Agri-environmental Measures:

In the stream

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EUROPEAN REGIONAL DEVELOPMENT FUND
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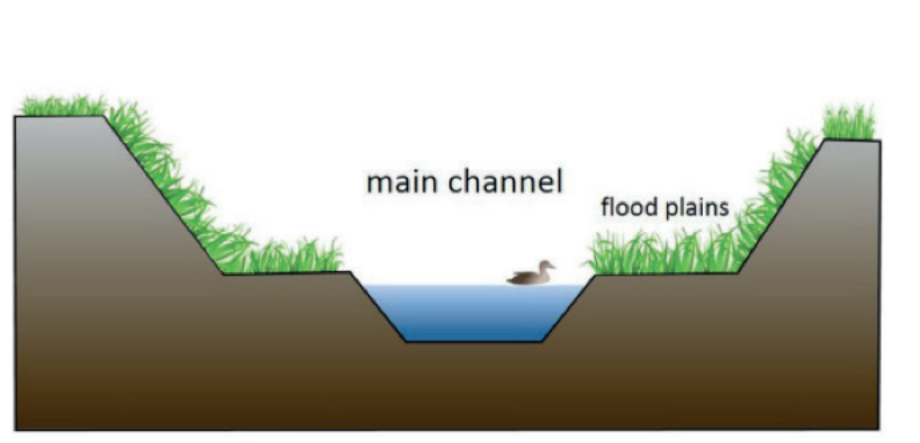
Agri-environmental Measures in the stream:

1. Two-stage ditches
2. Constructed wetlands – subsurface water flow
3. Constructed wetlands – surface water

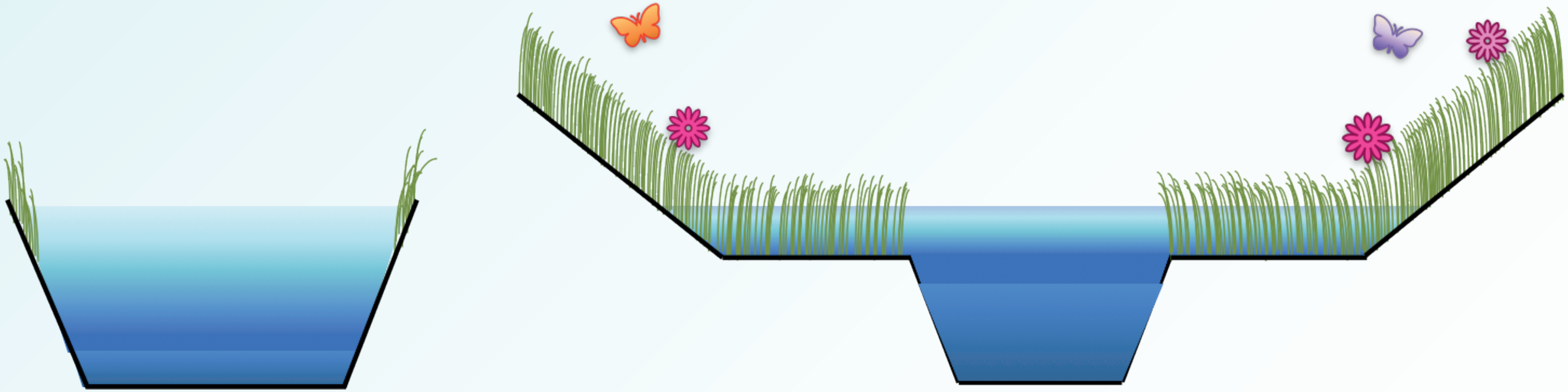
Two-stage ditches

- A two-stage ditch consists of a natural base flow channel with floodplain “benches” which are adjacent to the base flow channel within a drainage ditch. Floodplains can be either one-sided or two-sided.
- It consists of a main channel, where water flows when water volume is low, and of floodplains where water has more room to flow in times of increased water volume.
- The structure mimics the features of a natural stream and is therefore more sustainable. With two-stage ditches, natural processes reducing nutrient loads from the water are also possible. Two-stage ditches reduce erosion and flooding.
- Vegetation in floodplains prevents erosion and removes nutrients from the water.
- The construction of floodplains will also increase biodiversity in the region.



Two-stage ditch principle (photo: Heidi Nurminen) and floodplain excavation work (photo: Kaisa Västilä).

Two-stage ditches



Ordinary ditch

2-stage ditch

Floodplains can also serve as ecological corridors for a variety of animals and insects.

Localisation and implementation

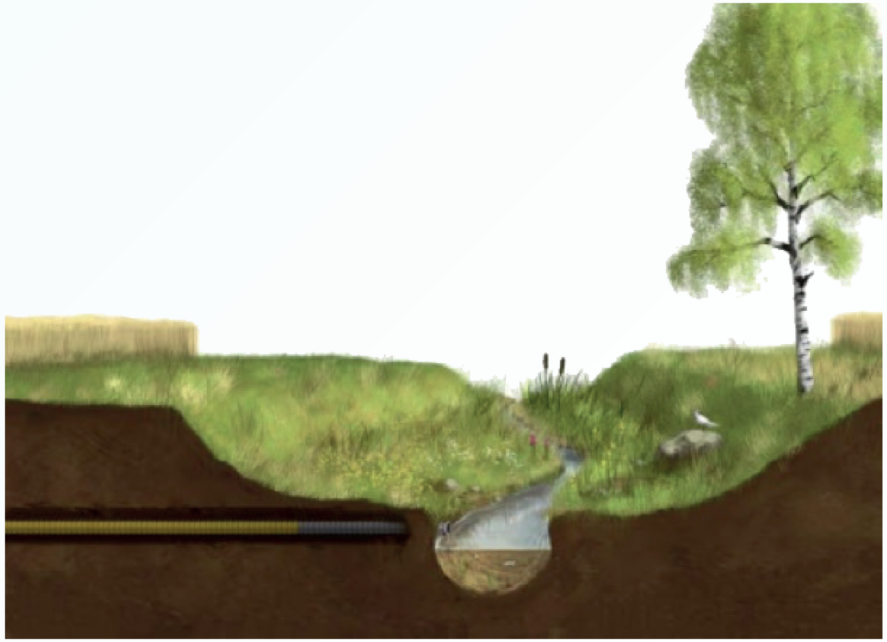
In agricultural areas, there is a demand for environmentally sustainable solutions to improve water quality but also biodiversity.

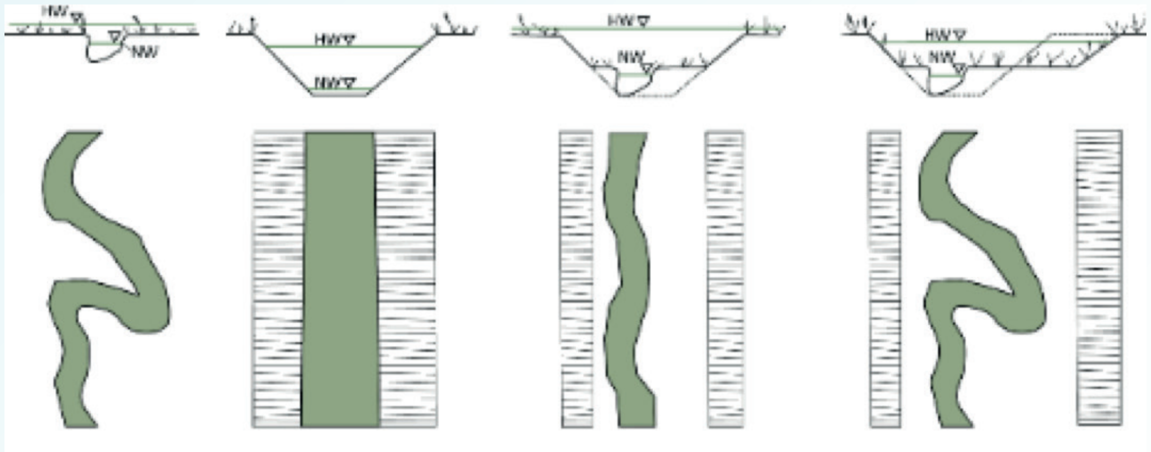
The two-stage channels are applicable to streams that need maintenance and to improve flood control.

Two-stage ditch requires more space than ordinary ditches used in agriculture, which leads to a loss of arable land.

Conventional trapezoidal channel

Two-stage channel, floodplain on both sides





Effects, duration and maintenance

Two stage channels provide a larger water holding capacity at high flows which can reduce downstream flooding while providing drainage. They promote fine sediment deposition on the floodplains during high flows, which will improve habitat for aquatic communities and reduce instream sediment loads. Also vegetative uptake of nutrients (e.g. by grasses) is enhanced which buffers downstream nutrient export. Two stage approach reduces bank erosion and failure, which can decrease the frequency of ditch maintenance activities especially in combination with bench sediment deposition. The surface area where denitrification can occur is larger, which increases permanent removal of nitrogen to the atmosphere, thus reducing downstream nitrogen export and eutrophication.

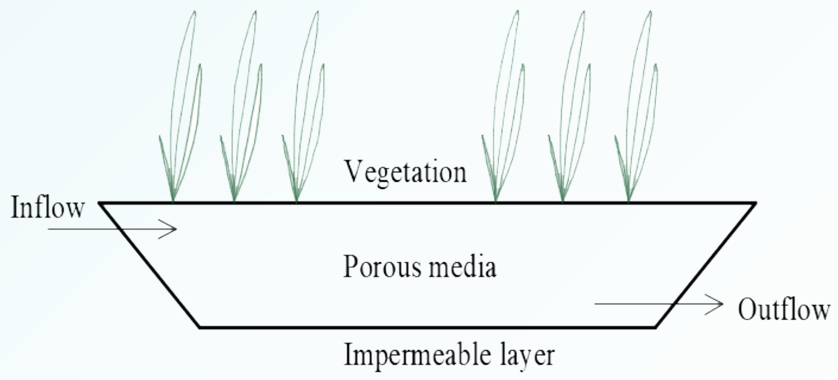
Two-stage ditch requires less maintenance than common ditches, but they are more expensive to construct than common ditches. The clearing of the ditch must be agreed between the actors in the area.

	Good/positive
	Moderate
	Negative
	Unknown
	Not relevant

Effects								**Costs**	
Water retention	N retention	P retention	Ground-water infiltration	Productivity	Biodiversity	Carbon storage	GHG reduction	Duration	Maintenance
								Investment	Vegetation removal

Constructed wetlands – subsurface water flow

- Subsurface flow constructed wetlands are mainly used as natural treatment systems to improve water quality.
- A subsurface flow constructed wetland usually consist of an excavated trench lined with impermeable layer of plastic membrane or clay, filled with porous media such as stones, gravel or coarse sand, and covered with planted or natural vegetation.
- The water distribution through the media can be vertical or horizontal ensuring that the water level remain below the surface of the filter bed.
- Due to physical processes the water is filtrated mechanically, while microbiological activity in the filter media leads to removal of nutrients, BOD5 and total suspended solids.



A schematic drawing of a subsurface flow constructed wetland:
1. Inflow;
2. Impermeable layer,
3. Porous media,
4.Vegatation,
5 Outlet

Localisation and implementation

Subsurface flow constructed wetlands can be adapted to remove pollution from:

- domestic wastewater
- storm water
- contaminated industrial wastewaters, and
- agricultural runoff

The dimensions of constructed wetlands should be calculated based on the amount and quality of the inflowing water.

The water can be distributed through the system without electricity in a proper slope of the area.

The subsurface flow constructed wetland at the Mezaciruli farm in Latvia

Effects, duration and maintenance

The subsurface flow constructed wetland has a potential to significantly remove nitrogen and phosphorous compounds as well as to decrease concentrations of total suspended solids and biochemical oxygen demand in the water.

The constructed wetland as a treatment system has low implementation and maintenance costs.

During exploitation it is required to remove the vegetation once per year and periodically monitor the water distribution system. In case of any evidences of clogging in the water distribution system the porous media need to be replaced.

	Good/positive
	Moderate
	Negative
	Unknown
	Not relevant

Effects								Costs	
Water retention	N retention	P retention	Ground-water infiltration	Productivity	Biodiversity	Carbon storage	GHG reduction	Duration	Maintenance
								Several years	Low

Constructed wetlands – surface water

- A well-planned constructed wetland includes deep and shallow, as well as open-water and vegetated areas with gentle slopes and curved shorelines.
- Constructed wetlands (CWs) reduce agricultural water pollution and complement the water protection measures made in the fields.
- Locally, CWs can significantly improve the status of waters, as they prevent the transport of nutrients and solids into the recipient waterbodies.
- CWs also store water and thus decrease the risk of flooding in the downstream areas. Moreover, farmers can use the stored water for irrigation and thereby recycle the nutrients back to the fields.
- Birds, game, fish, crabs and many other animals thrive in CWs. Well-planned and -built CWs also bring pleasure to the eye and enliven rural landscapes.

A schematic drawing of a constructed wetland:

1. Inflow (inflow weir); 2. flood zone,

3. Deep water area, 4 Shallow water area, 5 Outlet (outflow weir)

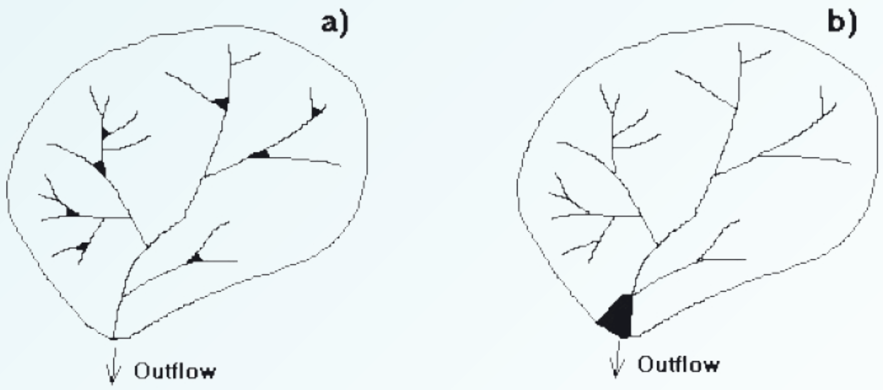
6. Isolation ditch, 7 Embankment; 8. Splits of land, 9. islet

Localisation and implementation

Two different strategies of locating CWs: several small wetlands along the upper reaches and tributaries (A) and one large wetland at the outlet of the catchment (B).

The advantages of strategy A are that (i) an adequate CW-to-watershed area ratio is more readily available and (ii) that the input waters are less diluted than in strategy b). Meanwhile in strategy B the advantage is that entire loading from the catchment will be treated in the CW.

CWs must be established primarily by damming, but in practice it is always necessary to carry out some excavation work, e.g. to create the deep parts.



Two different strategies of locating constructed wetlands; several small wetlands along the upper reaches and tributaries (a) and one large wetland at the outlet of the catchment (b).

A constructed wetland in Finnish countryside in summer 2019. (Photo: J.Koskiaho)

Effects, duration and maintenance

In terms of the retention of solid material, the positive effects of CWs are (a while after the construction) immediate, whereas for dissolved nutrients it takes some 5 years until the retentions are substantial. For nitrogen (N), the retention capacity of a CW is infinite (denitrification). For phosphorus (P), the retention capacity of CW soil (adsorption) is limited. Nevertheless, biological P (and N) removal and settling of P-rich soil particles will continue.

However, in order to remain effective, this requires This, however requires maintenance of CWs by removing the settled sediment and mowing of overgrown vegetation in every, say, 5–10 years.

	Good/positive
	Moderate
	Negative
	Unknown
	Not relevant

Effects								Costs	
Water retention	N retention	P retention	Ground-water infiltration	Productivity	Biodiversity	Carbon storage	GHG reduction	Duration	Maintenance
								Investment	Minor

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