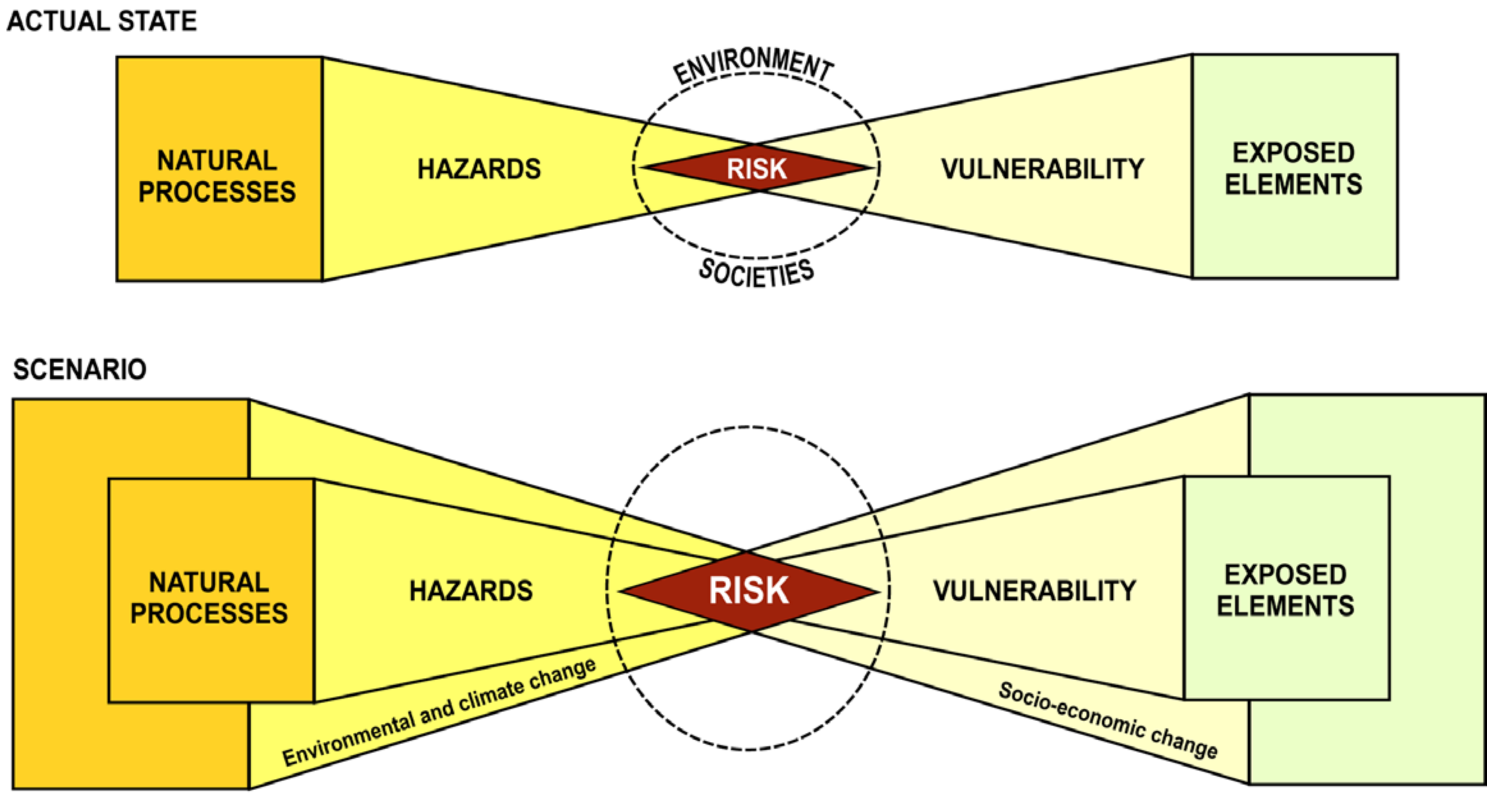
WP1: Changing hydro-meteorological hazards

KEY RESEARCH QUESTION

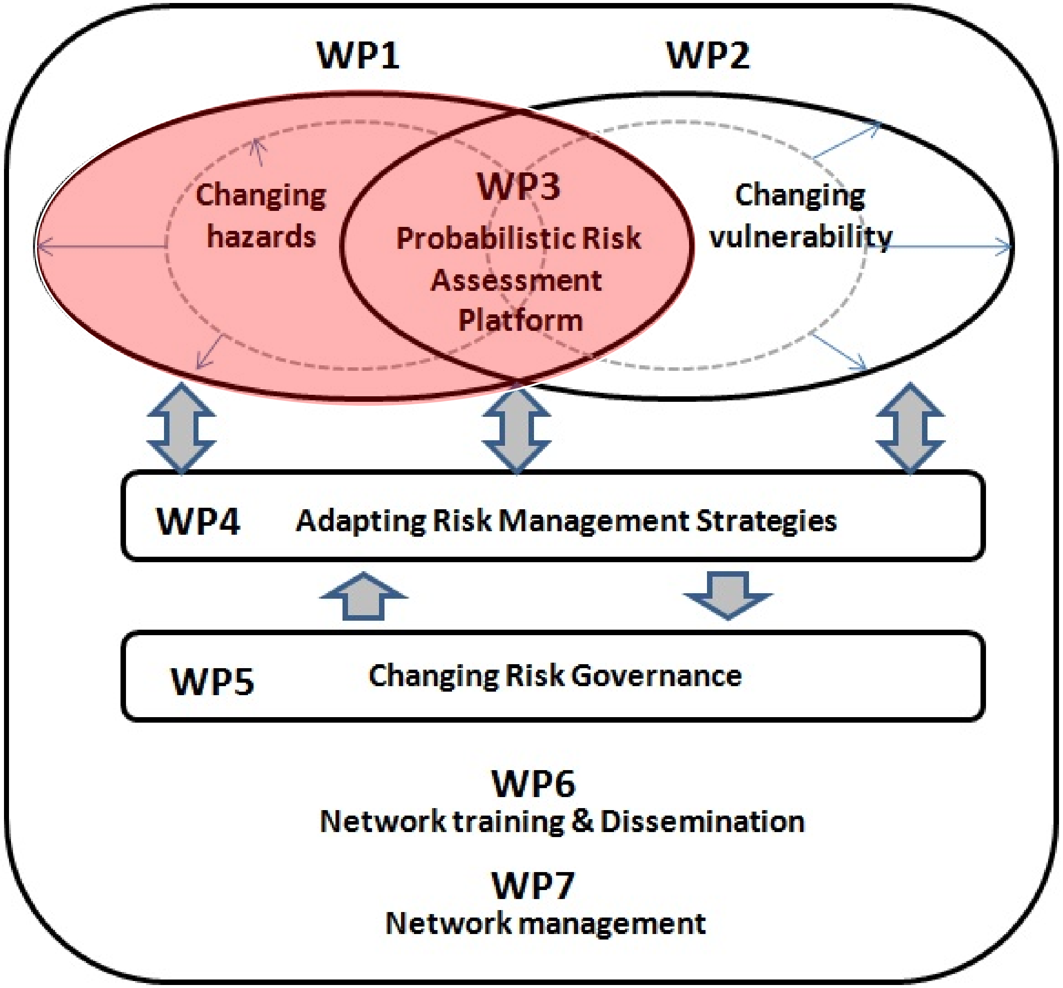
- Can we identify changes in **flood/landslide hazard** (susceptibility, frequency, magnitude) and **risks** (vulnerability, costs) associated to climate and landcover change scenarios?
- What **indicators** to express these possible changes?



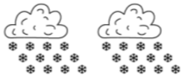
(modified from Glade & Crozier, 2005)

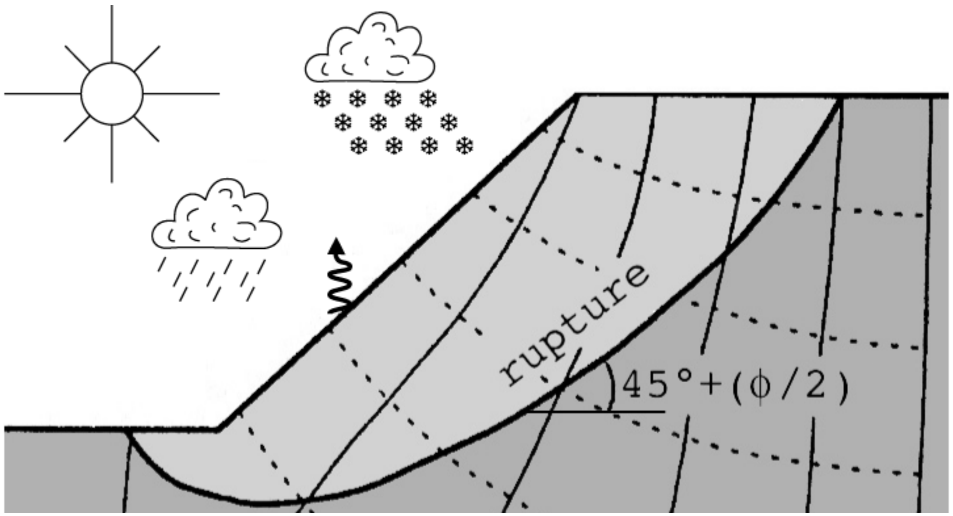
WP1: CHANGING HYDRO-METEOROLOGICAL HAZARDS

- Focus on changes in the triggers (meteorological/hydrological parameters) and the hazards (floods, landslides)



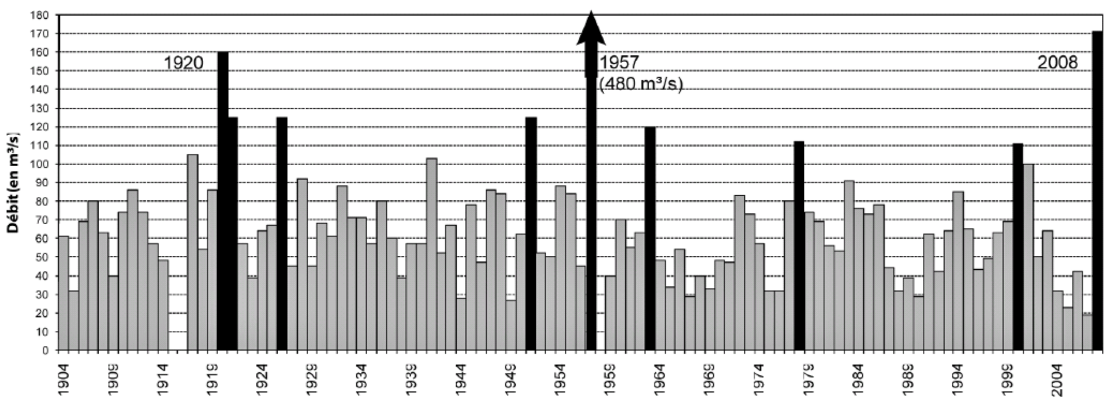
CHANGES IN TRIGGERS

- **Changes in …**
  - o rain amount? intensity? 
  - o rain characteristics (liquid, solid)? → implies changes in air temperature, radiation, etc 
  - o rain spatial distribution?
  - o temporal frequency of rain events? (focus on extreme events)
  - o hydrological response of the slope / catchment
    - o evaporation
    - o water water storage
    - o runoff

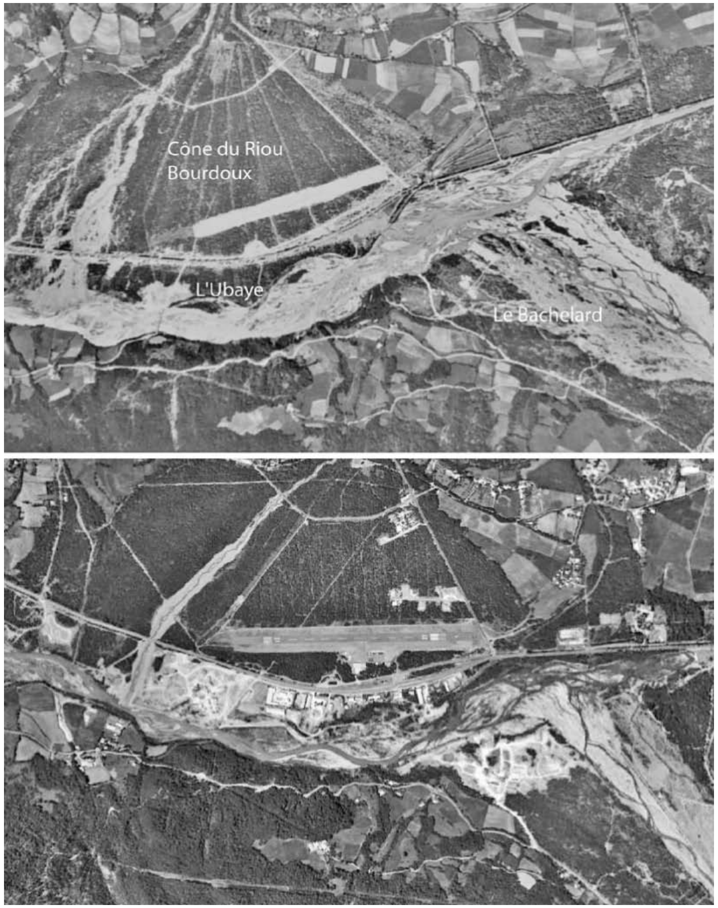


CHANGES IN HAZARDS

- **Changes in …**
  - o flood characteristics
    - - discharge, time to peak, amount of water
    - - spatial extent of the flooded area
    - - duration of the submersion
    - - ….



Flood events in Ubaye (events > 20 years return-period discharge, 1904-2008)

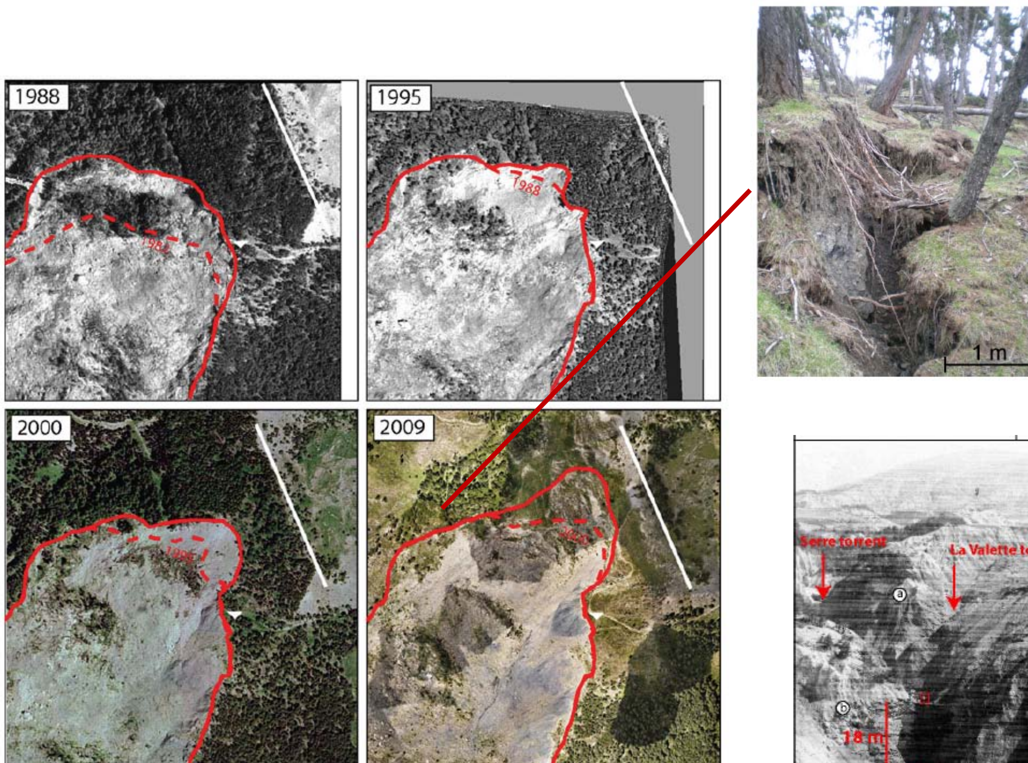


Changes in the morphology of the Ubaye river
1956 - 2008

Flood event of May 2008 in Ubaye

CHANGES IN HAZARDS

- **Changes in …**
  - o landslide characteristics
    - - spatial occurrence, e.g. susceptibility (source and runout areas)
    - - temporal occurrence
    - - intensity (displacement rate, volume, kinetic energy, etc)
    - - ….

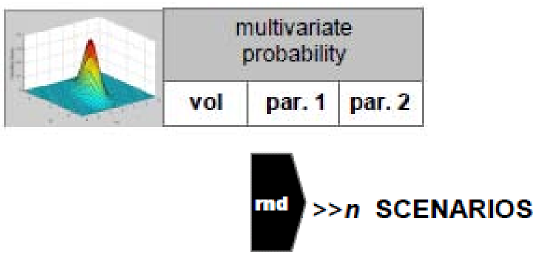


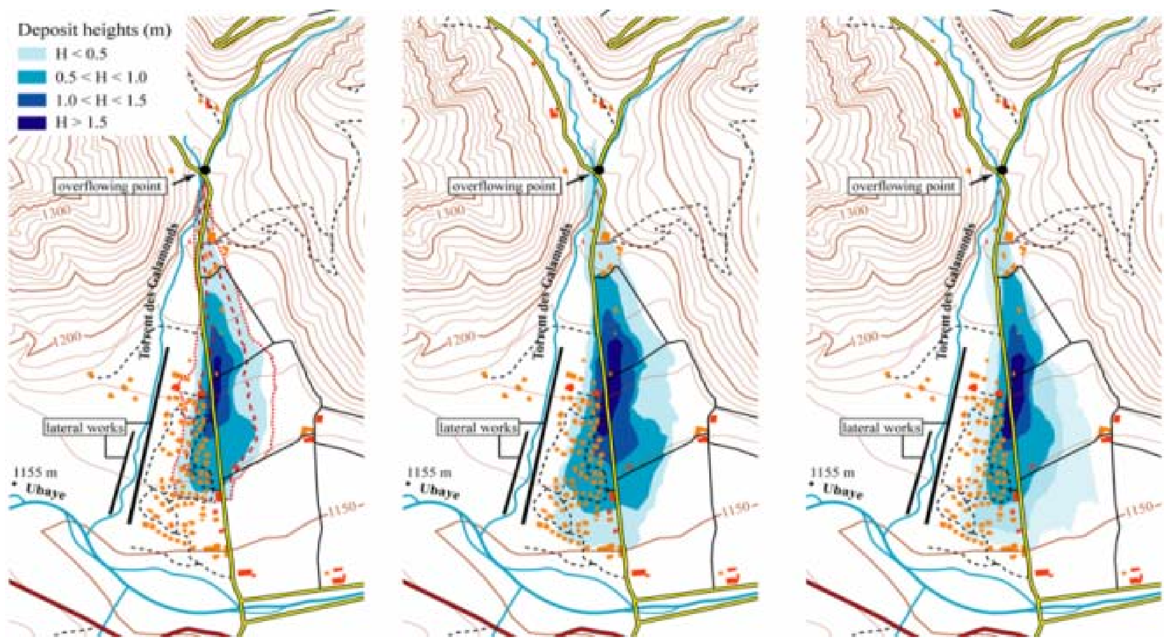
Observed changes (down & uphill extension) of La Valette landslide

CHANGES IN HAZARDS

- **Focus on the observations of reference events**
  → Identification of trends

- **Focus on modelling:**
  → Update of available models, creation of a 'modelling chain'
  → Definition of reference scenarios / Use of probabilistic modelling techniques

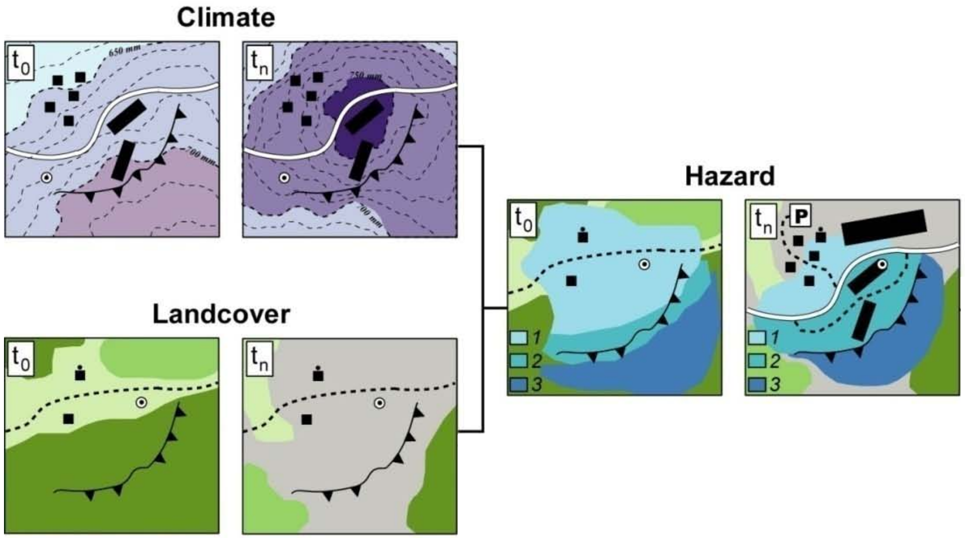




Example of probabilstic debris flow hazard maps for different input parameters – Monte-Carlo simulations

METHODOLOGY

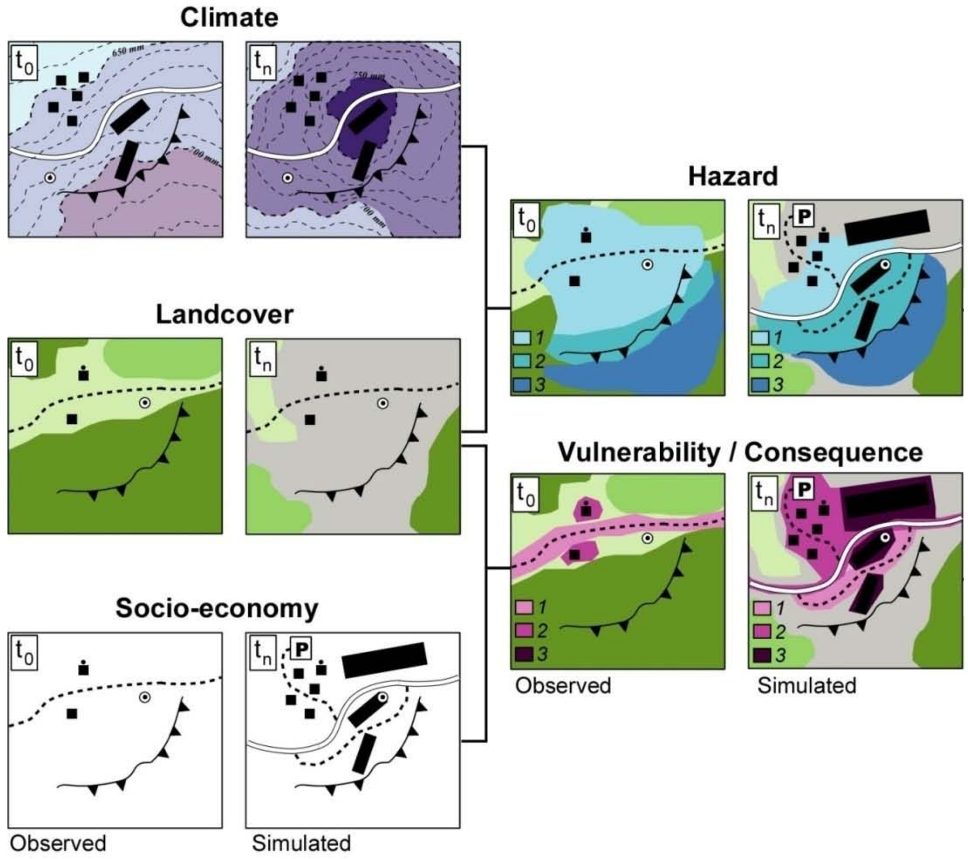
- Definition of time series & maps of actual/changing predisposing/triggering factors
  ➔ Creation of actual and 'changed' flood / landslide hazard maps



METHODOLOGY

- Definition of time series & maps of actual/changing predisposing/triggering factors
  ➔ Creation of actual and ‘changed’ flood / landslide hazard maps

- Definition of ‘changed’ maps of landcover and socio-economic factors
  ➔ Creation of actual and ‘changed’ landslide risk maps



METHODOLOGY

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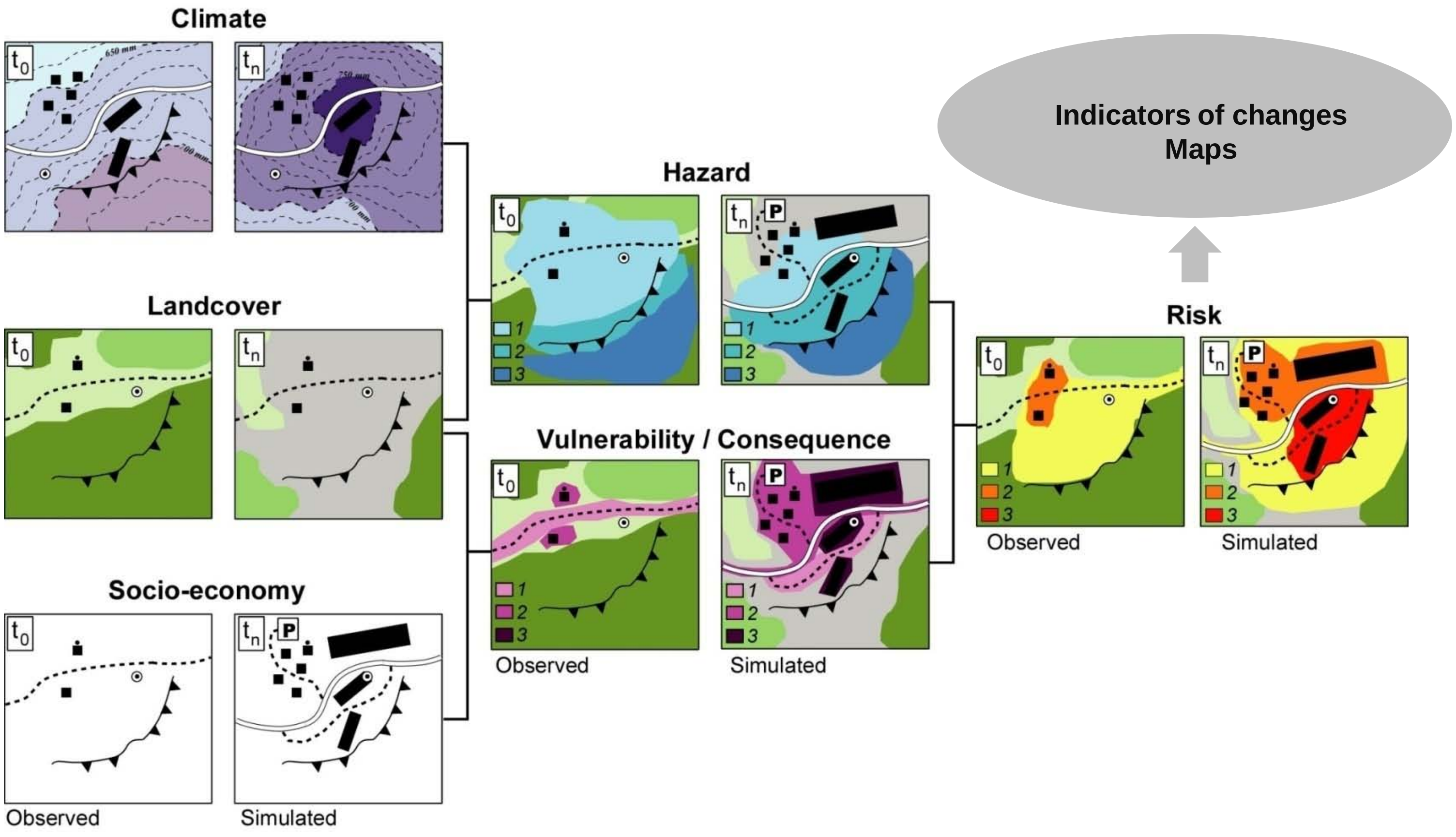
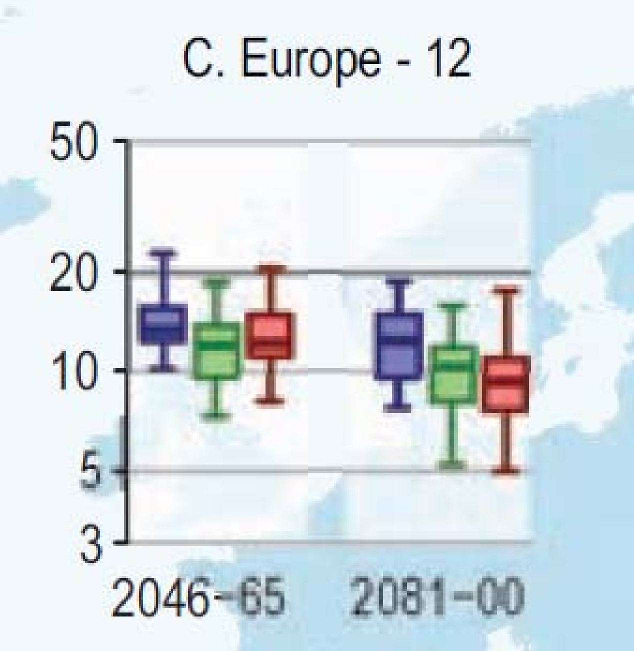


RESEARCH OBJECTIVES AND RESULTS

- The team in WP1

ESR1: Research of Mrs. Thea Turkington



Changes in 20 year maximum daily precipitation from the base period1986-2005 from Global Climate Models, (GCMs) -IPCC, 2012

How does this change relate to hydrometeorological triggers?

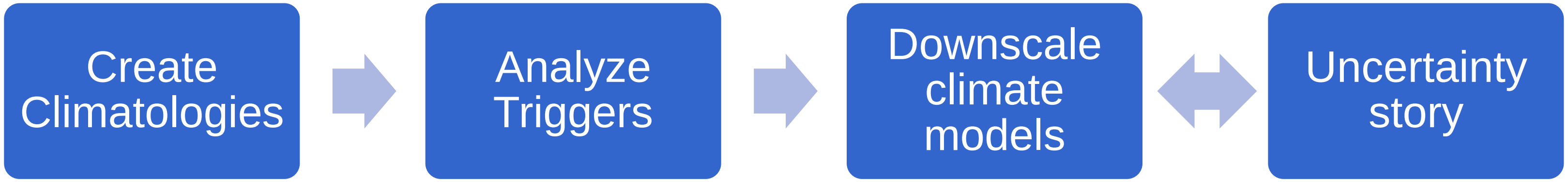
How does this change translate for the study areas?

ESR1: Research of Mrs. Thea Turkington

Objective: To create a framework where more information about changes in hydrometeorological triggers can be retrieved from climate model realisations.

Expected outputs:

- List of important meteorological triggers for floods and landslides
- How these triggers relate to larger scale processes
- Return rate of these parameters and the associated uncertainty
- Future projections of precipitation and other variables downscaled to the study areas
- Projections of how return periods of trigger parameters could change
- Understanding of reliability of the downscaling and changes in return periods



ESR1: Research of Mrs. Thea Turkington

Create Climatologies → Analyze Triggers → Downscale climate models ↔ Uncertainty story

Create Climatologies

- Trend analysis
- Homogeneity tests

Analyze Triggers

- Correlation between precipitation (different sources) and events
- Link events with larger scale atmospheric processes

Downscale climate models

- Criteria for model and scenario selection
- Analyse and compare results from different statistical downscaling techniques

Uncertainty story

- Group results based on large – scale changes
- Attempt “bottom-up” approach

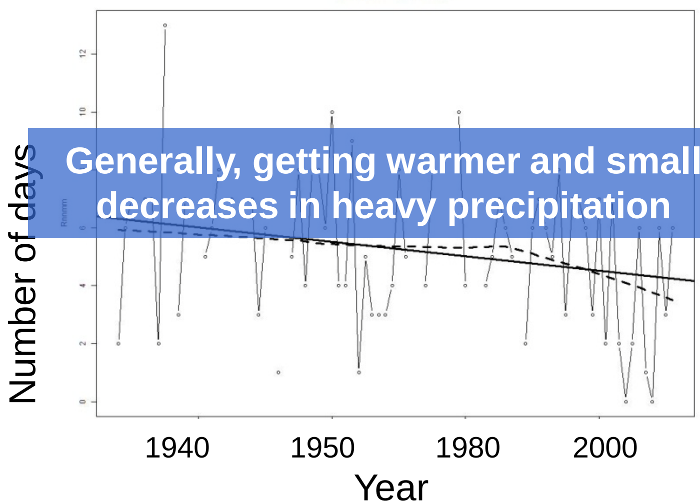
ESR1: Research of Mrs. Thea Turkington

Observed trends:

- Can indicate potential changes in the future
- Also influences frequency/magnitude of certain events – important for trigger analysis

Ubaye Valley, France

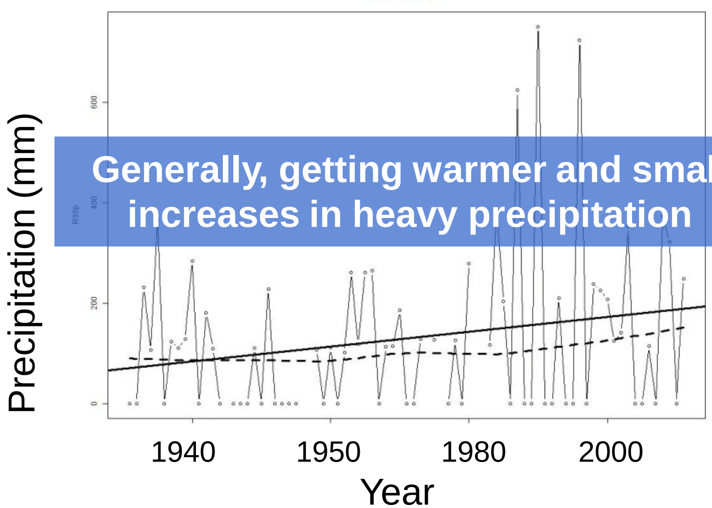
Days with precipitation >25mm



Generally, getting warmer and small decreases in heavy precipitation

Fella River Basin, Italy

Total precipitation, top 1% rainy days

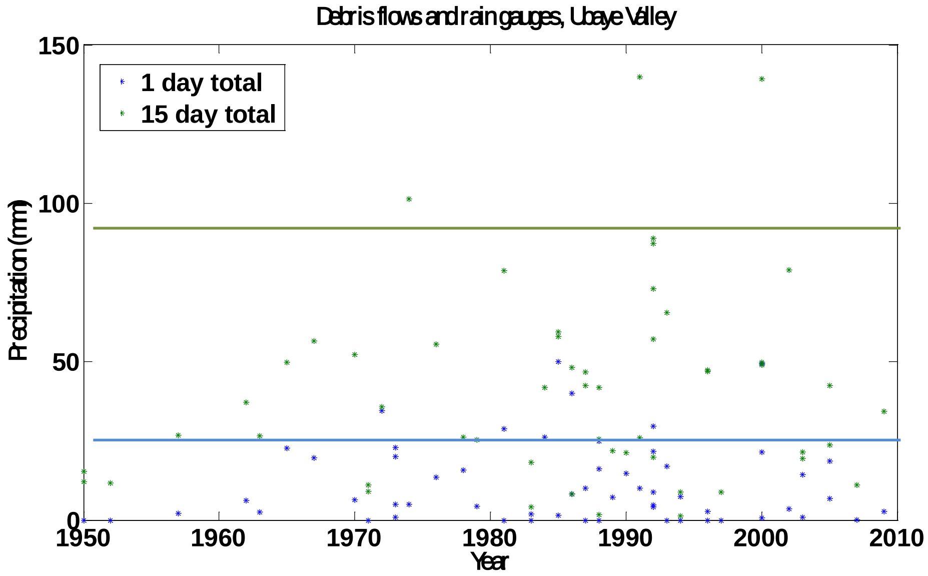


Generally, getting warmer and small increases in heavy precipitation

In both sites, temperature trends are much stronger than for precipitation

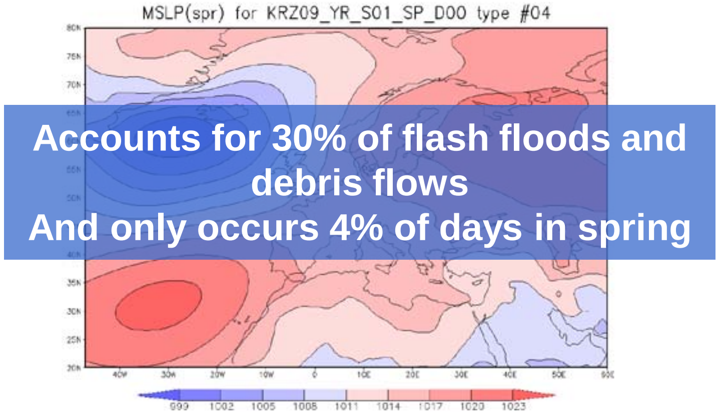
ESR1: Research of Mrs. Thea Turkington

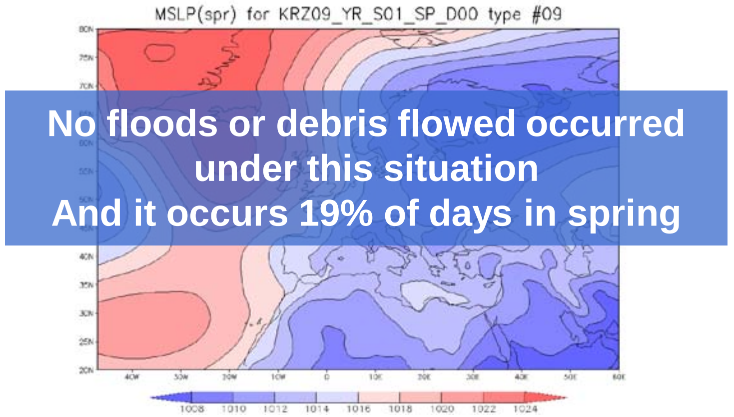
The next step is to look for triggers
Debris flows – no simple link between precipitation and occurrence!



The green and blue lines represent the 99% 15 and 1 day totals for the rain gauge respectively

So also looking at large scale atmospheric processes: Springtime floods and debris flows





Mean sea level pressure for two of the nine Kruizinga synoptic situations (COST733: http://geo23.geo.uni-augsburg.de/cgi/cost733plot.cgi)

CONTEXT

1. Flooding can be caused by different sources, including short severe rainstorms over urbanized areas ('pluvial flooding')

2. "Medium confidence that anthropogenic influences have contributed to intensification of extreme precipitation" (IPCC, 2012)

3. "Increase in the atmospheric moisture content would be expected to lead to an increase in extreme precipitation" (IPCC, 2012)

ESR2: Research of Mr. Korbinian Breinl

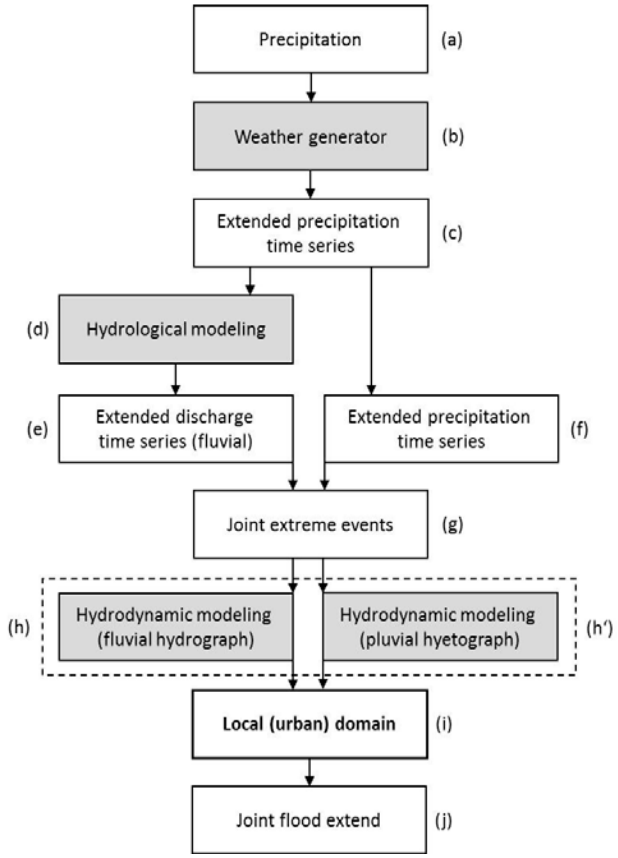
Objective: To create a probabilistic modelling framework that allows flood hazard assessment for pluvial flooding and fluvial (=river) flooding and any simultanous occurrence of both phenomena.

Expected outputs:

- New and innovative modelling framework
- Various tools (weather generator, calibrated rainfall-runoff model etc.) that can also be used for other purposes (downscaling of GCM/RCM, probabilistic landslide modelling etc.)
- Understanding of the contribution of pluvial phenomena to the overall flood hazard
- Understanding of how pluvial and fluvial phenomena are related to each other (spatially and temporally)
- Understanding of how climate change is going to change the frequency of and severity of both types of flood hazards

ESR2: Research of Mr. Korbinian Breinl

Methodology: The core element of the framework is a stochastic weather generator coupled with a hydrological model

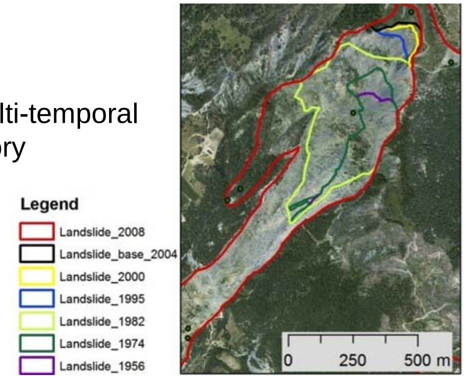


Modelling framework:

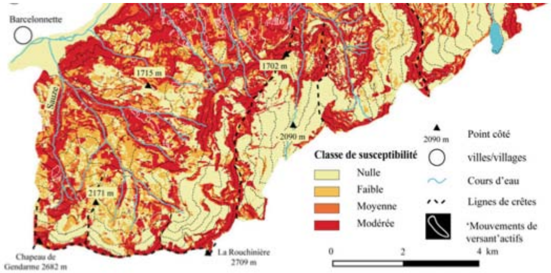
- Weather generator produces synthetic precipitation data of any length
- Synthetic weather is fed into hydrological model to produce discharge time series
- Synthetic precipitation and discharge events are simultaneously routed over the domain by means of hydraulic modeling
- Modeling framework is applied for observed and projected climate data

ESR3: Research of Mrs. Romy Schlögel

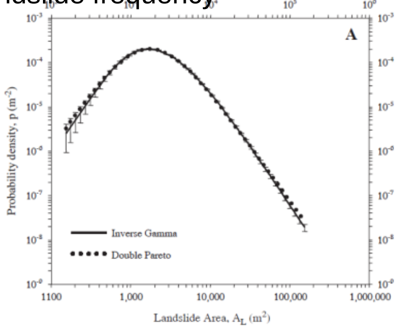
Observation: multi-temporal landslide inventory



Modelling:
landslide susceptibility at region scale



Modelling:
changes in landslide frequency



What are the observed changes in landslide characteristics observed in the study areas (Ubaye, Buzau)?

Do their magnitude changes over time, and what are the triggering events?

Can we assess quantitatively the hazard at regional and local scales?

Can we forecast and estimate trends in landslide hazards for the future?

ESR3: Research of Mrs. Romy Schlögel

Objective: To propose a methodology for the quantitative assessment of landslide hazard making extensive use of EO products, remote-sensing techniques and modelling

1. To update catalogues and inventories of landslides using a variety of geomorphological and geodetical techniques

2. To characterize the spatial and temporal occurrences and the intensity of events by analyzing the dynamics of active landslides

3. To identify relations among predisposing factors and triggering factors multivariate models

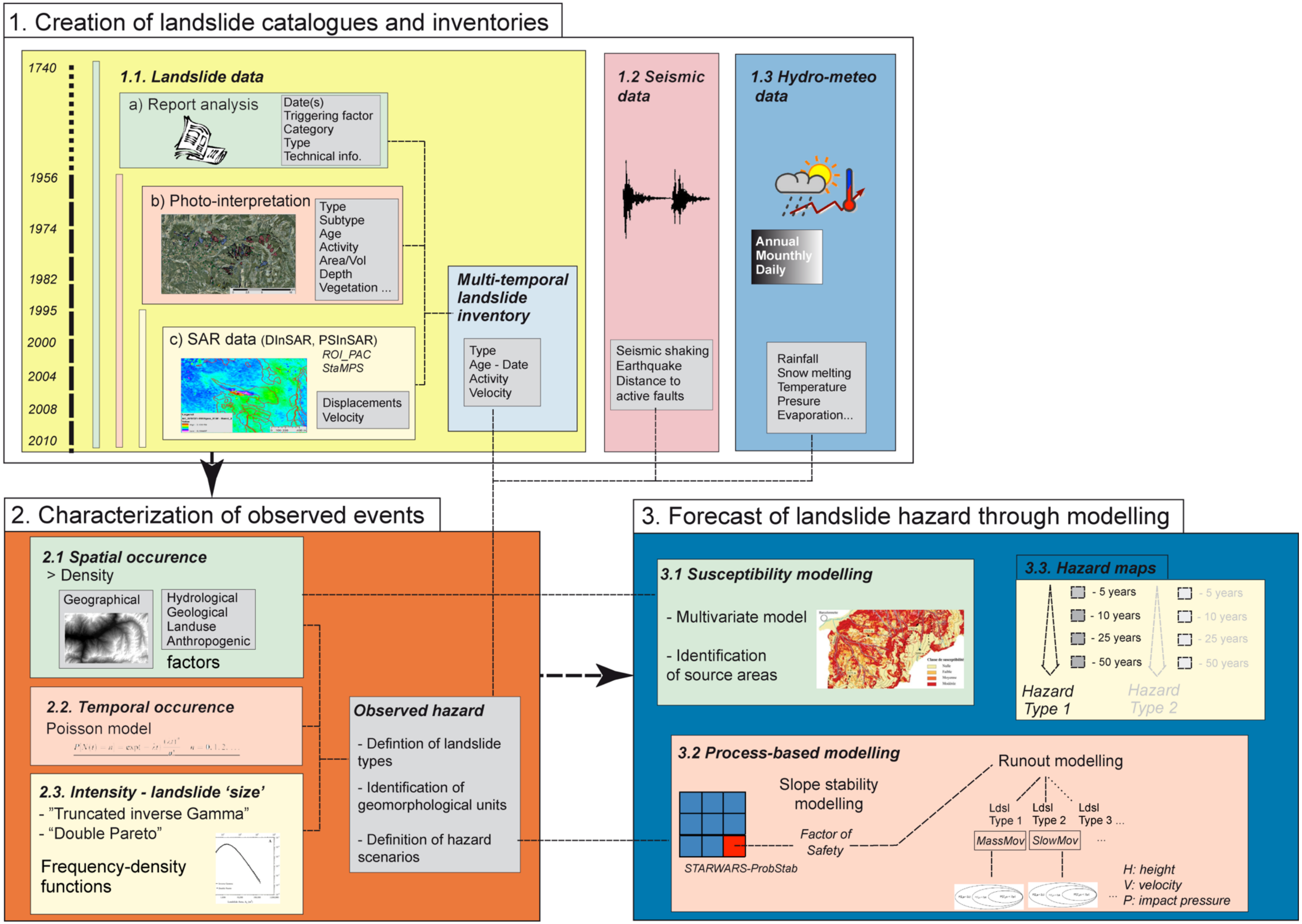
   To propose quantitative hazards assessments through the use of process-based models (slope hydrology, slope stability and slope kinematics)

   ➔ A framework to construct hazard maps

regional scale
(e.g. 1:25.000 – 1:10.000)

local scale / hot-spot
(e.g. 1:5000 – 1:2000)

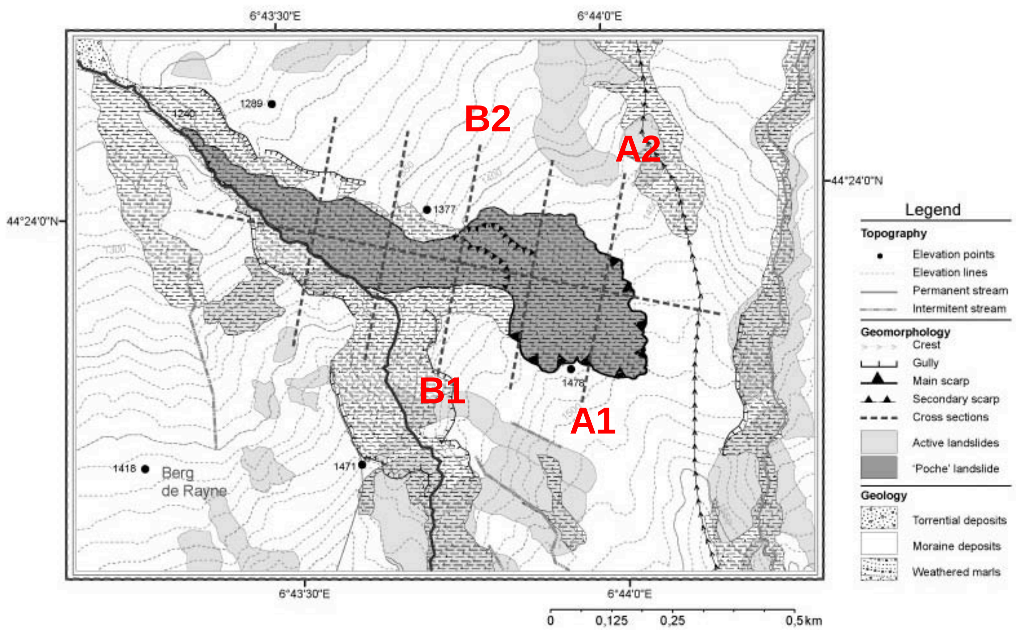
ESR3: Research of Mrs. Romy Schlögel

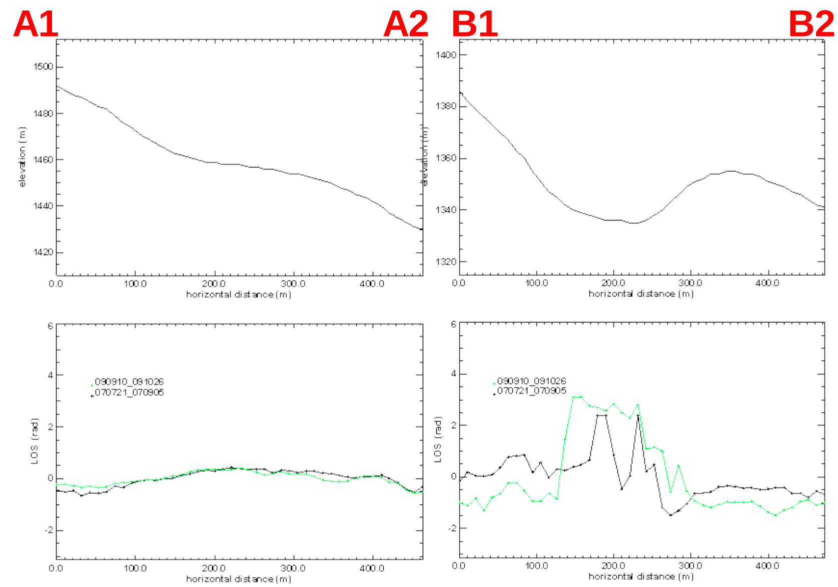


ESR3: Research of Mrs. Romy Schlögel

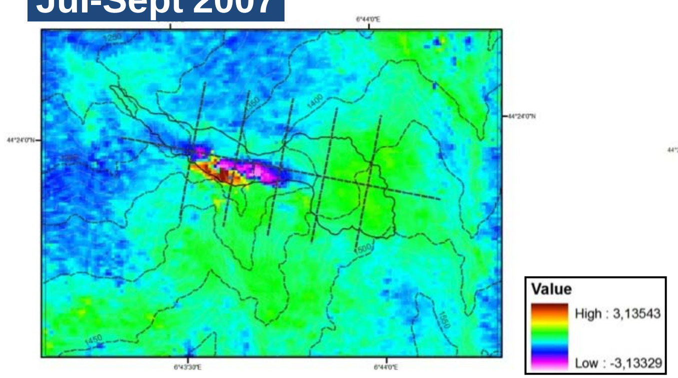
Results of D-InSAR processing of ALOS images – displacement calculation

‘Poche landslide’ (Ubaye Valley, France) case study

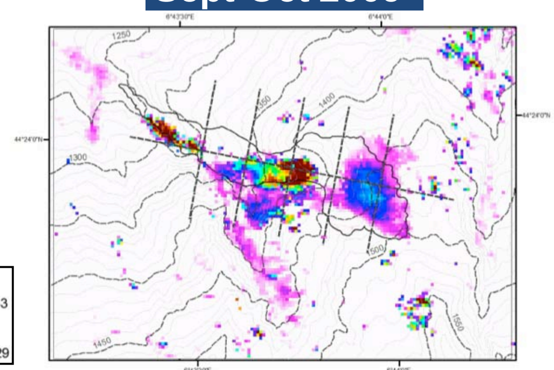




Jul-Sept 2007



Sept-Oct 2009

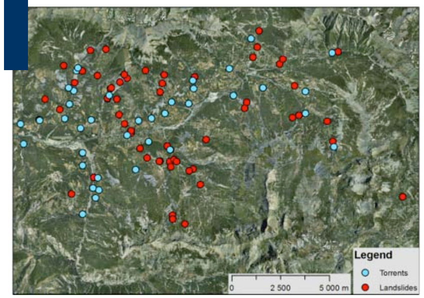


→ Displacement along the LOS (λ_{ALOS} =23.6 cm)

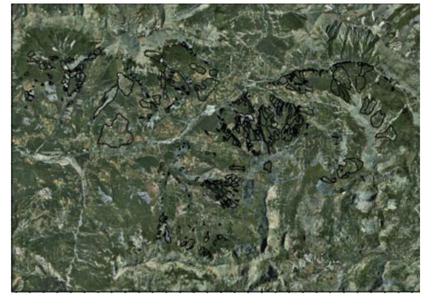
→ Displacement along the slope

→ Velocity (proxy for magnitude)

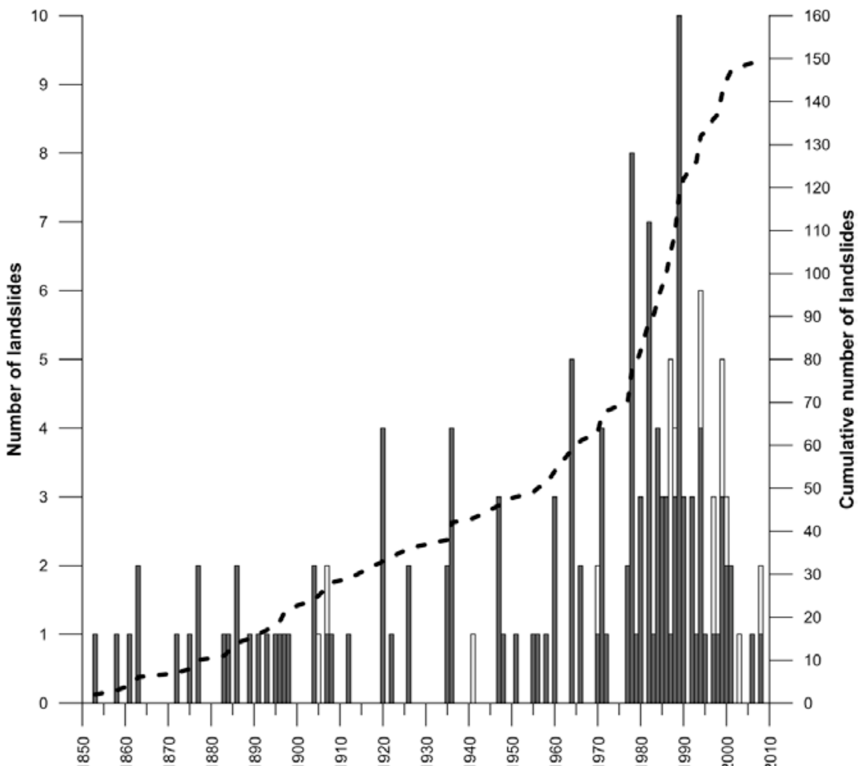
ESR3: Research of Mrs. Romy Schlögel

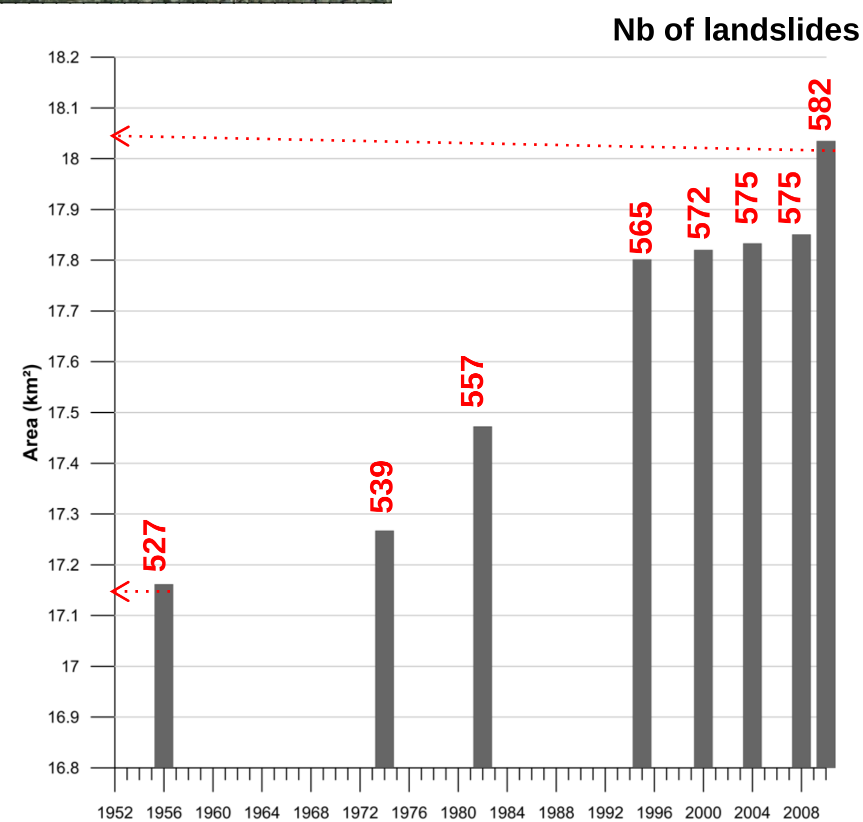


Evolution of the number of landslides (in black) and debris flows (in white) for 1850-2010



Evolution of areas affected by landslides for 1956-2010





Thank you for your attention!