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## **Linking the changes in groundwater recharge to community structure and the functioning of freshwater ecosystems**

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## Linking the changes in groundwater recharge to community structure and the functioning of freshwater ecosystems

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### Session in which your presentation proposal fits\*:

- Decision making, management and adaptive governance
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- Poster session: Sensors and analytical tools
- Free poster session

### SUMMARY

Climate change impacts groundwater recharge, which in turn may affect groundwater - surface water interactions. These changes might subsequently affect hydrological patterns of freshwater ecosystems, their biodiversity and functioning. Assessing groundwater recharge at a regional scale is a challenge, mainly due to the generally limited knowledge about infiltration processes, interaction with surface water or aquifers, available data and human activities impacts. A gridded water budget approach has been developed to compute groundwater recharge by precipitation in the Adour-Garonne Basin (France) and evaluate the impact of climate change on it. Using these first estimates, we will aim at understanding how it could impact biodiversity structure, ecosystem functioning and water/sediment quality using fresh waters as model ecosystems. Indeed, these systems can be highly dependent of groundwater and faces multiple human-induced perturbations. Here, we will aim to discuss how changes in ground water recharge, by interacting with eutrophication and biological invasions, might impact these freshwater ecosystems.

### KEYWORDS

Climate change, ecosystem functioning, freshwater ecosystems, gravel pit lakes, groundwater recharge.

# Linking the changes in groundwater recharge to community structure and the functioning of freshwater ecosystems

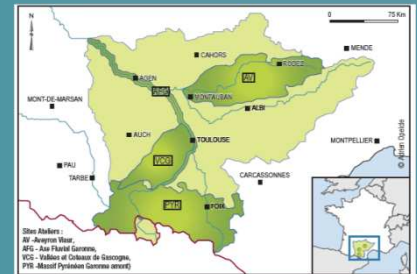
Beranger S., Le Cointe P., Cucherousset J., Delire C., Dejoux J.F., Probst J.L.

French LTSER ZA PYGAR – CNRS-INEE, EcoLab, Campus ENSAT, Avenue de l'Agrobiopole, Auzeville Tolosane - 31320 Castanet Tolosan – France.

## MAIN SCIENTIFIC QUESTIONS AND OBJECTIVES

The increase in temperature coupled to stable or decreasing rainfall forecasted in the current climatic models may lead to a decrease in groundwater recharge. This, in turn, may affect water resources, regarding both their uses and the groundwater - surface water interactions. These changes might subsequently affect hydrological patterns of freshwater ecosystems, their biodiversity and functioning. Because climate change, landscapes and practices evolve at similar timescales, the evaluation of the trends in water resources and the evolution of surface water / groundwater interactions requires a multidisciplinary approach to :

- Define the contribution of each forcing on the observed trends (climate, soil occupancy, human practices, uses),
- Understand and quantify the effects of these forcing on biodiversity and functioning within the ecosystems,
- Create complete and realistic scenarios to forecast the evolution of landscapes, practices and uses,
- Support government agencies in the more sustainable environmental management.



## PRELIMINARY RESULTS AND FUTURE WORK

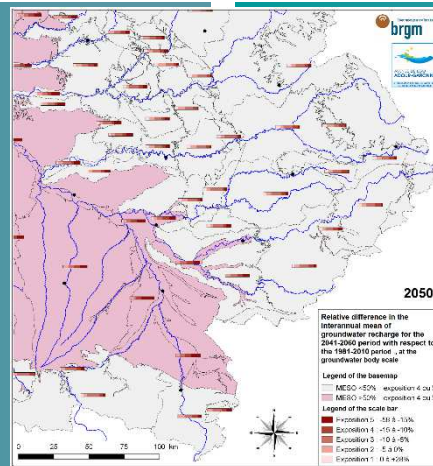
Groundwater recharge evaluation requires numerous data, including meteorological data, the soil type, thickness, and water storage capacity, the soil cover, the soil geomorphological characteristics and the subsoil hydrodynamics properties. Several groundwater recharge evaluation methods have been computed in order to compare the results and provide a more stable evaluation of groundwater recharge at the Adour-Garonne basin scale.

Groundwater recharge has been evaluated by (1) computing the effective rainfall using meteorological data (SAFRAN, Meteo-France) and a water balance model (Dingman or Gardenia / GR4J) and (2) evaluating the infiltration / runoff ratio.

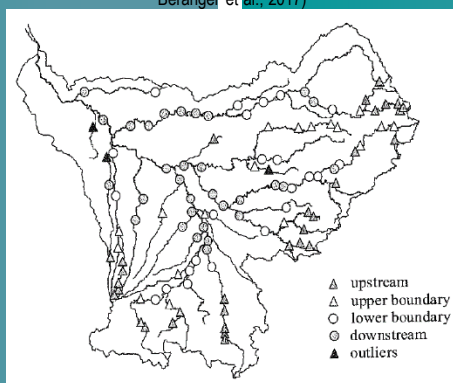
Several scenarios have been modelled :

- Two scenarios of greenhouse gas emissions (GIEC RCP 2.6 and RCP 8.5) ;
- Five climatic models covering France (BCC-CSM1-1-M, CanESM2, IPSL-CM5A-MR, NorESM1-M and CNRM-CM5) ;
- Two methods of data regionalization for global climate models (climatic decrease and Dayon) ;
- Two methods of water balance (Dingman and Gardenia / GR4J).

The differences between the groundwater recharge evaluated for the 2041-2060 period and the current groundwater recharge have been evaluated at the basin scale for each of the above scenario and presented in the map beside using a scale bar. Five classes of groundwater exposition to climate change have been defined (see legend beside). Comparing the scale bar allows defining the groundwater bodies that are more sensitive to climate change. At the Adour-Garonne basin scale, 42 % of the groundwater bodies may have a decrease in groundwater recharge greater than 10% by 2050.



**Difference between the groundwater recharge evaluated for the 2041-2060 period and the current groundwater recharge** (Adapted from Beranger et al., 2017)



**Fish species correspondence with landscape physiography** (Source : Aguilar Ibarra, 2004)

To differentiate fish populations and their repartition in the Adour-Garonne basin, Aguilar Ibarra (2004) drew a longitudinal profile of the whole Adour-Garonne basin showing differences in fish species across the basin (map beside - below). Grey triangles correspond to upstream assemblages with few species which have affinity to cold, well-oxygenated running water from the mountains. The downstream group (depicted as grey circles) had a high species richness of warm water fish inhabiting large rivers, including estuarine species in the furthest downstream sites. Between these two sites, piedmont sites (white triangles for the upper piedmont and white circles for the lower piedmont) show both communities linked along the longitudinal profile of the river network.

This map illustrates the eco-physiological requirements of fish species. Changes in the geographic distribution of fish species may occur due to climate change, human practices. Monitoring these changes at the physiographic region scale provides useful insight for water management, rehabilitation programs, biodiversity conservation.

### References :

- Beranger S., Caballero Y., Lanini S., Le Cointe P. (2017, à paraître). Réponse des Eaux souterraines au Changement climatique dans le bassin Adour-Garonne (RECHARGE). Rapport final. BRGM/RP-67149-FR
- Aguilar Ibarra A. (2004). Les peuplements de poissons comme outil pour la gestion de la qualité environnementale du réseau hydrographique de la Garonne. Thèse présentée pour obtenir le titre de Docteur de l'Institut National Polytechnique de Toulouse.

Using these first estimates, we will aim at understanding how changes in groundwater recharge and climate could impact biodiversity structure, ecosystem functioning and water/sediment quality using fresh waters as model ecosystems. Indeed, these systems can be highly dependent of groundwater and faces multiple human-induced perturbations. We will aim to discuss how changes in ground water recharge, by interacting with eutrophication and biological invasions, might impact these freshwater ecosystems.

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- CNRM-GAME, UMR CNRS-Météo Fr.
- ECOLAB, UMR CNRS-UT3-INPT
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