

PHD PROPOSAL FOR THE DOCTORAL SCHOOL « Ecologie, Géosciences, Agronomie, ALimentation »

GENERAL INFORMATION

Thesis title: Fracture and erosion in rivers
Acronym: FERI
Disciplinary field 1: Geosciences Disciplinary field 2: Select an element
Three keywords: fracture, erosion, river
Research unit : Geosciences Rennes
Name of the thesis director HDR (Habilitation thesis to supervise research) required: Dimitri Lague Email address of the thesis director: dimitri.lague@univ-rennes1.fr Name of the thesis co-director HDR (Habilitation thesis to supervise research) required: Philippe Steer Email address of the thesis co-director: philippe.steer@univ-rennes1.fr Name of the thesis co-supervisor: Laure Guérit Email address of the thesis co-supervisor 1: laure.guerit@univ-rennes1.fr
Thesis grant (funding origin and amount): Ordinary CDO Rennes 1 (99 400 €)
Contact(s) (mailing address and E-mail): Géosciences Rennes, Université Rennes 1 Campus Beaulieu. 263 Avenue Général Leclerc. 35000 Rennes.
Recruitment process: Recruitment process depends on thesis funding. To select the corresponding recruitment process, please visit the EGAAL website here . This information is needed for proposal publication. <input checked="" type="checkbox"/> Doctoral school contest <input type="checkbox"/> Interview <input type="checkbox"/> Other (indicate) :

All sections must be filled. Once filled, please save the proposal form in pdf format using the following naming: Supervisor Name_Unit_Subject Acronym_EN.pdf

ED EGAAL

Direction : 65 rue de Saint-Brieuc – CS 84215 – 35042 Rennes Cedex – France

Tél : 02 23 48 52 75

Mail : ed-EGAAL@doctorat-bretagne Loire.fr

Site Web : <https://ed-egaal.doctorat-bretagne Loire.fr>

SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

Socio-economic and scientific context : (10 lines)

The erosion of mountain ranges is strongly controlled by the processes and rates of incision in rivers. Incision is generally described as dependent on topography, water flow and rock erodibility. This last parameter is a poorly constrained term that includes any variable that can influence incision velocity such as climate or rock lithology. Among them, the role of rock fracturing remains very poorly understood, even though it could play a key rôle by controlling the dominant incision mechanisms in rivers: boulder stripping in fractured areas or abrasion due to sediment transport in non-fractured areas. These two mechanisms do not operate at the same rates, do not a priori lead to the same river morphology, and their respective importance in river incision remains unknown.

Assumptions and questions (8 lines)

How does fracturing contribute to change the dominance of one mechanism over the other, with what impact on incision rates in channels and at the landscape scale? To address these questions, the thesis will rely on laboratory experiments simulating the erosion of a fractured rock in a river, field work on a natural river to characterize the mode of erosion according to fracturing, and work on topographic data to identify the signature of fracturing in the geometry of rivers (slope, width, etc.). Experimental and field observations will be discussed in relation to Stream Power type models commonly used in geomorphology but which do not integrate fracturing.

The main steps of the thesis and scientific procedure (10-12 lines)

- 1) Laboratory experiments simulating the erosion of fractured rock in a river. Exploratory experiments already performed by the team show promising trends between fracture density, transported sediment size, erosion mode and rates. The thesis will explore more parameters with a statistical approach (fracture orientation, lithology, transported sediment size and mass, flow velocity)
- 2) Field work along the Hérault river, which presents fracturing variations from upstream to downstream, to characterize the erosion modes according to the fracturing (plucking or abrading zones, size of the torn fragments) from manual measurements and 3D data acquired by terrestrial LiDAR.
- 3) Work on topographic data to identify the signature of fracturing in the geometry of rivers (slope, width, etc.). Potential sites have been identified in France (Cévennes, Corsica, Alps) which will allow a field control.

Methodological and technical approaches considered (4-6 lines)

The monitoring of the experiments will be based on the acquisition, processing and analysis of 3D data (point clouds) acquired by photogrammetry. The work on natural cases will be based on manual measurements (size of the blocks torn off, orientation of the fractures) and the analysis of 3D data acquired by LiDAR (characteristic of the surfaces, geometry of the channels).

Scientific and technical skills required by the candidate

An interest for geomorphology, experimentation, field measurement and 3D data analysis is required.

THESIS SUPERVISION¹

Unit name: Géosciences Rennes	Team name: Rivière/Démo(dé)
Unit director name: Olivier Bour	Team director name: A. Crave / P. Steer&B. Guillaume
Mailing address of the unit director: olivier.bour@univ-rennes1.fr	Mailing address of the team director: alain.crave@univ-rennes1.fr
<p>Thesis director</p> <p>Surname, first name: Lague, Dimitri</p> <p>Position: Directeur de Recherche</p> <p>Obtained date of the HDR (Habilitation thesis to supervise research): 2009</p> <p>Employer: Centre National de la Recherche Scientifique (CNRS)</p> <p>Doctoral school affiliation: EGAAL</p> <p>Rate of thesis supervision in the present project (%): 40%</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 15%</p> <p>Number of current thesis supervisions/co-supervisions: 1</p>	
<p>Thesis co-director</p> <p>Surname, first name: Steer, Philippe</p> <p>Position: Maître de conférence</p> <p>Obtained date of the HDR (Habilitation thesis to supervise research): 2020</p> <p>Employer: University of Rennes 1</p> <p>Doctoral school affiliation: EGAAL</p> <p>Rate of thesis supervision in the present project (%): 30%</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 40%</p> <p>Number of current thesis supervisions/co-supervisions: 1</p>	
<p>Thesis co-supervisor 1</p> <p>Surname, first name: Guérit, Laure</p> <p>Position: Chargée de Recherche</p> <p>Habilitation thesis to supervise research <input type="checkbox"/> yes <input checked="" type="checkbox"/> no If yes, date diploma received:</p>	

- ¹ In EGAAL Doctoral School, if only one scientist in thesis supervision = 100% of supervision rate; if 2 people involved in thesis supervision = from 50% to 70% of supervision rate for the director; if 3 people involved in thesis supervision = 40% / 30% / 30% of supervision rate distribution among supervisors.

Employer: CNRS

Doctoral school affiliation: EGAAL

Rate of thesis supervision in the present project (%): 30%

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 0

Number of current thesis supervisions/co-supervisions: 0

Professional status of previous PhD students supervised by both director and co-supervisors (from 5 years)

Surname, first name: Jeandet, Louise

Date of PhD beginning and PhD defence: 2015-2018

Thesis supervision: Dimitri Lague and Philippe Steer

Professional status and location: Post-doctorat – Paris Sorbonne Université (France)

Contract profile (post-doc, fixed-term, permanent): post-doc

List of publications from the thesis work:

- Steer, P., Jeandet, L., Cubas, N., Marc, O., Meunier, P., Simoes, M., Cattin, R., Shyu, B., Mouyen, M., Liang, W.-T., Theunissen, T., Chiang, S.-H. & Hovius, N. (2020). Earthquake statistics changed by typhoon-driven erosion. *Scientific reports*, 10(1), 1-11.
- Jeandet, L., Steer, P., Lague, D., & Davy, P. (2019). Coulomb mechanics and relief constraints explain landslide size distribution. *Geophysical Research Letters*, 46(8), 4258-4266.
- Jeandet Ribes, L., Cubas, N., Bhat, H. S., & Steer, P. (2020). The Impact of Large Erosional Events and Transient Normal Stress Changes on the Seismicity of Faults. *Geophysical Research Letters*, 47(22), e2020GL087631.

Surname, first name: Bernard, Maxime

Date of PhD beginning and PhD defence: 2017-2020

Thesis supervision: Kerry Gallagher and Philippe Steer

Professional status and location: Post-doctorat – GFZ Potsdam (Allemagne)

Contract profile (post-doc, fixed-term, permanent): post-doc

List of publications from the thesis work:

- Bernard, M., Steer, P., Gallagher, K., & Lundbek Egholm, D. (2020). Modelling the effects of ice transport and sediment sources on the form of detrital thermochronological age probability distributions from glacial settings. *Earth Surface Dynamics*, 8(4), 931-953.
- Bernard, M., Steer, P., Gallagher, K., & Lundbek Egholm, D. (in review). The impact of lithology on fjord morphology, *Geophysical Research Letters*.

Five main recent publications of the supervisors on thesis subject:

Bernard, T. G., Lague, D., & Steer, P. (2021). Beyond 2D landslide inventories and their rollover: synoptic 3D inventories and volume from repeat lidar data. *Earth Surface Dynamics*, 9(4), 1013-1044.

Steer, P., Jeandet, L., Cubas, N., Marc, O., Meunier, P., Simoes, M., Cattin, R., Shyu, B., Mouyen, M., Liang, W.-T., Theunissen, T., Chiang, S.-H. & Hovius, N. (2020). Earthquake statistics changed by typhoon-driven erosion. *Scientific reports*, 10(1), 1-11.

Guerit, L., X. Yuan, S. Carretier, S. Bonnet, S. Rohais, J. Braun, D. Rouby Fluvial landscape evolution controlled by the sediment deposition coefficient: Estimation from experimental and natural landscapes - *Geology*, 2019, 47 (9), 853-856

Croissant, T., Steer, P., Lague, D., Davy, P., Jeandet, L., & Hilton, R. G. (2019). Seismic cycles, earthquakes, landslides and sediment fluxes: Linking tectonics to surface processes using a reduced-complexity model. *Geomorphology*, 339, 87-103.

Jeandet, L., Steer, P., Lague, D., & Davy, P. (2019). Coulomb mechanics and relief constraints explain landslide size distribution. *Geophysical Research Letters*, 46(8), 4258-4266.

Croissant, T., Lague, D., Steer, P. and Davy, P. (2017), Rapid post-seismic landslide evacuation boosted by dynamic river width, *Nature Geosciences*, 10 (9), 680

THESIS FUNDING

Origin(s) of the thesis funding: Ordinary CDO Rennes 1
Gross monthly salary: 1975 €/month
Thesis funding state : Non acquired
Funding beginning date/Funding ending date: 3 years

Date: 10/02/2022

Name, signature of unit director: Olivier Bour


Olivier BOUR
Directeur de Géosciences
Rennes UMR6118

Name, signature of thesis project director: Dimitri Lague

