Drought drives DOM reactivity in intermittent streams

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Introduction

In lotic ecosystems drought periods strongly influence the availability of Dissolved Organic Matter (DOM) in terms of quantity and quality (Von Schiller et al., 2015) . Within this context, the study explores the relationship between DOM quality and Net Ecosystem Production (NEP) in a pool which is disconnected from the river continuum during drought episode. It is expected that the increase of Water Residence Time (WRT), as a **consequence of drought, will enhance the transformation of DOM inside the pool . We hypothesize that the Hyporheic Zone (HZ) is a hot spot of DOM transformation and the interaction with the HZ and the pools is crucial for this qualitative heterogeneity.**

Methodology

- 13 sampling campaigns over 2 months of surface and hyporheic waters coupled to continuous measurements of Electrical Conductivity (EC) Dissolved Oxygen (O_2) and Coloured (C)DOM.
- The field site (Fig.1) is characterized by a permeable streambed and impermeable bedrock, which interrupts the surface-hyporheic connectivity during drought periods and maintains surface water captured in small pools.
- The pore water of the HZ was pumped from PVC tubes installed at a depth of 50cm in the stream bed (Fig.2).
- The samples were analysed for Dissolved Organic Carbon (DOC) concentration and its optical properties.
- NEP was calculated from the continuous measurement of DO and temperature with a reaeration coefficient k calculated for every night.
- The Fluorescence Intensity (FU) was measured in situ with a Turner Cyclops-7 Sensor for CDOM (mainly terrestrial derived DOM), which measures 470 emission at 325 excitation. The results were corrected by temperature according to Watras et al. (2011). The measured fluorescence intensity gave good correlation with the analysed DOC concentration (Fig. 3); however the under-estimation of autochthonous substances (blue line) was clearly visible in the data.
- The Chemical Index (CI) [$CI=\ln(O_2/NH_4)$] as described by Vazquez et al. (2010) was used as a surrogate for REDOX conditions.

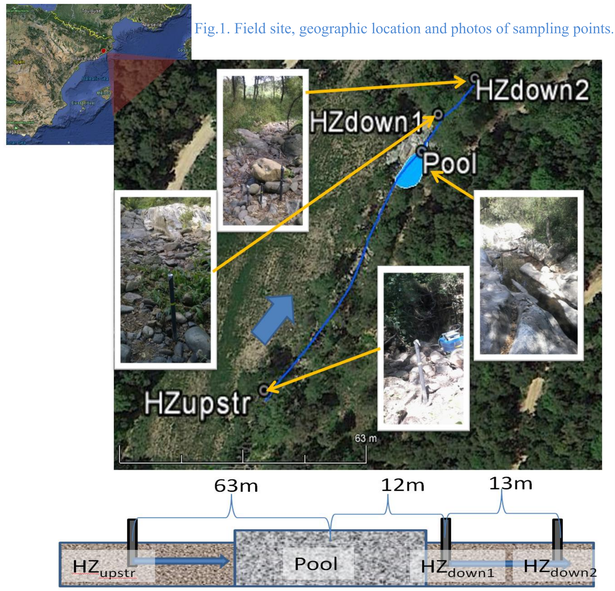

Fig.1. Field site, geographic location and photos of sampling points.

Fig.2. Schema of sampling location with sampling

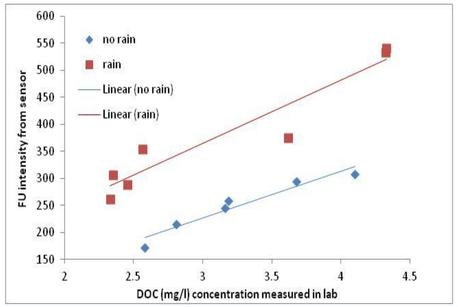

Fig.3. FU measured with fluorescence sensor compared to DOC concentration measured in the laboratory. Clearly visible the rain effect contributing terrestrial DOM.

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Results

EC offered a good discrimination between phases of connection and disconnection (Fig. 4). The HZ upstream is disconnected as soon as there is no surface flow anymore and the DOC concentration upstream decreases with drought. At flow conditions the HZ has the same DOC concentrations as the pool, but **during drought the DOC concentration in the HZ is lower.**

The **NEP is negatively correlated with DOC concentration during flow conditions**, but this relationship is not as evident during fragmentation (Fig. 5).

The **disconnection of the pool** (red arrow) from the HZ upstream **resulted in a facilitation of DOM transformation** and increase in aerobic and anaerobic respirations.

During the transition phase, **protein-like DOC was identified in the HZ** downstream of the pool. Autochthonous production raised there too (blue arrows) and even exceeded total DOC concentration of the pool (Fig.7) when the conditions were anoxic and very reduced (Fig.6).

The **pool** shows higher **Fluorescence Index** (FI) values during flow condition, while they are **lower than in the HZ during drought** (Fig. 8).

Fig.8. FI relative to HZupstr in the different sampling points during flow and no-flow conditions. During flow conditions the FI in the pool is higher than in the HZ, contrary to no-flow conditions.

Conclusions

- The **NEP** is not limited by the total amount of DOM, but by the **quality of DOM**. The negative relationship **during flow** condition is assigned to the **recalcitrant** nature of terrestrial DOM, which is not sufficiently processed due to low WRT.
- When there is no surface flow the DOM turns less recalcitrant. Additionally **during drought the HZ is an important source for autochthonous production of DOM**, showing higher FI values than the pool, but the overall **concentration depleted**. During surface flow DOM quality in the HZ, the pool and the stream water are similar.
- The **most relevant changes in DOM quality** occurred at the **transition phase** from surface flow to no-surface flow. These changes are related to **reducing conditions in the HZ** which seem to be a consequence of enhanced autochthonous production of DOM and therefore represent a Hot Moment.

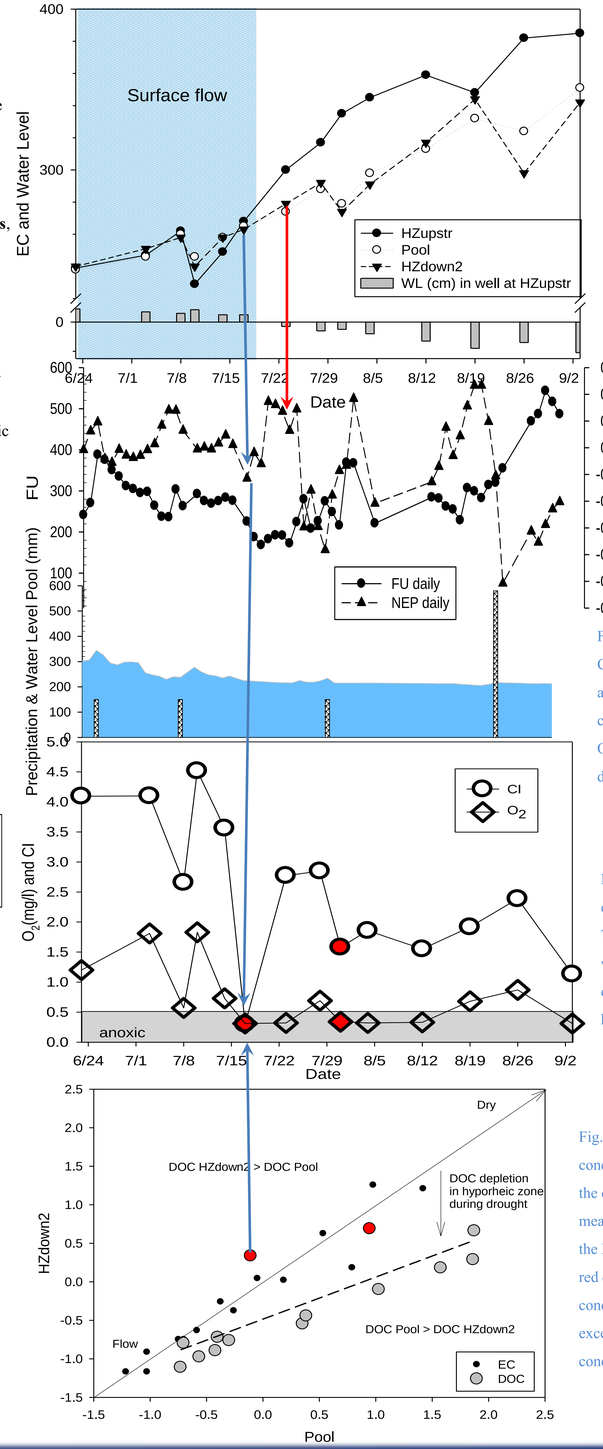

Fig.4. EC over time at HZupstr, Pool and HZdown2. The water level inside the well at HZupstr is referred to the surface and indicates when upstream is dry.

Fig.5. Measurements from CDOM probe , water level and NEP, calculated from continuous measurements of O_2 installed inside the pool during sampling period.

Fig.6. Cl and O_2 concentrations at HZdown2. The 2 sampling campaigns with lowest REDOX potential during transition time had the highest DOC concentrations.

Fig.7. Standardized EC and DOC concentrations measured during the different sampling campaigns measured inside the Pool and in the HZ 20m downstream. The red dots indicate DOC concentration in the HZ exceeding the DOC concentration in the pool.