A method for mapping topsoil field-saturated hydraulic conductivity in the Cévennes-Vivarais region using infiltration tests conducted with different techniques

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A method for mapping topsoil field-saturated hydraulic conductivity K_{fs} in the Cévennes-Vivarais region using infiltration tests conducted with different techniques

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1. CONTEXT AND OBJECTIVES

Context:
Flash floods are natural hazards that affect the Mediterranean region. They are caused by intense rainfall events but catchment characteristics, and particularly topsoil field-saturated hydraulic conductivity K_{sf}, are also influential on the hydrological response. For distributed hydrological models, maps of K_{sf} are useful, as K_{sf} impacts Hortonian runoff, but they are difficult to obtain from points measurements.

Objectives:
- Propose a method to map K_{sf} from GIS layers with application to the Cévennes-Vivarais region where infiltration measurements obtained with different methods were available (Fig. 1)
- Propose a method to pool available infiltration measurements obtained with various techniques in the region for regionalization

2. STUDY AREA AND DATA

Study catchment and available data (Fig. 1 and 2) : Infiltration measurements performed using
- Guelph permeameter (GP) and Double Ring infiltration devices (DR) between 2002 and 2008 in the Gardon and Avène catchments
- Single Ring (SR) infiltration measurements in the Claduègne catchment (2012) and Yzeron catchment (2008, blue rectangle in Fig. 1)
- Tension Disk Infiltrometers (TI)

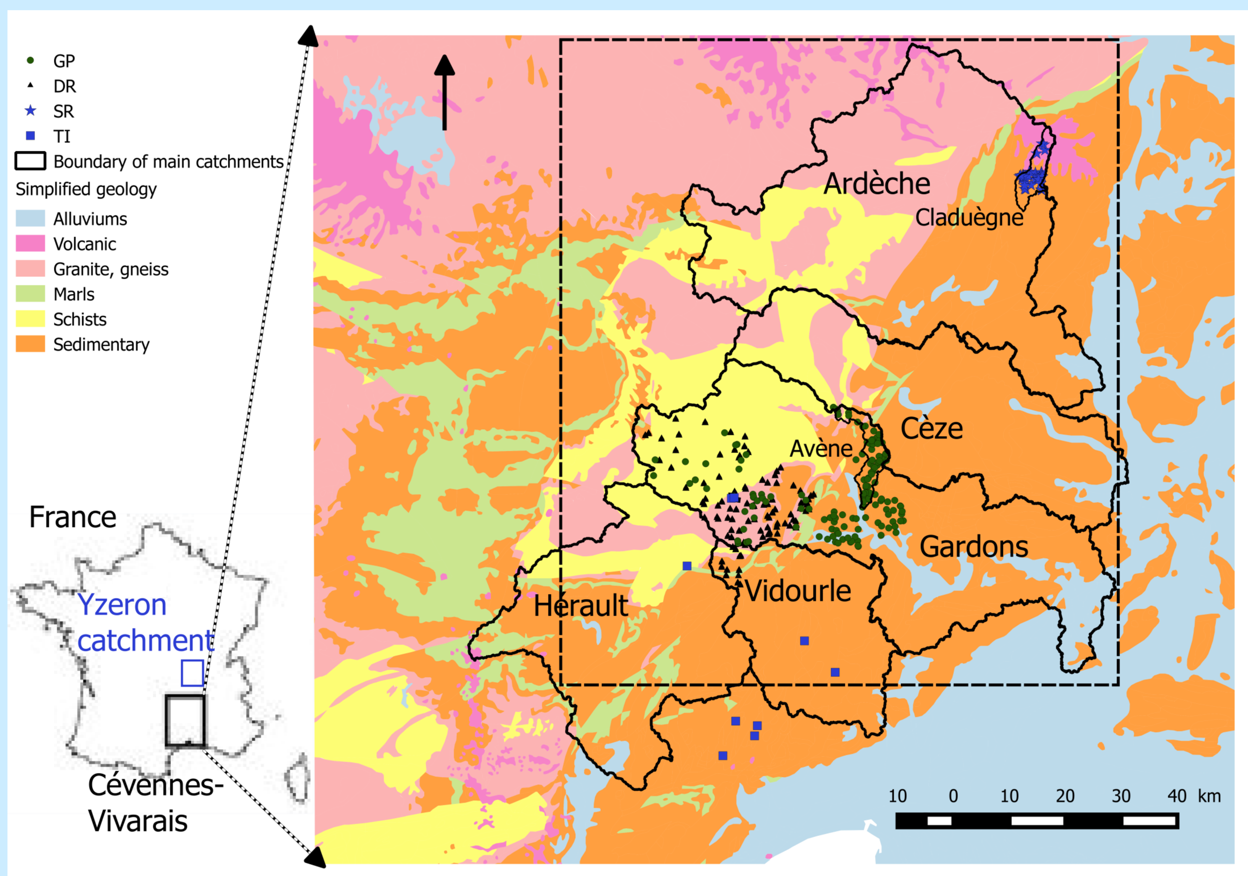

Figure 1: Location of the study areas in France and simplified geology map of the Cévennes-Vivarais region. The dotted black rectangle corresponds to the location of the land cover map. The infiltration methods are Guelph Permeameter (GP), Double Ring (DR), Single Ring (SR) and Tension Infiltrometer (TI).

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3. POOLING INFILTRATION MEASUREMENTS

- Raw data show significant difference in distribution among methods (Fig. 3) so pooling the data requires specific treatments

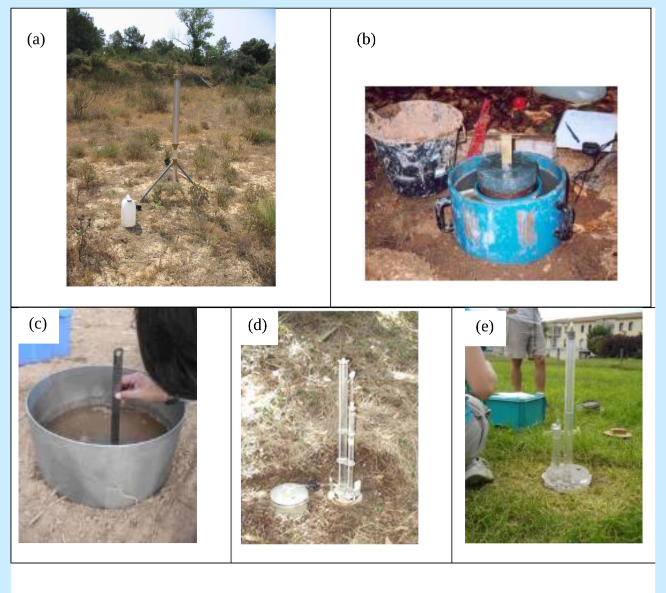


Figure 2: Photos of the various infiltration methods (a) GP; (b) DR; (c) SR; (d) TI where the disk has been removed from the tower (SDEC, SW 080 B); (e) Home-made TI from IGE.

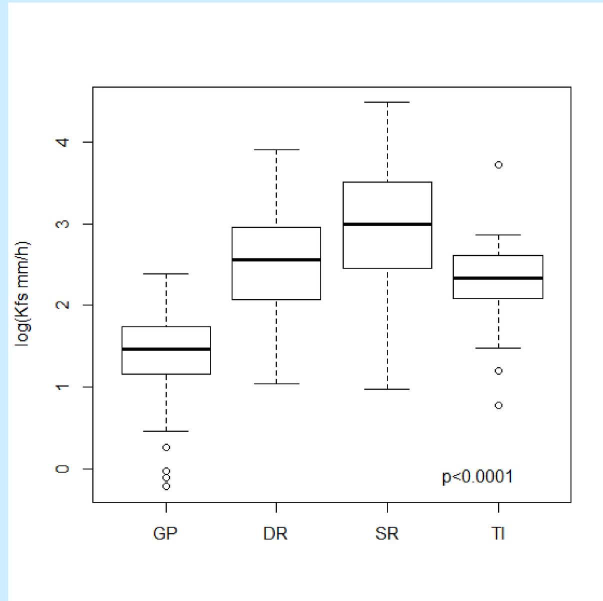


Figure 3: Boxplot of original K_{fs} data per method

A two steps method for pooling K_{fs} data from various methods:
- Pooling of GP and DR data by geology * land use (Desprats et al., 2010, Fig. 4) and conversion of GP data to equivalent DR data
- Pooling SR and DR + TI data (Fig. 5) to get a final set of homogeneized equivalent DR +TI data set

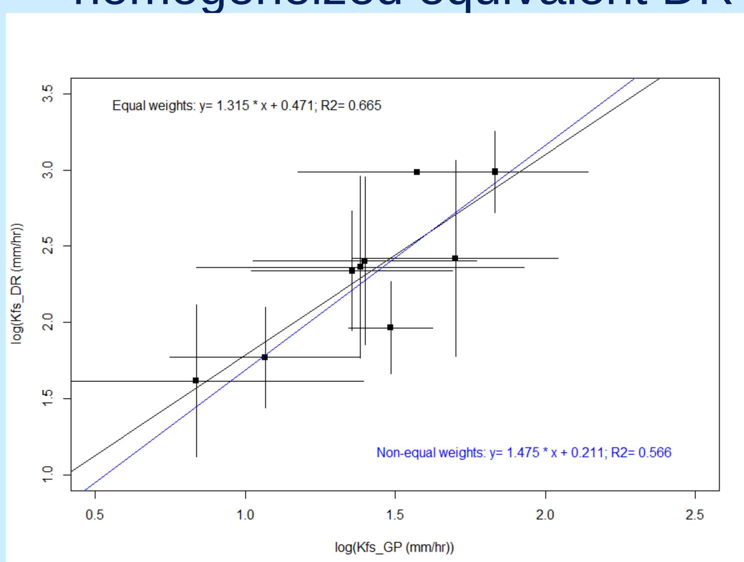


*Figure 4: Regression between log(Kfs) (mm h-1) for GP and DR infiltration methods. The points are mean values per geology * land cover classes and the vertical and horizontal lines correspond to one standard deviation.*

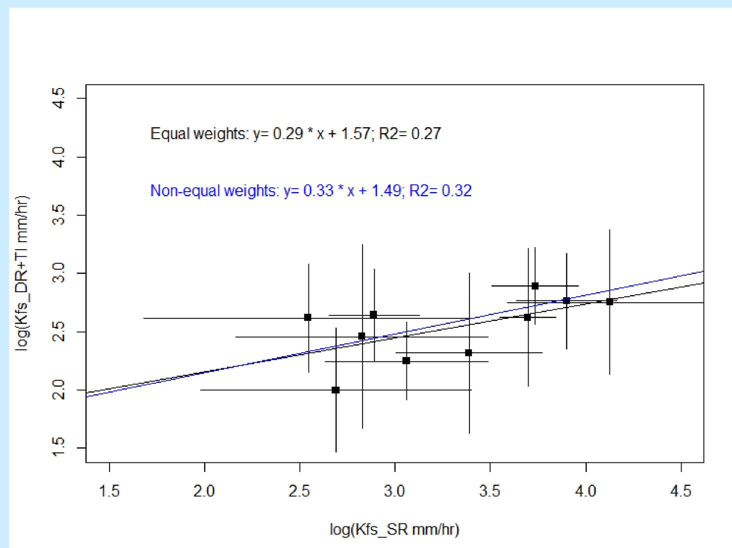


*Figure 5: Regression between log(Kfs) (mm h-1) for SR and DR +TI infiltration methods. The points are mean values per geology * land cover classes and the vertical and horizontal lines correspond to one standard deviation.*

5. MAPPING TOPSOIL K_{fs}

Mapping method
- Field data analysis show that geology and land use are significant explaining factors of K_{fs} and one value is assigned by geology * land use class (Fig. 6)
- Geology and land use were used to produce a map of K_{fs} (Fig. 7a) that is compared to a map derived from Rawls and Brakensieck (1985, RB85) pedotransfer function (Fig. 7b) based on a pedology map with associated soil data base including information about soil texture

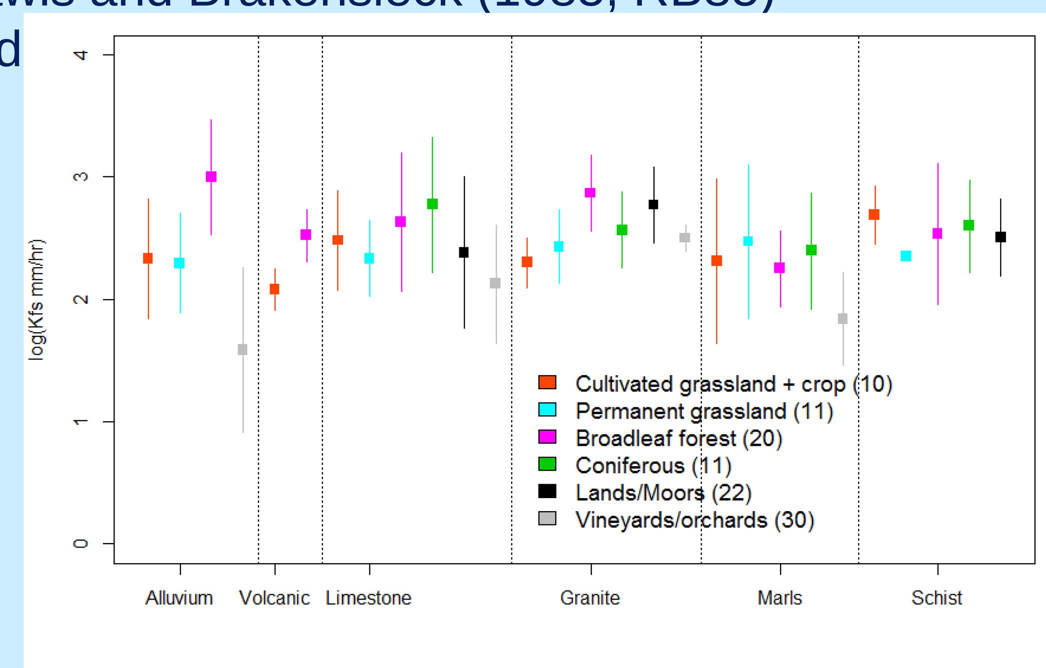
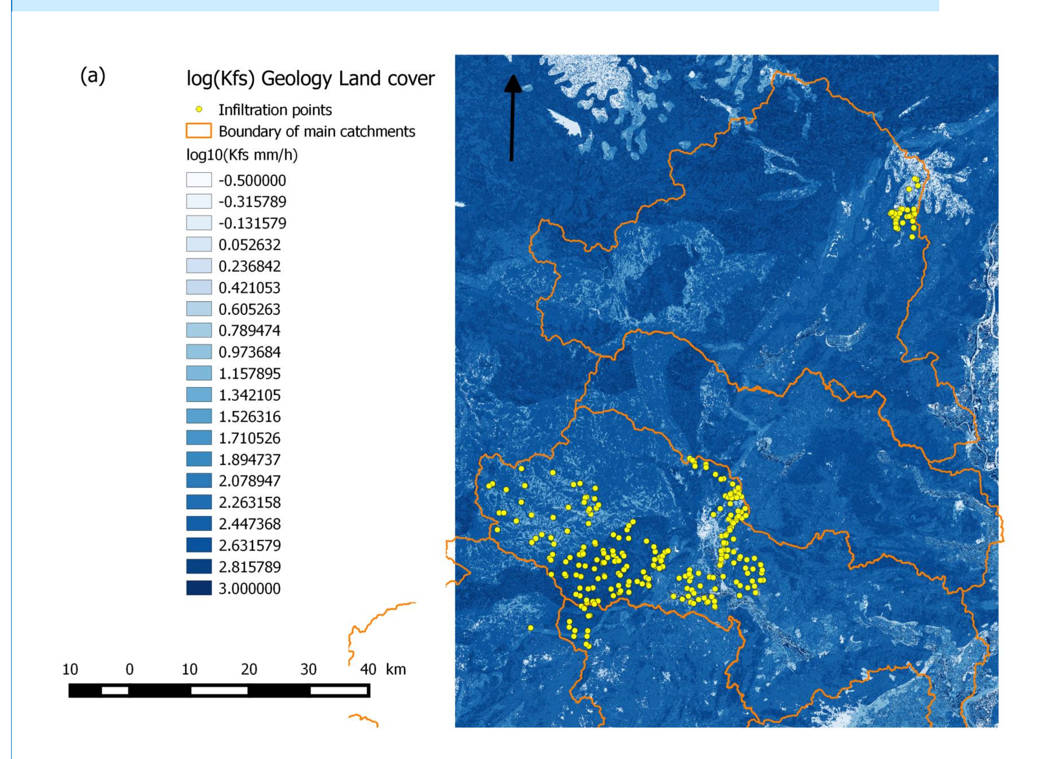


Figure 6: Bar plot of average log(K_{fs}) (mm h^{-1}) plus one standard deviation for the different combinations of geology and land cover derived from the final homogenized data set.



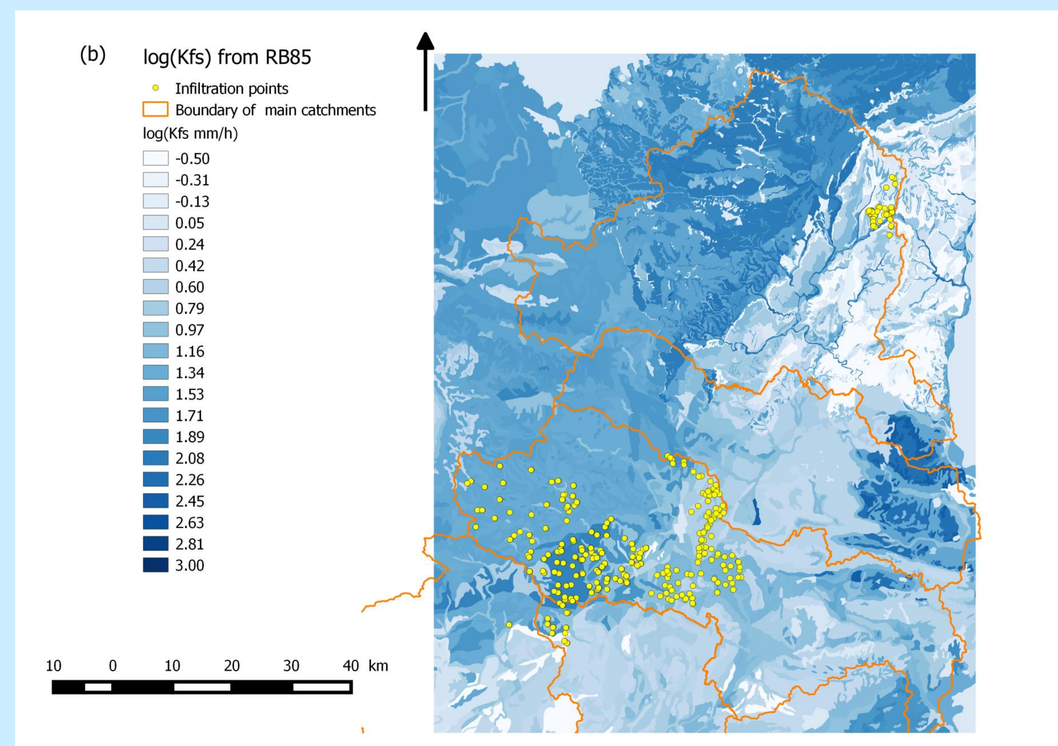


Figure 7: Maps of log(Kfs) for part of the Cévennes-Vivarais region using (a) the geology and land cover maps and the results of Fig. 6 and; (b) the pedology map and Rawls and Brakensieck pedotransfer function RB85.

Comparison of maps
- A pattern more governed by land use resolution (30 m) for Fig. 7a and more related to the pedology map for Fig. 7b
- Lower range and lower absolute values with RB85 pedotransfer function
- RB85 values not representative of field in situ measurements (Braud et al., 2017)

6. CONCLUSIONS AND PERSPECTIVES

- A method was proposed to pool infiltration measurements of K_{fs} obtained with different techniques
- Geology and land use were found to be discriminant factors explaining the variability of K_{fs}
- Geology and land use can be used to map K_{fs}
- Perspective: use the map in a distributed hydrological model to assess if flash flood simulation is improved as compared to the use of pedotransfer functions

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