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Water quality responses under droughts and heatwaves in river basins worldwide

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River water quality is strongly affected by droughts and heatwaves worldwide. However, these effects have only been studied in a small number of river basins and regions, mainly in the US, Europe, or Australia. In this study, we analyse the large-scale responses in river water quality under droughts, heatwaves and compound events for 300,000+ water quality monitoring stations worldwide between 1980-2021. We include 16 water quality constituents in the analysis, grouped into general constituents (e.g. water temperature, salinity, dissolved oxygen), biological constituents (e.g. faecal coliform, biochemical oxygen demand) and emerging contaminants (e.g. pesticides and pharmaceuticals). Further, we assess the water quality responses to droughts and heatwaves in relation to climate, land use and level of wastewater treatment. We find a general deterioration in river water quality under droughts and heatwaves globally for most types of water quality constituents, with on average higher water temperatures (+27%), increases in salinity (+23%) and lower concentrations of dissolved oxygen (-17%). We also find that climate type, land use and level of wastewater treatment have a significant effect on the magnitude of water quality responses under droughts and heatwaves. The median increase in river temperature under compound drought-heatwaves strongly depends on climate, with for example higher increases in the Polar climate zone (+4.5°C) compared to the Tropical zone (+2.1°C). Increases in salinity under droughts are on average twice as large in irrigated regions compared to non-irrigated regions. Phosphorus and nitrogen concentrations in rivers can either increase or decrease during drought events, depending on the type of nutrient form (dissolved versus particulate) and land use (urban versus rural). Higher levels of wastewater treatment lead to a stronger reduction in faecal coliform (an indicator of pathogens) during droughts and heatwaves. Compared to previous local and regional-scale analyses, this study provides a more consistent and broader understanding of how droughts and heatwaves affect river water quality. In addition, the results from this study could be used to validate large-scale models of river water quality under droughts and heatwaves.