Reducing nutrient load from catchments

4. Technical solutions for nutrient load reduction

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Technical solutions for nutrient load reduction

- Eligible load reduction solutions are highly dependent on the source of the external load.
- Purpose of these slides is to provide information on technical load reduction solutions for
  - Agriculture (crop growing)
  - Forestry
  - Storm waters
  - Waste waters

4.1. Reducing load from agricultural fields

- As described in section 2.4.1., nutrient load from agriculture originates mainly from crop growing fields and manure from animal husbandry.
- Best manure handling and application methods are important in controlling nutrient load from animal husbandry.
- This chapter (4.1.) presents information on how to reduce nutrient load that originated from crop growing fields

A small sedimentation pond in agricultural area (Photo: TUAS Water Engineering)

4.1.1. Selecting a load reduction solution for agricultural fields

- When selecting the best fit load reduction solution for agricultural fields, you should take several issues into consideration.
- The suitability and efficiency of the solution may be influenced for example by:
  - Slope of the field
  - Soil type
  - Nutrient content
  - Crop species
  - Climate conditions
  - Available space for solution

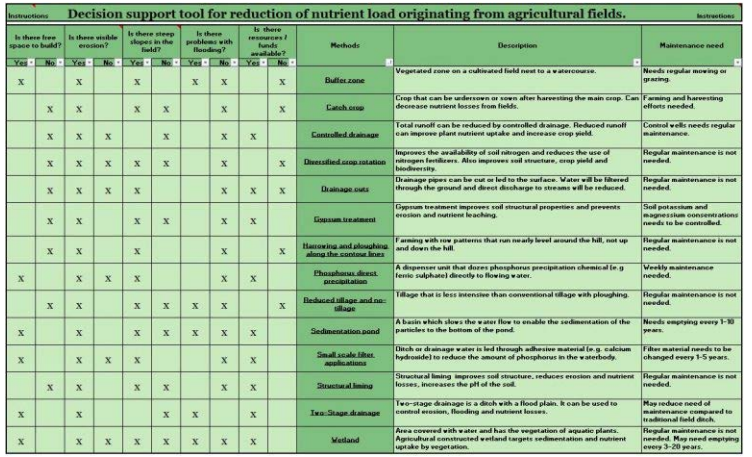

Photo: TUAS Water Engineering

- Nutrient load originated from crop growing may be reduced by:
  - Decreasing nutrient loss from the fields
  - Retaining nutrients from the runoff waters (agricultural ditches, drainage and streams)
- When selecting the load reduction method for nutrients, the erosion risk of the field should be taken into account.
- Erosion control measures are recommended if there is notable erosion seen at fields.
- At sites with low erosion and high dissolved nutrient load, erosion control measures or sedimentation based measures may have practically no effect.

Photo: Bob Jenkins / *Erosion in New Field* / CC BY-SA 2.0

- At waterchain.eu you can find a decision support tool (DST) that provides help in selection of load reduction methods for agricultural fields. Search the site for *Selecting the load reduction method for my field.*

- Test the tool (Excel table) to find out how available space, erosion, steepness, flooding or resources may affect the suggestion of suitable methods.



Instructions — **Decision support tool for reduction of nutrient load originating from agricultural fields.** — Instructions

Is there free space to build?		Is there visible erosion?		Is there steep slopes in the field?		Is there problems with flooding?		Is there resources / funds available?		Methods	Description	Maintenance need
Yes	No	Yes	No	Yes	No	Yes	No	Yes	No			
X		X		X		X	X		X	Buffer zone	Vegetated zone on a cultivated field next to a watercourse.	Needs regular mowing or grazing.
	X	X		X	X		X		X	Catch crop	Crop that can be undersown or sown after harvesting the main crop. Can decrease nutrient losses from fields.	Farming and harvesting efforts needed.
	X	X	X		X		X	X		Controlled drainage	Total runoff can be reduced by controlled drainage. Reduced runoff can improve plant nutrient uptake and increase crop yield.	Control wells needs regular maintenance.
	X	X	X	X	X		X		X	Diversified crop rotation	Improves the availability of soil nitrogen and reduces the use of nitrogen fertilizers. Also improves soil structure, crop yield and biodiversity.	Regular maintenance is not needed.
	X	X	X	X			X	X	X	Drainage outs	Drainage pipes can be cut or led to the surface. Water will be filtered through the ground and direct discharge to streams will be reduced.	Regular maintenance is not needed.
	X	X		X	X		X	X		Gypsum treatment	Gypsum treatment improves soil structural properties and prevents erosion and nutrient leaching.	Soil potassium and magnesium concentrations needs to be controlled.
	X	X		X			X		X	Harrowing and ploughing along the contour lines	Farming with row patterns that run nearly level around the hill, not up and down the hill.	Regular maintenance is not needed.
X		X	X	X			X	X		Phosphorus direct precipitation	A dispenser unit that dozes phosphorus precipitation chemical (e.g ferric sulphate) directly to flowing water.	Weekly maintenance needed.
	X	X		X	X	X	X		X	Reduced tillage and no-tillage	Tillage that is less intensive than conventional tillage with ploughing.	Regular maintenance is not needed.
X		X		X	X	X	X	X		Sedimentation pond	A basin which slows the water flow to enable the sedimentation of the particles to the bottom of the pond.	Needs emptying every 1-10 years.
X		X	X	X			X	X		Small scale filter applications	Ditch or drainage water is led through adhesive material (e.g. calcium hydroxide) to reduce the amount of phosphorus in the waterbody.	Filter material needs to be changed every 1-5 years.
	X	X		X	X		X	X		Structural liming	Structural liming improves soil structure, reduces erosion and nutrient losses, increases the pH of the soil.	Regular maintenance is not needed.
X		X			X	X		X		Two-Stage drainage	Two-stage drainage is a ditch with a flood plain. It can be used to control erosion, flooding and nutrient losses.	May reduce need of maintenance compared to traditional field ditch.
X		X	X	X	X	X	X	X		Wetland	Area covered with water and has the vegetation of aquatic plants. Agricultural constructed wetland targets sedimentation and nutrient uptake by vegetation.	Regular maintenance is not needed. May need emptying every 3-20 years.

[To decision support tool]

- There are several load reduction methods available for arable land.
- Methods used are dependent on country, grown crop, soil type, legislation, subsidies as well as available land, resources and machinery.
- Commonly known load reduction methods around the Baltic Sea include buffer zones, agricultural wetlands and reduced tillage.
- In addition to traditional load reduction methods, new methods are being tested and developed.
- At the WaterChain web-page you can find information sheets on 14 load reduction method targeted at crop farming.

Information sheets on load reduction methods for crop farming

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4.2 Reducing load from forestry

- As described in 2.4.2., loading from forest areas is highly dependent on applied forestry actions
- Need of load reduction measures should be assessed prior to major forestry actions such as:
  - Clear cut
  - Fertilizing
  - Soil preparation
  - Drainage actions
- Several load reduction methods and principals applied in agriculture can be utilised in reduction forestry load


Photo: TUAS Water Engineering

- Buffer zones:
  - Clear cut or fertilization area should not be immediately bordered by a water body.

- Reduced tillage in soil preparation:
  - Soil preparation especially at erosion sensitive soils should be minimised
  - Ploughing along contour lines is recommended

Clear cuts and heavy soil preparation may increase erosion and nutrient load.

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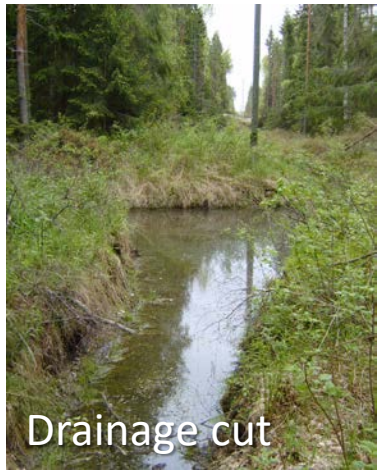
- Wetlands, sedimentation ponds/basins, submerged dams, drainage cuts and overland flow/vegetation fields:
  - Sedimentation, filtration and nutrient uptake by plants can be used to retain solids and nutrients from forest ditches

- Zero fertilization/nutrient balance
  - Minimized or no fertilization reduces nutrient load from forests


Sedimentation pond


Drainage cut


Submerged weir


Drainage cut


Wetland

Photos: TUAS Water Engineering

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4.3. Technical solutions to reduce loading from urban stormwater

- 2 general types of technical solutions to reduce nutrient and pollutant discharge with stormwater can be distinguished: Grey and Green Solutions
- Grey solutions include, e.g. retention and detention tanks, sewer systems and waste water treatment plants
- Green solutions include, e.g. bioretention and detention systems and green roofs. *Permeable pavements* combine grey and green aspects
- *Grey* solutions are applied mainly in urban and build-up areas where space is scarce and stormwater have to be handled underground and treated centralized
- However, green solutions are increasingly the method of choice also in urban areas as they provide added ecosystem services such as ecosystems and recreational factors

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Technical solutions to reduce loading from urban stormwater

<u>Examples of green solutions – Bioretention systems:</u>

- Are excavated structures filled with different infiltration and filter substrates
- Provide natural, on-site water retention and filtering functions
- May be connected to drainage systems through underdrains
- Comprise solutions as *bioswales, rain gardens, detention* and *retention ponds*
- Provide benefits as maintenance of local hydrological cycles, urban habitats and added liveability


Photo: TUAS Water Engineering


Image: Hamburg University of Applied Sciences

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Technical solutions to reduce loading from urban stormwater

<u>Examples of green solutions – Rain gardens:</u>

- Collect runoff from surrounding impermeable surfaces
- Retain excess water
- Filtrate surface runoff through slow infiltration
- Are vegetated areas
- Are low-cost and low-maintenance solutions that can easily be implemented on different scales
- Provide urban habitats

Photos: TUAS Water Engineering

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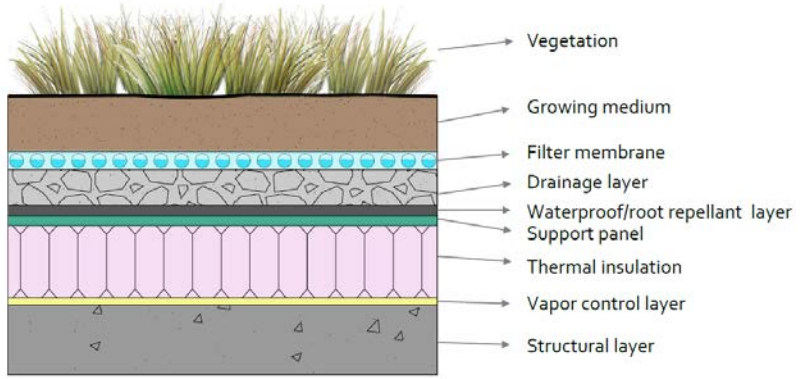
Technical solutions to reduce loading from urban stormwater

<u>Examples of green solutions – Green roofs:</u>

- Are vegetated layers on (flat) roofs
- Allow for water retention and evaporation – decrease runoff
- Retain pollutants
- Mitigate heat island effect and reduce cost for building air conditioning
- Provide urban ecosystems or roof-top gardens



Photos: TUAS Water Engineering

Technical solutions to reduce loading from urban stormwater

<u>Examples of green solutions – Porous pavements:</u>

- *Pervious* pavements allow for water infiltrations
- Utilize permeable materials or impermeable grid elements with permeable or vegetated filling

Benefits:

- Reduction of surface runoff
- Decrease of peak discharge
- Maintenance of local water balance

Disadvantages:

- Clogging and associated maintenance
- Limited functionality during winter
- Higher cost than conventional paving

Photos: Upper 2 TUAS Water Engineering, lower VTT

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Technical solutions to reduce loading from urban stormwater

Videos on green solutions as further reference:

Porous pavements

Green roofs

Bioretention structures incl. rain gardens

Bioswales

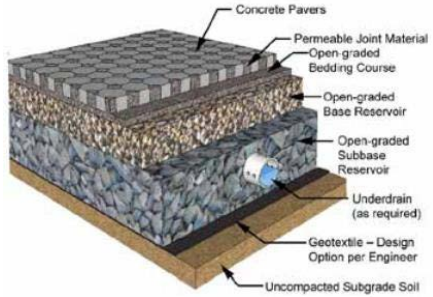

Photo: TUAS Water Engineering

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