



PARIS  
2 ▶ 7  
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INTERNATIONAL  
RAILWAY SAFETY COUNCIL

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

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# CONTEXT & OBJECTIVES



**WATER SURFACE  
RUNOFF**

**+**



**RAILWAY  
INFRASTRUCTURE**

**=**

**RISKS**

# FLOODS



## MUD DEPOSIT ON TRACKS



# MUDFLOWS



# LANDSLIDES



## BALLAST TRANSPORT



# CONTEXT & OBJECTIVES

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



# CONTEXT & OBJECTIVES

Creation and development of the IRIP method  
for surface runoff susceptibility mapping



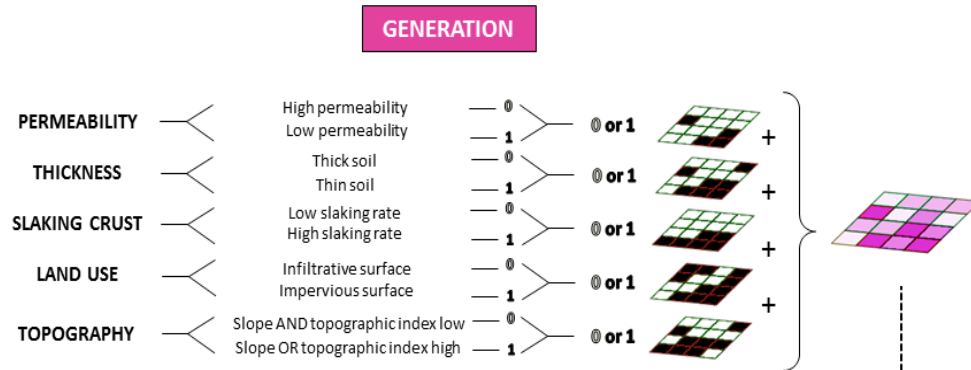
## OBJECTIVE OF THE STUDY

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

# PRESENTATION OUTLINES

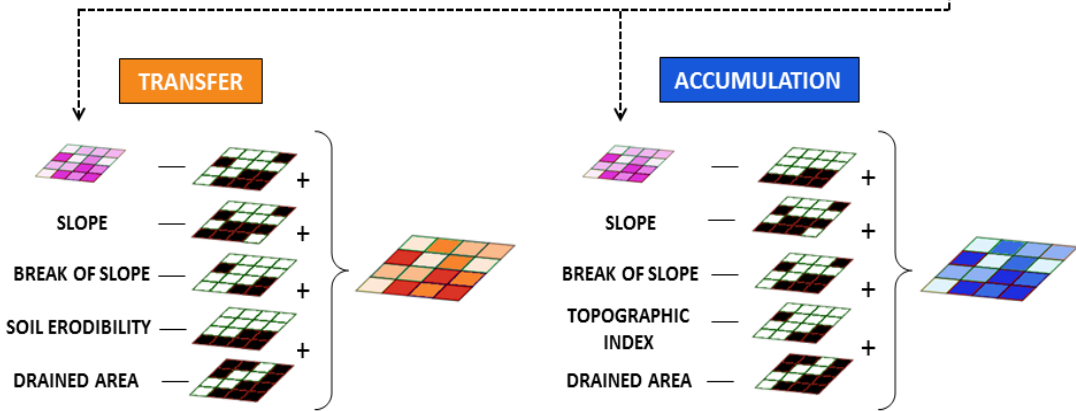
01. Presentation of the IRIP method
02. Presentation of the risk diagnosis
03. Comparison of the IRIP maps and the risk diagnosis
04. How to integrate the IRIP method in the current risk diagnosis process?
05. Conclusion

# 1. PRESENTATION OF THE IRIP METHOD



**« IRIP »**  
**Indicator of Intense Pluvial Runoff**

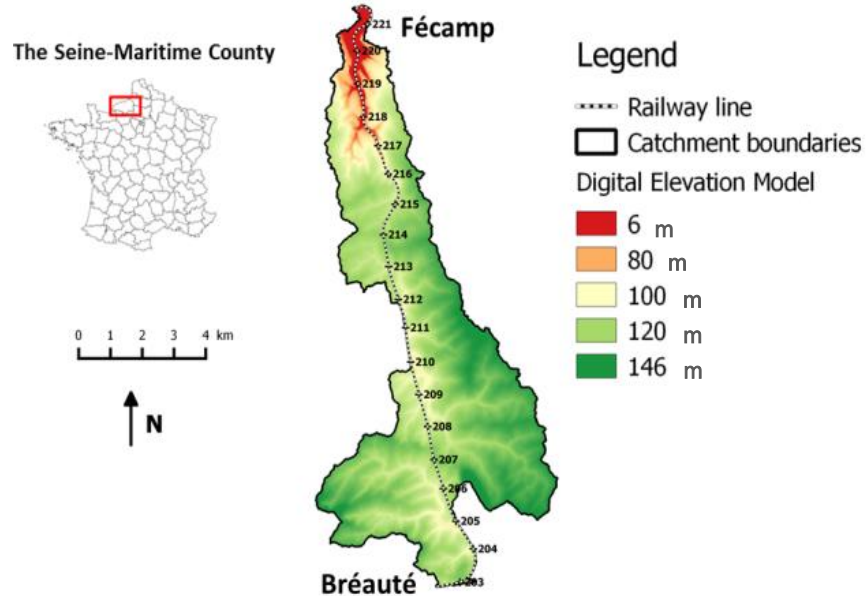
- To retain:**
- Mapping of 3 processes
  - Dry method for susceptibility mapping
  - 6 levels from 0 to 5
  - Only 3 input data



- 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)

## 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

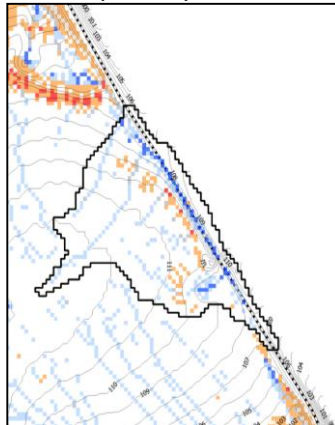
- Contingency table

Total railway line = 20 km

		Risk diagnosis	
		Selected	Not selected
IRIP method	Detected	9,5 km	1,6 km
	Not detected	0 km	8,9 km

- Examples

✓ Detected by the IRIP method →  
Susceptibility levels  $\geq 4/5$



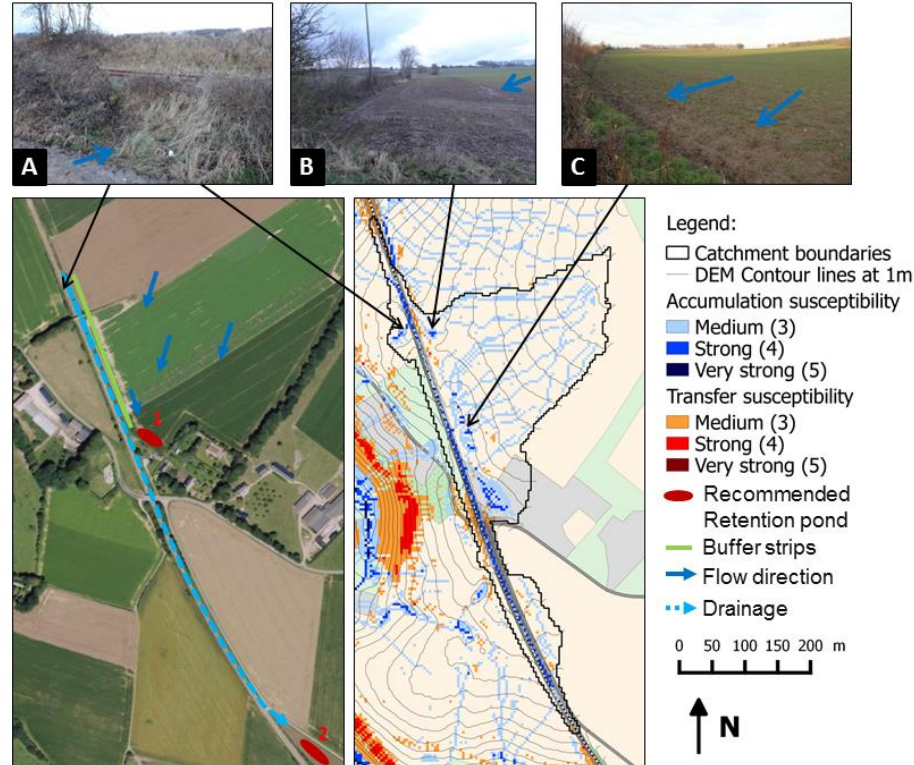
✓ False alarm → Explained  
by low vulnerability of  
the infrastructure



Large draining sidetracks and  
small catchment  
→ low vulnerability

# 3. COMPARISON ON A RAILWAY SECTION

Example  
1/2



# 3. 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

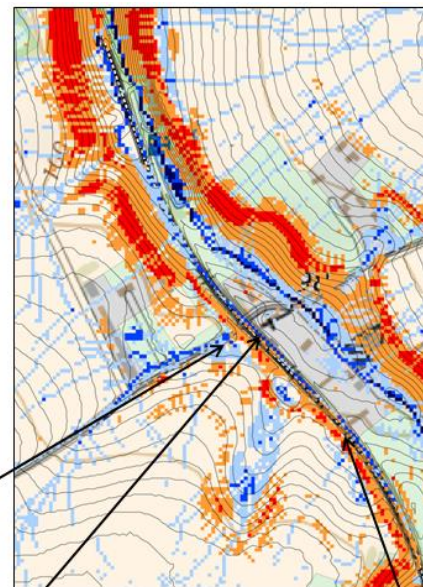
Retention pond

Buffer strips

Flow direction

Drainage

0 50 100 150 200 m



# 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

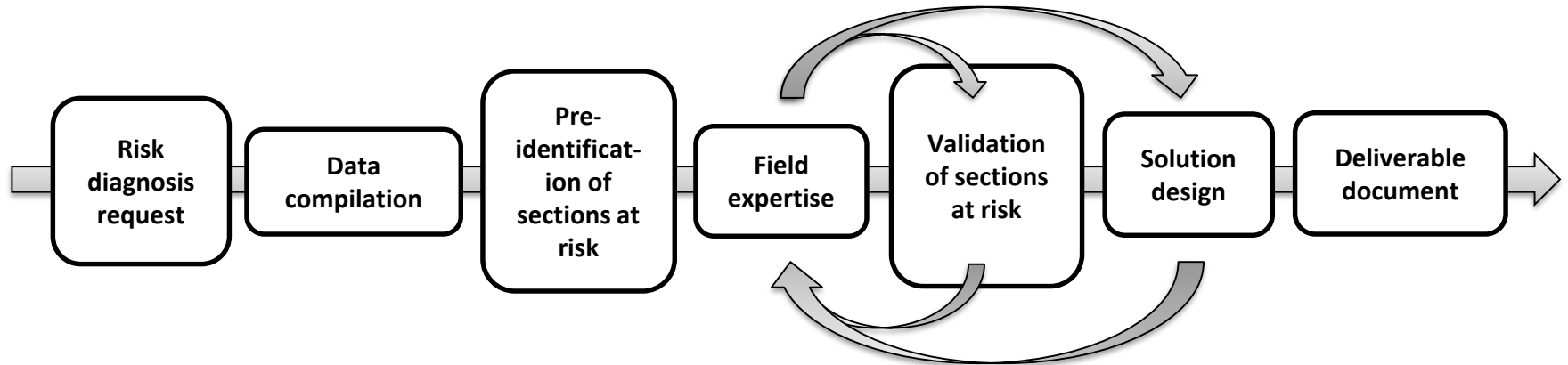
#### Identification of steps:

- 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



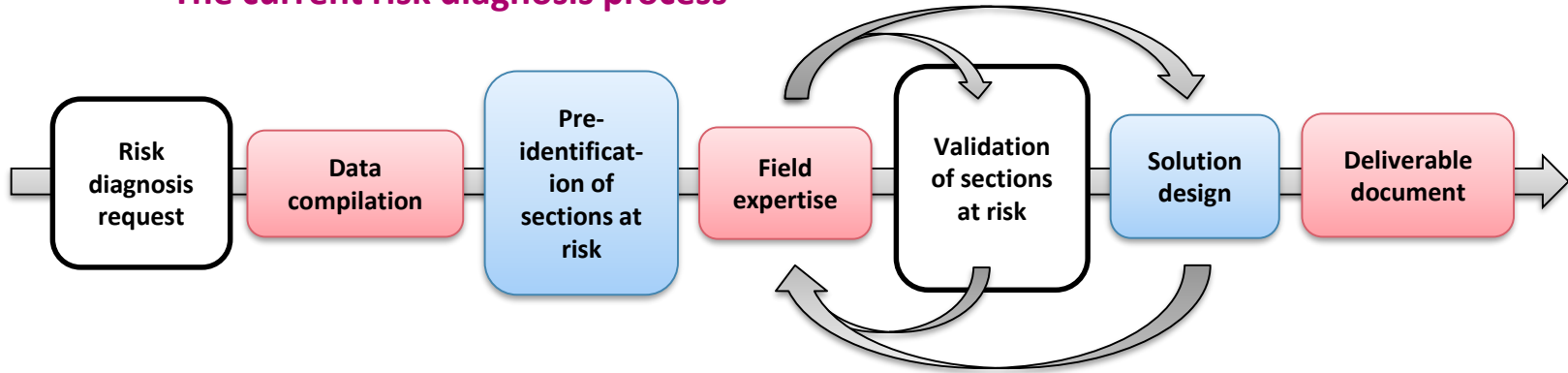
# 4. INTEGRATING IRIP IN THE ACTUAL PROCESS

## The current risk diagnosis process



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## The current risk diagnosis process



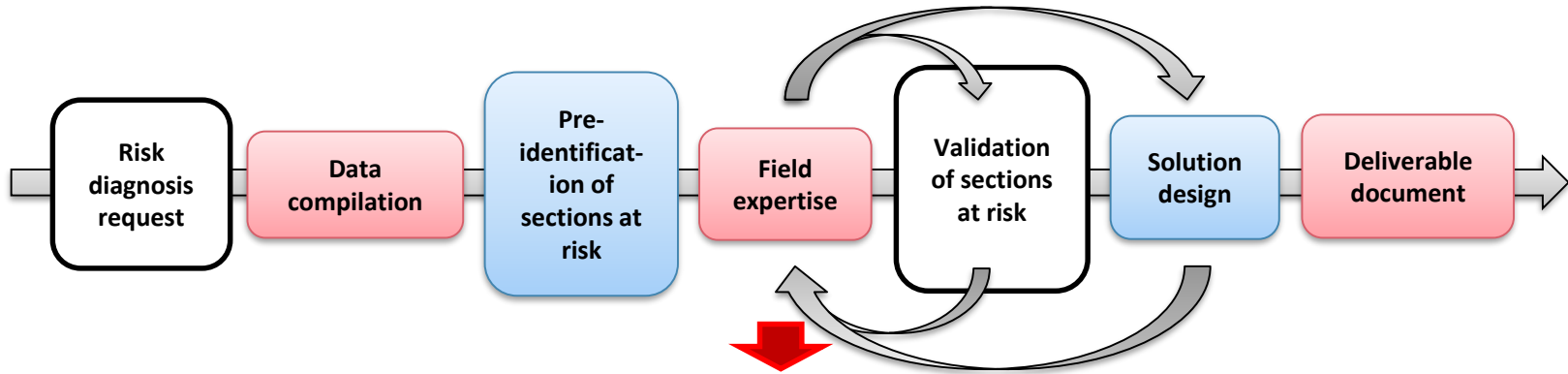
→ Steps where IRIP can bring direct contribution

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



# 4. INTEGRATING IRIP IN THE ACTUAL PROCESS

## The current risk diagnosis process

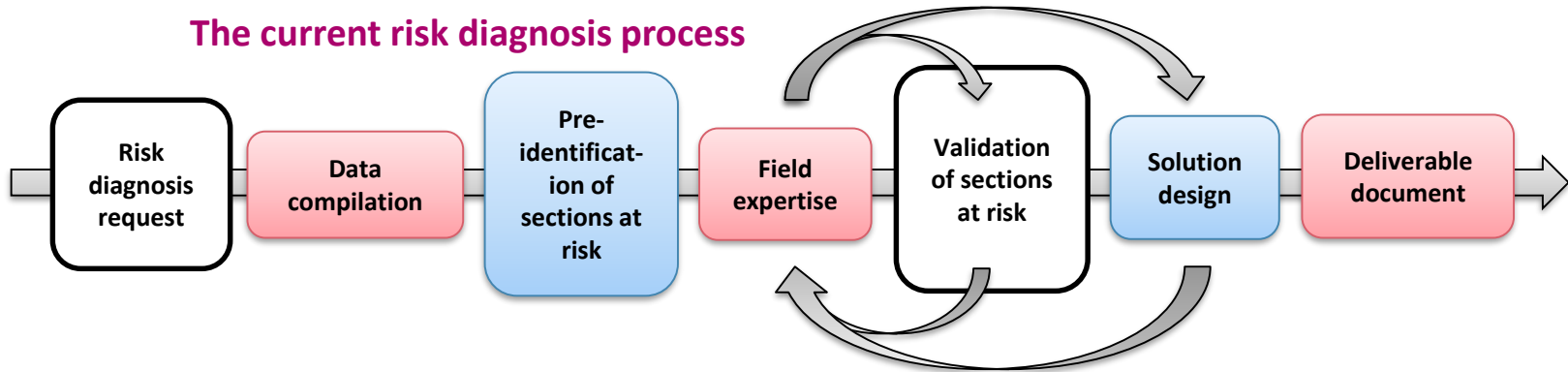


- ✓ The IRIP maps provide a **simple combination of landscape indicators**
- ✓ Orient the field observation toward **what is expected to be seen**:
  - ▶ Sediment deposits in accumulation areas
  - ▶ Erosion traces in transfer areas

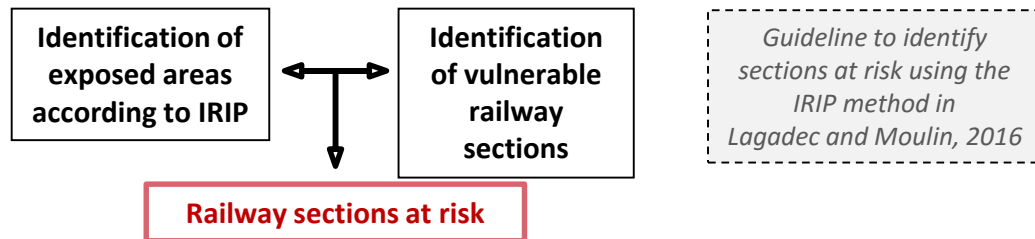


# 4. INTEGRATING IRIP IN THE ACTUAL PROCESS

## The current risk diagnosis process

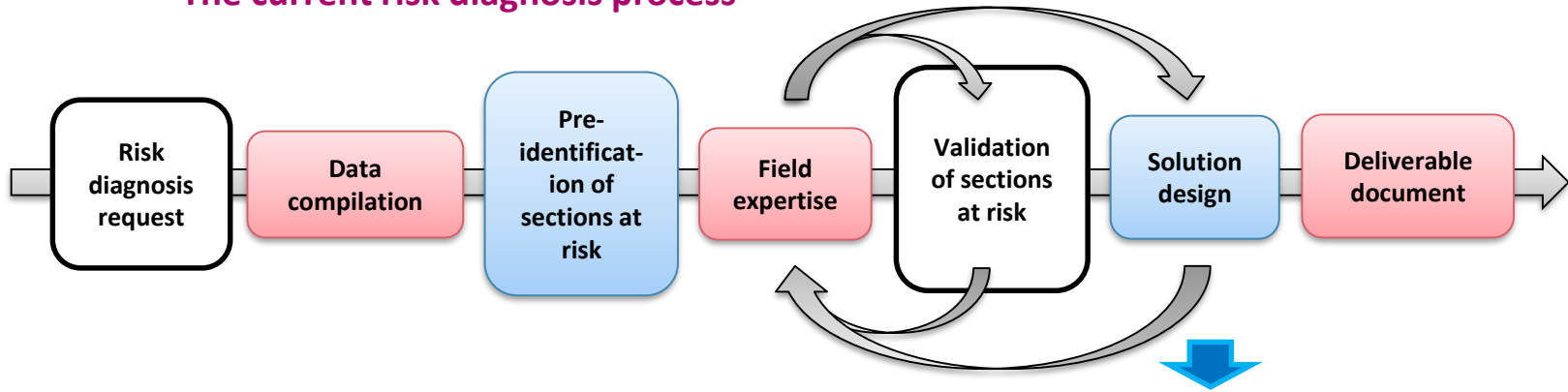


- ✓ Require a **post-process** of the IRIP maps **and an evolution** of the current diagnosis process
- ✓ Need of a full catalogue of all the available tools and methods for risk assessment



# 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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