ATMOSPHERIC NITROGEN INPUT IN TEMPERATE HARDWOOD FORESTS IN CHILE AND FLANDERS

Jeroen STAELENS¹, An DE SCHRIJVER¹, Carlos OYARZÚN² & Noël LUST¹

¹Ghent University, Laboratory of Forestry, Geraardsbergsesteenweg 267, B-9090 Gontrode, Belgium. E-mail: jeroen.staelens@rug.ac.be
²Universidad Austral de Chile, Instituto de Geociencias, Casilla 567, Valdivia, Chile.

Abstract: Although nutrient cycling in pristine temperate forests of southern Chile is largely undisturbed by atmospheric contamination, agricultural activities in south-central Chile are strongly expanding. Deposition monitoring is therefore a necessary tool to analyze temporal and spatial trends, in order to evaluate the consequences of emission changes. Total atmospheric nitrogen input to forest ecosystems is the sum of (i) wet deposition of precipitation water, (ii) dry deposition of aerosols and gases on the forest canopy, and (iii) fog and cloud deposition. Using the throughfall method, total atmospheric input of inorganic nitrogen was estimated to be about 9 kg N ha⁻¹ y⁻¹ in Chile and 38 kg N ha⁻¹ y⁻¹ in Flanders.

Introduction

The chemistry of incident precipitation is often considerably altered after its passage through forest canopies. Compared to bulk precipitation, water that reaches the forest floor as throughfall and stemflow is (i) enriched in certain chemical elements because of wash-off of dry deposition on the canopy from aerosols and gases, and (ii) enriched or depleted because of canopy exchange, i.e. release and uptake of ions from plant tissues. It has been well documented that nitrogen can be absorbed by tree canopies from atmospheric input (Johnson & Lindberg, 1992). While nitrate uptake is often assumed to be negligible, ammonium retention is believed to cause ion-exchange reactions with other ions present in the foliage (Stachurski & Zimka, 2002).

Materials and methods

Water and nutrient fluxes in bulk precipitation, throughfall, and stemflow were measured in two deciduous beech forests, located in regions with different air pollution characteristics and strongly differing in soil acidity and soil base saturation. For the Fagus sylvatica L. stand (Flanders), contribution of dry deposition and canopy exchange to net throughfall flux was estimated by a canopy budget method (Draaijers & Erisman, 1995), while canopy uptake of inorganic nitrogen in the Nothofagus obliqua (Mirbl.) Bl. stand (Chile) was estimated by a linear regression model (Johnson & Lindberg, 1992). As both
forest stands were low elevation plots without frequent fog events, cloud and fog deposition were not measured or estimated.

**Results**

Bulk deposition of inorganic nitrogen was significantly higher (p < 0.001) in Flanders than in Chile (Table 1). Nitrate input via rainwater was eighteen times higher in Flanders, and ammonium input via rain was eight times higher. Also inorganic nitrogen input to the forest floor was significantly higher in the Flemish beech stand (Table 1).

<table>
<thead>
<tr>
<th>Element</th>
<th>Chile</th>
<th>Flanders</th>
<th>Chile</th>
<th>Flanders</th>
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</thead>
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<td></td>
<td>BD</td>
<td>TF+SF</td>
<td>NTF</td>
<td>BD</td>
</tr>
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<td>NO₃⁻-N</td>
<td>0.3</td>
<td>1.5</td>
<td>1.3</td>
<td>5.4</td>
</tr>
<tr>
<td>NH₄⁺-N</td>
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<td>3.7</td>
<td>2.4</td>
<td>10.5</td>
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<td>Organic-N</td>
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<td>4.9</td>
<td>2.1</td>
<td>5.5</td>
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<tr>
<td>Total-N</td>
<td>4.4</td>
<td>10.1</td>
<td>5.8</td>
<td>21.4</td>
</tr>
</tbody>
</table>

Estimated canopy uptake of ammonium was 5 kg N ha⁻¹ y⁻¹ in Chile and 12 kg N ha⁻¹ y⁻¹ in Flanders. Estimated dry deposition was 7 kg N ha⁻¹ y⁻¹ in Chile, and 22 kg N in Flanders. Compared to Flanders, relatively more inorganic nitrogen was dry deposited as aerosol and gas than by wet deposition due to rain scavenging. Most of the NH₃ in the atmosphere appears to be a result of agricultural activities, mainly volatilization from animal wastes and fertilized soils (Johnson & Lindberg, 1992). Dry deposition of ammonia depends on factors as source height, wind speed, atmospheric stability, surface resistance and surface roughness length, while removal from the atmosphere by precipitation depends on temporal rain distribution (Asman, 1998).

Total atmospheric input of inorganic nitrogen was estimated to be about 9 kg N ha⁻¹ y⁻¹ in Chile, and 38 kg N ha⁻¹ y⁻¹ in Flanders. The results demonstrate that in both studied regions, dry deposition contributes to a considerable extent to total atmospheric nitrogen input in forests at agricultural sites.

**References**


