La gestion du risque d'éboulement de masse à Séchilienne (France)
Landslide risk management for the National Road 91 at Séchilienne (France)

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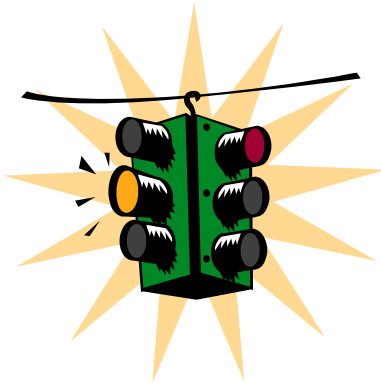
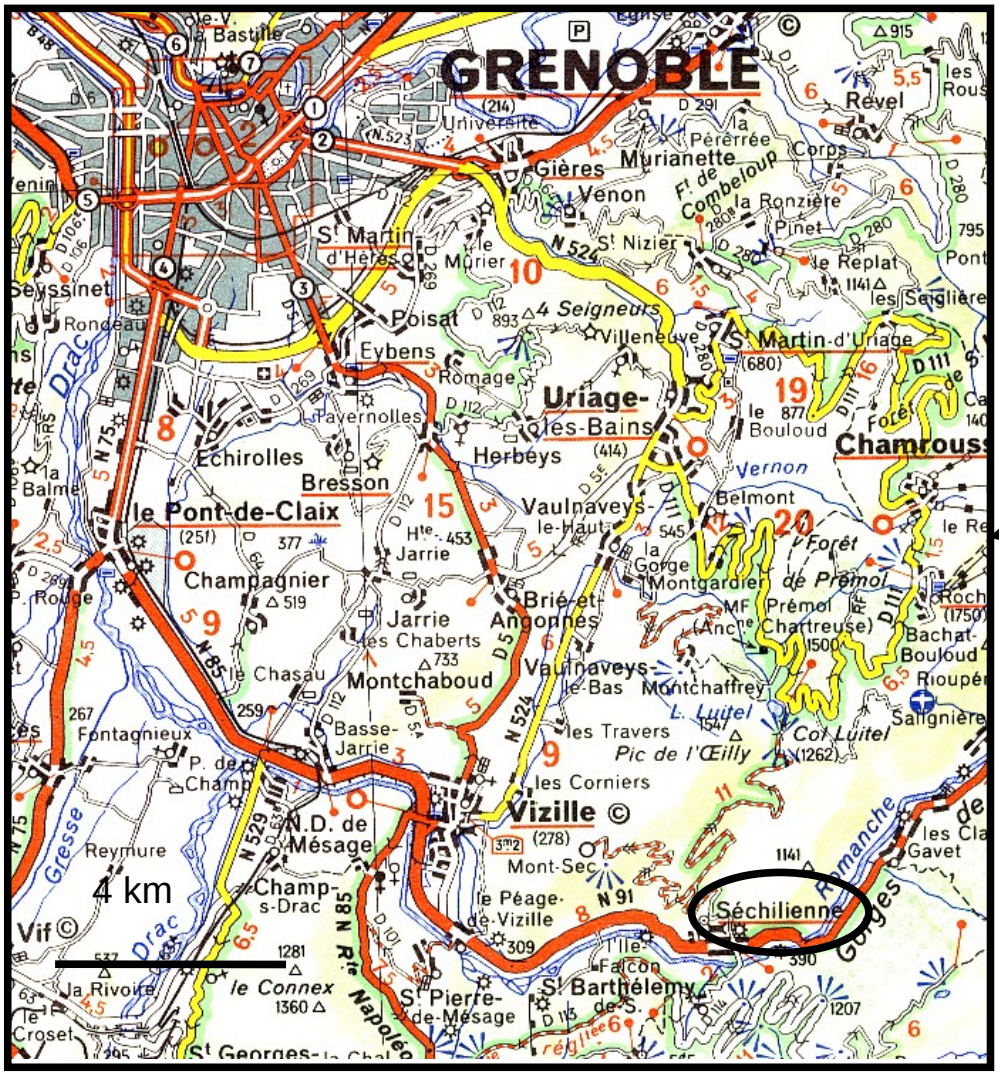


Location map



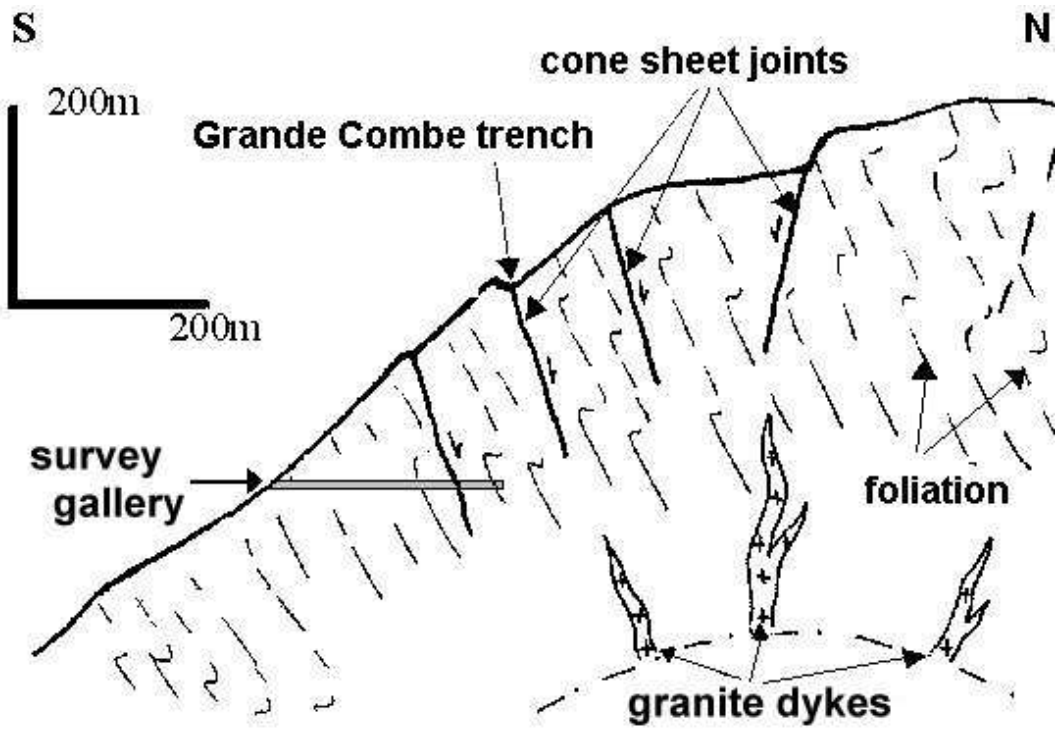
Rockfalls in 1980 and 1985 hit the RN 91

Eye and ear monitoring

Barrier of concrete blocks with detecting wire and red lights

Active deformation in the frontal part

Geological surveys



Consequences of a major failure (1990's)

Large rockslide --> Damming of the valley --> Formation of a lake --> Failure of the dam (overflow and erosion) --> Sudden flood --> Flood propagation downstream.

According to the volume of water in the lake:

- The bridge upstream and the crossroads could be submerged by the lake.
- RN 91 would be damaged in several places
- Part of the town of Vizille would be flooded, as well as chemical industries located downstream
- Certain districts of the town of Grenoble could be reached by the flood.

Economy

The high valley of the Romanche river: 11 000 inhabitants and more than 80 000 beds (tourist resorts).

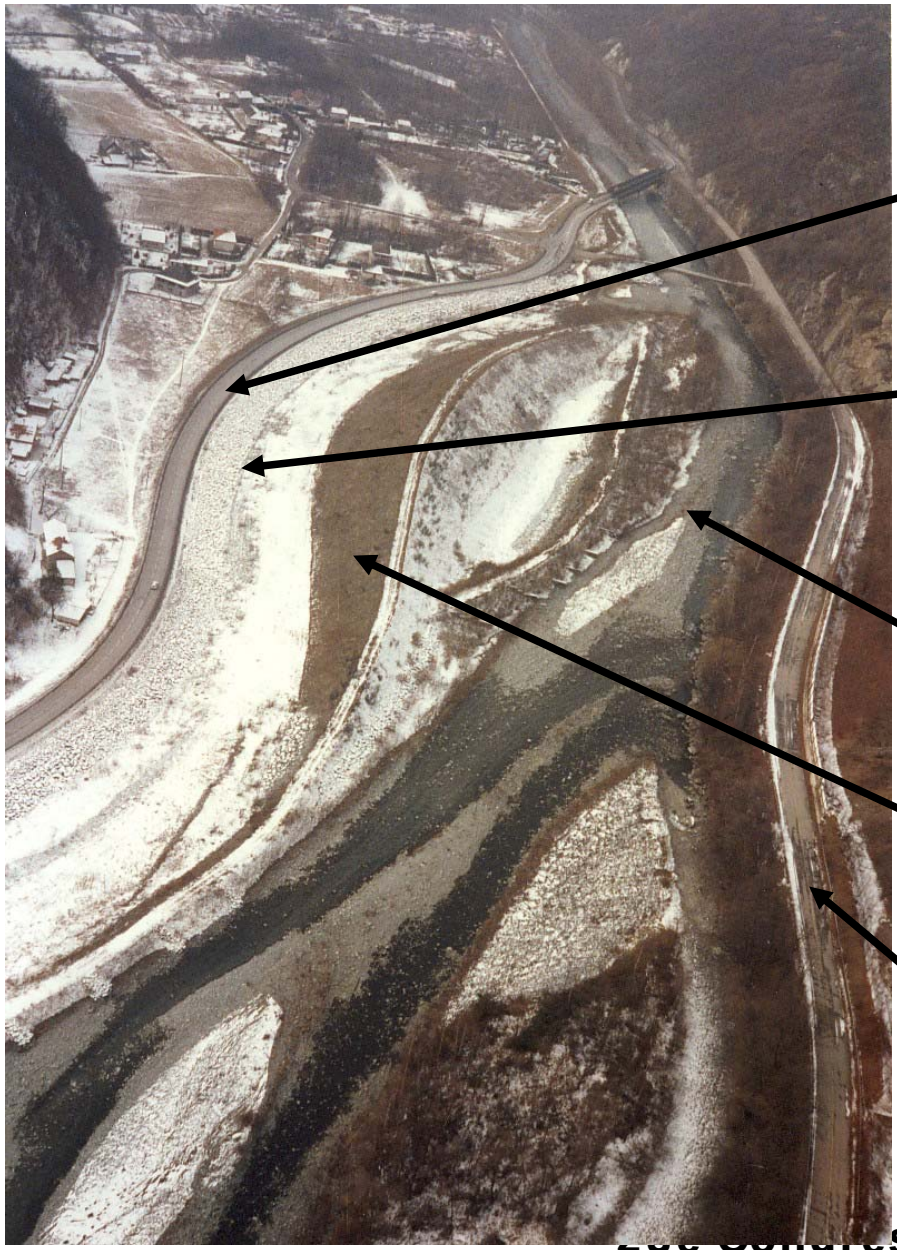
Daily traffic + seasonal flow of the tourists.
Average traffic: 9000 veh/day (peaks > 20 000 veh/day).

Solutions of replacement:
- one very narrow road, inaccessible to the lorries and buses,
- a mountain road, with many turns (lengthening of 46 km),
- the Lautaret pass, closed in winter, avalanche hazard (extension of more than 200 km).

A closure of the RN 91 would lead to costs as follows:
- lengthening of route: 100 000 - 150 000 € per day,
- loss of earnings in the tourist activity --> 400 000 € per day.

View from the frontal zone

First responses (1985 - 2000)



Diversion road

River diversion channel

Romanche River

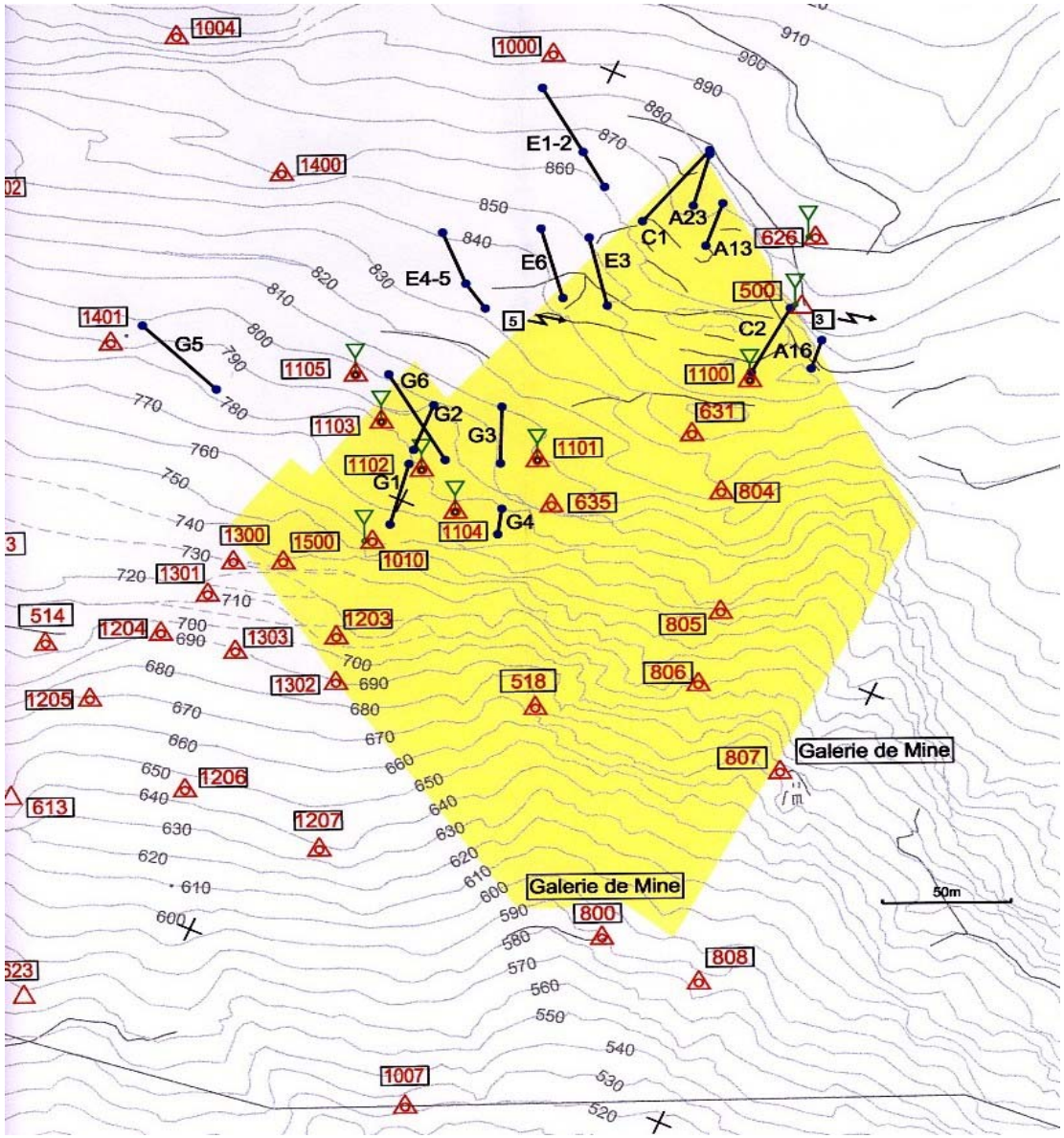
Earth barrier

Old RN 91

Earth barrier , river diversion channel, road diversion

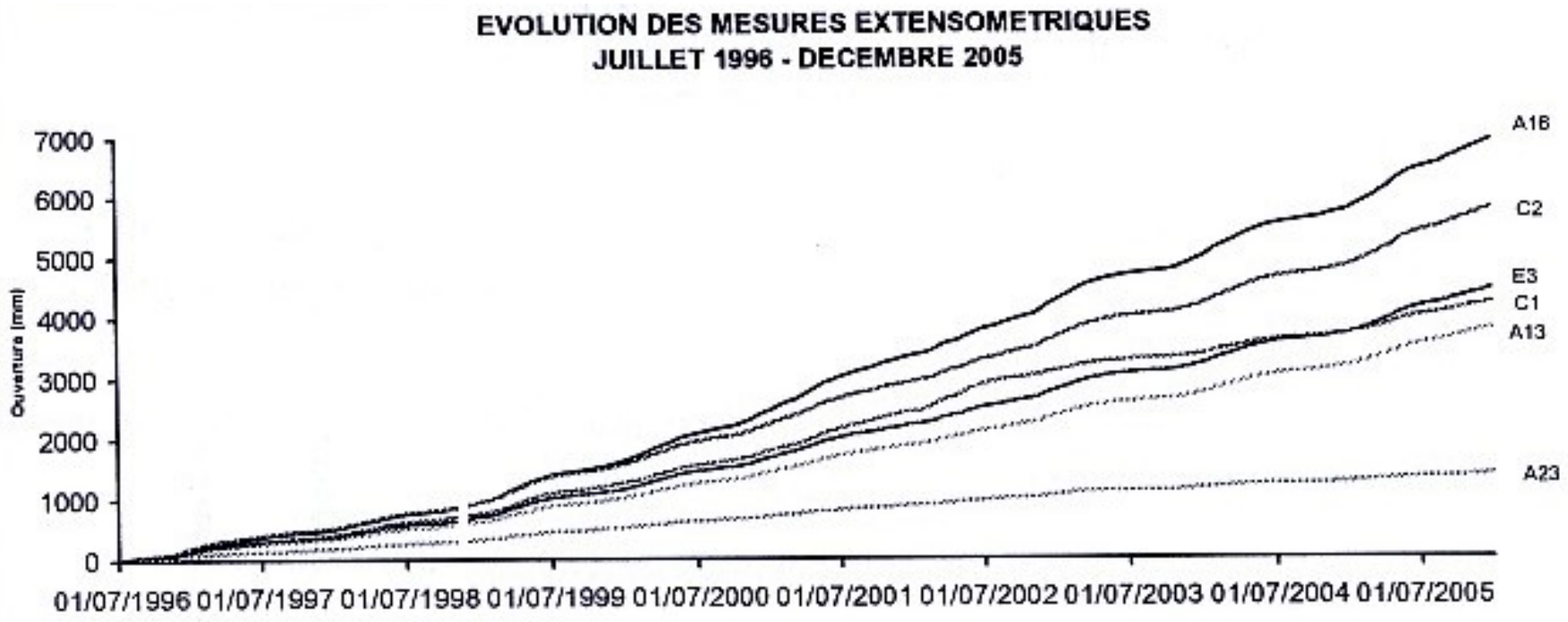
View from upstream – The new bridge

Monitorage – Sensors in the frontal zone



Monitoring

Monitoring of the slope:
seasonal variations
accelerating trend



The risk analysis (2000)

Different scenarios:

- **Small rockfalls from 1 m3 to 100 m3**

short term

no significant impact

- **Large rockfalls: 1000 – 50 000 m3**

short term

no significant impact

- **Catastrophic failures: 1 – 10 - 25 hm3 (?)**

medium to long term

significant to major impact

The risk evaluation (2000)

Volume of fallen rock:

- **About 1 hm3:**

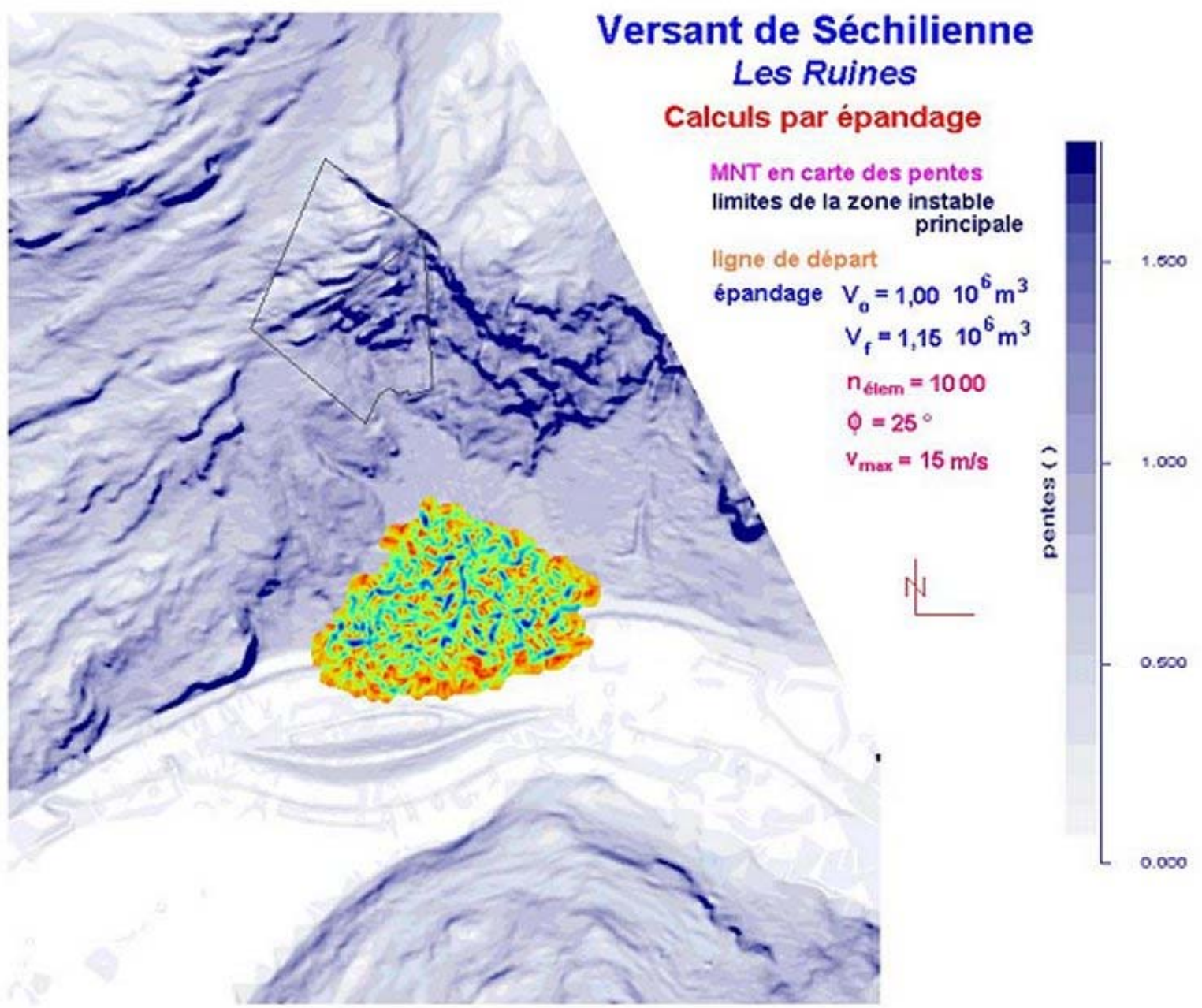
isolated rock blocks on the road

- **2-3 hm3:**

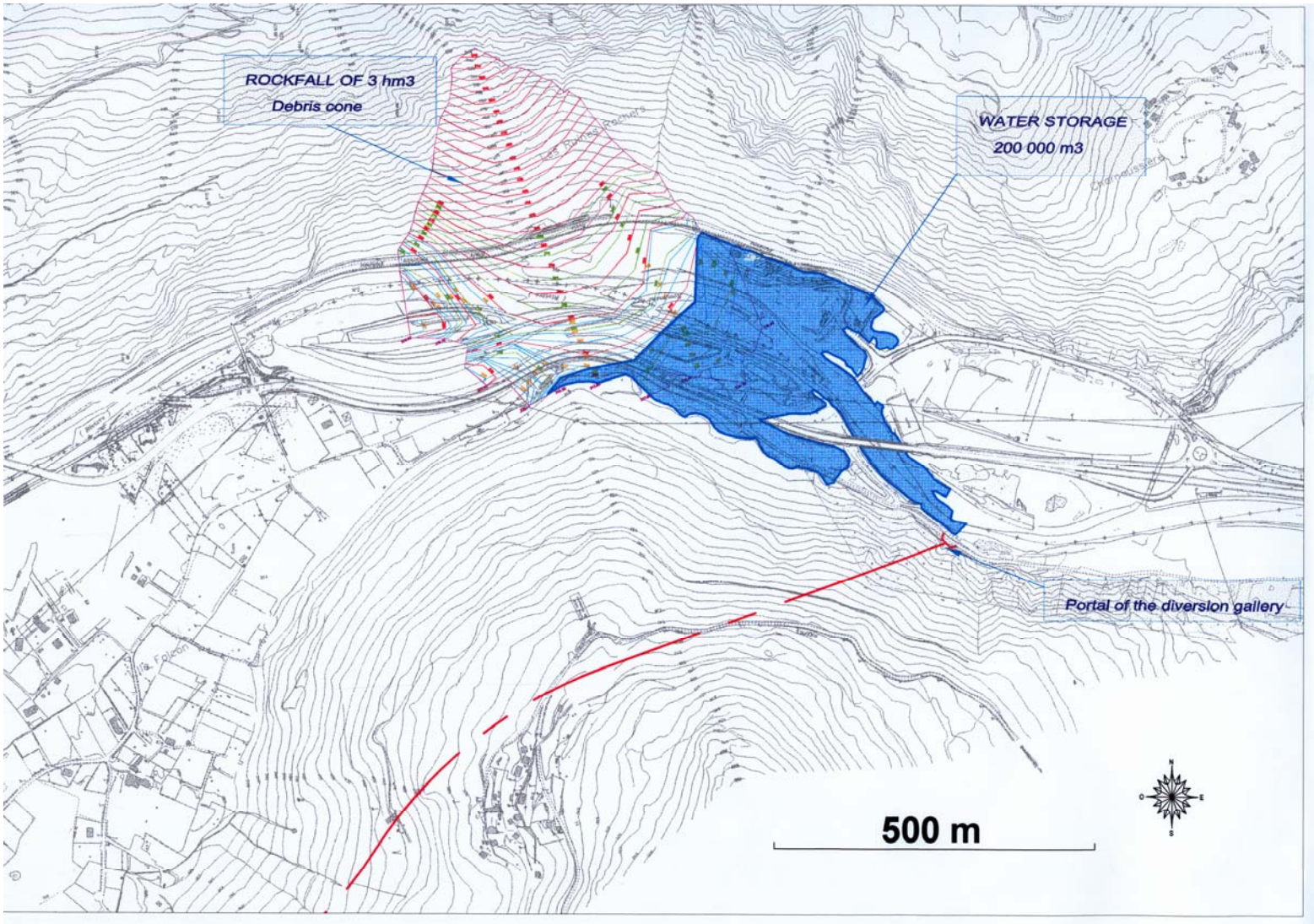
debris on the road (1-5 m thick; 100 m long)
river bed on the road

- **Over 3 hm3:**

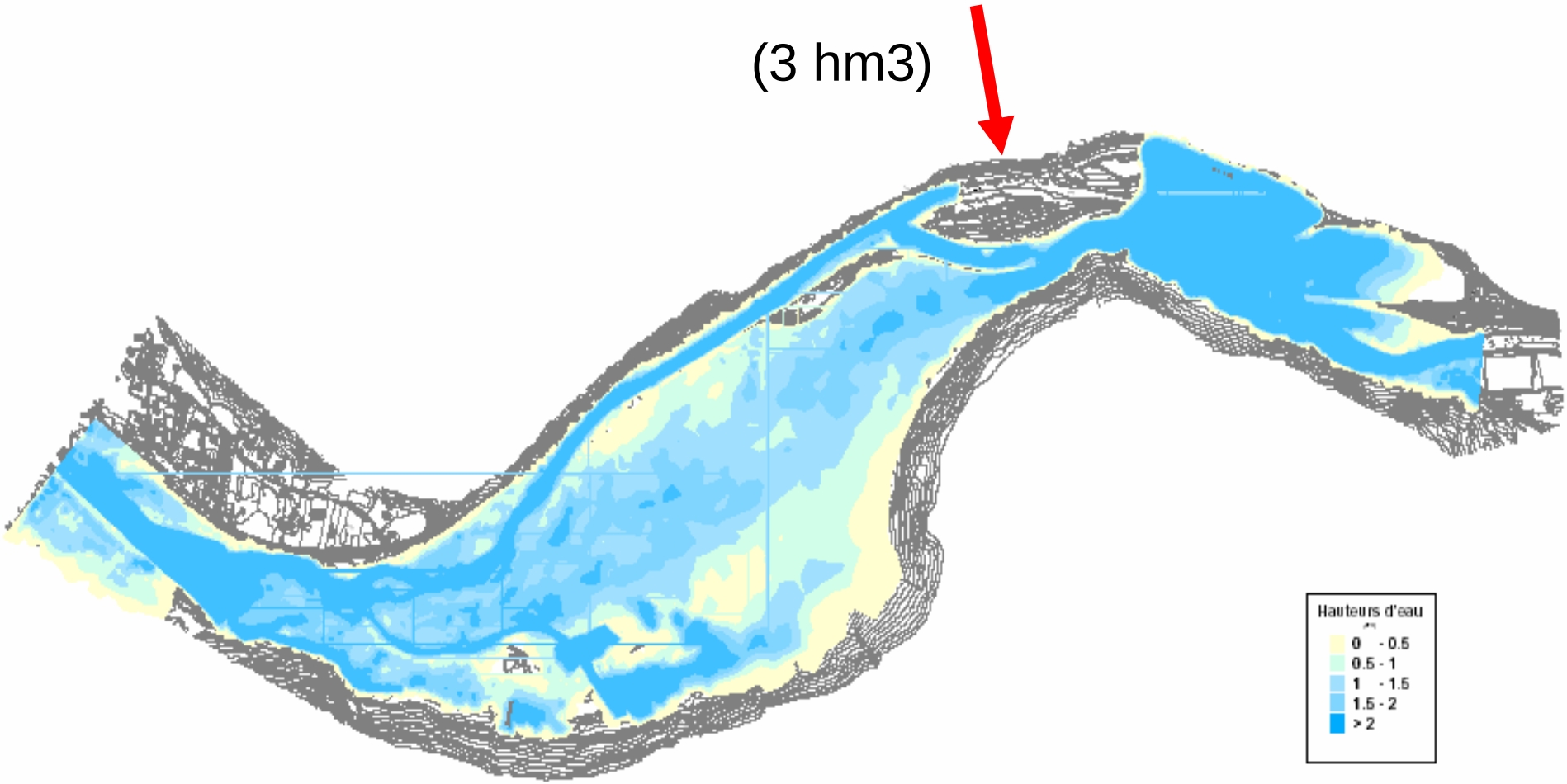
damming of the valley


Versant de Séchilienne
Les Ruines
Calculs par épandage
MNT en carte des pentes
limites de la zone instable principale
ligne de départ
épandage $V_o = 1,00\ 10^6\ m^3$
$V_f = 1,15\ 10^6\ m^3$
$n_{élem} = 1000$
$\varphi = 25°$
$v_{max} = 15\ m/s$
N
pentes ( )
1.500
1.000
0.500
0.000

Upstream flooding (3 hm3 of rock fall)



Flood after dam failure



DDE DE L'ISERE	EBOULEMENT DE SECHILIENNE
EBOULEMENT DE 3 Mm3 - Brèche en 1 h HAUTEURS D'EAU - Q100 SECHILIENNE - JOUCHY	
SOGREAH ECHELLE 1/5 000 GCA - AMN	Septembre 2004 01.NS.13.03.00	PLAN No 3.1 VERSION PROVISOIRE

Countermeasures (2008-2012 ?)

- **Road:**

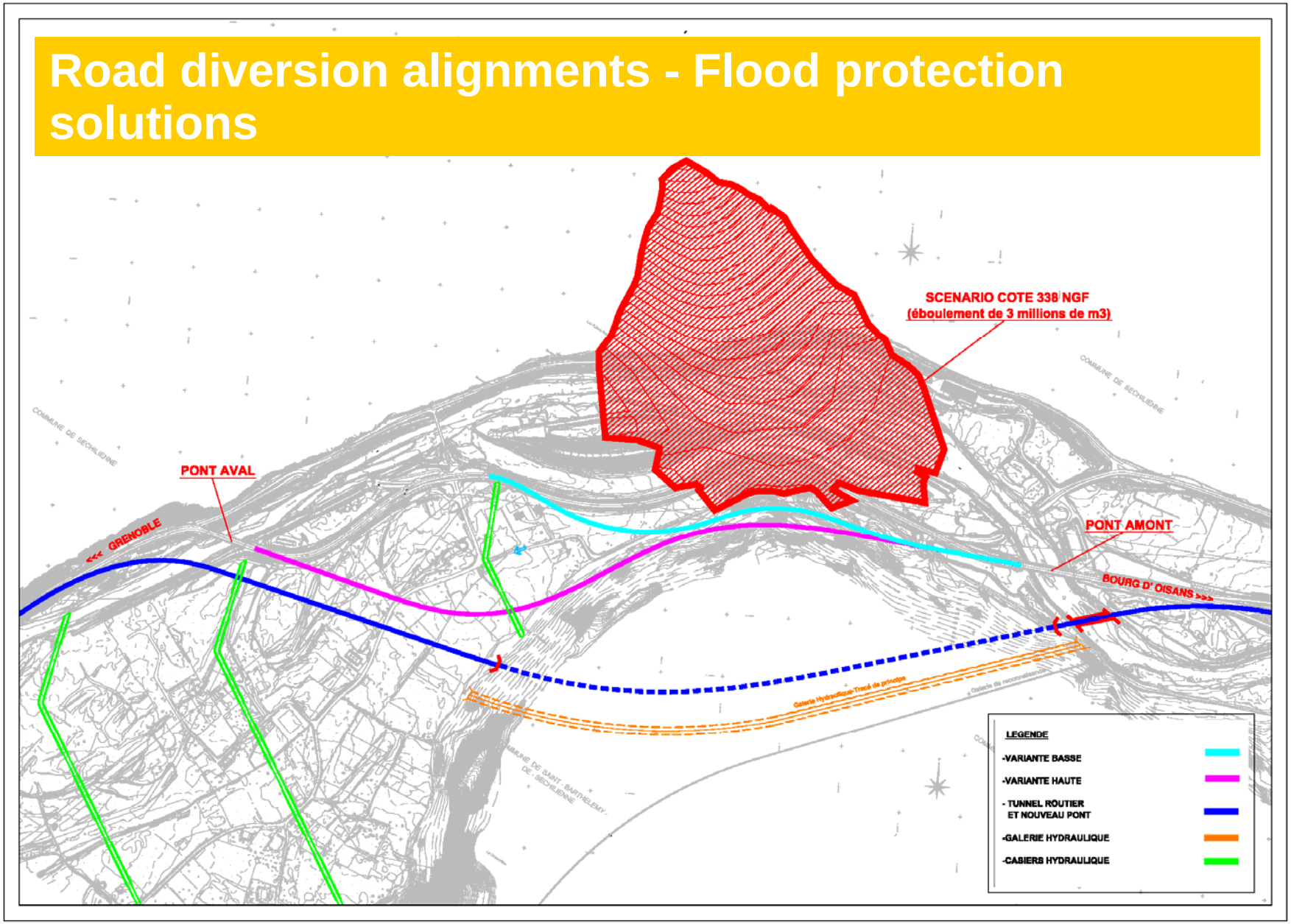
Diversion:
Cut in the opposite slope (which elevation?) :
15 Meuros
Tunnel (place of portals?) : 50 Meuros

Upstream and downstream protections?

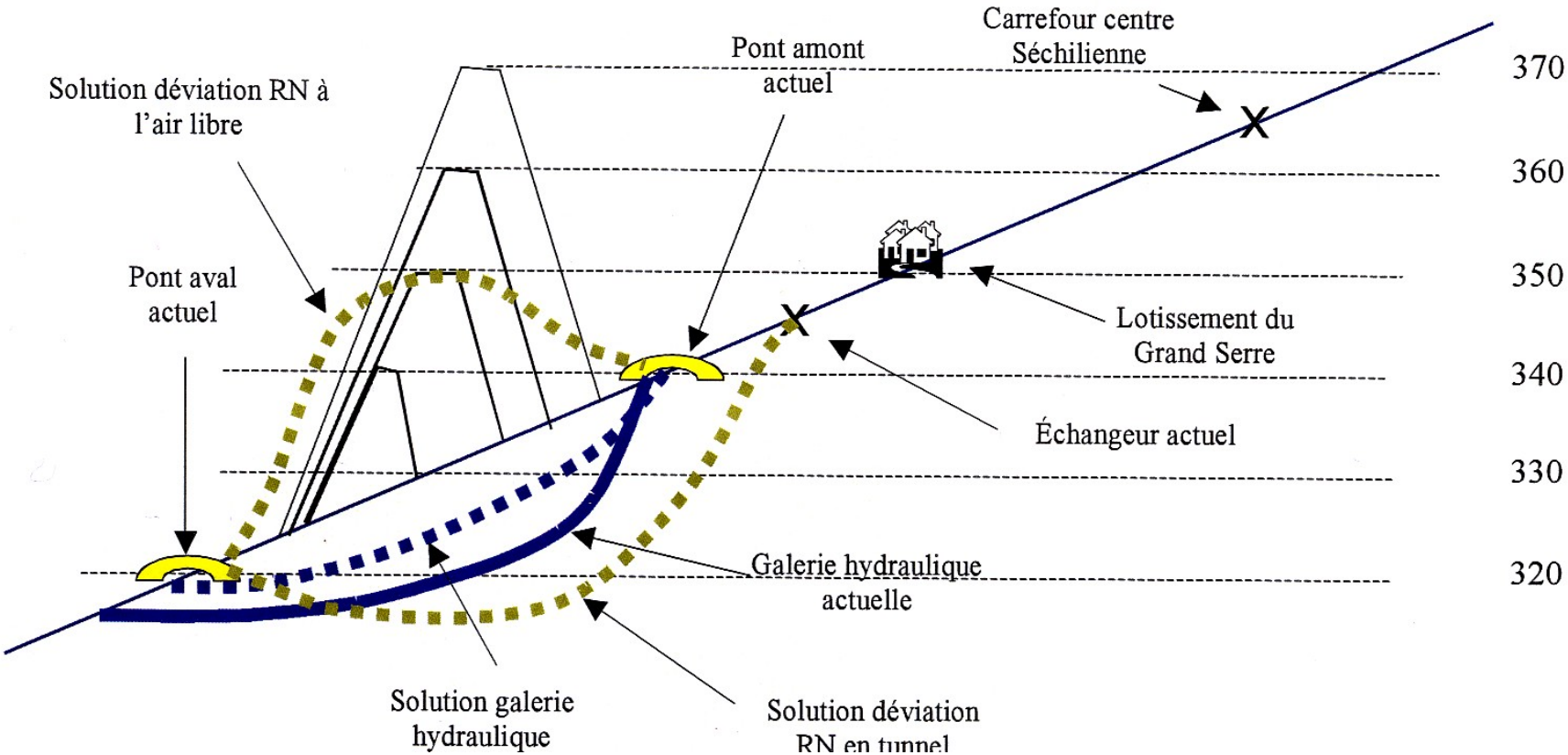
- **River**:

Diversion gallery (which design discharge?)
Flood control downstream

Road diversion alignments - Flood protection solutions



Countermeasures



Conclusion

Facing a high risk, it is essential:

- **to define scenarios**
- **to evaluate and to compare these scenarios** (degree of risk, time occurrence, etc.)
- **to carry out short term countermeasures:**

suitable to short term scenarios (e.g. emergency plan), but coherent with possible long term protections

- **to be prepared to mid-term scenarios**