Dam failures by erosion: lessons from ERINOH data bases

R290

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EROSION IS THE THREAT OF WATER RETAINING STRUCTURES

According to data collected from February 2010 to April 2012 :

- 47 failures were recorded
- 44 causes of failure identified
- 43 failures caused by erosion
- whose 8 large dam failures
- 20 published cases of water retaining structures failures per year
- 4 large dam failures per year

INTERNAL EROSION IS THE MAJOR CONCERN FOR SMALL STRUCTURES

According to data collected from February 2010 to April 2012:

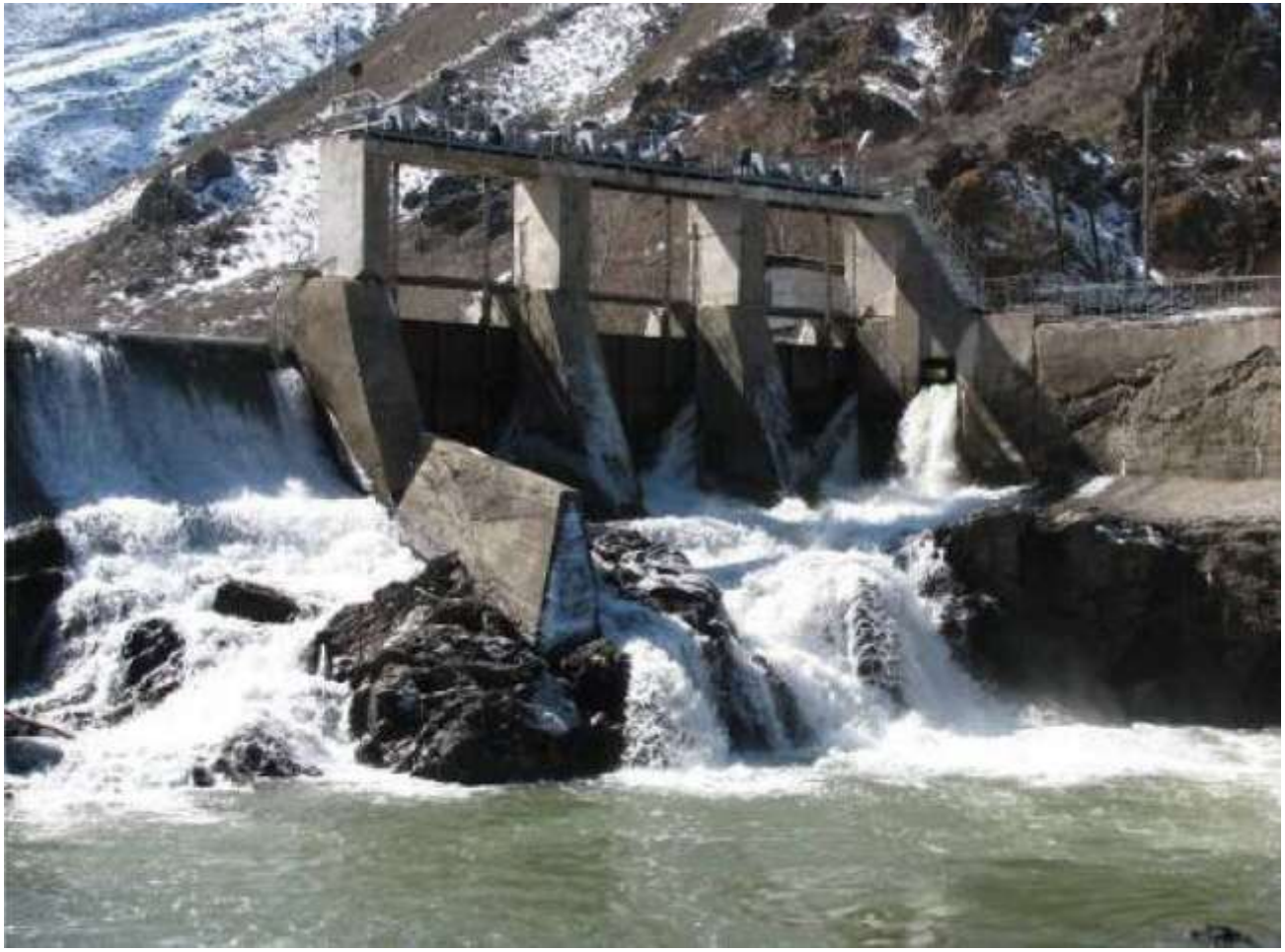
Failed water retaining structures:

- internal erosion: 23 failures of 44
- external erosion: 20 failures of 44

Failed large dams:

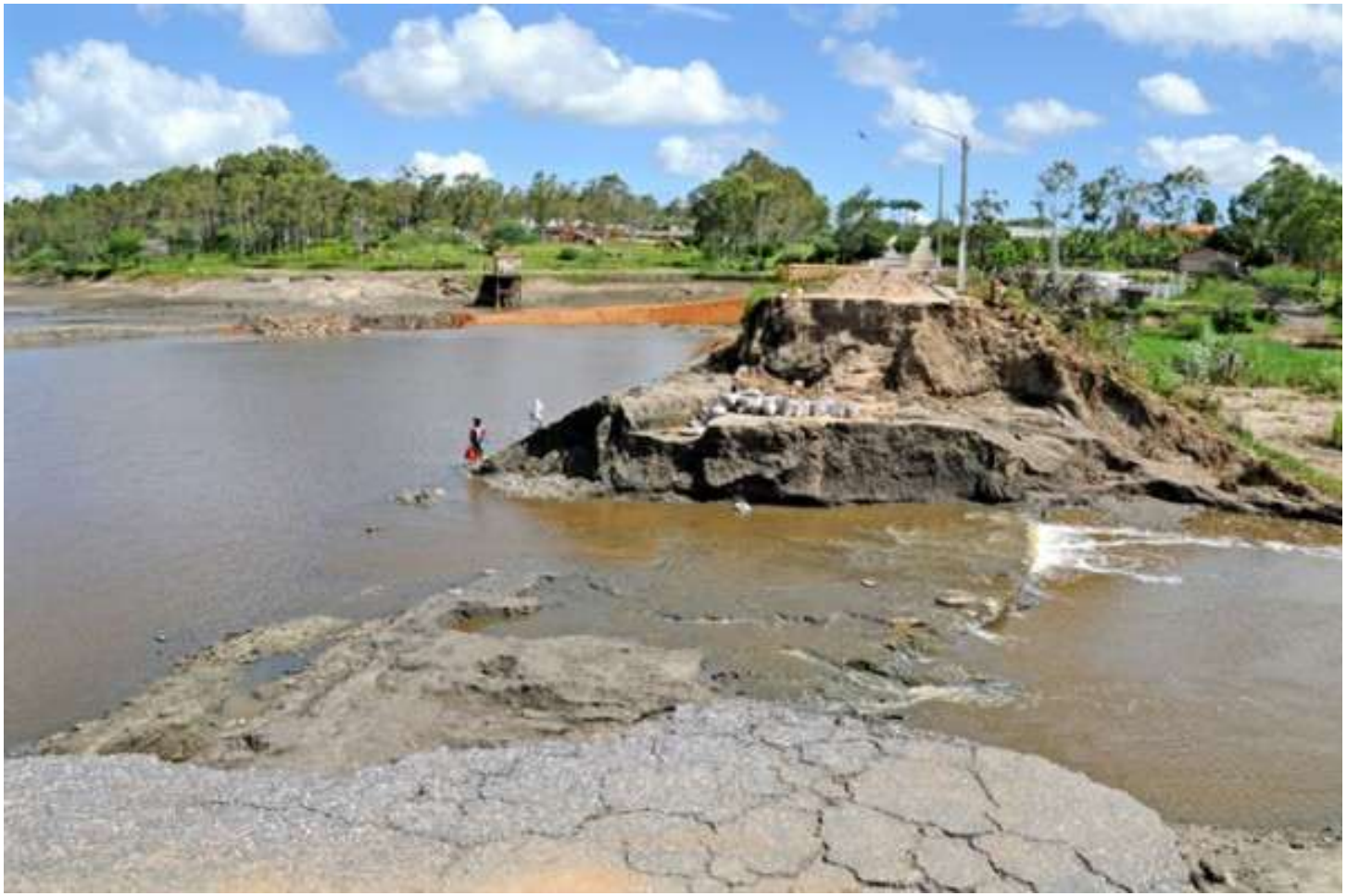
- external erosion: 5 failures of 8
- internal erosion: 3 failures of 8
- instability: 1 seismic failure of 8

EXAMPLE OF RECENT LARGE DAM FAILURE



- Kyzylagash (Kazakstan) dam breached by overtopping (2010)

EXAMPLE OF RECENT LARGE DAM FAILURE

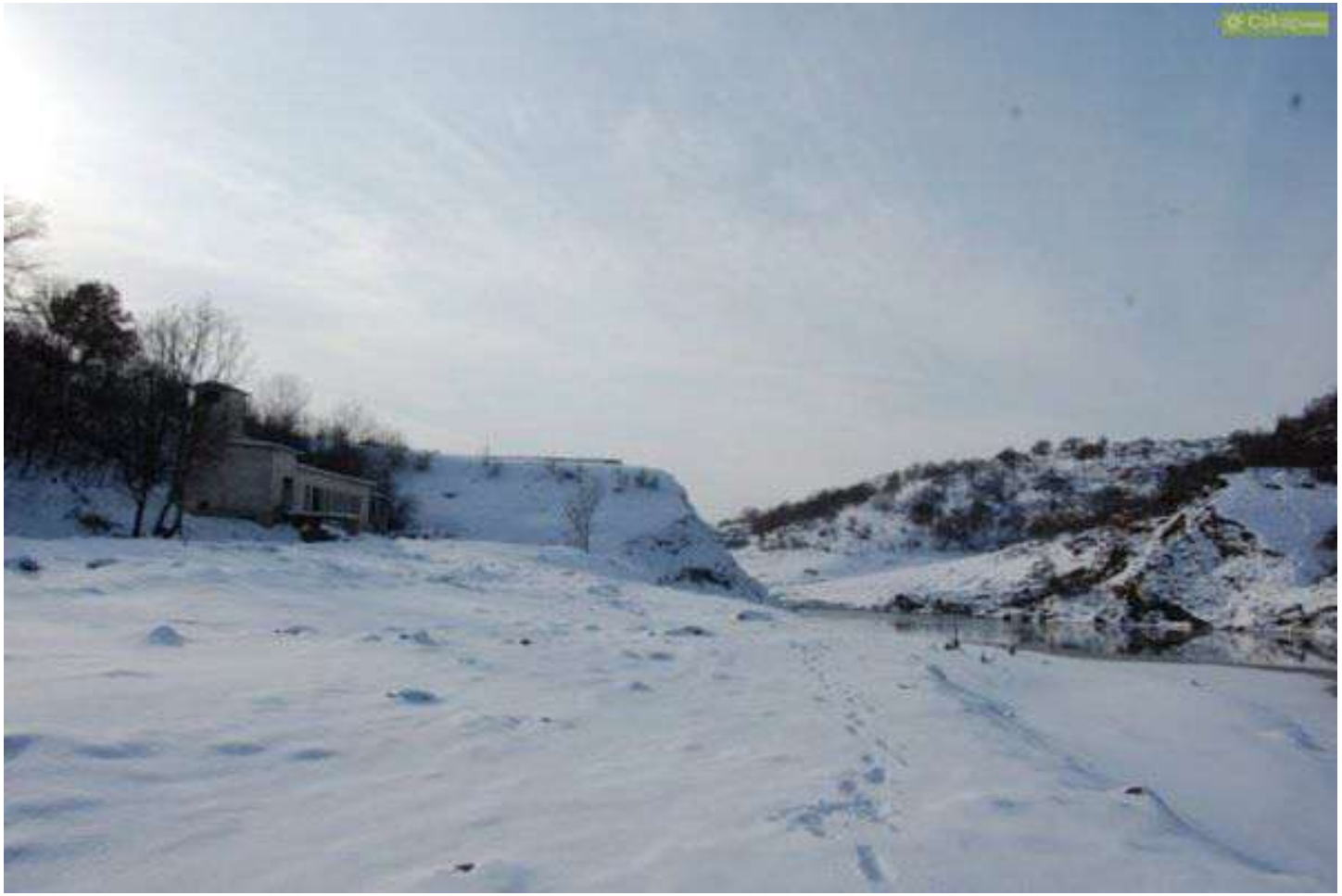


- Bom Conselho earth dam (Brazil) breached by overtopping (2010)

EXAMPLE OF RECENT LARGE DAM FAILURE

- Niedow or Witka earth dam (Poland) breached by overtopping (2010)

EXAMPLE OF RECENT LARGE DAM FAILURE



- Failure of Ivanovo earth dam (Bulgaria 2012)

EXAMPLE OF RECENT LARGE DAM FAILURE

- Failure of Barlovento reservoir with geomembrane (Canaries 2011)

ERINOH Data bases on failures and incidents: OBJECTIVES

- ERINOH: Project devoted to internal erosion
- The "database of incidents“, developed by IRSTEA, lists the incidents, accidents and failures caused by internal erosion and external erosion (overtopping) of dams or dikes (retaining navigation or hydroelectric canals and flood levees). The objective of the database is to identify all the mechanisms and use data on the frequency of occurrence for risk analysis.
- The "validation database" was originally developed by EDF and its partner International Risk Assessment as part of the project "Erosion of Embankment Dams" led by CEATI / DSIG and continued through ERINOH. Its purpose is to provide robust data on dam failures by overtopping or internal erosion for validation of numerical models of breach hydrographs.

ERINOH Data bases on failures and incidents: STRUCTURE

- As details often vary, they are assigned a confidence level represented by a color code (green = good, orange = medium, red = bad) possibly supplemented by a commentary. Each case sheet includes attached files with reports, photos, maps, charts. The database is ‘living’ and changes are logged.
- Each sheet contains 70 incident fields, grouped into six sections:
- identification of the type of structure and the type of incident;
- geometry of the structure where the incident occurred;
- materials in the embankment body;
- materials in the foundation;
- description of the reservoir (dam, canal or river);
- description of the incident and the breach.

Data bases content

- Incidents data base:

Water retaining structure	Cases number
Dams	41
Flood levees	120
Hydropower & navigation canals	45
Total	206

- Validation data base

External erosion failure	13 Cases
Internal erosion failure	3 Cases

First lessons from collected data : Dams

- Incidents:

Path	Cases
Incidents in foundation	10
Incidents along structures	9
Incidents in dam body	9
Total	28

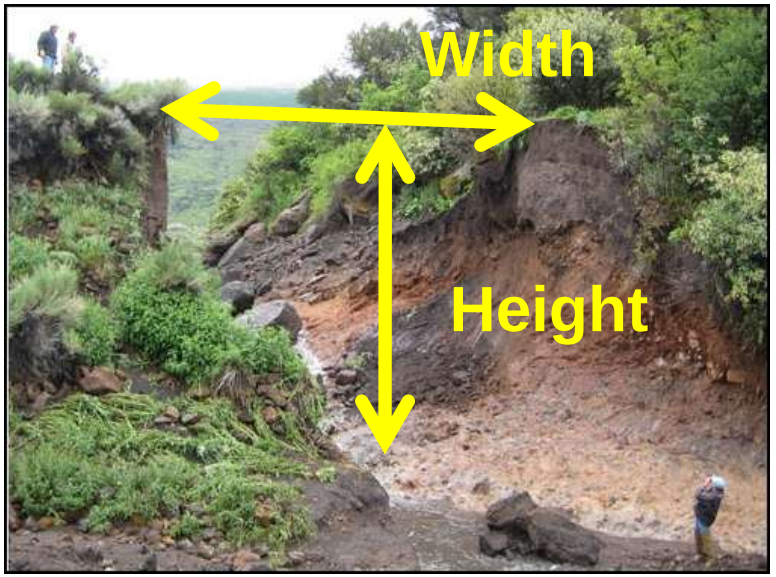
- Failures:

Large dams	0 Cases
Low dams : all homogeneous dam without filter And no fatalities	6 Cases

First lessons from collected data : navigation and hydropower canals

Features	Navigation canals	Hydropower canals
➢ Height :	1 to 12 m (3 to 6 m)	4 to 20 m
➢ Crest width :	1,5 to 5 m	min 5 m
➢ Type of fill :	homogeneous	zoned with a few cases of upstream facing
➢ Construction:	19th century	1950 to 1987.
➢ Failures/Incidents :	20/45	0/45

First lessons from collected data : flood embankment



- BREACHES DIMENSIONS:
  - Internal erosion :
    - **Width (21m) = 6.Height [1;14]**
  - External erosion: overtopping
    - **Width (190m)= 58.Height [6 ; 210]**
  - No clear correlation between the dimensions of the breach and the dimensions of the flood levee (crest width, slopes)
  - No enough data to correlate the breach width to the flood duration

CONCLUSIONS

- Erosion is the threat of water retaining structures.
- Large dams suffered more external erosion and low dams suffered more internal erosion failures.
- No zoned dam or dam with good filter failed by internal erosion. No fatalities occured during the 6 small dam failures by internal erosion
- Breaches caused on levees by overtopping are more dangerous than those caused by internal erosion