Post-Doctoral Position. TipHyc project (exploring Tipping points in the West African Hydrological Cycle)

Deadline for application : March 31st, 2022

Job type:
24-month fixed-term contract, full-time ; post-doctoral position / junior researcher

Contract duration:
April 15th 2022 to April 14th 2024

Location:
IGE (Institut des Géosciences de l'Environnement)
OSUG B 460 Rue de la piscine
38400 Saint Martin d'Hères
Grenoble, France

Presentation of the host institution:
The Institute for Geosciences and Environmental research (IGE, https://www.ige-grenoble.fr/?lang=en) is a public research laboratory in Earth and Environmental Sciences, under the supervision of the National Center for Scientific Research (CNRS), the French Research Institute for Sustainable Development (IRD), Grenoble Alpes University (UGA) and Grenoble Graduate schools of Engineering and Management (Grenoble-INP). IGE employs approximately 255 people, including 155 permanent members (researchers, teacher-researchers, engineers) and about 100 phD students, post-doctoral fellows and staff on fixed-term contracts. The laboratory also welcomes several dozen trainees and scientific visitors each year. The laboratory is located on three sites on the Grenoble University Campus (Glaciology, OSUG-B, and Maison Climat Planète).

The research activity will take place within the PHyREV team (Hydrological Processes and Vulnerable Water Resources) composed of about 30 people (researchers, teacher-researchers, doctoral students and contract researchers) covering the different compartments of the hydrological cycle (from hydrogeology to climate) and focusing on the West African region.

The TipHyC Project:
The TiphyC project (exploring TIPping points in the west african HYdrological Cycle) is funded by the French National Research Agency (ANR) from January 2021 to December 2024. The work will be carried out in close collaboration with the HSM laboratory (Montpellier) and INRAE DEPE, and with the contribution of the other project partners.

The Institute of Environmental Geosciences (IGE) is looking for a young scientist to work on tipping points in the hydrological cycle in West Africa in the framework of the TipHyC project.

Main tasks:
In a dynamical system with positive feedbacks, an abrupt change to an alternative state can occur in response to a gradual change in external forcing. In this type of transition (regime shift), the system can remain in the alternative state even if the forcing returns to its initial value. The tipping point describes the moment when the change of state occurs. Many environmental systems exhibit this type of behaviour (Scheffer, 2009).

West Africa is a global change hotspot (IPCC, 2021, 2014; Toreti et al., 2013), where adaptation challenges are strong. By 2050, a temperature increase of about 1°C and increased climate variability are projected under medium GHG emission scenarios (IPCC, 2021). The West African population is the fastest growing in the world and is expected to double by 2050 (UN, 2017). As a result, cultivated areas are expanding(Eva et al., 2006), leading to deforestation, which is often accompanied by soil degradation. All these trends could have serious impacts on the land surface and the water cycle, which are strongly coupled. Loss of agricultural production (Sultan et al. 2019) and increased exposure of populations to flooding (Di Baldassarre et al., 2010) are early signs of the impact that global change could have in this region.

The central hypothesis of the project is that climate and land use changes could trigger the passage of tipping points on the scale of a few decades, and cause regime shifts in the West African hydrological cycle. In the semi-arid Sahel region, these would result in a permanent increase in the runoff capacity of catchment areas, associated with a change in plant cover, a change in water redistribution in the hydrological compartments, and an increase in flood risk. Adaptation strategies may need to be rethought in light of these potential disruptions, which could have significant impacts on human living conditions. The objective of the project is to study at the regional scale (West Africa) whether tipping points could be crossed, where and when, and to identify thresholds that should not be crossed to avoid unacceptable consequences (Rockström et al., 2009), or conversely, thresholds that could bring desirable changes (Torou et al., 2013).

The initial stage of the project focused on the development of a system dynamic model (so called TipHyc model, work package 1) guided by long term observations to explore potential tipping points in the West African hydrological cycle (work package 2). This model, validated in a former work, is mainly driven by atmospheric (rainfall) and land use (Wendling et al., 2019). This tool is currently being applied to the evolutions observed during the second half of the 20th century in order to explore potential past tipping points.

The work proposed in this contract concerns the future period (work package 3): could hydrological regime shifts occur by 2100 in this region? With what consequences on water resources and hydrological risks?

The exploration of future regime shifts will make use of the “TipHyc model” forced by several scenarios: IPCC/CMIP6 exercise for the climate forcing and two narrative-based land-use / land-cover change (LULCC) projections : (i) the Agrimonde-Terra prospective (Mora et al., 2020) and (ii) the Shared Socioeconomic Pathways (Popp et al., 2017), both of which account for different population trends and GHG emission pathways.

References cited

Di Baldassarre, G. et al, 2010. Flood fatalities in Africa: From diagnosis to mitigation. Geophysical Research Letters 37, L22402. https://doi.org/10.1029/2010GL045467

Eva, H.D. et al 2006. Monitoring land cover dynamics in sub-Saharan Africa. A pilot study using Earth observing satellite data from 1975 and 2000. European Commission ; Joint Research Centre ; Institute for Environment and Sustainability.

IPCC, 2021. AR6 Climate Change 2021: The Physical Science Basis — IPCC [WWW Document]. URL https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/ (accessed 9.24.21).

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Mora, O. et al 2020. Exploring the future of land use and food security: A new set of global scenarios. PLOS ONE 15, e0235597. https://doi.org/10.1371/journal.pone.0235597

Popp, A. et al 2017. Land-use futures in the shared socio-economic pathways. Global Environmental Change 42, 331–345. https://doi.org/10.1016/j.gloenvcha.2016.10.002

Rockström, J. et al, 2009. A safe operating space for humanity. Nature 461, 472–475. https://doi.org/10.1038/461472a

Scheffer, M., 2009. Critical Transitions in Nature and Society. Princeton University Press.

Toreti, A et al, 2013. Projections of global changes in precipitation extremes from Coupled Model Intercomparison Project Phase 5 models. Geophysical Research Letters 40, 4887–4892. https://doi.org/10.1002/grl.50940

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UN, 2017. World Population Prospects. The 2017 Revision. Key Findings and Advance Tables (No. ESA/P/WP/248). United Nations, Department of Economic and Social Affairs, Population division.
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Main activities:

- Prepare and analyse climate forcing scenarios and land use scenarios;
- Disaggregate these scenarios to feed the dynamic/systemic model;
- Run the model and analyse simulation results and detect possible inconsistencies between the forcing scenarios and the internal dynamics of the model;
- Propose new model developments to improve the realism of the simulations, if needed;
- From the modelling results, propose a set of possible future "ecohydrological" trajectories associated with each combination of scenarios (climate and LULCC)
- Popularise these results to inform and support public decision-making

Expected results and deliverables:

- Publication of scientific papers in peer-reviewed journals ;
- Dissemination of results at national and international conferences;
- Outreach activities to the general public if opportunities arise
- Participation in TIPHYC project meetings.

Working methods:

Regular scientific exchanges with the team within IGE and with other contributors to WP3.
Quarterly progress reports with all project collaborators.

Expected professional skills:

- PhD in systems dynamic modelling, system analysis or environmental sciences (climatology, hydrology, agronomy, geography);
- The following computer skills would be appreciated: numerical methods on a computer server, handling of large databases (CMIP6), Python or R language, unix/linux environment;
- Interest in systemic approaches and dynamic models;
- Strong interest in multi-disciplinary studies;
- Fluent written and spoken English (B2 level as defined by the Common European Framework of Reference for Languages).

Expected know-how :

- Scientific curiosity ;
- Ability interact with scientists from different disciplinary fields.

Qualifications :

PhD, or other postgraduate degree

Salary:

2395 € gross per month or higher, depending on experience. In accordance with French social protection, the contract provides access to the health care system.

Contact :

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