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The thermal regime of abandoned channels: a preliminary analysis towards a water temperature model for the Allier River, France

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The growing recognition of the ecological and water quality significance of river water temperature led to a large number of studies assessing thermal processes in streams and rivers. Yet, thermal processes in abandoned channels, which play an important role in maintaining water quality and biological diversity in fluvial corridors, have received minor attention. This study evaluates water temperature regimes in three abandoned channels of the Allier River, France, and quantifies the regime sensitivity to climatic (air temperature) and hydrological (surface and subsurface flow) influence. Analysis was conducted at annual and daily scales, and at two distinct sections of each abandoned channel: (i) the downstream section, which is well connected to the main stream channel, and (ii) the upstream section, which is poorly connected to the main stream channel and hence subject to greater influence of subsurface flow. Annual and daily water temperature regimes for all channels and sections were classified based on relative differences in the 'shape' (timing) and the 'magnitude' (size) of the thermographs. The climatic and hydrological sensitivity of water temperature regimes was quantified using a Sensitivity Index. Analysis at the annual scale revealed relative similarity in patterns of thermal response over time, with clear differentiation between upstream and downstream channel sections in all sites. Water temperature regimes in the upstream channel sections were strongly linked to subsurface water temperature in terms of both timing and size of the annual thermograph; water temperature regimes in the downstream channel sections were more sensitive to air and river water temperature, especially regarding the timing of the annual regimes. Although annual regimes of water temperature exhibited distinct patterns that were similar across sites and over time, analysis of daily water temperature regimes revealed broad differences within and between sites. Day-to-day sequencing of similar classes of diurnal regime varied over the year, and between consecutive years. Furthermore, the direction and strength of climatic and hydrological sensitivity of daily water temperature regimes varied over time, and between sites. Temporal and spatial variability of diurnal regime class sequencing and sensitivity indicates complex climatic and hydrologic influence on water temperature variability, strongly related to the morphology of each site. Identifying thresholds of climatic and hydrologic influence, as well as temporal and spatial variations in the strength of climatic and hydrologic influence, is the key to further development of predictive models of water temperature in the abandoned channels of the Allier River.