RICOCHET WOKSHOP: effets cascades

RICOCHET
côtiers en contexte de changement global
Evaluation multirisques de territoires
ANR-16-CE03-0008

PROJET FINANCÉ PAR L'ANR - PROJECT FUNDED BY THE ANR
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Géosciences pour une Terre durable

1. Rappel

Tâche 6: Développement d'une plateforme multi-aléas puis multi-risques: outil intégrant les résultats des tâches 3, 4 et 5

- Définition des effets cascades et des hots spots
- Analyse multi-risques
- Production de cartes de risques pour différents scénarios
- Analyse des résultats
- Solution de mitigation

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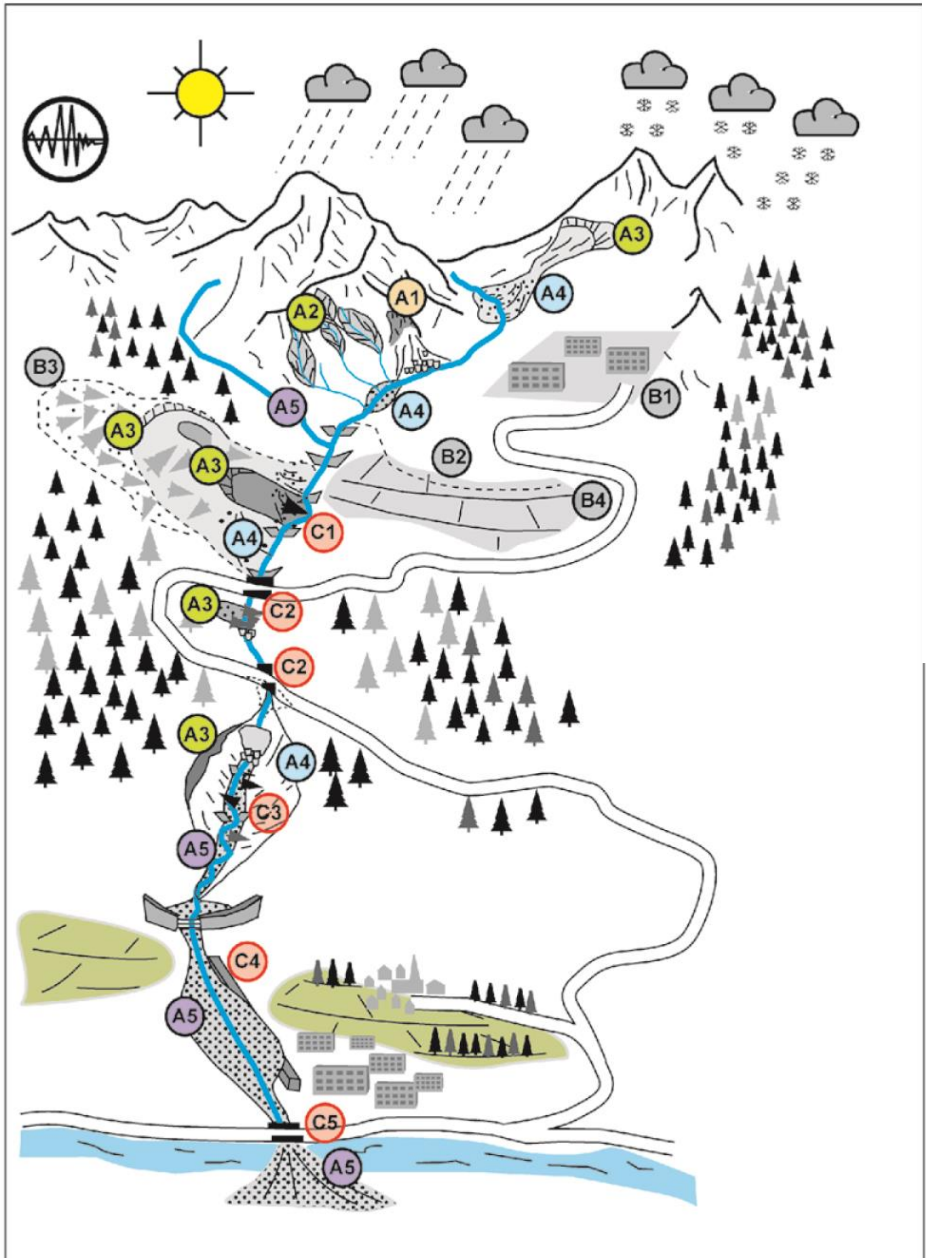
1. Rappel



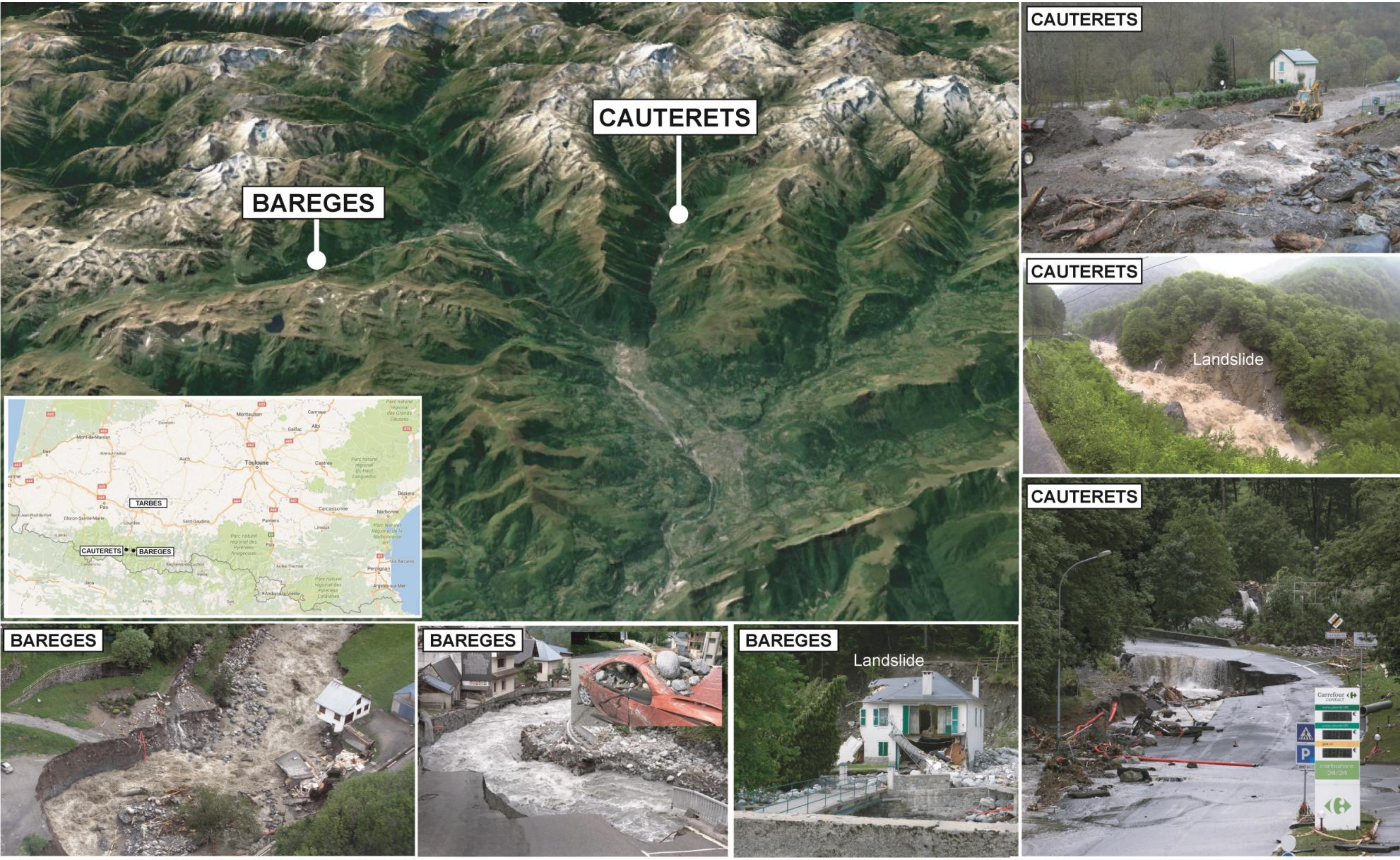
Human actions favourable to natural environment degradation

- B1 Intensive development & soil sealing
- B2 Drainage abandonment
- B3 Intensive deforestation
- B4 Abandonment of meadows adn grasslands

Hot-spots: impacts of processes or process combinations on infrastructures

- C1 Check-dam failure by torrential processes and landslides
- C2 Bridge degradation by landslides or torrential processes
- C3 Human thresolds failure by exceptionnal torrential processes
- C4 Protection and chenalized works rupture and overflow
- C5 Bridge rupture by overflow

1. Rappel



sources: France-info, France3, La République des Pyrénées, GoogleEarth, Pinaud 2014

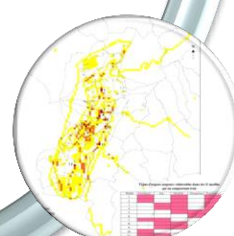
2. Effets Cascades : comment en tenir compte ?

- Une apparente simplicité ;
- Une vingtaine de définition trouvées dans la littérature

Effets cacades ou dominos

Approches centrées sur les aléas et leurs effets les uns sur les autres

Approches centrées sur la/les vulnérabilité(s) (infrastructures critiques…)→ effets d’un aléa sur une infrastructure



Approches centrées sur les enjeux majeurs, leur fonction et leur localisation

2. Effets Cascades : comment en tenir compte ?

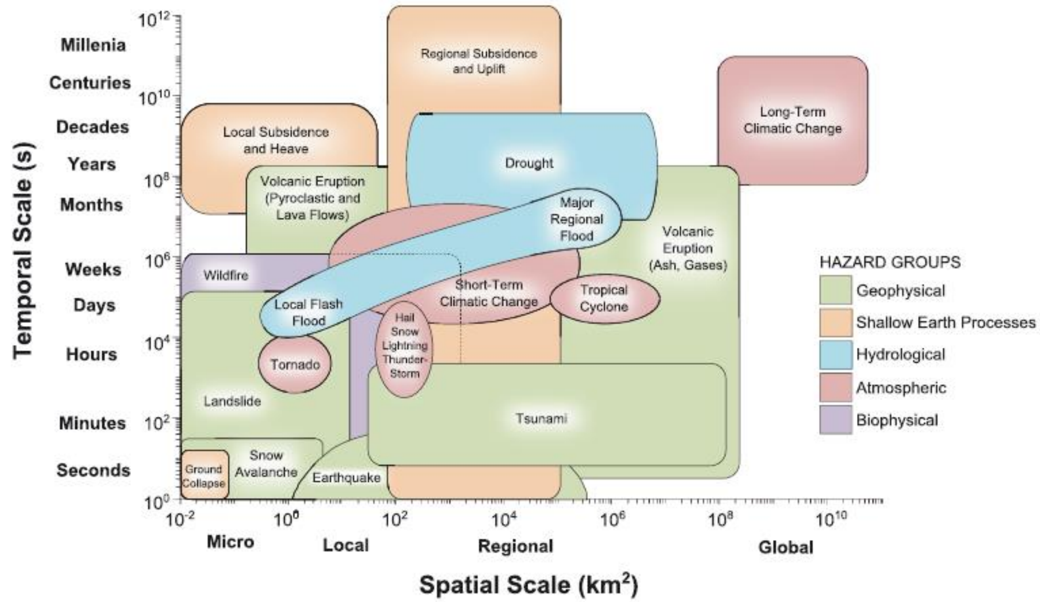
- Quelques défintions (Pescaroli and Alexander, 2015)

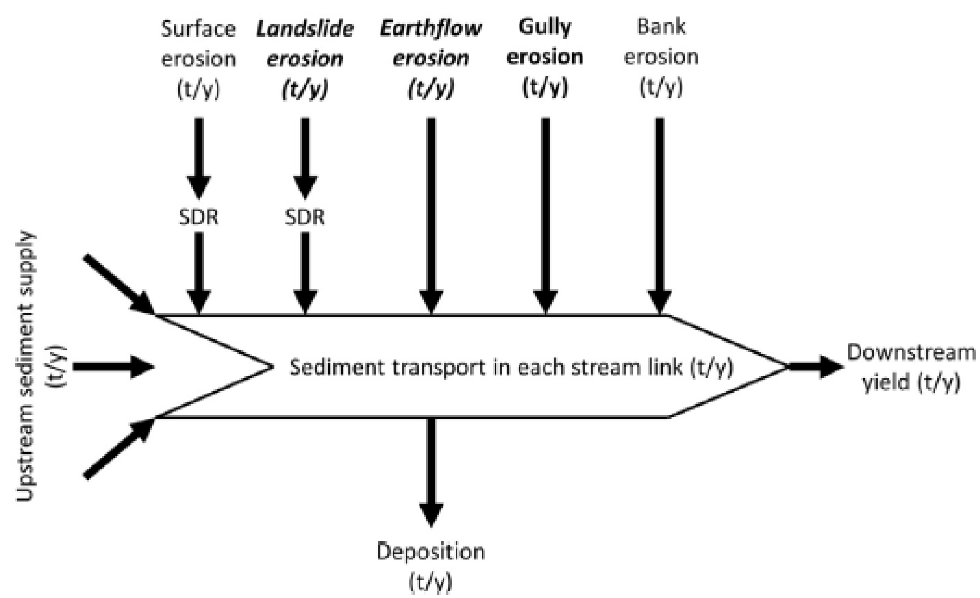
Reference	Quote
FEMA Independent Study Course, IS 230, Principles of Emergency Management	p. 3.17. Cascading events are events that occur as a direct or indirect result of an initial event. For example, if a flash flood disrupts electricity to an area and, as a result of the electrical failure, a serious traffic accident involving a hazardous materials spill occurs, the traffic accident is a cascading event. If, as a result of the hazardous materials spill, a neighborhood must be evacuated and a local stream is contaminated, these are also cascading events. Taken together, the effect of cascading events can be crippling to a community.
FEMA Independent Study Course, IS 393, Introduction to Mitigation	p. 1-6. Cascading emergencies— situations when one hazard triggers others in a cascading fashion— should be considered. For example, an earthquake that ruptured natural gas pipelines could result in fires and explosions that dramatically escalate the type and magnitude of events.
U.S. Department of Homeland Security National Response Plan, December 2004	p. 4 Additionally, since Incidents of National Significance typically result in impacts far beyond the immediate or initial incident area, the NRP [National Response Plan] provides a framework to enable the management of cascading impacts and multiple incidents as well as the prevention of and preparation for subsequent events.
FEMA for Kids Website, Resources for Parents and Teachers, How Schools Can Become More Disaster Resistant. `http://www.fema.gov/kids/schdizr.htm`	. . . disasters can have a cascading effect—forest fires can bring mudslides; earthquakes cause fires; tornadoes cause downed power lines
Resource Materials: Integrating Manmade Hazards into Mitigation Planning Risk Management in a Multi-Hazard World 2003 All-Hazards Mitigation Workshop June 12, 2003 Emergency Management Institute `http://www.fema.gov/txt/fima/antiterrorism/resourcematerials.txt`	Indirect attacks: infrastructures are really interconnected systems of systems; an attack on one can lead to cascading losses of service (ranging from inconvenient to deadly) and financial consequences for government, society, and economy through public- and private-sector reactions to an attack.
FEMA 428, Asset Value, Threat/Hazard, Vulnerability, And Risk	p. 2-11. What is the likelihood of cascading or subsequent consequences should the asset be destroyed or its function lost?
Hazard Analysis and Risk Assessment, 2003 Local Guide, Iowa Homeland Security and Emergency Management Division,	Hazards create direct damages, indirect effects, and secondary hazards to the community. Direct damages are caused immediately by the event itself, such as a bridge washing out during a flood. Indirect effects usually involve interruptions in asset operations and community functions, also called functional use. For example, when a bridge is washed out due to a flood, traffic is delayed or rerouted, which then impacts individuals, businesses, and public services such as fire and police departments that depend on the bridge for transportation. Secondary hazards are caused by the initial hazard event, such as when an earthquake causes a tsunami, landslide, or dam break. While these are disasters in their own right, their consequent damages should be included in the damage calculations of the initial hazard event. Loss estimations will include a determination of the extent of direct damages to property and indirect effects on functional use.
Regional All-Hazards Mitigation Plan, City of St. Louis and counties of St. Louis, Jefferson, Franklin and St. Charles, Missouri, November 2004.	Cascading hazards could include interruption of power supply, water supply, business and transportation.

2. Effets Cascades : comment en tenir compte ?

- Approches aléas (Gill and Malamud, 2014)

1. Interactions where a hazard is triggered.
2. Interactions where the probability of a hazard in increased.
3. Interactions where the probability of a hazard is decreased.
4. Events involving the spatial and temporal coincidence of natural hazards.





2. Effets Cascades : comment en tenir compte ?

- Approches aléas seuls ou conjoints sur éléments vulnérables (Pescaroli and Alexander, 2015)

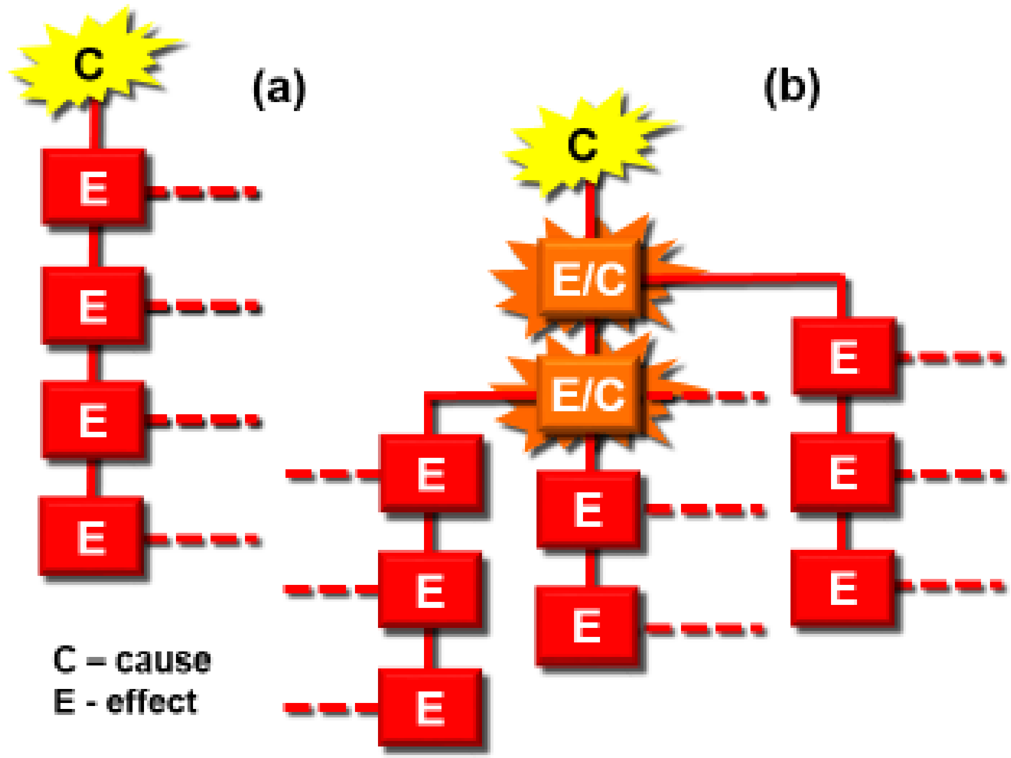
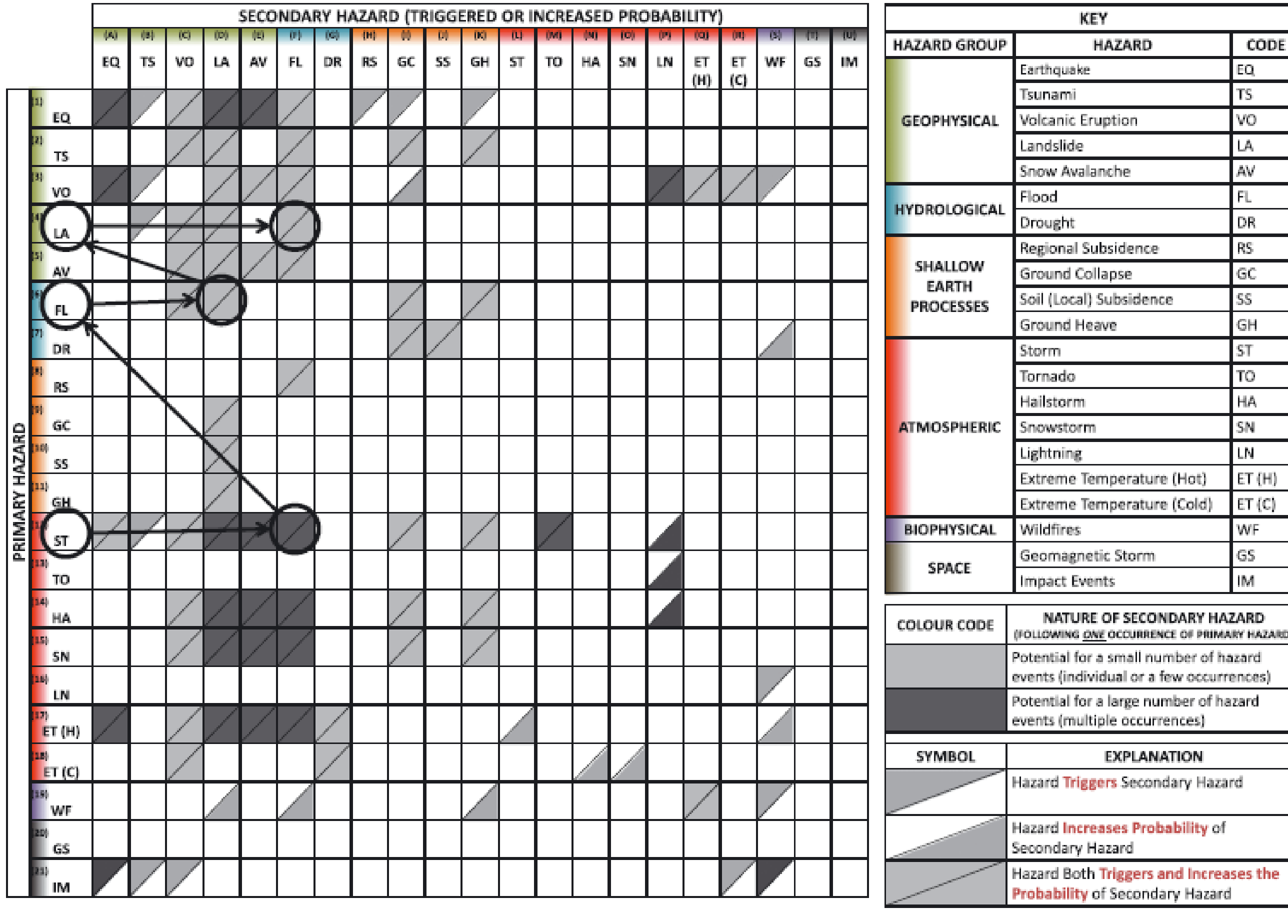


Figure 2: (a) Linear path of events in disasters, and (b) non-linear path of cascading, including amplification and subsidiary disasters.

(Pescaroli and Alexander, 2015)

3. Approche aléa



Footnotes

[1A,D,E; 3A,P; 12D-F,M,P; 13P; 14D-F,P; 15D-F; 17A,D-F; 21A] The secondary hazards in these cases are all accepted to most likely occur as large numbers of events, and are thus analysed in this way.

[1C] There is disagreement in the literature about the nature of this relationship .

[2,6,12,14,15C] Water input triggers or increases the probability of a phreatic/phreatomagmatic eruption.

[3I] Volcanism increases the acidity of rain, promoting dissolution of carbonate material.

[12A] Low pressure systems have been shown to trigger or increase the probability of slow earthquakes on faults that are already close to failure (Liu *et al.*, 2009).

[17A,C-F] Secondary hazards triggered or have an increased probability over a range of time-scales, through snow and glacial melting.

[18C] Long term reductions in temperature can increase glaciation and thus decrease sea-levels. This reduction in sea-levels can reduce confining pressures, promoting volcanic eruptions.

Figure 3. An example of a network of interacting hazards (a cascade system). A 21 × 21 matrix with primary natural hazards on the vertical axis and secondary hazards on the horizontal axis, the same as shown in Figure 2. These hazards are coded, as explained in the key. This matrix can be used to present an example of a hazard cascade system. In this example, a storm event (**ST**) triggers flooding (**FL**), which then triggers landslides (**LA**). These landslides (**LA**) may then trigger or increase the probability of further flooding (**FL**) through the blocking of a river or the increase of sediment within the fluvial system.

2. Approche aléa

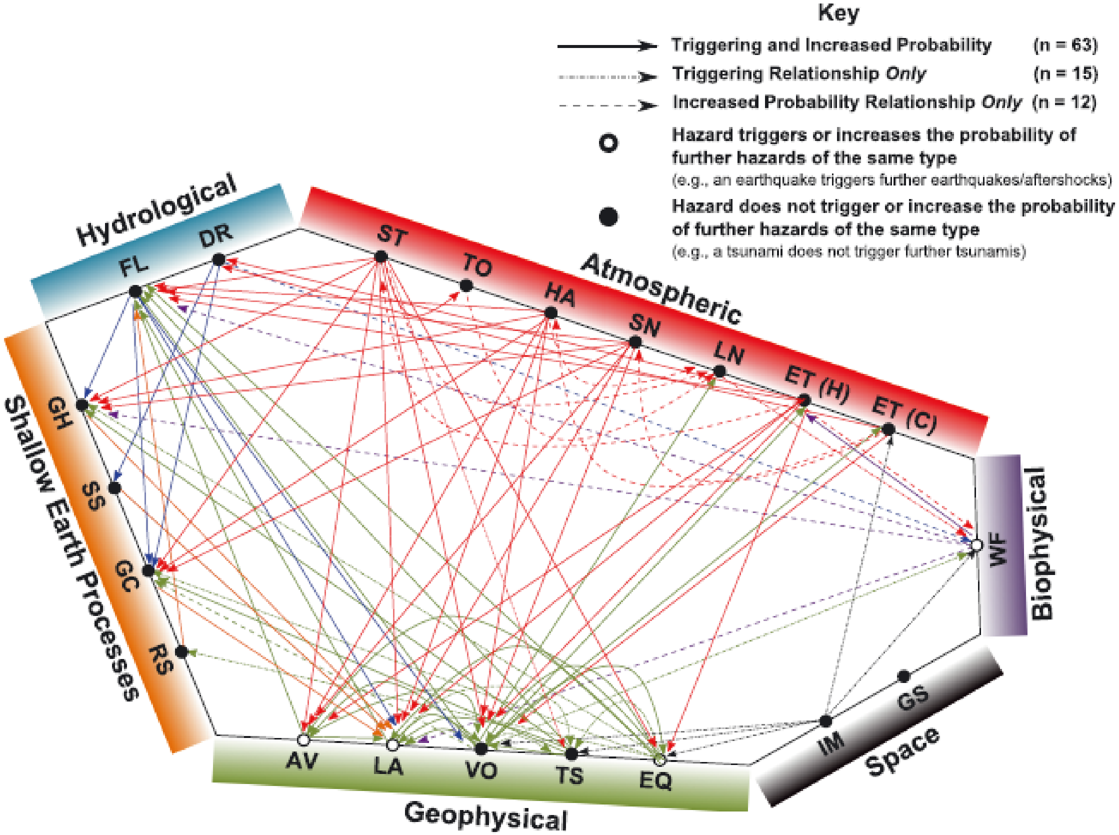
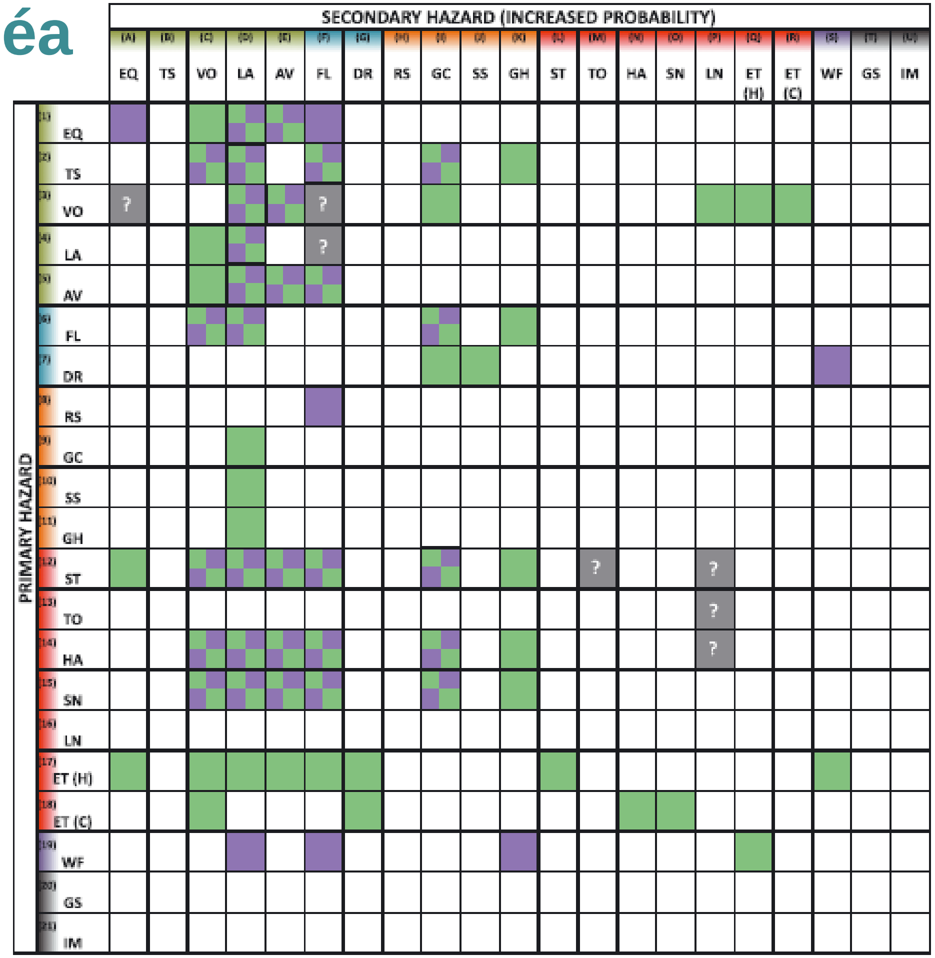


Figure 4. Hazard type linkages. A network diagram showing the potential hazard type linkages between 21 natural hazards: **EQ** = earthquake, **TS** = tsunami, **VO** = volcanic eruption, **LA** = landslide, **AV** = snow avalanche, **RS** = regional subsidence, **GC** = ground collapse, **SS** = soil (local) subsidence, **GH** = ground heave, **FL** = flood, **DR** = drought, **ST** = storm, **TO** = tornado, **HA** = hailstorm, **SN** = snowstorm, **LN** = lightning, **ET (H)** = extreme high temperatures, **ET (C)** = extreme cold temperatures, **WF** = wildfires, **GS** = geomagnetic storms, and **IM** = impact events. Hazards groups follow the same color coding as in Figure 2. Line patterns (see key) are used to represent cases where both triggering and increased probability are possible (solid), cases where only a triggering relationship is possible (dash-dotted), and cases where only an increased probability relationship is possible (dashed). Where a hazard may trigger or increase the probability of further hazards of the same type (e.g., earthquakes–**EQ**), the node is hollow to represent this relationship.

in Figure 5. This ranking shows that the hazards with the most primary hazard to secondary hazard links were volcanic eruptions (**VO**), earthquakes (**EQ**), and storms (**ST**) (each with nine primary to secondary links identified from Figure 4). Together these three primary hazards accounted for 27 (about a third) of the 78 total possible links where a primary hazard triggers a secondary hazard.

2. Approche aléa



KEY		
HAZARD GROUP	HAZARD	CODE
GEOPHYSICAL	Earthquake	EQ
	Tsunami	TS
	Volcanic Eruption	VO
	Landslide	LA
	Snow Avalanche	AV
HYDROLOGICAL	Flood	FL
	Drought	DR
SHALLOW EARTH PROCESSES	Regional Subsidence	RS
	Ground Collapse	GC
	Soil (Local) Subsidence	SS
	Ground Heave	GH
ATMOSPHERIC	Tropical Storm	TR
	Tornado	TO
	Hailstorm	HA
	Snowstorm	SN
	Mid-Latitude Storm	MLS
	Extreme Temperature (Hot)	ET (H)
	Extreme Temperature (Cold)	ET (C)
BIOPHYSICAL	Wildfires	WF
SPACE	Geomagnetic Storm	GS
	Impact Event	AS

SYMBOL	EXPLANATION
	Hazard Increases the Probability of Secondary Hazard

TYPE	CODE
A. Threshold 'alone'	
B. Continuous 'alone'	
A and/or B. Threshold 'Alone' *and/or* Continuous 'Alone' relationships are relevant	
(Complex, Location Specific)	?

The relationships examined within this table are only for when a primary hazard increases the probability of a secondary hazard occurring. The colour coding relates to ***how changes in the intensity of the primary hazard impact upon the potential intensity of the secondary hazard, should it occur.***

Footnotes

[1C] There is disagreement in the literature about the nature of this relationship

[1A,D,E; 3A,P; 12D-F,P; 13P; 14D-F,P; 15D-F; 17D-F] The secondary hazards in these cases are all accepted to most likely occur as large populations of events, and are thus analysed as a large population.

[2,6,12,14,15C] Water input increases the probability of a phreatic/phreatomagmatic eruption.

[3I] Volcanism increases the acidity of rain, promoting dissolution of carbonate material.

[12A] Low pressure systems have been shown to increase the probability of slow earthquakes on faults that are already close to failure (Liu *et al.*, 2009).

[12-15] If these primary hazards stall then the primary hazard intensity will be spatially concentrated, and therefore the hazard intensity is likely to increase.

[17C-F] Secondary hazard probability increased over a range of time-scales, through snow and glacial melting.

[18C] Long term reductions in temperature can increase glaciation and thus decrease sea-levels. This reduction in sea-levels can reduce confining pressures, promoting volcanic eruptions.

3. Approche aléa

Table 1. Approaches for Assessing Natural Hazard Interactions[a]

Type	Authors	Location	Hazards/Processes Considered	Interaction Classifications	Further Notes
Qualitative descriptions and classifications	*Han et al.* [2007]	General (case studies from China)	PRIMARY: Earthquake, rainstorm, rapid snowmelt, human activity SECONDARY: Landslides, debris flow activity, flooding, ground failure	(1) Spatial and/or temporal chains (2) Endogenic processes (3) Exogenic processes (4) Human-induced chains (5) Spatial/temporal coincidence of independent hazards	
Matrices and diagrams	*Tarvainen et al.* [2006]	Europe	NATURAL: Avalanche, drought, earthquake, extreme temperature, flood, forest fire, landslide, storm surge, tsunami, volcanic eruption, winter storm TECHNOLOGICAL: Air traffic accident, chemical plant, nuclear power plant, oil processing/ transport/storage	One hazard influencing another hazard, based on real physical processes from casual correlation	Binary matrix examining interactions
	De Pippo et al. [2008]	Northern Campania, Italy	Shoreline erosion, riverine flooding, surge, landslide, seismicity and volcanism, man-made structures	One hazard influencing another hazard	Descriptive matrix to describe interactions
	Kappes et al. [2010]	Barcelonnette, Southern French Alps	Avalanche, debris flow, rock fall, landslide, flood, heavy rainfall, earthquake	(1) Triggering relationships (2) One hazard changing the disposition or general setting that favors a specific hazard process	Binary matrix and descriptive matrix examining interactions
	van Westen et al. [2014]	European Mountainous Environments	TRIGGERING FACTORS: Earthquake, meteorological extremes SECONDARY HAZARDS: Mass movement, snow avalanche, forest fire, land degradation, flooding, seiche, technological hazard	(1) Hazards triggered simultaneously (coupled) (2) Hazards causing another hazard	Possible interactions visualized in network diagram form
Probability/ scenario trees	*Neri et al.* [2008]	Vesuvius, Italy	Volcanic eruption, fallout, ballistics, pyroclastic density current, debris avalanche, tsunami, flood, landslide, lahar, mudslide, heavy rain	*Not Stated*	Probability tree for a specific volcanic setting
	Marzocchi et al. [2009]	NA	Volcanic eruption, fire, contaminant migration	Triggering effects and/or cascade adverse events	Hypothetical example
	Neri et al. [2013]	Kanlaon, Philippines	Volcanic eruption, fallout, ballistics, pyroclastic density current, debris avalanche, tsunami, flood, lahar/mudslide	*Not Stated*	Probability tree for a specific volcanic setting

[a] A range of approaches for assessing natural hazard interactions have been utilized, including qualitative descriptions and classifications, matrices, and diagrams, and probability/scenario trees (NA = Not applicable).

4. Approche par enjeux et fonction (D'Ercole & Metzger, 2009)

1. Analyse du territoire

- Identification des enjeux majeurs et de leur vulnérabilité ;
- Identification de l'exposition à chaque type d'aléa ;
- Identification de la dépendance d'un enjeu (dépendance d'un enjeu vis à vis d'un autre enjeu i.e. station de pompage d'eau vs alimentation éléctrique).

2. Croisement avec Aléa(s)

- Une carte d'aléa

3. Inconvénient s majeurs

- L'effet cascade et pris seulement dans le point 1.
- Pas de séparation des aléas, une carte d'aléa unique

4. Approche par enjeux et fonction (Tacnet, 2009)

1. Analyse des fonctions d’un élément vis à vis d’un aléa ;
2. Prise en compte de l’incertitude ;
3. Théorie des possibilités → compréhensible aisément par décideurs → méthode faite pour une réelle aide à la décision;

Mais : non expériementée dans le cadre des effets cascades….

5. Et pour RICOCHET ?

Effets cascades:

- Approche par matrice ?
- Approche par arbre décisionnel ?
- Boucle d’interactions ?
- Comment prendre en compte les effets d’une vulnerabilité “dynamique” avec conséquences sur un aléa ?

Scenarri :

- Élaboration de scenarri en amont ?
- Elaboration de scenarri selon les modèles ?

Et les décideurs dans tout cela ?

- Comment tenir compte de leur vision dans nos réflexions ?

5. Et pour RICOCHET ?

Pistes de réflexion

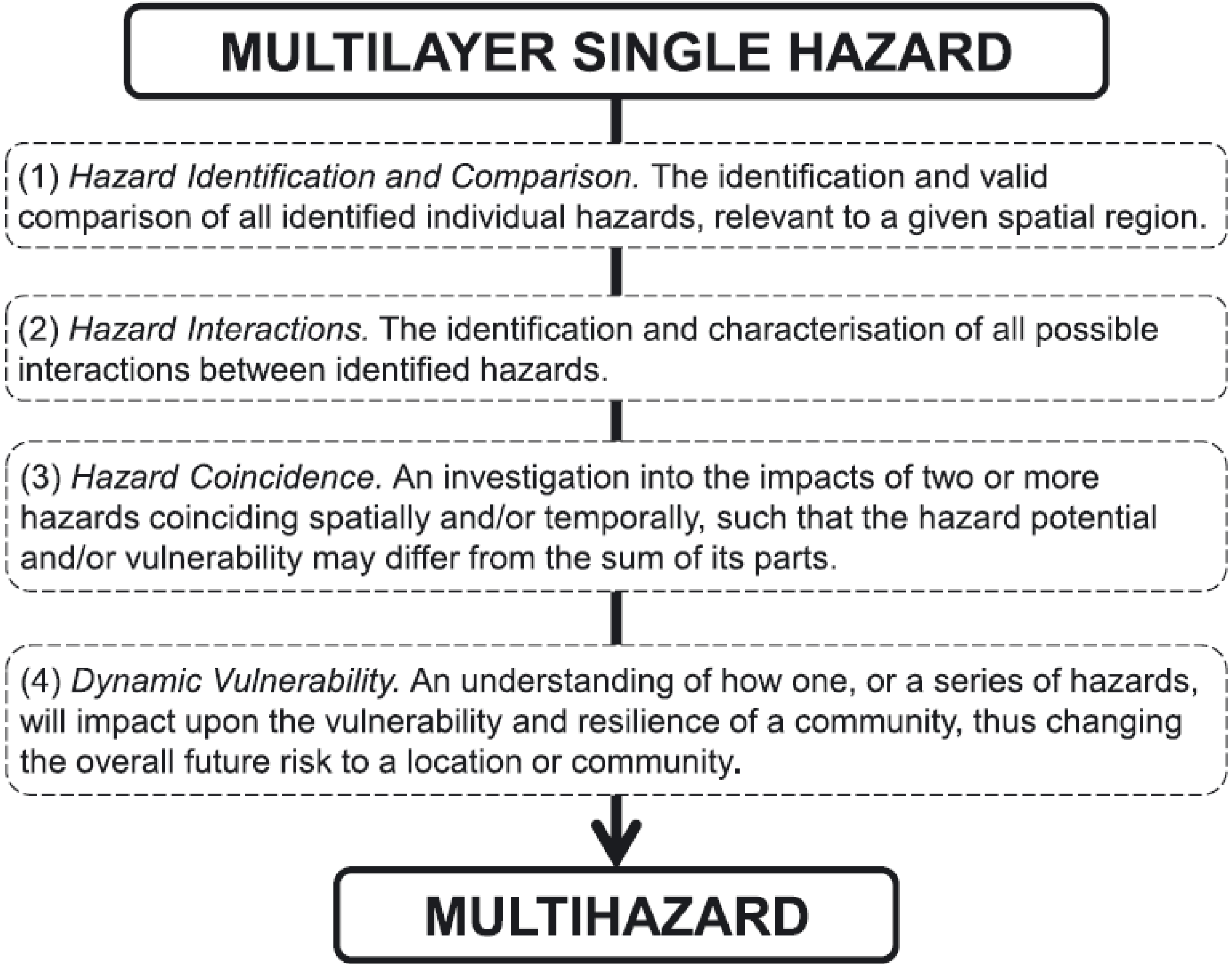
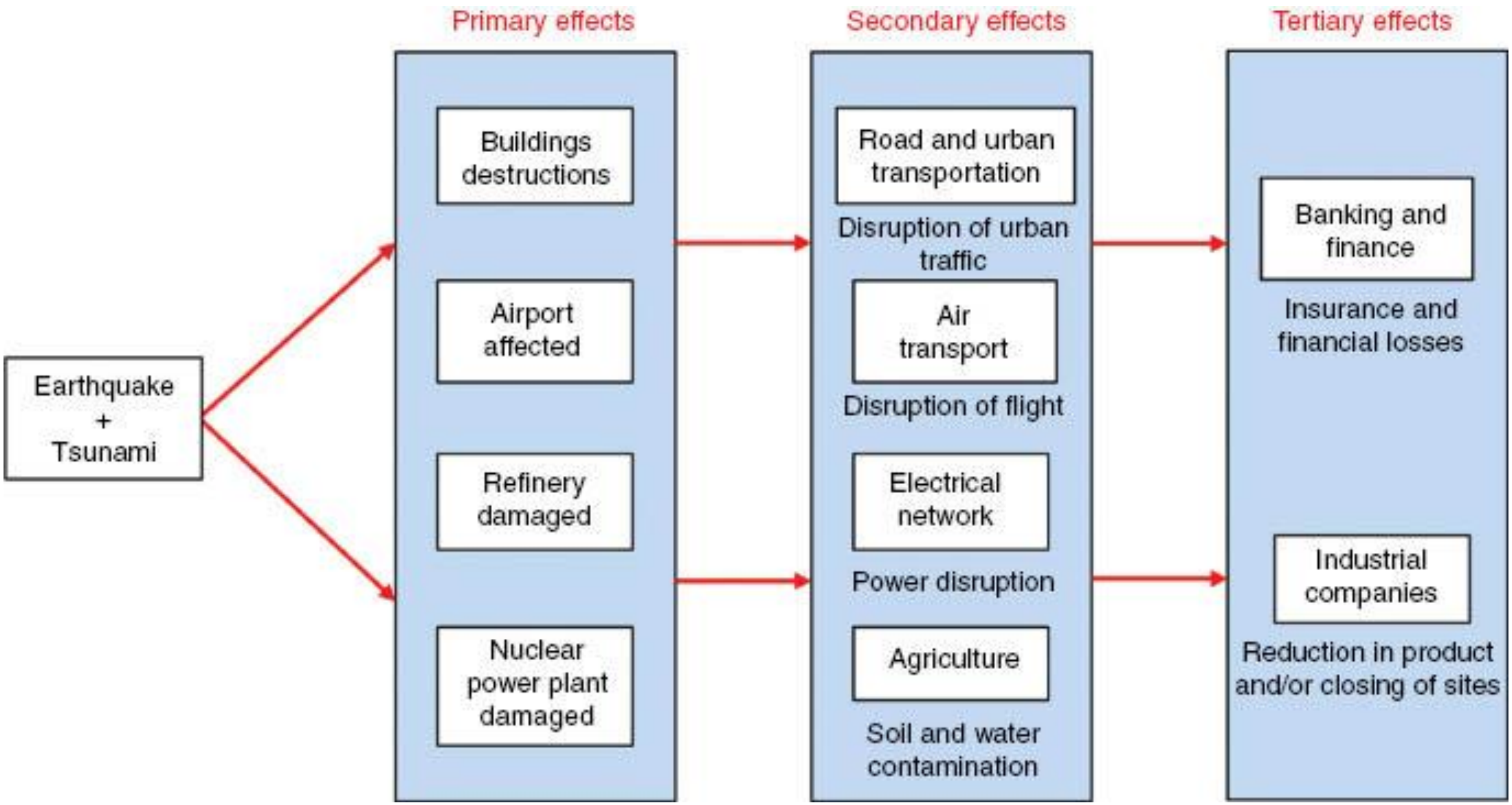


Figure 13. Multihazard framework. This figure represents the progression from a multilayer single hazard approach to a multihazard approach. This involves four key aspects, including (1) hazard identification and comparison, (2) hazard interactions, (3) hazard coincidence, and (4) dynamic vulnerability.

5. Et pour RICOCHET ?



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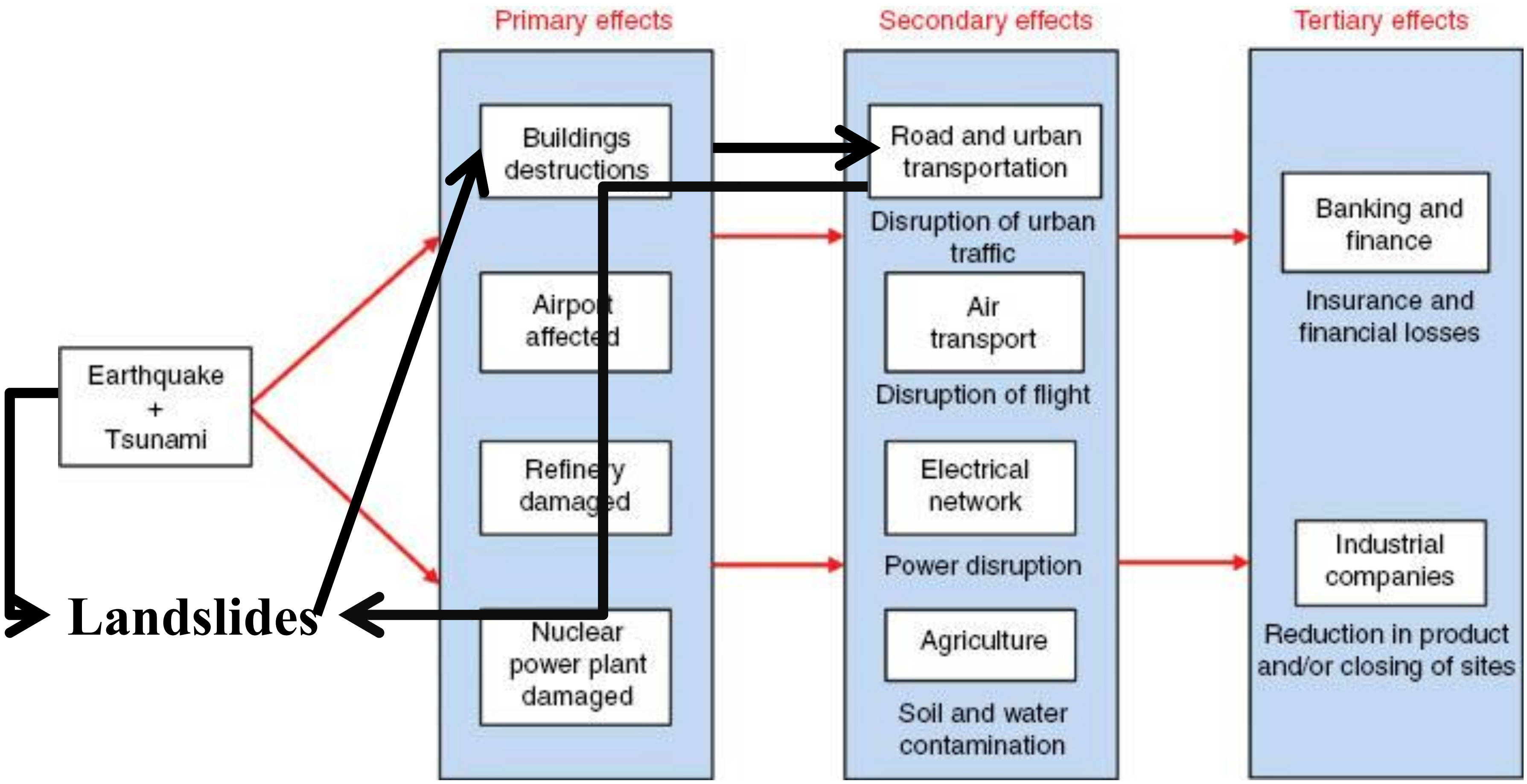
5. Et pour RICOCHET ?



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5. Et pour RICOCHET ?

Pistes de réflexion:

- Élaborer des scenarri ;
- Aléas :analyser les aléas et les effets des uns sur les autres ;
- Vulnérabilité : approche par fonctionnalité du territoire, indépendante des aléas
- ………

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