in collaboration with

4th WLF STUDY TOUR #3
ITALY

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Title: Outstanding and highly hazardous landslides in the Dolomites UNESCO World Heritage Site

Topic: Landslides affecting human activities: hazard and risk issues also in relation to climate change

Content: The superb landscape of the Dolomites is the result of their geology, which is different from the rest of the Alps and most of the mountains in the world. Here, pale dolomitic cliffs stand above gentle slopes mainly made up of dark pelitic and volcanoclastic terrains. The Assembly of UNESCO, held in Seville 22-30 June 2009, has proclaimed the Dolomites as a World Heritage Site. Among the scientific criteria required by UNESCO for the evaluation of the application - Aesthetics, Geology and Geomorphology - the latter was identified as a priority and crucial. In the nomination document landslides have also been taken into account due to their spectacularity and diversity that make the Dolomites an open-air lab for slope instability research and management.
The field-trip will be focused on geomorphology and engineering geology applied to slope instability. The main aim is to show significant cases of mass movements of various types, sizes and ages which have affected the dolomitic valleys since the retreat of the LGM glaciers, including the catastrophic Vajont landslide which occurred in 1963. Reference to the influence of climate changes on slope instability processes since the Lateglacial will also be made.

TENTATIVE PROGRAMME FOR STUDY TOUR IN ITALY – 4 DAYS

Saturday, 3 June 2017 (Ljubljana – Pordenone – Conegliano – Belluno – Longarone – Cortina d'Ampezzo – La Villa, Badia Valley)

Day programme:
Morning: Transfer from Ljubljana to the Dolomites.
Packed lunch in the field.
Afternoon: Visit to Vajont landslide.
Dinner and overnight stay in La Villa (Badia Valley).

The Vajont reservoir in Italy's eastern Alps is located along the lower reaches of the River Vajont, close to its confluence with the River Piave. Some 100 km NNW of Venice, the reservoir was created artificially in 1960

after T. Vajont was dammed as part of regional expansion in hydroelectric-power generation. The dam is 261.60 m high and 190 m across the top, and at the time of construction was the highest and one of the most advanced double-arched dams in the world. After the reservoir level had been raised and lowered several times, the southern margin of Mt. Toc eventually became destabilised and, after nearly three years of intermittent creeping, it catastrophically collapsed on 9th October 1963. Within 30-40 seconds, some 270 million m^3 of rock crashed into the reservoir, expelling a wave of water about 100-150 m high over the dam. This slide displaced a 250-300 m thick rock mass. It reached a velocity of about 20 m/s before running up and stopping on the opposite slope of the Vajont Valley. The landslide accumulation filled the valley and the reservoir in a few tens of seconds causing a wave of water propagating both upstream and downstream. This wave reached a maximum elevation of 935 m (235 m above the reservoir level). It swept across the dam and the Vajont gorge and eventually fell onto the Piave Valley floor, where it destroyed the town of Longarone and neighbouring villages, claiming almost 2000 lives.
The participants will have an overview of the Vajont landslide and its residual lake, and will have the chance to walk on the edge of the dam which resisted the strong wave above mentioned.

Sunday, 4 June 2017 (La Villa – Corvara in Badia and surroundings)

Day programme:
Morning: Landslides around the village of Corvara in Badia.
Packed lunch on the field or lunch in refuge according to weather conditions.
Afternoon: Landslides around the village of Corvara in Badia.
Dinner and overnight stay in La Villa (Badia Valley).

Landslide processes in the Alta Badia Valley are strictly related to lithologic, stratigraphic and tectonic conditions. The development of landslides in correspondence with the margins of the Sella, Puez-Gardenaccia groups is linked to the overlapping of jointed competent rocks, such as dolostones, on materials showing substantially ductile behaviour, such as the S. Cassiano and Wengen formations. The widespread outcropping of the latter formations favours the onset of earth slides and flows in the middle-lower parts of the slope, whilst rock falls and topples prevail in the jointed dolomites cliff which surrounds the valley. Often, various types of movement combine, thus giving origin to landslides of complex and/or composite style. Several landslides have been identified and mapped in recent years in the Alta Badia Valley and, in particular, at Corvara in Badia where the largest mass movement in the area can be found.
This is the case of the Corvara landslide which affects an area of more than 2.5 km^2. It can be classified as an active, slow moving, deep-seated rotational earth slide - earth flow, which has an estimated overall volume of more than 30 million m^3. Present day movements of the landslide - ranging from 0.01 to more than 2 m/year - cause continuous damage to power lines, cable cars and, in particular, to state road no. 244, which connects the village of Corvara to Campolongo Pass and the neighbouring village of Arabba. Hazard mapping and monitoring have been performed on the landslide and surroundings, and the outputs of long-standing research activities will be shown to the participants.
The programme will also include a visit of the Crep de Sela landslide which suddenly occurred in 2014 causing severe damages to the cableway connecting Corvara and Colfosco, and threatening a number of houses which had to be evacuated.

Monday, 5 June 2017 (La Villa – S. Leonardo and surroundings)

Day programme:
Morning: Landslides around the village of S. Leonardo.
Packed lunch on the field or lunch in refuge according to weather conditions.
Afternoon: Landslides around the village of S. Leonardo.
Dinner and overnight stay in La Villa (Badia Valley).

The same stratigraphy and tectonic setting found in the Corvara area characterize also the stretch of the Alta Badia Valley from La Villa to S. Leonardo, heading north towards Brunico (Pusteria Valley). From the geomorphological view point, a clear asymmetry can be found between the valley sides: the left one is steeper and mainly covered by talus and scree slope, while landslide deposits are limited to the lower sector; the right one has lower slope angles, its bedrock is intensively dissected by landslide bodies of slide/flow type and the more stable slope sectors are covered by thin glacial deposits. Among the landslides affecting the right hand side,

participants will visit the large landslide near the village of Sottrù, few hundred metres north of La Villa. It is a historic landslide that reactivated in December 2012, destroying a few houses, cutting two roads and almost damming the Gadera torrent. The previous known activation dates back to June 1821, which took place after persistent rainfall and snow melting. What strikes the most is that the 2012 event occurred during an unusual season for landslides in the study area, while its spatial extent appears to be quite similar to that of the 1821 event. Of considerable length and width (1300-1400 m and 500 m respectively), the landslide can be identified as complex (earth slide - earth flow).
After the stop at the Sottrù landslide, some other landslides in the surroundings will be shown, to get a more complete picture of the morphodynamics of this portion of the Alta Badia Valley.

Tuesday, 6 June 2017 (La Villa – Cortina d'Ampezzo – Ljubljana)

Day programme:
Morning: Landslides in Cortina d'Ampezzo.
Packed lunch in the field.
Afternoon: Transfer to Ljubljana.
Arrival in Ljubljana in the evening.

Landslide investigations in the area of Cortina d'Ampezzo, where the geological situation is similar to that of the Alta Badia Valley, have been carried out on a multi-disciplinary basis since the beginning of the 1990s mainly within European research projects, involving primarily experts in geomorphology and engineering geology. This has enabled the researchers not only to define a general picture of landslide causes, occurrence and evolution in the study area, but also to assess landslide hazard, and therefore plan and install monitoring systems on the most landslide-prone slopes so as to forecast future movements. Landslide dating proved that the area of Cortina d'Ampezzo has been affected by slope instability since the Lateglacial. The stratigraphic succession features an alternation of dolomite rocks showing brittle mechanical behaviour and pelitic rocks with ductile mechanical behaviour. This favoured the development of mass movements and deep-seated gravitational slope deformations (e.g., rock spreading at Cinque Torri). Landslide distribution is linked to both lithological and structural conditions: rock falls occur in the higher parts of the slopes, where the dolomitic rocks outcrop, whereas slides and flows take place in the medium and lower sectors of the slopes, where marly and clayey formations are present.
A general overview of the main landslides of the Cortina d'Ampezzo area will be provided to the participants, as well as an insight on active mass movements (e.g., Lacedel landslide) which characterize the valley inducing risk conditions.

Number of participants: from 25 to 30.

Travel: By bus (maximum 30 seats).

Field trip cost: 600 EUR (the price includes: travel by bus, accommodation with breakfast, lunch, dinner and entrance fees).

Field-guide: will be distributed to the study-tour participants.

Requirements for participants: trekking equipment.