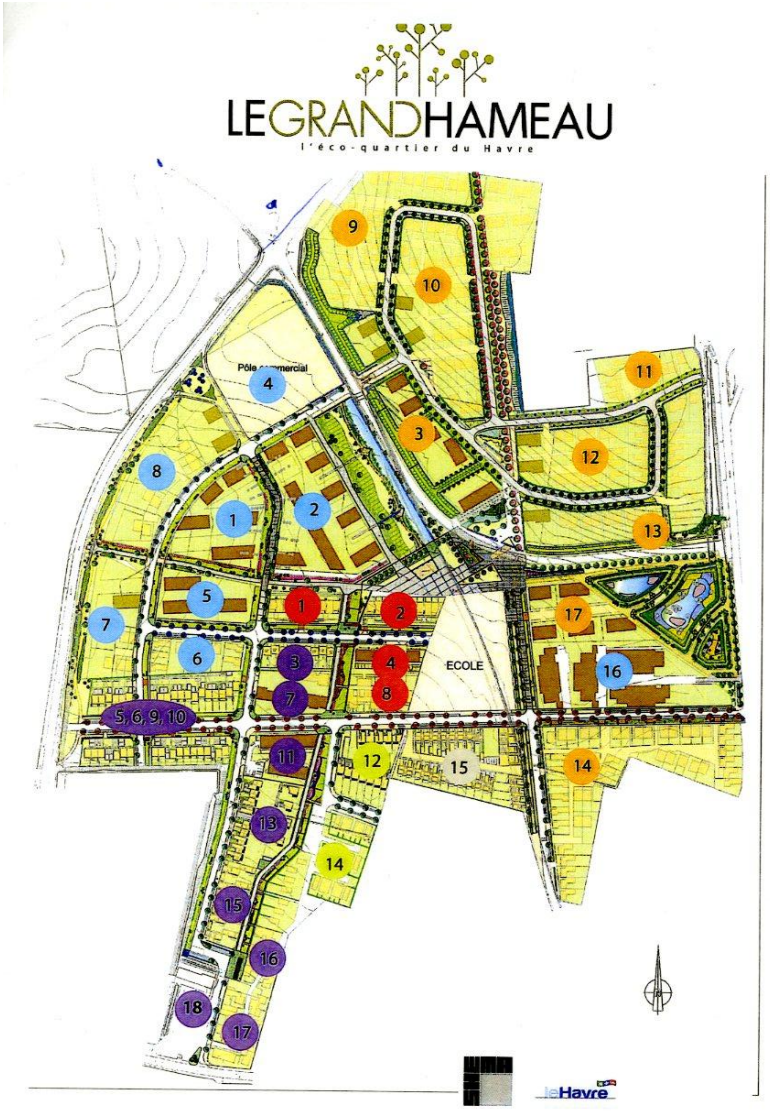
Le vert ? On aime...

L'impact écologique du Grand Hameau est également réduit par la diminution de la minéralisation des espaces publics.

Les toits végétaux sont préconisés, à la fois pour des raisons esthétiques et écologiques.



Source: Town Hal of *Le Havre*,
Grands projets, Aménagement Urbain et prospective.



OPERATIONS LIVREES

SECTEUR LOTISSEMENT HAUTS DE BLEVILLE

Lot 3 : Estuaire de la Seine
architecte : Bettinger/Desplanques
9 maisons de ville
livré fin juin 2011

Lot 7 : Estuaire de la Seine
architecte : CBA
43 logements collectifs
livré fin juin 2011

Lot 11 : Estuaire de la Seine
architecte : Bettinger/Desplanques
36 logements collectifs
livré fin juin 2011

Lot 15 : Estuaire de la Seine
architecte : Bettinger/Desplanques
10 maisons de ville
livré fin juin 2011

Lots 5, 6, 9, 10 : Maisons ELIKA
architecte : CBA
35 maisons
livré fin novembre 2011

Lot 13 : Estuaire de la Seine
architecte : CBA
13 maisons
livré mi-novembre 2012

Lots 16, 17 : PFN
architecte : ATAUB
20 maisons
livré mars 2013

OPERATIONS EN COURS

SECTEUR LOTISSEMENT HAUTS DE BLEVILLE

Lot 12 : Estuaire de la Seine
architecte : CBA
12 maisons
livraison prévisionnelle : mars 2013

Lot 14 : Pierres Normandes
architecte : MILLET – CHILOU et Associés
43 logements (36 collectifs, 7 individuels)
livraison prévisionnelle : mars / avril 2013

SECTEUR ZAC NORD BLEVILLE

Lot 15 : IBS
architecte : CBA
23 logements individuels / 12 logements collectifs
livraison prévisionnelle : mars 2013

OPERATIONS A VENIR

SECTEUR LOTISSEMENT HAUTS DE BLEVILLE

lot 1 : PFN
architecte : G2
30 logements collectifs
stade avancement : PC déposé

lot 2 : PFN
architecte : ATAUB
29 logements collectifs
stade avancement : PC déposé

lots 4/8 : PFN
architecte : ATAUB
8 logements intermédiaires / 13 logements individuels
stade avancement : PC déposé

lot 18 : PFN
architecte : ATAUB
7 maisons
stade avancement : en commercialisation

SECTEUR ZAC NORD BLEVILLE

Lot 1 : GOTHAM
architecte : agence Margerie & Pasquet
115 logements collectifs
stade avancement : en commercialisation

Lot 2 : OTI
architecte : agence Devillers / agence Paumier
191 logements collectifs / 7 logements individuels
stade avancement : en commercialisation

Lot 4 : projet NATUREO
architecte : SUD
supermarché bio + commerces de proximité + programme tertiaire
stade avancement : PC en cours d'instruction

Lots 5 / 6 / 7 : CAP HORN
architecte CBA
13 logements indivuduels / 14 logements intermédiaires /
57 logements collectifs
stade avancement : en commercialisation

Lot 16 : European Homes
architecte : BILLARD DURAND et Associés
74 logements
stade avancement : en commercialisation

PROGRAMMATION PREVISIONNELLE

SECTEUR ZAC NORD BLEVILLE

Lot 3 : 90 logements collectifs
Lot 8 : 10 logements individuels / 35 logements intermédiaires
Lot 9 : 25 logements individuels / 47 logements intermédiaires
Lot 10 : 30 logements individuels / 50 logements intermédiaires
Lot 11 : 8 logements individuels
Lot 12 : 25 logements individuels / 25 logements intermédiaires
Lot 13 : 22 logements individuels / 10 logements intermédiaires
lot 14 : 53 logements individuels
Lot 17 : 60 logements collectifs

Source: Town Hal of *Le Havre, Grands projets, Aménagement Urbain et prospective.*

Index 9

Potential damage by the water height:

Water Height	Damages during the construction	Damages on the networks and the finishing	Damages on personal goods
On the ground floor	Little damage on the structure. The water can enter from the basements, cellars and through the baseboard. Erosion is possible under the base.	Damage on the plugs and other networks in the cellars and basements. The carpets of these rooms must be removed.	All goods and objects placed in the cellar or basement are ruined.
Up to 50 cm above the ground floor	Damage in the finishing of the inside walls such as the wall covering and the sheetrock. They have to be subtracted to allow the wall to dry. The floors and the walls can be filled with water and so be in need of cleaning and drying. Humidity problems could follow that. Floor coverings must be replaced. External and internal doors as well as skirting boards are ruined.	Damage on the electric network and more particularly the meters and the circuit-breakers. Damages on the gas network, the heater and the land lines. Carpets and floor coverings mousy be replaced. Linoleums and kitchen cupboards can be strongly damaged. Washing machines, ovens, fridges and freezers will be damaged. Saturation of the sewage system.	Damage on the sofas, other furniture and TV / hi-fi. Damages on personal goods such as books, cassettes, videos, pictures. Food that is stored in the down kitchen cupboards can be infected.
More than 50 cm above the ground floor	Important damage of the walls. Possible damage of the structure of the house.	Damage of all networks.	Potential damage of all goods.

Source: SMVB 2011

Index 10

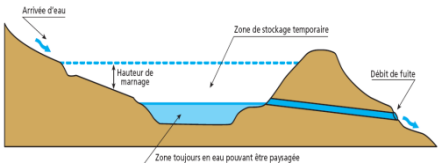
Measures mitigation in *Montivilliers*:

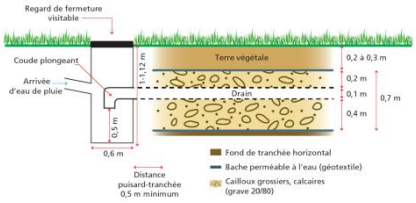
Catchment Scale.

The management of runoff is provided at different geographical scales and different communities in the territory of the watersheds of the Havre community. SMBV leadership and technical support to control runoff through storage water units. But the realization of the so-called "fight against floods" work was possible with the support and the responsibility of municipal structures as CODAH and SMVB.

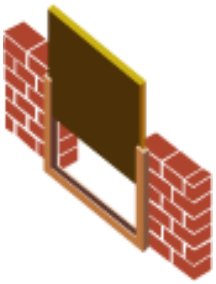
Flood Retarding Basins. Flood attenuation, or provision of temporary water storage capacity during flood events, to reduce peak flows.	
Flood Barrier or Dams. Those are made through an excavation of earth to create dams along in the valley. Grass located upstream of the dam is a flood meadow.	
Field Expansion Rise. These areas provided in the lower valley close to the river, allowing store several hundred cubic meters millers. A hundred hectares is being gotten for these facilities. Hence, the pressure over land as well as to deal with the owners always makes long processes to get it (expropriation and negotiation).	

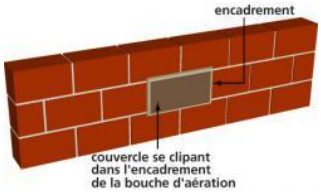
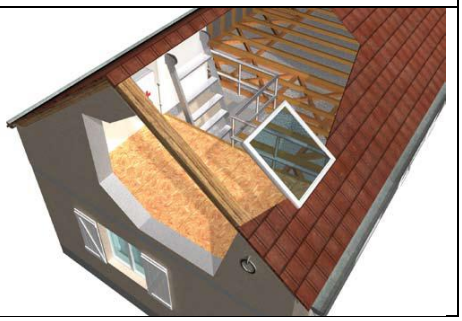
Neighborhood Scale.

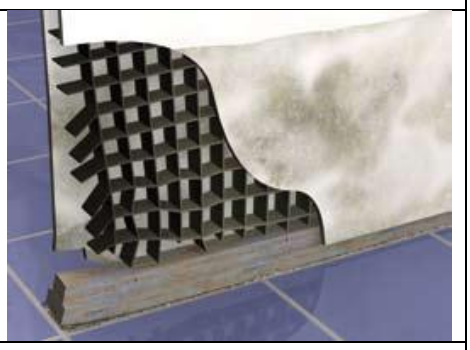
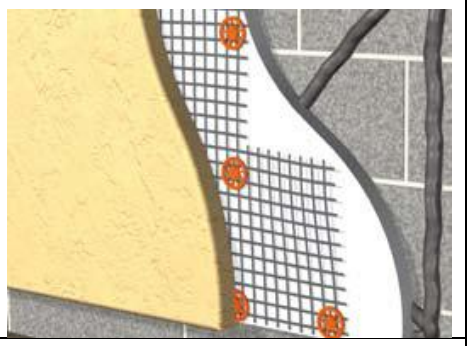
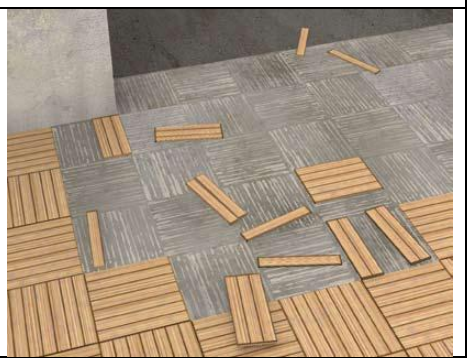
Dew Pond. At the beginning their aims were of watering animals but most of them have been removed the last decades. However, nowadays they come back focused on hydraulic function which is integrated into the landscaped.	

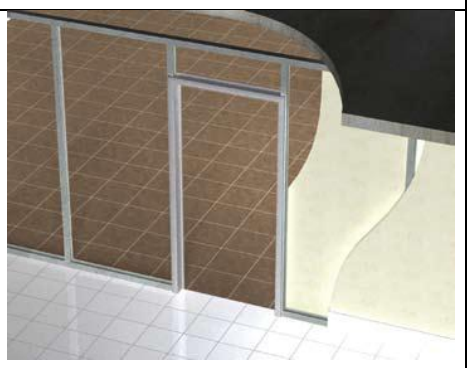
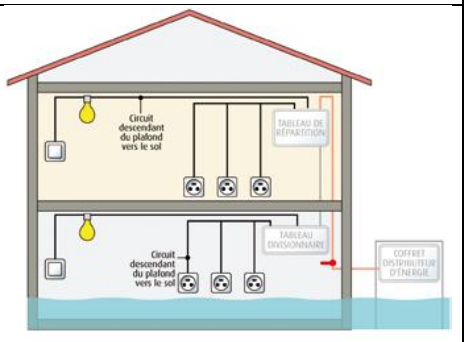
Draining Trench. It is a trench filled with granular material for the retention volume of water before discharge into the collective or network infiltration.	
Waterway. Ditch outdoor, shallow and wide profile that to become green area maintenance.	
Permeable pavement. Porous coatings improves water infiltration and are more and more used to replace conventional coatings which are the major providers of runoff and pollution.	

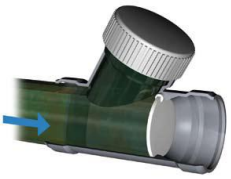
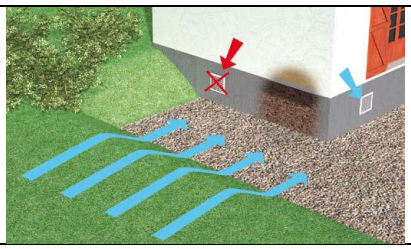
Building Scale.

Provide temporary protection strategies. The action is to promote the sealing of the house where the water pressure is bearable by the structure of the building. These kind of strategies will be applied on places where *water level not exceeding 1 meter level during the overflow*; because the pressure difference between the inside (no water) and outside (with rather than 1 meter of water level) would result irreparable damage to the building structure.	
Cofferdams. These are plates that fit into corners to prevent water from entering through openings (door, courtyard door, garage door, and window). Their efficacy and duration of protection depends on the care given to the seal.	

Sandbag. There may be a protective barrier from sandbags or absorbent polymers, positioned flat in the longitudinal direction of the flow in a staggered and superimposed. This barrier should not face the direction of flow but only contain its expansion. They are not tight.	
Wrapping. The penetration of water through the walls can be avoided as the moisture problems, holding a plastic film along the walls, complete with a drainage system. This is relatively long to implement.	
The temporary sealing vents. It will provide to block temporarily the vents located below the level of flooding. (Will use it only during the flood, otherwise it is forbidden to put it permanently).	
To protect the front porches located in the axis of the stream.	
Wastewater management. During the application of temporary protection measures are necessary as well as to ensure the evacuation of the wastewater by various methods adapted to each situation: mop, scoop. The full pumping will become efficiency and thereby helps to minimize the damage and time rehabilitation.	
Refuge area into the housing. The goal is to set security. The refuge area is a waiting area that can get away from the water until the eventual disposal or decline.	

Adaptation of building materials against flood. The action is to adapt the housing to the presence of water when *the water level exceeds 1 meter height*. To balance the pressure and prevent damage to the structure, the water must be able to enter the house by causing the least possible damage.	
Walls. Waterproof bricks, solid concrete, removable inner lining and waterproof, exterior foundation drains.	
Dividing walls. Solid brick masonry, plasterboard waterproof, partitions mounted metal frame, masonry walls coated.	
Weather-proofing. Rigid insulation polystyrene, polyurethane.	
Coatings wall. Wallpaper (drying facility by removing walls), earthenware	
Floors. • Work of armed concrete floors: The technical implementation of lower floors of existing buildings are varied but for individual houses, structures floor joists (steel, concrete) and slab (clay, concrete, synthetic material) and	

compression casting slabs in place are the most common. • Replacement flooring: concerns the choice of flooring that will be affected by water (at the material itself or its fixing method) and must take into consideration: *.Material behavior according to the contact with water.* *.Cost of material.* *.Ways to replace it.* *.It helps to reduce damage and delay return to normal.*	
<u>Woodwork.</u> PVC, aluminum, steel, treated wood protection product, it will apply indoor and outdoor as well.	
<u>Protection of climate control equipment.</u> Some examples, such as boilers, pumps heat, control devices, and so on; can become successful.	
<u>Redistribution and / or modification of electrical circuits.</u> The electrical distribution system is particularly vulnerable. They are however essential to achieve an effective drying (heating, ventilation) and cleaning thereby reducing the time back at house.	

Protection of elevators.	
Prevention of damage to networks. The wastewater systems are designed to discharge effluent from the building to the outside. During flooding, these effluents can follow the opposite path, pushed inwardly of the building by the pressure exerted by the water. Polluted water can cause significant damage to the building, despite the installation of protective devices openings.	 
Prevention of damage caused by oil tanks.	
Protection of persons in presence of swimming pools.	 
Protection of crawl spaces.	

Source: All of the images were taken from data analyzed in literature review, such as SMVB, Ministry of ecology, CODAH and by the author.

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Experimental survey did by the CODAH in *Montivilliers*, which is part of the mitigation measures adopted from the municipality.

(SURVEY)

In October 2012 a project from the CODAH / SMBV started. It was based on flood events occurred during 2003. It consists of making a guide to provide recommendations/measures/suggestions on how to rebuild their houses and making them less vulnerable against overflows. Then this guide will be given to them even including the specific cost for each house about materials, processes, and so on.
The first step has created a test to gather data about housing having as a result a diagnosis. It was done only among 40 houses.

Characteristics:

- Test was carried out as a survey manner.
- All persons engaged were volunteers.
- All of the persons had already been affected by floods events at home before.
- Test was done taken building scale into account, which means residential houses.
- Engineers, architects and sociologists worked on it.

Process:

- The sociologist team did interviews with owners to know different point of view or perceptions about flood risk according to each experience.
- It was developed mainly by SBVPC.
- As an outcome it expects to get a broad diagnosis over all cases, to follow it focusing in each of them through suggestions, structural recommendations, measures, and so on.
- After the diagnosis, meetings with the concerned population in order to contrast the results and addressing them towards the correct way will be carried out.

Outcomes:

- It will be showed mainly to the population concerning it, and then one way could be to get an official document. Nowadays it has been analyzed by the stakes on debate.
- How to continue this process? One of the doubts which have been discussed among people engages it.

Suggestions/comments:

- Which were the aims of the test?
- Which should be the logical process to follow? That means, according to the actors and related to scales.
- They propose them some measures to mitigate flood risk at home. It has a good instrument to carry out links among different scales, meaning large, medium and small. How to implement it?
- Could it be an example to implement it as non structural and structural mitigation measure?

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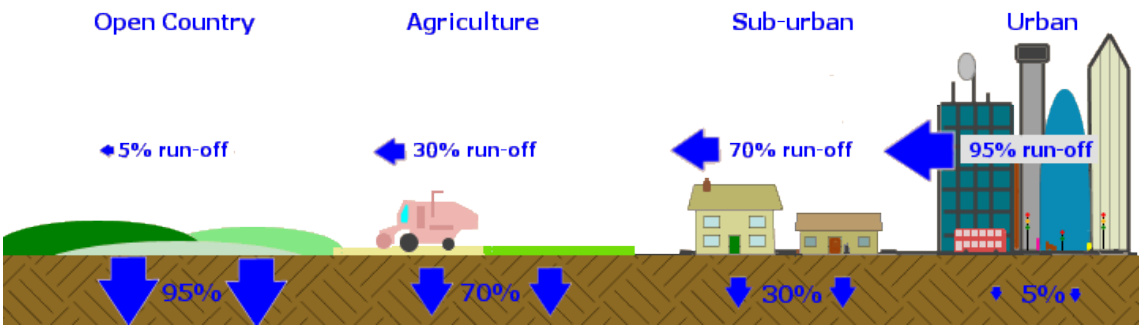
Permeability Processes between countryside and cities:



Source: www.pavingexperts.com.

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Different Permeable Pavements Specifications:

Material	Specification	Notes
Permeable Interlocking Concrete Pavers	Surface open area: 5% to 15%. Thickness: 3.125 inches for vehicles. Compressive strength: 55 Mpa. Open void fill media: aggregate	Must conform to ASTM C936 specifications. Reservoir layer required to support the structural load.
Concrete Grid Pavers	Open void content: 20% to 50%. Thickness: 3.5 inches. Compressive strength: 35 Mpa. Open void fill media: aggregate, topsoil and grass, coarse sand.	Must conform to ASTM C 1319 specifications. Reservoir layer required to support the structural load.
Plastic Reinforced Grid Pavers	Void content: depends on fill material. Compressive strength: varies, depending on fill material. Open void fill media: aggregate, topsoil and grass, coarse sand.	Reservoir layer required to support the structural load.
Pervious Concrete	Void content: 15% to 25 %. Thickness: typically 4 to 8 inches. Compressive strength: 2.8 to 28 Mpa. Open void fill media: None	May not require a reservoir layer to support the structural load, but a layer may be included to increase the storage or infiltration.
Porous Asphalt	Void content: 15% to 20 %. Thickness: typically 3 to 7 in. (depending on traffic load). Open void fill media: None.	Reservoir layer required to support the structural load.

Source: Virginia DCR Storm water Design Specification No. 7 *Permeable Pavement. Version 1.8* – March 1, 2011