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The use of Thermal Infrared Imaging to identify low-thermal groundwater inflow in mountain stream.

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Thermal infrared imaging technique is widely used in hydrological research for different purposes: detection of groundwater inflow into stream or sea; estimation of soil moisture, characterization of vegetation type, etc.
In this study a ground-based thermal imaging camera FLIR P620 is used to identify low-thermal groundwater inflow in creek in a mountain region.
The test area is located in northern Apennines of Italy. Due to the geological history and the current geological setting of the mountain chain, it is relatively common to find thermal springs, which are characterized by anomalously high salinity and temperature. The latter, it is due to the depth of the groundwater circuits. Many of these springs were already known during Roman times when they were used for curative purposes and the surrounding areas were a source of hydrocarbons (they are often associated with methane and oil natural spills).
Normally the thermal springs are located in fault zones. In some cases they are located along the slope or in other cases, they are located directly at the bottom of creeks and interfere with streams.
The locations of the thermal springs have different impact for different aspects. For the archaeology could be important to find new area of research; for hydrology could be important to study base flow and water quality; for biology and ecology could be important to study different aquatic ecosystem; for engineering could be important to find new energy resources for local communities.
The aim of the study was to localize thermal springs that inflow into a creek inside the Gova tectonic window (Upper Secchia river basin) which is characterized by a canyon morphology and by the outcropping of faulted and fractured sandstones that are bounded by clay formations. The mean altitude of the test site is 800 m a.s.l. The mean annual temperature is 8°C and the total amount of rainfall is 1,300 mm. The normal springs are characterized by water with mean temperature around 8°C and electrical conductivity from 100 to 1000 μS/cm. The thermal springs are characterized by water with mean temperature of 20°C and electrical conductivity from 10,000 to 20,000 μS/cm.
Two field surveys were realized in summer 2010 and in winter 2011. These two periods were selected because coincident with the low flow periods of the creek. Due to the high difference in temperature, between the groundwater and the water of the creek, that is around 15 degree, the winter season was the most favourable time to detect the thermal springs. During the surveys more than 10 thermal springs were detected inflow at the bottom of creeks. They generally inflow into the creek as a discrete point of discharge or, in some cases, as a diffuse seepage. In two cases, where the discharge of the springs were higher, thermal plumes with the length of some meters could be identified in the water of the creek.