

DAM SAFETY

LESSONS FROM RECENT INCIDENTS AND ACCIDENTS

ICOLD DECLARATION

Michel LINO

Vice-President of ICOLD

Chairman of CFBR (French COLD)



SYMPOSIUM CFBR

Marseille, 31 janvier 2019



Au Kenya, la rupture d'un barrage fait de nombreuses victimes

NAKURU
10 mai 2018



2017 – 2018 marked by major accidents

- **OROVILLE**, one of the biggest dam in the USA, has been in great danger (200.000 persons evacuated).
- The failure of **ITUANGO** hydroelectric dam, which has been imminent for weeks, would have been a major disaster in the dam industry.
- The failure of the **XE PIAN – XE NAMNOY** saddle dam D in Laos made 70 fatalities or missing and more than 6000 families homeless.
- **PATEL**, a small irrigation dam, failure in Kenya caused 41 fatalities
- **SWAR CHAUNG** in Birmanie : 65.000 persons affected people

OROVILLE – USA, February 2017



- ✓ Project completed 1968
- ✓ Storage for water transfer from Northern to Southern California and energy (880 MW)
- ✓ Embankment dam 230 m high
- ✓ $C = 4,4$ billions of m^3

OROVILLE – USA, February 2017



A major incident occurred in February 2017 to the service spillway
200.000 persons were evacuated

OROVILLE – USA, February 2017

Initial destruction to main spillway





Emergency spillway was operated in order to relieve the service spillway. Severe erosions of the emergency spillway occur.



Extent of destruction immediately downstream of auxiliary spillway



Ultimate damages at the service spillway

CAUSES OF FAILURE *(from Independent Forensic team)*

Physical causes

Inherent vulnerabilities in the spillway design (inefficient drainage under the chute slab, poor joint design...)

→ **Uplifting of the slab**

- Poor spillway foundation in some location

→ **Rapid erosion of the foundation** when exposed to high velocity flow after uplifting of the slab

Organisational causes

- The seriousness of the weak as-constructed conditions and lack of durability of repairs not recognized during numerous inspections and review process over almost 50 years.
- Progressive deterioration of concrete and corrosion of steel bars, decrease of anchor capacity, especially in zones with poor foundation conditions.

LESSONS

The evacuation of 200,000 people was efficiently decided and executed.

However, the Oroville accident teaches us nothing or not much technically because the weakness of the spillway were well known and wrong decisions were made during 50 years.

The main physical cause was **poor geological condition** not properly taken into account

It challenges our profession about the long-term safety monitoring of our works.

Central Core Rockfill Dam

227 m high

C = 2,7 billions m³

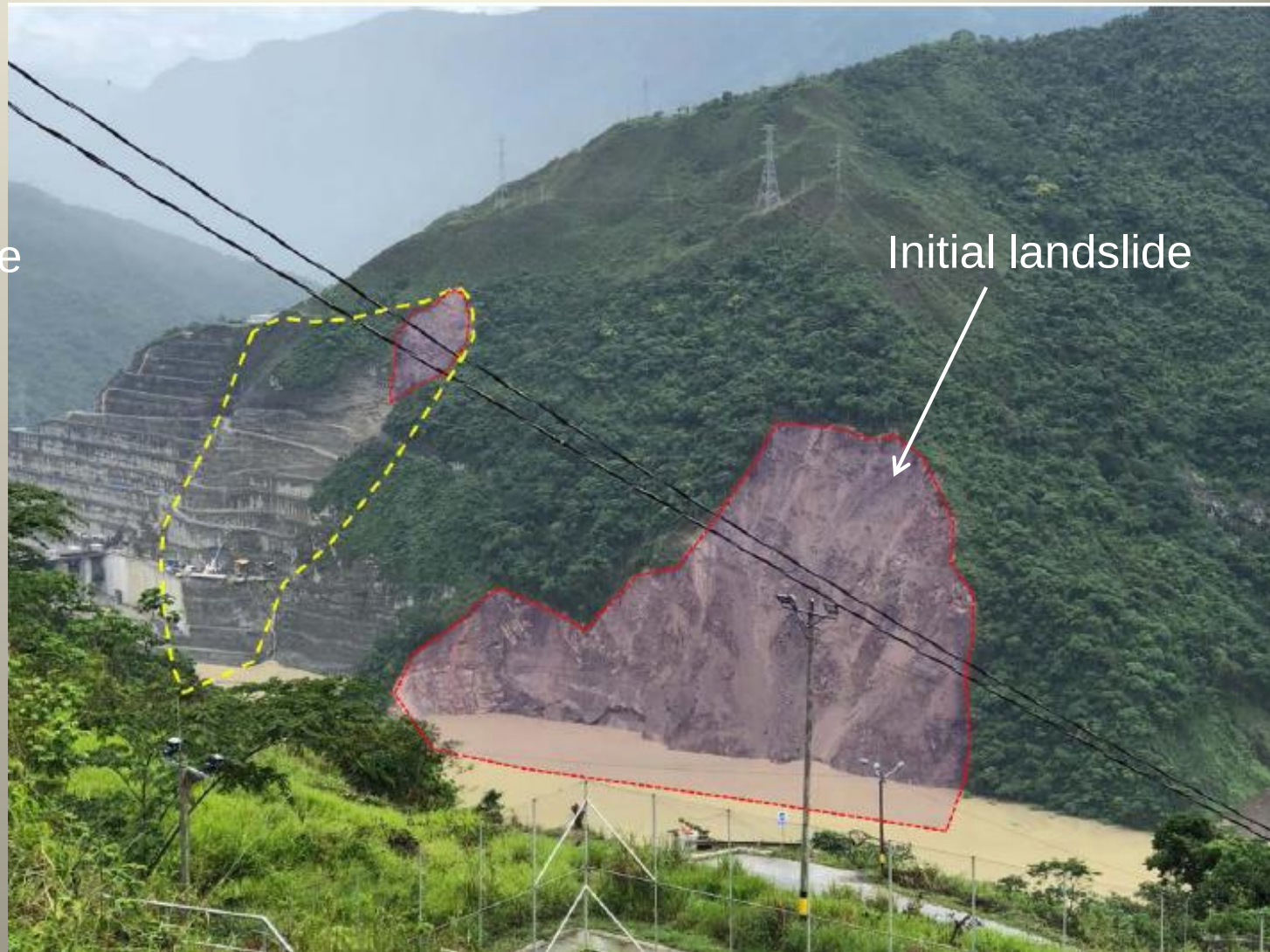
- Loss of the diversion tunnel blocked by a landslide and fontis near the end of construction
- Uncontrolled rise of the reservoir level

Discharge by the powerplant cavern

≈1000 m³/s under 200 m head!!!



Right abutment
landslide upstream
the dam blocked the
diversion tunnel





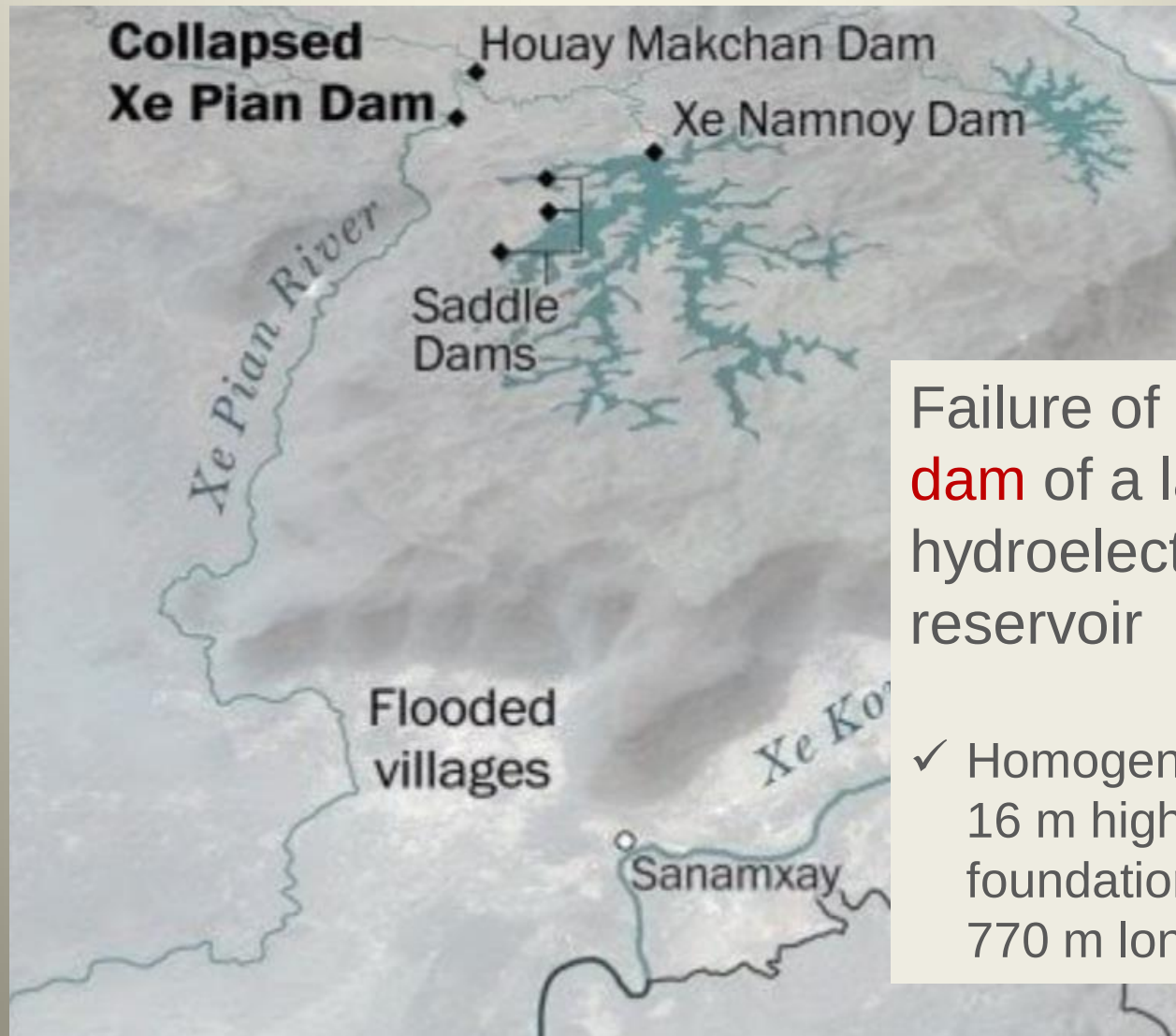
Speed race
between the rise of
reservoir (100 m in
a few days) and
the rise of the
priority
embankment ...

Presantation of Ituango case and the action of CFBR at the
sympoium



- Small earthdam in Kenya for agriculture
- Small capacity around 200.000 m³
- Failure after heavy rains and flood following a severe drought
 - Possibly no spillway...
 - Flow in a secondary thalweg
 - No alert to the people

More than 40 fatalities among them a lot of children



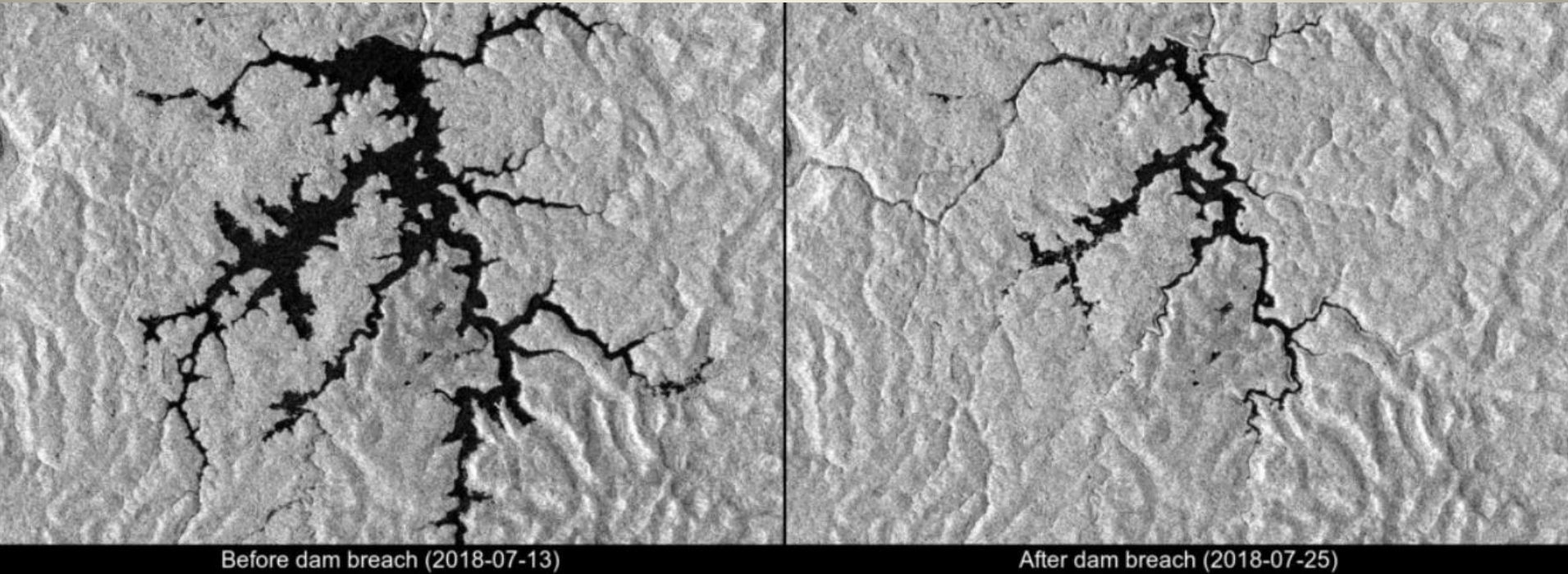
Failure of a **saddle dam** of a large hydroelectric reservoir

- ✓ Homogeneous dike
16 m high on lateritic foundation
770 m long

XE PIAN – LAOS, July 2018

Failure of a saddle dam
of a large hydroelectric
scheme





Total volume of the Xe Nanmoy reservoir : 1 billion m³

Volume released : around 0,5 billion m³

XE PIAN – LAOS, July 2018

- ✓ 70 fatalities or missing
- ✓ 6000 families homeless
- ✓ Large international mobilization



SWAR CHAUNG DAM – MYANMAR, August 2018



The ruptured spillway
had flooded 85 villages

affecting more than
63,000 people

submerging a section of
highway

SWAR CHAUNG DAM – MYANMAR, August 2018



FAILURE OF A TAILING DAM – BRAZIL, January 25th 2019



Mud flow – dozens of fatalities – 300 missing

SYNTHESIS AND LESSONS

- OROVILLE or Chronicle of an announced disaster
 - ✓ The weaknesses of the dam were perfectly known ...
 - ✓ Geologic risk not correctly managed
- ITUANGO : a challenging project and a context of risk taking to finish the project in time
 - ✓ Be carefull with **river diversion design and operation**
 - ✓ Geologic risk not correctly managed

SYNTHESIS AND LESSONS

- XE PIAN – XE NAMNOY : the failure of a saddle dam almost as critical as the dam failure itself
 - ✓ Pay special attention to **saddle dams often sidelined**
 - ✓ Geologic risk not correctly managed
- PATEL dam failure shows that a small dam failure can be highly destructive
- PATEL AND SWAR CHAUNG : exceptional monsoon in Africa and Asia this last summer
 - ✓ Effect of climate change?

SYNTHESIS AND LESSONS

- The **period of construction and first filling** is a period at high risk. The EPP must be implemented early enough.
- **Foundation/Geological problems** are a key cause in the case of Oroville, Ituango and Xe Pian – Xe Namnoy.
- Crucial importance of the **Emergency Preparedness Plan** to minimize the number of victims.

SYNTHESIS AND LESSONS

- The transfer of responsibilities for major projects from the States to the Companies may be problematic and questionable...
 - Negative trend worldwide with the "privatization" of dams
 - Crucial role of National Safety Regulation
 - Importance of dissemination of State of the Art and good practices by ICOLD

SYNTHESIS AND LESSONS

- A major dam failure would be a disaster at the global scale and a drama for our profession.
- It is our responsibility and privilege to design, build, monitor, and operate our dams according to the best practices and highest safety standards.
- ICOLD is mobilized to achieve this goal.
- ICOLD will issue a Dam Safety Declaration in

Ottawa



THE INTENT OF THE DECLARATION (1/2)

- Increase awareness of importance of safety in planning, designing and constructing new dams and in operation of existing dams;
- Raise alertness on alarming situation following the various incidents or accidents that affected dams in 2017 and 2018;

THE INTENT OF THE DECLARATION (2/2)

- Reconsider and update on the policy and actions of ICOLD on Dam Safety;
- Identify gaps / weaknesses and consider how ICOLD can help to improve the state of dam safety;
- Develop an action plan to improve the safety of dams.

Thank you for attention