

# The nitrate monitoring in the soil-groundwater system - the effective drinking water source management

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## Abstract

Percolate water was sampled and analyzed on a weekly basis from September 2002 to the end of 2004 from the lysimeter on the premises of the Water Supply station Klece in Ljubljana. In the observed period total of 64 samples were taken. Year 2003 was drier comparing to the year 2004, which also influenced the amount of outflow from the lysimeter north. In the observed period 2002 - 2004 total of 4247.30 mg of  $\text{NO}_3\text{-N}$  was leached, more than half of the amount was leached in 2003. Established measurements and monitoring of  $\text{NO}_3\text{-N}$  in percolated water from non-fertilised area gives invaluable information about nitrate natural background.

## Zusammenfassung

Auf der Lysimeterstation der Wasserversorgungsstation Klece in Ljubljana wurden zwischen September 2002 bis Ende 2004 wöchentlich Sickerwasserproben entnommen. In der beobachteten Periode wurden insgesamt 64 Proben analysiert. Das Jahr 2003 war im Vergleich zum Jahr 2004 trockener, was auch die Ausflussmenge aus dem Lysimeter Nord beeinflusst hat. In der beobachteten Periode 2002 - 2004 wurden insgesamt 4247.30 mg  $\text{NO}_3\text{-N}$  ausgewaschen, mehr als die Hälfte davon im Jahr 2003 (2354.39 mg  $\text{NO}_3\text{-N}$ ). Durchgeführte  $\text{NO}_3\text{-N}$  Messungen und Monitoring im Sickerwasser aus nicht gedüngten Gebieten geben wertvolle Information über den natürlichen Nitratgehalt.

## Introduction

Water Supply Station Klece is, with its total capacity of 2000 l/s, the heart of Ljubljana's fresh water supply system. About 35% of the capture area of the Water Supply Station's is used for agriculture, predominantly for intensive ve-

getable production. In the nineties nitrate ( $\text{NO}_3^-$ ) concentration levels of the groundwater in Ljubljana aquifer were increasing. Disconcerting trends prompted Water Supply Station Klece to set up several monitoring systems of nitrate concentration levels to gain overview of the situation, determine trends and main pollutants as well as to take preventive steps to decrease pollution established. Nitrate levels are monitored in groundwater, in percolate water as well as in the soil on the arable areas of the watershed. The paper presents results of the nitrate concentration in percolate water sampled on the lysimeter station in Water Supply Station Klece.

## Materials and methods

Lysimeter station in Klece, Ljubljana, Slovenia, consists of two concrete lysimeters on the premises of Water Supply Station Klece (Picture 1). Ground and lysimeter surface (1,539 m<sup>2</sup>) is covered with grass, which is not fertilized. Water balance calculations for the years 2001 - 2003 indicated rupture in the ly-

simeter south, making the percolation amount unreliable parameter (ZUPANC et al., 2005). Water sampling for nitrate concentration measurements was therefore done from lysimeter north. Percolate water was sampled and analyzed on a weekly basis from September 2002 to the end of 2004 (GVARDJANCIC, 2005).

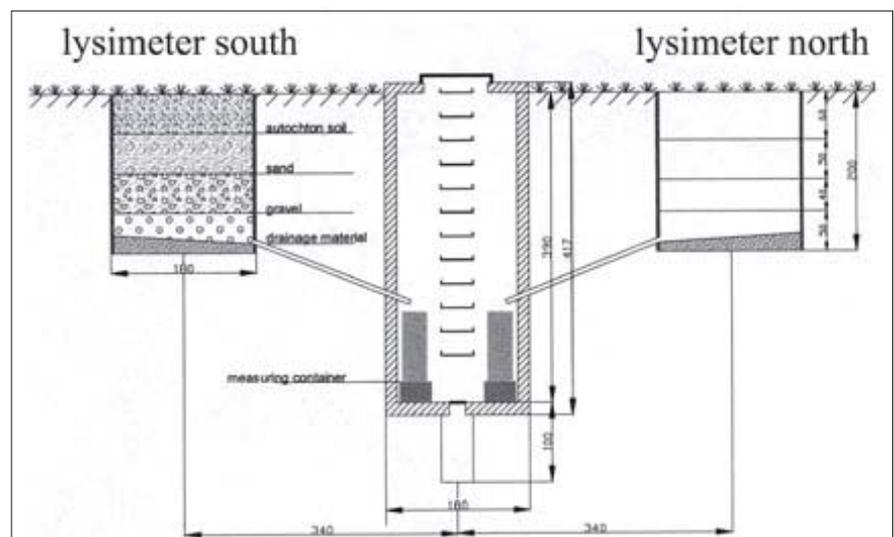
Based on the data, nitrate concentration was calculated with help of the lysimeter area and precipitation amount, using equation (1):

$$m_2 = \frac{m_1 \times 10^{-6} \text{ kg} \times 1000 \text{ m}^2}{1,539 \text{ m}^2} \quad \dots(1)$$

where  $m_1$  is amount of leached  $\text{NO}_3\text{-N}$  (g/m<sup>2</sup>),  $m_2$  is amount of leached  $\text{NO}_3\text{-N}$  (kg/ha),  $10^{-6}$  factor was used to change mg into kg of kg  $\text{NO}_3\text{-N}/\text{m}^2$ .  $10^5$  factor was used to calculate the amount of kg  $\text{NO}_3\text{-N}$  leached per hectare and 1,539 m<sup>2</sup> is lysimeter area.

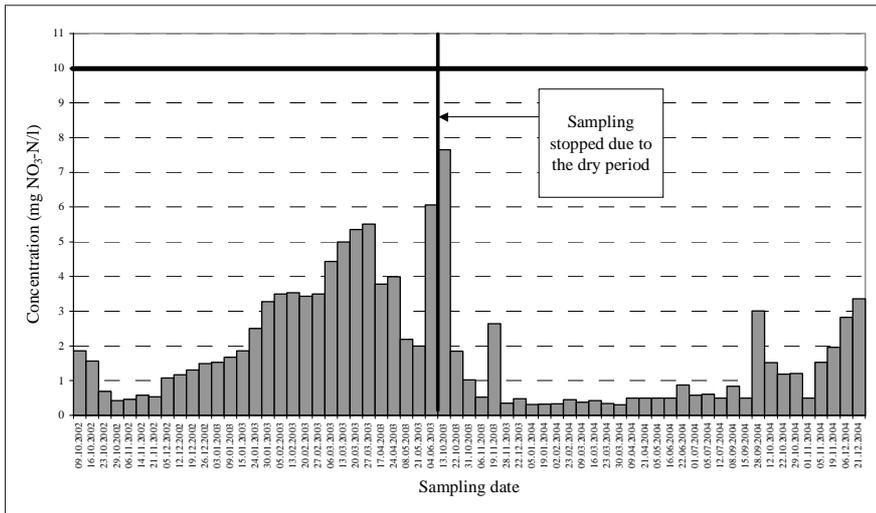
## Results

Water samples were taken 11 times in the year 2002, 26 times in the year 2003

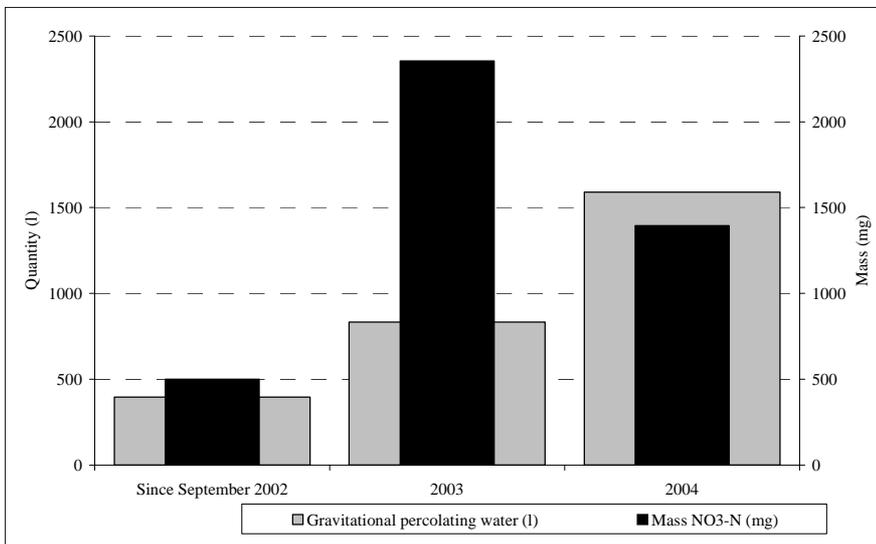


Picture 1: Lysimeter station profile on Water Pumping Station of Public Water Supply Company in Klece, Ljubljana.

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Picture 2: Nitrate concentration in gravitational percolating water with marked level for drinking water 10 mg of  $\text{NO}_3\text{-N}$ .



Picture 3: Gravitational percolating water (l) from the lysimeter north and mass  $\text{NO}_3\text{-N}$  (mg) in the sample of the lysimeter outflow for the period 2002 - 2004

and 27 samples in the year 2004 (Picture 2). In the second half of the year 2003 sampling was discontinued due to no outflow from the lysimeter. Regular sampling resumed in the fall 2003. Nitrate concentration in the outflow was gradually rising from the beginning of the sampling in the fall 2002 till March 2003. In the years 2003 and 2004 detected nitrate concentrations were lower

than in year 2002, exception being the first sample in October 2003 (7.65 mg/l). At the end of September 2004 nitrate concentration increased, decreased again in October then began to increase again in November and December.

From September to December 2002 total of 498.28 mg of  $\text{NO}_3\text{-N}$  was leached in 394.20 l of  $\text{NO}_3\text{-N}$  gravitational percolating water from the lysimeter north.

In the year 2003 total amount of 2354.39 mg of  $\text{NO}_3\text{-N}$  was leached from 831.90 l of gravitational percolating water. In the year 2004 the amount of leached  $\text{NO}_3\text{-N}$  was 1349.00 mg from 1589.20 l of gravitational percolating water. Using equation (1) calculations shows that 3.24 kg  $\text{NO}_3\text{-N/ha}$  was leached in the year 2002, in the year 2003 15 kg  $\text{NO}_3\text{-N/ha}$  and in the year 2004 9.60 kg  $\text{NO}_3\text{-N/ha}$ .

## Conclusion

In the observed period from the September 2002 till the end of 2004 total of 64 samples were taken. Year 2003 was drier comparing to the year 2004, which also influenced the amount of outflow from the lysimeter north. In the observed period 2002 - 2004 total of 4247.30 mg of  $\text{NO}_3\text{-N}$  was leached, more than half of the amount was leached in 2003 (2354.39 mg of  $\text{NO}_3\text{-N}$ ). Calculations from nitrate concentrations in percolate water show that 3.24 kg  $\text{NO}_3\text{-N/ha}$  was leached in the year 2002, in the year 2003 15 kg  $\text{NO}_3\text{-N/ha}$  and in the year 2004 9.60 kg  $\text{NO}_3\text{-N/ha}$ .

Established measurements and monitoring of  $\text{NO}_3\text{-N}$  in percolated water from non-fertilised area gives invaluable information about nitrate natural background. These results help to determine the correct use of plant fertilizers as well as enable better and precise field measurement data interpretation.

## References

- GVARDJANCIC, D., 2005 Nitrate leaching through the soil profile at Klece Water Supply Station. Graduation Thesis. 31 p.
- ZUPANC, V., M. PINTAR and B. BRACIC-ELEZNIK, 2005: Water balance assessment for lysimeter station in Ljubljana field. HBLFA Bericht über die 11. Lysimetertagung 2005, Gumpenstein, 229-230.