Managing erosion, sediment transport and water quality in drained peatland catchments

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-focus on boreal forests and peatlands

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Background

- Peatlands form 33.5 % of the land area of Finland (10,4 Mha). About 2/3 of this area has been drained
- Peatland forestry drainage is made to improve growth of pine trees
- Key current issues in Finnish peatland management is the reduction of environmental impacts of drainage and restoration of abandoned peatlands.

Peatland forestry drainage and suspended solids

- Increased suspended solids (SS) transport is classified as most harmful pollutant from forestry areas
- Effect on water quality and stream bed formations (siltation)
- Decreased aquatic habitat
- SS transport highest during high flow events
    - Difficult to control

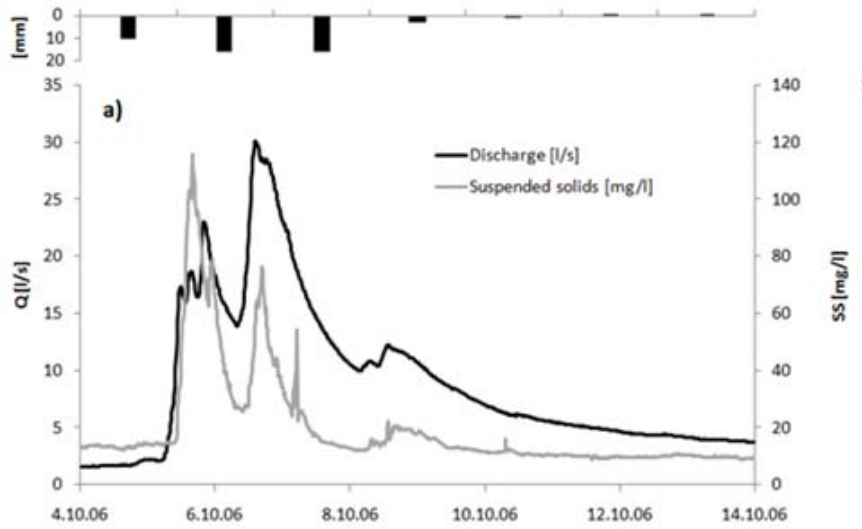
- Agenda for water protection in peatland forestry
  - Minimize erosion at drainage areas
  - Main part of transported SS is trapped before water bodies
  - Nutrients transport is reduced using available water protection methods

Erosion in peatland forestry drainage ditches

- Typically erosion in peatland forestry can be attributed to three factors:
  - drainage operations produce SS for direct transport
  - ditch surfaces are subjected to shear stress by flowing water
  - ditches are exposed to rainfall and weathering processes, which produce sediment for delivery
- Many local factors affect on erosion processes
- Erosion is possible to prevent with proper planning and transported SS control with proper water protection methods

Organic peat sediment in drainage areas

- In-channel sediment plays important role in management perspective
- Fluffy peat sediment is easily transported
- Summer runoff peaks can be dominant role in SS transport
- Major part of nutrients are transported within SS



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Water protection methods in peatland forestry

- Two basic principles:
  - minimisation of SS and nutrient transport with good planning before drainage operations
  - prevention of SS and nutrient transport to watercourses
- Used methods includes:
  - ditch breaks, sludge pockets, buffer zones, sedimentation basins, wetlands, etc.

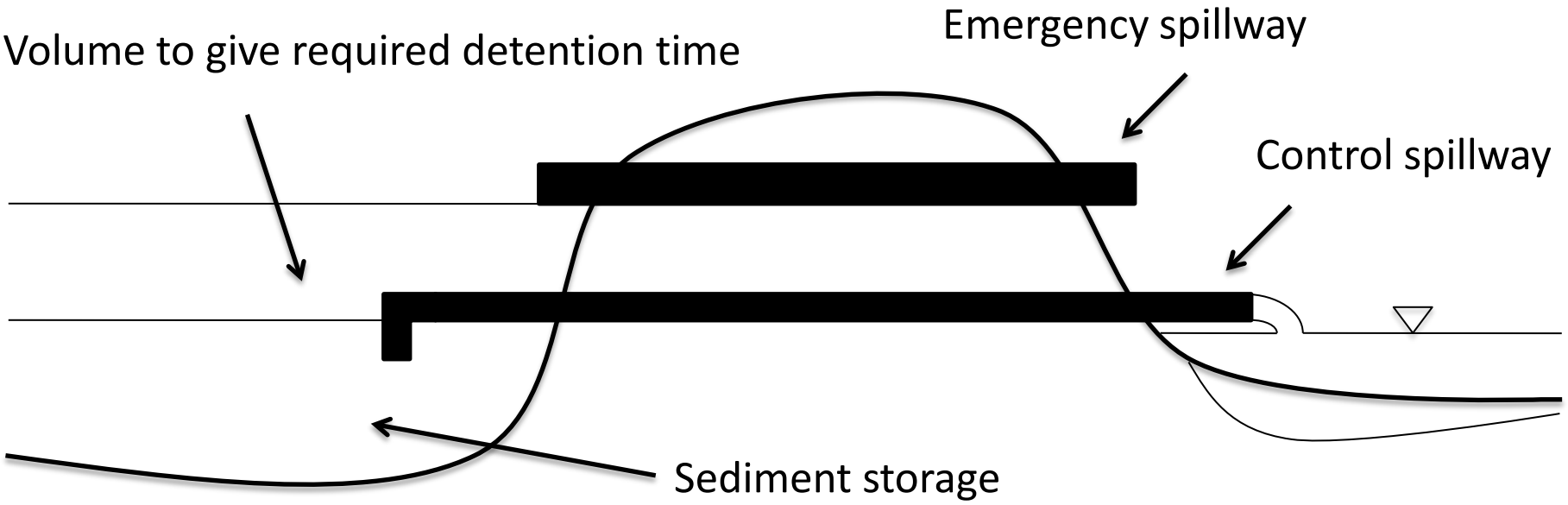
Problem…

- Most water protection methods function well during base and moderate flow events, but not properly during high flows
- The most problematic events for water protection are large storm flows and high pollutant load transport during these events.

One solution… Peak runoff control (PRC) method

- The idea for detention of storm flow was first utilised for urban runoff and later for peat drainage areas.
- Different peak runoff control methods have been proposed as a solution to control these events and loads
- Special demands in peatland forestry
  - cheap, no maintenance, easy structure and installation

Peak runoff control in peatland forestry



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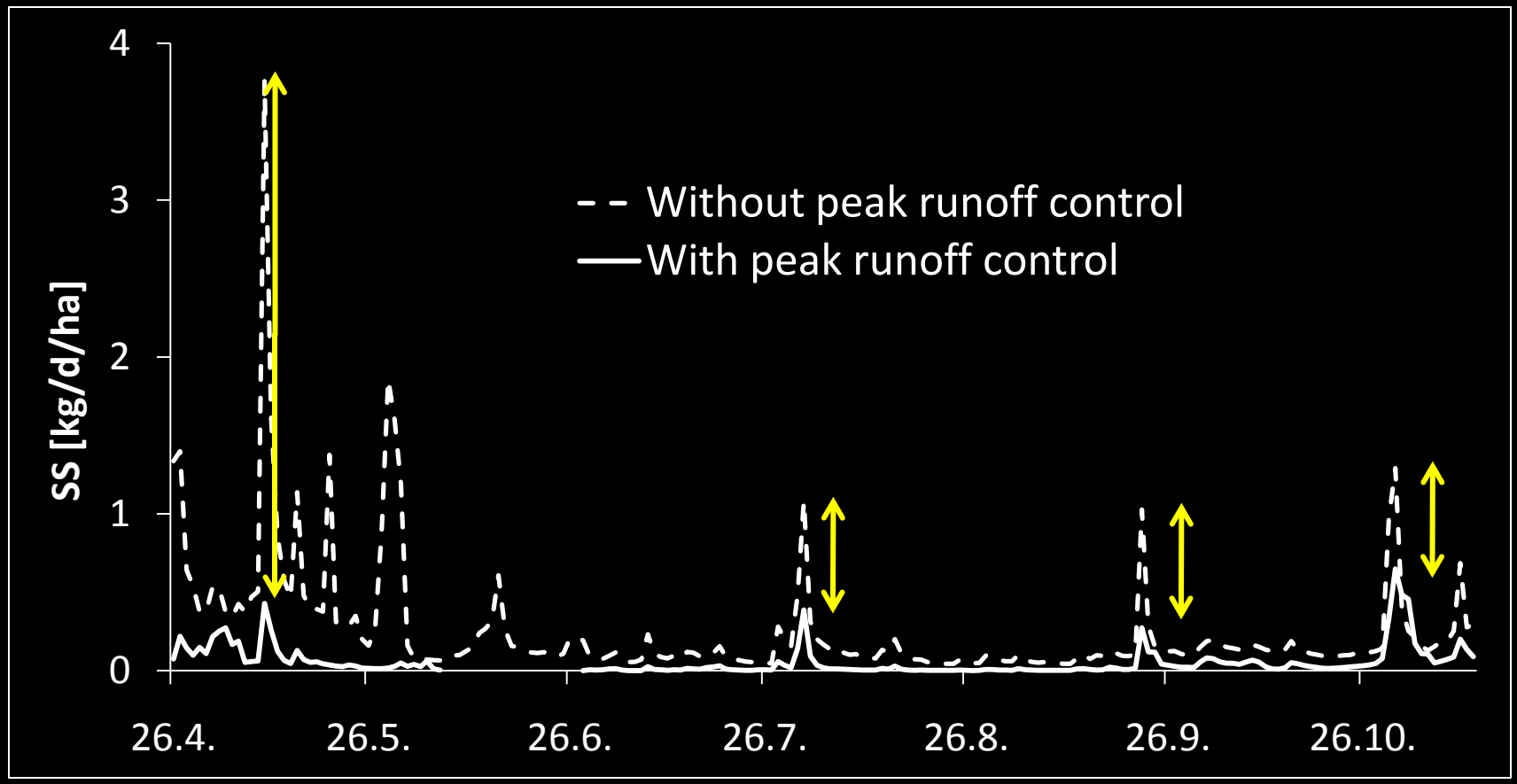
Flood/storm water is temporally stored to the ditch system
Principals:
• Flow and peak runoffs decrease
• Erosion decrease
• Longer retention time provide settling time for eroded sediment

The PRC structure is cheap and can easily be created with forest drainage machinery during the ditching and ditch network maintenance operations



- Average SS reduction 82 % when comparing two adjacent study areas
- Most efficient during high peaks, just as designed

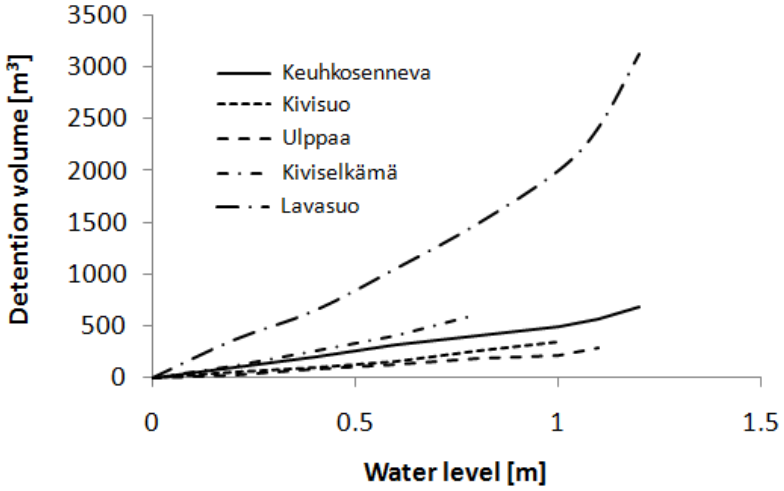
Effect of peak runoff control on water quality in peat drainage areas

Pollutant	Removal rate (%) in peatland forestry[1],[2]	Removal rate (%) in peat harvesting sites[3],[4]
Suspended solids (SS)	54-86	61-95
Total Phosphorus (P_{tot})	30-67	47-88
Total Nitrogen (N_{tot})	65	45-91

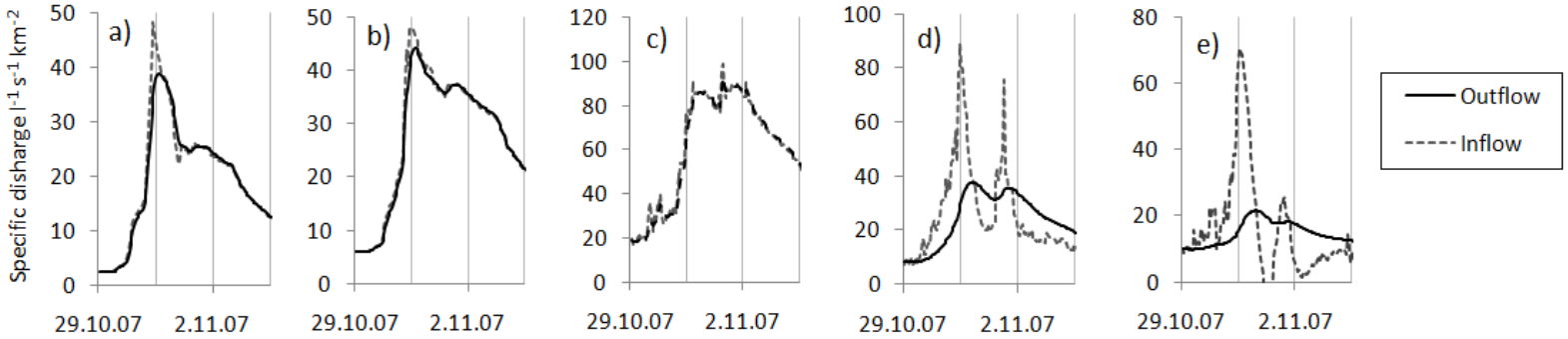
(1) Marttila and Kløve, 2010, (2) Amatya et al., 2003 (3) Marttila and Kløve, 2009, (4) Kløve, 2000.

- The main effect of PRC is on SS and SS-bound nutrients
- Temporal detention did not effected on wood growth

Function of PRC method in different drainage areas

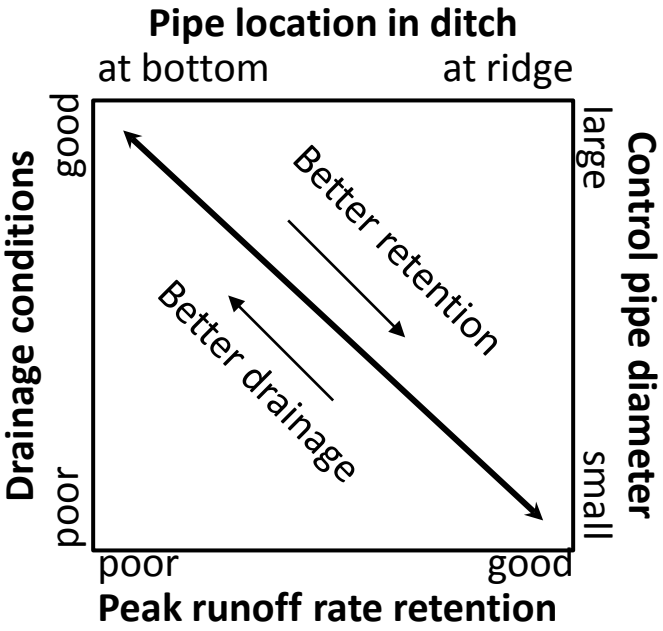


- The peak runoffs have noted to reduce by 10–73%
- The method functioned especially well during largest runoff peaks – just as designed
- The effectiveness of the method depended on
  - catchment topography (slope) and available detention volume
  - dimensioning and location of the PRC structure
  - runoff rates



Summary – suitability of PRC method on peatland forestry conditions

- When properly designed and installed, method operate well in peatland forestry conditions
- The PRC structure is cheap and can easily be created with forest drainage machinery during the ditching and ditch network maintenance operations.
- The main effect is on SS and SS-bound nutrients
- Drainage conditions need to remain
- Best results for water protection will be reached when different methods are combined



Thank you!

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