



Bundesministerium  
für Umwelt, Naturschutz  
und Reaktorsicherheit



## **Precautionary Flood Protection in Europe International Workshop**

5 – 6 February 2003, Bonn

---

### **Flood risk reduction strategy along the river Loire**

**Nicolas-Gérard Camp'huis**

**Flood risk management team on the Loire river basin  
France**

---

## Flood risk reduction strategy along the river Loire

---

The “Loire moyenne” area was flooded three times in the XIX<sup>o</sup> century. 1.500 km<sup>2</sup> was under 1 or 2 meters water, the 700 km long dikes protection system was breached in more than 150 locations and the towns of Orléans and Tours was completely flooded.

Since 150 years, everybody has forgot those cataclysms and today there are around 300.000 inhabitants, 14.000 companies, 1.500 farms, 4.100 power plants and 1.550 public properties in the 1/1000 flood area. The damages caused by such a flood are estimated, with a precision around 100%, at 6 billions €

The Loire flood prone area in the middle Loire valley is split in 33 different “val” or polders, each one separated from the river bed by a many hundred years old dike’s system. Many are little “val” with a dike only 10 to 30 km length. Three “vals” are protected by a 40 to 70 km length dike. To reduce the breach’s risk, the construction of 19 weirs (spillways) in the dikes was decided after a long study on the causes of and the way to reduce the inundation. Only 7 of them have been installed between 1870 and 1900.

For a 1/50 flood, the present system of protection can’t avoid the flood of 22.000 inhabitants, 1.620 companies and 310 public properties, and a damage estimated very approximately around 110 millions € Such a flood wont overtop any dike and open any breach. But a significant part of the 50 towns and villages that are entirely in the flood prone area, will be flooded because of an inadequate local protection.

A 1/100 flood will overtop dike in many “vals”, breaching more than 20 km dikes.

A 1/500 flood will inundate 75% of the entire valley: only two “vals”, luckily two of the richest, would not be flooded, except by an accidental breach always possible or by surging groundwater level who will produce a lot of incidents in a big and modern town like Tours.

A flood management strategy was decided in 1979 by the government, in accord with the local authorities. All the local authorities (municipalities, départements, régions) founded an association to apply the strategy and support many projects. The government, owner of all the dikes, reinforce the dikes year after year from 1970 to 1990. The association of local authorities built a reservoir to protect the river Loire against the flood. Two other should have been built in 1990 and 1992, and after a important fight managed by the ecologists during more than two years, the government decided not to build the two reservoirs and to find other ways to reduce the risk.

After a three years study, combining hydraulic, socio-economic and risk vulnerability aspects, the government together with the Régions and the association of local authorities decided to finance the first step of a strategy not entirely defined en 1999, in a six-years contract 2000-2006.

This first step is based of three kinds of actions to predict, prevent and protect therefore called the “3 P” strategy.

**Prediction** aims at, on the middle Loire river :

- ✓ Extension of the area covered by the monitoring system, with more than hundred new data-collectors and four new tributaries covered by the system.
- ✓ Amelioration of the prediction for rare floods, using the hydraulic model elaborated for the middle Loire river study

- ✓ Re-evaluation of the alert plans in 6 different “départements”, using the re-evaluated knowledge on the flood
- ✓ Promotion of the interpretation by each major in each municipality, of the alert, using for example flood map.

**Prevention** aims at, on the middle Loire river :

- ✓ Elaboration and publication of maximal flood map along all the river
- ✓ Access to those maps in every municipality
- ✓ Reduction of the extension of the urbanisation in the 250 municipalities along the middle Loire, like everywhere in France, in application of the law
- ✓ Elaboration of emergency plan at the “départemental” level by every “Préfet” and at the local level by every major (council)
- ✓ Identification of the vulnerability of every goods who will be flooded by the next flood : company, housing, agriculture plant, etc. Elaboration of a diagnose for companies and agriculture and test on many plants before diffusion
- ✓ Constitution of a network of “risk reducing manager” in 3 regions and 6 départements, and also in many big towns (like Blois or Orléans), to promote the strategy and sustain the city councils who want to reduce the flood-risk.
- ✓ Elaboration and test of a new way to manage the river environment, especially to restore the river bed and his annexes
- ✓ Elaboration of a monitoring system of the bed river and of his components, by aerial surveying, collecting the water level many times every year, and mapping the land-use evolution in the river bed

**Protection** aims at, on the middle Loire river :

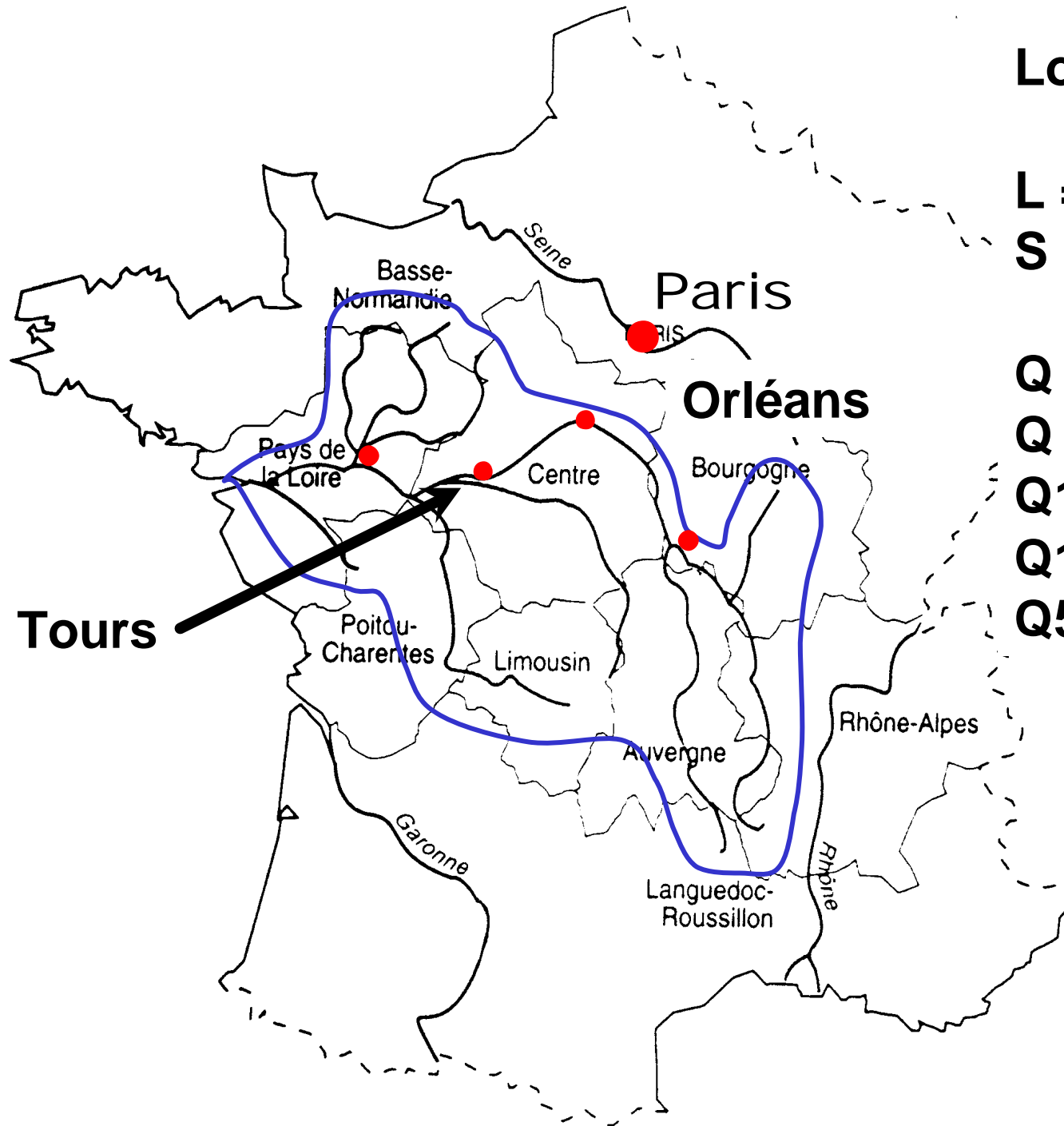
- ✓ Analysing a new risk of dike’s breach because of deepening of the river bed along the dike’s foot, after twenty years of sand and gravel extraction
- ✓ Reinforcing the dikes in some places where they haven’t been yet
- ✓ Promoting local protection in some towns without protection against direct flood, like wall
- ✓ Studying a new empty dam to reduce the peak of the flood
- ✓ Studying three new weirs where breach overtop the dikes
- ✓ Studying a 2 km length prolongation of a dike for a best protection of Orléans

The government and the local authorities manage together each part of this interregional project and get around 65 millions euros on 2000-2006 for it implementation. More than 20 persons will join the project either for the government, either for the local authorities, to run the program.

A 3P study will be carried by government and local authorities also on two others catchment area of the Loire basin : on the Maine (22.000 km<sup>2</sup>) and on the Upper Loire (6.800 km<sup>2</sup>) with a similar integrated approach.

*N-G Camp’huis, Equipe pluridisciplinaire du plan Loire grandeur nature*  
 B.P. 6339 – F 45063 Orléans cedex 02  
 Tel: 33 2 38 69 18 28 – [nicolas-gerard.camphuis@equipe-plan-loire.org](mailto:nicolas-gerard.camphuis@equipe-plan-loire.org)





## Loire river basin

$$L = 1.020 \text{ km}$$

$$S = 120.000 \text{ km}^2$$

## Q in Orléans

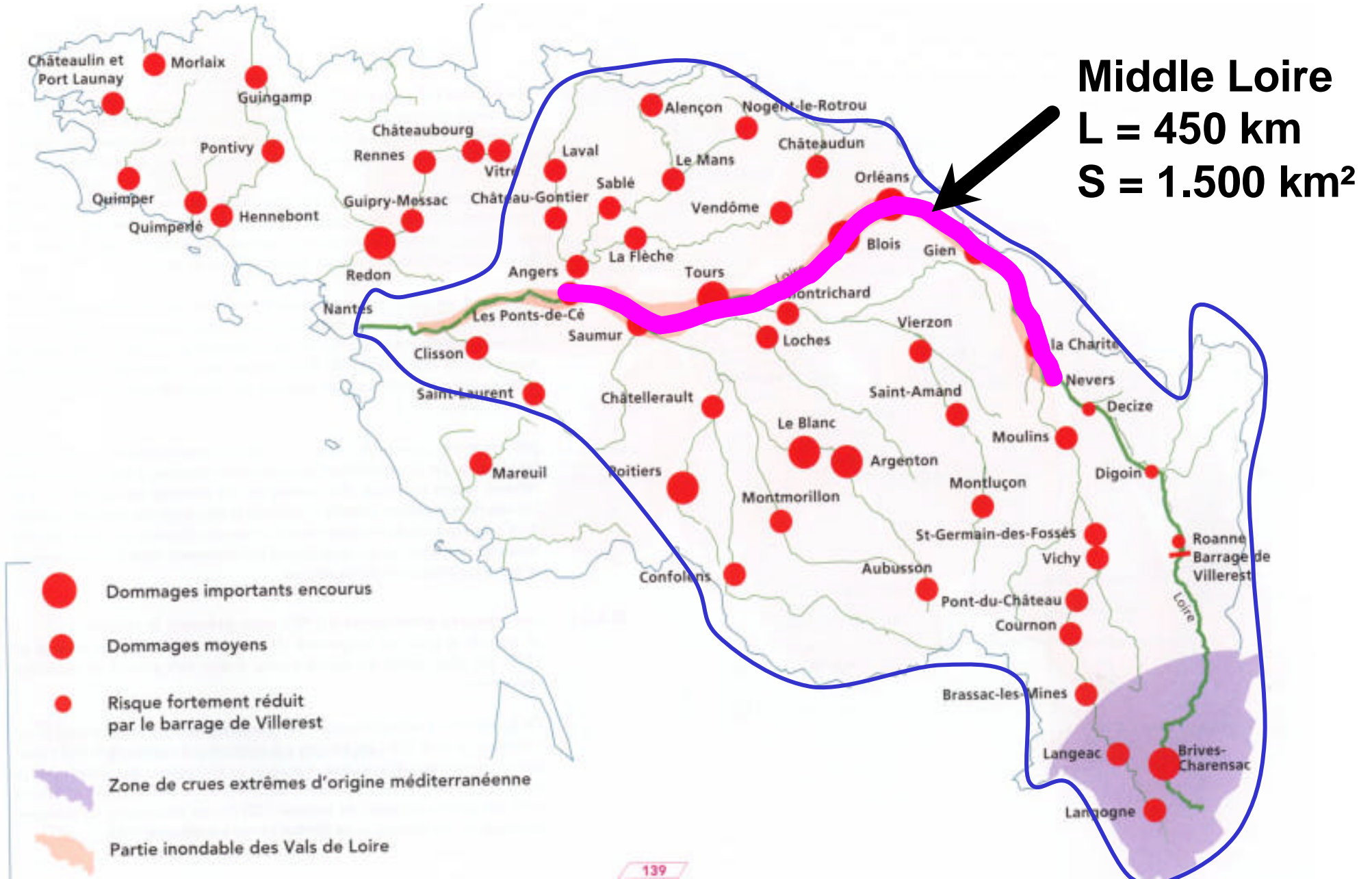
$$Q_{\text{an}} = 300 \text{ m}^3/\text{s}$$

$$Q_{10} = 3.000 \text{ m}^3/\text{s}$$

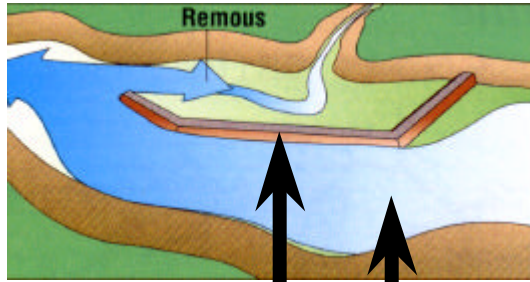
$$Q_{100} = 6.000 \text{ m}^3/\text{s}$$

$$Q_{500} = 8.000 \text{ m}^3/\text{s}$$

# Flood risk on the entire river basin



33 X



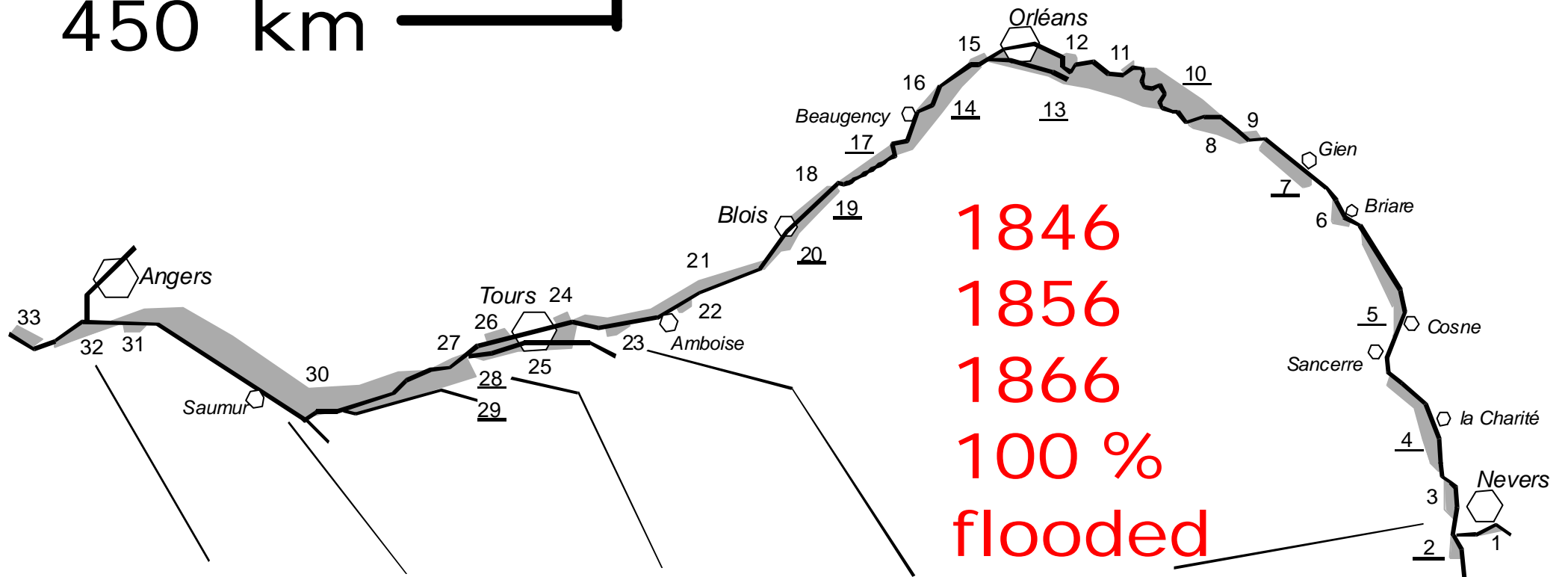
700 km

450 km

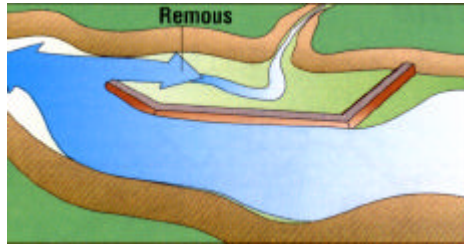
300.000  

190.000 

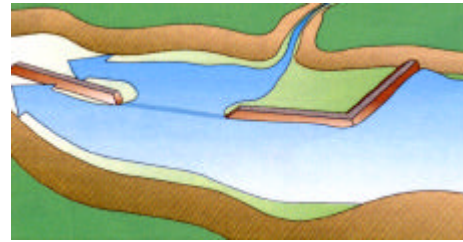
14.000 



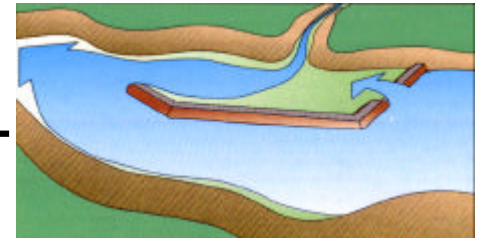
# 1/100



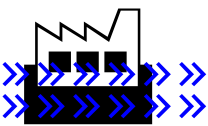
+

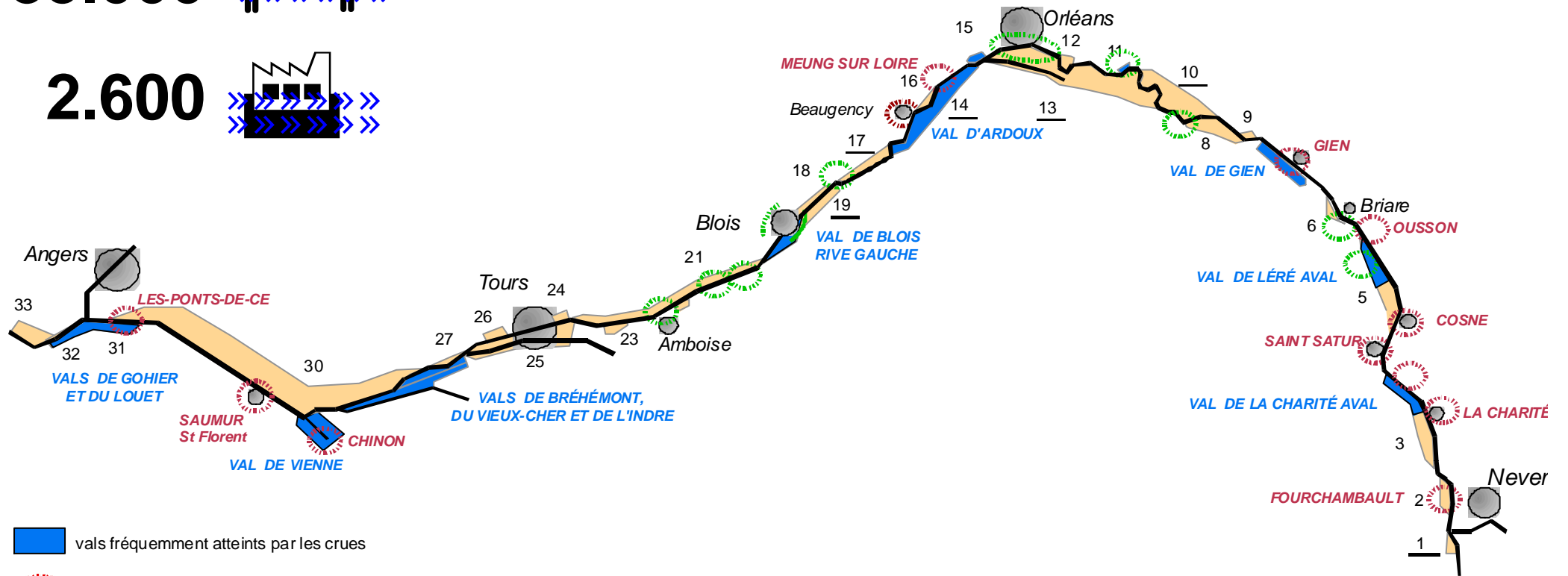



+



35.000 

2.600 



 vals fréquemment atteints par les crues

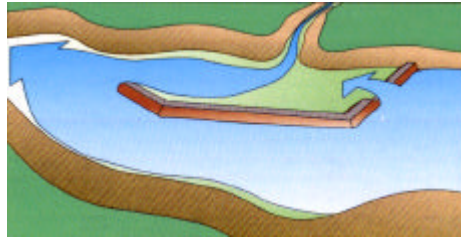
 communes où le modèle détecte une inondation potentielle forte

 autres communes concernées

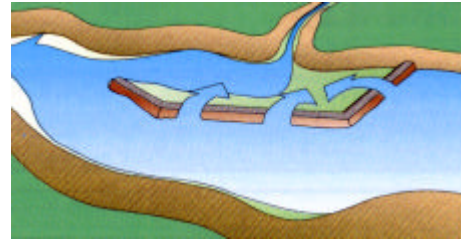
# damages

# 1.000.000.000 €

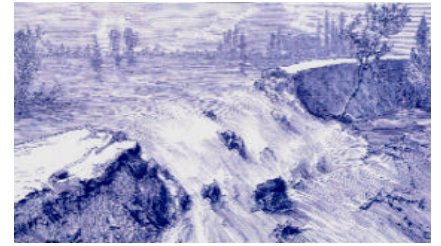
1/500



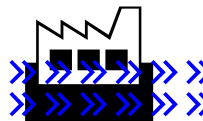
+



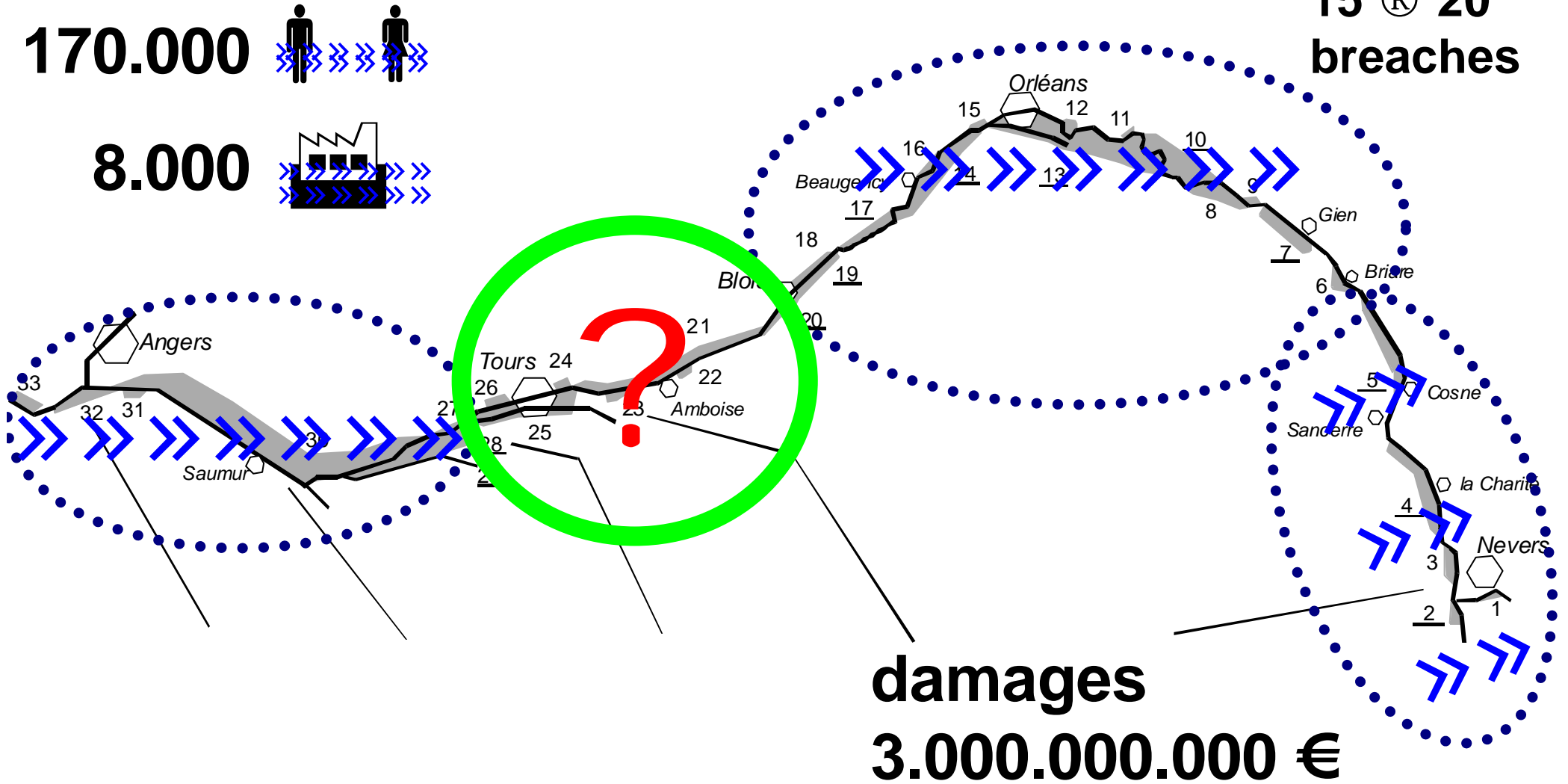
=



170.000 

8.000 

15 @ 20  
breaches



## ***3P strategy***

***P***REDICTION & *adequate alert*

***P***REVENTION & *crisis management*

***P***ROTECTION

***500 Millions € in 15 to 20 years***

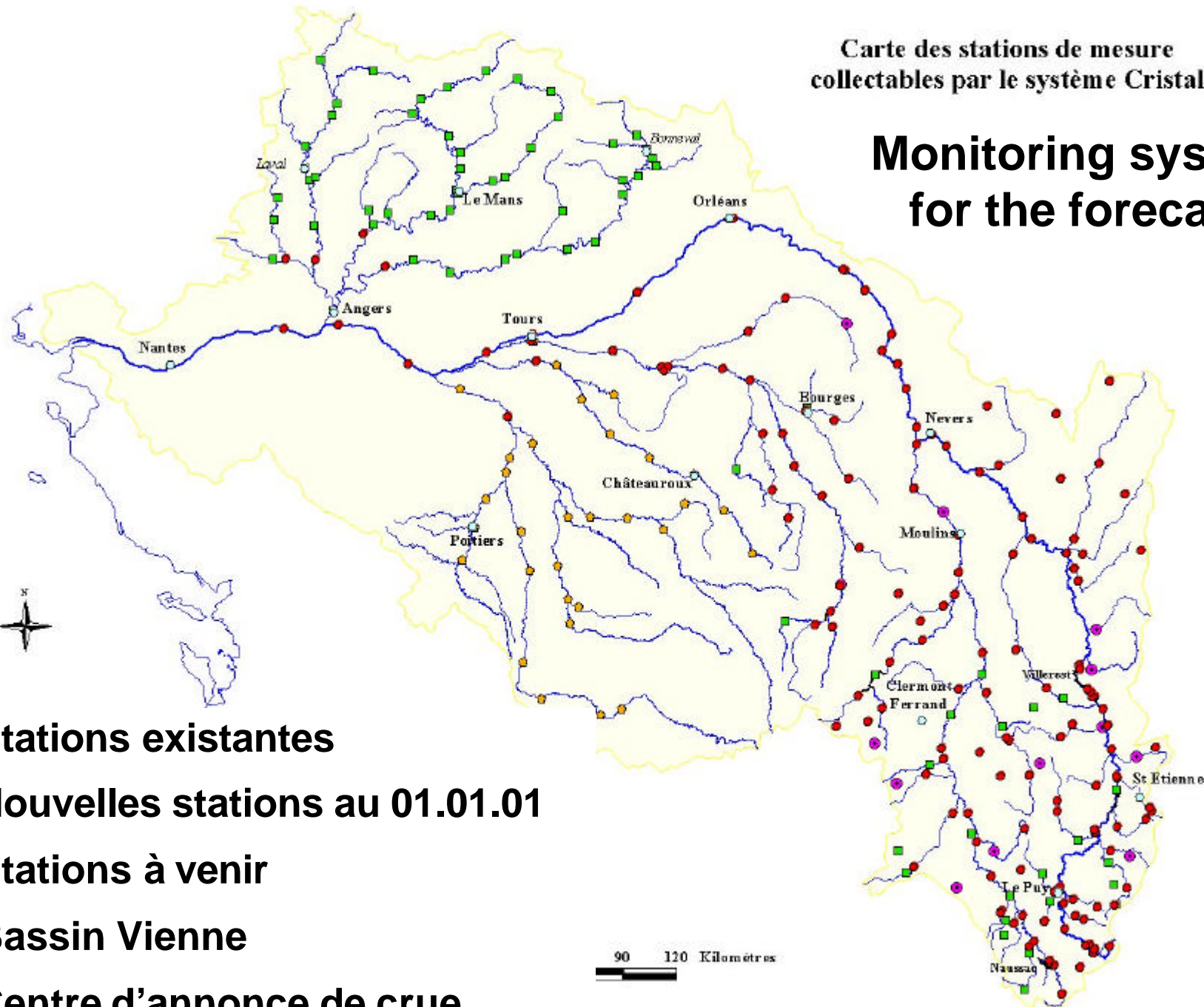
***55 Millions € on 2000-2006***

# **P***PREDICTION & adequate alert*

- ? Extension of monitoring system**
- ? Better prediction model**
- ? Adequate alert plan at every level**
- ? Local interpretation of the alert using modeled flood map**

Carte des stations de mesure  
collectables par le système Cristal

## Monitoring system for the forecast



- Stations existantes
- ⊕ Nouvelles stations au 01.01.01
- Stations à venir
- Bassin Vienne
- ⊕ Centre d'annonce de crue

scale 1/50.000

## Probable extension of the inundation

0 0.75 km 1.5 km  
1/50 000 ème (format A3)

### HAUTEURS D'EAU



### Hauteur d'eau à l'échelle d'Orléans (Pont Georges V)

TYPE	MESURES	UNITE
Zéro échelle	90.48	m IGN69
Cote	96.58	m IGN69
Hauteur	6.1	m
Débit lit endigué	5 700	m3/s

# **P**REVENTION & *crisis management*

- ? **Crisis management plan at every level**
- ? **Control of the extension of urbanisation**
- ? **Identification and reduction of the vulnerability of every good**
- ? **Public's information of the risk**
- ? **“risk manager” network along the Loire**
- ? **Monitoring system of the hydrosystem**

# ***P*ROTECTION**

- ? Dike's reinforcement (deepening)**
- ? Promotion of local protections**
- ? Reduction of discharge's peak  
by a new "empty" reservoir**
- ? 3 New weirs to better protect**