WHAT KIND OF
ENVIRONMENTAL
TRANSITION
FOR THE MEDITERRANEAN REGION?

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Pharo

The impacts of floods in the mediterranean basin : drivers, trends and adaptation

Dr Freddy Vinet
Professor of geography
Head of the department of geography University Paul-Valéry Montpellier 3

Contact : freddy.vinet@univ-montp3.fr

UMR GRED Gouvernance, Risque, Environnement, Développement

IRD Institut de Recherche pour le Développement FRANCE

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Introduction (objectives & methods)

- What are the human impacts of floods in the Mediterranean basin ?

- Past and future trends of Flood related Mortality ?

- Drivers of mortality for the future ?

→ Put together some results of several researches at different scale

Introduction

We start from **flood related mortality**

- We believe that loss of life during floods is not hazardous, not casual :
It is due to hazards factors, exposure, vulnerability of people, bad behavior, lack of alert lack of prevention…

- Good indicator to monitor long term flood impacts and to assess flood prevention

→ time-independant and comprehensive

Source : municipality of Draguignan, L. Boissier 2013

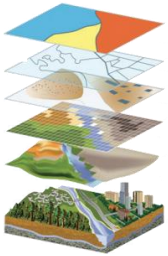
Introduction

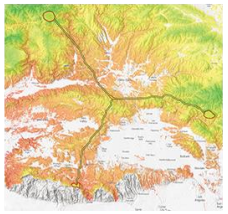
French Data
Spanish Data
Balearic I. Data
Greek Data
Italian Data
Turkish Data
…/…

Statistical analysis
Petrucci et al. (2017)

Building of the DB

Spatial analysis (GIS)
georeferencing





Calculation and downscaling analysis of Fatality rate

By country

By NUTS 3 region

By grid

By watershed area

Input data :
- *Hazard data*
- *Population*
- *Land use*
- *Prevention measures*

…

Comparisons, explanation and outcomes for prevention

Introduction

The MEFF (MEditerranean Flood Fatalities) database
Database of victims caused by floods in 6 Mediterranean areas : Catalonia, Balearic Islands, South of France, Calabria, Greece, Turkey

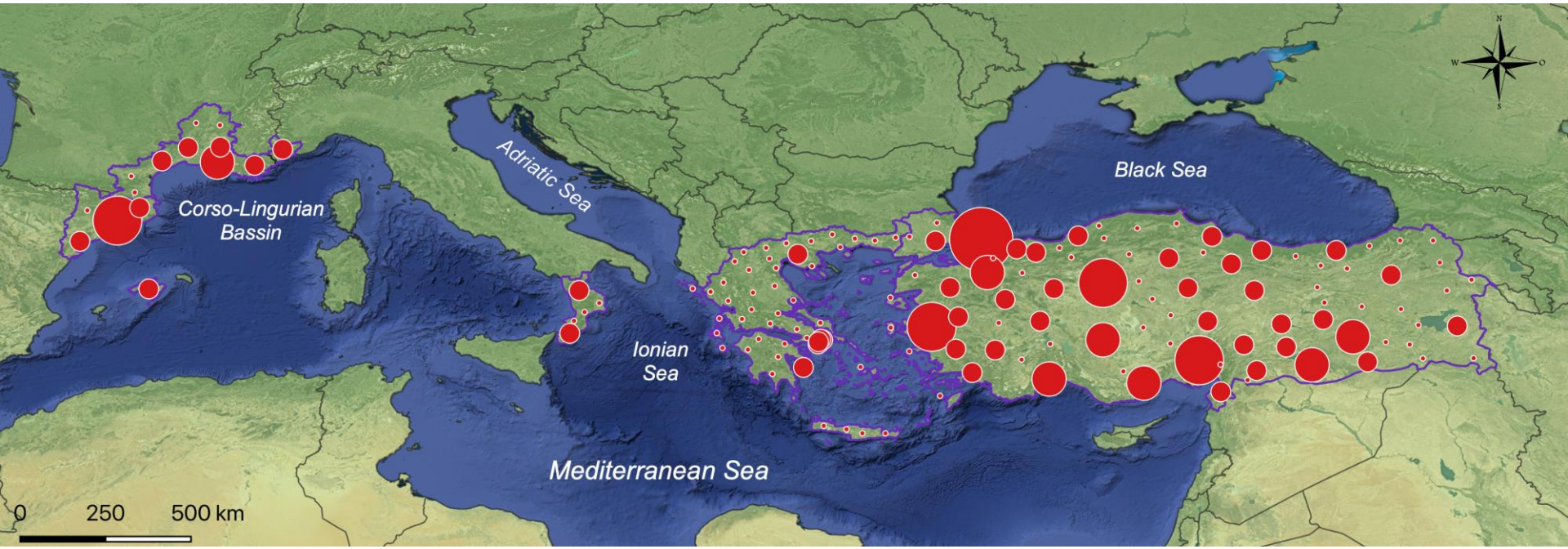
Data sources: press archives
Study period: 39 years, 1980-2018
Space resolution: municipal scale
Time resolution: year, month, day, hour

→ *Petrucci O. et al. (2018) MEFF: the database of Mediterranean Flood fatalities (1980 to 2015) Journal of flood risk management. DOI:10.1111/jfr3.12461*

→ *Petrucci O. et al. (2018)* People-flood interaction: victims throughout four mediterranean countries in 35 years. *PICO EGU conference Vienna April 2017*

1- Overview of flood related mortality in the Mediterranean Basin

The population of the study area in 2000



Sources : Socioeconomic Data and Applications Center (SEDAC) and Eurostat

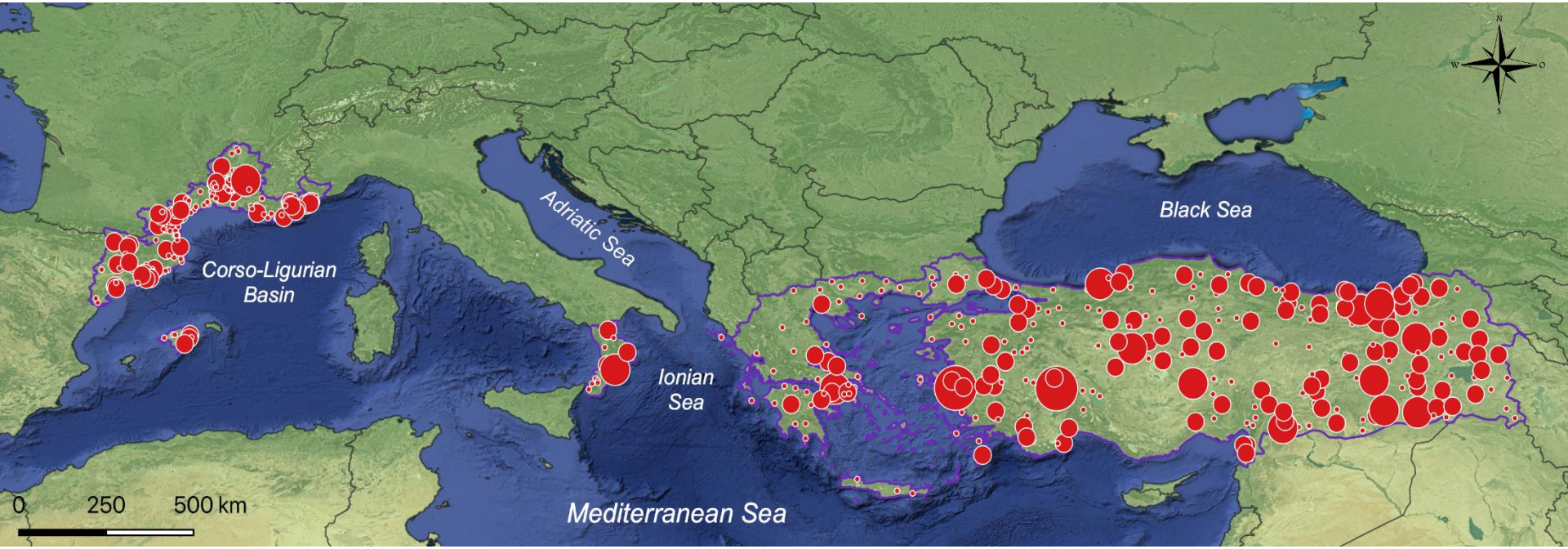
Vinet et al. Water 2019

NUT3 administrative unit

Population per NUTS3 region (2000)
- 20 000 - 500 000
- 500 000 - 1 200 000
- 1 200 000 - 2 000 000
- 2 000 000 - 5 000 000
- 5 000 000 - 10 075 652

1- Overview of flood related mortality in the Mediterranean Basin

1809 flood related deaths in the MEFF DB



Sources : MEFF DB and Socioeconomic Data and Applications Center (SEDAC) and Eurostat

Vinet et al. Water 2019

Number of fatality per municipality

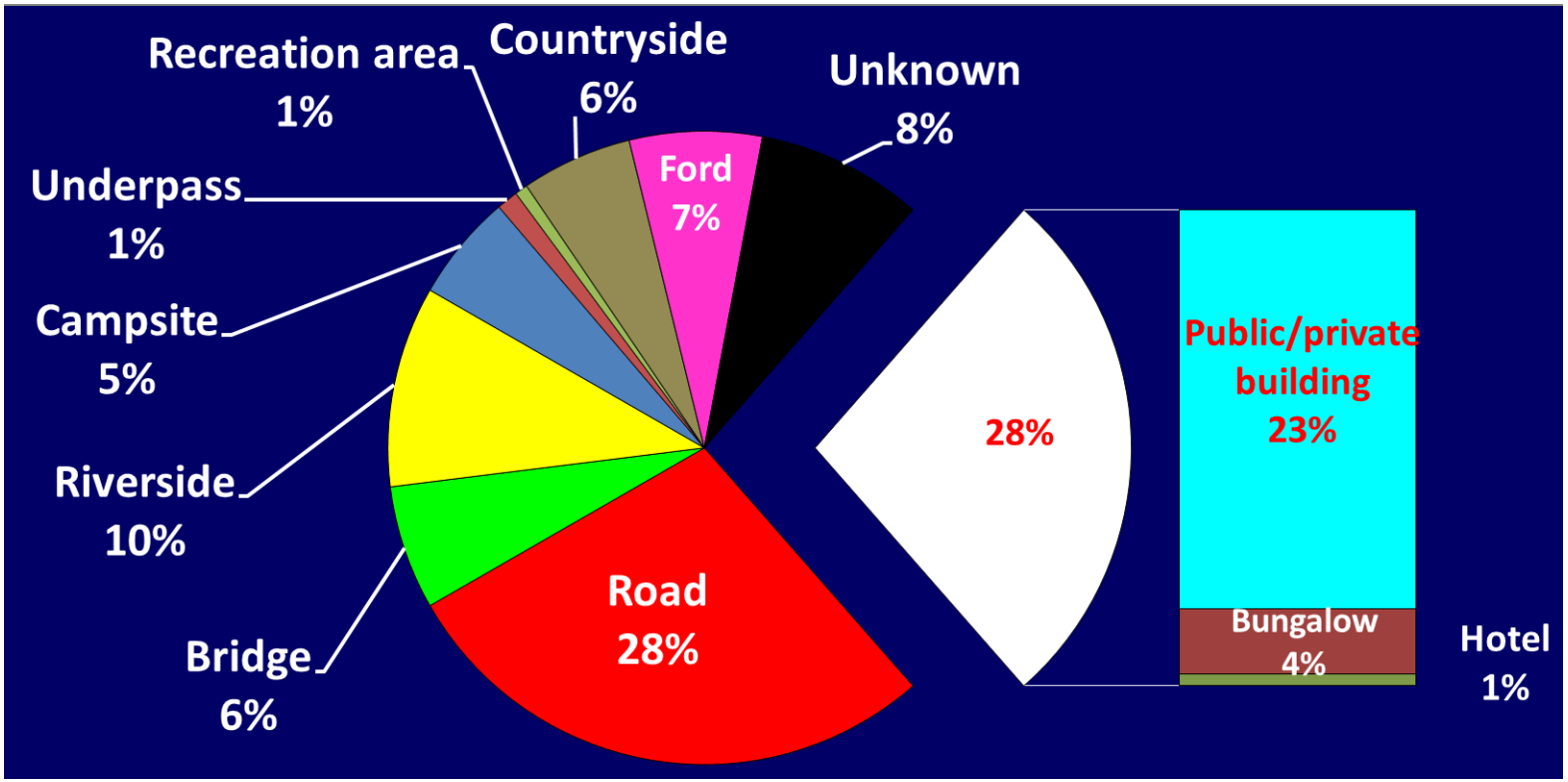
- 1 - 2
- 2 - 11
- 11 - 46
- 46 - 74

The density of mortality is linked to high population densities.

→ Greece

1- Overview of flood related mortality in the Mediterranean Basin

The profile and circumstances of flood related deaths



Petrucci et al., 2018

72 % outdoor, 28% indoor

1- Overview of flood related mortality in the Mediterranean Basin

The flood-related fatality rate is the annual number of fatality per million of inhabitants

$$F = \frac{(Nf * Pop^{-1}) \times 1000000}{N_y}$$

F = fatality rate

Nf = number of fatality per spatial entity

Pop = Population in 2000

N_y = number of years of the record period (39)

128 regions (NUTS3) out of 153 (84%) got fatalities through the period

Median rate Fm = 0,27 (Fm = 0,406 if we exclude Nf = 0)

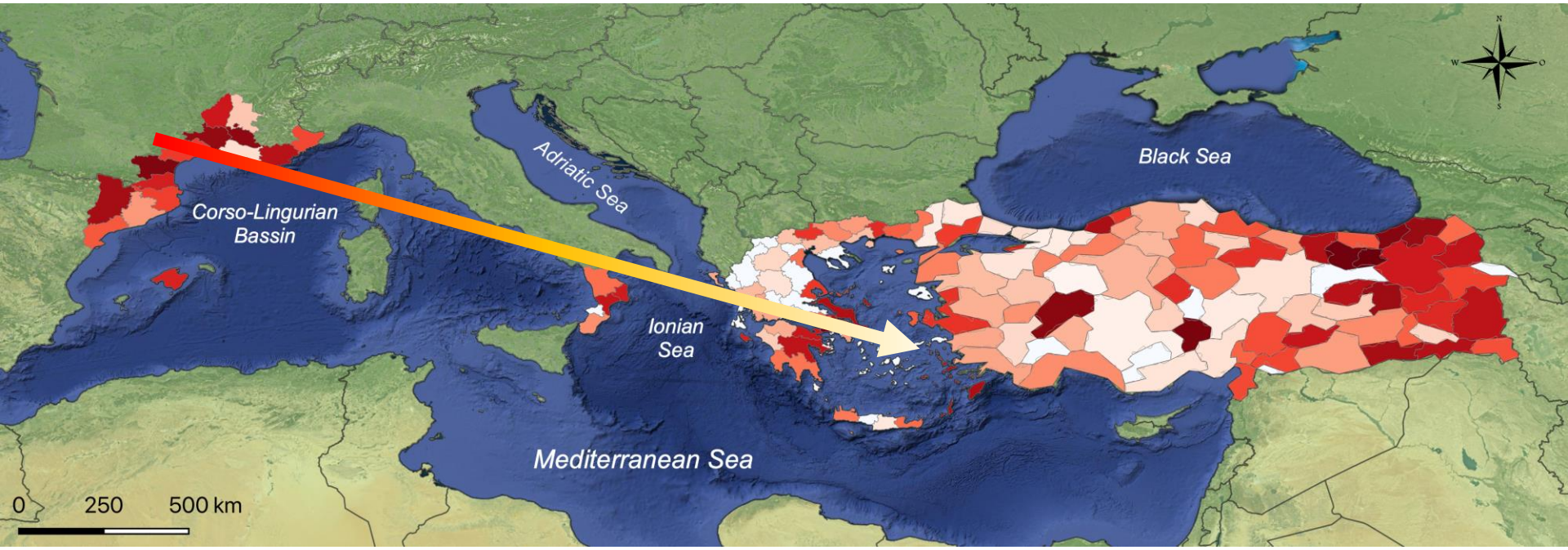
Max F = 16,482 Trabzon (Turkey)

1- Overview of flood related mortality in the Mediterranean Basin

Area	Number of fatalities	Population (2000)	Fatality rate Number of death / year / 1M inhabitants
Turkey	1242	66 890 000	0,476
France (Mediterranean Side)	275	7 233 580	0,975
Greece	132	10 780 000	0,314
Spain (Catalonia)	100	6 293 440	0,407
Italy (Calabria)	40	2 028 630	0,506
Spain (Balearic I.)	20	823 401	0,623
Study area	**1809**	**94 050 000**	**0,49**

1- Overview of flood related mortality in the Mediterranean Basin

Mapping of Flood related mortality rate per NUTS 3 region



Sources : MEFF DB and Socioeconomic Data and Applications Center (SEDAC) and Eurostat

Vinet et al. Water 2019

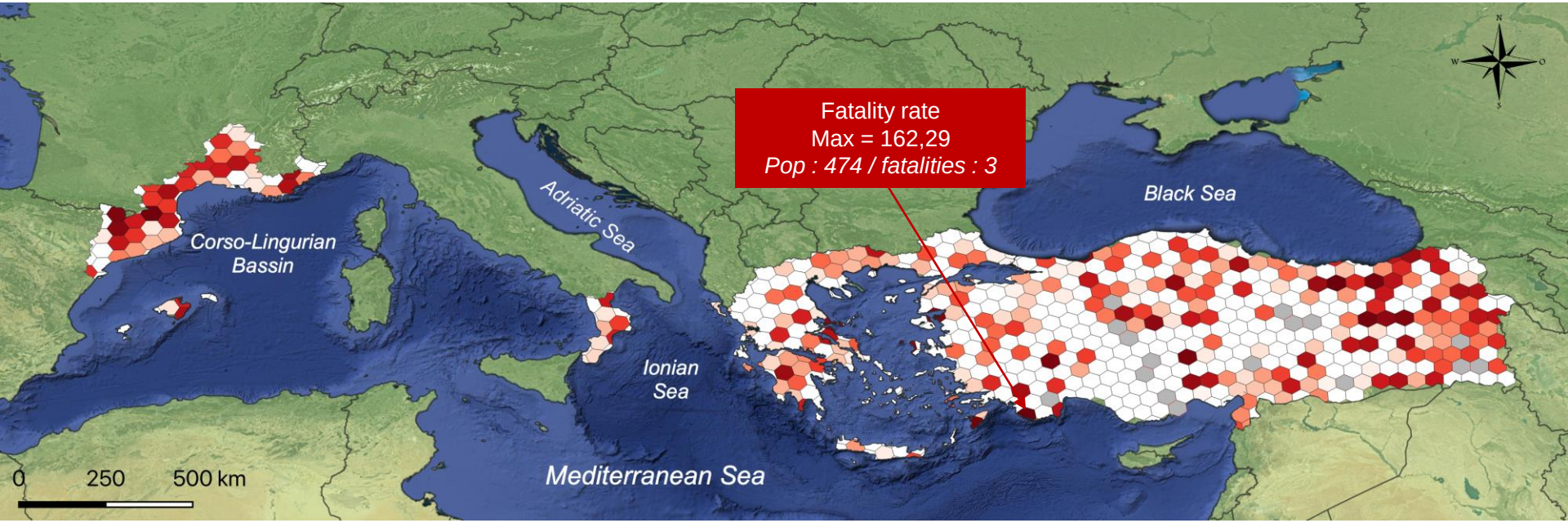
A decreasing gradient of mortality from West to east

Fatality rate *(fatality / year / 1M inhabitants)*

0 — *16,482*

1- Overview of flood related mortality in the Mediterranean Basin

Mapping of Flood related mortality rate per grid (50*50 km = 2 165,06 km2)



Sources : MEFF DB and Socioeconomic Data and Applications Center (SADAC) and Eurostat

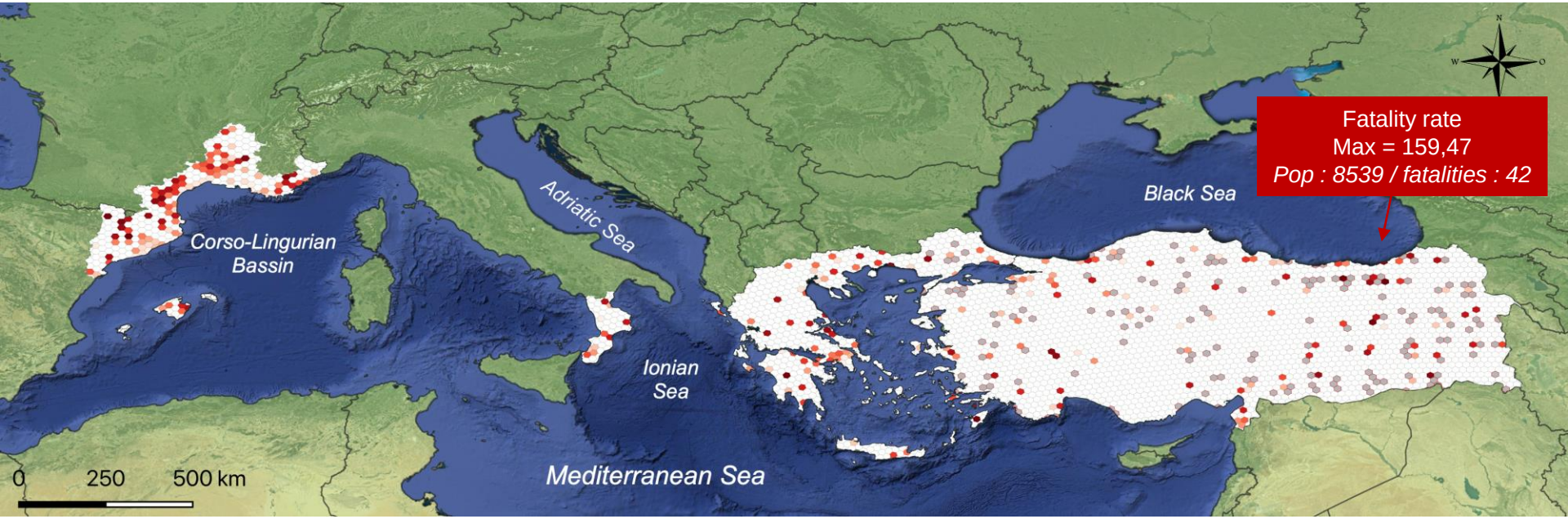
Fatality rate *(fatality / year / 1M inhabitants)*

0 *162,29*

No population data

1- Overview of flood related mortality in the Mediterranean Basin

Mapping of Fatality rate per grid (20*20 km = 346,41 km^2)



Sources : MEFF DB and Socioeconomic Data and Applications Center (SADAC) and Eurostat

Vinet et al. Water 2019

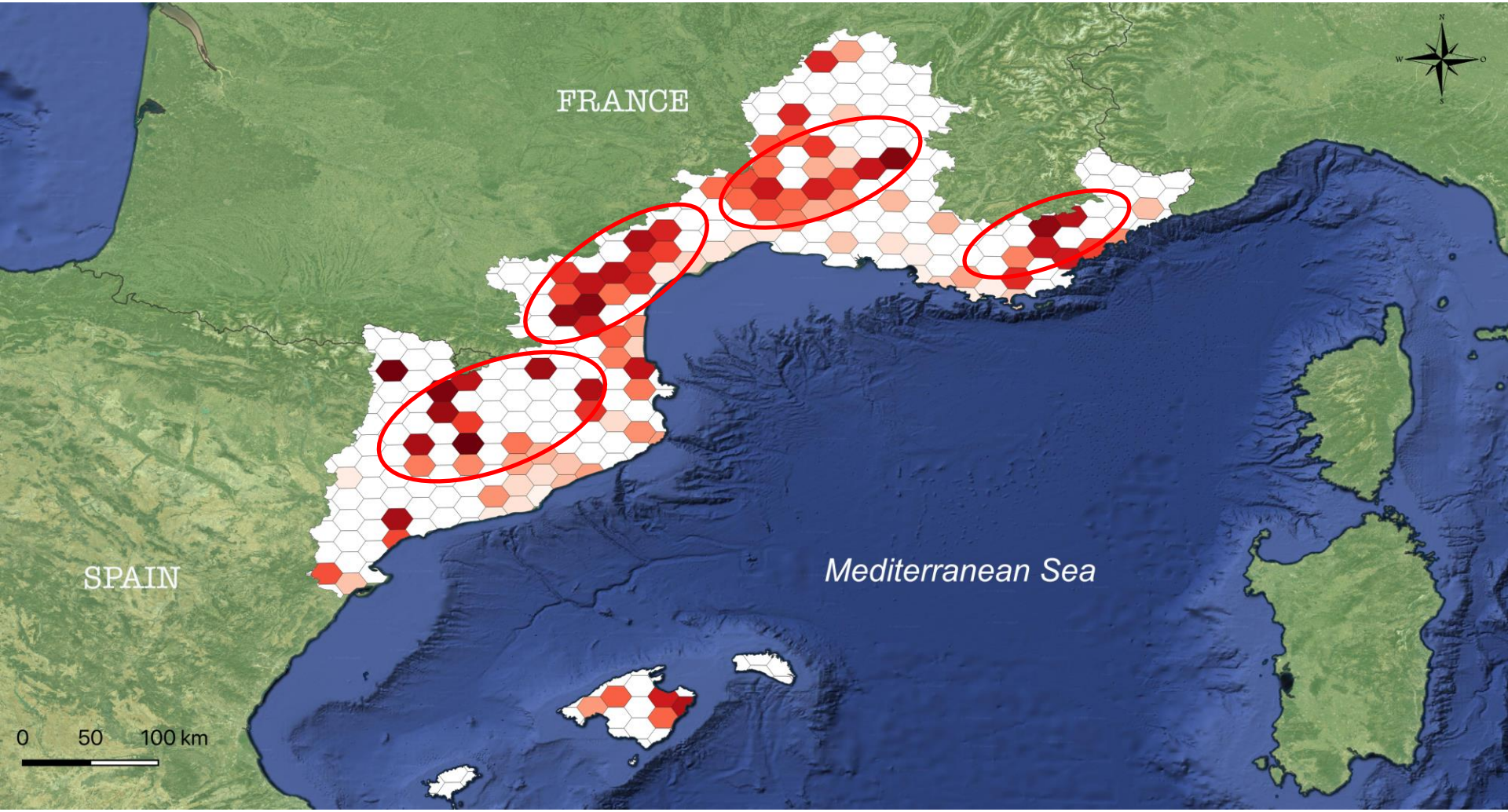
Fatality rate *(fatality / year / 1M inhabitants)*

0 *159,47*

No population data

When fatality number is high enough
→ Spatial discrepancies at local level

1- Overview of flood related mortality in the Mediterranean Basin



Vinet et al. Water 2019

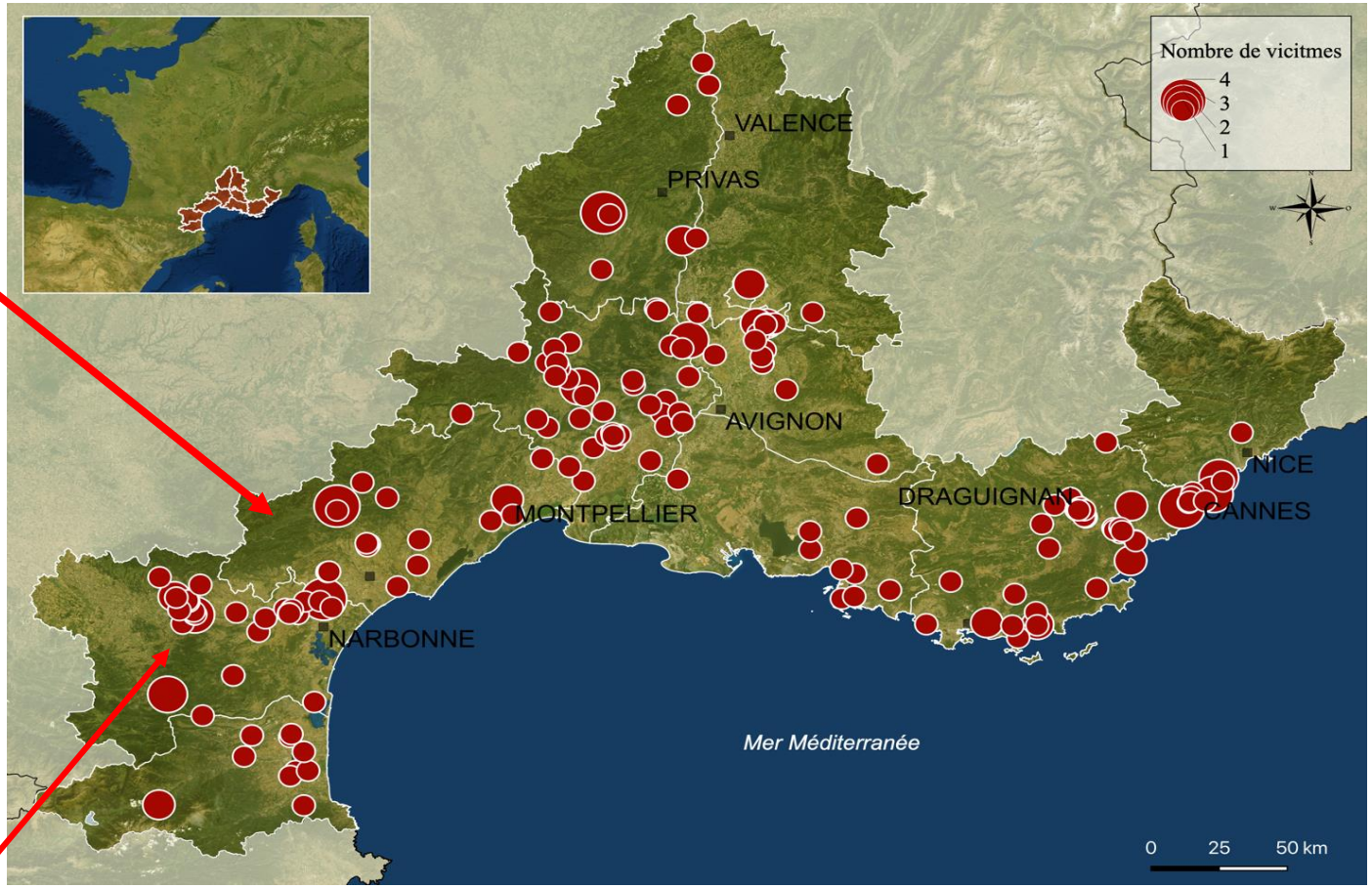
foothills and hinterland are prone to highest mortality

Fatality rate *(fatality / year / 1M inhabitants)*

0 *95,58*

1- Overview of flood related mortality in the Mediterranean Basin

Low mortality on upstream lands



Map of Flood related fatalities in Southern France (1980-2018)

High mortality in the medium part of catchments :

- High density of population
- Narrow valleys (lack of flat field)
- High speed flow

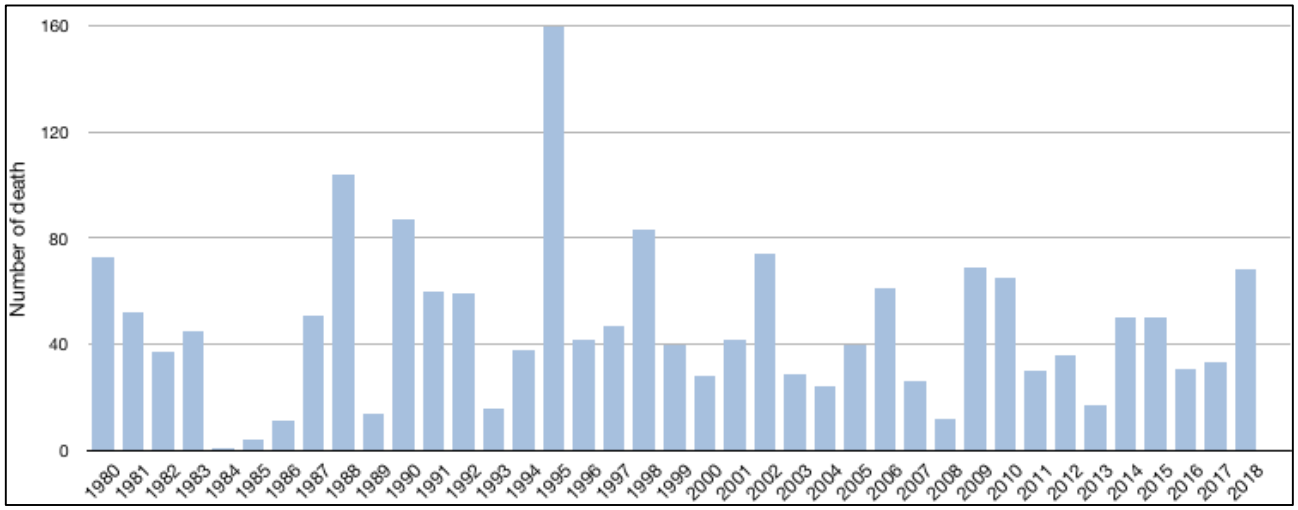
2- Drivers of FRM and trends : hazard drivers

Mortality is a multi factor driven phenomenon explained by anthropic factors (population….) and hazard drivers (?)

- Geography of extreme rainfall events

- Seasonality of FRM

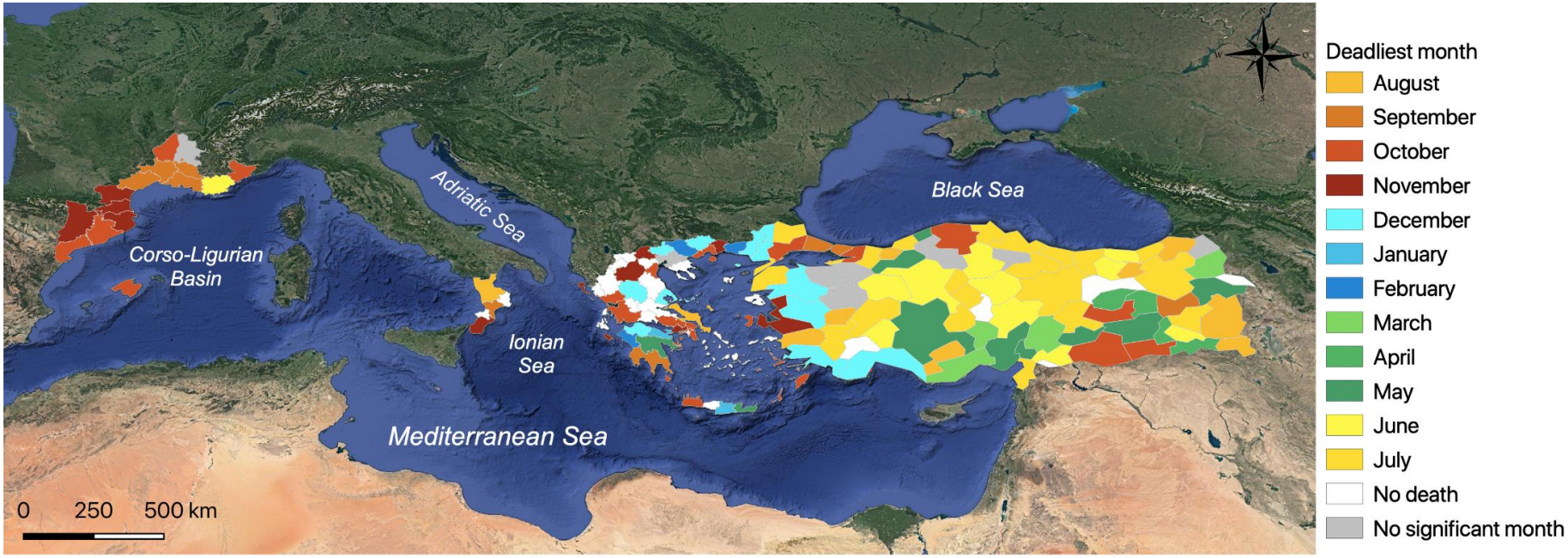
- Trends in FRM vs trends in extreme events



Annual number of FRF in Greece, Calabria, Turkey, Catalonia, S. France (1980-2018)

2- Drivers of FRM and trends : hazard drivers

Mortality is consistant with seasonality of intense rainfall



Vinet et al. Water 2019

Early fall season in western mediterranean basin

End of fall season in eastern mediterranean basin

Spring in southern turkey

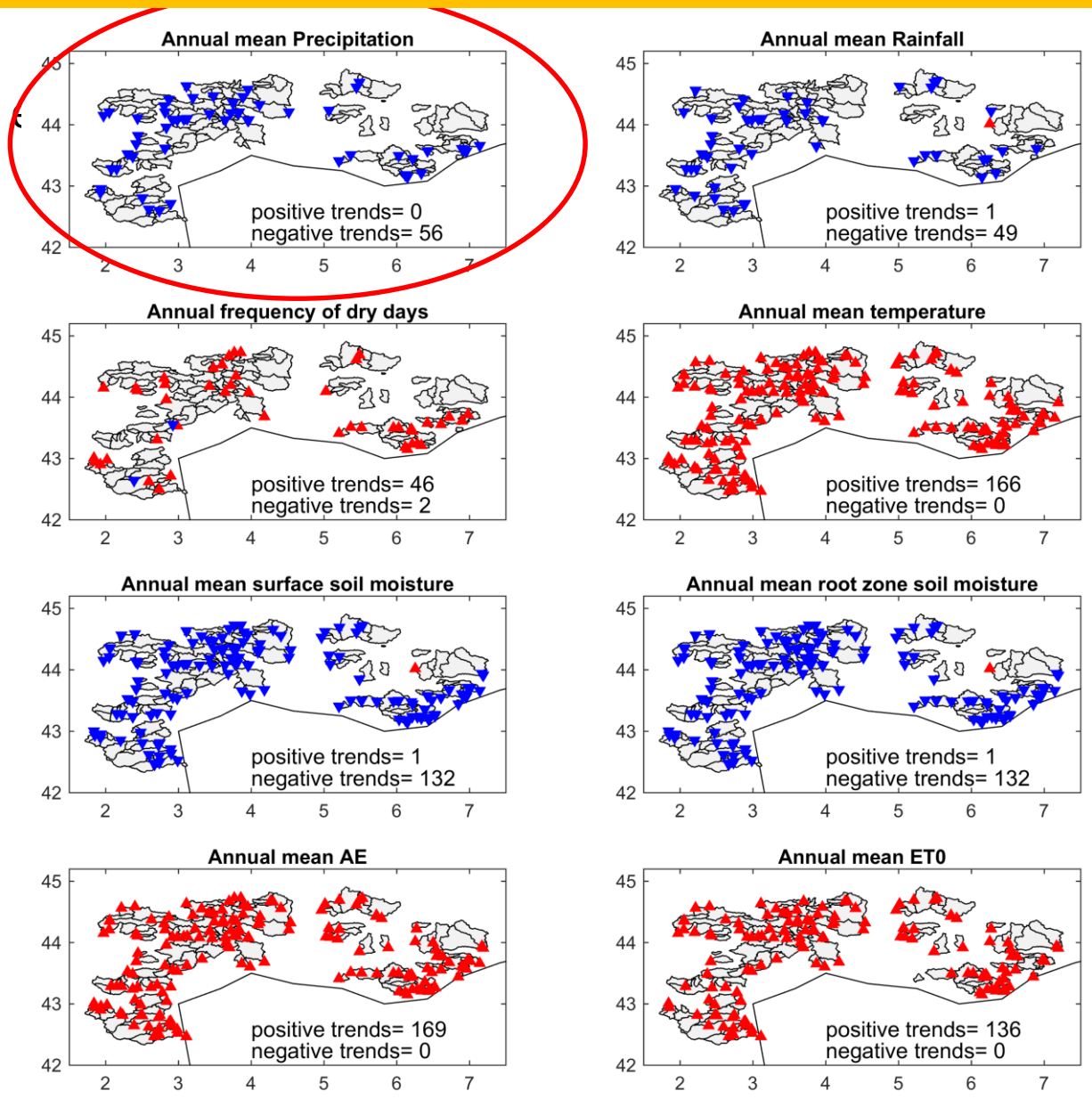
Summer in continental turkey (non mediterranean climate)

2- Drivers of FRM and trends : hazard drivers

Past trends of F (fatality rate)

2- Drivers of FRM and trends : hazard drivers

Trends in extreme flood



Tramblay et al. HESS 2019

2- Drivers and trends of FRM : hazard drivers

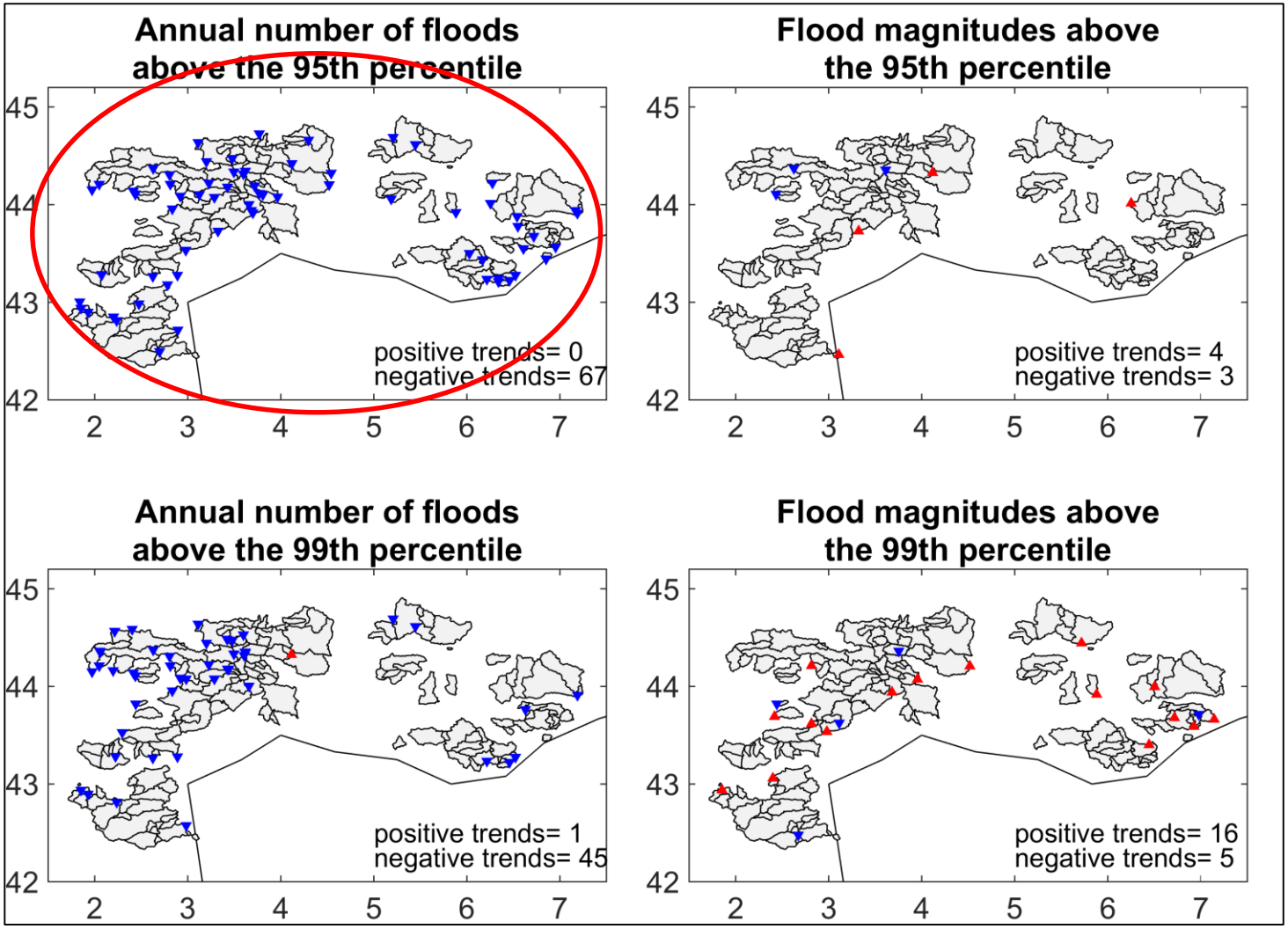


Figure 4: Trends in the annual number of flood events above the 95th and 99th percentiles (left) and in the magnitude of these threshold exceedances (right).
Blue triangles indicate a decrease and red triangles an increase.

Tramblay et al. HESS 2019

2- Drivers of FRM and trends : hazard drivers

In short
less extreme rainfall events
but more intense

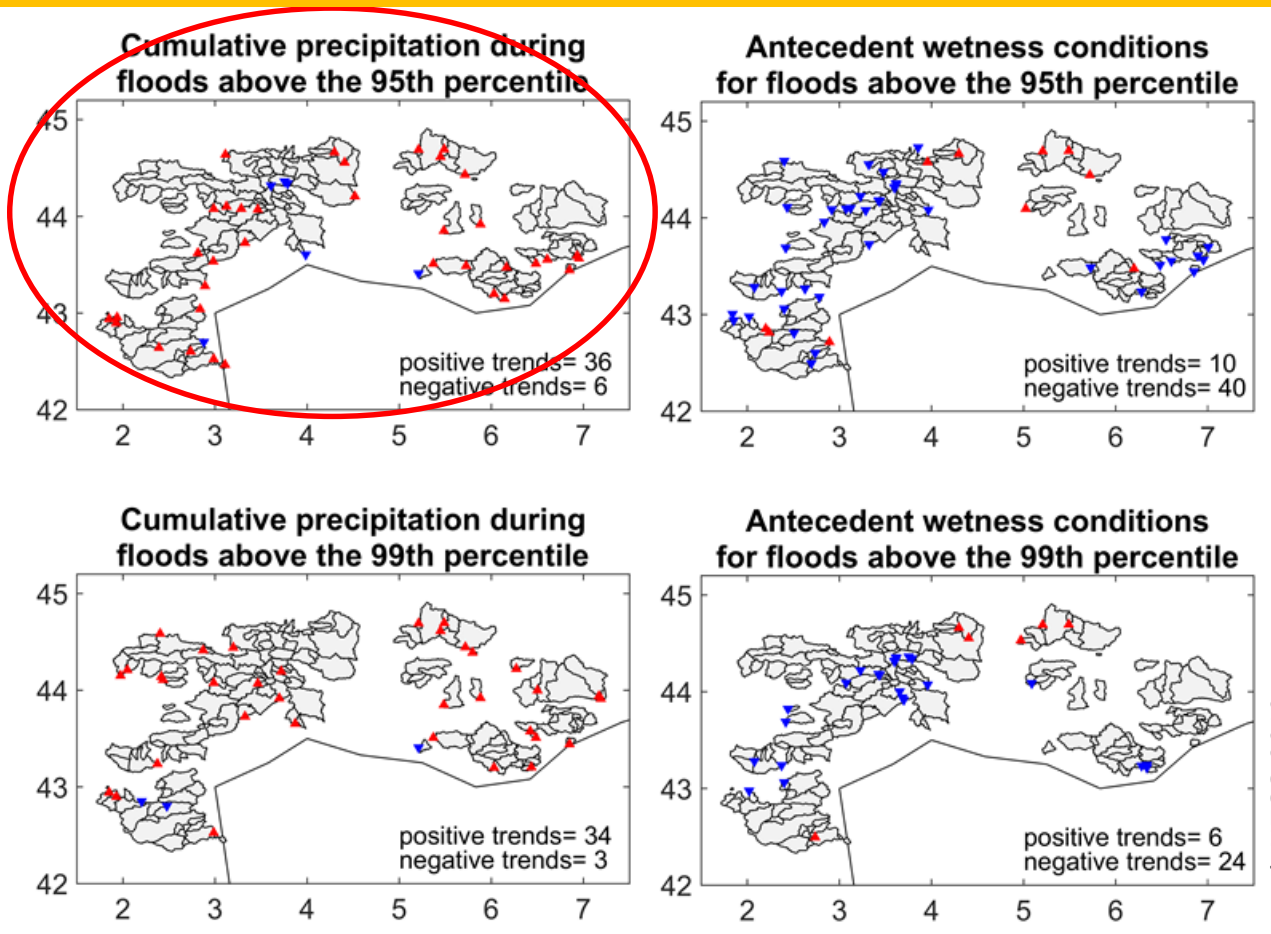
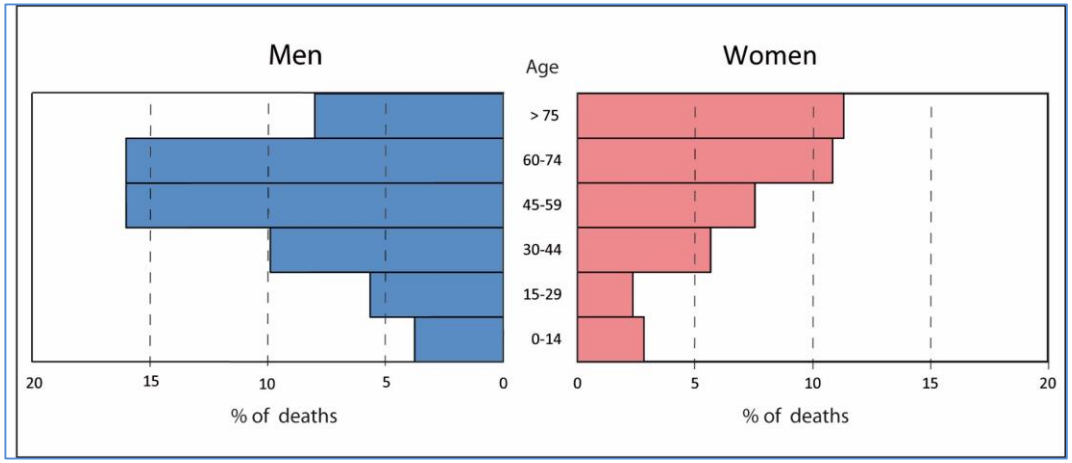


Figure 6: Trends in cumulative precipitation during flood events above the 95th and 99th percentile (left) and in the soil moisture initial conditions (right). Blue triangles indicate a decrease and red triangles an increase.

Tramblay et al. HESS 2019

3- Anthropic drivers



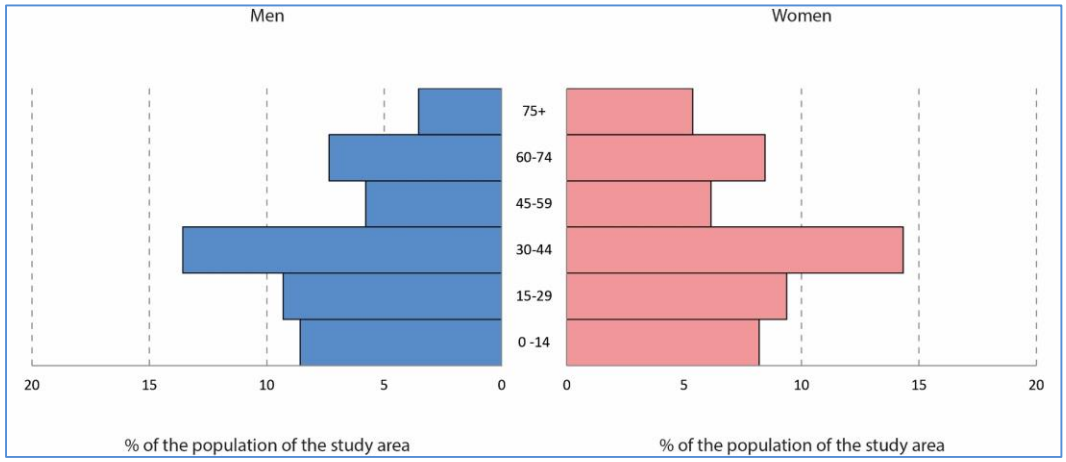
Vinet et al., 2016

Median age of FRM in S. France = 54

Men : 61 %

Population pyramid of flood-related deaths (n = 212)

Median age of whole population = 38



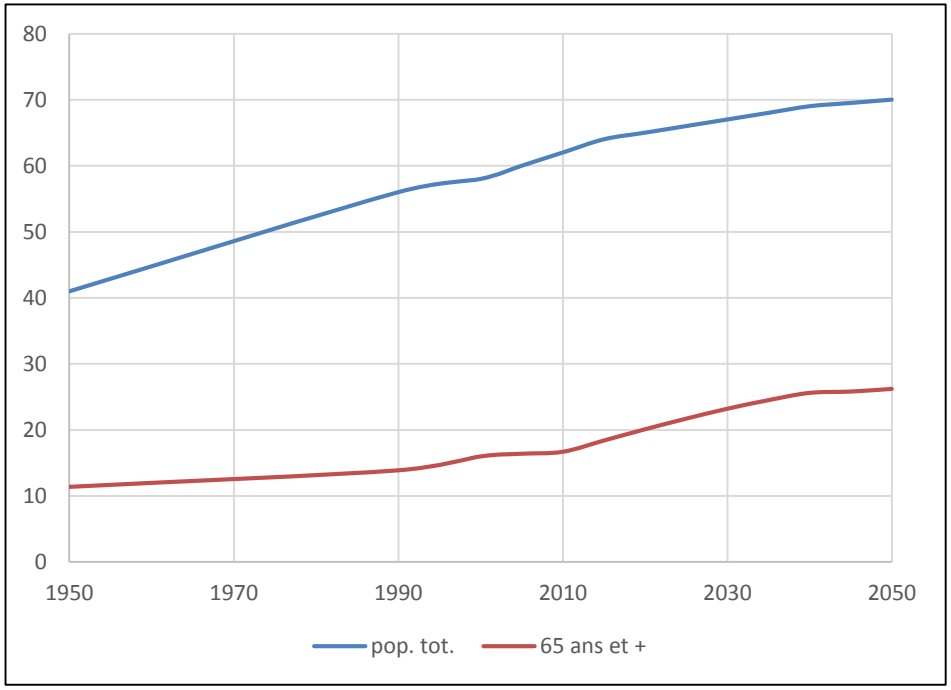
Vinet et al., 2016

Population pyramid of the whole population of studied area (1999)

3- Anthropic drivers

Expected evolution of french population

> 65 years : 20 M in 2019 ; 26.2 M in 2050
> 75 years : 9 M in 2019 ; 15.6 M in 2050



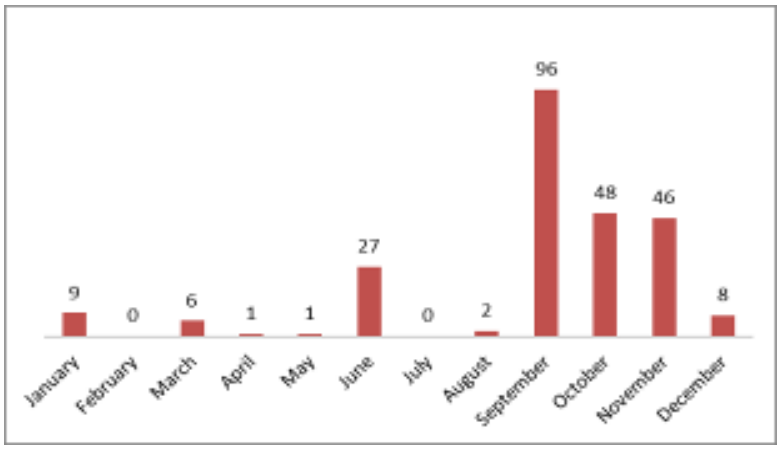
Growth of French population 1950-2050 (Insee)

Ageing of population
→ vulnerability

Mobility

New behaviours

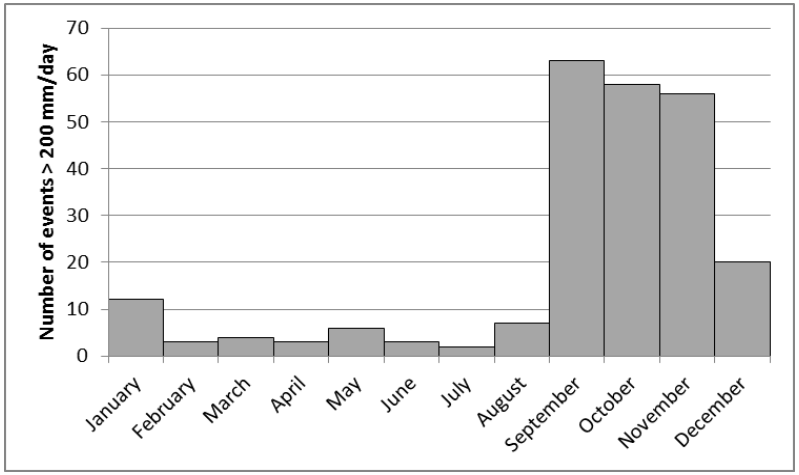
3- Anthropic drivers



Monthly distribution of flood-related fatalities

Foreign people = 32/244 (13 %)

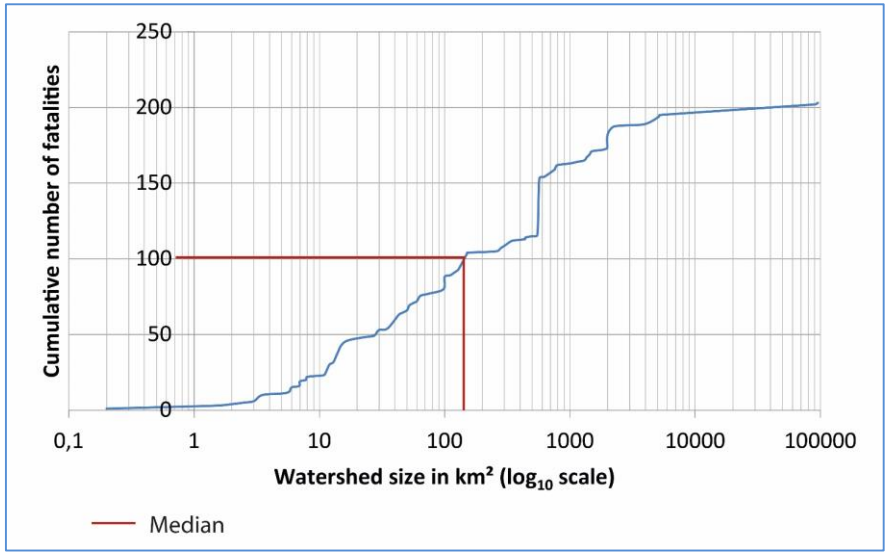
Change in tourism activity (retired pop., CC..)



Monthly distribution of high rainfall events (> 200 mm per day) Southern France (1988-2014)
Source: Météo-France (http://pluiesextremes.meteo.fr/)

Due to CC and new behaviours, tourist season is longer and the tourist population is more scattered → difficulties to warn people

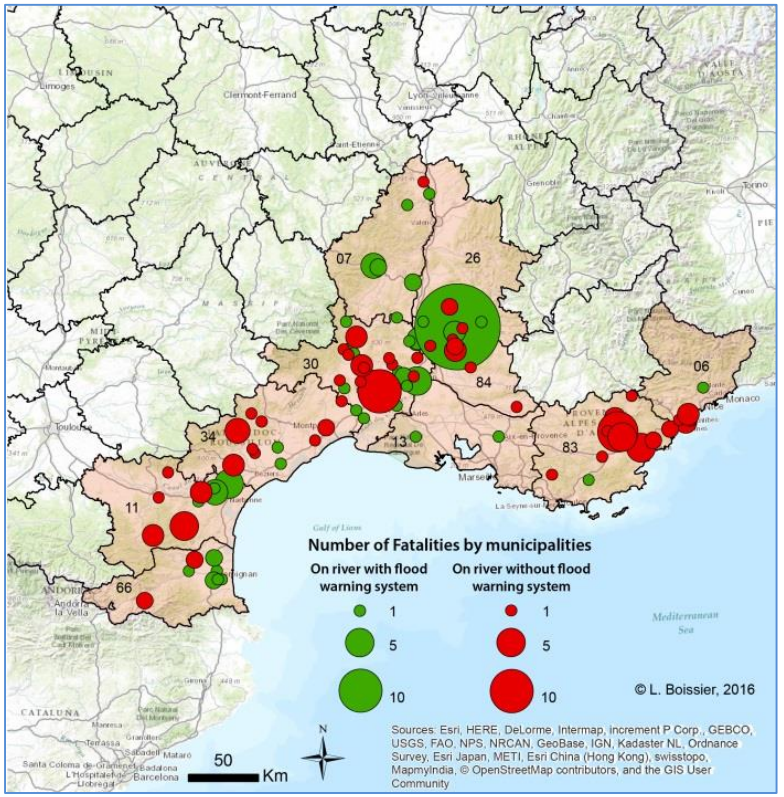
Flood related fatalities and prevention : the case of flood warning



Distribution of fatalities according to the watershed size

Median size of catchment area upstream fatalities : 150 km^2

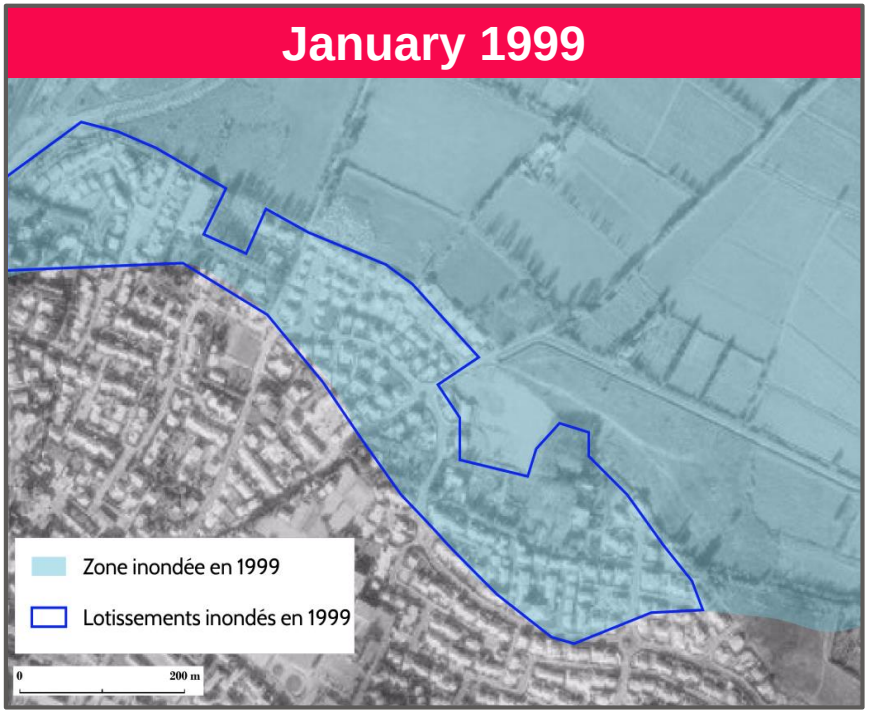
55% of fatalities on non-monitored rivers

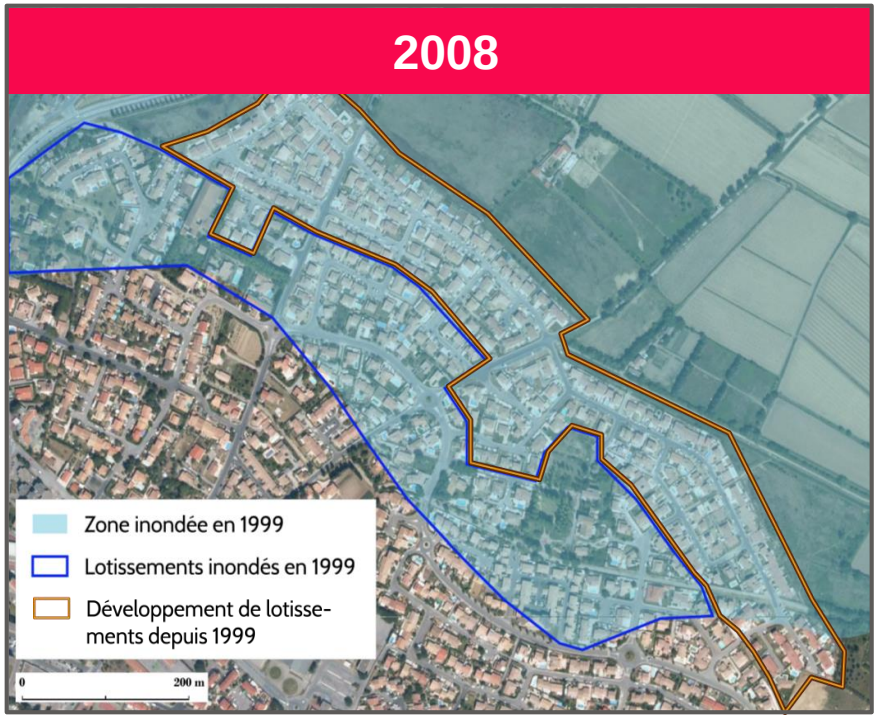


Location of fatalities regarding flood warning system

4- Prevention : the importance of land use control

- Lack of land use control

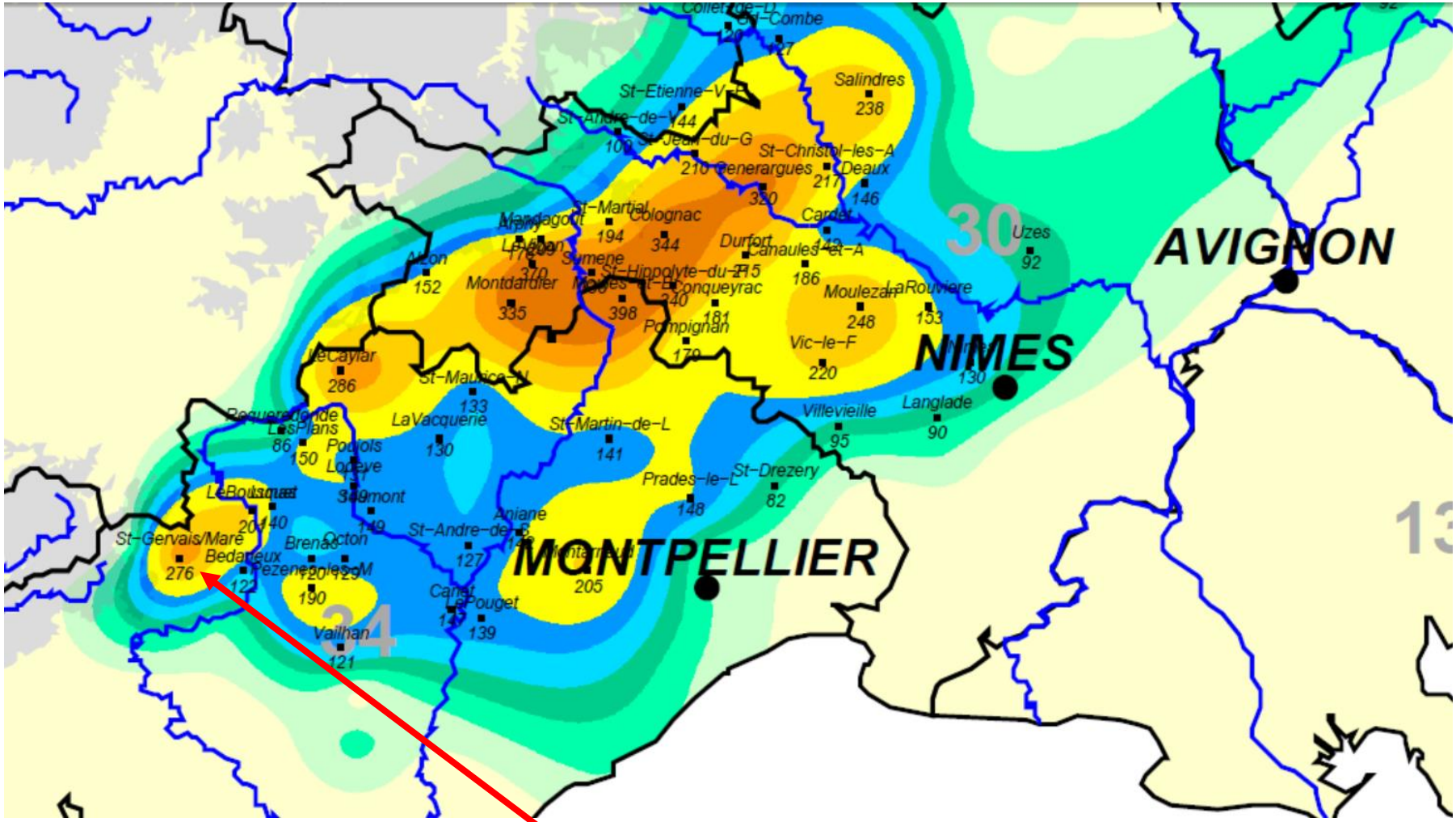




Lack of land use control in Southern France Narbonne (quartier Razimbaud) *source : Ph D Bourguignon, 2015*

4- Prevention : the importance of land use control

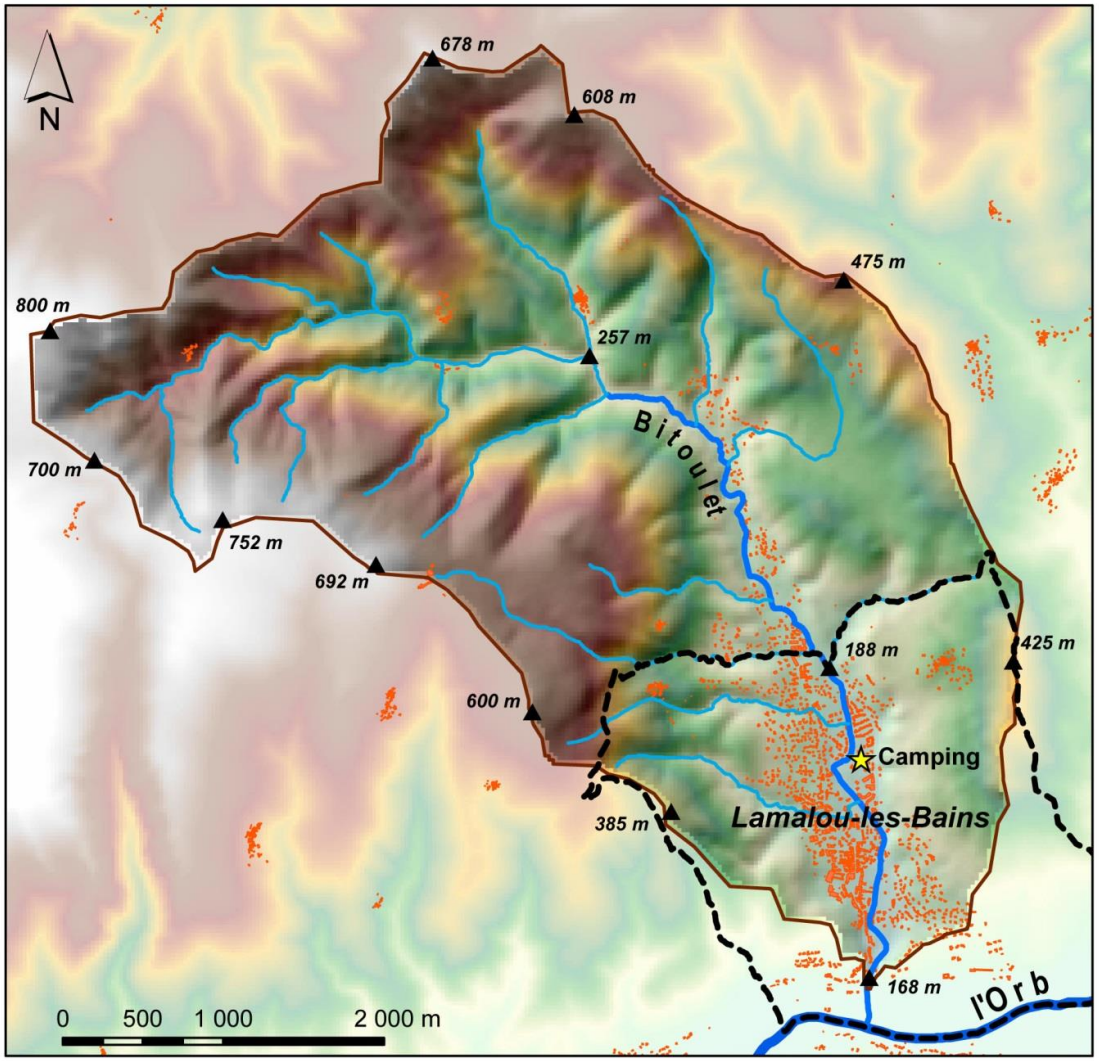
RR 17 Sept to 18 Sept 2014



Source : Météo-France

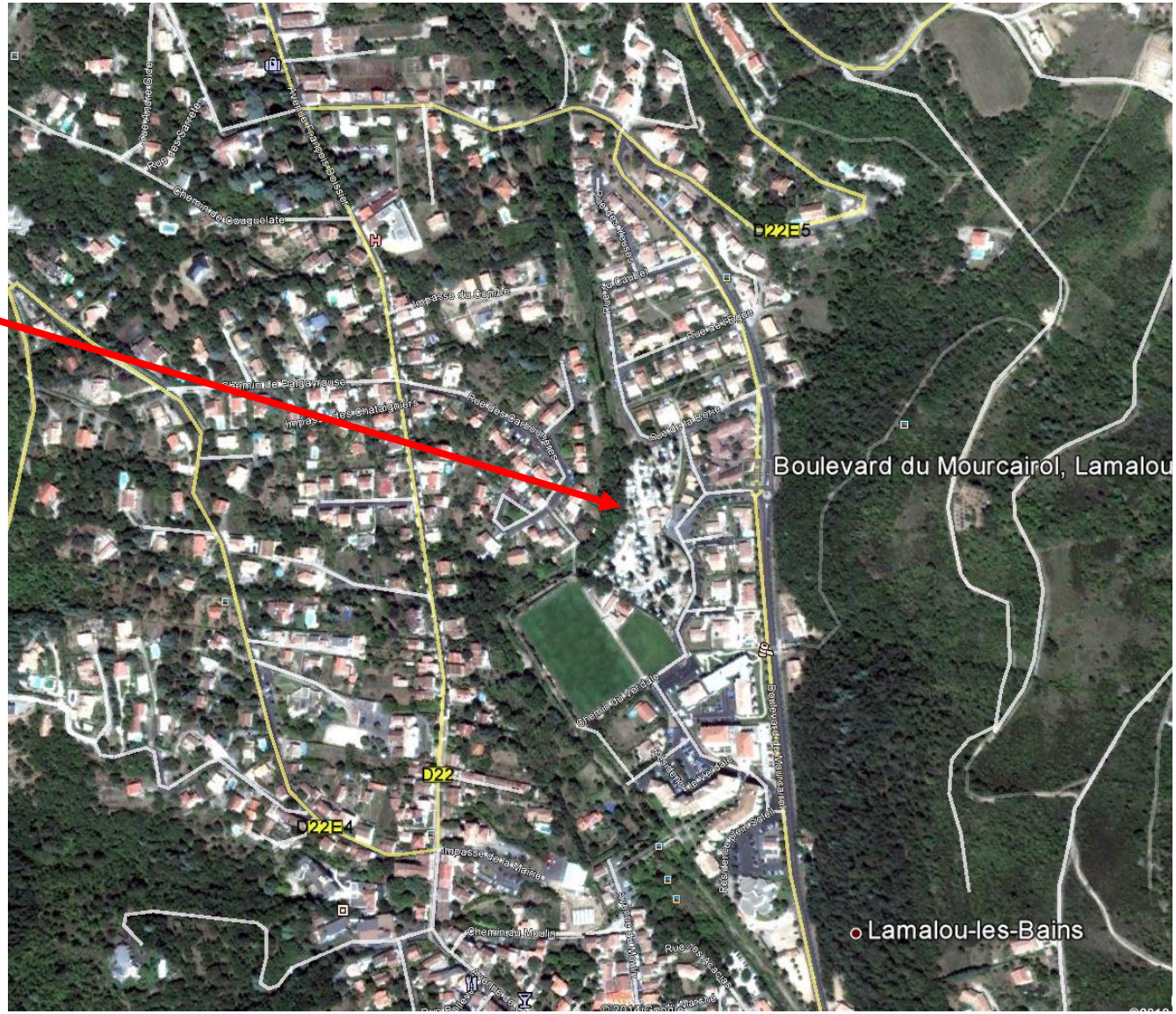
4- Prevention : the importance of land use control

Catchment area :
13 km^2



4- Prevention : the importance of land use control

4 deaths in the campsite



4- Prevention : the importance of land use control

4 deaths
In a campsite

4- Prevention : the importance of land use control

Quoted from a report on flood prone zone of the Orb River Basin (DREAL-LR & H2GEAU (2005)

mineurs et moyens sont bien encaissés dans le lit majeur, là aussi de plusieurs mètres (2-3 m), ils sont en général colonisés par une ripisylve assez dense. Il faut noter sur cette feuille *deux cônes de déjection qui doivent faire l'objet d'une attention particulière. Le premier est situé au lieu dit « Gatignés » en rive gauche de l'Orb à hauteur de Poujols-sur-Orb en amont du pont suspendu. Un terrain de camping est placé sur ce cône. Le deuxième cône est situé au village des « Aires » et au lieu dit « les Palenques ». Il est largement urbanisé. L'aléa dans ce secteur est très élevé.*

Dans ce secteur, le Bitoulet, le rieu Pourquié et la Mare se jettent dans l'Orb en rive droite.

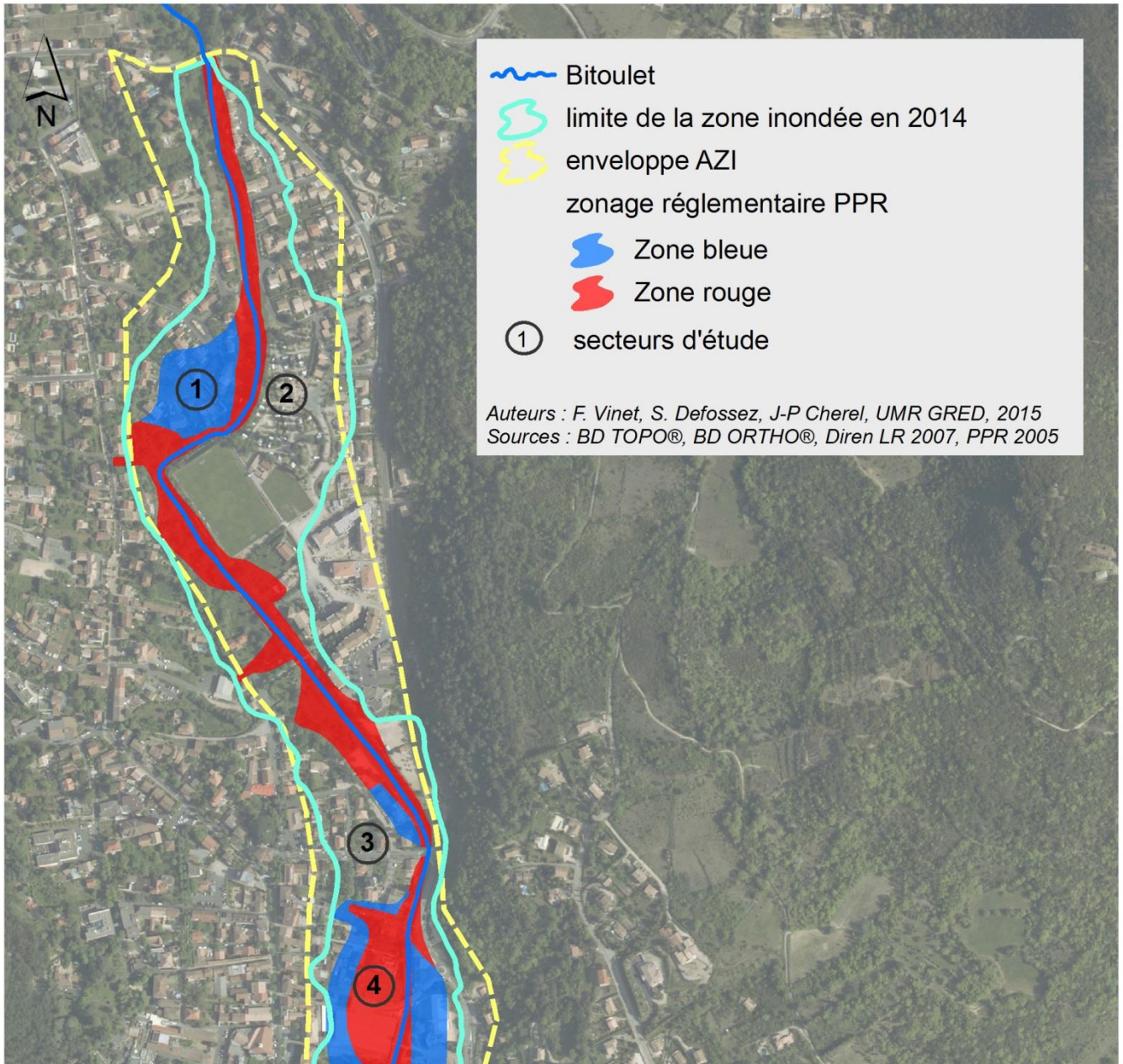
Le Bitoulet

Le Bitoulet est un cours d'eau torrentiel, et son tracé a été entièrement rectifié, canalisé dans toute sa traversée de Lamalou-les-Bains. Selon les dires d'habitants, lors de crues orageuses fortes, le Bitoulet reprend le tracé de son cours naturel en entrecoupant ses méandres. *Des lotissements ainsi qu'un terrain de camping sont construits dans l'axe des écoulements majeurs en cas de forte crue. Les enjeux ainsi que l'aléa sont donc particulièrement forts dans toute la traversée du village.* Le lit

According the inhabitants, during flash floods, the Bitoulet river flows into its natural bed overcrossing the meanders. Housing areas and a campsite are located in the mainstream flow area in case of flood. Assets at risk and flood hazard are potentially strong in all the river course in the village of Lamalou

La configuration de la plaine alluviale de l'Orb sur cette planche est sensiblement la même que

4- Prevention : the importance of land use control



Conclusions

Trends in anthropic drivers of Flood impacts	Evolution of Flood deaths	Evolution of flood damage
Population growth	+	++
Ageing of population	+	?
Tourism and mobility	++	V
Urbanization (low land, coastal zones)	+	++
Improvement /decline in living standards	-/+	+
improvement of housing	-	V
Prevention policies	-	-

Conclusions

- Mortality is a key indicator to monitor and assess flood impacts

- Uncertainty around hazard drivers : less events ? more intense ?

- Many anthropic drivers influence on Flood mortality

- The combination of those factors is specific for each region and each territory.

- We must not focus on the sole CC to address forthcoming changes in floodrisk

- Adaptation of territories facing social and natural changes is crucial

Thank you for your attention

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Petrucci O., Papagiannaki K., Aceto L., Boissier L., Grimalt M., Kotroni V, Llasat M.C., Llasat-Botija M., Pasqua A.A., Rosselló J., Vinet F., (2018) MEFF: the database of Mediterranean Flood fatalities (1980 to 2015) *Journal of flood risk management*. DOI:10.1111/jfr3.12461