Report on National ICP IM Activities in Estonia

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ICP IM Programme has been carried out at two monitoring sites in Estonia since 1995. Vilsandi (EE01) area is located on Estonia's westernmost island (58º23´ N, 21º50´ E) and Saarejärve (EE02) is located at the forested sub-catchment area (109,2 ha) of Lake Saare in eastern Estonia (58º39´ N, 26º45´ E). During 2008 the Integrated Monitoring Programme continued at both of the ICP IM areas under a number of sub-programmes: AM, AC, PC, TF, SF, SC, SW, LF, VS, FD, EP, MB and BI at Vilsandi and, additionally, under RW and AL at Saarejärve (EE02) area.

2008 was ekstraordinarily rainy at both IM areas (Fig.1). Annual bulk precipitation amounts and all other measured water fluxes were the highest of the entire monitoring period (Table 1). In 2008 runoff fluxes from the 1. subcatchment of Lake Saare (EE02) were measured on a record 337 days. The runoff was frozen only 5 days in January, 6 days in February and 8 days in March. Last winter (2007/2008) was the warmest in the history of instrumental meteorological observation (142 years) in Estonia (Jaagus, 2009).

Table 1: Stand characteristics and average annual water fluxes (mm) in 2008 compared with the study period's average water fluxes (in brackets) in permanent plots at Estonian integrated monitoring areas.

Permanent plot	Vilsandi (EE01) pine stand	Saarejärve (EE02) pine stand	Saarejärve (EE02) spruce stand
Site type	*Fragario-Pinetum*	*Rhodococco-vitis-idaeo-Pinetum*	*Vaccinio-myrtilli-Piceetum*
Soil type	*Calcari-Gleyic Leptosol*	*Haplic Podzol*	*Haplic Podzol*
Age of dominant trees	100	120	90
Bulk precipitation	609 (510)	1021 (624)	
Throughfall	336 (226)	827.4 (513)	755.4 (430)
Soilwater amount from depth of 10 cm	138 (78)	69.8 (57)	166.3 (113)
Soilwater amount from depth of 40 cm	83 (67)	43.2 (25)	115.5 (74)
Runoff		230.5 (100)	

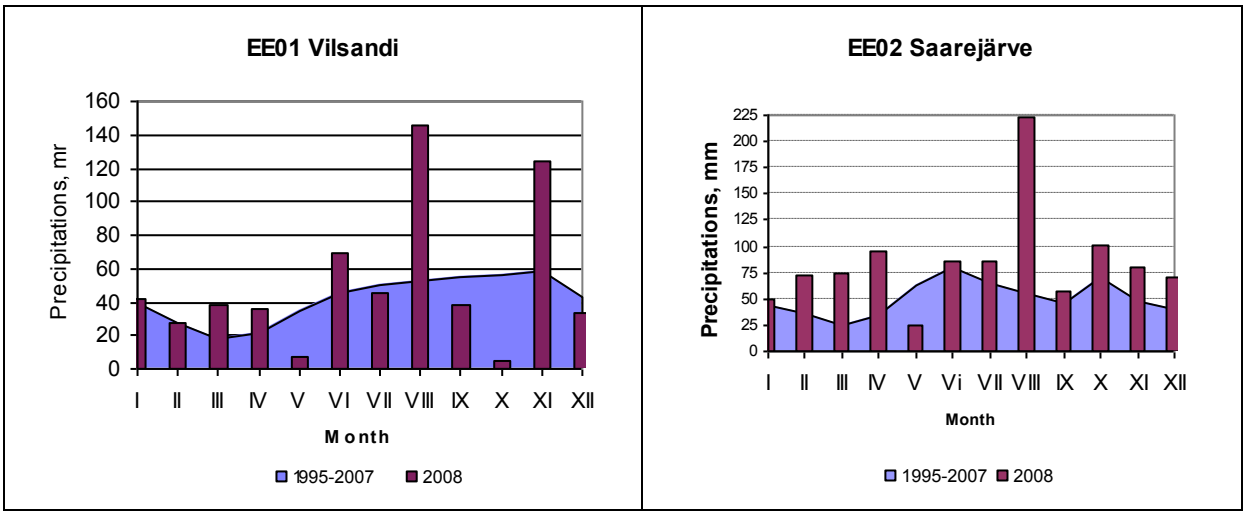

Figure 1. Monthly bulk precipitation of open area at Vilsandi (EE01) and Saarejärve (EE02) in 2008 and during the monitoring period (1995-2007).

Increased output of eutrophicating nutrients from catchment (EE02)

I subcatchment, situated in North-West of Lake Saare, is the largest (109.2 ha) out of 4 subcatchments and its runoff is richest in water (Table 1). Daily discharge of runoff was recorded using a calibrated V- shaped metal barrier. Runoff water samples were collected twice a month. Major anions (Cl^-, NO_3^-, and SO_4^{2-}) and cations (Na^+, K^+, Ca^{2+}, and Mg^{2+}) in the water were analyzed by ion chromatography. NH_4^+ was analysed by spectrophotometry, while alkalinity (HCO_3^-) and pH were measured potentiometrically. SiO_2 was determined using atomic absorption spectroscopy.

Concentrations of major ions (mostly calcium and bicarbonate, but also magnesium) were higher in the runoff water than in bulk precipitation and throughfall. Weathering of carbonate minerals is a major source for content increase of these ions. The positive outputs of Ca, Mg, HCO_3 and SiO_2 were correlated with higher runoff fluxes. Such input/output balances are characteristic to well buffered surface water that is not sensitive to acidifying deposition. High buffering capacity is characterized also by pH, which varied between 7.2 – 7.8.

The share of anthropogenic anions (SO_4^{2-} , Cl^- and NO_3) in runoff was low, only 16% of all anions on an equivalent basis. Since 2000 when average annual deposition SO_4-S has been 4-5 kg per ha, net release of S from the catchment has been occurred. In the last two years with higher runoff fluxes net release of S was 5 kg per ha in 2007 and 4.2 kg per ha in 2008.

In the mild winter of 2007/2008 high concentrations of NO_3-N (Fig. 2) and Ntot were recorded in runoff water, in bulk precipitation and in throughfall of pine and spruce stands during winter months. High deposited loads (2.8 kg NO_3-N and 8.8 kg N_{tot} per ha) with high runoff water fluxes resulted in the positive output of NO_3-N from the catchment area. The enrichment of NO_3-N in runoff was 2 kg per ha in 2007 and 3.2 kg per ha in 2008. On the previous period (1994-2006) on average 58% of the NO_3-N deposition was retained in the catchment area. Concentrations of NO_3-N in the runoff water were higher in winter months (Fig. 3). In 1999-2006 from the average of 6 kg Ntot deposited, only 1.5 kg per ha flowed into the lake: the retention varied between 74 and 85%. In the warm November and December of very rainy 2008 retention of Ntot was only 46% and about 4 kg N per ha reached the lake.

Nutrients originating from mineralization and deposition reach the lake during mild winter months in considerable amounts due to lack of consumption by vegetation in dormant period, and this will cause some extra eutrophication of the lake.

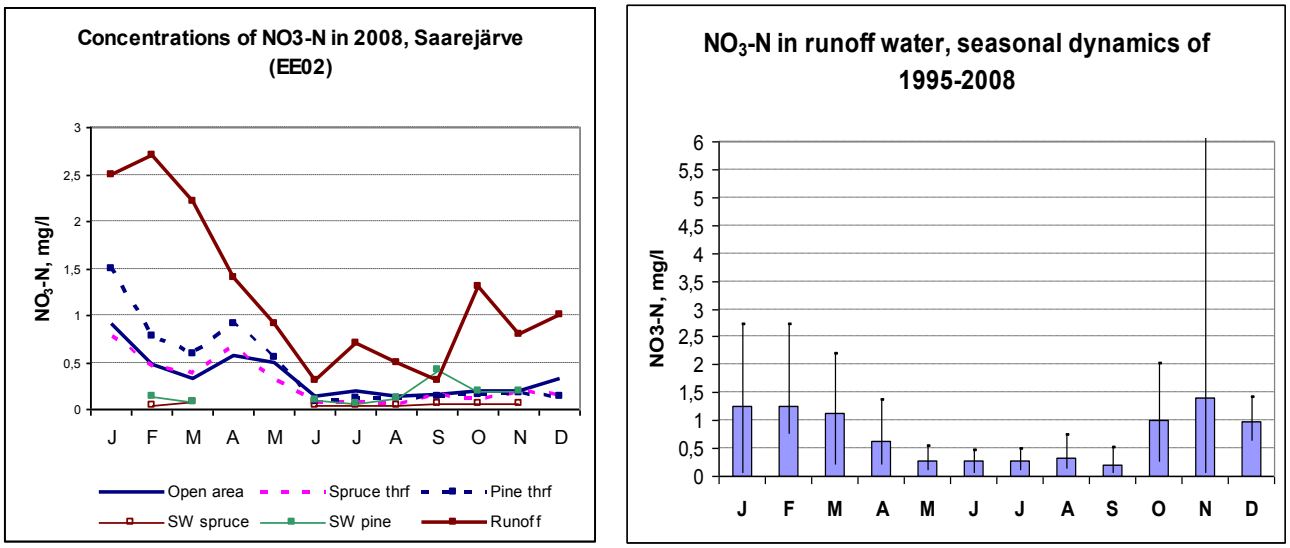

Figure 2. Concentrations of NO_3-N in various fluxes: bulk precipitation, throughfall in spruce and pine stands, runoff, and soil water (measured in depths of 10 cm in spruce and pine stands at the catchment).

Input/output balance of heavy metals at Vilsandi (EE01)

In 2008, the concentrations of cromum (Cr), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn) and manganese (Mn) were measured in deposition (throughfall + stemflow) and in soilwater (collected under organic horizon) at Vilsandi. Input/output balances of heavy metals (Fig. 3) show highest retention for Mn in soil organics. At relatively high deposition of Mn, 100% of this ion was retained in soil organics (Mn concentrations in soilwater were below detection limit (0,02) over the entire year (Fig. 3). Pb was the second most effectively retained metal (74.2%). Retention for Zn was 50 % and for Cu - 19.5 %. Previously accumulated stores of Ni and Cr in the organic layer of soil are important sources of these ions in the soilwater. Leaching of Ni from organics was 312% (11.3 mg/m^2). It should be noted, that input of Ni was calculated only by stemflow (3.6 µg m^{-2}), because all concentrations in troughfall were below the detection limit (1.0). Leaching of Cr from soil organics was about 200 %.

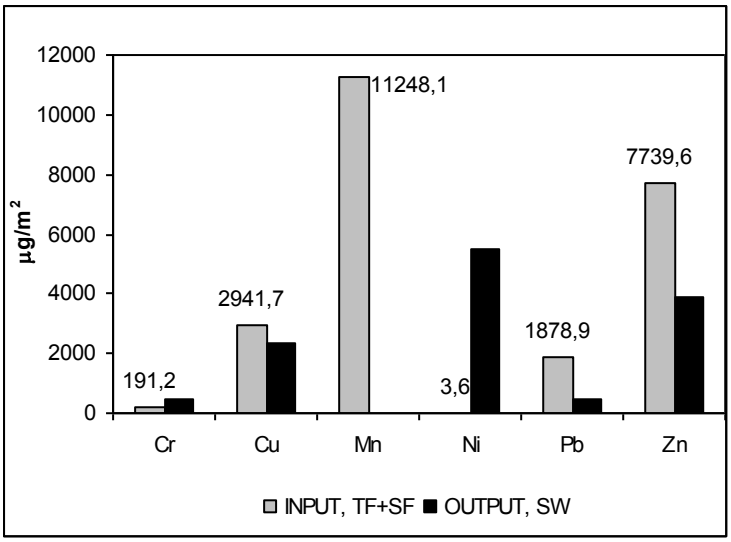

Figure 3. Input/output balances for heavy metals in Vilsandi (EE01) pine stand in 2008

References

Jaagus, J, 2009. Läbi aegade kõige soojem talv. Eesti Loodus Nr. 3.