Presentation of a surface runoff susceptibility mapping method and test on the Lezarde catchment (Paris basin, France)

L.R. Lagadec, Pierre Patrice, B. Chazelle, Isabelle Braud, L. Moulin, J. Dehotin, E. Hauchard, Pascal Breil

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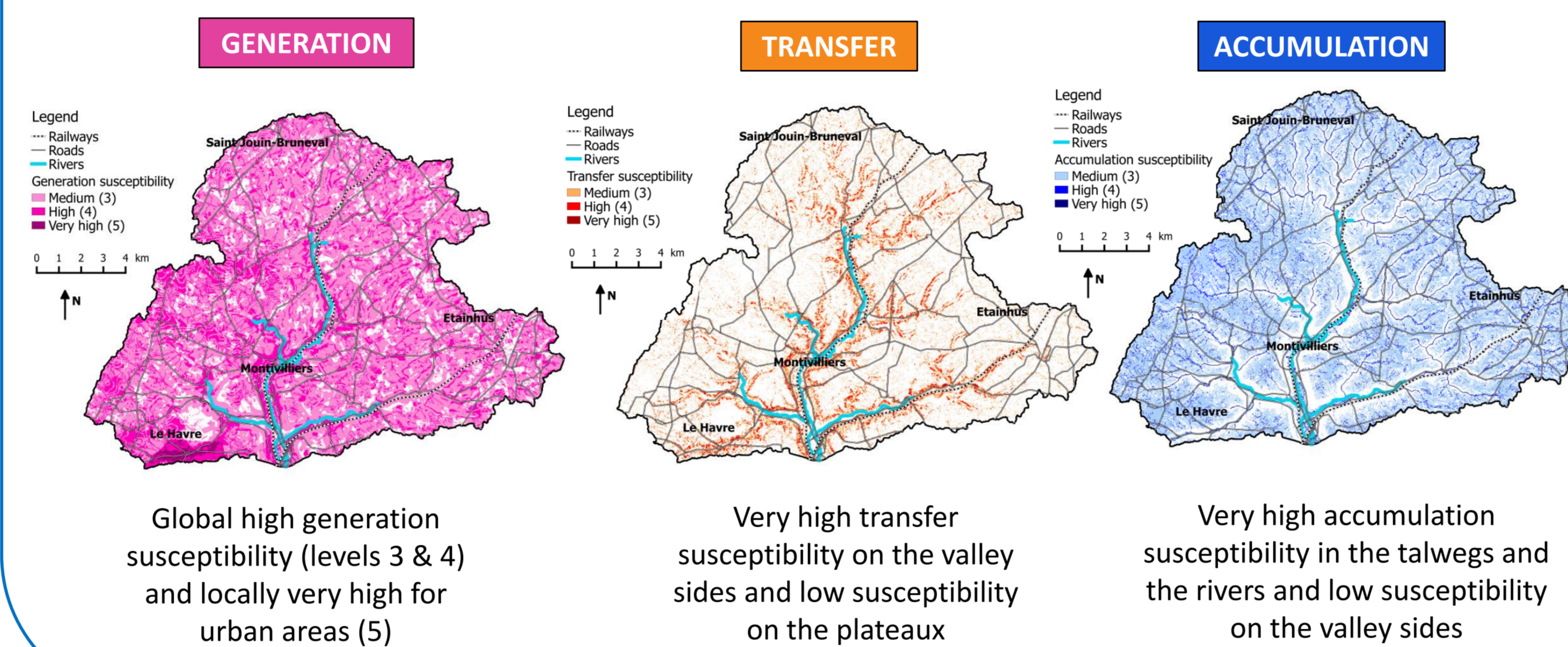## 1 Contexte

Hazards + Stakes → Risks

2 Challenge

Intense surface runoff occurs quickly and is difficult to measure on large territories, only limited observations are available

→ How to better know and understand the surface runoff hazard?

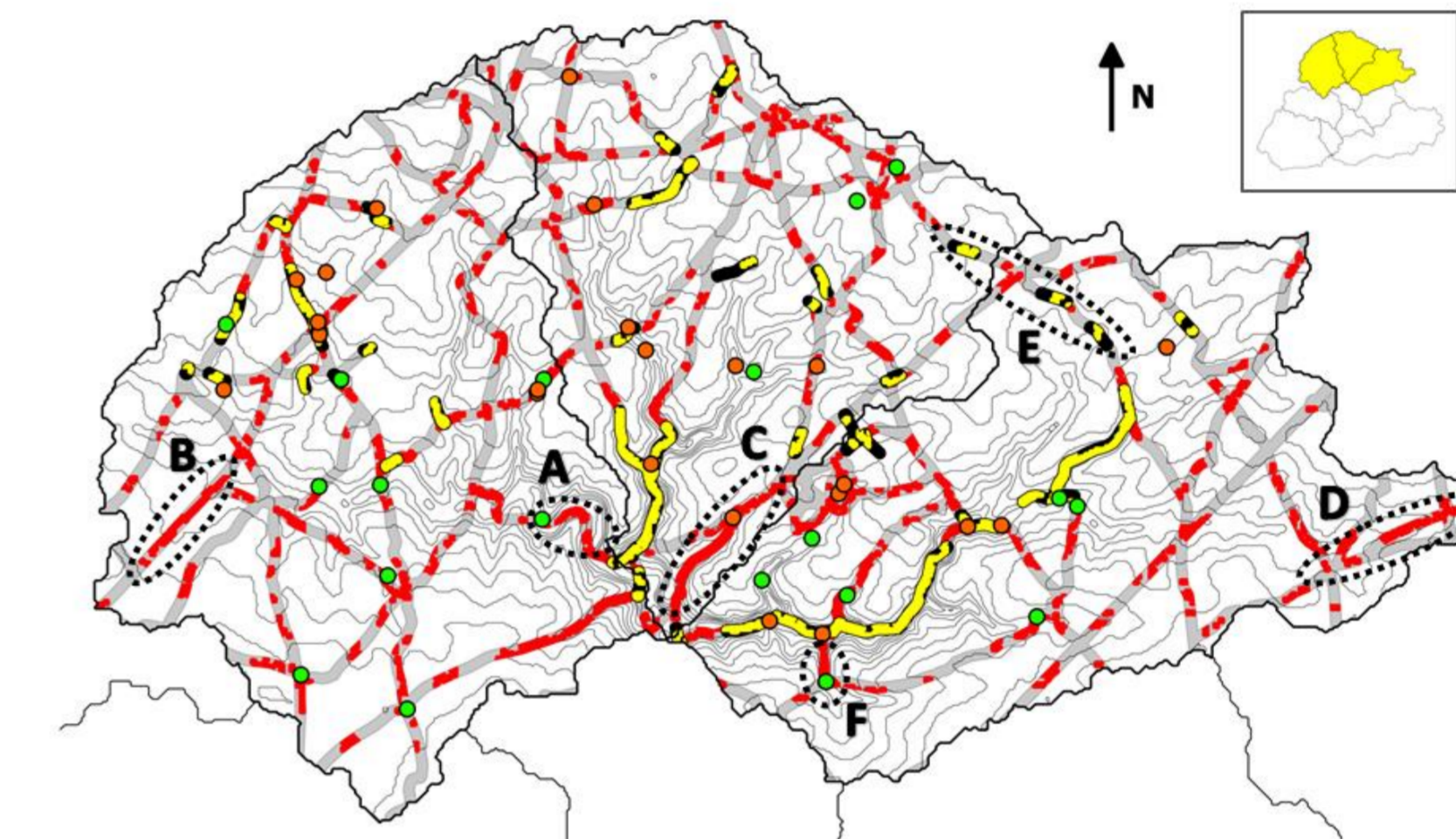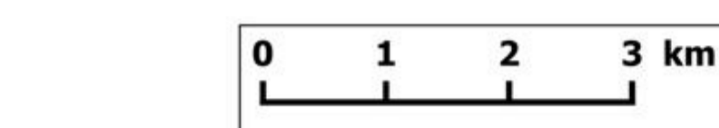→ How to evaluate the relevance of the hazard representation method?

3 The IRIP method

« Indicator of Intense Pluvial Runoff » (French acronym)

GENERATION

PERMEABILITY	High permeability / Low permeability	0 / 1
THICKNESS	Thick soil / Thin soil	0 / 1
ERODIBILITY	Low erodibility / High erodibility	0 / 1
LAND USE	Infiltrative surface / Impervious surface	0 / 1
TOPOGRAPHY	Slope AND topographic index low / Slope OR topographic index high	0 / 1

TRANSFER
- SLOPE
- BREAK OF SLOPE
- COMPACTNESS
- GROUND LINEAR AXES

ACCUMULATION
- SLOPE
- BREAK OF SLOPE
- TOPOGRAPHIC INDEX
- DRAINED AREA

Provides 3 susceptibility maps of 3 surface runoff stages
1/ generation   2/ transfer   3/ accumulation
Susceptibility levels ranging from 0 to 5

4 The study area

- 210 km²
- Large plateaus/ narrow valleys
- Short permanent river network/ dense talweg network
- Silt and clay with flint stones
- Oceanic climate

The Seine-Maritime County

5 Application of IRIP

GENERATION — Global high generation susceptibility (levels 3 & 4) and locally very high for urban areas (5)

TRANSFER — Very high transfer susceptibility on the valley sides and low susceptibility on the plateaux

ACCUMULATION — Very high accumulation susceptibility in the talwegs and the rivers and low susceptibility on the valley sides

6 Evaluation method

1. Use of proxy data

- Two risk regulatory zoning maps for surface runoff flooding and soil erosion
- Geolocalized impacts of surface runoff on roads and railway sections

2. Contingency table

		Observed event	
		Yes	No
IRIP Forecast	Yes	True positives (T+)	False positives (F+)
	No	False negatives (F-)	True negatives (T-)

3. Related correspondance indicators:

- Success ratio (SR) $= \frac{(T+)}{(T+)+(F+)}$
- Probability of detection (POD) $= \frac{(T+)}{(T+)+(F-)}$
- False alarm ratio (FAR) $= \frac{(F+)}{(T+)+(F+)}$

Indicators ranging from 0 to 1
SR + FAR = 1

7 Are the IRIP maps relevant?

1. Surface runoff zoning

- **Success ratio of 0.91** using a 50 meters buffer area aroud the regulatory zoning and considering pixels with an IRIP susceptibility level of 5
- 0.82 using a 25m buffer; 0.64 without buffer

2. Soil erosion zoning

- **Success ratio of 0.92** using a 50 meters buffer area aroud the regulatory zoning and considering pixels with an IRIP susceptibility level of 4 and 5
- 0.89 using a 25 m buffer; 0.72 without buffer

8 Are the IRIP maps able to detect impacted network sections?

Example of comparison for roads
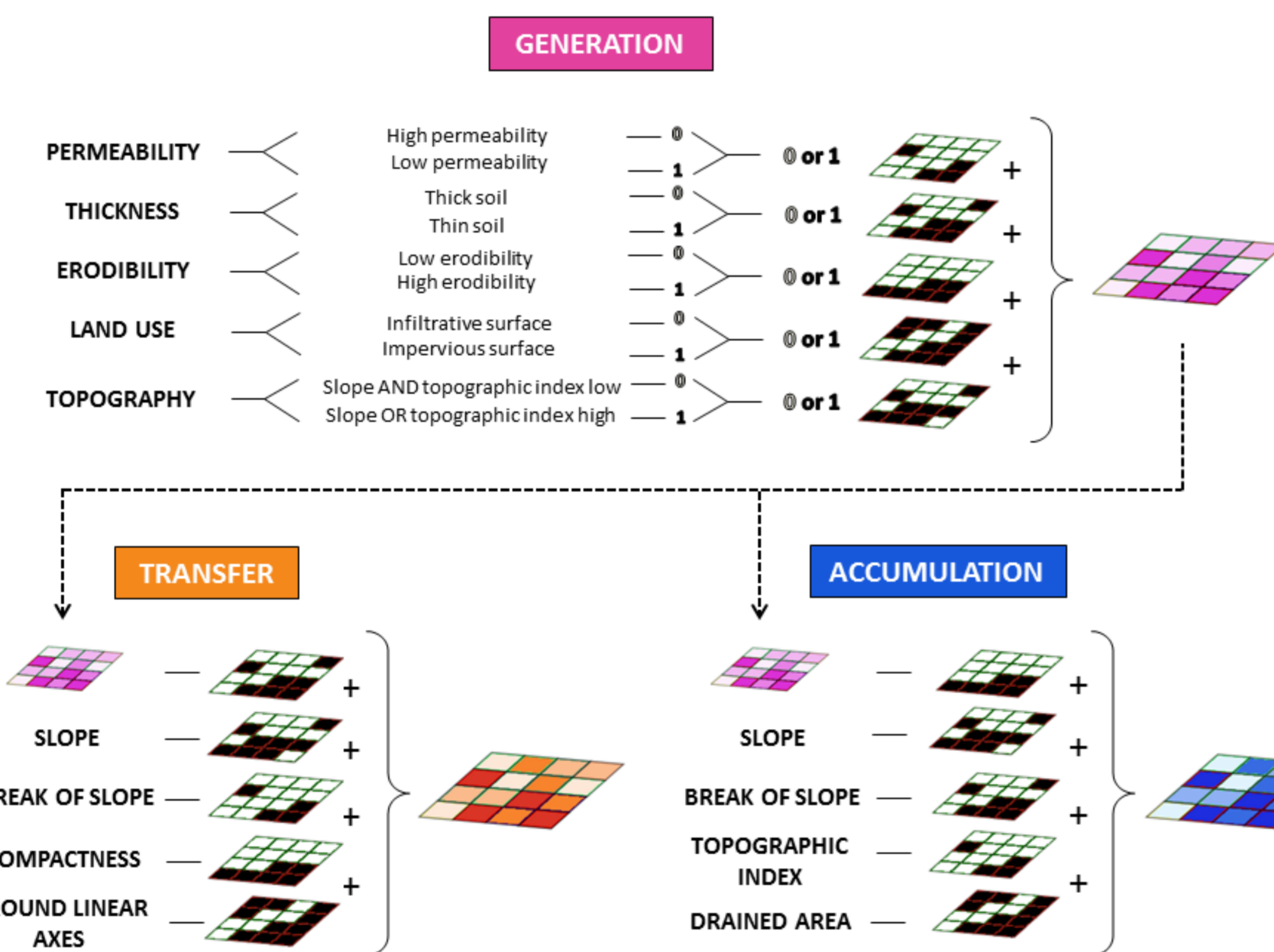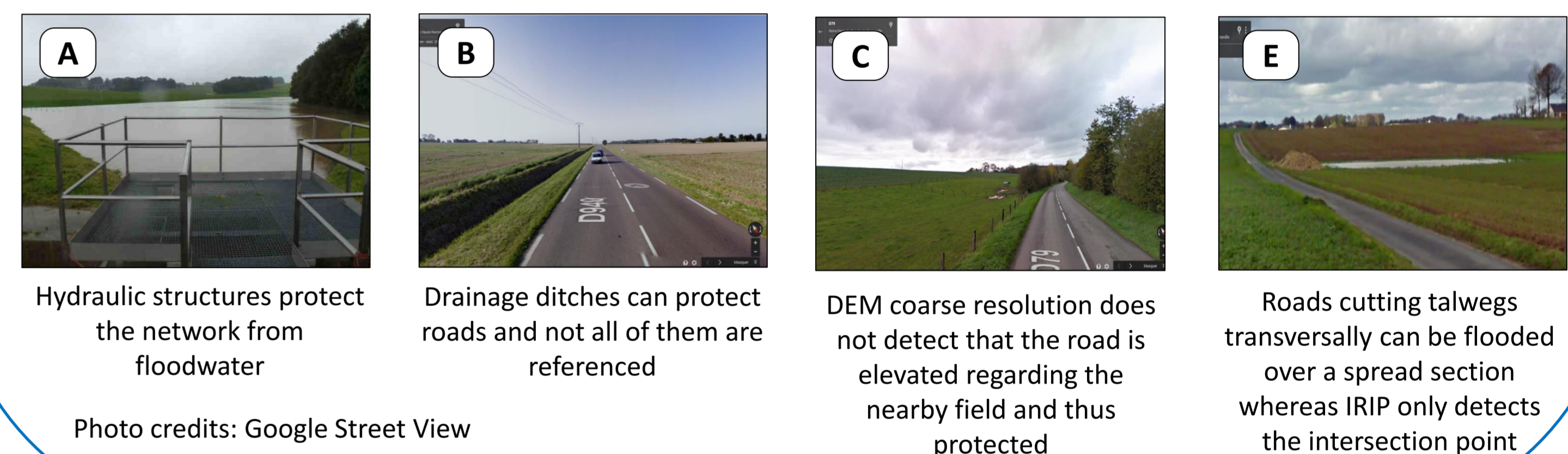
	Roads	Railways
Probability of detection	0.73	0.80
False alarm ratio	0.77	0.92

With respect to a buffer area of 25 meters both sides of the network - Not taking into account isolated pixels

- Promising probabilities of detection
- False alarm ratios should be reduced considering hydraulic protective structures and the vulnerability of road and railway infrastructures

A — Hydraulic structures protect the network from floodwater

B — Drainage ditches can protect roads and not all of them are referenced

C — DEM coarse resolution does not detect that the road is elevated regarding the nearby field and thus protected

E — Roads cutting talwegs transversally can be flooded over a spread section whereas IRIP only detects the intersection point

Photo credits: Google Street View

9 Origins of discrepancies

The evaluation method
- Standard verification indicators only assess a small part of the IRIP information
- Indirect relationship between susceptibility maps and surface runoff impacts: Rainfall patterns, exposure and vulnerability
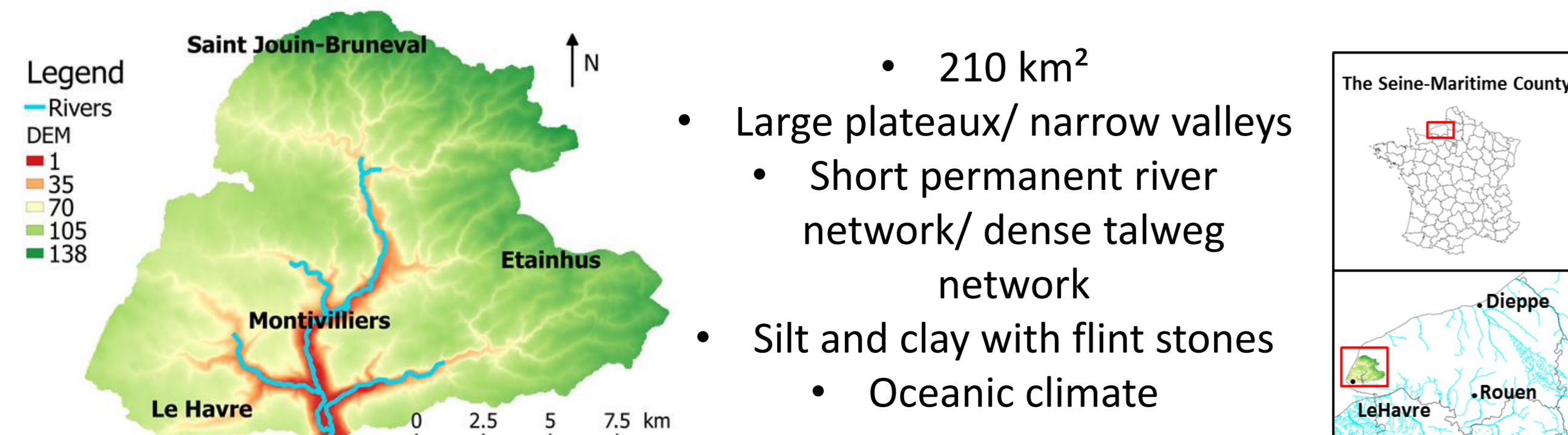
The comparison data
- Exhaustiveness
- Representativeness
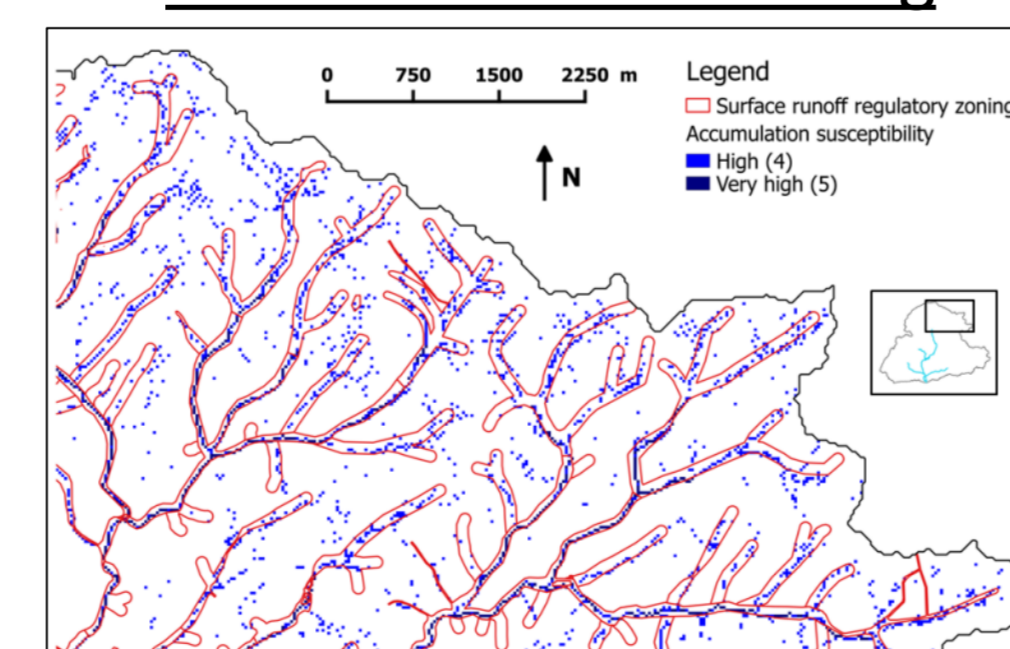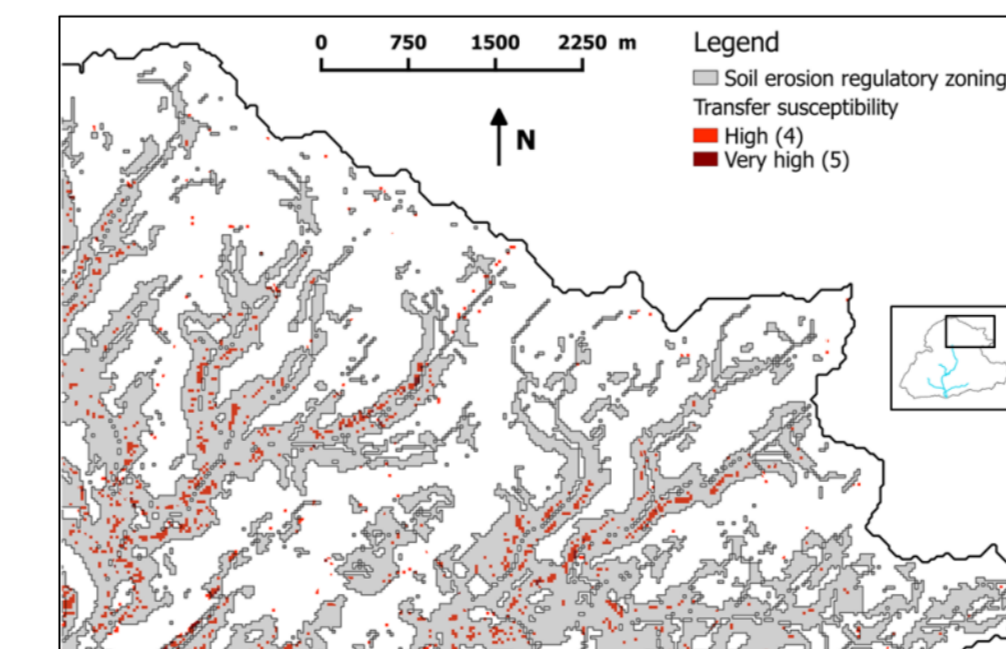- Biases in measuring and collecting the data
- Location accuracy

The IRIP method
- Input data accuracy
- Indicator combination and computation method
- The IRIP "yes" forecast thresholded at ≥ 4
- Presence of natural sinkhole not taken into account

10 Conclusion

- IRIP, a simple and robust method to a have global view of the susceptibility of territories to intense surface runoff hazards.
- Vulnerability of the transportation network to surface runoff must be characterized to better assess sections the most susceptible to be impacted.