Using maps of surface runoff susceptibility for optimizing risk diagnoses on railways

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CONTEXT & OBJECTIVES

WATER SURFACE RUNOFF

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RAILWAY INFRASTRUCTURE

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RISKS
FLOODS
MUD DEPOSIT ON TRACKS
MUDFLOWS
Focus on **maintenance** and on **risk diagnoses** on railways

**Where does surface runoff is susceptible to occur?**

*Current methods:*
- Perform field expertise
- Compile Local knowledge

*Issues:*
- Complex phenomenon (outside rivers, not only topography)
- No hazard mapping at network scale

**What measures must be taken to reduce risks of damage?**

*Current methods:*
- Adapt and design protective structures
- Provide maintenance and monitoring recommendations

*Issues:*
- Design formulas not adapted to surface runoff
- Liquid and solid flows
OBJECTIVE OF THE STUDY

- How can the IRIP method contribute to perform risk diagnosis?
- How to integrate it in the current risk diagnosis process?
01. Presentation of the IRIP method

02. Presentation of the risk diagnosis

03. Comparison of the IRIP maps and the risk diagnosis

04. How to integrate the IRIP method in the current risk diagnosis process?

05. Conclusion
1. PRESENTATION OF THE IRIP METHOD

**Input data:**
- lidar DEM from IGN (5m resolution)
- European soil database from LUCAS database (1km resolution)
- Land use map from the Haute-Normandie county (1/25000 and 1/5000 urban areas)

**To retain:**
- Mapping of 3 processes
- Dry method for susceptibility mapping
- 6 levels from 0 to 5
- Only 3 input data

**1. PRESENTATION OF THE IRIP METHOD**

**GENERATION**

- **PERMEABILITY**
  - High permeability
  - Low permeability

- **THICKNESS**
  - Thick soil
  - Thin soil

- **SLAKING CRUST**
  - Low slaking rate
  - High slaking rate

- **LAND USE**
  - Infiltrative surface
  - Impervious surface

- **TOPOGRAPHY**
  - Slope AND topographic index low
  - Slope OR topographic index high

**TRANSFER**

- **SLOPE**
- **BREAK OF SLOPE**
- **SOIL ERODIBILITY**
- **DRAINED AREA**

**ACCUMULATION**

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

**« IRIP »**

**Indicator of Intense Pluvial Runoff**
2. PRESENTATION OF THE RISK DIAGNOSIS

- Project of railway regeneration of the Bréauté to Fécamp railway line of 20 km
- Risk diagnosis performed in 2014/2015
- 12 sections selected for drainage regeneration works
- Good knowledge of the railway infrastructure
3. COMPARISON OVER THE RAILWAY LINE

- **Contingency table**
  Total railway line = 20 km

<table>
<thead>
<tr>
<th>IRIP method</th>
<th>Selected</th>
<th>Not selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detected</td>
<td>9,5 km</td>
<td>1,6 km</td>
</tr>
<tr>
<td>Not detected</td>
<td>0 km</td>
<td>8,9 km</td>
</tr>
</tbody>
</table>

- **Examples**
  - Detected by the IRIP method → Susceptibility levels ≥ 4/5
  - False alarm → Explained by low vulnerability of the infrastructure

Large draining sidetracks and small catchment → low vulnerability
3. COMPARISON ON A RAILWAY SECTION

Example

1/2
3. RESULTS

3. COMPARISON ON A RAILWAY SECTION

Example 2/2

Legend:
- DEM Contour lines at 1m
- Accumulation susceptibility
  - Medium (3)
  - Strong (4)
  - Very strong (5)
- Transfer susceptibility
  - Medium (3)
  - Strong (4)
  - Very strong (5)
- Existing
  - Retention pond
- Buffer strips
- Flow direction
- Drainage

A B C D

0 50 100 150 200 m

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4. INTEGRATING IRIP IN THE ACTUAL PROCESS

✓ Identification of a substantial contribution of the IRIP method for hazard assessment
✓ Identification of an opportunity to push forward our methods

HOW TO INTEGRATE THE IRIP METHOD IN THE CURRENT RISK DIAGNOSIS PROCESS?

Analysing the current risk diagnosis process

Identification of steps:
→ Where the IRIP method can bring direct contribution
→ Where a mutual evolution of the IRIP maps and of the risk diagnosis methods is required to push forward our risk management process
4. INTEGRATING IRIP IN THE ACTUAL PROCESS

The current risk diagnosis process

1. Risk diagnosis request
2. Data compilation
3. Pre-identification of sections at risk
4. Field expertise
5. Validation of sections at risk
6. Solution design
7. Deliverable document
The current risk diagnosis process

→ Steps where IRIP can bring direct contribution

→ Steps where the IRIP maps and the risk diagnosis methods must be adapted to push forward our risk management process
The current risk diagnosis process

- The IRIP maps as a basis for surface runoff hazard assessment for hydraulic expertise
- Combine the IRIP maps created using the iRIP software with all information about the study area (Infrastructure, incident history, railway surroundings ...)

4. INTEGRATING IRIP IN THE ACTUAL PROCESS
The IRIP maps provide a simple combination of landscape indicators:

- Sediment deposits in accumulation areas
- Erosion traces in transfer areas
4. INTEGRATING IRIP IN THE ACTUAL PROCESS

The current risk diagnosis process

- Risk diagnosis request
- Data compilation
- Pre-identification of sections at risk
- Field expertise
- Validation of sections at risk
- Solution design
- Deliverable document

✓ The IRIP maps, **a visual tool as a mean of communication** between experts and:
  - Project stakeholders
  - Local actors
The current risk diagnosis process

- Require a post-process of the IRIP maps and an evolution of the current diagnosis process
- Need of a full catalogue of all the available tools and methods for risk assessment

Identification of exposed areas according to IRIP
Identification of vulnerable railway sections

Guideline to identify sections at risk using the IRIP method in Lagadec and Moulin, 2016

Railway sections at risk
4. INTEGRATING IRIP IN THE ACTUAL PROCESS

The current risk diagnosis process

- Possible post-process of the IRIP maps to suggest mitigation approaches depending on the area
- Promote actions outside the railway right-of-way
- Increase communication between experts and project managers during and after the diagnosis
5. CONCLUSION

- The IRIP method: co-development to answer to scientific and industrial needs

- The IRIP method can bring direct contribution to the actual risk diagnosis methods
  - IRIP as a tool to support hydraulic expertise

- There is an opportunity to push forward our risk management process
  - Capitalisation of all the available risk assessment methods
  - The IRIP maps as a tool for communication with project stakeholders and local actors
  - Develop the risk management outside the railway right-of-way in cooperation with the territory development

➔ Toward a systemic management of risks
Thank you for your attention

« NO DRAIN, NO TRAIN!»

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