Karst-Collapse Activity in Cam Lo District, Quang Tri Province, Vietnam

Tran Thanh Nhan, Dr.
Nguyen Van Canh, Prof.
Do Quang Thien, Dr.
Tran Huu Tuyen, Dr.

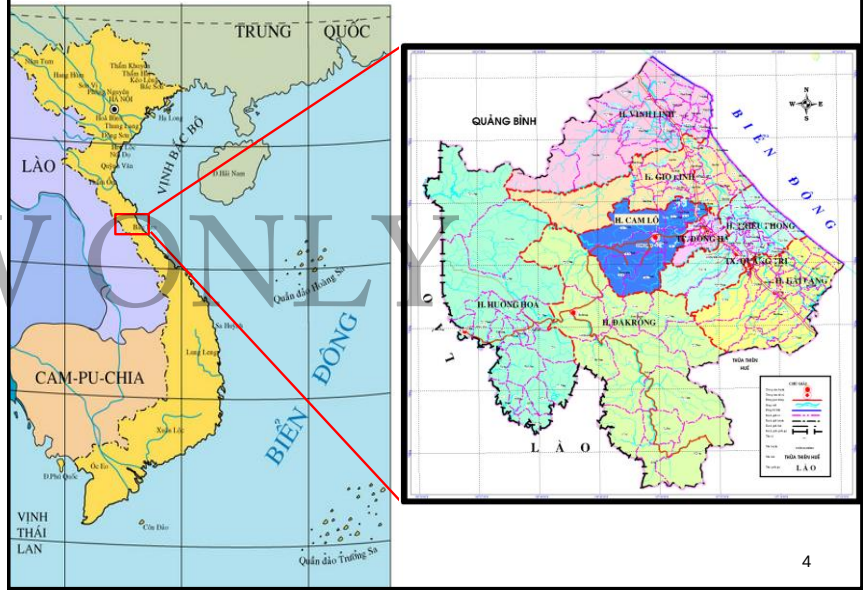
Department of Engineering Geology and Hydrogeology
Hue University, Vietnam.

Outline of Presentation

- Overview and Background
- Conditions for Karst-Collapse Activity in Cam Lo
- Potential Karst-Collapse Zoning
- Results
- Conclusions

OVERVIEW AND BACKGROUND

Cam Lo District, Quang Tri Province



Cam Lo Hospital, Thiet Trang area (1993 -1993):

- Occurred in 1993 – 1994
- Sinkholes with dimensions of 4-5m in diameter and from 0.5m to 2-3m in depth under Cam Lo Hospital Center foundation and in agricultural land.
- Damage Cam Lo Hospital Center ⇒ rebuilt a new one

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Hau Vien, Trung Vien and Thuong Vien (from 1990)

- Consecutively occurring with high intensity, especially in 1998.
- Total number of 112 sinkholes with various dimensions: from 0.1 to 8.0m in diameter and from 0.5m to 7m in depth.
- Damage local houses.

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Tan Hiep area

- Occurred from February 18 to October 3, 2006 with total number of 52 sinkholes.

- Sinkholes distribute in EN-WS direction being coincident with tectonic fault F2.

- Sinkholes with dimensions of 0.2-5m in diameter and 4-5m in depth. The largest sinkhole has diameter of 25m.

- Damage and directly affect 122 out of 178 local houses and road.

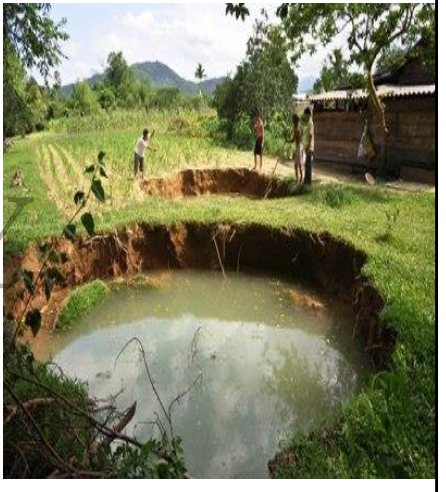
Tan My area

- Ocurred in 1999 and 2005 with total 7 sites.

- Related to the historical floods in 1999 and 2005.

- Sinkholes with diameter of 1.5-4m and depth from 0.5 to 3m distributing along the bedrock of Co Bai formation.

- Mainly occurred on argricultural land area.



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Tan Lap area

- Ocurred in 1999 and 2006 related to heavy rain during historical floods in 1999 and 2006.

- Sinkholes with diameter of 1.5-4m and depth from 0.5 to >5m distributing along the bedrock of Co Bai formation.

- Mainly occurred on argricultural land area.

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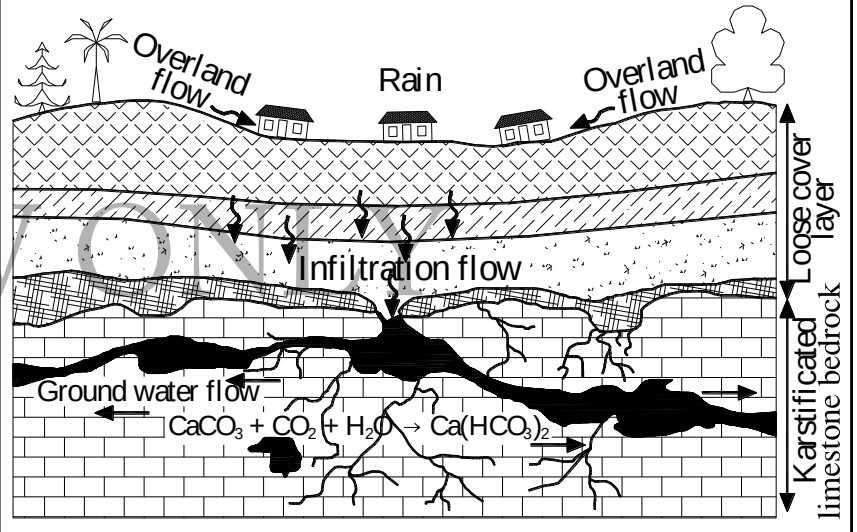
CONDITIONS FOR KARST-COLLAPSE ACTIVITY IN CAM LO

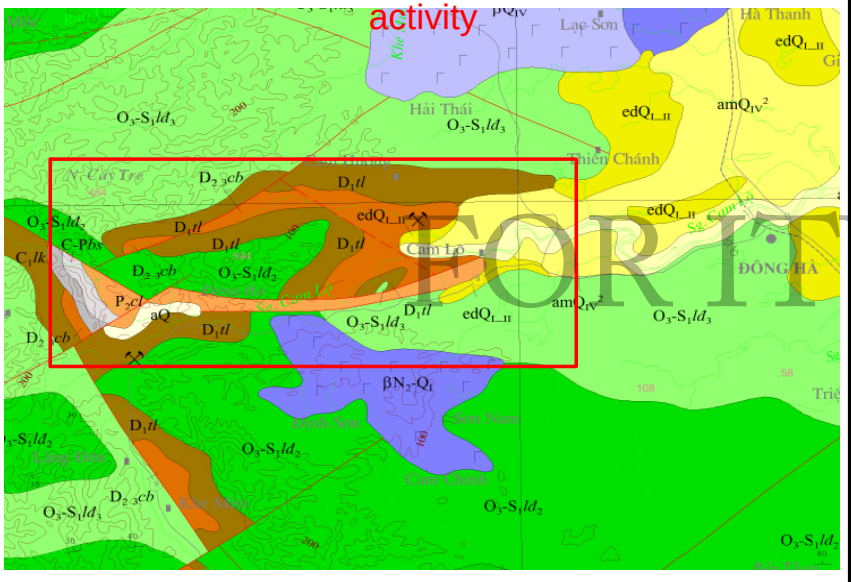
Conditions of Karst Activity

1. Bed rock and neo-tectonic activity;
2. Cover layers;
3. Topographical feature;
4. Regional meteorologic-hydrological condition;
5. Consecutive underground water flow;
6. Human factor.

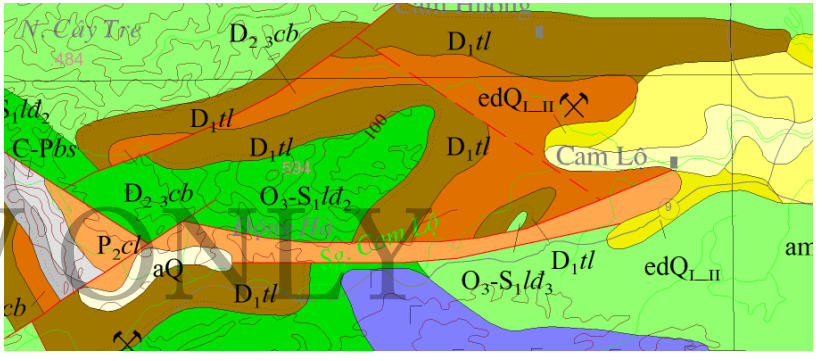
Mechanism of cover karst-collapse sinkholes



Bed rock (dissoluble), tectonic and neo-tectonic activity

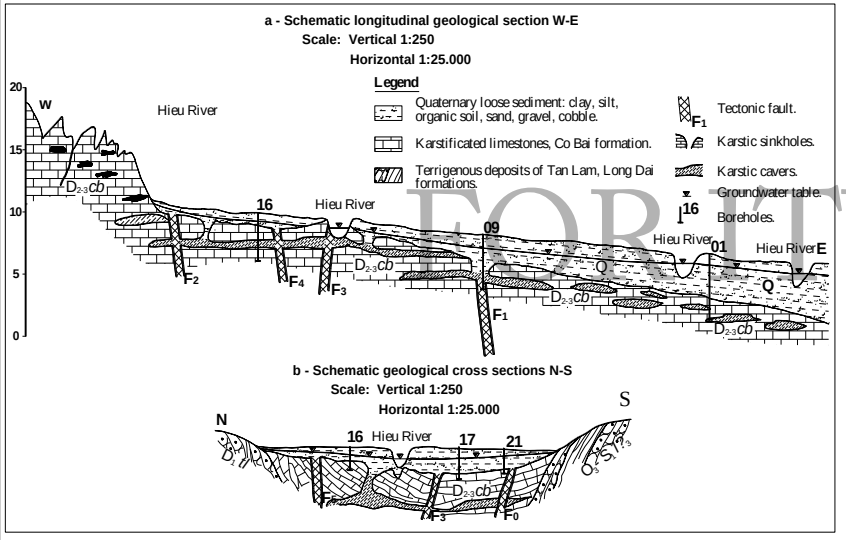


Stratigraphy



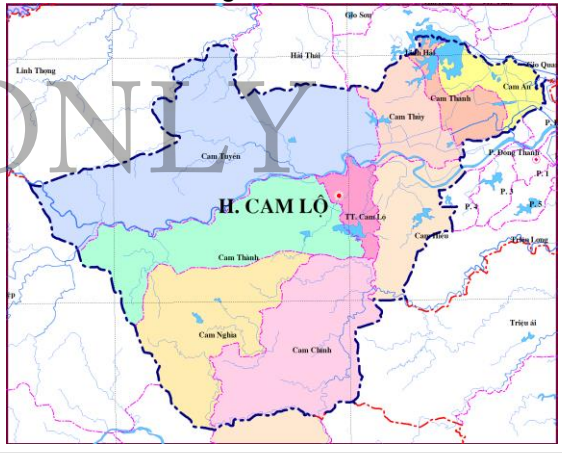
P_2	Cam Lo Formation (P_2cl): Silty sand stone, shale, lenses of **limestone**, marl Khe Giua Formation (P2kg): **Limestone**, clayish **limestone**, siliceous **limestone**.
C-Pbs	Bac Son Formation: While-grey, light-grey thick-bedded to massive **limestone**.
C_1lk	La Khe Formation: Dark-grey, weakly recrystallized **limestone**, marl, thin beds of siliceous **limestone**.
$D_{2-3}cb$	Co Bai Formation: Grey, black-grey **limestone**, calcareous shale, lenses of cherty **limestone**.

Cover layers and topographical feature



Regional meteorological - hydrological condition

- Long term of dry weather was immediately replaced by heavy rain, commonly in April, May, September and October.
- Strong relationship between Hieu river and underground water.
- Vertical variation of underground water level from 5 to 6m.



POTENTIAL KARST-COLLAPSE ZONING

The research area can be divided into five potential levels of cover karst-collapse as follows:

Zone I

- Occupies all Cam Lo plain area. Boundaries are determined by exposed bed rock of Tan Lam and Long Dai Formations and main tectonic faults,
- Fissured limestone are covers by thick loose soil layers,
- Limited cover karst-collapse sinkhole may occur,
- Almost safe. This zone was then divided into higher potential zones.

Zone II

- Occupies about 15km^2 of zone I,
- Fissured limestone covered by thinner soil layers and exposes in several areas,
- Cover karst-collapse sinkhole has occurred in some places,

Zone III

- From zone II, there are three places can be divided into zone III,
- Coincident with main tectonic faults and crushed bed rocks,
- Fissured limestone covered by thin soil layers and exposes in many areas,
- Cover karst-collapse sinkhole with different dimensions,

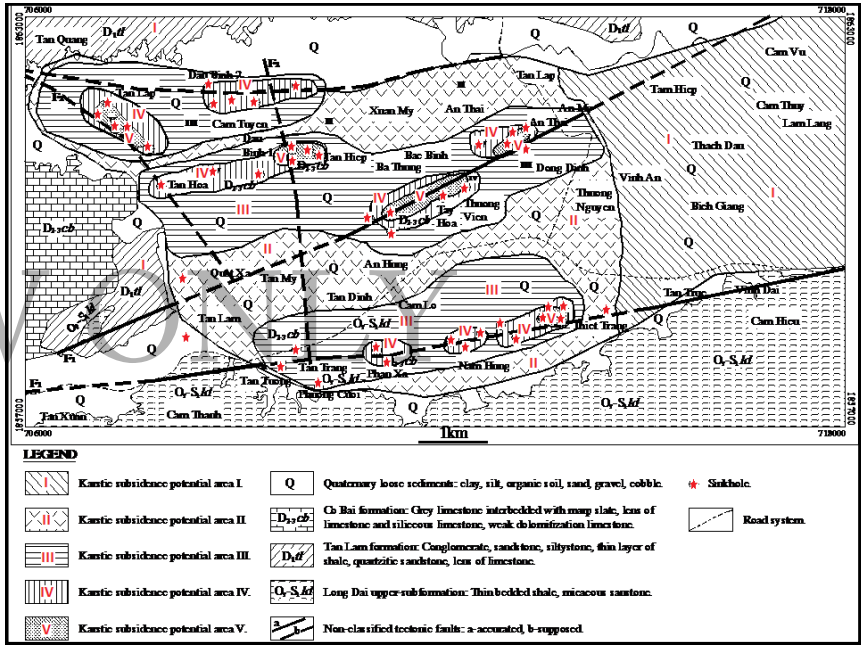
Zone IV

- High fissured limestone mainly exposes.
- Cover karst-collapse sinkhole widely occurred,
- Many large karst caves develop in bed rocks,
- Underground water easily moves within caves and strongly related to surface flows.
- Geological environment is not stable.

Zone V

- Cover karst-collapsed sinkhole extremely occurred damaging constructions and used land.
- Strongly crushed limestone with large caves directly exposes to the surface.
- Cover layers constituted mainly by coarse materials and so water easily move down (vertical).
- Human's activity such as construction, underground water exploit.

RESULTS



CONCLUSIONS

(1) Geological environment change in Cam Lo is mainly caused by vertical karst-collapse.

(2) Karst-collapse is affected by many natural and man-made factors including bed rock and tectonic feature, cover layers of loose soil, topography, meteorological-hydrological properties, underground water flow and human's activity.

(3) The potential karst-collapse in Cam Lo can be divided into five levels.

THANK YOU FOR YOUR ATTENTION!

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