Agricultural water management using two-stage channels: performance and policy recommendations based on northern European experiences (Primary reach-scale study site: Ritobäcken, Sipoo, Finland)

Final fact sheet, Contract number: 939642

General

Country: Finland

Site name: Ritobäcken

Summary:
Conventional dredging of ditches and streams to ensure agricultural drainage and flood mitigation has severe environmental impacts. We assessed the main benefits of an alternative, nature-based two-stage channel design with floodplains excavated along the main channel. We conducted investigations at Finnish field sites (primary field site: Ritobäcken, Finland) and performed a literature survey focusing on Boreal and Continental climatic conditions. The 820 m long two-stage channel was constructed in 2010. The study results show that two-stage ditches provide efficient flood control and drainage, and likely improve stream water quality and biodiversity. The obtained knowledge can be used to estimate environmental effects from the similar type of drainage solutions in rural areas.

NUTS Code:
Helsinki-Uusimaa

RBD code:
FIVHA2

Transboundary:
0

Data provider:
Kaisa Västilä, SYKE

Source(s):
?

NWRM(s) implemented in the case study:
Floodplain restoration and management
Wetland restoration and management
Buffer strips and hedges

Longitude:
25.2199 E (two-stage channel outlet)
Latitude:
60.3336 N (two-stage channel outlet)

Site information

Climate zone:
Cool temperate moist

Mean rainfall:
630 mm/year

Average temperature:
6 ºC

Average runoff coefficient:
0,200

Type:
Case Study Info

Light or indepth?
Light

Water quality inflow:
-

Mean annual runoff range:
150–300 mm

Average slope range:
nearly level (0–1%)

Vegetation class:
Site surrounded by agricultural and forested areas; the banks and floodplains of the channel are covered by grasses and shrubs.

Monitoring maintenance

Monitoring impacts effects:
-

Performance

Performance impact estimation method:
Retention of suspended sediment (SS) and particulate phosphorus (P) based on repeated cross-sectional monitoring, continuous monitoring of water level, discharge and SS loads, and water sampling during baseflow and rainfall/snowmelt events; plant and pollinator diversity through field investigations; improvement in drainage and flood mitigation based on cross-sectional surveys and measured and modelled water levels;

Performance impact estimation information:
The case study compiles together results from earlier published research and new analyses

Biophysical impacts

Runoff reduction:
Rather small as volume of floodplain low in comparison to catchment area

Runoff reduction unit:
-

Information on runoff reduction:
-

Peak flow rate reduction:
Rather small as volume of floodplain low in comparison to catchment area

Peak flow rate reduction unit:
-

Information on peak flow rate reduction:
-

Water quality overall improvements:
Positive impact through increased retention of suspended sediment and phosphorus on the floodplain

Water quality Improvements Phosphorus (P):
The retention efficiency per 1 km of two-stage channel length was 16.3% for the floodplain in relation to the total load and 3.5% considering the entire cross-sectional channel area. The significant re-suspension of

earlier deposits from the low-flow channel in the first 2 years after construction decreased the total retention efficiency.

Water quality Improvements (P) unit:
% retention of total load per 1 km of two-stage channel length

Water quality Improvements Nitrogen (N):
Not determined; two-stage channel sites from USA show increased nitrogen removal through denitrification

Water quality improvements (N) unit:
-

Water quality Improvements Total Suspended Solid (TSS):
The retention efficiency per 1 km of two-stage channel length was 13.6% for the floodplain in relation to the total load and 2.1% considering the entire cross-sectional channel area. The significant re-suspension of earlier deposits from the low-flow channel in the first 2 years after construction decreased the total retention efficiency.

Water quality Improvements (TSS) unit:
% retention of total load per 1 km of two-stage channel length

Soil quality overall soil improvements:
The solution may have positive impacts on soil quality by likely ensuring the long-term functioning of drainage and flood control, which likely maintains good soil structure and composition

Lessons, risks, implications...

Key lessons:
The Ritobäcken case study represents a research work which aimed to assess whether and how a two-stage channel improves and regulates stream water quality and flow.

Financing mechanism:
Investment costs of two-stage channels can be publicly subsidized through the Centres for Economic Development, Transport and the Environment (ELY centres) and partly by landowners.

Success factor(s):

Type	Role	Comments
Existing case studies	Main factor	Contributed real-life cost and performance data
Careful design of the channel	Main factor	benefits through frequent floodplain inundation
Supporting landowners	Main factor	
Collaboration with stakeholders	Main factor	Research-development-practice link

Financing:

Type	Comments
Other	Investment costs can be subsidised

Barrier:

Type	Role	Comments
Lacking long term water quality data	Main barrier	Long term effects have to be estimated

Type	Role	Comments
Lacking data on monetized benefits	Main barrier	Need to use estimations which are as close as possible

Driver:

Type	Role	Comments
Dredging need	Main driver	Growing need for re-dredging has been recognized which could offer an opportunity to increase the number of two-stage channels

Financing share:
Land surveying & planning costs were covered by an R&D project and construction costs by local state authority (ELY-centre)

Socio-economic

Direct benefits information:
Two-stage channels can enhance biodiversity and water quality in agricultural channels in comparison conventional dredging. This could also partly serve the implementation of The Water Framework Directive (2000/60/EC).

Costs investment information:

Costs (operation, maintenance):
No operation costs, maintenance costs low with less need for maintenance compared to conventional dredging.

Costs total information:
Initial construction cost of two-stage channels is higher than conventional maintenance dredging, but the life-cycle maintenance costs are estimated to be notably lower. The costs related to lost field area can be largely mitigated by integrating two-stage channels into CAP-AES as eligible vegetated buffer.

Ecosystem improved biodiversity:
Yes

Information on Ecosystem improved biodiversity:
The two-stage channel design provides a more natural-like habitat with increased plant and fish biodiversity.

Ecosystem provisioning services:
-

Ecosystem water supply:
Low-flow channel of the two-stage channel enables more constant water flow and supply in the stream, and ensures higher water levels during low-flow periods compared to conventionally dredged channels.

Ecosystem impact climate regulation:
Good and sustainable drainage of the fields and flood mitigation.

Information on Ecosystem flood control volume:
Maintains good drainage of the fields with less need for maintenance compared to conventionally dredged ditches, thus decreasing the need for ecologically harmful re-dredging.

Policy, general governance and design targets

Policy description:
The study deals with Ritobäcken two-stage channel, in Sipoo municipality. The channel was carefully designed to improve drainage and water quality and to prevent harm to stream biodiversity. The aim was to evaluate the total costs and monetary environmental benefits of the two-stage channel approach in comparison to the conventional dredging. The pilot-scale results can be up-scaled to larger agricultural catchments. We also investigated the bottlenecks in the financing and governance hindering the mainstreaming of two-stage channels.

Part of wider plan:
No

Policy pressure:
No

Policy requirement directive:
No (?)

Policy impact:
Not yet

Policy wider plan:
Based on this study, our target was to provide recommendations on how to tackle the bottlenecks, and propose how to finance two-stage channels, including their integration into the CAP-AES based on their optimal spatial targeting with respect to other types of vegetated riparian buffers.

Policy area:
?

Policy target:
?

Target purpose
Ensuring long-term functioning of agricultural drainage and flood mitigation
Natural-like stream morphology to support stream biodiversity
Retention of suspended sediment and phosphorus and removal of nitrogen to improve water quality

Design & implementations

Application scale:
Reach-scale (820 m long two-stage channel)

Area (ha):
0,33 (Area of the two-stage channel)

Area subject to Land use change or Management/Practice change (ha):
0,33

Size:
0,33

Size unit:
ha

Constraints:
Sipoonkorpi natural park right downstream

Inflow volume:
0.12

Inflow volume unit:
m3/sec

Outflow volume:
0.12

Outflow volume unit:
m3/sec

Annual peak flow rate:
~1.4 m3/sec

Public consultation:
-

Contractural arrangements:
-

Design contractual arrangement:

Arrangement type	Role	Responsibility	Name	Comments

-

Design consultation activity:
-

Design land use change:
-

Design authority:

Authority type	Role/Responsibility	Name	Comments
Regional environmental authority	Initiation; Implementation	Uusimaa Centre for Economic Development, Transport and the Environment (ELY)	
University	Monitoring	Aalto University	Water Protection Association of the River Vantaa and Helsinki Region, and Uusimaa ELY Centre participated in monitoring in 2010-2011
Designing consultant	Design	Ympäristötekniikan inisnööritoimisto Jami Aho Oy	Design of the two-stage channel
Construction company	Construction		
Private landowners			Knowledge sharing with others interested in the solution