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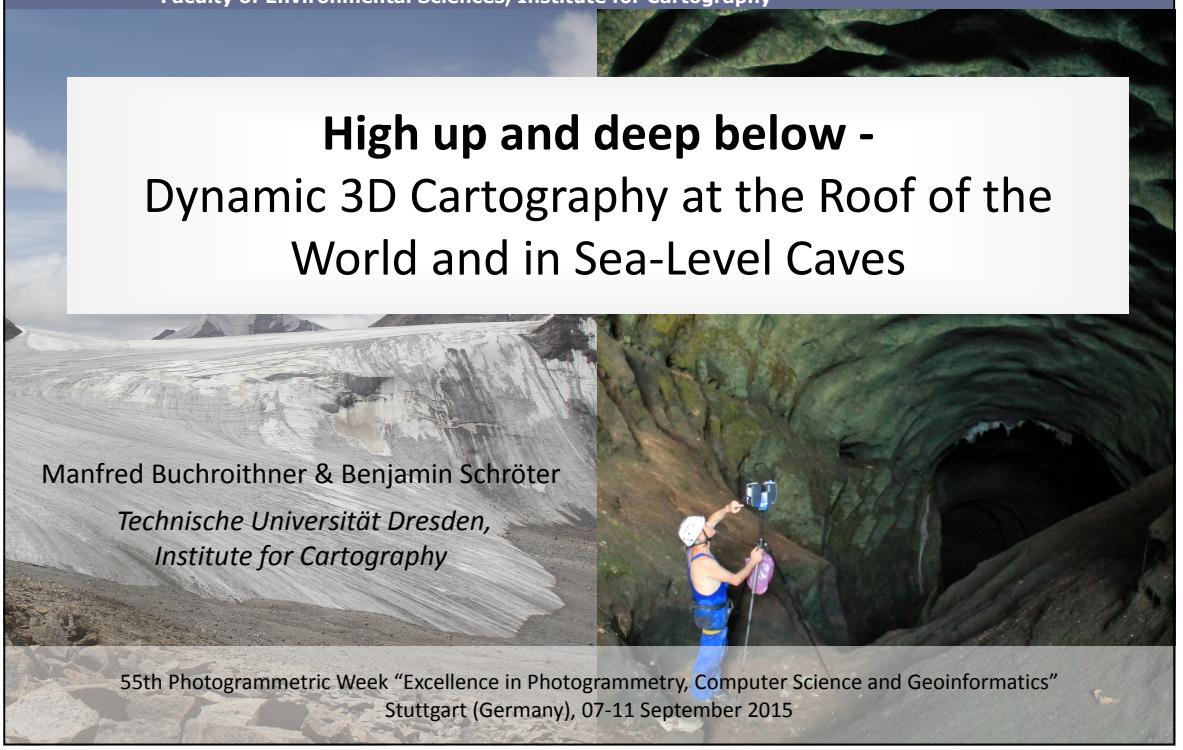
High up and deep below - Dynamic 3D Cartography at the Roof of the World and in Sea-Level Caves



Manfred Buchroithner & Benjamin Schröter

Technische Universität Dresden, Institute for Cartography

55th Photogrammetric Week "Excellence in Photogrammetry, Computer Science and Geoinformatics"
Stuttgart (Germany), 07-11 September 2015

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Outline

1. Time-lapse photography Zhadang Glacier/China
2. GLOF monitoring Halji Glacier/Nepal
3. Terrestrial laser scanning Gomantong Caves/Malaysia

NB: „Dynamic Cartography":
Either object (e.g. glaciers or snow) or viewer in motion (e.g. fly-through)

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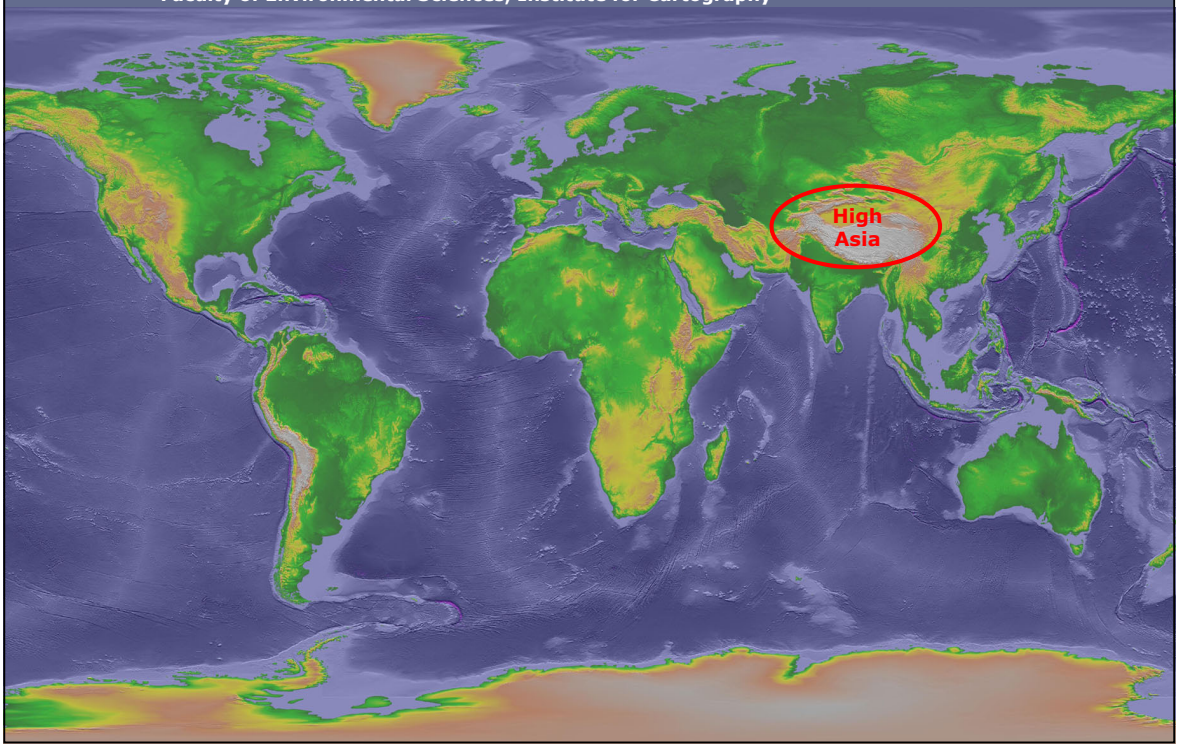

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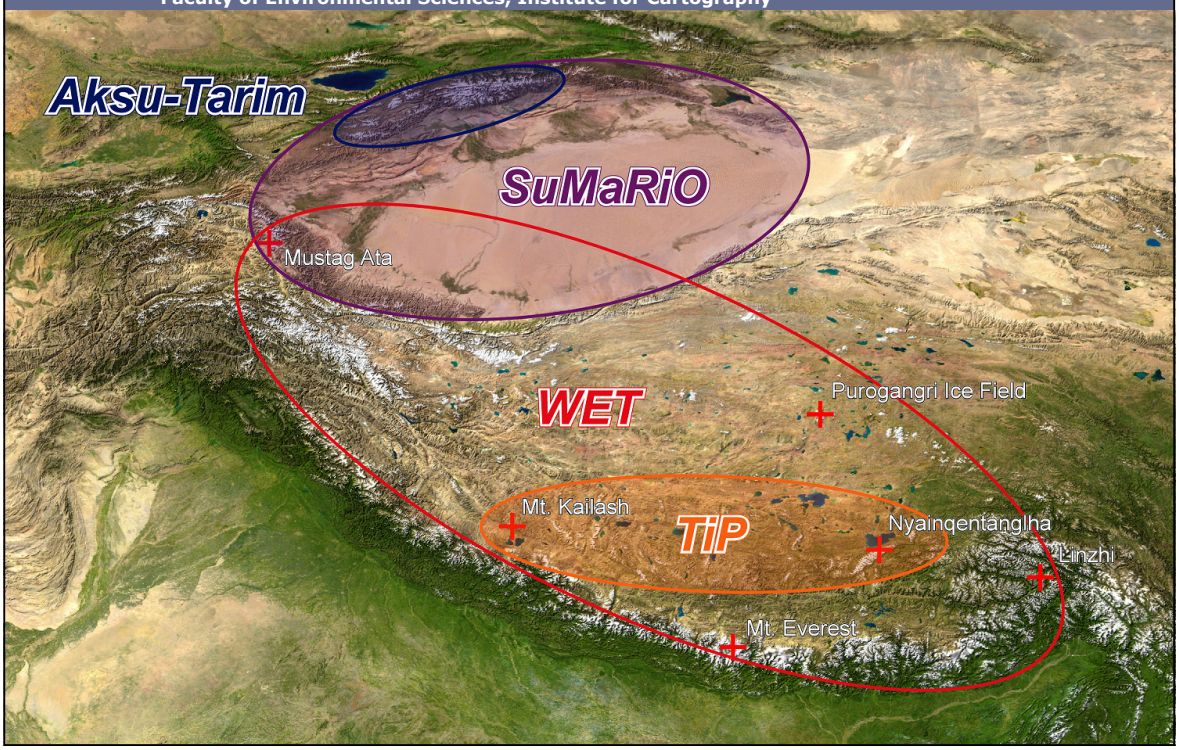

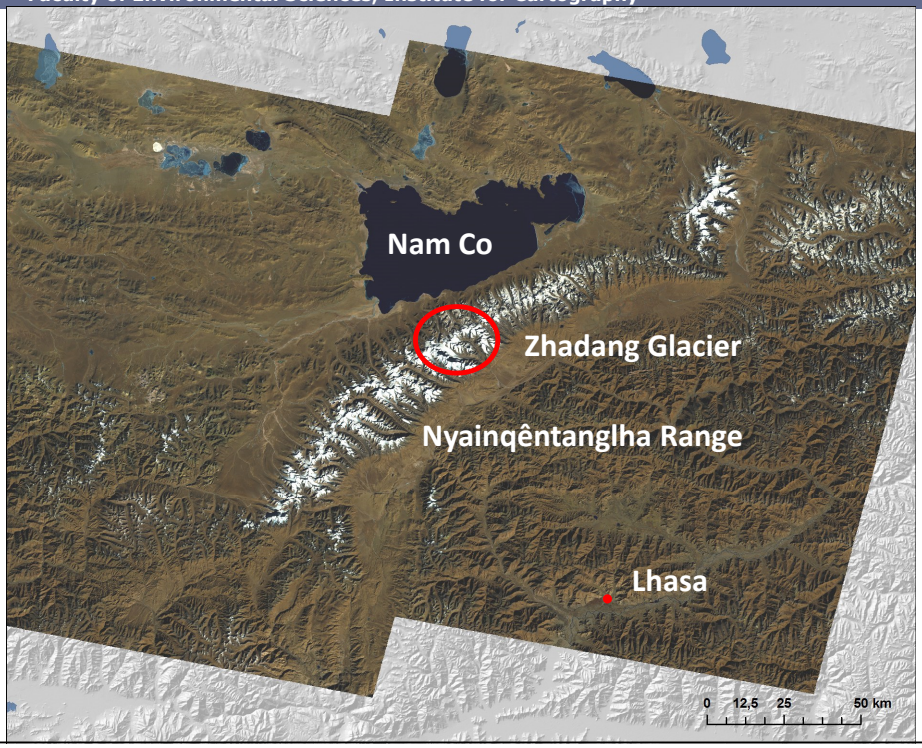

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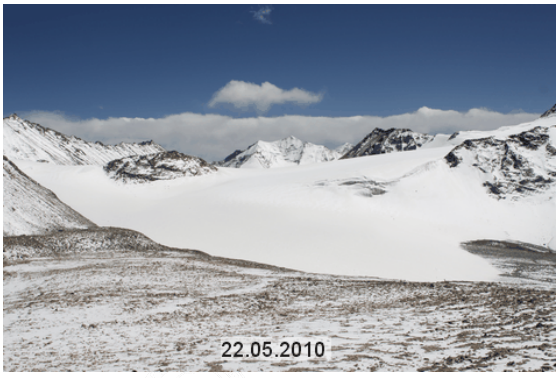
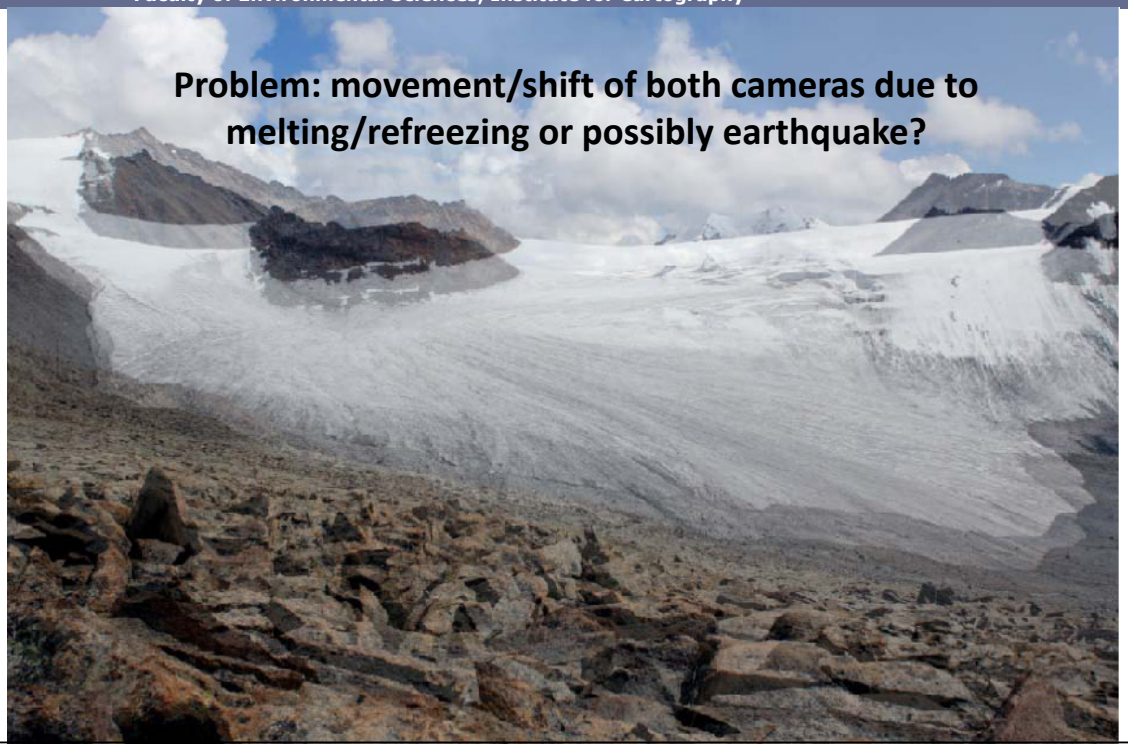
Terrestrial camera system, Zhadang Glacier 2010/2011



Picture series from 2010

Picture series from 2011

2 cameras, each 6 pictures/day = 6,225 images between May 2010 and September 2012 (no missing data!)



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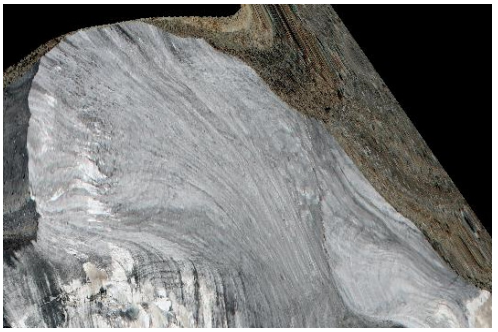

Example of workflow image to ortho-image with snowline mapping

Camera 1: view towards south

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Orthorectified area of Zhadang Glacier
(Image distortion due to very gentle rise of the upper part of the glacier)


Nadir view, northened


Snowline on nadir view

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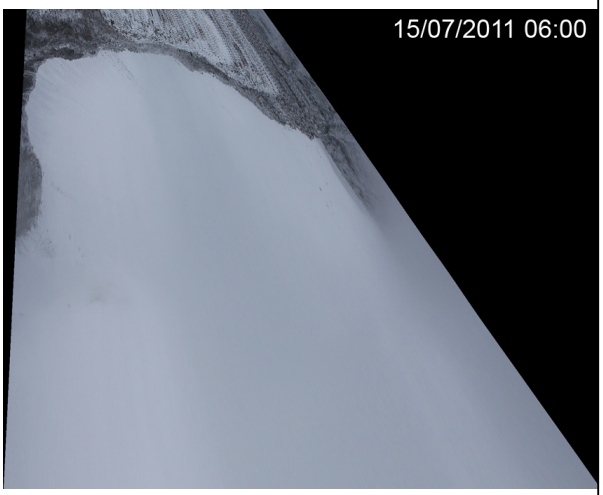

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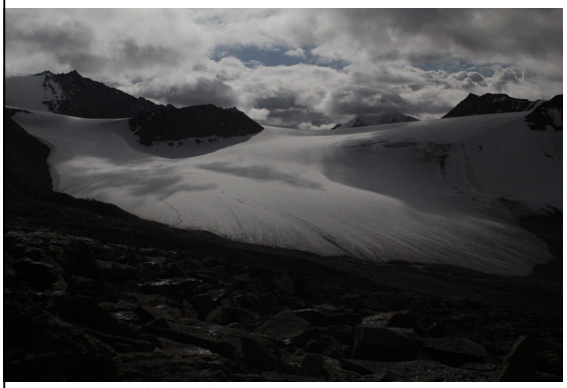

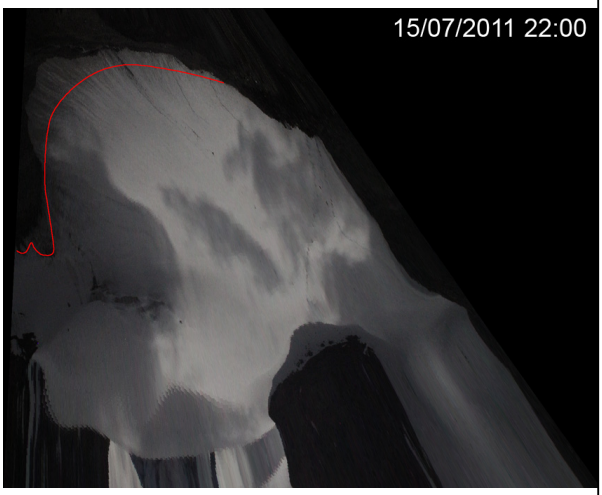

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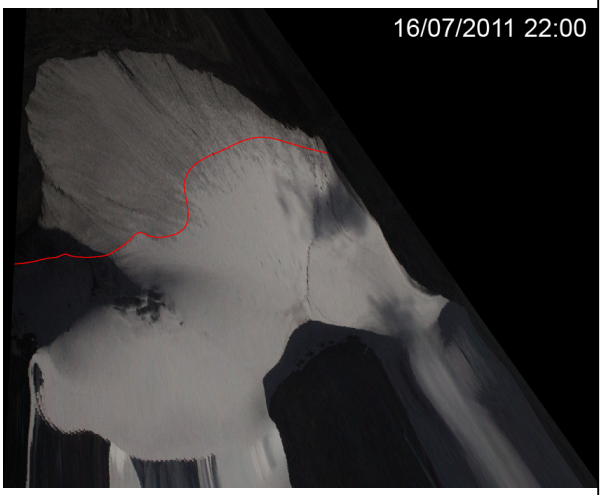

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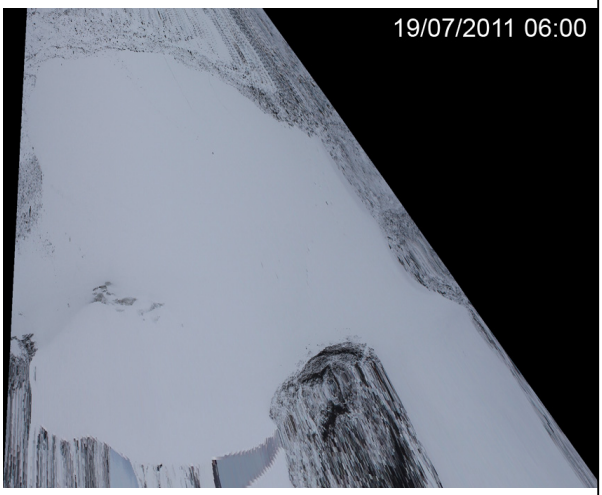

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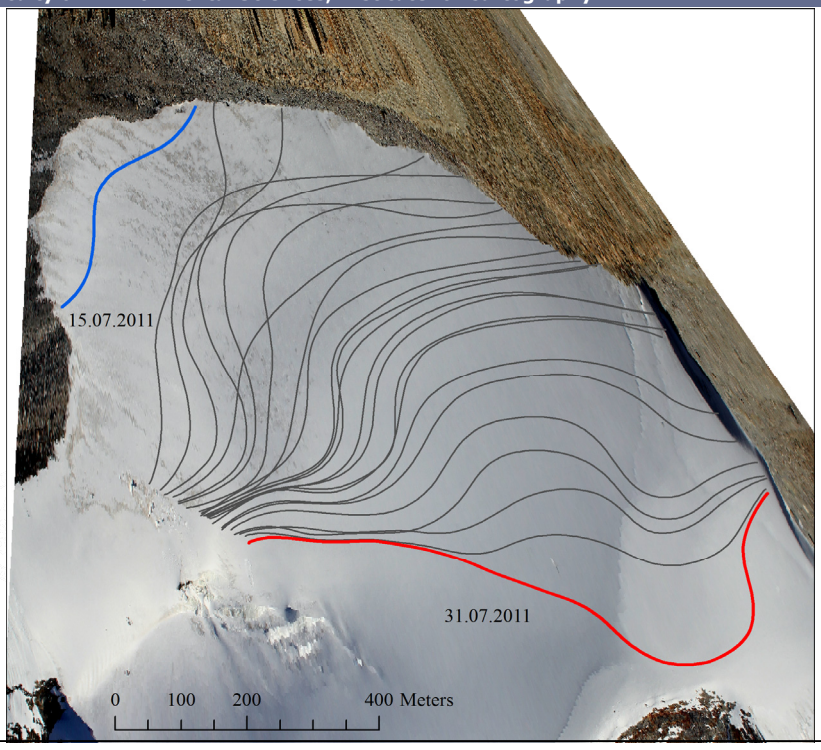

Major Finding

One remarkable result is the proof of the existence of *complete* ablation due to *heavy snow drift* and *sublimation* on high-altitude glaciers during the winter months (DJFM).

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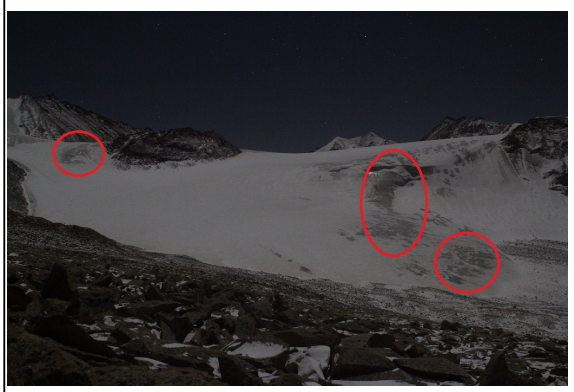
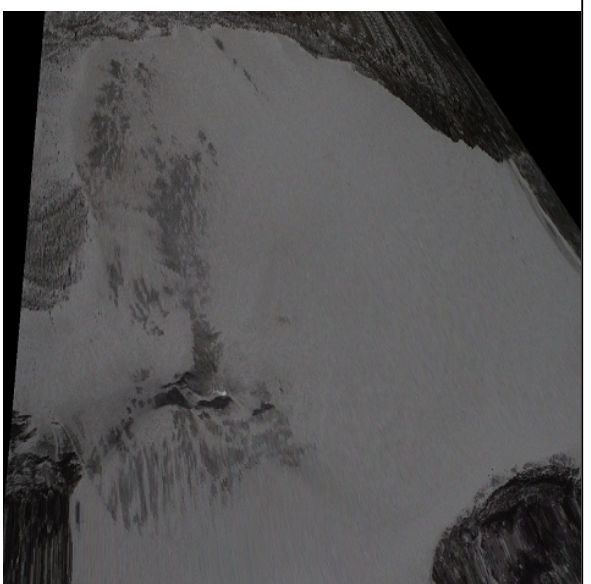
Image from **February** 6 2012 at 22:00





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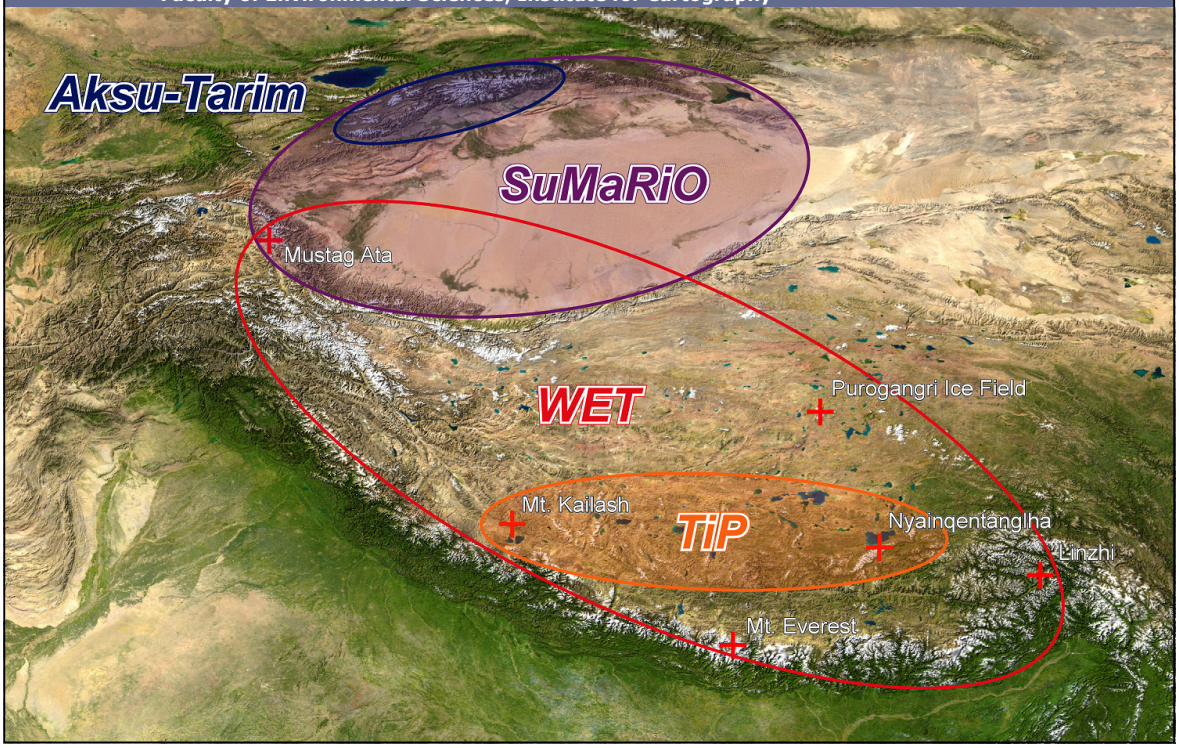

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Photo: B. Schröter (2013)

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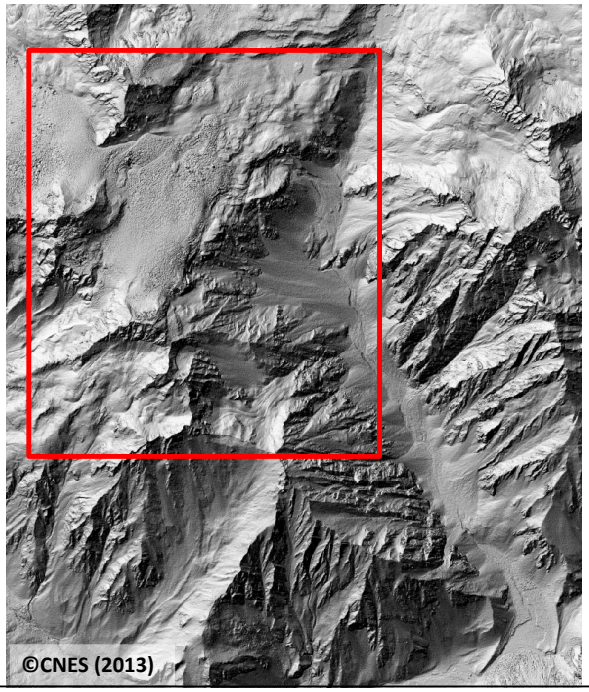
Photo: A. Hovden (2008)

Pléiades DEM (2013), 1 m resolution



Halji-Glacier

Pléiades DEM (2013)
versus SRTM-3 (2000)

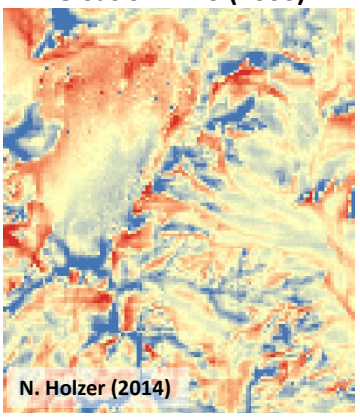


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Photo: B. Schröter (2013)

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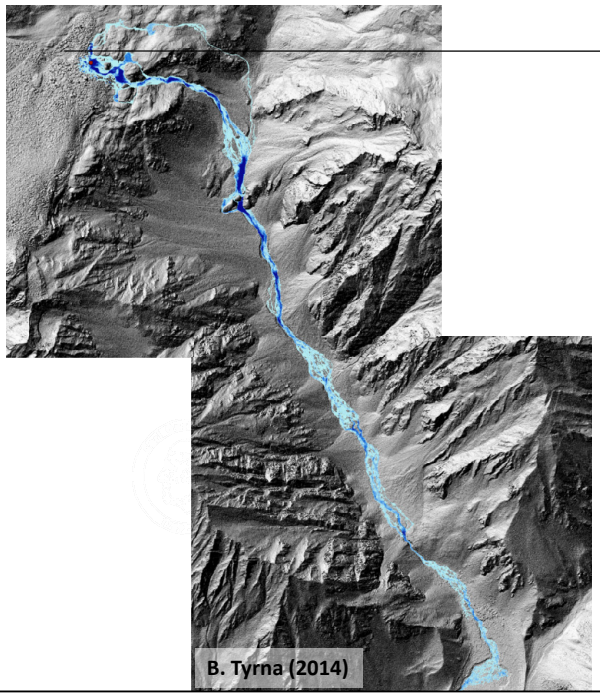
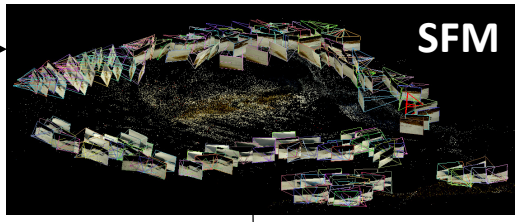
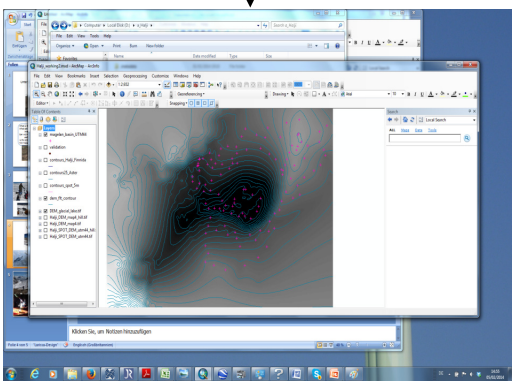
First GLOF modeling results



B. Tyrna (2014)

Morphometry of the lake basin





DEM based on fusion of SFM and DGPS measurements

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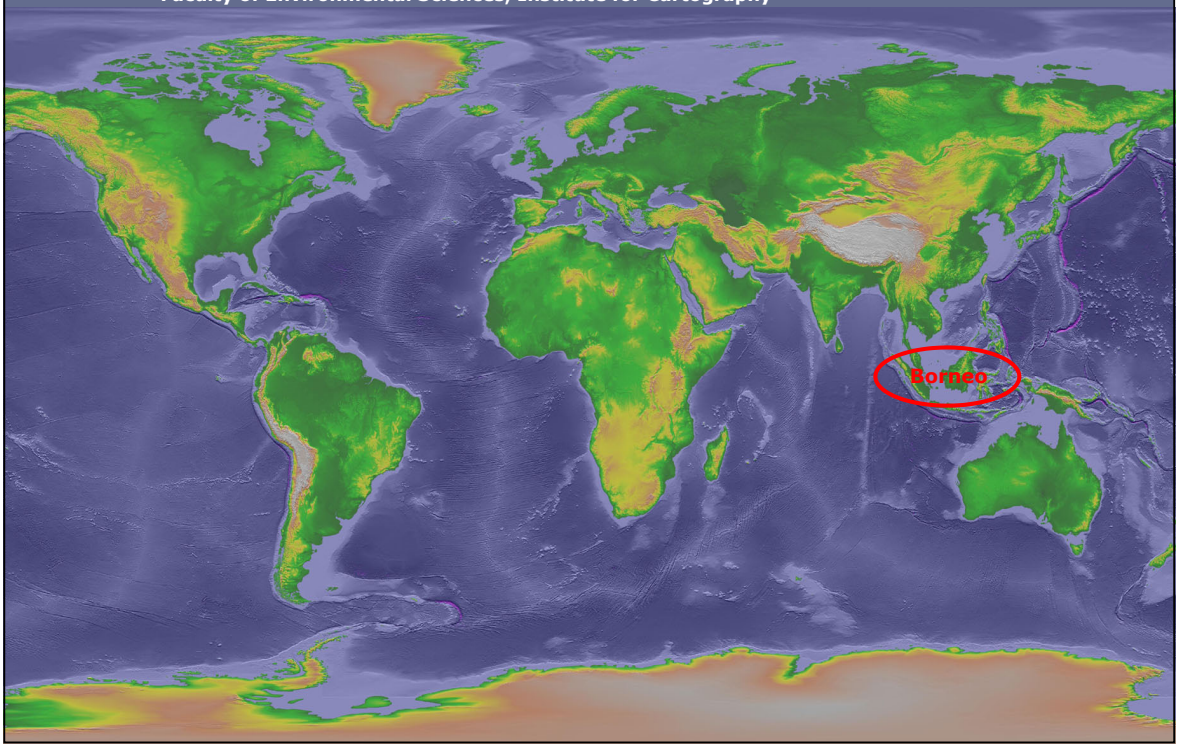
Terrestrial Camera

Automatic Weather Station

Photos: B. Schröter (2013)



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Gomantong Caves

Karst cave system on Borneo Island

Tourist attraction

Economic importance: swiftlet nest harvesting + export to China

Two National Geographic Expeditions:

1. Cave scanning with TLS
2. Aerial stereo-imaging using an UAV

Photo: K. Christenson (2014)

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Photo: K. Christenson (2012)

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Photo: B. Schröter (2014)

Photo: K. Christenson (2012)

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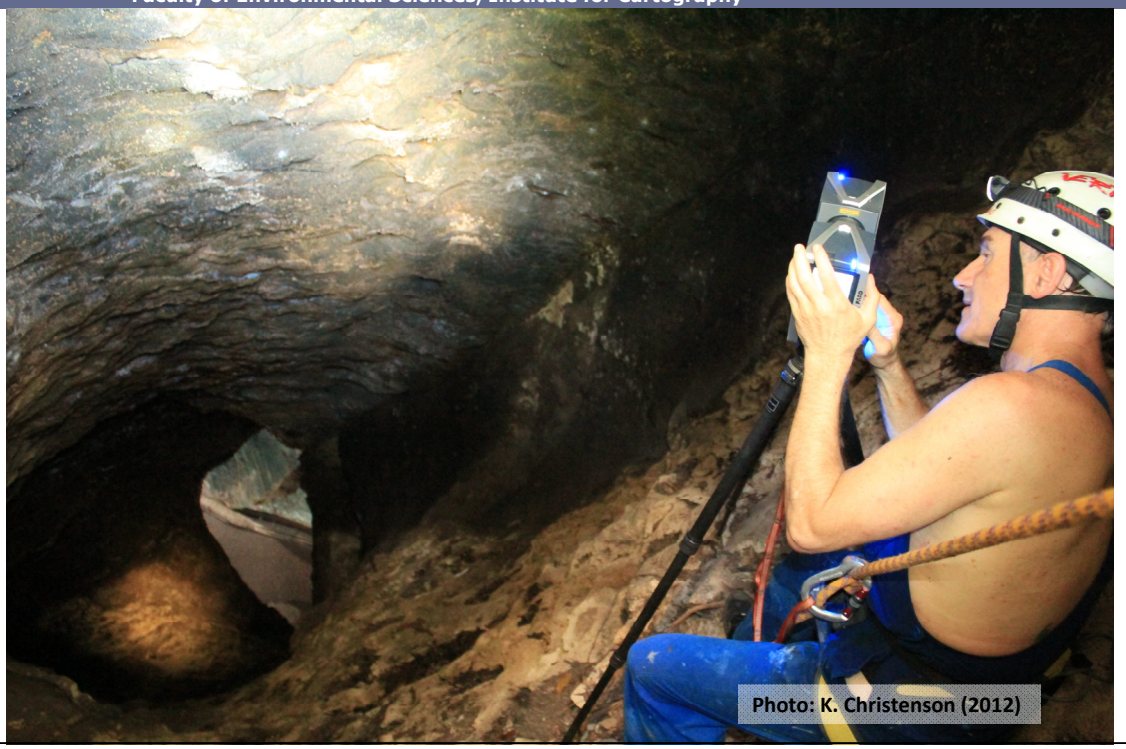
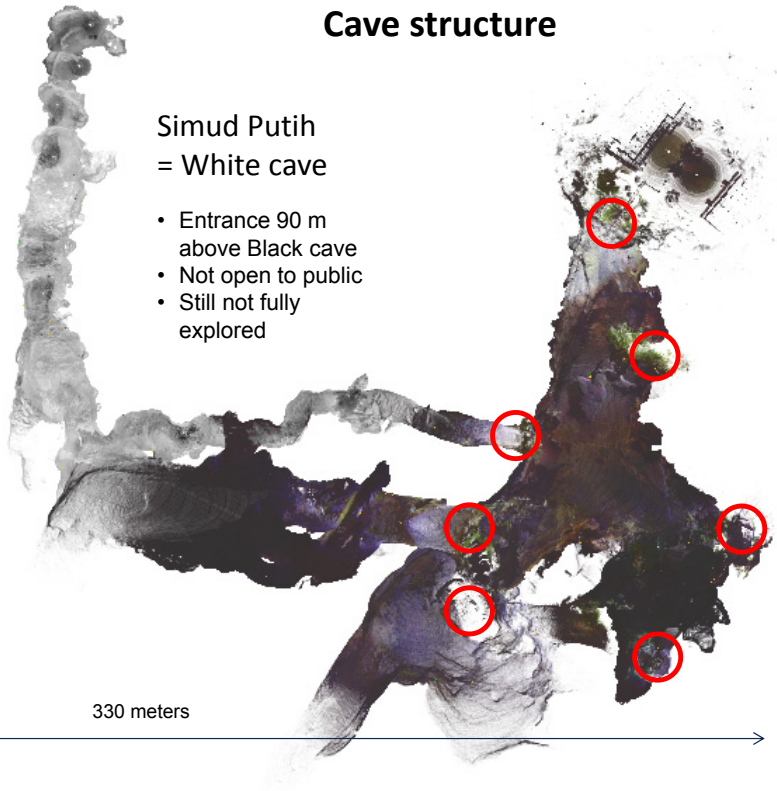


Photo: K. Christenson (2012)

Photo: K. Christenson (2014)

Photo: K. Christenson (2014)

Cave structure



Simud Putih
= White cave

- Entrance 90 m above Black cave
- Not open to public
- Still not fully explored

Simud Hitam
= Black cave

- Main entrance
- Ceiling up to 90 m high
- Open to public
- Walkway

entrance

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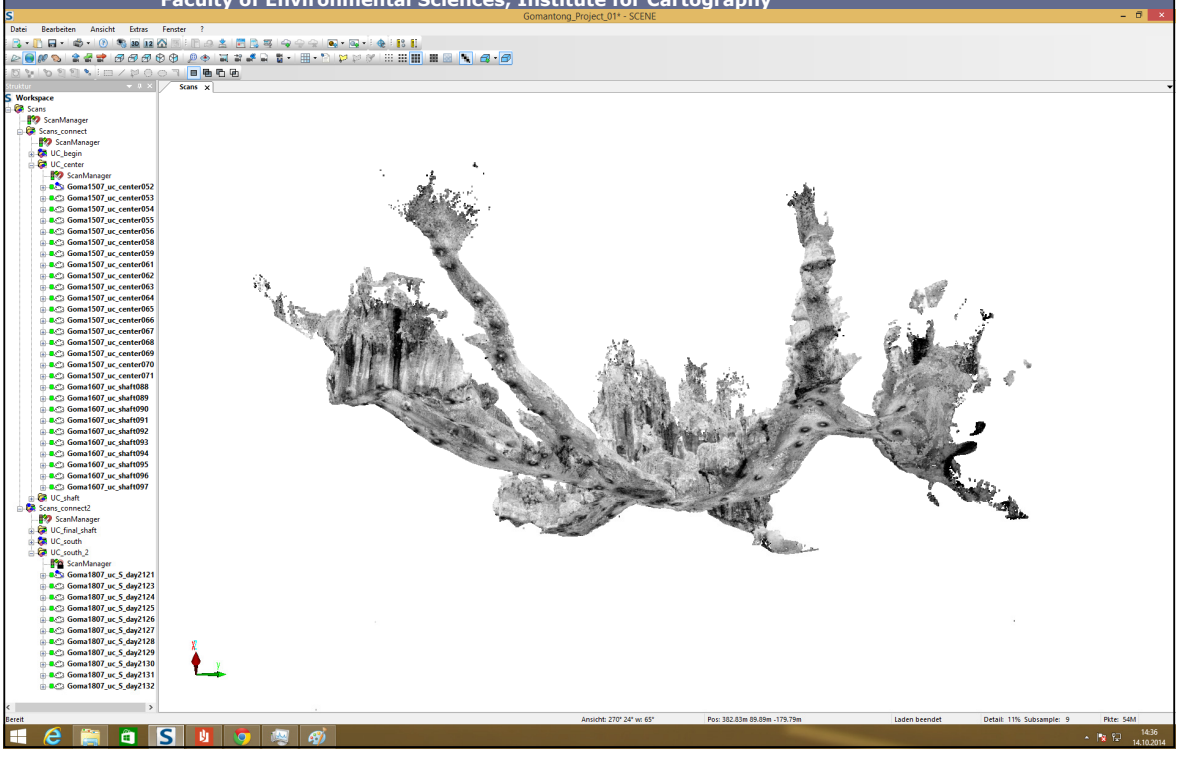
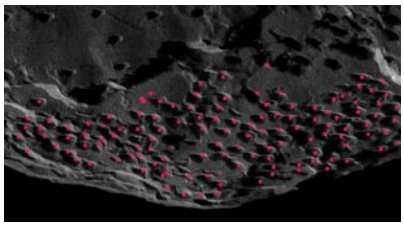


Application of 3D Model

1. Scientific analyses (speleological, geological, hydrological & volume estimation…)
2. Automated nest/bat count algorithm



3. Visualisation: Video - TLS & UAV data combined

   (8550 frames, 5:42 min)

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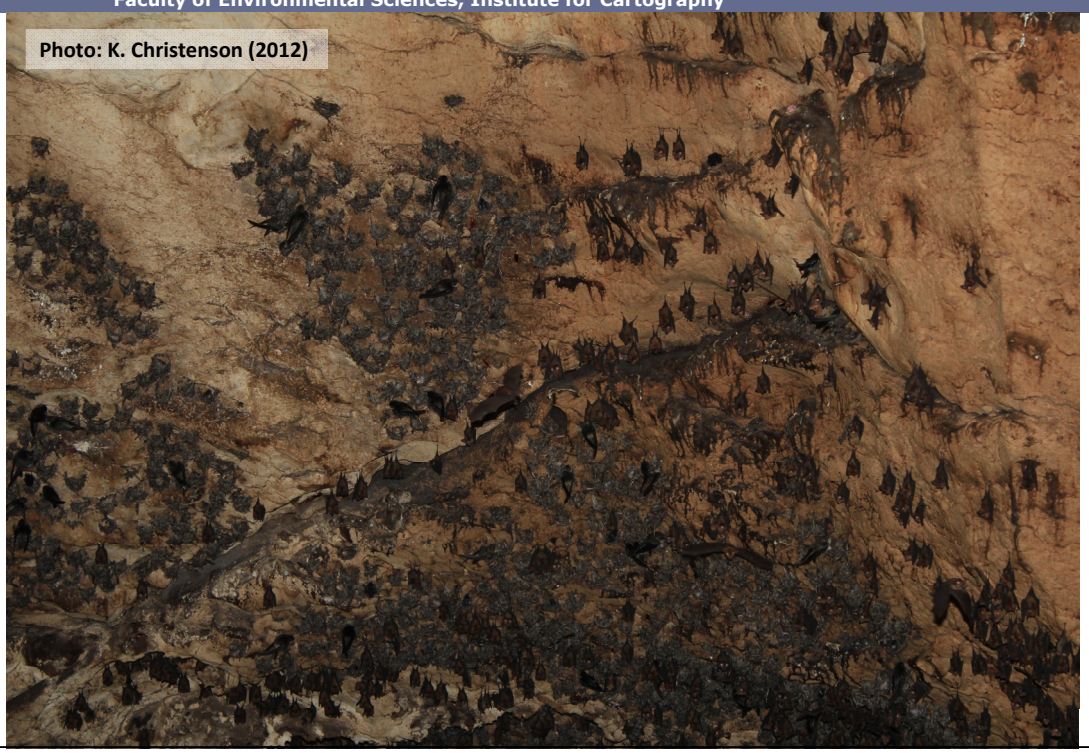

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SIMUD HITAM and SIMUD PUTEH
Black Cave and White Cave
Gomantong Hill
Lower Kinabatangan area, Sandakan division
in the Malaysian state of Sabah, BORNEO

BCRA survey grade: XD

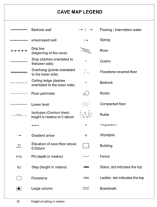
Instrument: Faro Laser scanner Focus 3D S 120

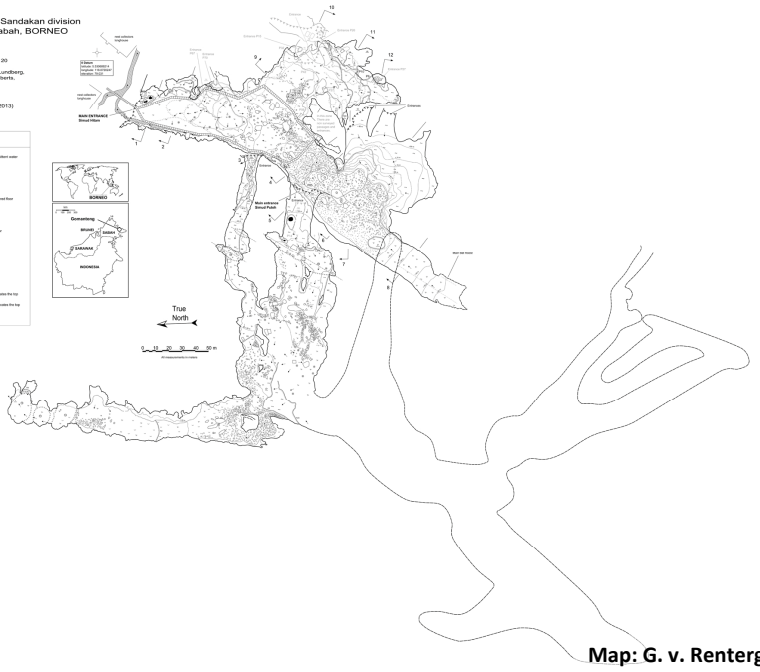
Survey Group: Manfred Buchroithner, Joyce Lundberg, Don Mc Farlane, Christin Petters, Warren Roberts, Stephan Schoen, Guy Van Rentergem

Date: 10 - 16 july 2012

Map Layout & Design: Guy Van Rentergem (2013)

PLAN VIEW of floor level
The upper levels of Simud Hitam are grayed out





Map: G. v. Rentergem (2013)

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SIMUD HITAM or **BLACK CAVE**
Gomantong Hill
Lower Kinabatangan area, Sandakan division
in the Malaysian state of Sabah, BORNEO

BCRA survey grade: XD

Instrument: Faro Laser scanner Focus 3D S 120

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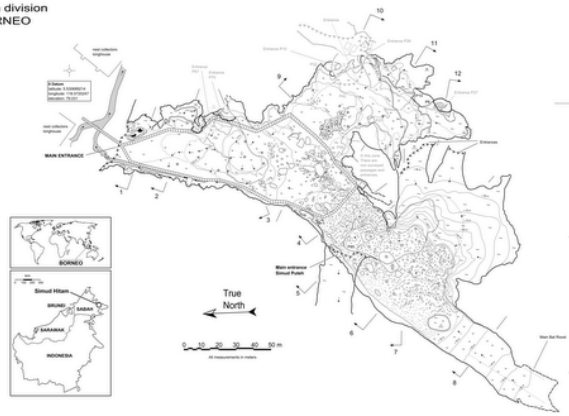
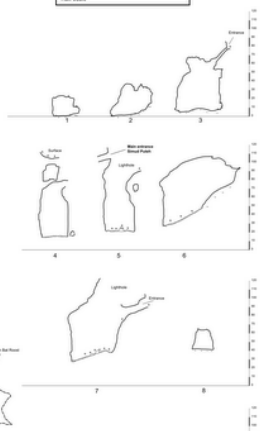
Date: 10 - 16 july 2012

Map Layout & Design: Guy Van Rentergem (2013)

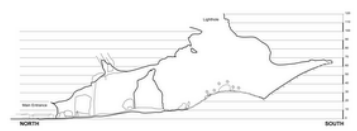
PLAN VIEW of floor level
The upper levels are grayed out

CROSS SECTIONS
Half scale

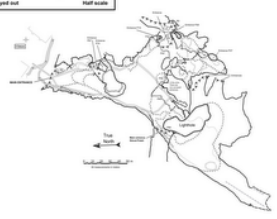


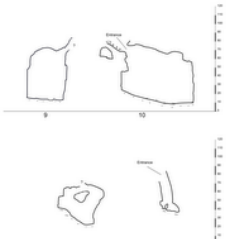


EXTENDED PROFILE
Half scale



PLAN VIEW of top levels
The floor level is grayed out
Half scale





Map: G. v. Rentergem (2013)

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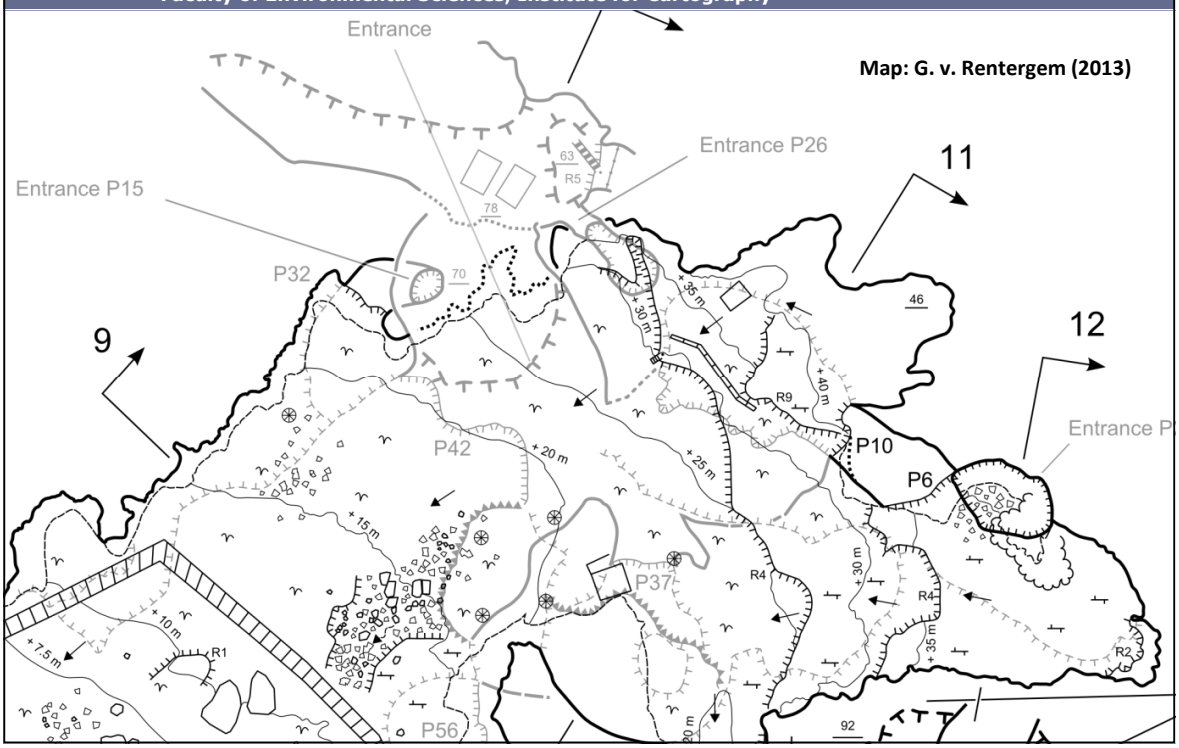

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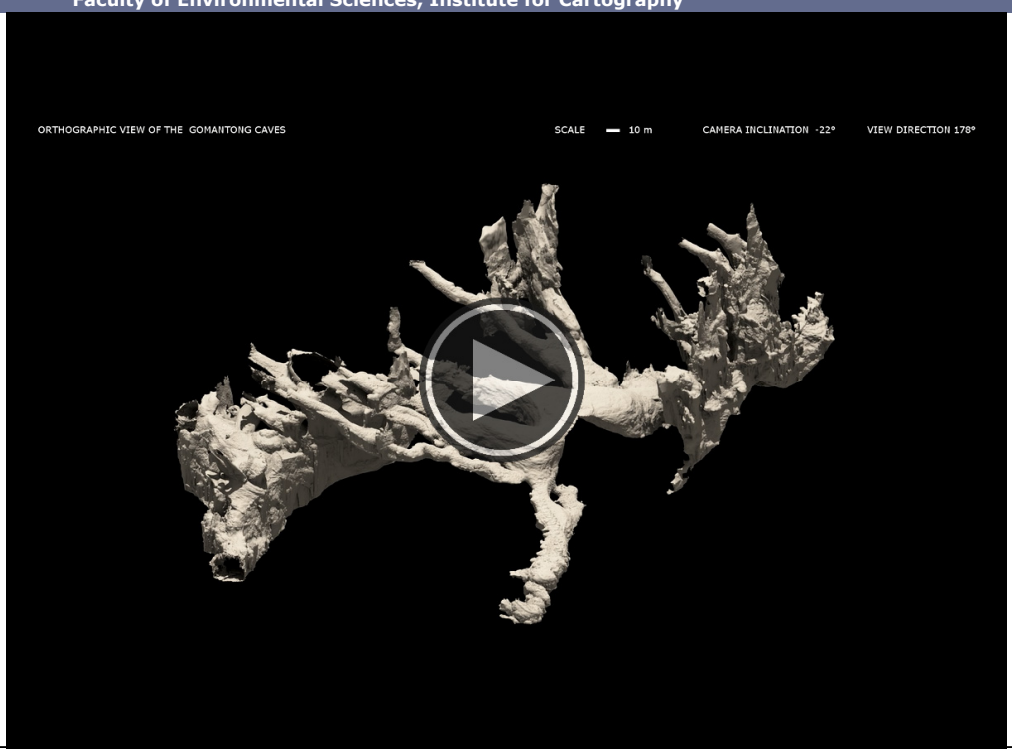

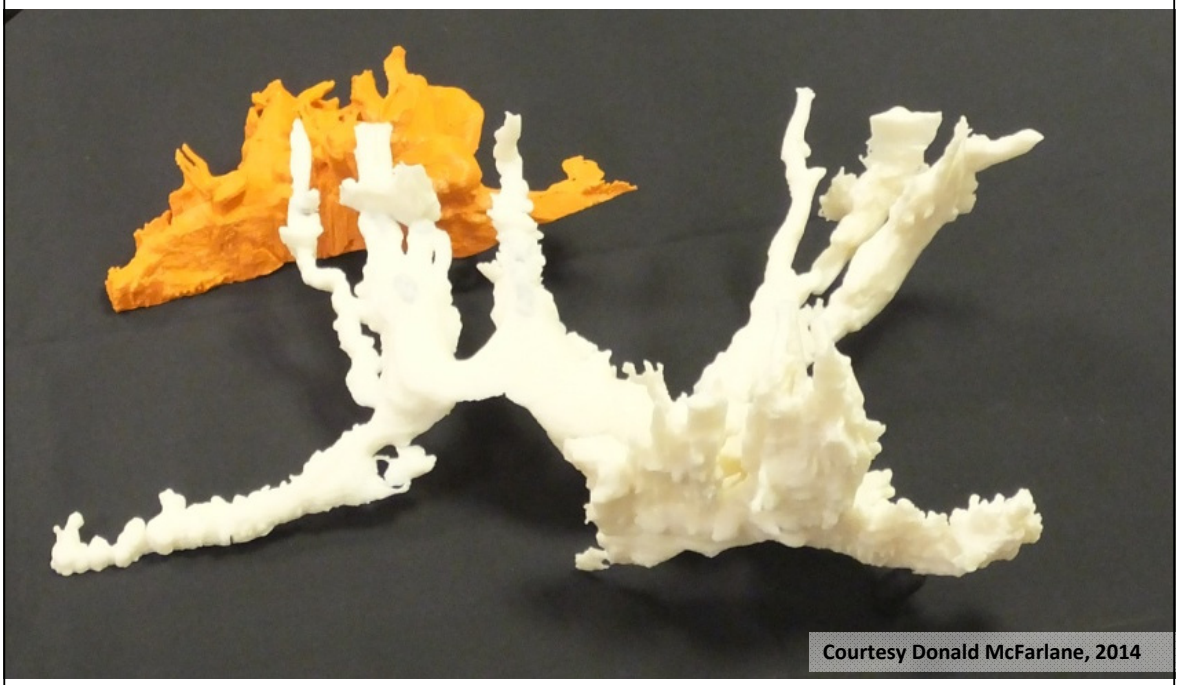

Courtesy Donald McFarlane, 2014

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Conclusions

Photorealistic *mental* 3D map of complex cave systems can only be conveyed by

1. **physical models (3D printings) – however, cave-wall impression missing - and/or by**

2. **dynamic outside views of the cave systems combined with simulated walk-throughs or fly-throughs displaying the cave-wall texture.**

„Classical“ cave cartography is – unfortunately – in these cases by far not sufficient.

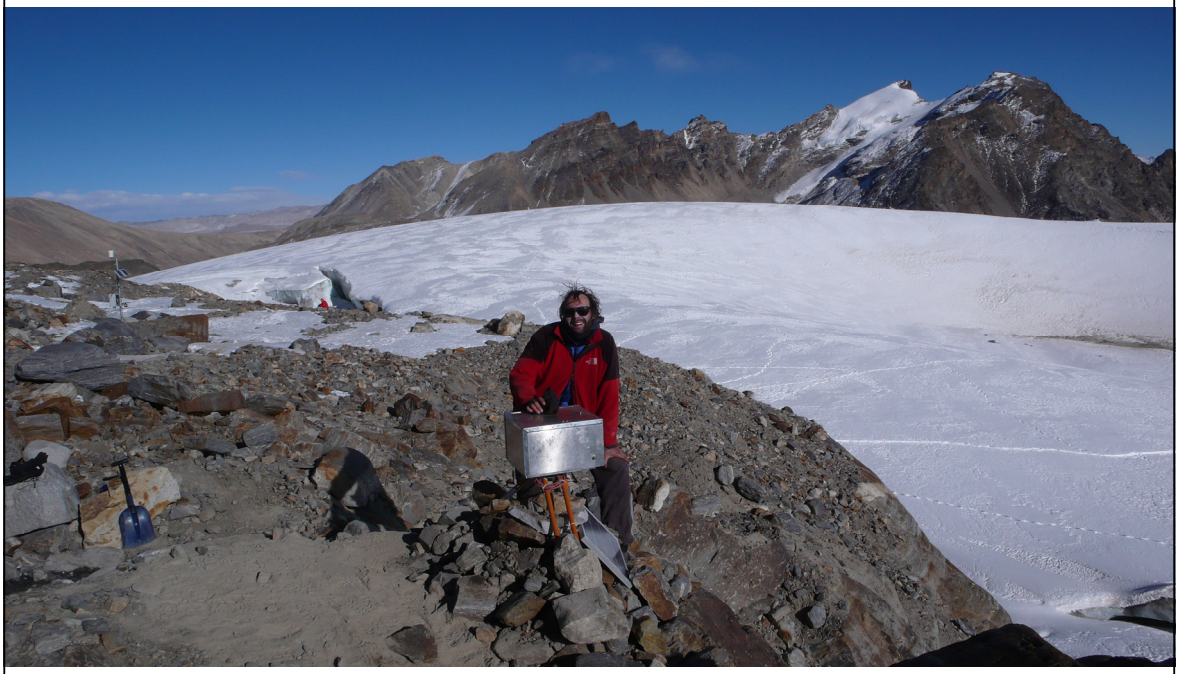

Photo: B. Schröter (2013)

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Photo: K. Christenson (2012)

Photo: B. Schröter (2014)