PhD position in karst hydrology

within the research units of BRGM & UMR LISAH

at Montpellier, France

2017 – 2020

Title: Hydrologic modelling of flood events and identification of spatial indicators of runoff genesis : Application on karstic basins (Mediterranean zone, Jura, Normandy)

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Employer: UMR LISAH (INRA)

Location: Montpellier (FRANCE) at UMR LISAH & BRGM

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Deadline for application: 31 May 2017

Key words

Runoff ; Karst ; Flood forecasting ; Modelling ; catchment

Issue

Over the last decade, many catastrophic floods that have occurred in France and in Europe have caused considerable loss of human life. The level of the disasters has resurrected the recurring controversy on natural risks, the possibilities of preventing such disasters and especially the impact of geomorphology, soil properties, climate and constructions. In particular, the groundwater contribution to floods from permeable carbonate formations has been demonstrated in karstic basins during exceptional rainfall events (Mijatovic, 1988, Bonacci et al., 2006, Maréchal et al., 2008, De Waele Et al., 2010, Zanon et al., 2010, Kourgialas et al., 2012, Fleury et al., 2013). The issue of what can be called "karst floods" are important in Europe and notably in France since 1) karstic basins cover approximately ¼ of France and 2) large agglomerations (Marseille, Montpellier, Nîmes, Evreux ...) are potentially vulnerable to this type of phenomenon.

Take into account for karstic aquifers in the implementation of hydrological models for flood forecasting comes up real operational problems, mainly for two reasons: i) the key features of flood generation in karst basins are difficult to define and to generalize, due to complex surface / groundwater exchanges in such heterogeneous media (Bailly-Comte et al., 2009; Charlier et al., 2015), and ii) there are few tools devoted to karst media that are modular or easily adaptable to

generic hydrological models, conventionally used by forecasters. The identified scientific challenges are related to:

i) the quantification of the real influence of karstic zones on flood generation at the basin scale,

ii) the identification of modules / tools that could introduce the specificity of karsts in hydrological models used in forecasting,

iii) the development of a method for spatialization of runoff indicators on karstic basins

Project description

The aim of the PhD is to better understand the role of karst in flood generation at the catchment scale, in order to spatialize runoff indices and to improve hydrological models on catchments having significant karstic areas.

The provisional program is:

Task 1: Bibliographic synthesis on modelling flood events on karstic basins.

The state of the art will focused on flood generation on catchments having permeable aquifers (notably karst, chalk), current concepts on the role of karst on flood generation and propagation, surface-groundwater interactions in karst areas, the spatialization of processes and their modelling.

Task 2: Analysis of runoff on karstic basins, definition of spatial runoff indicators function of geomorphologic, soil and climatic properties

The aim of this task is to characterize relationships between the hydrological response variability (gain/loss/threshold effects…) at the catchment scale and the geomorphological indicators (Moussa, 2008) as percentage of karstic areas, density/rugosity of the hydrographic network, covered karst aquifers/or not, soil thickness *vs.* thickness of the non-saturated zone of the aquifer; degree of karstification,…). The hydrological response in karstic reaches will be analysed using lateral flow modelling between 2 gauging stations (see the application of a Runoff-runoff approach in Moussa, 1996 ; Charlier et al., 2015).

Task 3: Modelling flood events taking into account the specificities of karstic basins.

The aim of this task is to better constrain the hydrological models used in forecast (e.g. lumped models) by identifying production functions, transfer functions and specific reservoirs which allowed introduce behaviours devoted to karstic areas. A comparison between devoted karst models and standard hydrological models will be tested

Task 4: Evaluation of the karst response function of different scenarios of rainfall intensities.

The aim of this task is to better understand the influence of the karst area on the intensity of the food (attenuation/amplification, velocity/inertia), and to identify the scenarios of rainfall favouring a modification of the hydrological response (threshold effect, karst saturation, etc.).

The methods used are:

- Geomorphologic indicators of karstic zones (see Mardhel et al., 2004) and of runoff (Moussa, 2008);

- Runof-runoff modelling for flood events using an inverse approach (see Charlier et al., 2015 ; Cholet et al., 2016), on the basis of the MHYDAS model (Moussa et al., 1996, 2002) ;

- Conceptual rainfall-Runoff modelling of karstic basins (see Dorfliger et al., 2009 ; Charlier et al., 2012; Ladouche et al., 2014).

All the study sites are located in France, in the Mediterranean regions (south), in the Jura Mountains, and in Normandy.

Work environment

We offer an interdisciplinary work environment within two research units specialized in hydrology and soil sciences (UMR LISAH), and in hydrogeology and geological sciences (BRGM). An intensive exchange of the PhD student between the two research teams at Montpellier is foreseen.

This thesis project is a continuation of the work initiated within the two units since several years, which are working closely with the Central Hydrometeorology and Flood Forecasting Support Service (SCHAPI) in the field of “karst floods” and flood forecasting.

Profile and skills required

The candidate needs to have a MSc degree in Hydrology, Hydrogeology, Hydraulic or Environmental Sciences.

Good level: GIS, modelling hydrology/hydrogeology/hydraulic

A good level in English (oral and writing) is required (French is an asset)

Application

Please send a CV, a letter of motivation, and a letter of recommendation to Jean-Baptiste Charlier (j.charlier@brgm.fr) before 05 June 2017.

A first selection will hold before mid-June to select candidates accepted for an interview at the beginning of July 2017 (web-conference available for distant candidates).

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