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1 **ESPERE, a multiple-method Microsoft Excel application for estimating aquifer**

2 **recharge**

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13 Natural groundwater recharge mainly comes from the fraction of rainfall that infiltrates

14 and replenishes the aquifer. Methods described in the literature for estimating it (e.g.,

15 Healy 2010) vary in terms of the time scale and the nature of the data they treat. To

16 obtain both a realistic estimation of groundwater recharge and a confidence interval

17 at the hydrogeological basin scale, it is important to use a variety of approaches that

18 complement each other (Scanlon et al. 2006).

19 The Microsoft Excel application ESPERE was developed for this purpose. It includes

20 several commonly used methods that are run simultaneously to estimate the

21 recharge of an aquifer. Depending on the available data, the user can choose which

22 methods to apply: empirical methods, such as the one proposed by Turc (1954); the

23 water budget method presented by Thornthwaite (1948) and improved on by

24 Dingman (2002); the water table fluctuation (WTF) method (Delin 2007): and the

25 three streamflow time-series treatments proposed by Gustard et al. (1992), Chapman

26 et al. (1996) and Eckhardt (2005).

27 The user fills in a table with a few parameter values, such as the surface of the

28 catchment area, the soil maximum storage capacity (needed for the water budget

29 methods), the infiltration/effective rainfall ratio, or the specific yield (for the WTF

30 method only). The user then provides daily time-series data for at least precipitation

31 and potential evapotranspiration and, if available, data for temperature, main river

32 streamflow at the catchment outlet, and groundwater level. Daily effective rainfall and

33 recharge values previously calculated using other models can also be supplied in

34 order to be included in the final graphs for comparison of results.

35 ESPERE presents a separate result worksheet for each method, which includes a

36 short text describing the method. A summarizing worksheet compiles tables showing

37 the results of all the methods applied. When possible, results are presented at

38 different time steps (daily, monthly, inter-annual monthly mean, annual). Spatial

39 scaling is done automatically, which allows the results of all the methods to be

40 compared for a given recharge area. The calculated recharges are also converted

41 into annual infiltrated volumes to enable later comparison of several aquifers. To

42 facilitate a comparison among methods, the results are automatically displayed as

43 bar graphs. Finally, several descriptive statistical elements (mean, maximum,

44 minimum, standard deviation, median, and top and bottom deciles) are generated for

45 comparison of the annual infiltrated volumes in the form of tables and box plots.

46

47 **About ESPERE**

48 Both light and complete version of ESPERE_1.5 were developed in Visual Basic for

49 Applications with Excel Office 2010 within Windows 7. The complete version requires

50 XLSTAT© by Addinsoft for the post-process on statistical analysis. ESPERE_1.5 is

51 freely available (in both French and English) on request from espere@brgm.fr.

52

53 **Acknowledgment**

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57 **Supporting Information**

58 Appendix S1: ESPERE User Guide.

59

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