Seismicity and the Tendaho Dam safety

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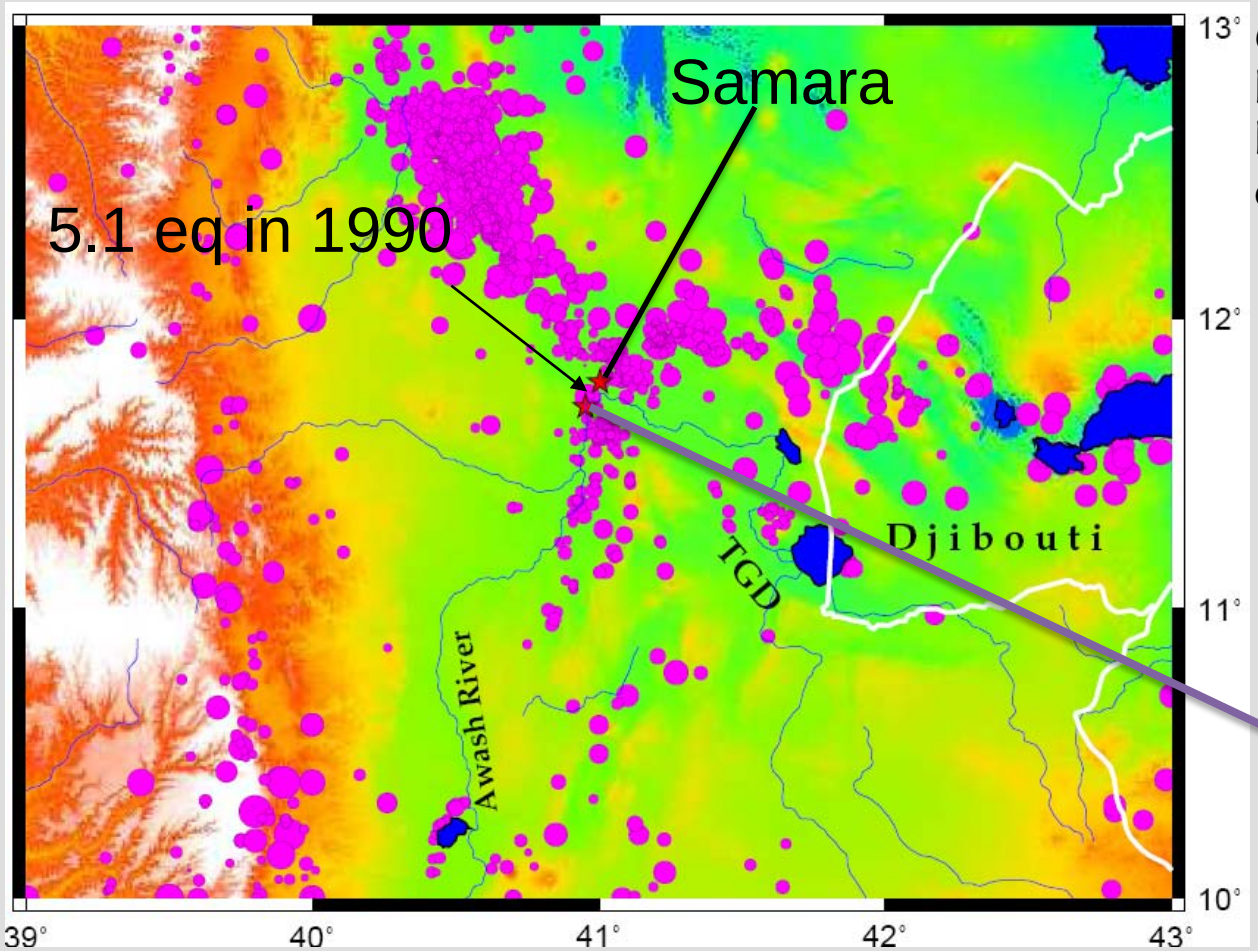
Dam at a triple Junction



Objective: to develop 60,000 ha of sugarcane plantation and hence produce 500,000 tons of sugar per year

But the site is not only active plate boundary which is in constant motion but close to a triple junction even worse!

Reservoir induced seismicity

- Earthquakes can be induced by dams. Globally, there are over 100 identified cases of earthquakes that scientists believe were triggered by reservoirs (Gupta, 2002)

- The most widely accepted explanation of how dams cause earthquakes is related to the extra water pressure created in the micro-cracks and fissures in the ground under and near a reservoir

The Sichuan (China) earthquake as an example

The most serious case may be the 7.9-magnitude Sichuan earthquake in May 2008, which killed an estimated 80,000 people and has been linked to the construction of the Zipingpu Dam

Objective of this presentation

- To compile all facts and figures about the Tendaho Dam and assess the level of the risk of running the sugarcane plantation as originally planned
- To suggest an alternative mechanism to recover the invested capital on the Dam
- To get a lesson for other dams being constructed or planned in the future targeted for hydro power generation and irrigation

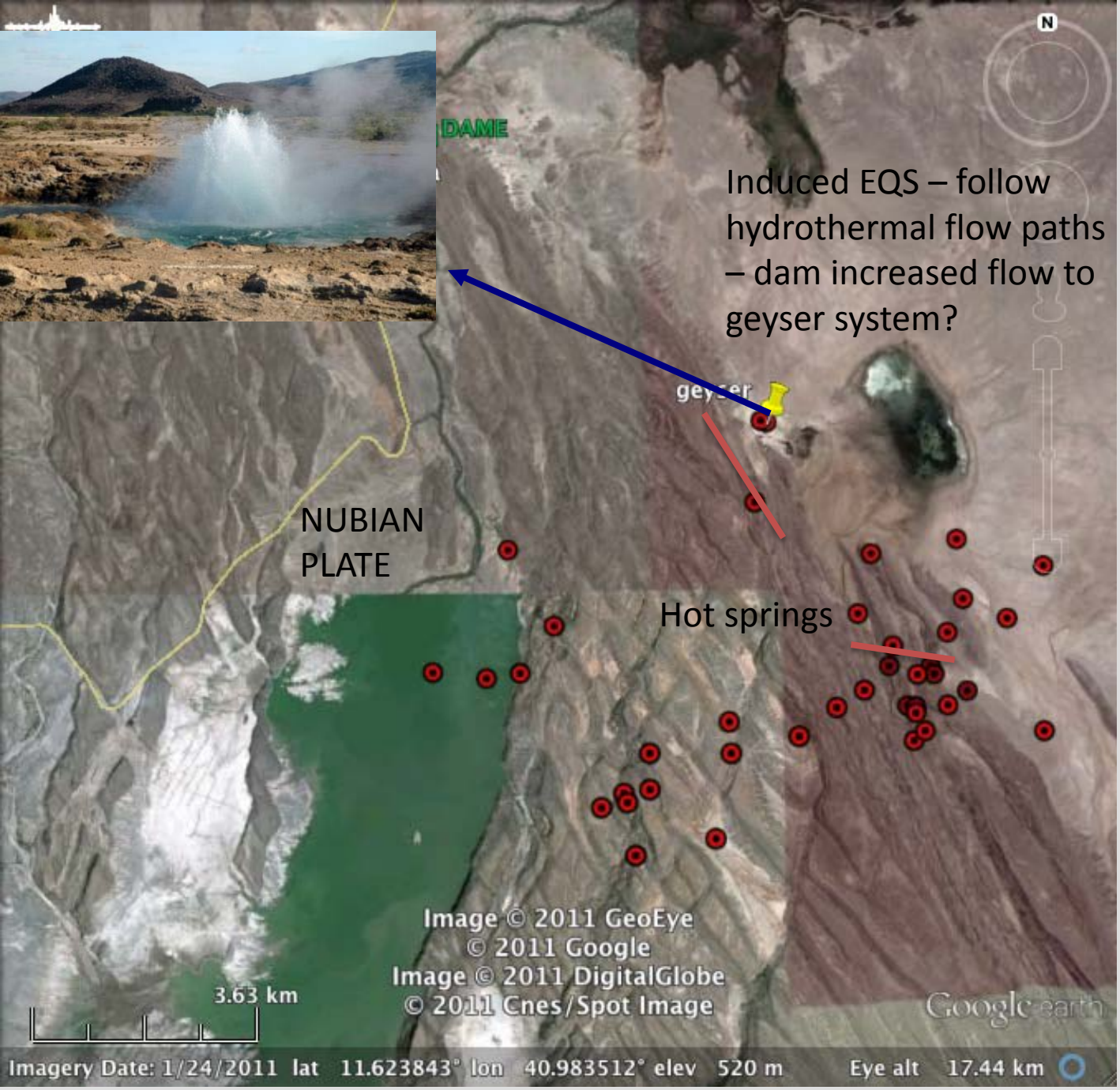
Some features of the Tendaho Dam

- Earth fill

- located at a tectonically complicated structure

-1.86 billionm3

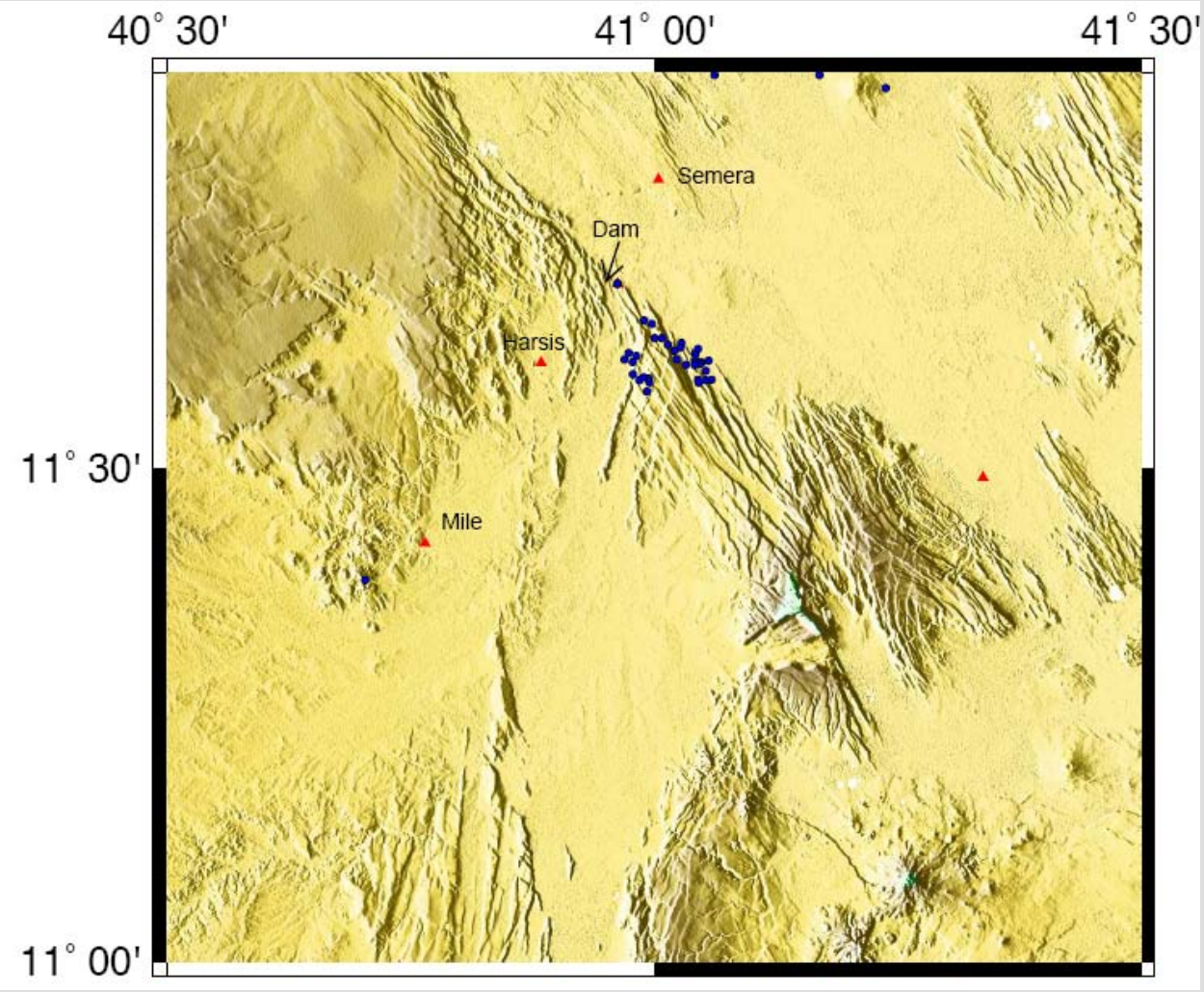
- The PGA value for the concrete construction of the spillway is 0.35g which is intact so far



Red dots are EQs located by AAU-NSF array in 2009 after dam filling. Most occurred as swarms in February-July, 2009.

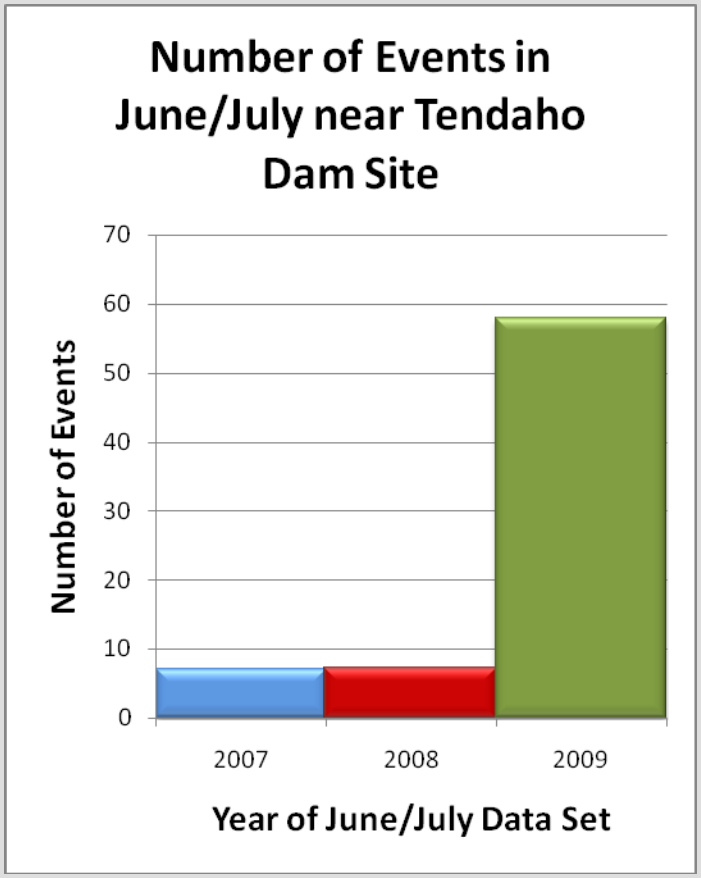
Line of EQs (location errors < 500 m) follow inferred subsurface water flow patterns. Eastern cluster of events coincides with a hot springs region (note persistent vegetation). Flow along NNE-trending faults

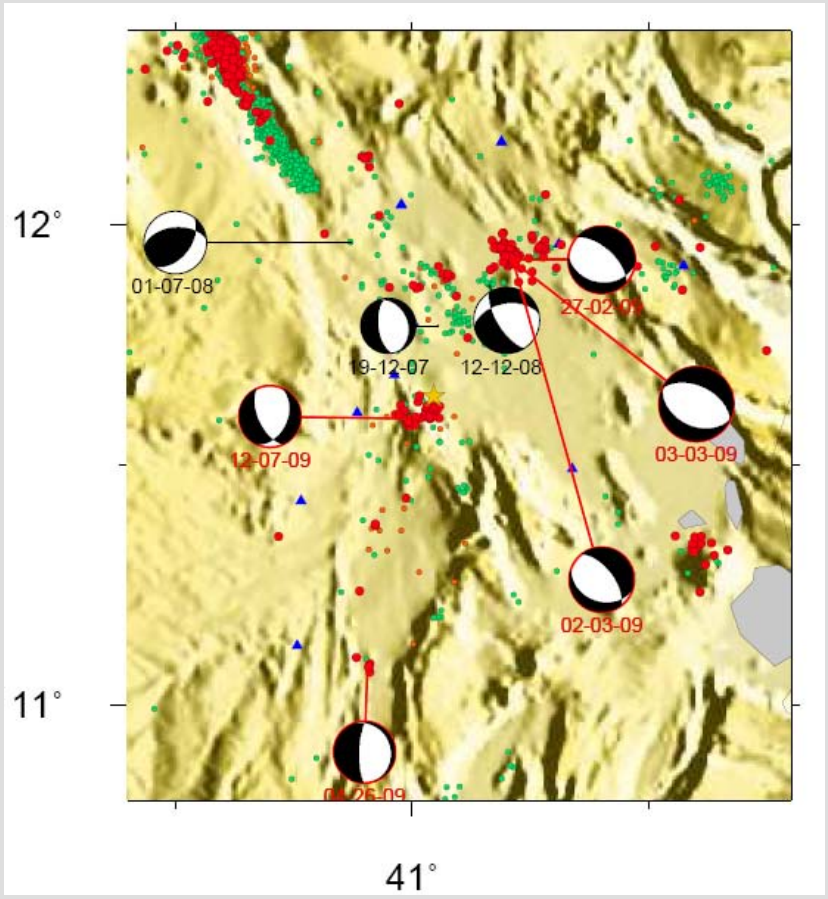
Seismicity of the Dam neighbourhood from 2007 to 2009



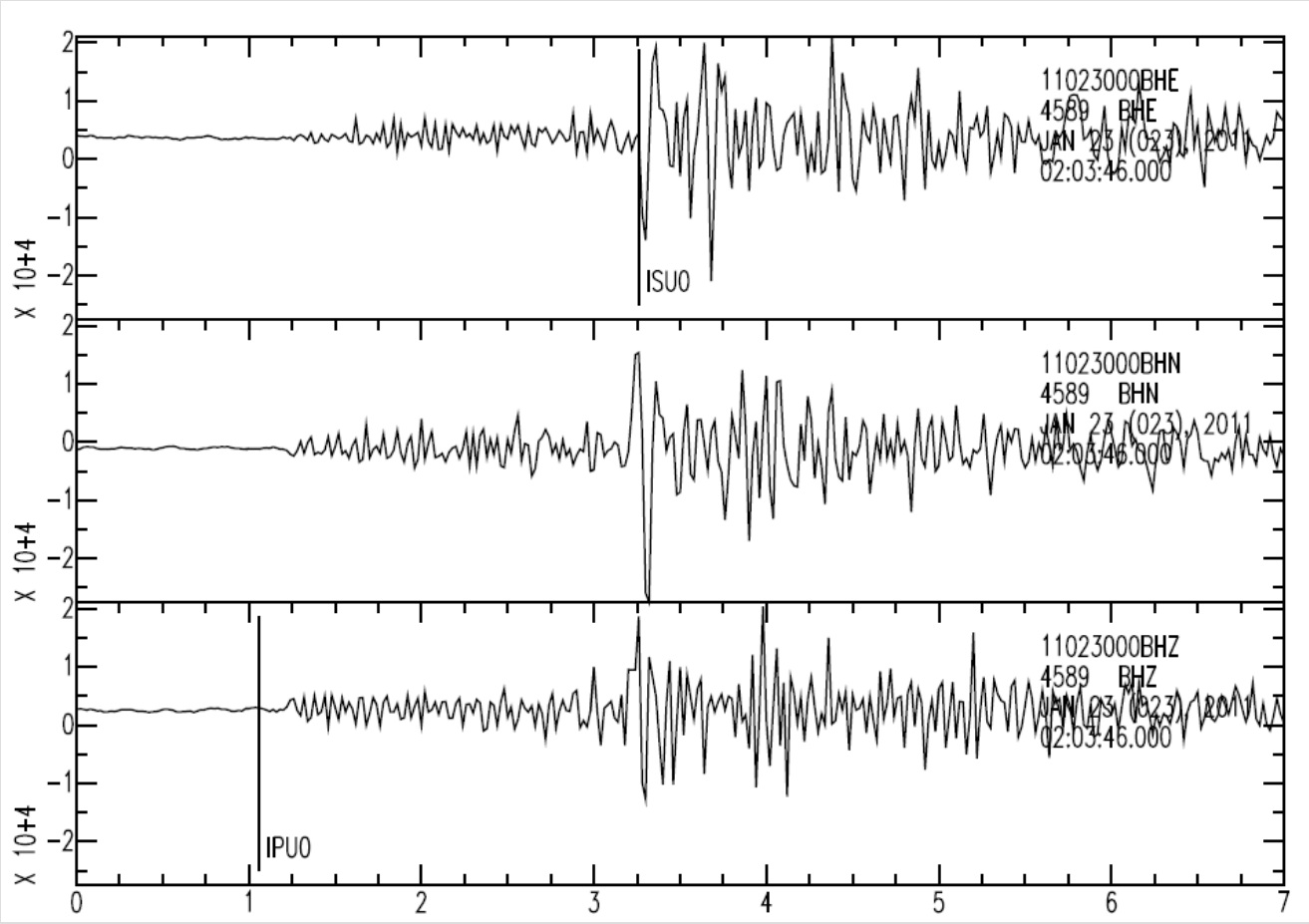
This information has been communicated to the concerned government bodies

Activity increased after impoundment





Seismicity is still active in the Dam neighborhood



A small earthquake that occurred close to the Dam on January 23, 20011

Ts-tp = 2.201 seconds

Leakage in 2010

Leakage occurred both on the right and left abutment

The right abutment was more serious

This is leakage through the right abutment after the raining season in 2010. The sever leakage wasn't through the Dam body but the country rock

Task force report coordinated by Water Works Design & Supervision

Leaking water from the right abutment has a temperature of 40ºC, and from the left abutment a temperature of 33ºC; while the reservoir water is 31ºC.

Leakage adjacent to the right abutment

In the US, 20% of Dam failures have been caused by piping (internal erosion caused by seepage)

Seepage often occurs around hydraulic structures, such as pipes and spillways; through animal burrows; around roots of woody vegetation; and through cracks in dams, dam appurtenances, and dam foundations.

Currently the leakage is reduced by grouting but is not a lasting solution

Zoomed view of the right side of the dam

Dam Hazard Potential Classification	Los of Human life	Economic, Environmental, lifeline losses
Low	Not expected	Low and generally limited to owner (dam)
Significant	Not expected	yes
High	Probable, one or more expected	Yes but not necessary for this classification
Tendaho??	At least 3X20,000 downstream residents are at risk	Towns like Logia, Asaita and Dubti are at risk

Problems & the way forward

- The level of awareness of the concerned organizations is very low
- If development agenda risks human life it is not a development strategy
- Plan irrigation scheme with low level of the Dam without risking downstream residents and infrastructure