Norway – Raingarden treating road runoff

Rødland, Elisabeth; Karlstrøm, Stina; Tollefsen, Knut Erik; Moe, Jannicke; Meland, Sondre; Gragne, Ashenafi, Gjeitnes, Mari; Ribeiro, Anne Luise, Barkved, Line, 2025, «Illustrations of nature-based solutions for treating urban road runoff in Tåsen, Oslo; **A)** The road and the raingarden during a heavy rain event (August 2023), **B)** the raingarden and the influent monitoring box, **C)** sensors installed in the influent monitoring box, **D)** Illustration of raingarden with treatment from road runoff, **E)** the raingarden and the influent monitoring box showing water flowing over the v-notch».

DESCRIPTION

The Norwegian pilot is a **raingarden that treats runoff** along Tåsenveien in the City of Oslo. It was built as part of an upgrade in the area, where sidewalks and bike lanes on both sides of the road encourage more people to walk, cycle and travel by public transport. The upgrade project on Tåsenveien spans approximately 730 m and includes a stretch of road prone to flooding. It incorporates the planting of over 50 trees and the establishment of five separate rain gardens to **mitigate flooding and to treat runoff**. The pilot monitored is the first of the three rain gardens. The rain gardens are a good example of **nature-based solutions built to retain and remove pollutants** found in the road runoff so that they will not enter water pathways and eventually pollute the Oslofjord.

DESIGN AND TECHNICAL DETAILS

Type of influent

Urban stormwater, including runoff of from road, bike lanes and green areas.

Design criteria

- Impact area of raingarden about 1300 m^2.
- Raingarden area of about 60 m^2 offering a potential surface storage volume of about 19.6 m^3 along its 33.5 m length.
- Road runoff enters the raingarden through two 20×15 cm inlet gutters located about 16 m apart.
- The inlet received 30m^3 of road runoff in one year of monitoring (2023), whereas the outlet received 160m^3.
- Automatic ISCO samplers placed at the influent and effluent of the raingarden have time-paced composite water samples at rainfall events.

Climatic conditions

Varied climate with seasonal variations in temperature (-23°C – 31°C) and precipitation (rain and snow).

Operational constraints

- Manpower
- Skills
- Seasonal variations

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TREATMENT PERFORMANCES

- **Conventional Pollutants:** Effective retention of TSS (88.5% reduction); Accumulation of total nitrogen, total phosphorous, P and Cl (120–1400% increase), where accumulation of Cl is most likely due to accumulation of road salt used during the winter.
- **Metals:** Effective retention potential for Al, Cr, Fe and Pb (60–90% reduction); Cu, Ni and W had lower retention potential (5–35% reduction); Cd, Na and Zn had a negative retention potential (24 – 244% increase), where accumulation of Na is most likely due to accumulation of road salt used during winter.
- **Organic Micropollutants:** Of 6 target compounds related to vehicle tires (6PPD, 6PPD-Q, ABT, BT, MBT, MTBT and OHBT), the average potential reduction in concentration was 73%.
- **Microplastics:** The average concentration of tire wear particles (TWP) was 2.57 ± 2.30 mg/L (average ± SD) in the inlet and 0.488 ± 0.188 mg/L in the outlet (81% potential reduction).
- **Treatment efficiency:** Runoff is infiltrated to the ground and the estimated retention of pollutants based on inlet and outlet concentration data does not fully explain the treatment performance of the raingarden.

RISK ASSESMENT

- **Inlet:** With Cumulative Risk Assessment (CRA), 10 chemicals exceed the risk threshold – Al, 6PPD-quinone, Fe, Cu, Cl, Pb, fluoranthene, 2-(methylthio) benzothiazole, Zn and Na. Using Probabilistic Risk Assessment (PRA) metals pose a 100% probability risk, and plastics pose 95%.
- **Outlet:** Using CRA, 7 chemicals exceed the risk threshold – Al, 6PPD-quinone, Cu, Cl, Zn and Na, where Na and Cl are due to road salt, and 6PPD-quinone and Zn are due to TWP. Using PRA, metals pose a 100% probability risk, and plastics pose 55%.
- **Treatment efficiency of rain garden:** CRA show a varied risk reduction efficiency of raingarden treatment from inlet to outlet due to sampling dates and emphasize the challenges with seasonal variations. Using PRA, 5 chemicals pose a substance level risk to the environment after raingarden treatment – Al, Cu, fluoranthene, 6PPD-quinone and Zn. The group risk sum indicates no environmental risk.

CO-BENEFIT ANALYSIS

Environmental value:
Increased and preserved biodiversity and increased green infrastructure after establishment of raingarden compared to before development of Tåsenveien. Reduced flood risk, based on results from stress test of rain garden.

Socio-economic value:
Improved public health and well-being based on survey of public. Improved traffic safety from inspections of Tåsenveien.

TAKE-HOME MESSAGES

- **Effective road runoff pollutant removal:** The rain garden had an effective retention potential of TWP and TWP-related compounds from inlet to outlet, and an effective retention potential of TSS and metals such as Al, Cr, Fe and Pb, and some retention potential of Cu, Ni and W.
- **Enhanced environmental and socio-economic value:** The rain garden, with its green infrastructure and enhanced biodiversity pose a positive value for the public, traffic safety and environment.
- **Optimized stormwater mitigation and flood risk:** A stress test of Tåsenveien demonstrated an optimized flood risk and storm water mitigation of the raingarden.
- **High treatment capacity:** The rain garden has an impact area of 1300 m^2, including road, parking lot, bicycle lane, park area and pedestrian lane. However, due to flaws in the inlet design, a significant proportion of road runoff bypasses the raingarden during heavy rainfall.

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