

## Seed Money 2018 Final Report

### Project title (& acronym)

Monitoring geomorphological changes due to debris flows in mountain rivers using UAV: exploiting similarities between Alpine and Andean regions.

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### Short project summary (max. 5 lines)

Definition of proper methodologies for unmanned aerial vehicle (UAV) to monitor debris flows will be done in two workshops: one in each participant institution. The objective is to do field demonstrations and measurements to exploit similarities between Alpine and Andean mountain regions. Results will involve digital elevation models of two mountain rivers to be used in further monitoring and modelling of actual debris flow events.

### Key words (5 words illustrating the project and its content)

debris flows, sediment transport, UAV, geomorphology, fluvial systems

### Type of project (please select only the most adequate option)

- exchanges aimed at launching a new research project
- capacity building / technical assistance / training and education
- transfer of material /equipment
- conference / seminar / workshop
- general exchange activities
- other (please describe)

<b>Budget overview</b>			
Amount of Seed Money grant awarded in 2018 (CHF):	15000	Amount of Seed Money grant spent in 2018 (CHF):	11381
Amount contributed by EPFL unit and Southern partner(s) (CHF):	1000	Amount of third party funding in 2018 (if any) (CHF):	0

## **Activity Report** (maximum 7 A4 pages length)

### **1. Summary of project objectives**

The main objective of the present project was to obtain high resolution topographic data for Alpine and Andean regions.

The project's objectives were:

- exploring and sharing experience in the usage of unmanned aerial vehicles (UAV) for field surveying mountain rivers and basins.
- capturing morphological changes after important rainfalls and floods in the Alps and Andes.
- exploiting similarities and differences between Alpine and Andean regions for UAV surveying.

The initial issue was to select a location in Chile for the surveying. The location had to be an active creek where debris flows occur frequently. A side objective, was the purchase of equipment and the selection of methods for the surveying by the Chilean partner. Funding did not comprise the purchase of equipment, just the interaction and sharing of techniques between partners.

### **2. Activities carried out**

The activities comprised:

- A workshop held from the 4 and 7 June 2018 in EPFL, Lausanne. The workshop included a demonstration of the capabilities of UAV to survey Alpine rivers and the survey of the Navisence River in Zinal, Valais, on 6 June 2018. Three Chilean researchers came to the workshop and gave seminars at EPFL.
- A second workshop held from 26 and 29 November at Universidad de Chile, Santiago. A two-day field survey was carried out in Cajón del Maipo, Metropolitan Región. In this field survey, an active debris flow deposit was surveyed and other surrounding areas were scouted for future surveying. The end of the workshop was marked by an extended seminar where Chilean government institutions and research agencies were invited to discuss on prospective monitoring and collaboration. Two EPFL researchers went to Chile and gave talks in various seminars.
- Obtaining and analysing detailed topographies of two mountain regions, in Switzerland and Chile. Changes in topography were captured by subsequent surveys done between workshops.

### **3. Main results**

A first result of the active collaboration was the decision of the Chilean partner to use similar methods and the same equipment used by the Swiss partner for their own surveys. Discussion on these matters was extensive throughout the entire project and it is still undergoing.

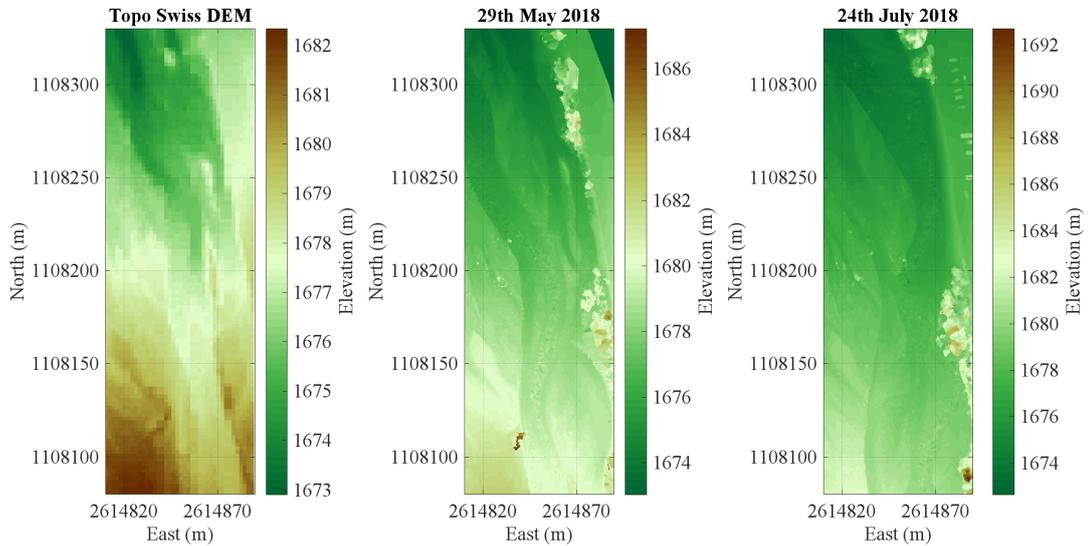


Figure 1. Digital elevation models for the Navisence river, Zinal (VS). Left: swissALTI3D DEM (grid element size of 2 m). Center: DEM obtained with UAV survey, 29 May . Right: DEM obtained with UAV survey, 24 July. Grid element size for UAV surveys is of 1.4 cm.

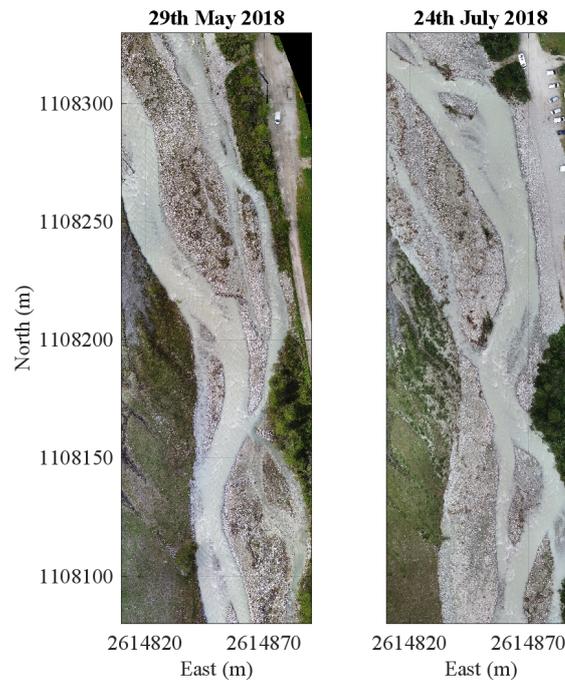


Figure 2: Orthophotos on May 29 and July 24. Morphological changes in the main stream bed are observed clearly, lateral erosion is evidenced in the right bank next to the road and parking lot.

Surveying in the Navisence River was done by the Swiss partner between mid-spring and mid-autumn, including the survey done during the first workshop. Topographic information reflecting the morphological condition of the river was obtained each two weeks. A severe flood event occurred on 2 July, 2018. The flood eroded a local road, destroyed a bridge and some instruments of our monitoring station. These consequences of the flood were captured by the surveys. As examples, Figures 1 and 2 show digital elevation models (DEM) and orthophotos for 29 May and 24 July. The DEMs are compared to the one provided by TopoSwiss ([https://shop.swisstopo.admin.ch/fr/products/height\\_models/alti3D](https://shop.swisstopo.admin.ch/fr/products/height_models/alti3D)) to test the definition and precision.

The identification of an active creek in Cajón del Maipo, Chile, was done by the Chilean team. The Amarillo Creek is relevant due to the frequent occurrence of debris flows that block a local road. Past debris flows in this creek greatly affected the local communities and the construction of a hydraulic power plant located in the upper basin of the Maipo river.

Digital elevation models and orthophotos were obtained for the Amarillo Creek in two surveys. No major floods or debris flows were captured by the surveys but a base state for the creeks was obtained with the provided funding. An orthophoto and a DEM are shown in Figure 3.

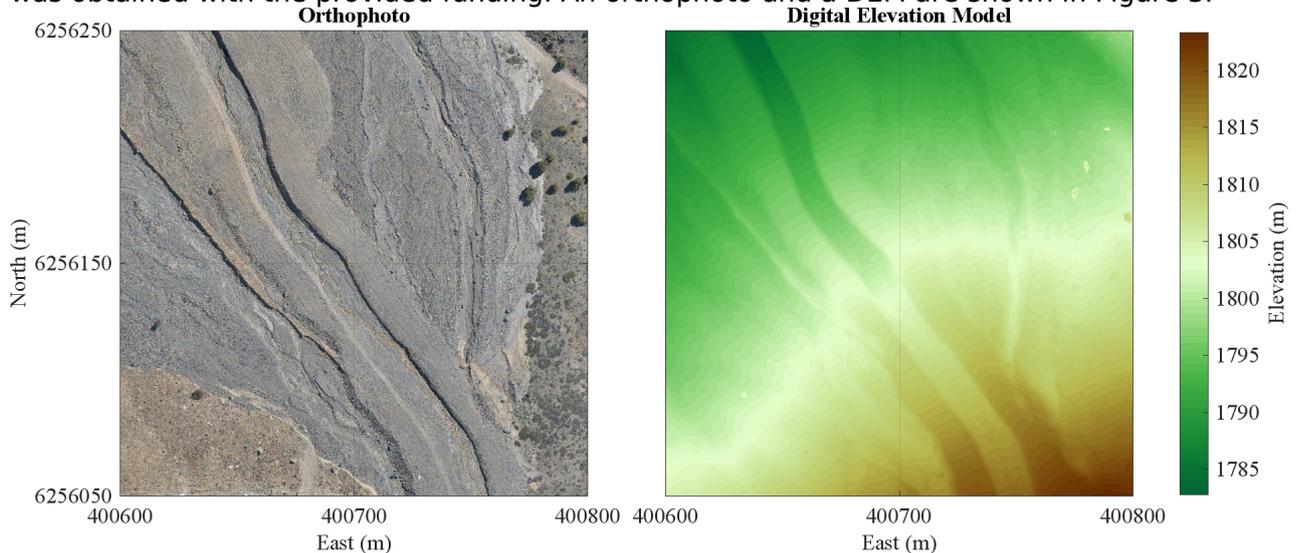


Figure 3. Orthophoto (left) and DEM (right - resolution of 2 cm) for the Amarillo Creek, Cajón del Maipo, Chile.

Observed differences between locations are the lack of vegetation and a higher slope in Amarillo Creek. The lack of vegetation helps the survey, while Amarillo Creek higher slope poses a challenge for flying the UAV. Terrain-awareness technique were used to overcome this difficulty. The slope is not an issue for the surveys in the Navisence River. However, there are planned surveys for the upstream region of the river. There, the slope increases and terrain-awareness will be used.

#### 4. Practical application of results and impact to the SDGs

- The Chilean team will supervise a doctoral thesis that will use the experience and the topographic information gathered in the Amarillo Creek during this project.
- In Chile, access to detailed topographic information is limited and there is no central database for public access. This situation makes topographical surveys valuable for scientific studies and posterior uses.
- In general, applying results obtained through the project involves mass movement estimation, the study of geomorphological structures and sediment transport dynamics.

#### 5. Publications and dissemination activities

An open seminar for government and research institutions from Chile was held at the Universidad de Chile. The Instituto Nacional de Hidráulica (<http://www.inh.cl/>), the Dirección de Obras Hidráulicas (<http://www.doh.gov.cl/>), the Servicio de Geología y Minería (<http://www.sernageomin.cl>) and the Servicio Aerofotogramétrico of the Fuerza Aérea de Chile (<http://www.saf.cl/>), among other institutions, attended and presented talks in the seminar. Data management, surveying and collaboration were discussed at the end of the session.

#### 6. Difficulties encountered

No major difficulties were encountered during the project.

There were some practical difficulties or risks taken for selection the date for the field work in Switzerland. Weather conditions could have made the field work impossible to do within the 4-day span of the first workshop. Selecting a date for the meeting involves long-term planning that is not compatible to weekly-weather forecast, hence critical decision making was necessary.

Another important issue is human intervention in the selected locations. Damage generated by floods to infrastructure has to be quickly repaired by local communities and companies,

that is, they have to remove or displace sediments. Such intervention requires measurements to be undertaken quickly after the events, so undisturbed morphological conditions are captured. This condition is difficult for field work planning.

## **7. Partnership experience**

Cooperation between partners went well. Exchange of knowledge and ideas was in both directions. KFPE principles were followed but without explicitly referring to them along the project.

- Setting the agenda and the responsibilities were done as detailed in the principles.
- The promotion of mutual learning was achieved throughout the duration of the project and evaluation of the activities and results was done via mail and during the meetings. Either partner will use methods used by the other for future field campaigns.
- Dissemination of activities and the enhancement of capacities were in Chile with the workshop carried out the 29 November, 2018.

Our opinion is that there is still much to do to improve the collaboration, especially to make the results significant for both partners. A joint scientific issue is still missing to consolidate the collaboration.

## **8. Follow-up activities and perspectives**

Follow-up collaboration and funding will be sought by the Chilean partner through Conicyt (the Chilean research agency). Similar funding as the one provided by CODEV can be achievable, but bigger funding can still be an option.

Secondary activities may involve students exchange financed by the Universidad de Chile.

## **9. General comments**

The participants and partners are grateful for the opportunity and the support. A general comment from both-parties is related to the restrictions imposed by CODEV for budget elaboration. It is difficult to satisfy the requirement that both partner spend the same amount of money. However we must recognize the flexibility of CODEV to accept changes on the active members during the project, due to external reasons.

It would also be nice that CODEV also support or offer funding opportunities when the project comes to its end, as to supplement the prospective funding search undertaken by the partners.