Impact of River Seine on Groundwater Temperature in the aquifers of Paris area (France) : Extent, Attenuation, and Phase Lag of Seasonal Variation

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The city of Paris has decided in 2007 to take action to reduce greenhouse gas (GHG) emissions and presented its Climate and Energy Action Plan, promoting a major turning point in urban planning for global energy efficiency. One of the objectives to be achieved by 2020, is to reach 30% renewable or recovered energy in its energy consumption. Within the research program “Paris2030”, we promoted a study dedicated to the evaluation of the direct use of thermal water from the local low enthalpy reservoirs. Because the coefficient of performance (COP) for geothermal heating/cooling systems is a direct function of intake water temperature, it is important to be confident in the spatial temperature distribution of the main targeted aquifer and at this stage, too few measurements are available. Moreover, in aquifers that are hydraulically connected to rivers that have water flux into the aquifer, which is the case for the river Seine due to the high water intakes and strong depletion in the center of Paris, the local aquifer temperature can show seasonal variations. This project is focused on the thermally-altered, near-river zone of such multi layer aquifer system, where a steady state hydraulic regime described by a piezometric map is available. We use numerical methods to examine the extent of seasonal variation in temperature into the aquifer, and the attenuation and phase shift of the signal with distance from the Seine, which temperature oscillates in between 5 and 25°C. It is shown that in some areas the heat transport is driven mostly by advection, and is dependent on the hydraulic gradient between the river and aquifer. This might be of high practical value to help to delineate the extension of the zones where the temperature signal is in phase with the river. In such areas, the heat pump system will be extracting water that is warmer than desired for cooling, and cooler than desired for heating, resulting in a loss in system efficiency.