Influence of hydrologic processes on spatial patterns of nitrogen in an arid stream of Southeast Spain

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Introduction
Spatial variability in nutrient concentrations has often been observed according to the extremely heterogeneity of streams. However, most work has focused on temporal variation. An interest in the causes and consequences of spatial variation in streams increases, there is growing recognition of the need for more spatially explicit data sets and for quantitative analyses of these data. Nitrogen is the focus of our study because of its high natural content in sedimentary watersheds of Murcia Province.

Our objectives are:
- To determine the nitrogen content in the surface water of Chícamo stream over different hydrological conditions (base flow, rainfalls, low flow).
- To analyze the nitrogen spatial variation patterns at different spatial scales (watershed, reach; permanent and temporal, sub-reach).
- To know the degree of spatial dependence between sampling sites.
- To analyze the hydrology effect over nitrogen spatial variability.

Results

<table>
<thead>
<tr>
<th>Sites</th>
<th>Base flow</th>
<th>Rainfalls</th>
<th>Low flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent reach</td>
<td>12.0</td>
<td>37.9</td>
<td>86.9</td>
</tr>
<tr>
<td>Intermittent reach</td>
<td>50.4</td>
<td>12.2</td>
<td>68.1</td>
</tr>
<tr>
<td>Watershed scale</td>
<td>74.0</td>
<td>98.1</td>
<td>68.1</td>
</tr>
</tbody>
</table>

Spatial dependence of N-NO₃ at the watershed scale

- Base flow
- Rainfalls
- Low flow

Methods

A sampling survey was carried out along Chícamo stream, in a total of 30 samples station located 473 m apart as mean distance. Water samples were taken during 2003-2004 under different hydrological conditions, (base flow: permanent reach= 18 l/s; intermittent reach= 8-5.3 l/s; rainfalls: permanent and intermittent reach= 74 l/s; low flow: permanent reach= 17 l/s; intermittent reach= 0 l/s), by triplicates and analyses were conducted according to Standard Methods.

For the study at sub-reach scale, we used data from 1994. To analyze spatial and seasonal variability we used the variation coefficient (CV%) as an indicator of overall variation. To determine spatial dependence, we used the partial autocorrelation function (APC, partial) (SPSS ver. 12.0).

Conclusions

We hypothesized that high nitrogen content in upstream reaches Chícamo stream can be related with geological bedrock. Water nitrogen content in the intermittent reach was higher than in the permanent, under any hydrological condition, with the exception of rainfalls. In-rainfall was the dominant fraction.

As nitrogen concentration was very high at base flow, rainfalls produced a decrease of nitrogen content in surface waters (dilution effect), while the dry period produced an increase. Nitrogen spatial variability increased as water flow decreased. This was specially true for the intermittent reach, whereas rainfalls had an opposite homogenizing effect, decreasing nitrogen spatial variability.

Nitrogen spatial variability at watershed scale was higher than at intermittent reach scale > permanent reach

As temperature and precipitation were high (30°C, 300 mm), the natural cover of the watershed is open mediterranean scrub. Agricultural and urban activities are located downstream, close to the stream mouth, affecting to the stations located under 28 (figure 5).

Permanent and intermittent reaches are very different as it is summary in table 1.

Spatial variability of N-NO₃ (CV%)

- Watershed scale: 57.2
- Permanent reach scale: 3.4
- Intermittent reach scale: 56.1
- Sub-reach scale: 33.5

References

The Chícamo stream is located in the Murcia province, an arid type Mediterranean watershed of 502 km² with a permanent reach of 13.5 km, with a permanent (5.8 km) and intermittent (7.7 km) reaches. Climate is semi-arid mediterranean (mean annual temperature higher than 18 °C and annual precipitation of less than 250 mm). The natural cover of the watershed is open mediterranean scrub. Agricultural and urban activities are located downstream, close to the stream mouth, affecting to the stations located under 28 (figure 5).

Permanent and intermittent reaches are very different as it is summary in table 1.

Spatial variability of N-NO₃ (CV%) at different spatial scales and hydrological conditions

Table 1: Nitrogen concentrations at sampled sites (mg/l) intermittent reach scale (5).

Figures

- Figure 1: Distribution of sampling sites at Chícamo stream.
- Figure 2: Ombroclimatic diagram of EFM AMJ DJF JJA SON D.
- Figure 3: Samples sites location in the Chícamo stream.
- Figure 4: Samples sites location in the sub-reach.
- Figure 5: Spatial distribution of nitrogen at Chícamo stream.
- Figure 6: Conceptual model of nitrogen spatial heterogeneity in temporal and permanent reaches in relation to flow.