Updating dams under operation: a real challenge

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Independent consultant


UNU-INWEH
REPORT
SERIES
11
Ageing Water Storage Infrastructure: An Emerging Global Risk
Duminda Perera, Vladimir Smakhtin, Spencer Williams, Taylor North, Allen Curry

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April 2022

Ageing Water Storage Infrastructure: An Emerging Global Risk?

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Ageing vs obsolescence


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GRANDS BARRAGES
SCANDINAVIE JUIN-JUILLET 1933

VOLUME I
QUESTION 1 a

DÉTÉRIORATION, PAR VIEILLISSEMENT,
DU BÉTON DES
BARRAGES-POIDS

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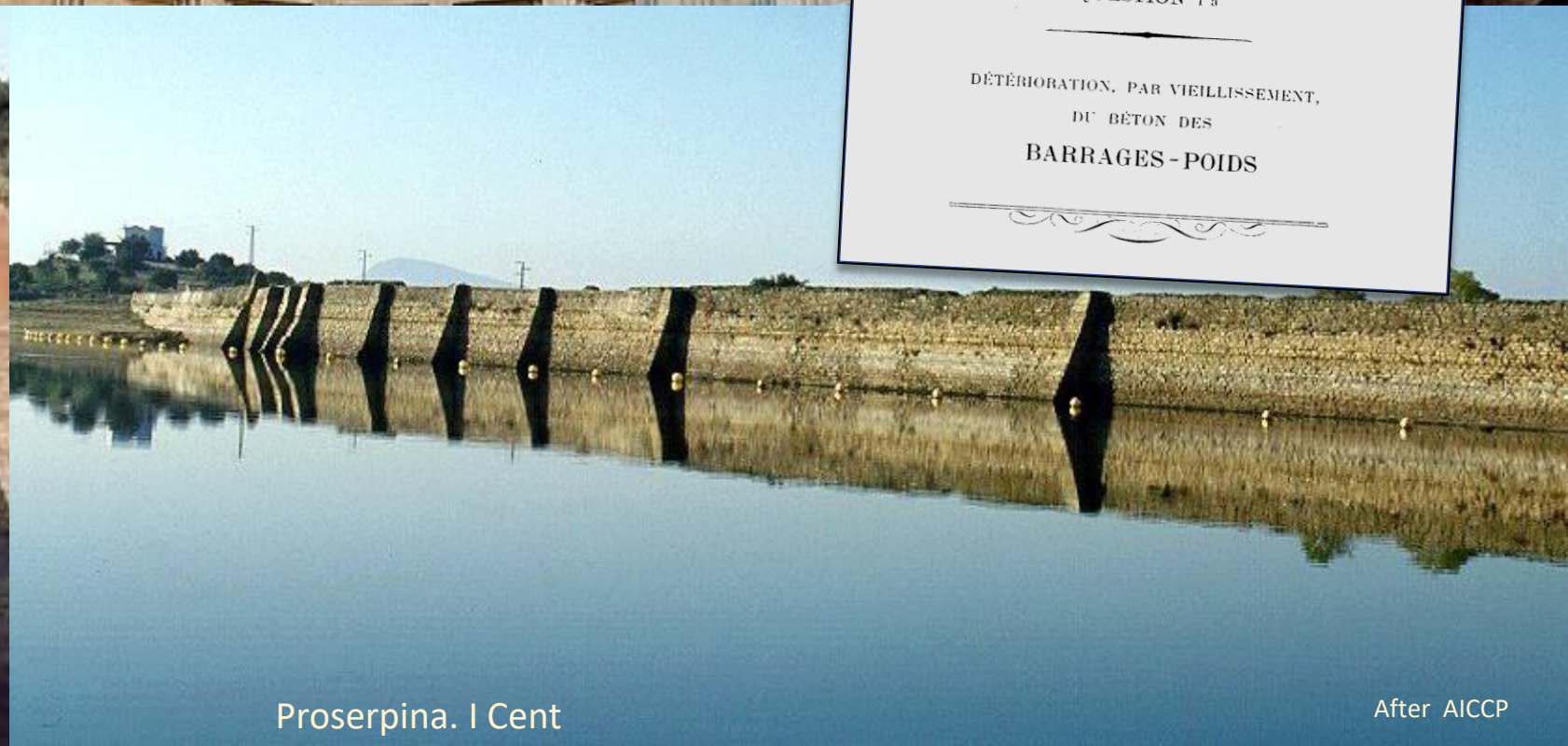

Proserpina. I Cent

After AICCP

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Safe water for megacities


World declaration

Water Storage for Sustainable Development

In 2050 world population will likely exceed nine billion inhabitants

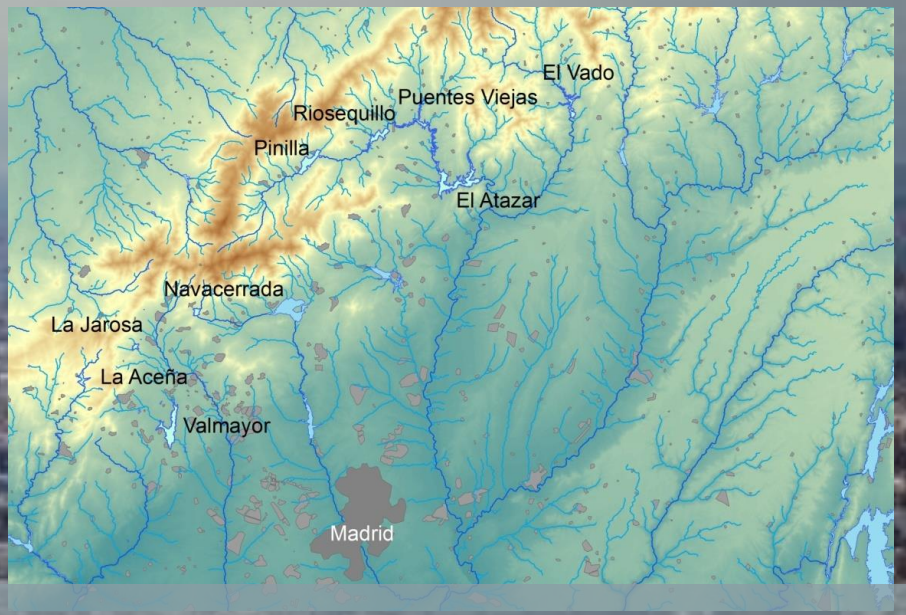
The continuously increasing demands of water, food and energy will challenge the natural resources. We need to face this exceptional situation because at the same time:

Water is precious and water storage infrastructure will become increasingly important!

Humanity is facing a more severe water situation than it has ever faced in the past.

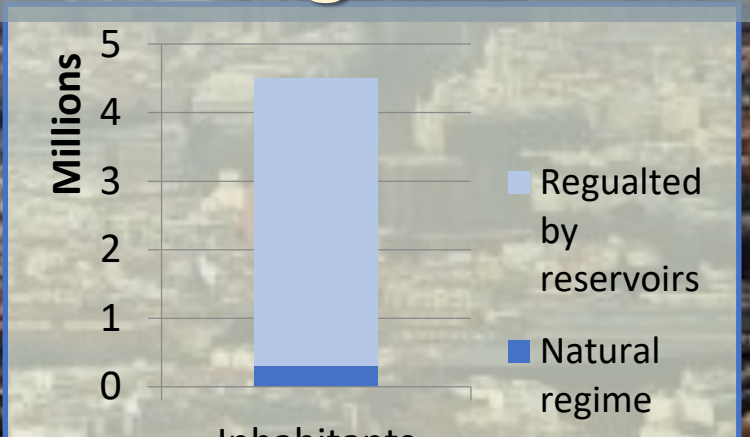
We, therefore, call for joint efforts to develop water storage infrastructure in a sustainable way.

Approved on 5th June 2012 in Kyoto, by:
The International Commission On Large Dams (ICOLD),
The International Commission on Irrigation and Drainage (ICID),
The International Hydropower Association (IHA),
and the International Water Resources Association (IWRA).



Keep them under operation: a real challenge

Embalse	Año	
Cuenca de Lozoya		
El Villar	1879	
Puentes Viejas	1939	
Riosequillo	1958	
Pinilla	1967	
El Atazar	1972	
Cuenca Jarama		
El Vado	[illegible]0	
Cuenca Guadalix		
Pedrezuela	1968	
Cuenca Manzanares		
Manzanares el Real	1912-1971	
Navacerrada	1969	
Cuenca Guadarrama		
Navalmedio	1969	
La Jarosa	1969	
Valmayor	1976	124,4
Cuenca Alberche		26
Los Morales	1988	2,3



Madrid

Rehabilitación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Rehabilitating “adult” dams

Alarcón dam, since 1945

Rehabilitated in 2004

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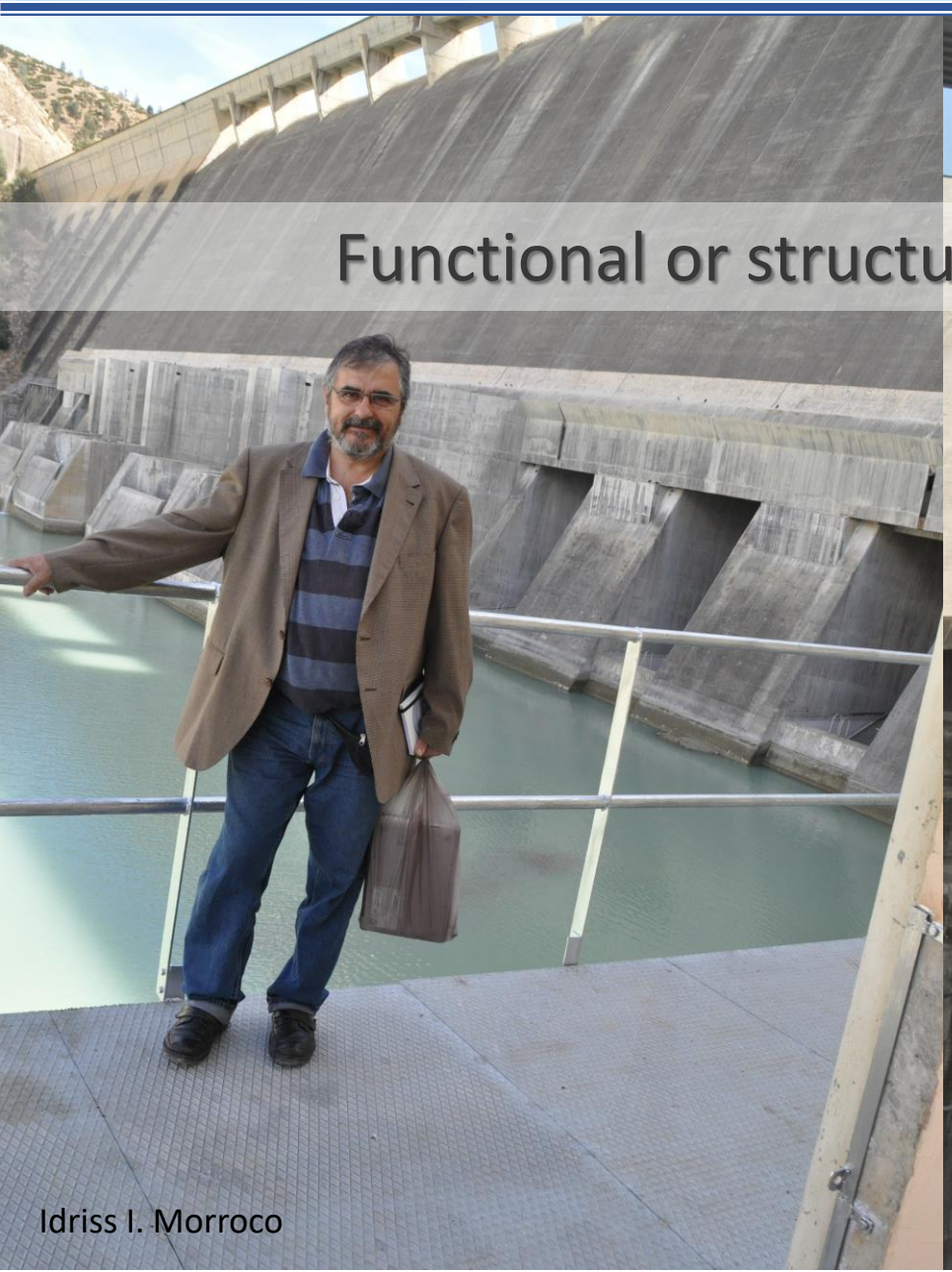
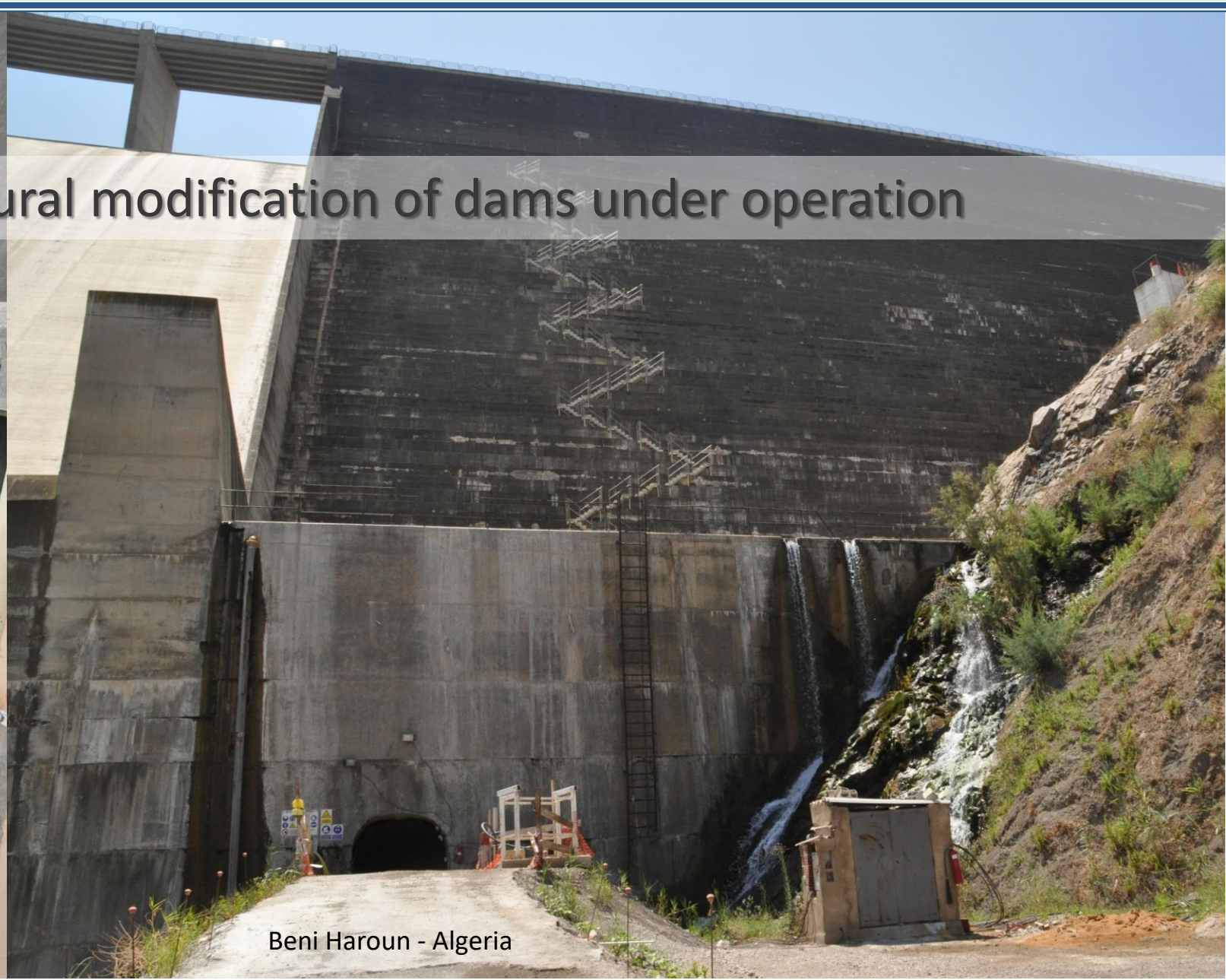
Functional or structural modification of dams under operation

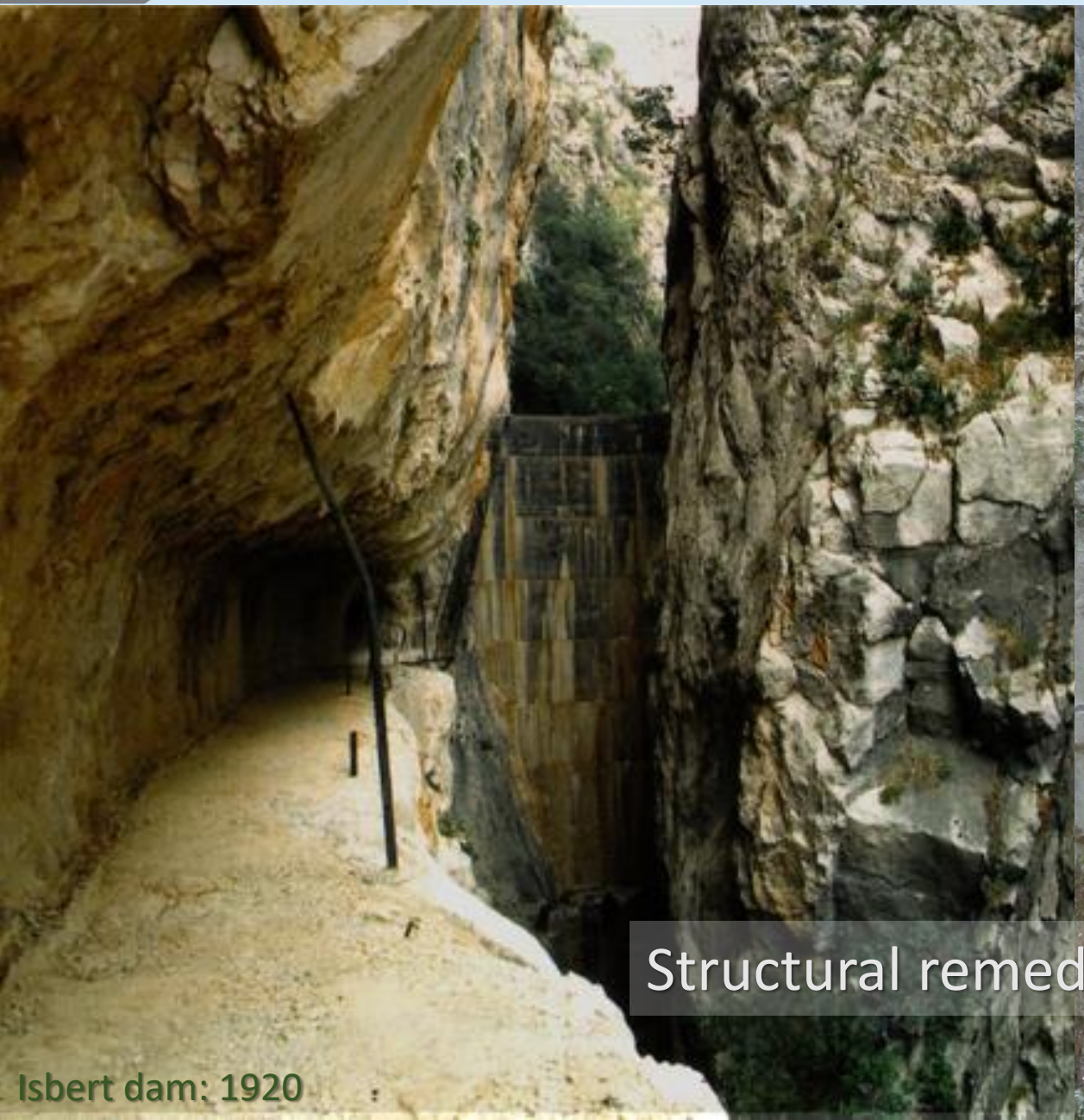


Idriss I. Morroco



Beni Haroun - Algeria

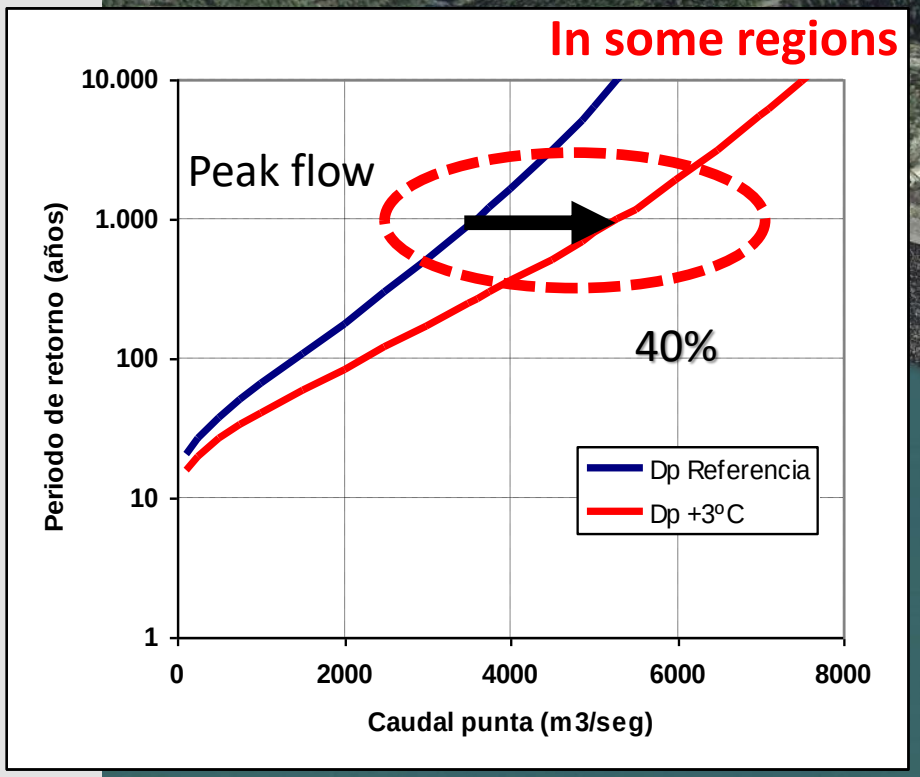
Structural remedial of old dams



Isbert dam: 1920

Upgraded in 1988

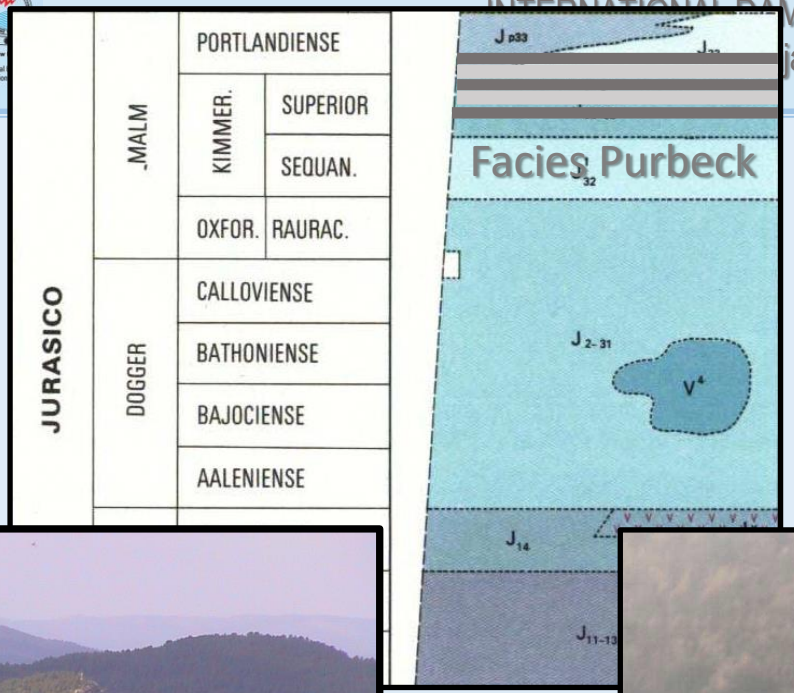
Hydrological safety

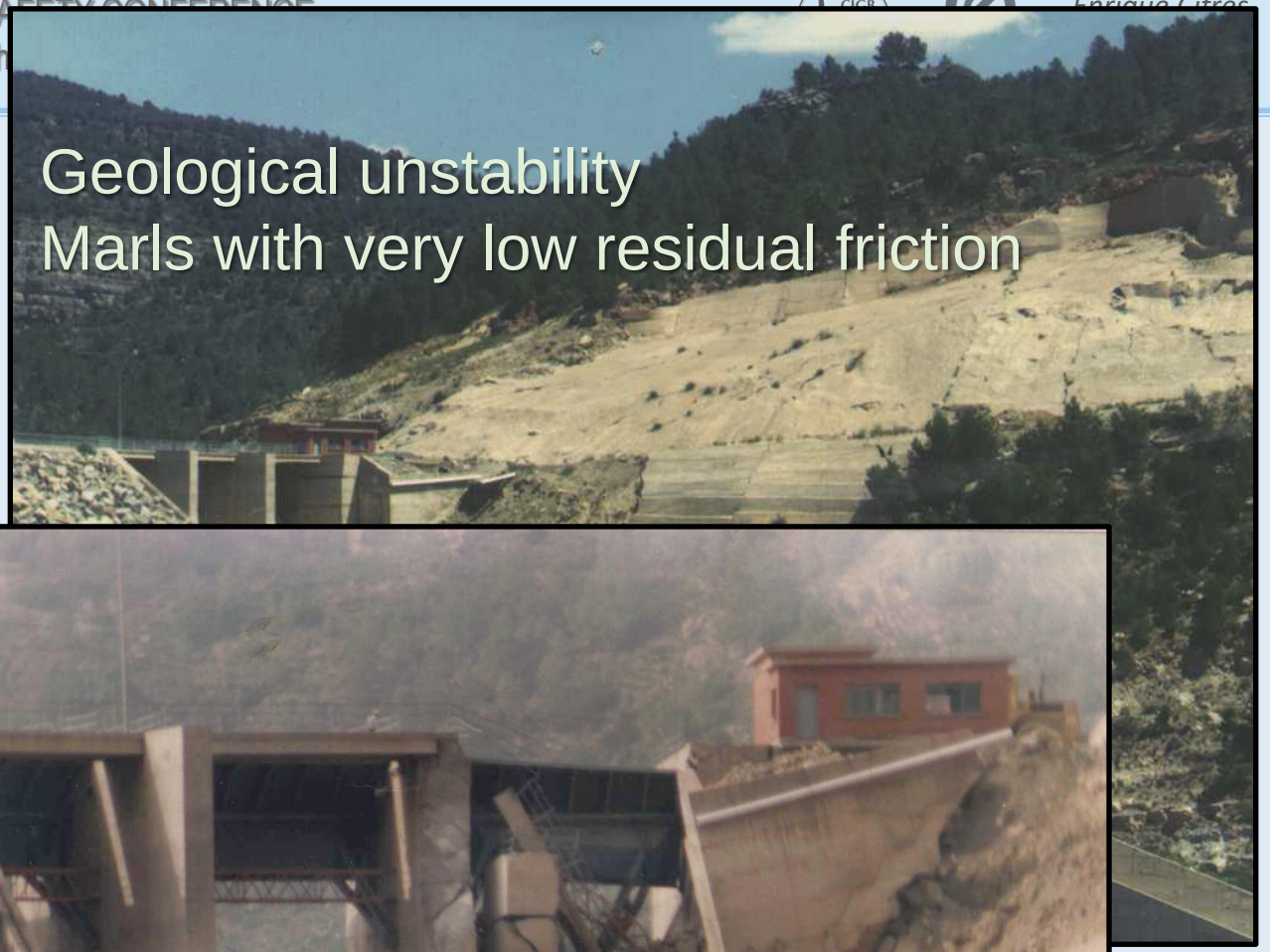


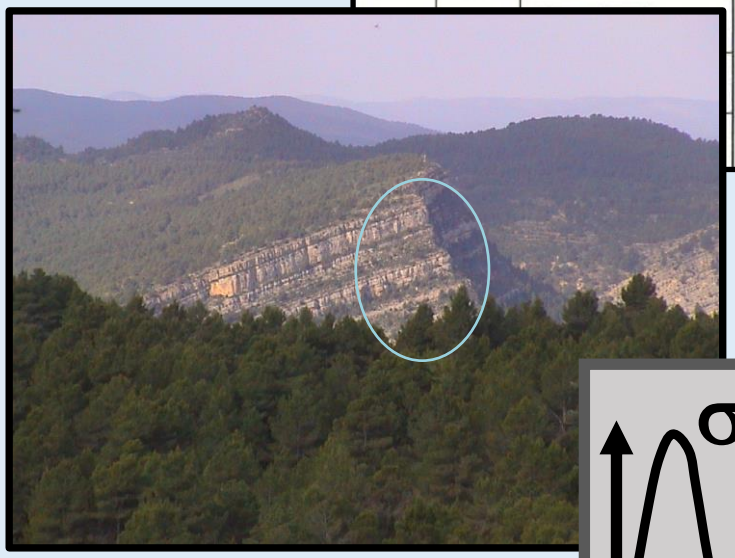
Updating spillway capacity

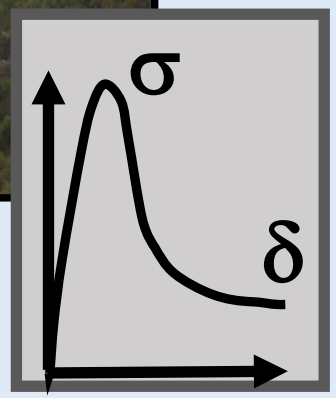
- New data, new flood assessment
- New conditions, standards, regulation ..
- Climate change
- or..
- …

Transposition stochastique et orographique des tempêtes pour estimer les débits des crues d'haute période de récurrence.
Source: Thèse de doctorat. Enrique Cifres


JURASICO
MALM
KIMMER.
SUPERIOR
SEQUAN.
OXFOR.
RAURAC.
DOGGER
CALLOVIENSE
BATHONIENSE
BAJOCIENSE
AALENIENSE
PORTLANDIENSE
Facies Purbeck


Geological unstability
Marls with very low residual friction

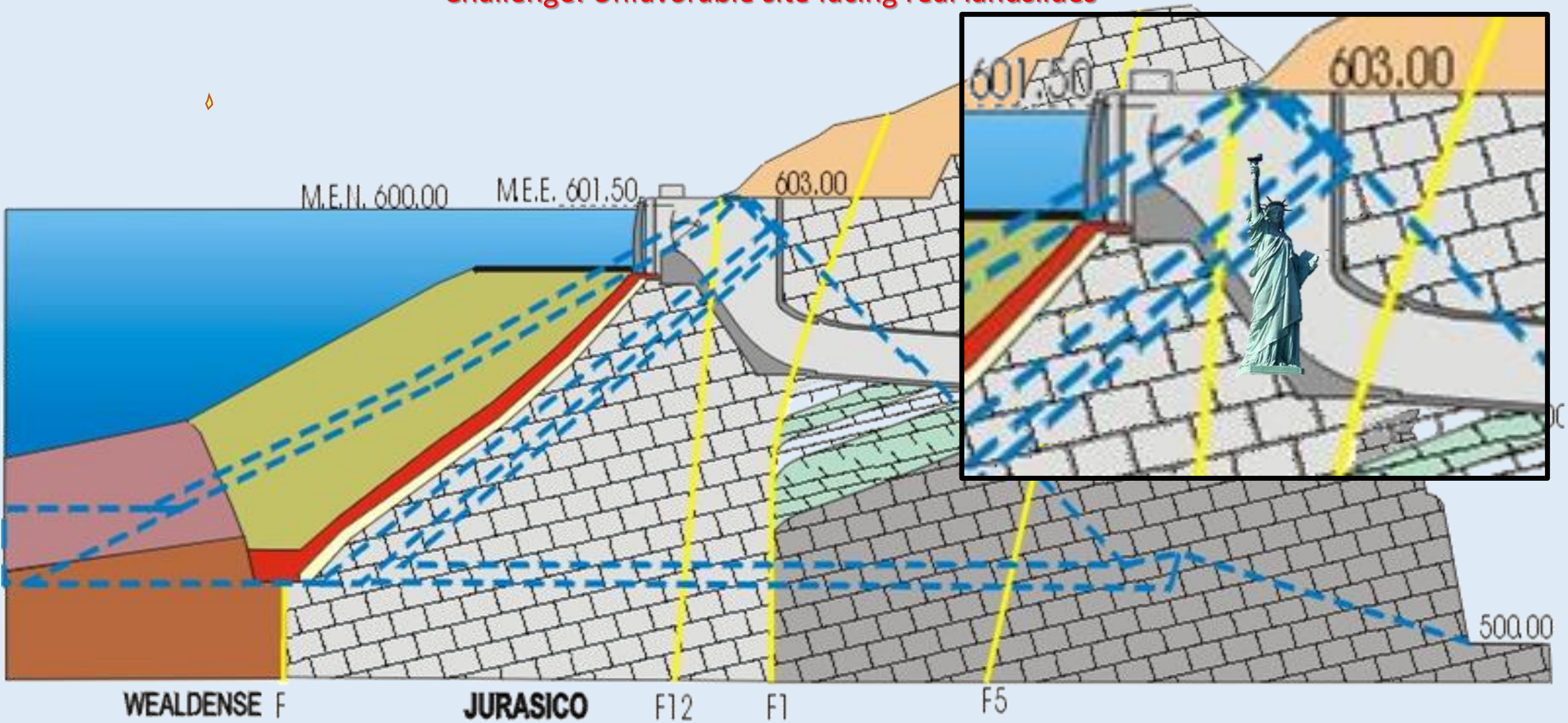



σ
δ

$\phi_R = 18^o$

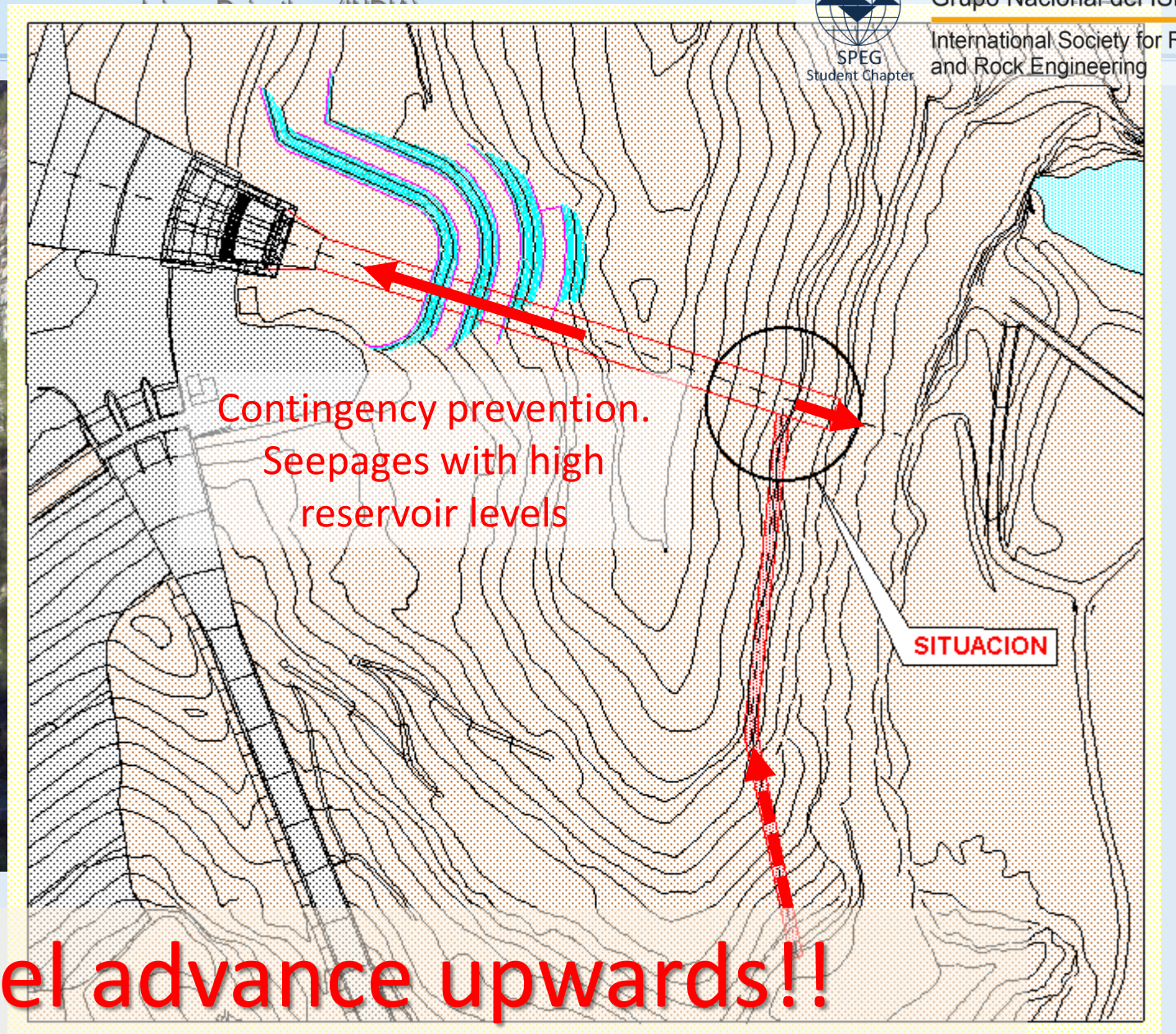

New spillway during operation:
A case of study
No restrictions to seasonal impounding
Cost of opportunity: Loss of incomes higher than new CAPEX
Very demanding conditions !

Challenge: Unfavorable site facing real landslides

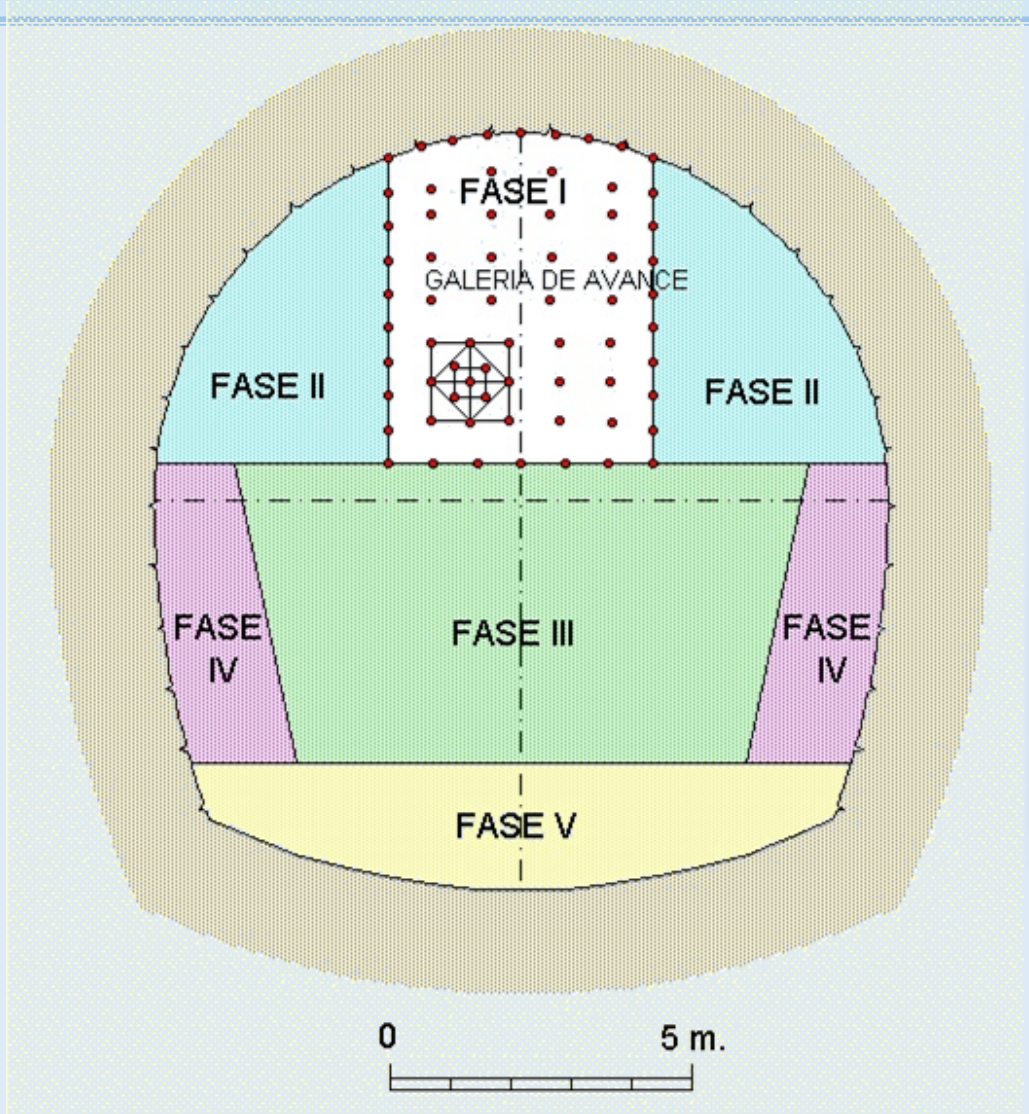


Isolating the reservoir
No restrictions to seasonal impounding

Cofferdam:
Double curvature arch dam
H = 22 m



Tunnel advance upwards!!



Typical Cross-section.

Paradox: smash for safety

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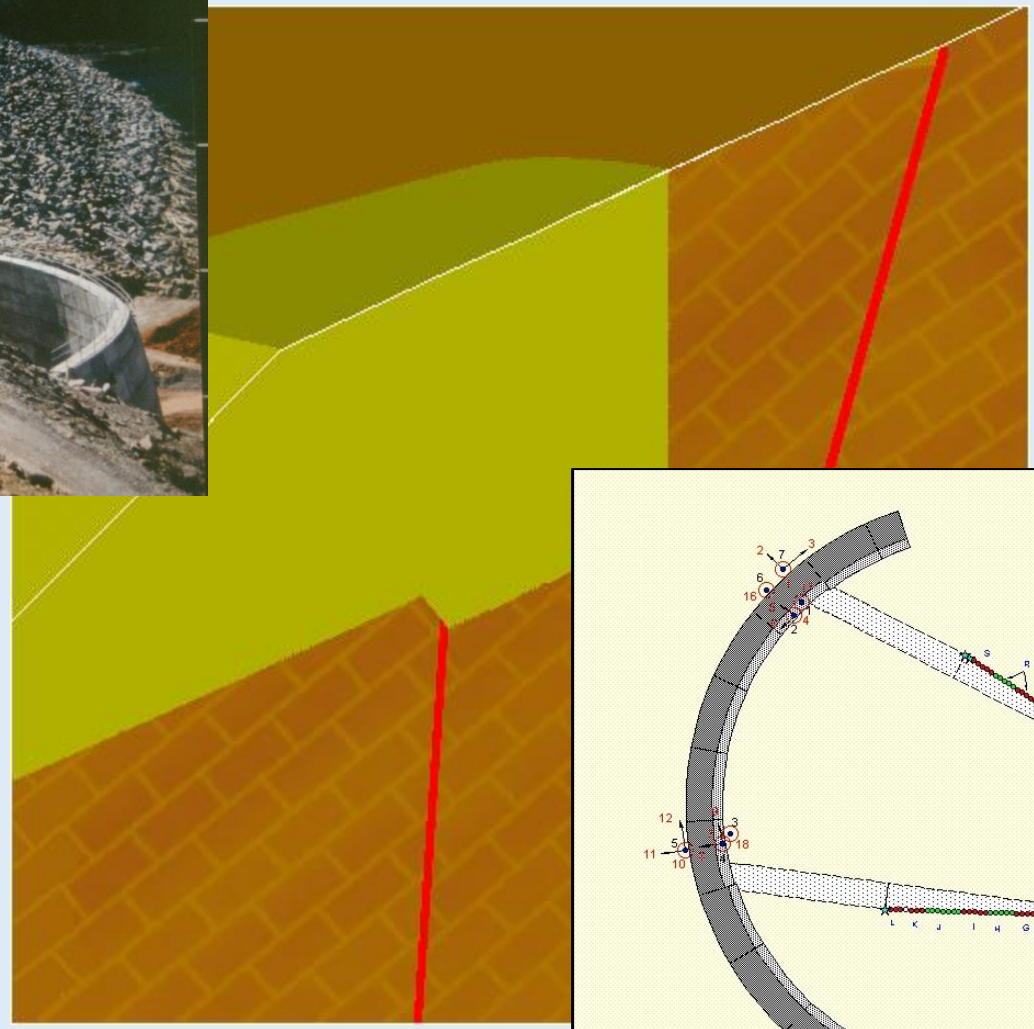
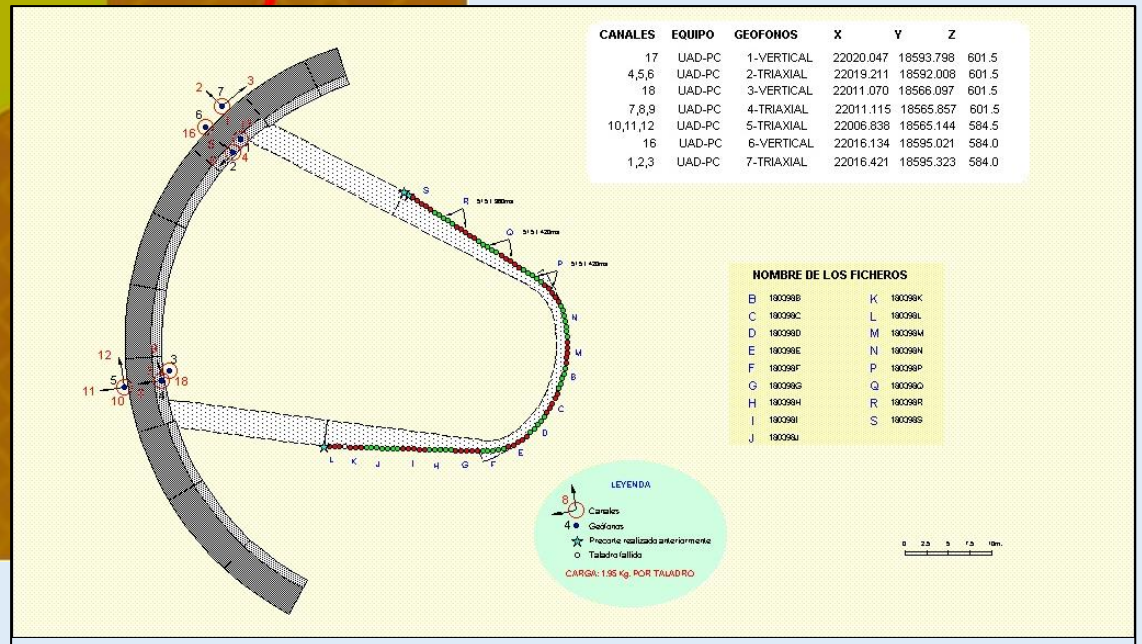


During blasting
4g !!
At crest



Building “TOP-DOWN”

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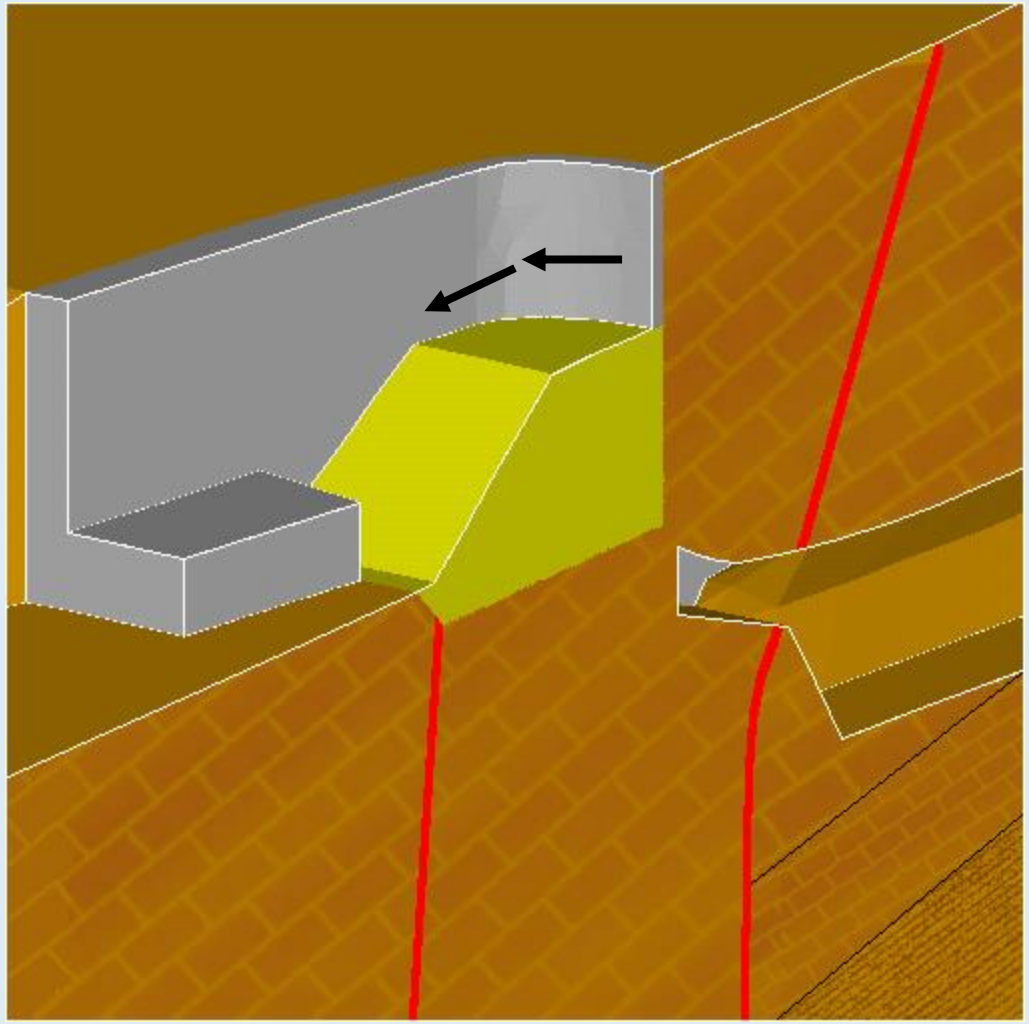

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Uncertainty in real actions

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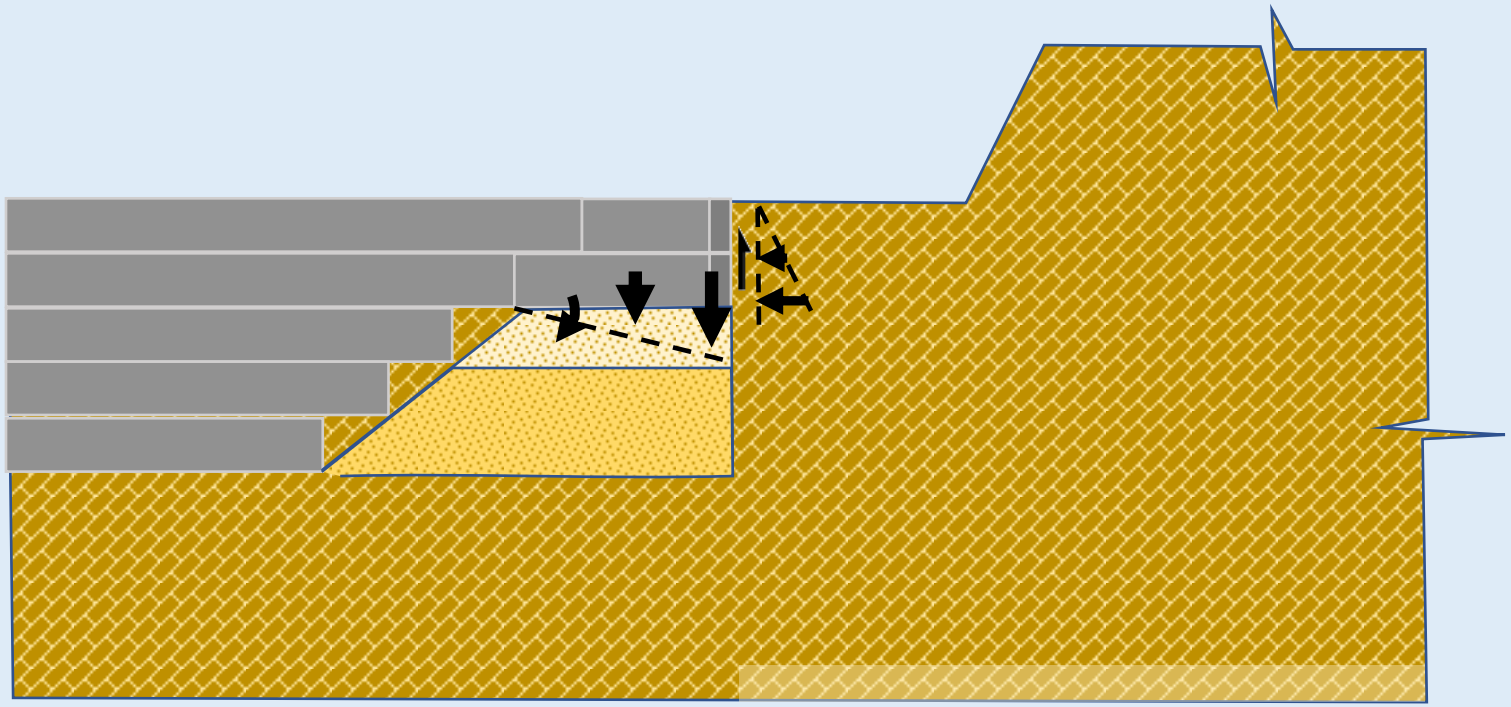

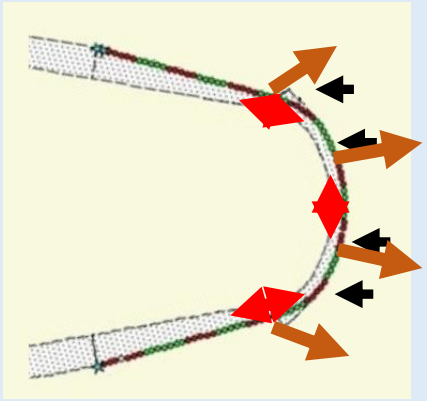

Uncertain action

Artificial action

Forced reaction

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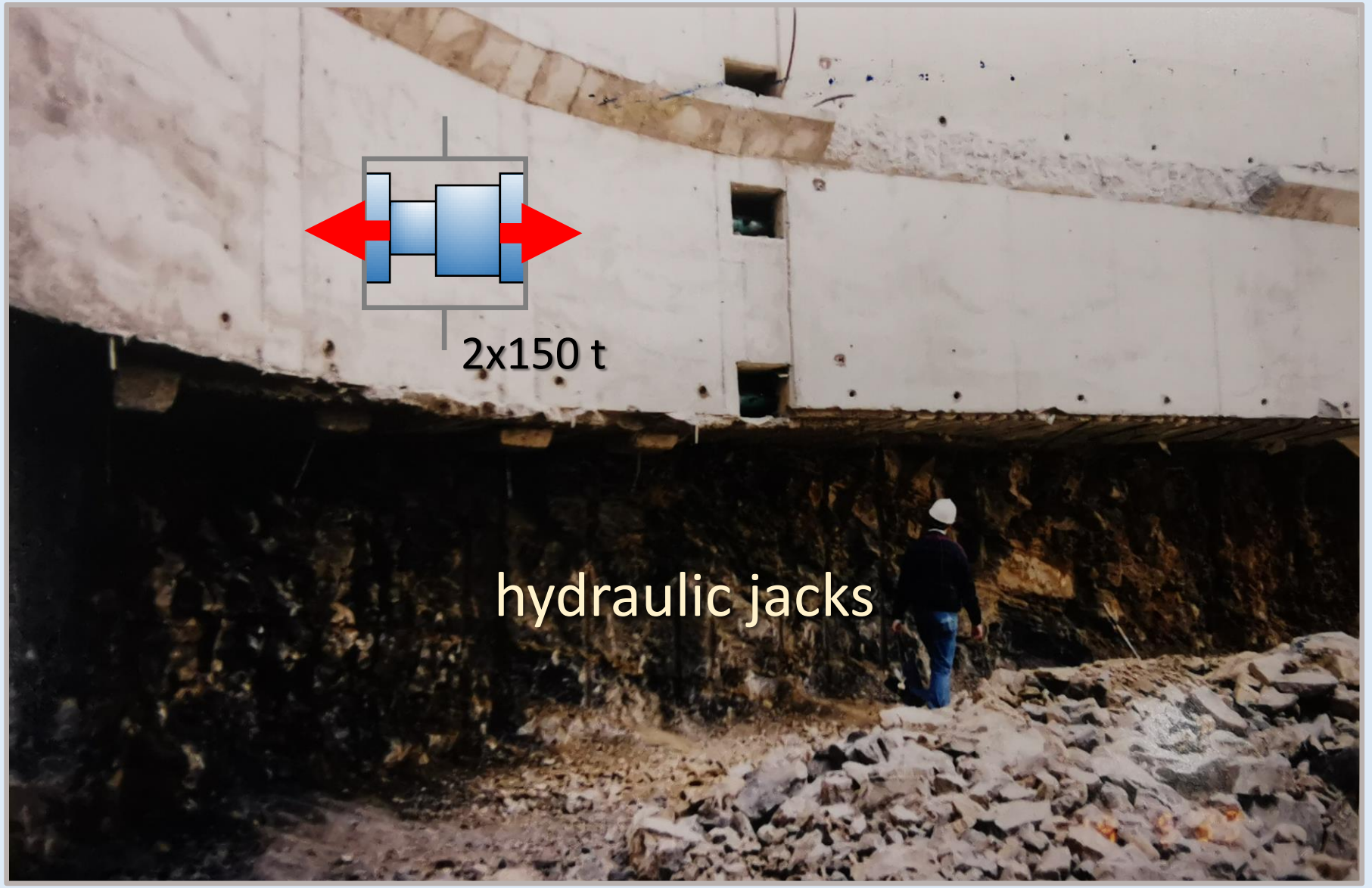

Building “TOP-DOWN”

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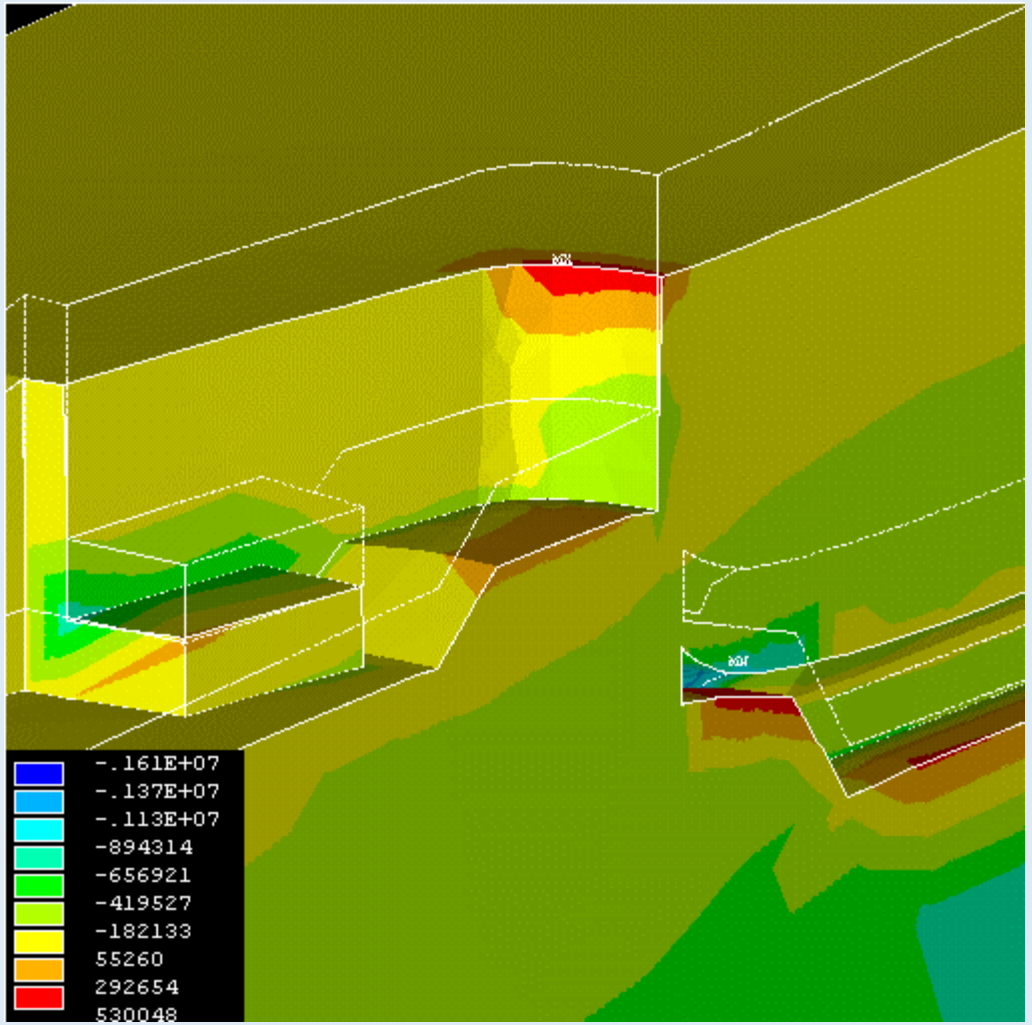
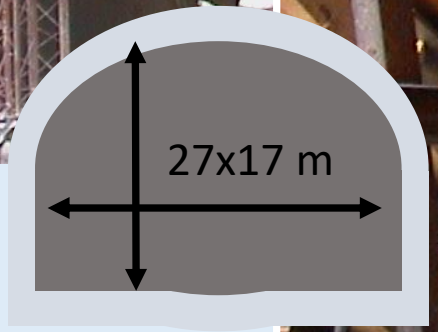
MODEL ⇦



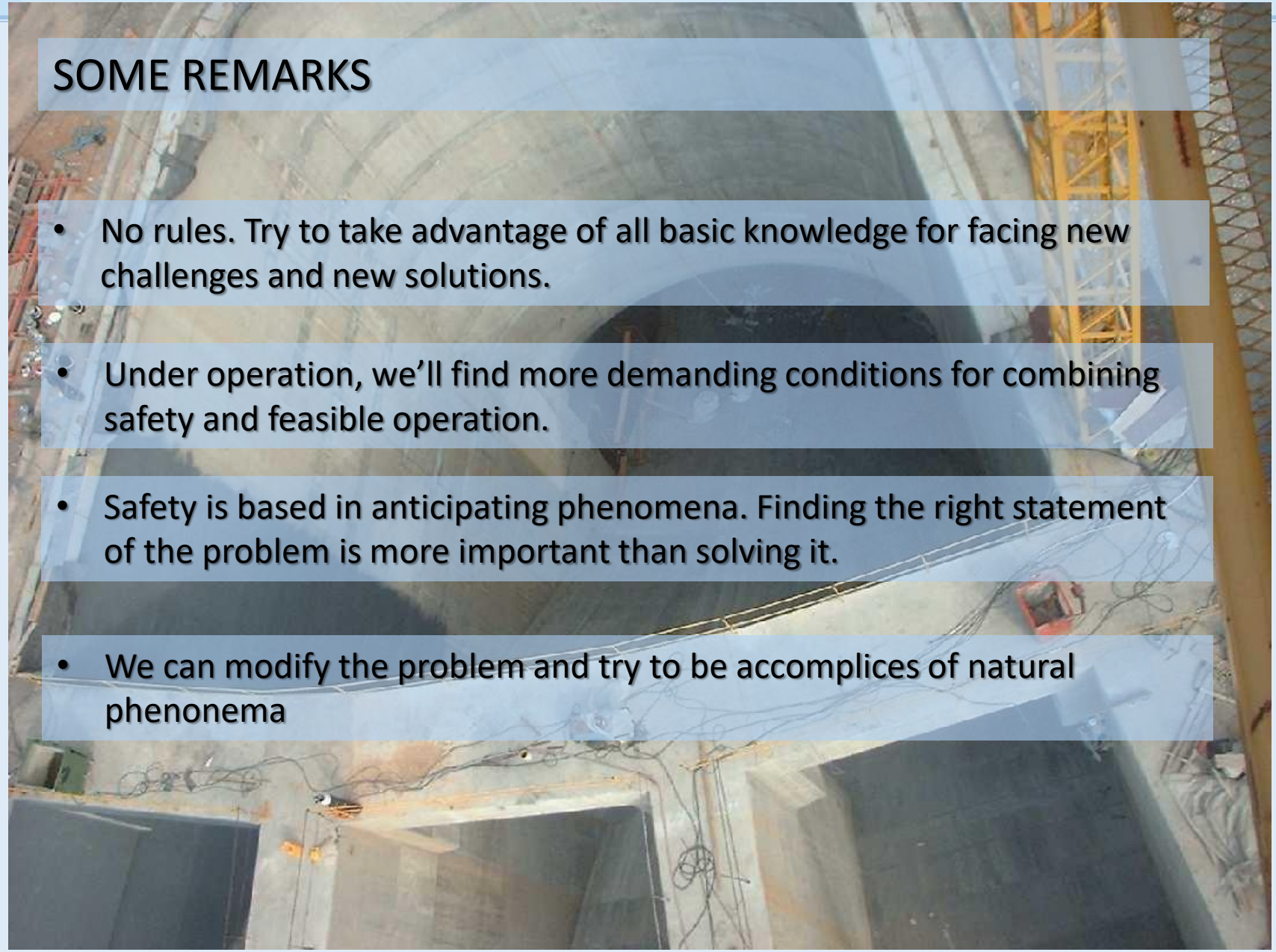
⇨ MONITORING

Critical phase. Rock mass decompression



Reverse engineering

Complex calculation.
Real time strain monitoring



SOME REMARKS

- No rules. Try to take advantage of all basic knowledge for facing new challenges and new solutions.
- Under operation, we'll find more demanding conditions for combining safety and feasible operation.
- Safety is based in anticipating phenomena. Finding the right statement of the problem is more important than solving it.
- We can modify the problem and try to be accomplices of natural phenonema

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Thanks for your attention

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