Assessing Motorists' Vulnerability to Flash Flooding

Insights from a French case study

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1- Statement of research problem

2- Objectives, study area and methods

3- Main results

4- Conclusion and looking ahead

More drowning deaths occur in cars than anywhere else

- In France about half of all flash flood fatalities are vehicle-related
- In 2007 in U.S.:
  - 87 persons died from flood including 70 from flash floods.
  - In Flash flood 70% were vehicle-related
  - Texas State is # 1 in deaths

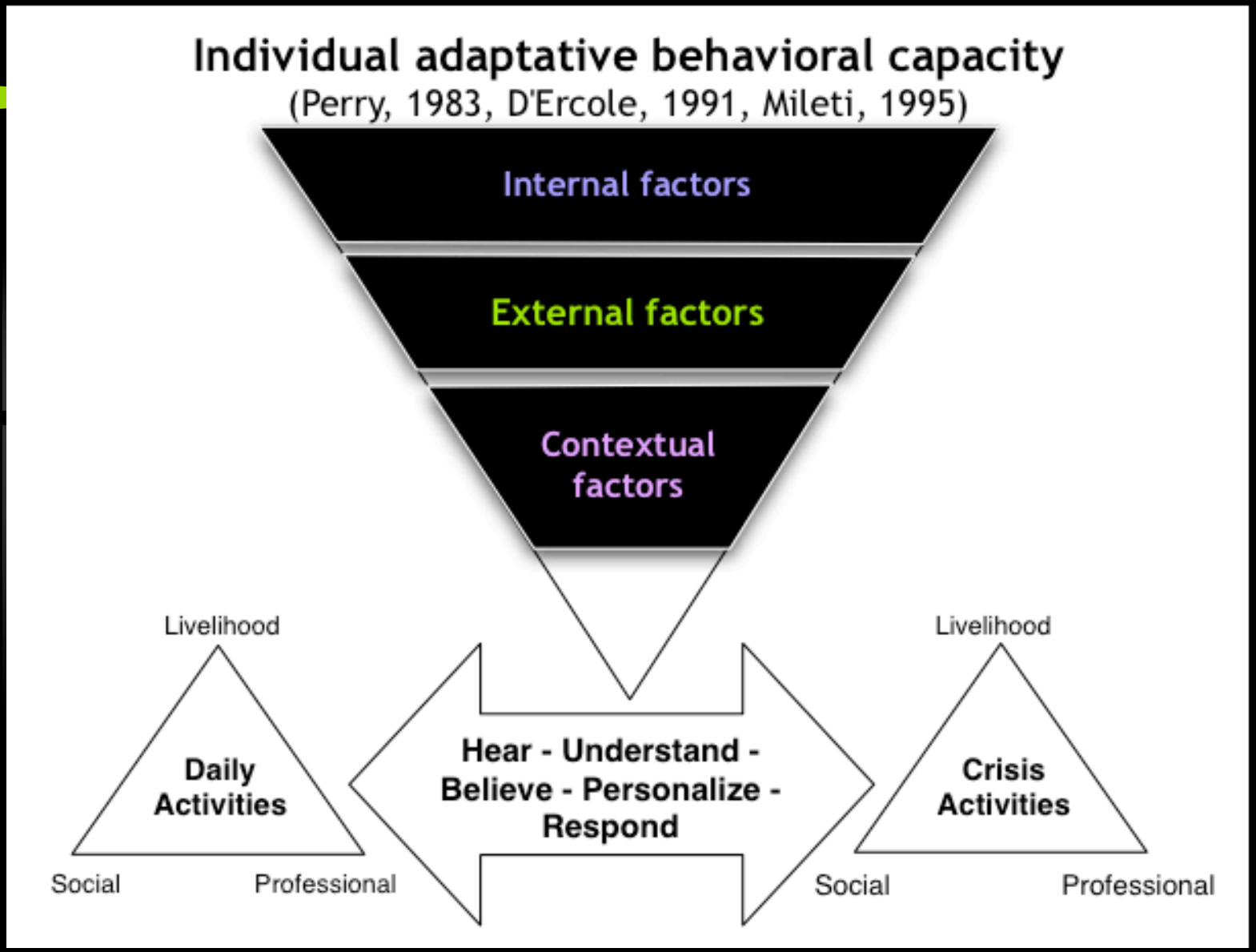
1- Statement of research problem

Why people decide to travel in flash flood conditions?

① People's unwillingness to change their daily routines

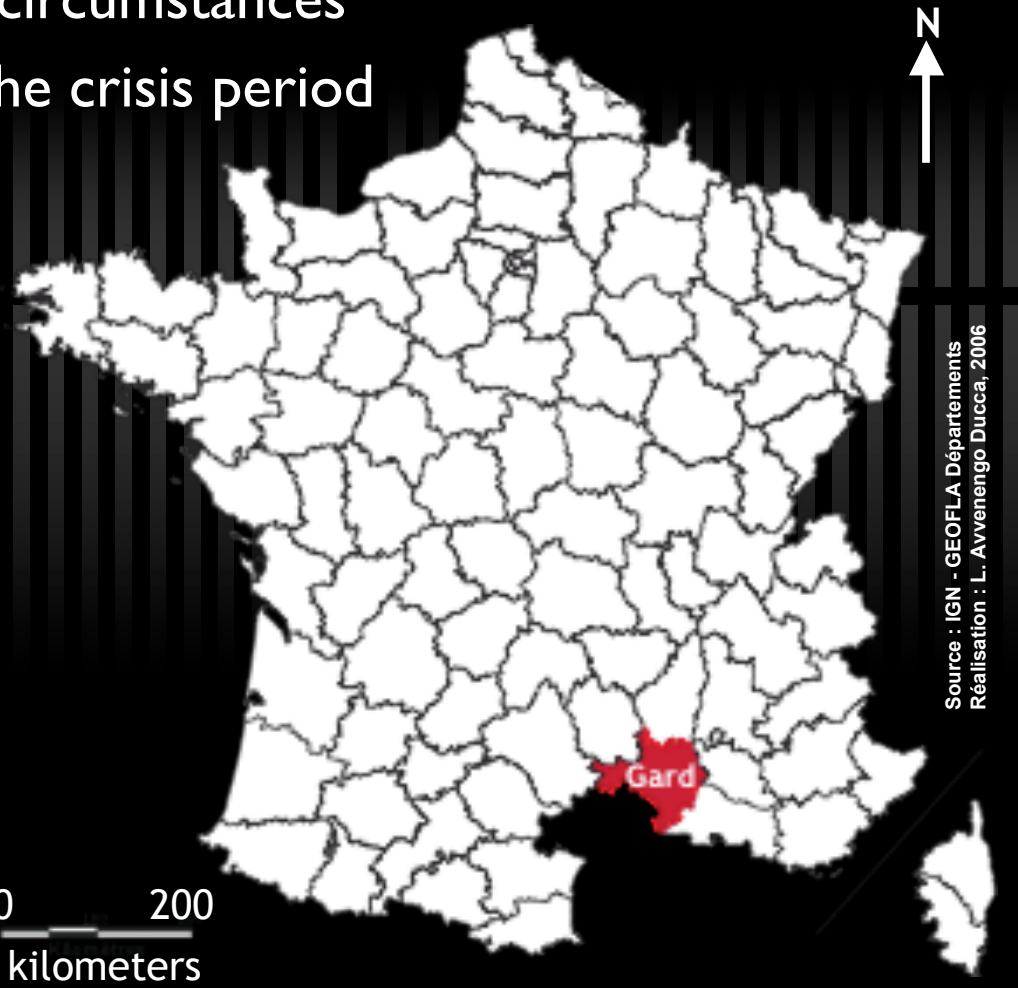
② Discrepancy between individual space-time representations and actual flash flood phenomenon characteristics

2- Investigating public response components

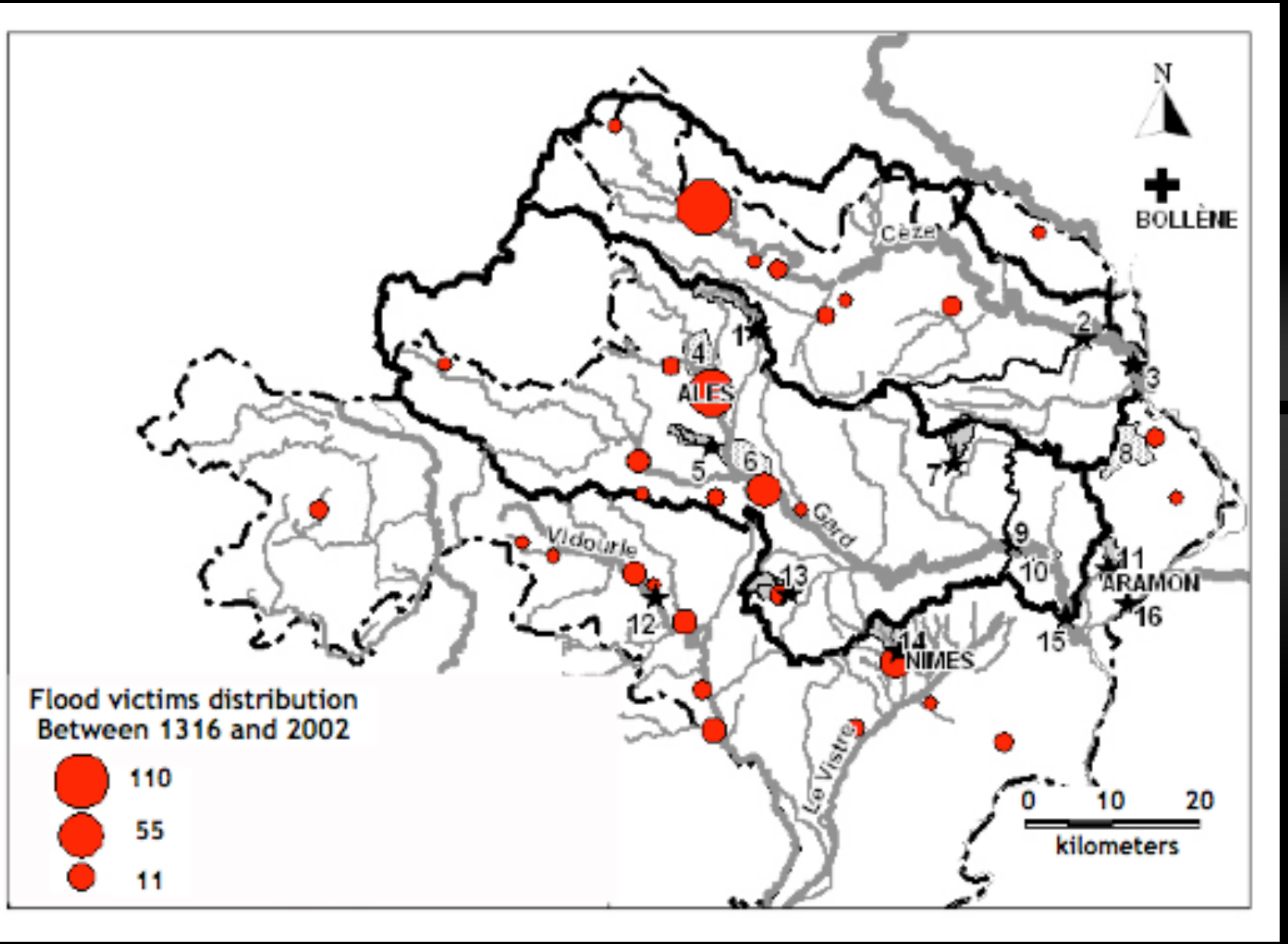


Study area and methods

- Post-flood investigations (2002, 2005)
  - ✓30 in-depth interviews
  - ✓Analysis of loss of life circumstances
  - ✓Observations during the crisis period
- Questionnaires surveys
  - ✓ 960 residents (representative sample)
  - ✓ 260 tourists
- Cognitive mapping
  - ✓ 200 residents: spatially stratified sampling

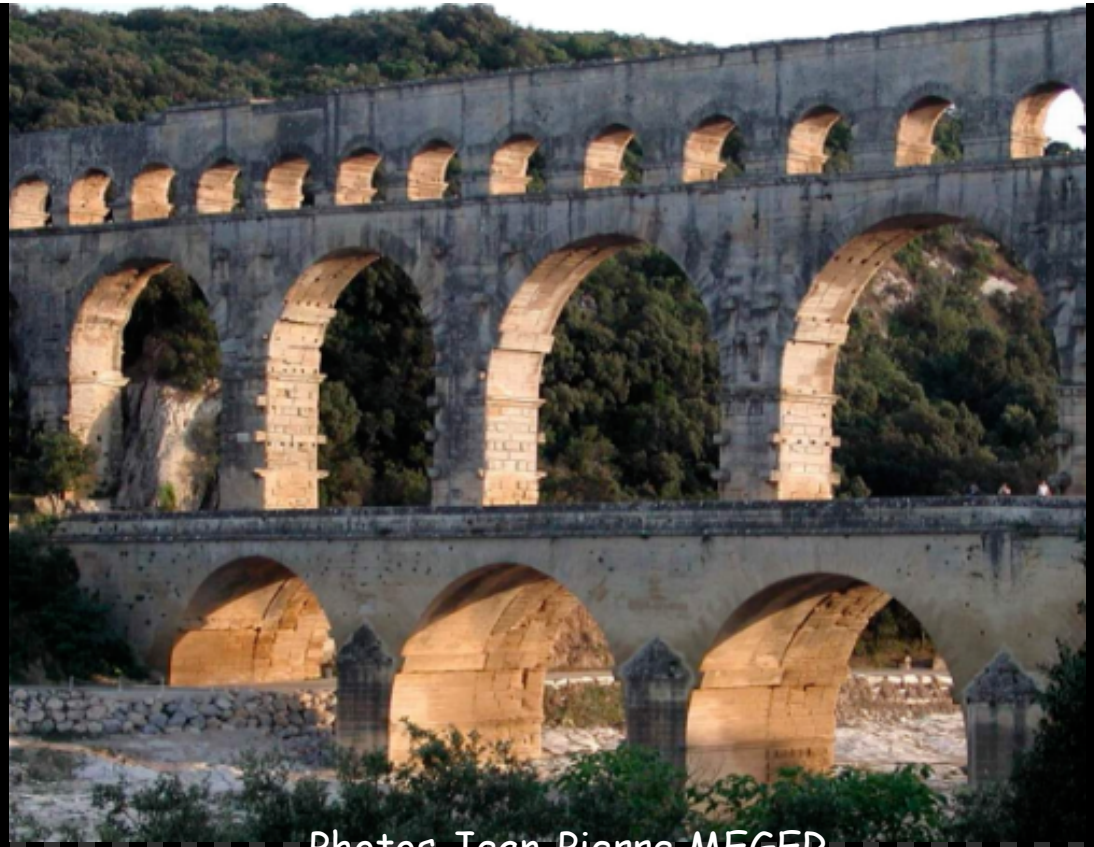


A vulnerable area




High water mark
Dions

Pont du Gard

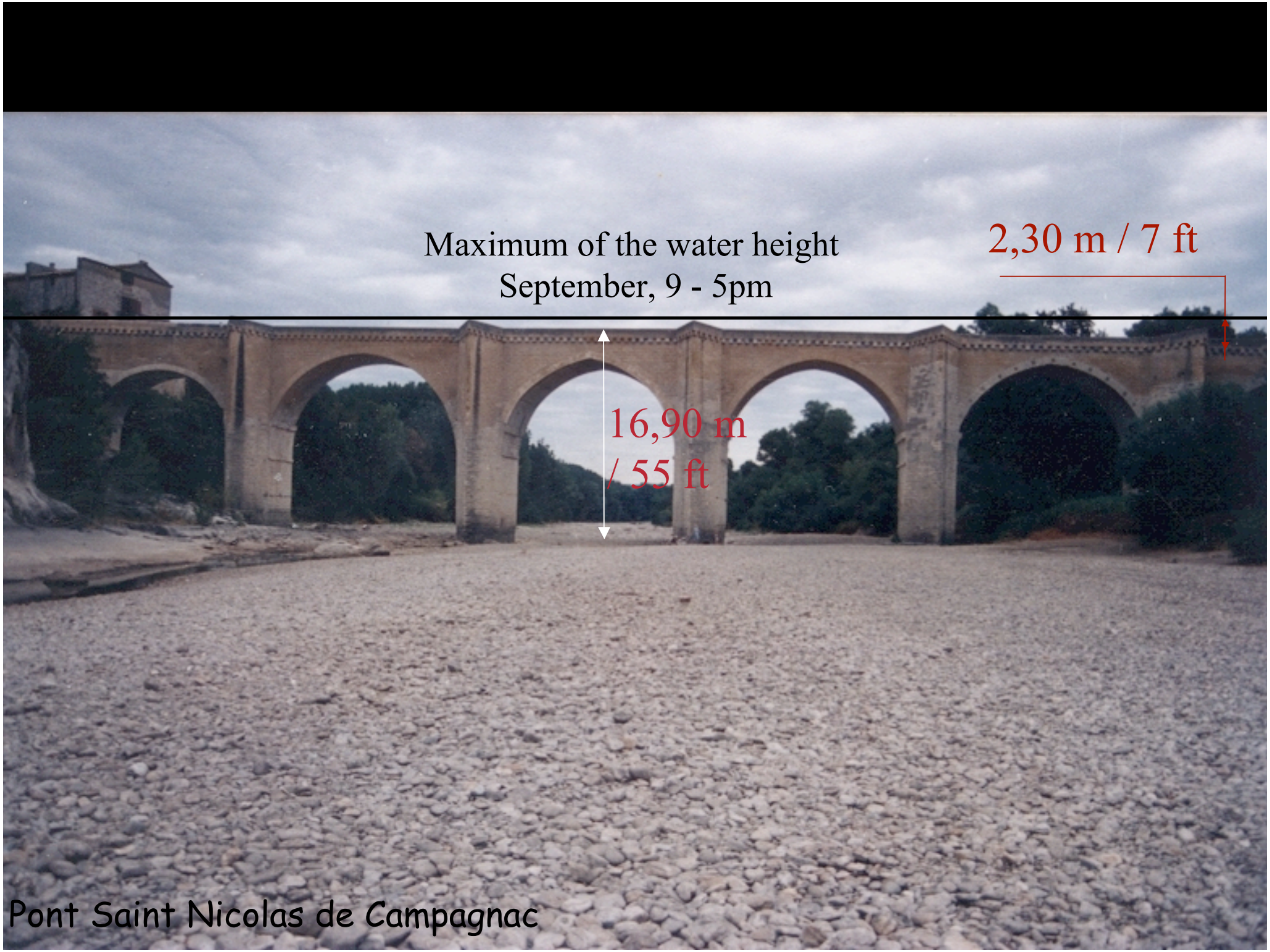


Photos Jean-Pierre MEGER

September, 9 2002 5:30pm

Pont du Gard maximum peak flow

Pont Saint Nicolas de Campagnac


Maximum of the water height
September, 9 - 5pm
2,30 m / 7 ft
16,90 m
/ 55 ft
Pont Saint Nicolas de Campagnac

Power of Flash Floods

Nîmes

Rues Catinat - Richelieu

October - 1988

Nîmes

Boulevard G. Pompidou

Before

During

October 1988

3- Main results

External factors

- Spatio-temporal scales of Flash floods
- Road network exposure
- Human exposure

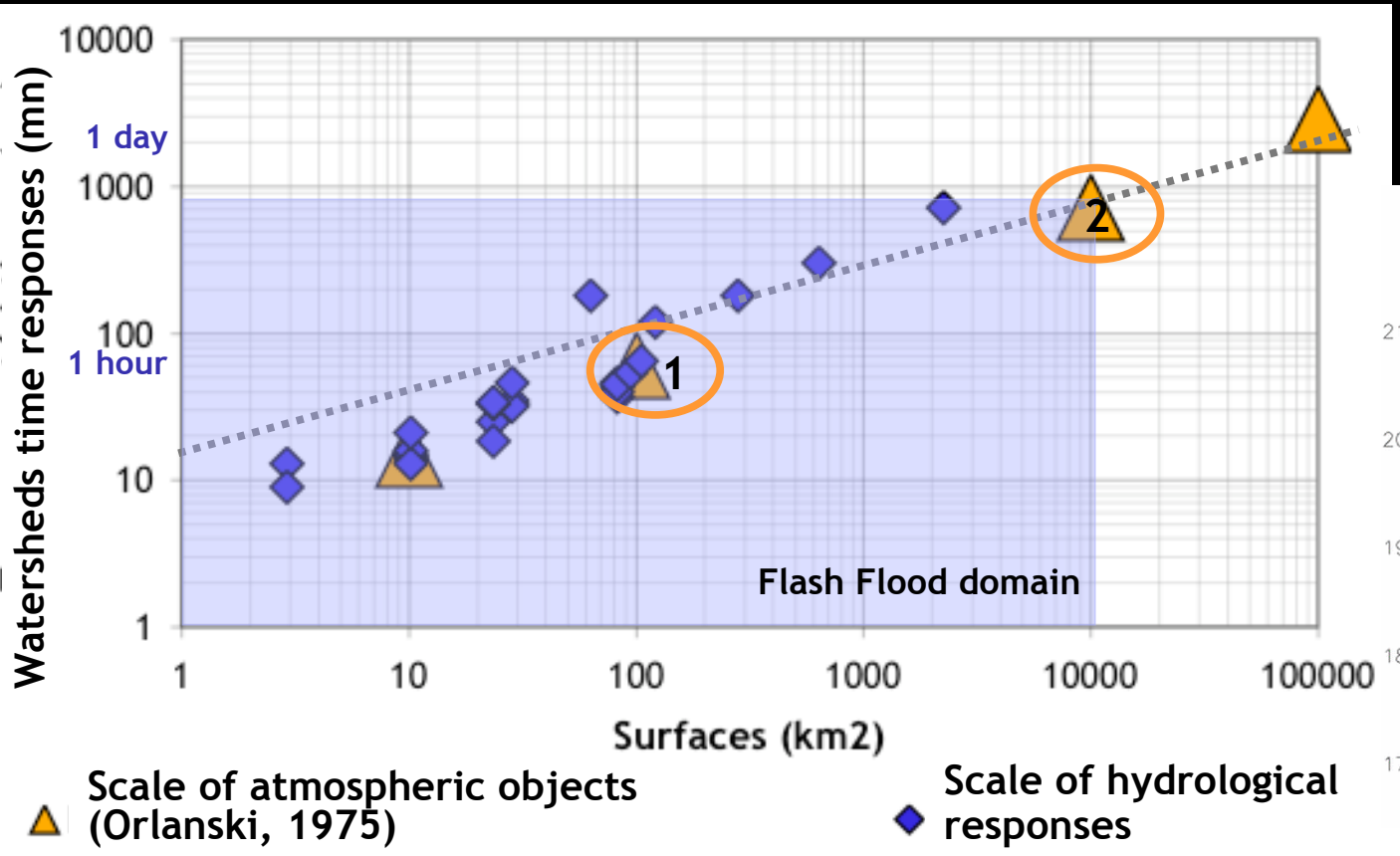
Internal factors

- Motorists' danger perceptions on daily itineraries
- Perceptions of vulnerability
- Personal traits
- At-risk travel patterns in the Gard region

Contextual factors

- Influence of spatial and temporal settings
- Social constraints

Spatio-temporal scales of Flash Floods

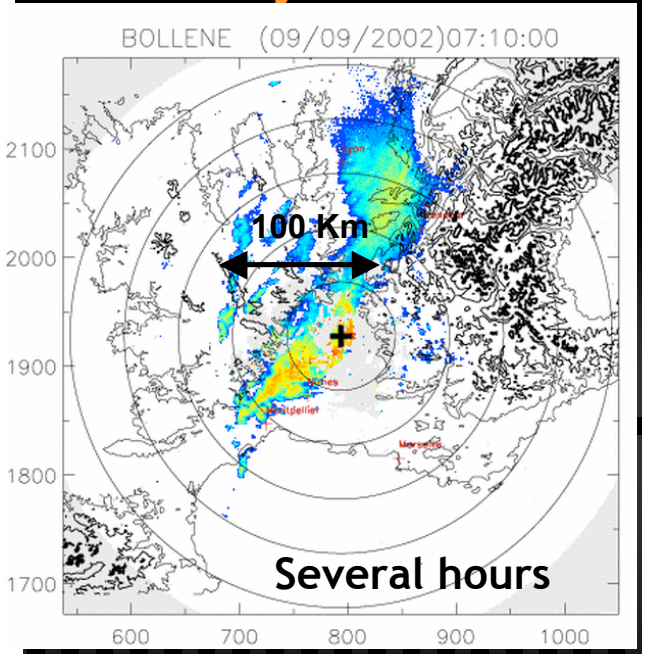


Scale of atmospheric objects (Orlanski, 1975)

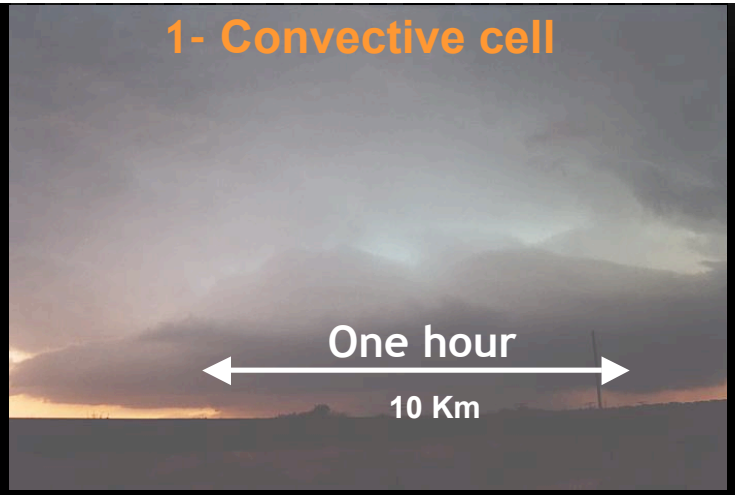
Scale of hydrological responses

Source : Creutin, 2001

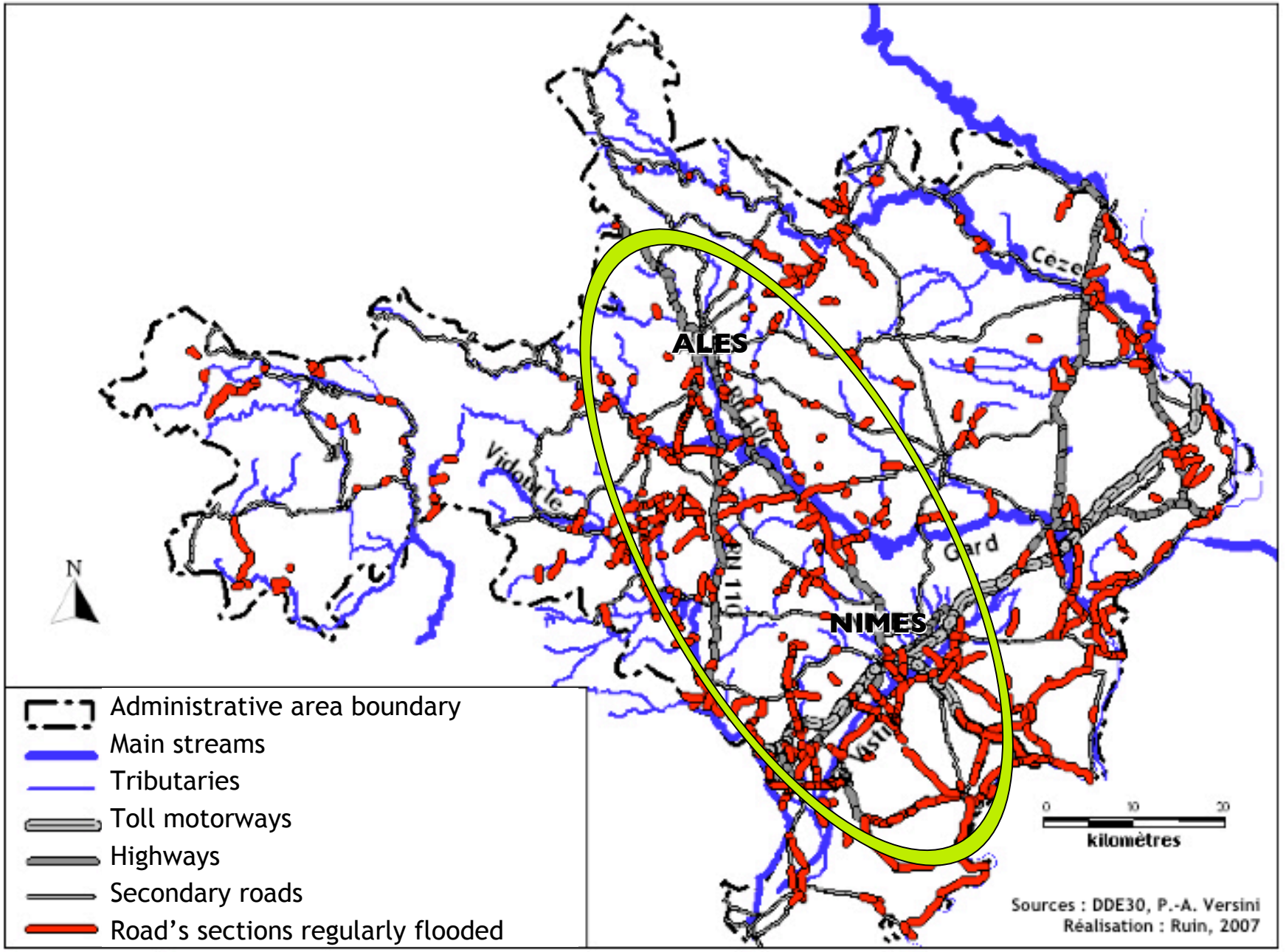
2- Meso-scale convective system



1- Convective cell

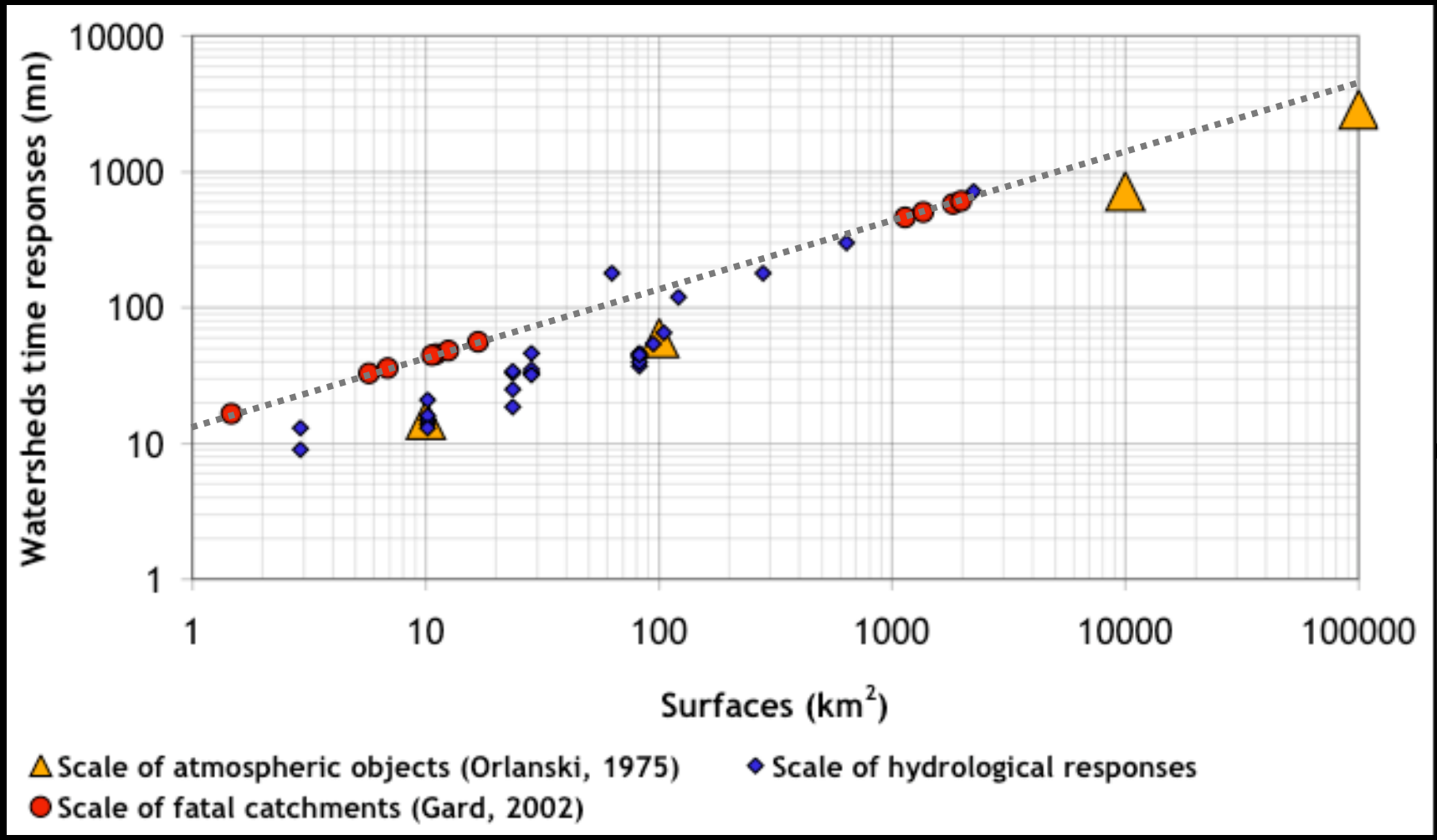


Large road network exposure



Human exposure during the 2002 Flash flood event (1)

Loss of life: hydrometeorological circumstances



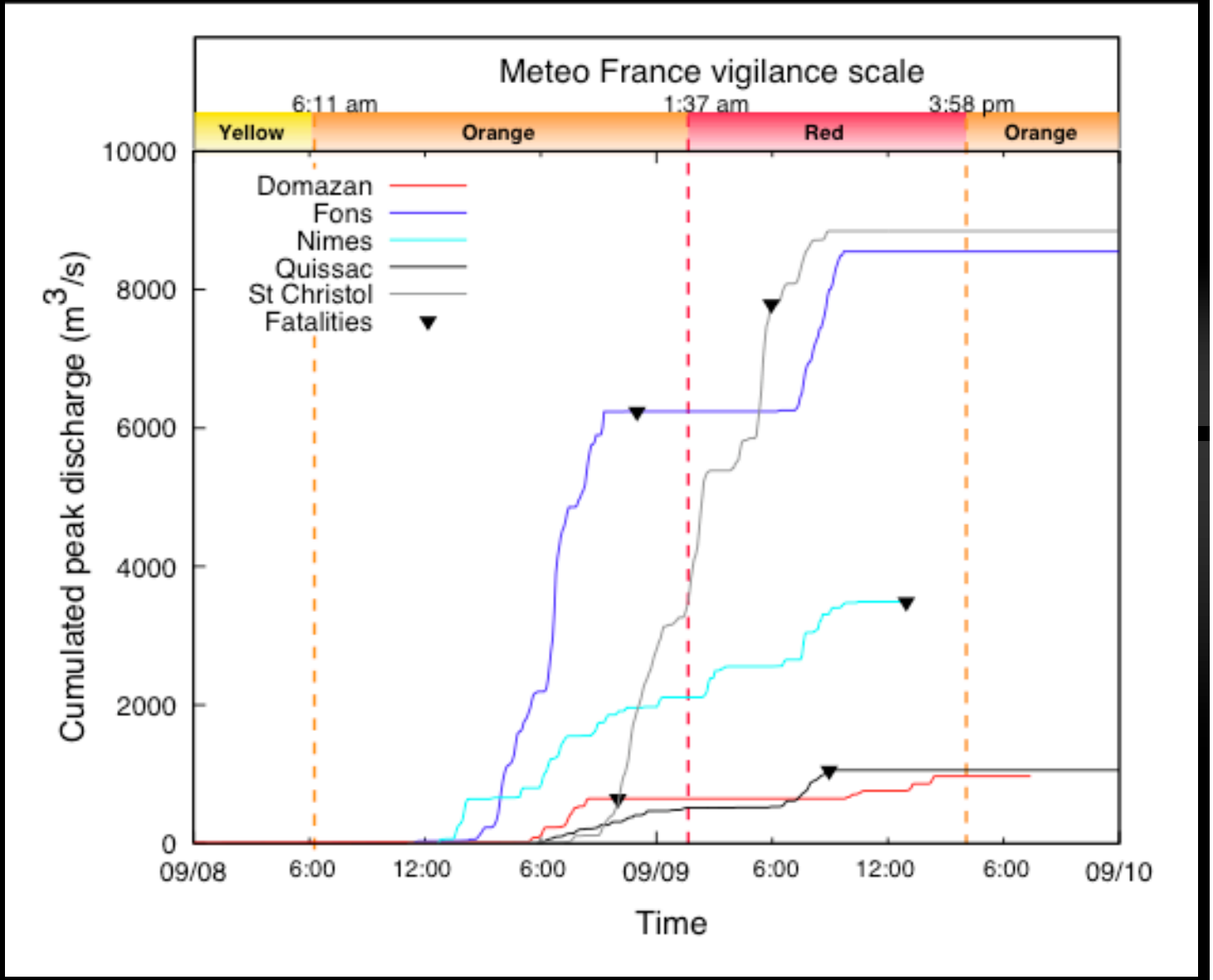
- ✓ 11 young individuals died in 9 watersheds smaller than 20 km^2
- ✓ 11 old individuals died in 5 watersheds bigger than 1000 km^2

Human exposure during the 2002 Flash flood event (2)

Loss of life: Warning efficiency

Extreme speed of watershed responses

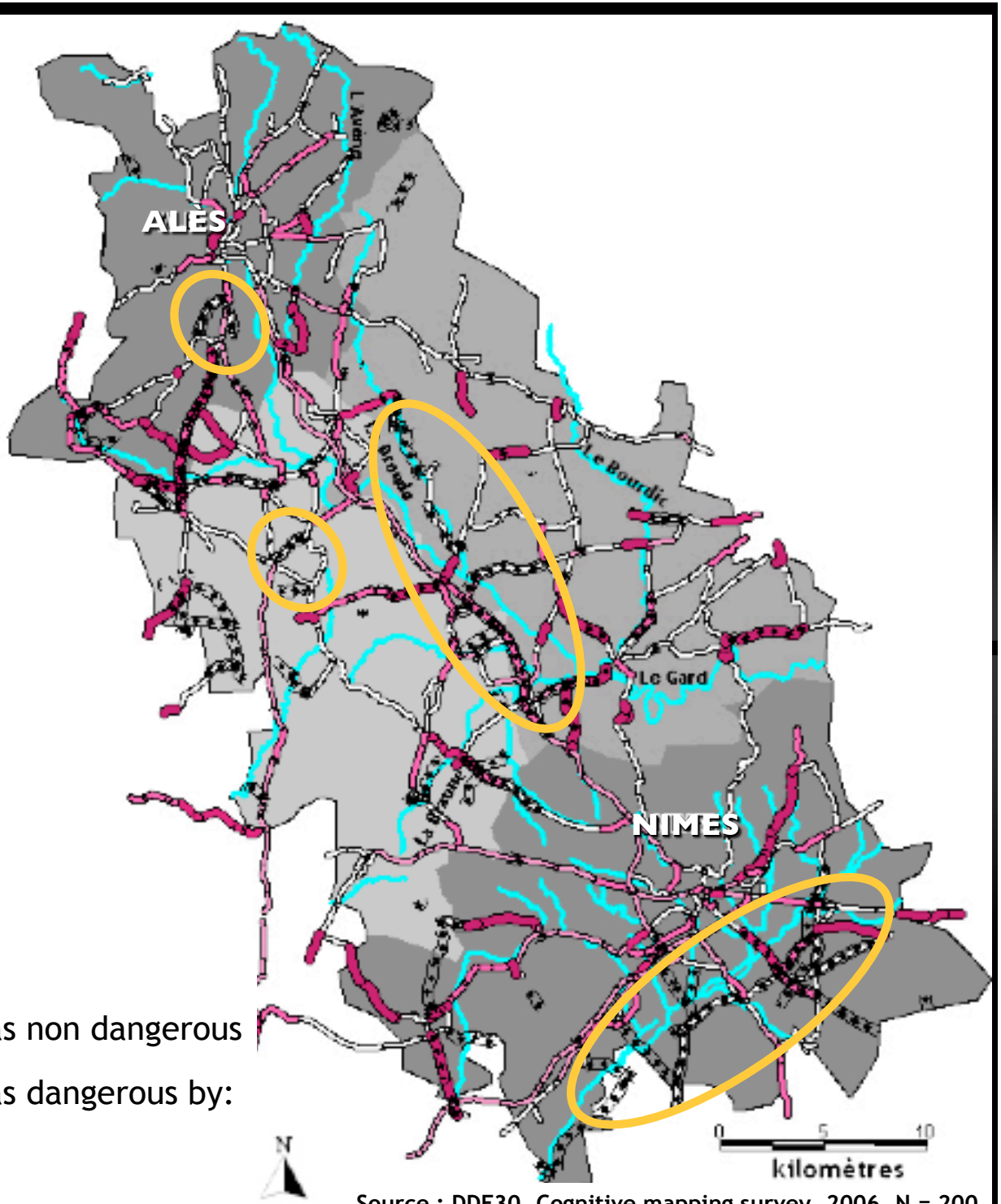
Extremely short lead-time for warnings



Motorists' danger perception on daily itineraries

✓ 29% of the road sections used by our sample are prone to flooding

➡ The 2/3 are not considered as dangerous



Source : DDE30, Cognitive mapping survey, 2006. N = 200
Ruin, 2007

Perceptions of vulnerability

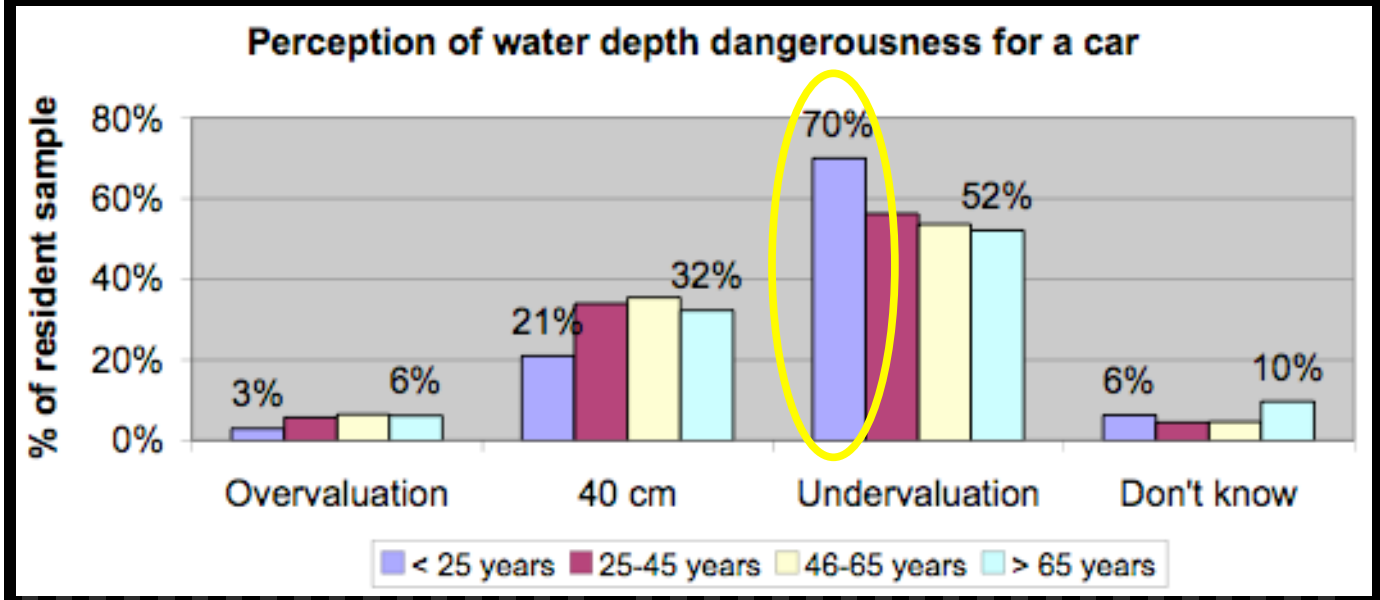
✓ Rapidity of watershed time response is mostly underestimated, especially for small catchments

✓ More than 60% underestimate the height of moving water that can sweep a car away. But they are more realistic about the water depth for a person to be knocked off their feet.

✓ Only 35% of the residents think Météo-France Orange alert represents a warning for fatal danger, but 55% associate it with danger on their own daily itinerary

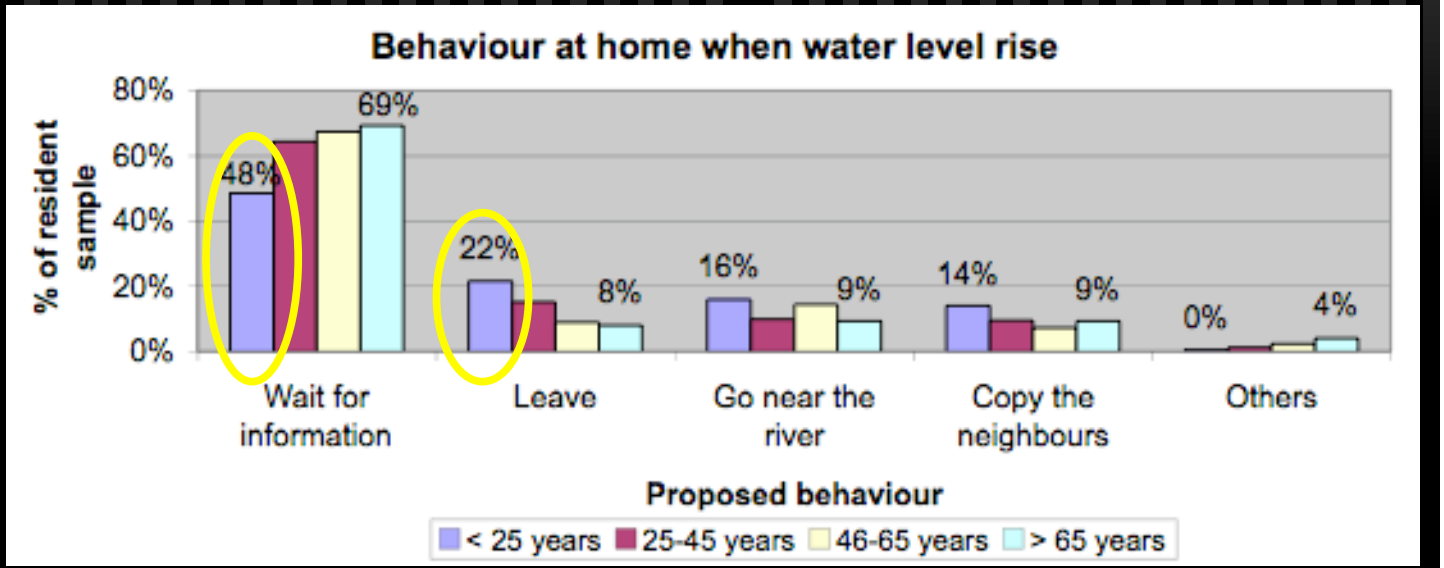
➔ **Traveling during a flash flood event is known to be dangerous, but thresholds of dangerousness are hardly perceived**

Age influence perception and declared behaviors

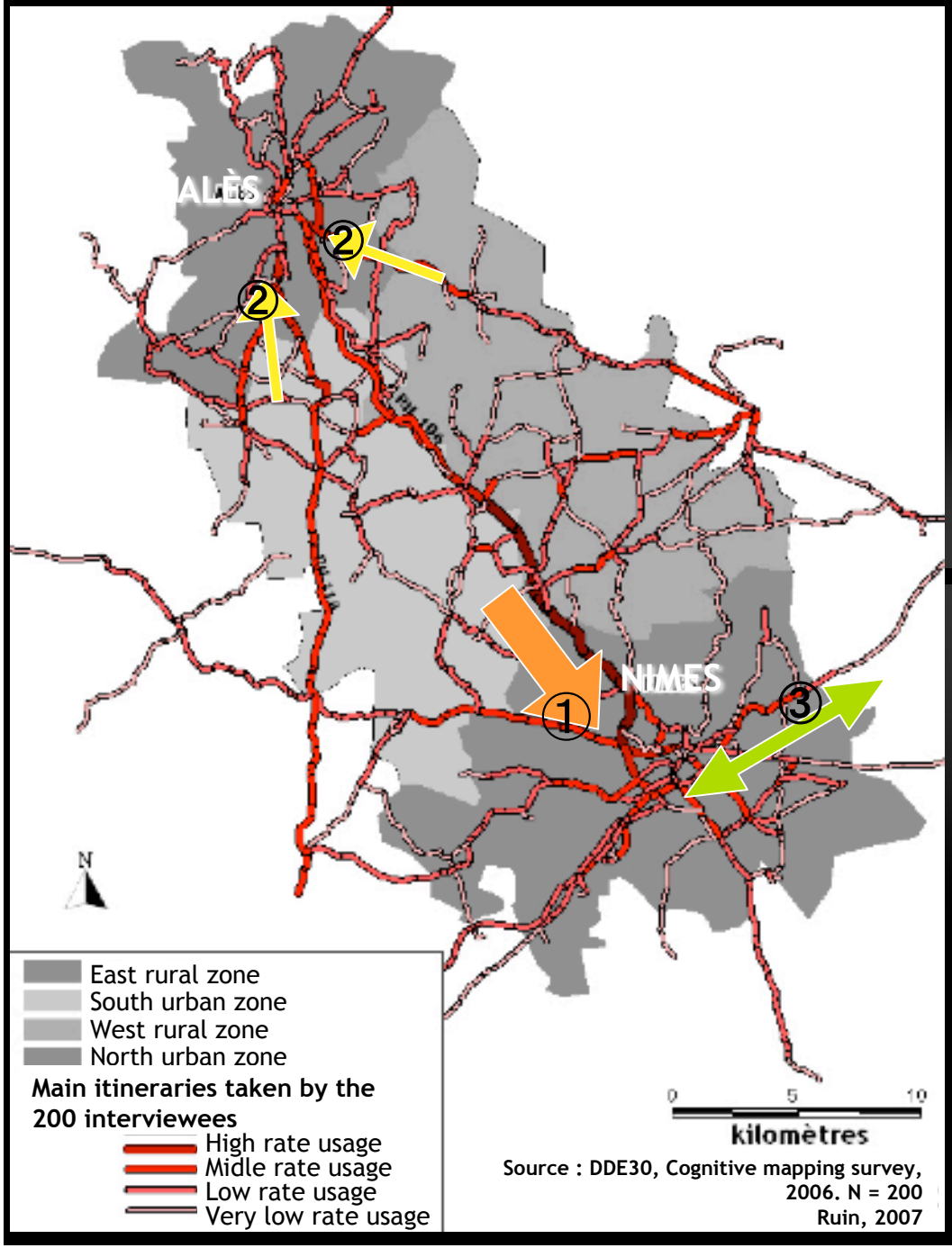


✓ Youngest people tend to undervalue dangerous water depth

✓ They also tend to be more mobile in emergency situation



Three kinds of at-risk mobility in the Gard area



① Commuting is highly risky

- 30% of the sample
- frequent and highly hazardous travels
- weak perception of risk on roads

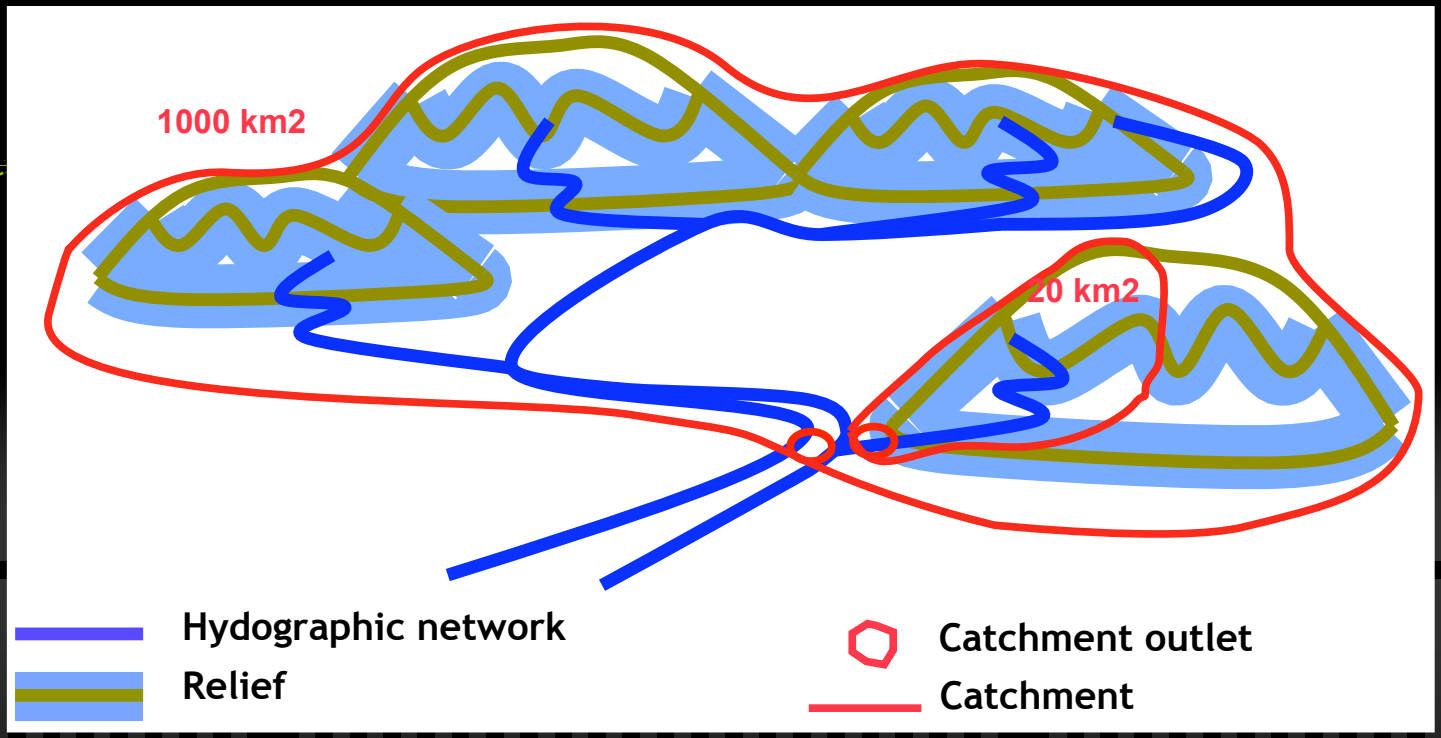
② At-risk mobility of rural retired

- 20% of the sample
- frequent but little hazardous travels
- weak perception of risk on roads

③ Inter-state mobility fairly risky

- 10% of the sample
- unfrequent and fairly hazardous travels
- weak perception of risk on roads

Influence of spatial and temporal settings

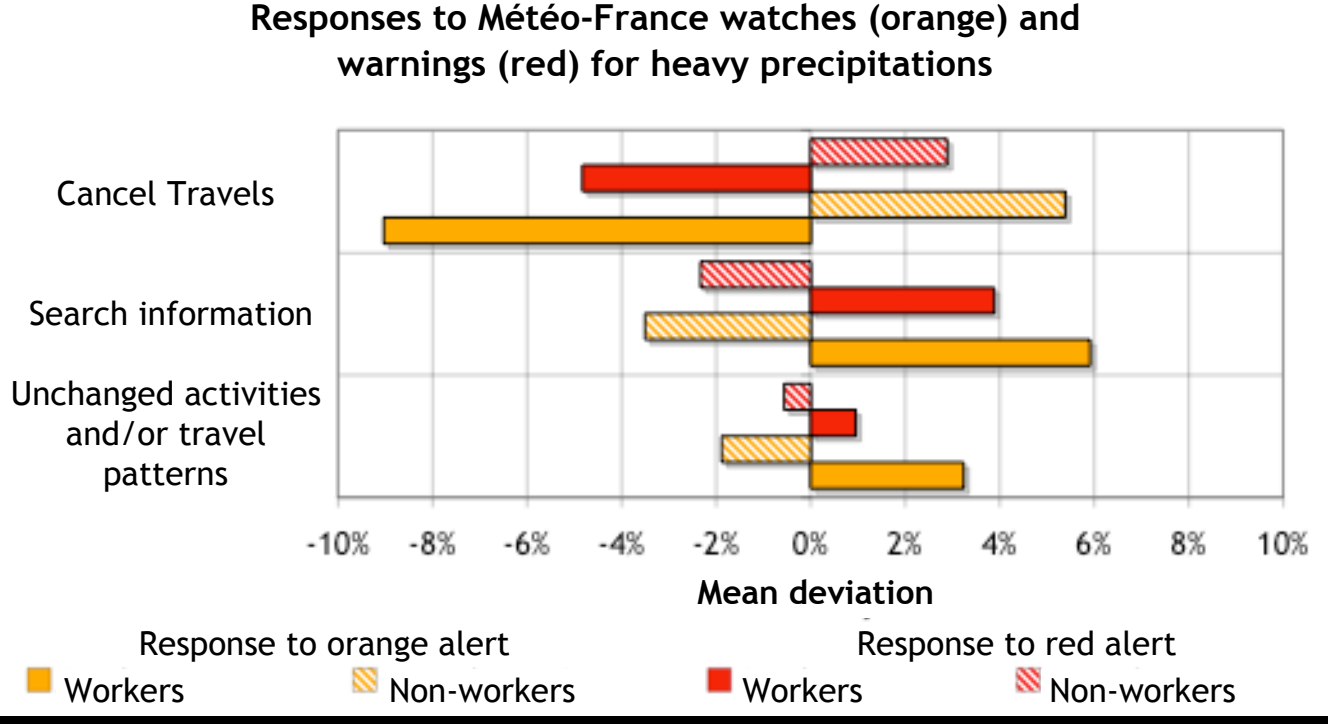


- ✓ People located at the confluence of watersheds of different sizes
- ✓ Succession or simultaneity of flood peaks due to differences in catchment sizes
- ✓ Vulnerability variations within the time of the day, week, season...

Social constraints

✓ In reaction to warnings, 50% of the parents would pick up their children from school.

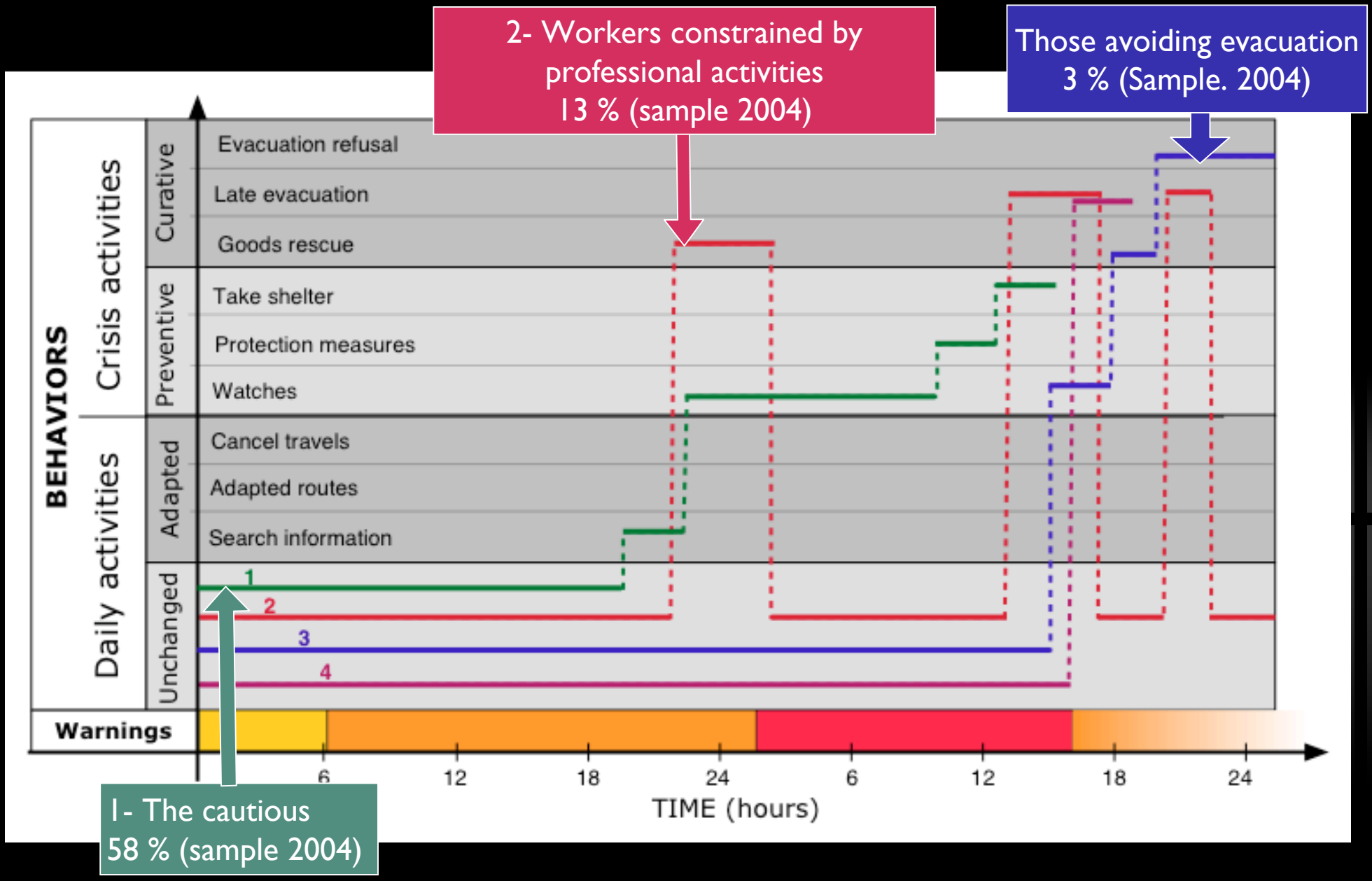
✓ Workers would hardly cancel their travels



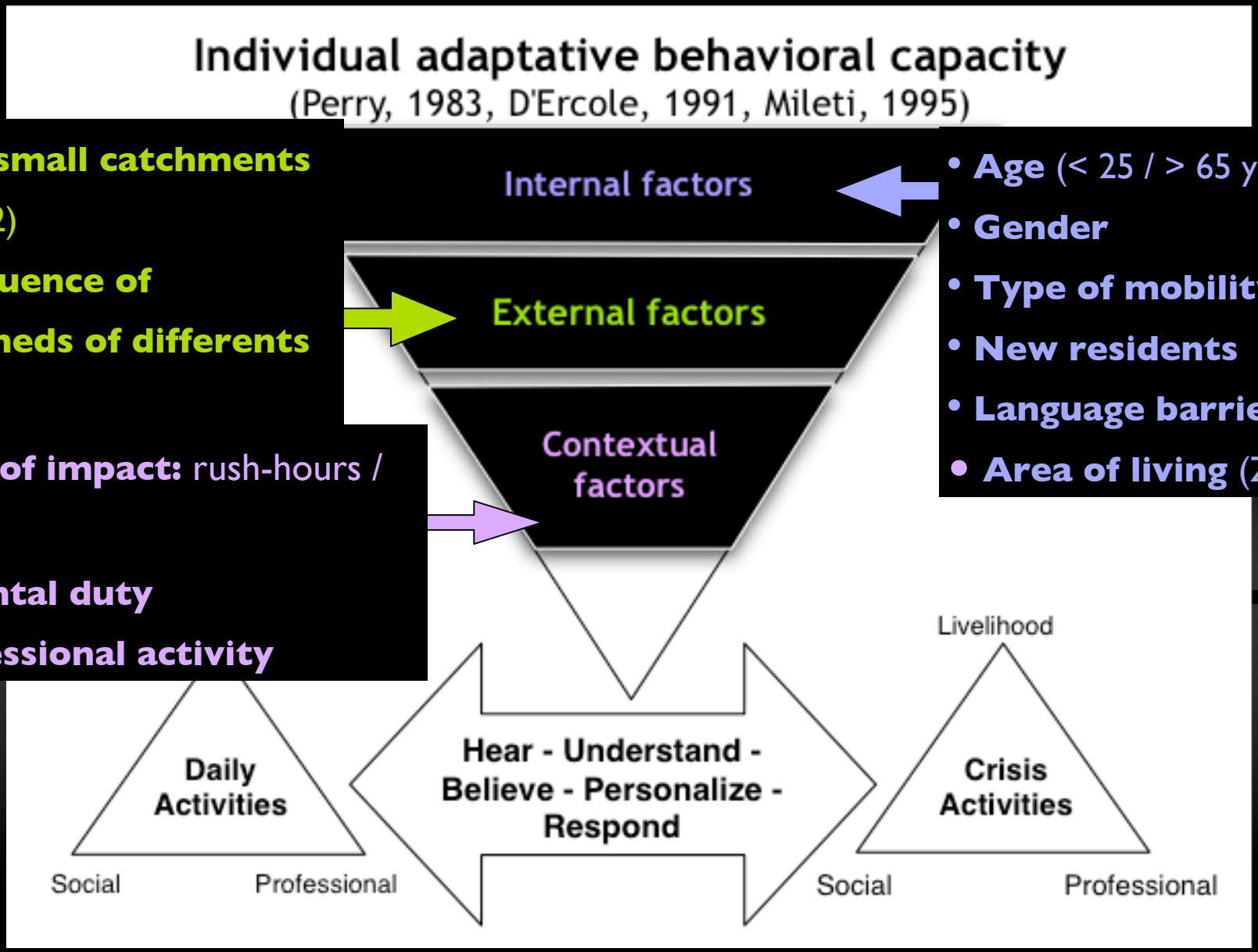
4- Conclusion and looking ahead

- ✓ Behavioral verification
- ✓ Synthesis of vulnerability factors in crisis period
- ✓ Research perspectives

Behavioral verification



Synthesis of vulnerability factors in crisis period



- **very small catchments** (< 20km2)
- **Confluence of watersheds of differents sizes**
- **Time of impact:** rush-hours / night...
- **Parental duty**
- **Professional activity**

- **Age** (< 25 / > 65 years old)
- **Gender**
- **Type of mobility**
- **New residents**
- **Language barrier** (tourists)
- **Area of living** (ZUsud)

Research perspectives

➔ Need for **Behavioral verification surveys** to assess adaptative capacities of drivers in different weather conditions:

1. Observe behaviors in both normal daily life and extreme weather conditions

2. Organize extreme events post investigations

1- Observe drivers' behavior

Objective 1: Identify environmental factors influencing drivers' behaviors at low water crossings in Texas

- ✓Do different types of barriers prevent motorists from driving through flooded roads?
- ✓How are behaviors influenced by environmental cues (visibility, rainfall, water depth, water flow…), weather forecast, watches and warnings?
- ✓Does the type of car make a difference in terms of behavior?

→ Quantitative assessment through car counting and video observations

1- Observe drivers' behavior

Objective 2: Identify personal factors influencing drivers' behavior at low water crossings in Texas

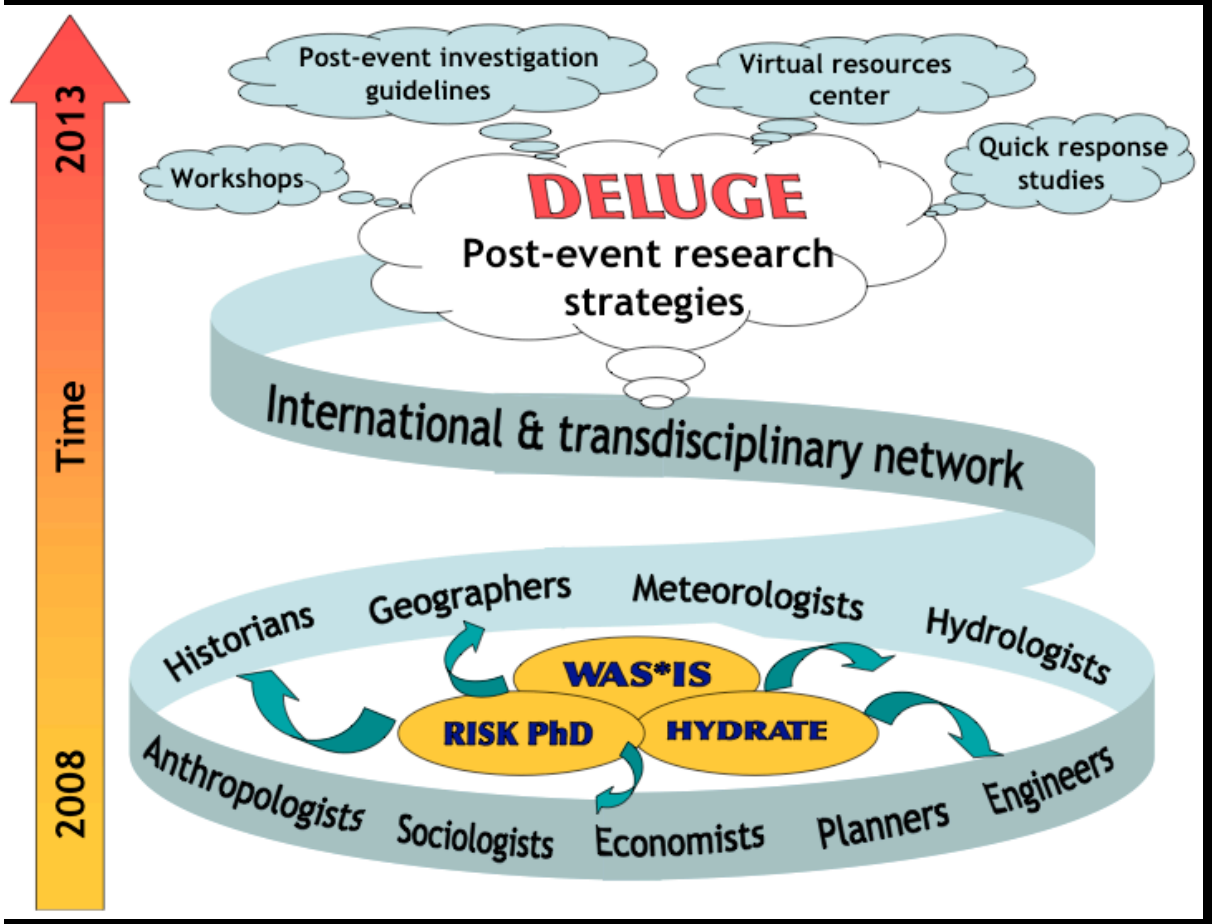
- ✓How much local knowledge and cognitive mapping of neighborhoods' residents influence driving behaviors?
- ✓What personal traits may be correlated with risky or cautious behaviors?
- ✓What travel purposes lead to most risky behaviors?

→ Qualitative assessment thru travel diaries and in-depth interviews

2- Improve post-flood investigations

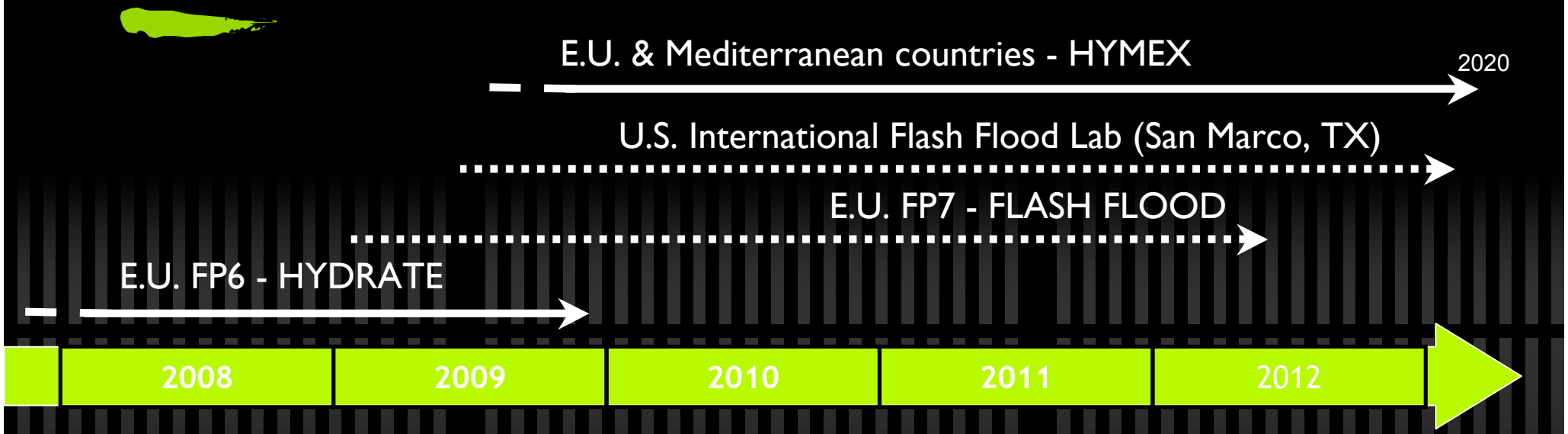
DELUGE: Eve Gruntfest new initiative

Disasters **E**volving **L**essons **U**sing **G**lobal **E**xperience



- ✓ Focus on post-event field studies for floods to **maximize interactions between social scientists, hydrologists and meteorologists**
- ✓ **New guidelines on post-event investigations** for use by integrated teams of physical scientists, social scientists, and practitioners.

U.S. and E.U. flash flood research opportunities



HYDRATE: Hydrometeorological data resources & technologies for effective flash flood forecasting

HYMEX: HYdrological cycle in the Mediterranean Experiment (Observation campaign)

FLASH FLOOD: Development of a European-wide integrated framework for flash flood and associated debris flow risk management

Intl FF Lab: Negociations underway for a development at the James and Marilyn Lovell Center for Environmental Geography and Hazards Research, Texas State University

Thank You for your attention

Questions?