**HYCAR Research Unit**

# Internship offer
# Academic year 2019-2020

## 1. Subject

**Modelling glacier dynamics to improve streamflow simulations in high-mountain environment: evaluation on several Alpine basins**

## 2. Internship type

Internship within a Master or during the last year of engineering schools

## 3. Period and duration

Six months starting in February-Mars 2020

## 4. Host Institute and supervisors

**Host Institute:**
Irstea/INRAE
HYCAR Research Unit
1, rue Pierre-Gilles de Gennes CS 10030
92761 Antony Cedex
Web : https://www.irstea.fr/hycar

**Supervisors:**
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This internship will be carried out in collaboration with CIMA Research Foundation and the Environmental Protection Agency of Aosta Valley (Italy).

Applications (CV + motivation letter) should be preferably addressed by email to the main supervisor, whose contact is detailed above.

## 5. Internship allowance

Monthly allowance of about 550 €.

## 6. Applicant profile

- Good knowledge of hydrology and modelling
- A good knowledge of mountain hydrology is an added value for this internship
- Expertise in statistics
- Programming skills (Fortran and/or R, if possible)
- Experience with traditional office tools (Word, Excel, etc.)
- Fluency in writing and speaking

## 7. Prospective PhD offer

No, but PhD projects on other topics may be proposed within the host research team (depending on the available funding).

## 8. Internship description

- ***Context***

Glacial meltwater runoff affects both water resources and the hydrological regime of mountain rivers through a significant contribution, especially during the summertime (Casassa et al., 2009; Koboltschnig and Schöner, 2010). Depending on their size and the main features of the basin where they are located, the glacier dynamics can also have a critical impact on the management of hydroelectric facilities. When modelling river streamflow in mountain environment, the simulation of the meltwater runoff from glaciers is of key importance, especially under climate change conditions (Hock et al., 2005; Viviroli et al., 2011). Indeed, high-mountain glaciers are directly affected by the climate changes and they are currently subject to a sharp shrinkage in the Alps, due to the rising temperatures.

- ***Internship goals***

The HYDRO research team of Irstea/INRAE Antony has developed a semi-distributed hydrological model GRSD (de Lavenne et al., 2019), which relies on the CemaNeige snow accumulation and melting model to evaluate the snow meltwater contribution to discharge (Valéry et al., 2014; Riboust et al., 2019). The internship aims at developing a new module of glacier dynamics within the hydrological model in order to enhance the streamflow simulations in mountain environment by taking account of the glacial meltwater supply. Several approaches have been already developed to represent the glacier dynamics, which differ in terms of their end application, complexity and required input data (for instance, Gsell, 2014). The glacier dynamics will be modelled according to a simplified and conceptual approach, consistently with the structure of the rain-runoff model.
Different schemes will be tested with the aim of identifying the outperforming configuration providing the best simulated streamflow at the outlet of the selected basins of interest. Thanks to the collaboration with CIMA Research Foundation and the Environmental Protection Agency of Aosta Valley (Italy), which is constantly monitoring some Alpine glaciers, the regional glacial database will be available to assess the performance of the modelling module of glacier dynamics. The accuracy of the simulated streamflow will be analysed against discharge measurements at the outlets.

- ***Methodology / Main tasks***

The work will consist in:

**A. [1st and 2nd months]**

- A literature review on hydrological modelling in mountain environment, specifically on the modelling of glacier melting dynamics;
- The setting up of a database needed to perform the simulations, after a preliminary critical assessment of the available data;
- The acquisition of skills in using the available programming and modelling tools.

**B. [3rd and 5th months]**

- The definition and implementation of different configurations of glacier modelling, according to a conceptual approach;
- The assessment of the performance of several configurations of the glacier modelling module through the comparison against the observed glacial data;
- The hydrological evaluation of the simulated streamflow at the outlet of the selected basins of interest, with the aim of analysing the impact of the glacial meltwater supply on the discharge estimation.

**C. [6th month]**

- The drafting of the Master's thesis.

Depending on the progress of results, these scientific tasks could result into a publication in a scientific peer-reviewed journal.
This study will be carried out in collaboration with CIMA Research Foundation and the Environmental Protection Agency of Aosta Valley (Italy).

- ***For more information***


Casassa, G., López, P., Pouyaud, B., and Escobar, F. (2009). Detection of changes in glacial run‐off in alpine basins: examples from North America, the Alps, central Asia and the Andes. Hydrological Processes, 23(1), 31-41.

de Lavenne, A., Andréassian, V., Thirel, G., Ramos, M.‐H., & Perrin, C., 2019, in press. A regularization approach to improve the sequential calibration of a semi-distributed hydrological model. Water Resources Research, 55. https://doi.org/10.1029/2018WR024266

Gsell, P.S. (2014). Apports et voies d'amélioration de la représentation des glaciers et de leur évolution au sein d'un modèle hydrologique. Sciences de la Terre. Université Pierre et Marie Curie - Paris VI, 2014. Français. NNT : 2014PA066641. tel-01164802. https://tel.archives-ouvertes.fr/tel-01164802

Hock, R., Jansson, P., and Braun, L. N. (2005). Modelling the response of mountain glacier discharge to climate warming. In Global Change and Mountain Regions (pp. 243-252). Springer Netherlands.

Koboltschnig, G. R., and Schöner, W. (2010). The relevance of glacier melt in the water cycle of the Alps: an example from Austria. Hydrology and Earth System Sciences Discussions, 7(3).

Riboust, P., Thirel, G., Le Moine, N., and Ribstein, P., 2019. Revisiting a simple degree-day model for integrating satellite data: implementation of SWE-SCA hystereses. Journal of Hydrology and Hydromechanics, dx.doi.org/10.2478/johh-2018-0004, 67, 1, 70–81.

Valéry, A., Andréassian, V., Perrin, C., 2014. 'As simple as possible but not simpler': What is useful in a temperature-based snow-accounting routine? Part 2 – Sensitivity analysis of the Cemaneige snow accounting routine on 380 catchments, Journal of Hydrology, 517(0): 1176-1187, https://dx.doi.org/10.1016/j.jhydrol.2014.04.058.

Viviroli, D., Archer, D. R., Buytaert, W., Fowler, H. J., Greenwood, G., Hamlet, A. F., ... and Lorentz, S. (2011). Climate change and mountain water resources: overview and recommendations for research, management and policy. Hydrology and Earth System Sciences, 15(2), 471-504.