Approach, Method and Tool for Risk Management related to Climate Change: GERICI

- Reducing the Vulnerability of Infrastructures
- Network, Route, and Section Approaches
- Lessons learnt for:
  - new design concepts / rules
  - upgrading optimisation
  - investment versus operations adaptability

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Why GERICI?

- Infrastructures are designed (eg.r 50 or 100 years…) according to specific "**reference" events** (i.e. frequency: flood of one hundred years return period)

  References on Specific events are currently based on **past** experience **with a stable climate hypothesis.**

➔ **Climate Change** modifies (already now, and much more over the next 50 or 100 years…) the actual risk level and therefore **challenges design rules**

- There is and will be an increase in unusual climatic events (strength-frequency) caused by climate change; **impacts** on infrastructures, operations, and the economy at large may be **significant**, and in some cases more dangerous than many now think.

- **Other factors** will increase the impacts of unusual climate events. i.e. Urbanisation growth leading to more run-off, increase in trade, "just-in-time" transport, increasing sensitivity of transport users to risks.

➔ **A more-in-depth, wider-open and more-systematic Risk Management approach is necessary**

Typical examples of impacts of unusual climate events

Stronger Winds

Source : SANEF

December 1999:
Storm in France: winds from 160 to 200 km/h

Heat & Drought

Summer 2003:
Forest fire close to A8 motorway (South of France)

Source : ASF/ Escota

Typical examples of impacts of unusual climate events

Rain & Flood

8 July 2001:
A1 motorway flooded (North of France), following very local strong storms

Source : SANEF

Flood in Bulgaria

Typical examples of impacts of unusual climate events

Hurricane & Bridges


Photo:J. O'Connor (for MCEER)

US 90 - St. Louis, Mississippi

Hurricane & Roads Network

Photo:J. O'Connor (for MCEER)

Many part of Interstate 10 (**New Orleans**, Louisiana) were underwater.
Some ramps were used to support emergency operations

Typical examples of impacts of unusual climate events

Heat & Pavements

Rutting phenomena in wide areas cannot be excluded, and may be costly to repair

Hurricane & Pavements

Large masses of asphalt pavement peeled off US-90, Louisiana.

An Applied Research program

- In response to a **Call** for Proposals by RGCU (2003)
  (French Ministry for Infrastructure and Research Ministry: National Platform for Urban and Civil Works)
- Supported by Infrastructure and Transport **Ministry**
  (Directorate for Scientific and Technical Affairs)
- An applied-research Project presented by a **Consortium** of 7 partners

EGIS-SCETAUROUTE	Project leader – Engineering firm Specialised expertise and integration
SANEF	Large motorway concession companies: Needs of infrastructure owners & operators
ASF	
EGIS-BCEOM	Hydraulics Expertise
METEO France	Meteorological data and expertise
LCPC	High-level expertise
ESRI	GIS tool

GERICI objectives

- Design of a **Climate Risk Analysis** and Management Approach for Infrastructures :
  - A large-**Network** approach for General Directorates

- Design of a Risk Management **Tool**:
  - Short-term action of alert and prevention for **operation managers** facing unusual events
  - Medium term action to **adapt** infrastructures to climate evolution

- Propose **Palliative** Measures to mitigate the Risks

- Understand new challenges to anticipate and suggest **policy changes** and **cooperation** strategies between concerned stakeholders

GERICI objectives

A systematic identification of Risk Factors

Climate Factors (rain, wind,...)

Infrastructure Intrinsic Factors

Site Factors (evolution, increase,…)

- Assessment of the **Infrastructure sensitivity** (issues at stake)
- Determination of Risk Levels and their **critical thresholds**
- Ability of **continuous adjustment** to Climate Data evolution
- Networking Knowledge and Experience Capitalisation for **sustainable relevance** of both methods and tools

Key-Unwanted Events targeted

- A Meteo-France data table details strength and frequency of each key-weather-phenomenon:

- Rain
- Snow
- Floods
- Heat waves
- Cold / Frost
- Wind

May also occur in pairs:
- Frost and rain
- Frost and snow
- Rain and wind
- Flood and wind
- etc.

Fields of impacts, Scope of Expertise, and Risk Maps

Seven domains of expertise analysed:

- Pavements
- Geotechnics
- Small Hydraulics and drainage
- Structures
- Environment
- Equipment
- River Hydraulics

Each domain of Expertise is structured into:

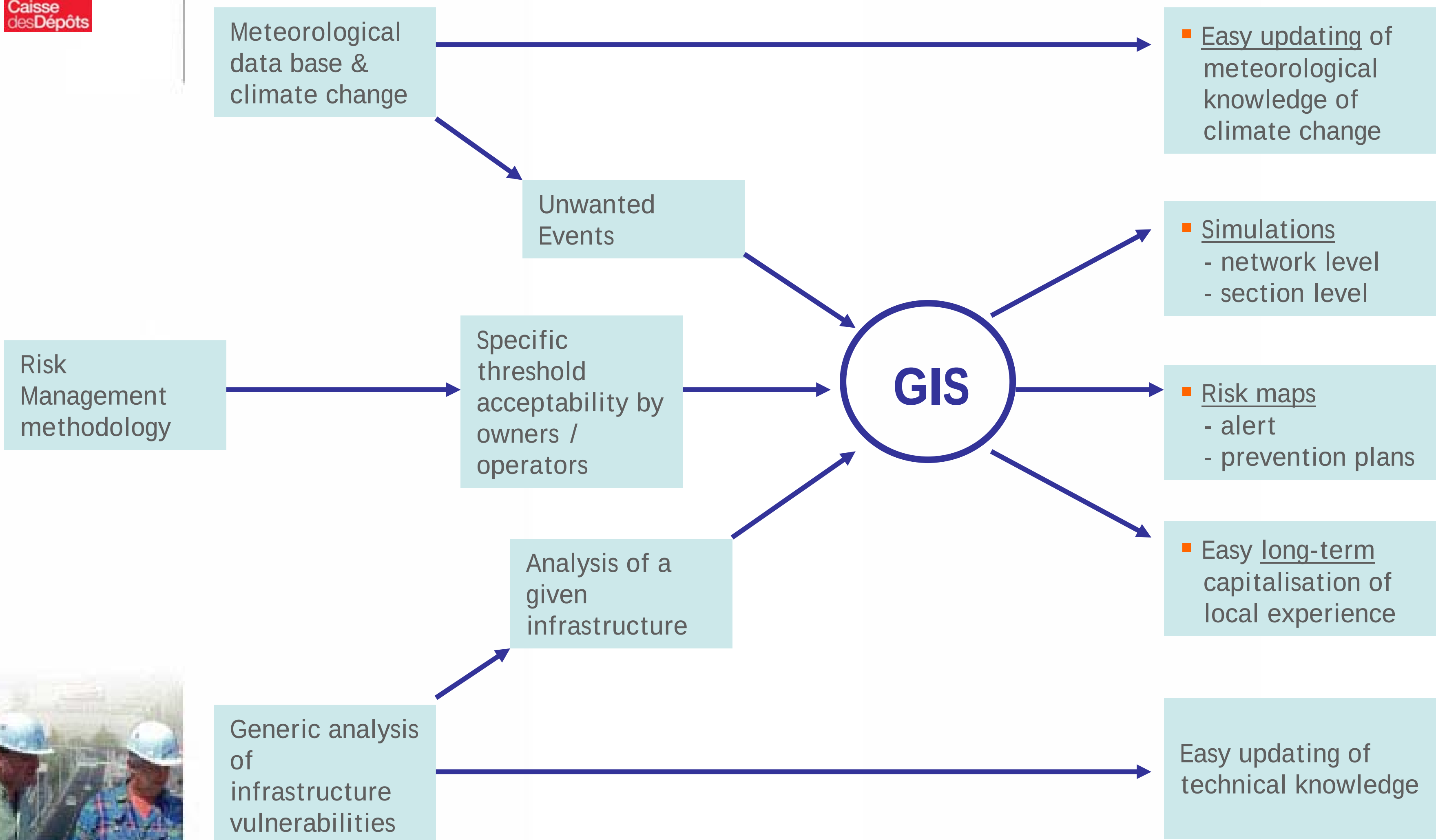
- "**Families**" (such as "sign gantries" for Equipment),
  - "**Sub-families**" (such as "Variable Message Signs"), and
    - "**Objects**" (such as "Variable Message Sign" at mileage point X).

For the "section approach", each infrastructure to be analysed is fully detailed by object.

So, an object is a unique element, with only one geo-localisation.

(sign gantry, tree, bridge, canopy, culvert, low point in the longitudinal profile, electric line,…)

Structure of GERICI Approach & Results



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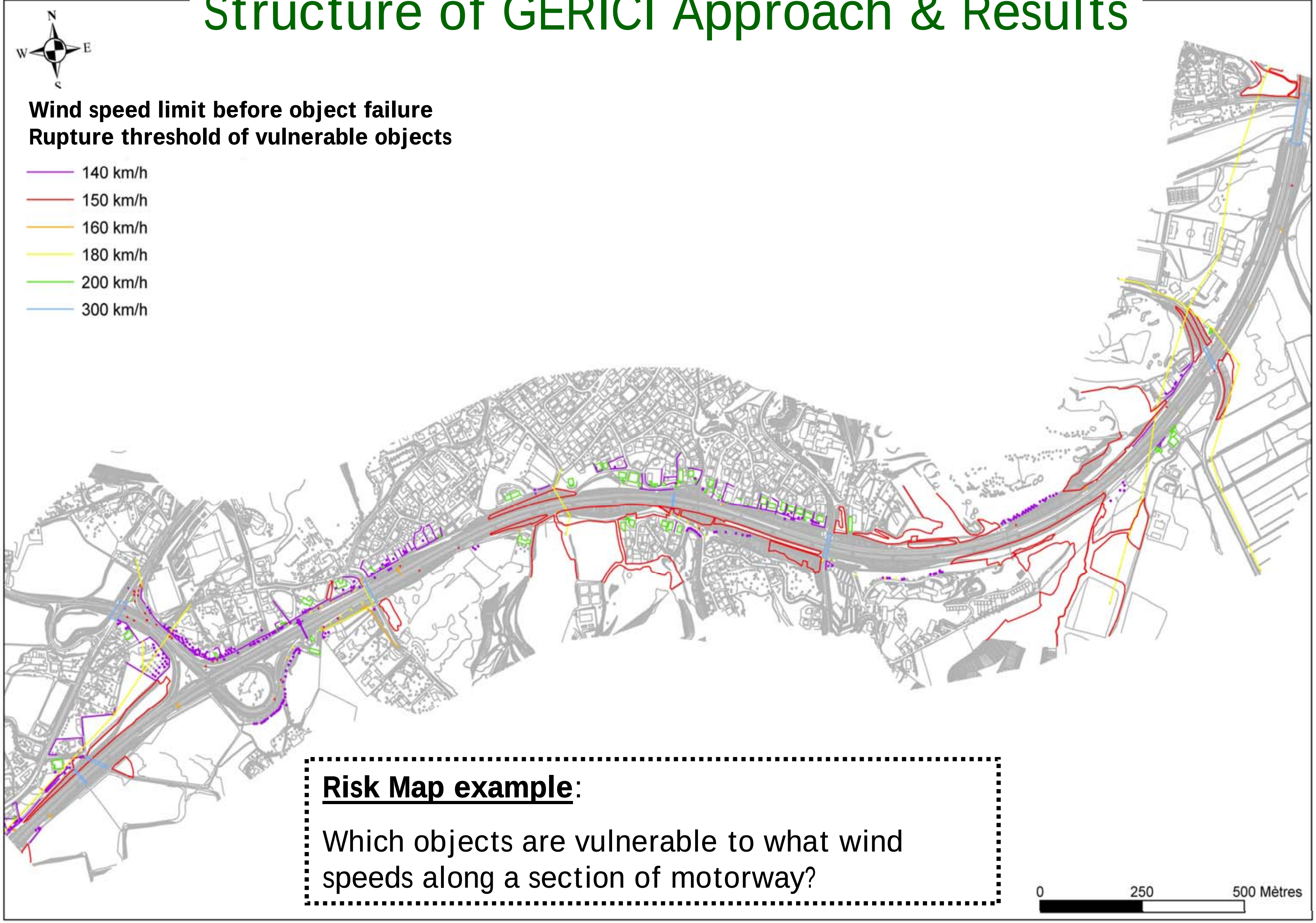

Risk Map example:

Which objects are vulnerable to what wind speeds along a section of motorway?

Fields of impacts, Scope of Expertise, and Risk Maps

Risk maps are analysed in light of their foreseeable consequences on:

- Costs
- Infrastructure's Durability
- Continuity of service to Users
- Users' safety
- Prejudicial effects to Environment

This leads to the identification of critical scenarios:

- Route disruption
- Disruption of access to sensitive areas
- People injuries

→ **Risk Matrix**
(Frequency / Severity)

Lessons learnt and Conclusions

1. **Specific Design Rules Must Change**. Examples:

The concept of a “design-basis-event” based on a “return period” (ten-year rainfall,100 year-flood, etc.) was very useful. It is now **dangerous**. The hypothesis of a stable climate is now incorrect:

a) Our knowledge of such events is uncertain and will vary with time. A **new robust concept** is necessary.

b) The probability of “**combined events**” (i.e. frost + rain; or flood + wind) may vary even more

c) **Risk-analysis** approach is necessary

d) The knowledge of the **cost-sensitivity** of a given infrastructure to climatic condition levels (i.e. winds) is necessary to make sound decisions

Lessons learnt and Conclusions

2. The Design Process Needs Improvements.

The concept of "**force majeure**" (i.e. when the flood is greater than the 100 year-flood reference) often induces a perception of lower responsibility of stakeholders.

2.1. Infrastructure owners and designers need to ensure **lower-but-reasonable service to users** even after an event over a 100 year-return-period event.

2.2. Such a process demands a **more-open cooperation** with more stakeholders than before in order to obtain a sound economic optimal solution.

Lessons learnt and Conclusions

3. Innovative Solutions Exist. We Need to Change the Way we Look at Things.

3.1. The cursor between infrastructure investment costs and operational costs for a given functional need may have to move towards better **operations reactivity** if our knowledge on future climate is more uncertain tomorrow than yesterday:

- **medium-term** reactivity to adapt infrastructure and operations rules to the new knowledge of climate evolution, and
- **short-term** reactivity, for example when a two-day weather forecast announces 180 km/h winds

3.2. The El-Niño example on Peru West Motorway shows that a "submersible crossing" flooded some days every ten years is more effective and less costly than large bridges collapsing every ten years...

Lessons learnt and Conclusions

4. In-depth Dialogue between Stakeholders is Needed.

4.1. At National or International level, new concepts and rules need an in-depth **innovative dialogue** between the authority in charge of design rules, the concession authority, the infrastructure network owners and the operators, in order to find optimum solutions for users and costs.

4.2. At Local level, **simulation** tools such as GERICI now allow for a useful and preventive **dialogue between stakeholders** to maintain (even under severe climate conditions) safety of users and neighbours, operations, infrastructure capital, and the local economy.

4.3. The **Katrina impacts on New-Orleans were studied** reasonably and presented at TRB congress **two years before the event**:

- Launching similar studies now on high-risk (even with low probability) situations is necessary;

- Working on more effective "**governance"** along the whole decision chain is worthwhile now.

Lessons learnt and Conclusions

5. Appropriate Networking and Knowledge Capitalisation are Keys.

5.1. The emergence of new climatic events with possible large impacts demands a wide and very-well-organised **networking** to avoid errors occuring twice.

5.2. Accidents and even "**quasi-accidents**" need to be carefully **capitalised** and stored (GIS for specific infrastructures; by well-identified specialised experts per specialty).

"Nature often forewarns, in some ways, those who know what to look at".

Lessons learnt and Conclusions

6. Progress Achieved and Progress Needed

6.1. At the present time, as a result of GERICI three year's multidisciplinary work:

- **owners can request an analysis of the vulnerabilities** of their **networks**, and the identification of the most critical sections;
- **operators can request** the implementation of the tool on infrastructure **sections** or routes:
  . to **simulate** risks and,
  . develop the most appropriate * program of intervention
  * **preventive** investments

6.2. Progress is needed:

- To better **share** experience nationally and internationally, and launch specific research already identified;
- To **implement** what is already available to "learn by doing" with dynamic infrastructure owners / operators.

6.2. Final lessons learnt:

- The size and the complexity of the **issues at stake**;
- **Humility** and the need to **work better together** to efficiently take the challenge

Thank you for listening

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