INTRODUCTION

Hydrology influences the nutrient supply, directly or indirectly, and other physicochemical environment characteristics that in turn affect productivity and nutrient dynamics. A change in hydrology can release nutrients to the open water system or atmosphere from the sediment and can affect nutrient uptake by plants (SCHLESINGER, 1991).

Danube floodplain controls the inputs into Danube Delta, which is the interface between Danube River System and North-West Black Sea. This complex of ecosystems provides goods and ensure services, having an important role in the functioning of the regional system Danube-Black Sea (VADINEANU & CRISTOFOR, 1994). Its functioning is strongly dependent on water discharges and flows, as well as water load, sedimentation, transport and erosion processes.

This paper presents preliminary results on the influence of hydrological regime on nutrient dynamics in representative systems of the Danube floodplain.

METHODS

Thirteen stations were established in representative ecosystems of the Danube floodplain, in three transects (G, H, I). The following parameters were determined in a one year survey at each station: water level, soil humidity, pH and temperature (fortnightly), soil nitrate (5 replicates, monthly, with water extraction followed by phenoldisulfonic acid method), soil ammonium (5 replicates, monthly, with KCl extraction and indophenol blue method) and soil phosphate (5 replicates, monthly, with NaHCO₃ extraction and green malachite method).

RESULTS AND DISCUSSIONS

In order to compare the dynamics of the nutrients and of the water level we used clustering methods. Fig. 1a shows the tree diagram obtained in the case of the water level. Stations are
grouped in accordance with the type of system in which they are placed (table 1). The clusters for nutrients were obtained in two ways. In the first variant the stations were grouped in function of the concentrations standardized within each station. That means that the effect of the absolute values of the nutrient concentrations on similarities was minimised, and that the importance of the synchronisation of variations was increased. The cluster looks as a chain (Fig. 1b), without strong separations. Stations are grouped by transects, excepting for H2 which show a peculiar behaviour. Transects G and I are in the same cluster and are relatively well separated from transect H. In the first variant the stations were grouped in function of the concentrations standardized for all stations, i.e. the standardization was done using a single average value and SD of a nutrient, obtained with data from all stations. Now the computed similarities will take into account differences in the absolute value of the concentrations. In the new diagram (Fig. 1c), one can remark similarities with the diagram obtained for water level. The shore stations and the levee stations are better separated, excepting for transect G, in which all the stations are very similar from nutrients point of view. We suggest that this is due to the human impact registered at this transect. H2 preserves its distinct position, being even more separated from the other stations. H4 and H5 are very similar and well separated from other internal units.

Table 1 Synthetic characterisation of the studied systems.

<table>
<thead>
<tr>
<th>Parameter/station</th>
<th>H1</th>
<th>H2</th>
<th>H3</th>
<th>H4</th>
<th>H5</th>
<th>I1</th>
<th>I2</th>
<th>I3</th>
<th>I4</th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of system</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Direct anthropic impact</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Water speed when flooded</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Soil type</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>

LEGEND

Type:
1 = shore
2 = natural levee
3 = internal zone of intermediary altitude
4 = depression
5 = exbowl lake
6 = internal zone isolated by artificial levee

Anthropic impact:
0 = none
1 = low
2 = high
3 = very high

Soil type:
1 = sandy and silty strips alternating
2 = sand and silt in equal parts, >90%
3 = clay, >90%

Water speed when flooded:
1 = high, 2 = low 3 = low or stagnant

Another way to point out the influence of the hydrological conditions, expressed as water level and soil humidity, on nutrients, is by correlation. In Fig. 1 one can see the regression matrix for the annual averages of parameters describing hydrology, nutrients, soil pH and soil temperature at the studied stations. The negative correlation between nitrate and water level (Fig. 1d) and the positive one between nitrate and phosphate, are in fact due to an outlier, H2.
Fig. 1 Cluster diagrams for dynamic of nutrients and of the water level (1a-1c). Water level vs. nitrate in soil (1d). Ammonium in soil vs. soil temperature, with the position of the different types of stations (1e). Soil humidity vs. soil pH vs. ammonium in soil (1f). Correlation matrix (1g)
Values of p under brackets characterise the regressions after eliminating this point. The general trend remains, but the statistical significance is lost. The correlation between soil temperature and ammonium is not depending on outliers (Fig. 1e). The hydrological regimen influences both parameters, directly or indirectly, by the vegetation cover. At opposite sides are situated two groups of stations: depresionary stations (H4-5, lower soil temperature, higher ammonium concentrations) and shore stations (higher soil temperature, lower ammonium concentrations). The strongest relationship is that between soil pH and soil humidity (Fig. 1f). The internal stations H3-H5 have the lowest pH and the highest soil humidity, at the other extreme being situated G2. The special behaviour of H4 and H5 is due to the longer period of flooding per year, to the soil granulometry and to their location not allowing high export of litter.

CONCLUSION

The dynamic of nutrients is directly and indirectly influenced by the hydrological conditions. In internal stations high similarities in hydrology were associated with similarities in nutrients dynamic. The stations located on natural levees are more different in this respect, in spite of their similar hydrology. There are also other factors controlling the nutrients behaviour, among which the soil type and anthropogenic impact.

ACKNOWLEDGEMENTS

This research was supported by EC-DG XII in the frame of the programme Functional Analyses of European Wetlands Ecosystems (Suppl. Agreem. ERB CIP DCT940108 to ERB EV5 VCT940559).

REFERENCES


First author address: Carmen POSTOLACHE - Bucharest University, Dept. of Ecology and Environmental Management, Spl. Independentei 91-95, 76201, Bucharest 5, Romania Phone/Fax: (40) 1 312 2310, Email: carmen@bio.bio.unibuc.ro