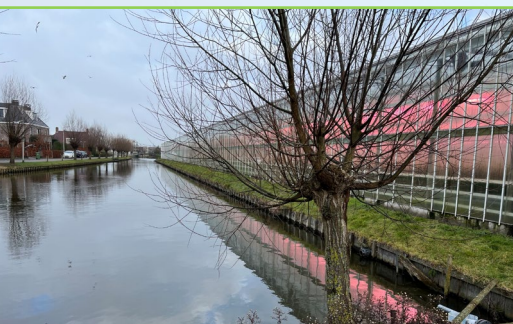


Determination of Nitrate and Nitrogen in surface water and agricultural applications.

Nitrogen is a crucial nutrient that helps plants and crops grow, but high concentrations are harmful to people and nature. Pure, clean water is vital to human health and to natural ecosystems. Excess nitrogen from agricultural sources is one of the main causes of water pollution in Europe. Studies done by Wageningen University & Research in collaboration with Glastuinbouw Nederland, Acacia Water, Hoogheemraadschap Delfland, Fixeau B.V. and Stichting AKVO have proven the usability of the LAQUAtwin meter in this application.



Introduction

Nitrates and organic nitrogen compounds from fertilizer and manure enter groundwater through leaching and reach surface water through runoff from agricultural fields. A high level of nitrate makes water unsuitable as drinking water.

In rivers, lakes and marine waters, nitrogen and other nutrients, in particular phosphorus, stimulate the growth of algae. At moderate levels, algae serve as food for aquatic organisms, including fish. However, excessive nutrient concentration in water systems will cause algae to grow excessively. This affects the natural ecosystem and can lead to depletion of oxygen in the water. This phenomenon, known as eutrophication, has negative consequences for biodiversity, fisheries and recreational activities.

Both phosphorous and nitrogen play a role in eutrophication, but while the main cause of eutrophication in fresh water is phosphorus, it is mainly caused by nitrogen in marine water.

Source:
https://environment.ec.europa.eu/topics/water/nitrates_en

EU Directive

The maximum allowable nitrate concentration in surface water is 50mg/l (ppm) NO_3^- or 11,3 mg/l $\text{NO}_3\text{-N}$.

The EU Nitrates Directive (91/676/EEC) aims to protect water quality across Europe by preventing nitrates from agricultural sources that pollute ground and surface waters and by promoting the use of good farming practices.

The Directive aims to reduce water pollution caused by nitrates used in agriculture by

- monitoring nitrate of water bodies
- designating nitrate vulnerable zones
- establishing codes of good agricultural practices and measures to prevent and reduce water pollution from nitrates

Method

Testing for nitrates in water can be done in the laboratory, online and in the field. The determine the source of potential nitrate pollution a field measurement is preferred.

There are several methods to measure nitrate in water in the field. These range from simple test kits to more advanced measurement equipment.

Some commonly used methods are:

Chemical Test Kits

- Based on colour change.
- Sample is mixed with reagents that convert into a coloured solution. The intensity of the colour is measured.
- Change is read using a colour scale or spectrophotometer.
- **Advantages:** Portable, relatively inexpensive, quick.
- **Disadvantages:** Less accurate

Spectrophotometry

- Measures absorption of light by the solution at specific wavelengths.
- Absorption is converted into a concentration using a calibration curve.
- **Advantages:** High accuracy.
- **Disadvantages:** Less suitable for field conditions, more expensive, less portable than other methods.

Ion-Selective Electrodes (ISE)

- Ion-selective electrodes respond specifically to nitrate, allowing a direct measurement of the concentration.

- **Advantages:** Fast, portable.

- **Disadvantages:** Requires calibration and maintenance.

Test Strips (Dipsticks)

- Dip into the water to measure.

- Colour changes based on the concentration, the colour is compared to a scale to read the concentration.

- **Advantages:** Very simple, fast, and inexpensive.

- **Disadvantages:** Less accurate and sensitive than other methods.

Portable UV-Vis Spectrometers

- Measure light absorption.

- Similar to lab-based meters but more compact and suitable for fieldwork.

- **Advantages:** Very accurate, suitable for detailed field measurements.

- **Disadvantages:** More expensive and less portable.

Each method has its own pros and cons depending on the situation, such as accuracy, cost, ease of use, and required equipment. For field measurements, simple kits or test strips are often the most practical, while ion-selective electrodes or spectrophotometry are recommended for more precise work.

Instruments

For measurement of nitrate (NO_3^-) and nitrate nitrogen ($\text{NO}_3\text{-N}$) the HORIBA WQ300 series handheld and LAQUAtwin pocket meters can both be used. The HORIBA instruments use **Ion Selective electrodes** to measure the concentration.

In field test conditions, where both instruments were used there was a good correlation between the results of the two instruments.



Research

Recent research by Wageningen University and Research (www.wur.nl) has shown the usability of the LAQUAtwin NO3-11.

WUR published the results in this report: <https://research.wur.nl/en/publications/on-twikkeling-en-evaluatie-van-een-handzame-nitraatmeter-voor-drai>

Citation from the abstract of the report:
By 2027, greenhouse horticulture in the Netherlands must grow almost emission-free. Measuring surface water quality by growers themselves on and around their greenhouse could provide more insight into disasters. Measuring nitrates in surface water seems to be a good method to detect fertigation water in surface water due to leaks. Research has therefore been conducted into a nitrate meter that growers can easily use themselves. Based on desired technical and practical specifications, handheld meters available on the

market and prototypes from research have been assessed for, among other things, suitability, accuracy, ease of use and cost price. A practical evaluation was carried out at six greenhouse growers using the handheld meter found to be most suitable. The meter has been found to be handy, robust, and sufficiently reliable to detect increased concentrations of nitrate in surface water. The meter has a large measuring range, allowing measurements to be made in surface water as well as in nutrient solutions and drainage water. To detect leaks, the surface water must be checked weekly. The accuracy of the meter is less than that of laboratory analyses, but the low purchase price and operational costs are such that the use of the hand meter is more economical as soon as more than one measurement is carried out per week.

Field test WQ300

In the Netherlands the WQ300, with nitrate ion sensor head and cartridge, was compared against brand "Y" in the lab and during field test by Hoogheemraadschap Delfland*.

	HORIBA	Brand Y
Battery live	400 hrs	80 hrs
Sensor technology	digital	analog
Stores cal data when replacing batteries	Yes	No
Field calibration	Yes	No
Wireless data transfer	Yes	No

NO_3^- or $\text{NO}_3\text{-N}$

The terms "nitrate (NO_3^-)" and "nitrogen ($\text{NO}_3\text{-N}$)" both refer to forms of nitrogen, but they are used in different contexts, and there is a distinction between them:

Nitrate can be converted to nitrate nitrogen by dividing the NO_3^- with 4,4268 and vice versa:

- 100 mg/L (ppm) NO_3^- = 22,58 $\text{NO}_3\text{-N}$ mg/L (ppm) ($100 / 4,4268$).
- 22,58 mg/L (ppm) $\text{NO}_3\text{-N}$ = 100 mg/L (ppm) NO_3^- ($100 \times 4,4268$).

HORIBA LAQUA instruments for measurement of nitrate:

The LAQUAtwin pocket nitrate meters are small, light weight and easy to take everywhere. Easy 2-point calibration gives a good accuracy across the complete range.

- Simple calibration
- Instant results
- Small sample
- Waterproof



The WQ300 series handheld meters can measure pH, ORP, Ion selective, conductivity and dissolved oxygen.

- Connect up to 3 electrodes simultaneously.
- All parameters in one screen
- Digital electrodes
- Calibration data stored in sensor head
- Replaceable electrode cartridges
- Calibration up to 6 points
- Waterproof
- Wireless and USB data transfer



* **Waterschappen** (water boards) are regional governmental organizations in the Netherlands that manage water systems, such as rivers, canals, and dikes. Their main responsibilities include flood protection, managing water quality, and regulating water levels in various areas. They play a crucial role in maintaining the country's water safety, given that much of the Netherlands is below sea level. Waterschappen are also responsible for ensuring proper drainage, water purification, and sustainable use of water resources. They are unique to the Netherlands and are an essential part of the country's water management system.

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