Agri-environmental Measures:
Between the field and stream

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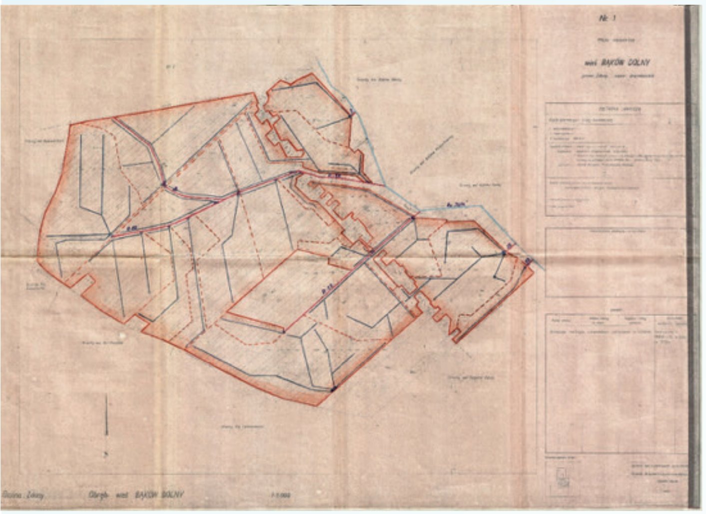
Agri-environmental Measures between the field and stream:

1. Renovation of drainage systems
2. Controlled drainage
3. Buffer zones
4. Floodplains

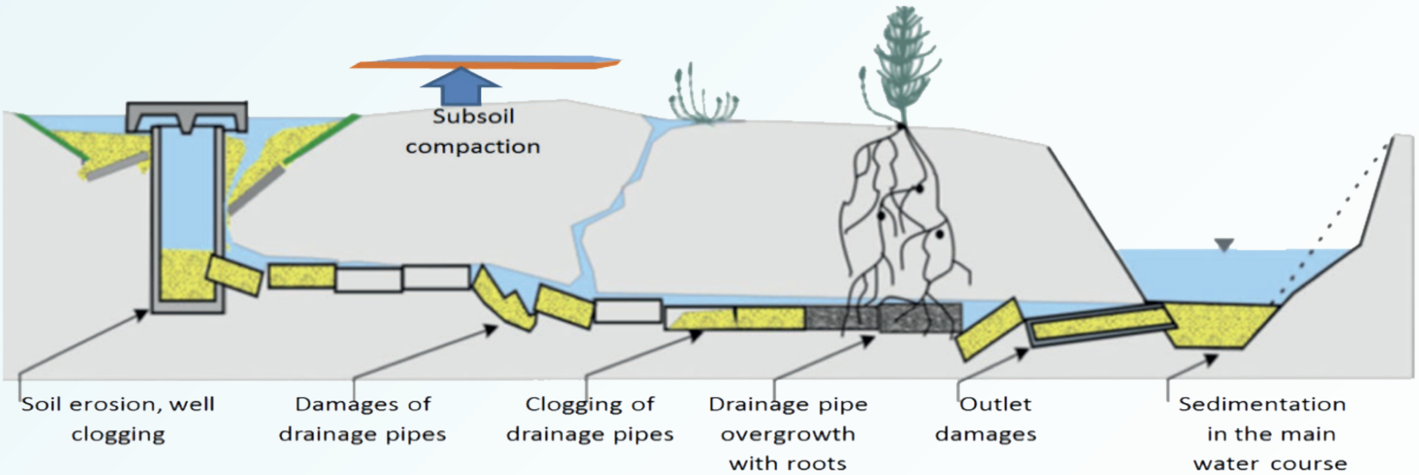


Renovation of drainage systems

Surface and subsurface drainage systems are needed to collect and remove standing or excess water from agricultural fields, especially during spring time for soil preparation, sowing, and fertilizer application purposes, vegetation season to secure healthy agricultural crop development and late autumn for harvesting purposes.

Over the exploitation time malfunctioning of drainage systems could appear thus leading to increased groundwater level, restricted field operations, and failure in crop growth. Therefore, the maintenance and renovation of drainage systems is suggested.

The most common malfunctions of surface and subsurface drainage systems



1. Soil erosion, well clogging
2. Damages of drainage pipes
3. Subsoil compaction
4. Clogging of drainage pipes
5. Drainage pipe overgrowth with roots
6. Outlet dameges
7. Sedimentation in the main water course

Localisation and implementation

- First step to identify failures in agricultural drainage systems is to inspect overall functioning and condition of the main water course (channel or ditch), where water from subsurface drainage systems is discharged.
- Prior any practical work, the status and ownership of a specific water course must be identified and legal requirements for planning and implementation activities have to be studied.
- If the main water course is covered by vegetation, i.e., grass, shrubs, small trees, it is likely that the bottom section of this water course has been filled with sediments over time often leaving drain collector outlets buried under a layer of sediments.
- Second step is to localize drain collector outlets to mark those accordingly in order to avoid potential damages during excavation work.
- In case of necessity of excavation work it is suggested to perform mechanical cleaning activities in the water course during the summer low flow season starting from the downstream segments of the water course and continuing in the upstream direction.
- Once the drain collector outlets are found and repaired, those also should be protected, for example with concrete lining or rip-rap stones underneath to exclude risks of soil erosion from the embankment.

Effects, duration and maintenance

To improve performance efficiency of drainage systems surface water inlets if present should be inspected and cleaned every year.

In case of problems with clogging in subsurface drainage systems caused by sedimentation or chemical deposition rinsing machinery should be used.

	Good/positive
	Moderate
	Negative
	Unknown
	Not relevant

Effects								Efficiency	
Water retention	N retention	P retention	Ground-water infiltration	Productivity	Biodiversity	Carbon seque-stration	GHG emissions	Duration	Maintenance
									yearly

Controlled drainage

Controlled drainage regulates the subsurface drainage from the fields by means of damming devices installed in the control wells. This improves growth conditions and reduces nutrient leaching.

With controlled drainage, the groundwater level can be kept occasionally higher than with conventional drainage, and as a result the soil moisture increases and the subsurface drainage decreases.

Increased soil moisture improves plant water and nutrient uptake, increasing yields and reducing the amount of potentially leachable nutrients in the soil.

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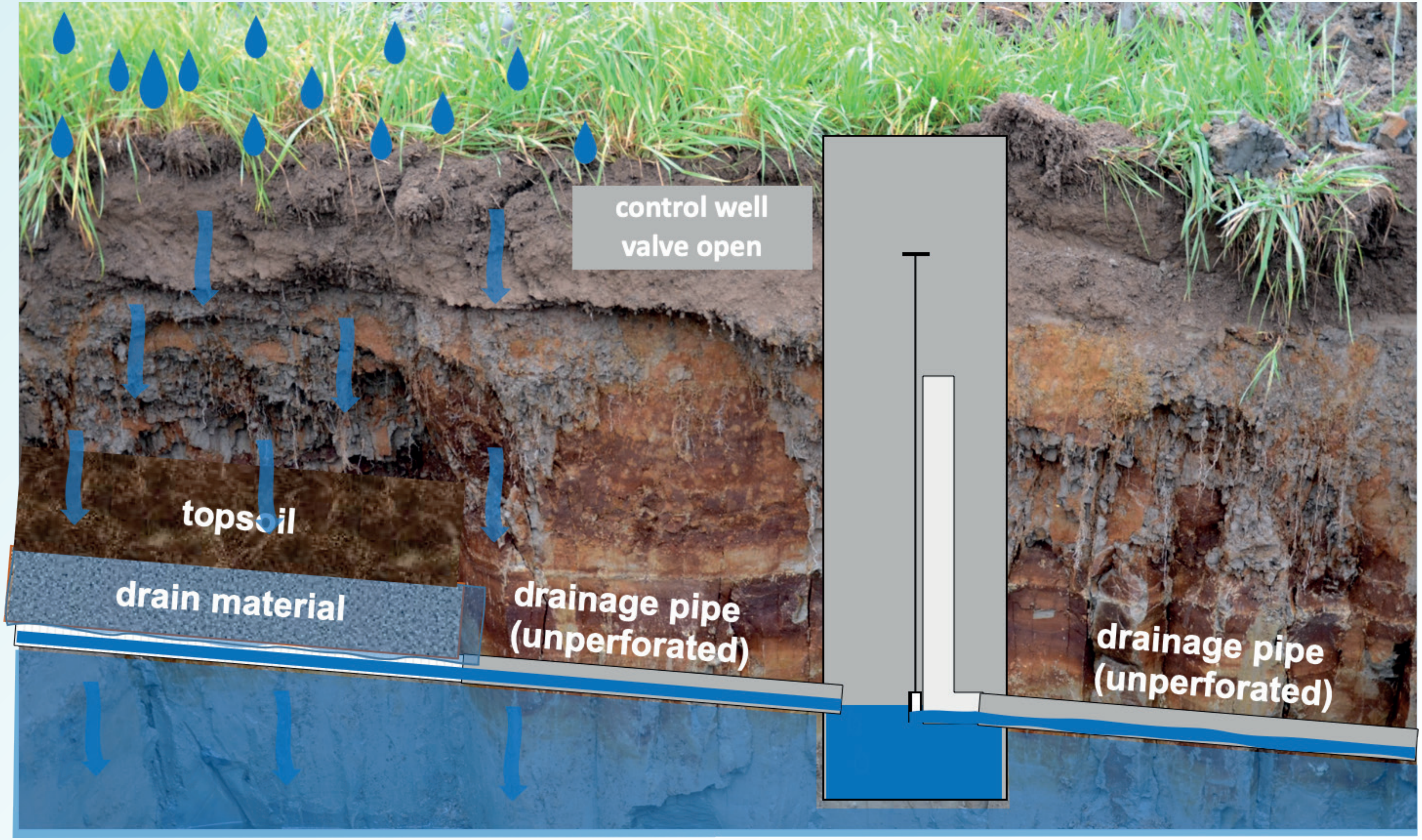
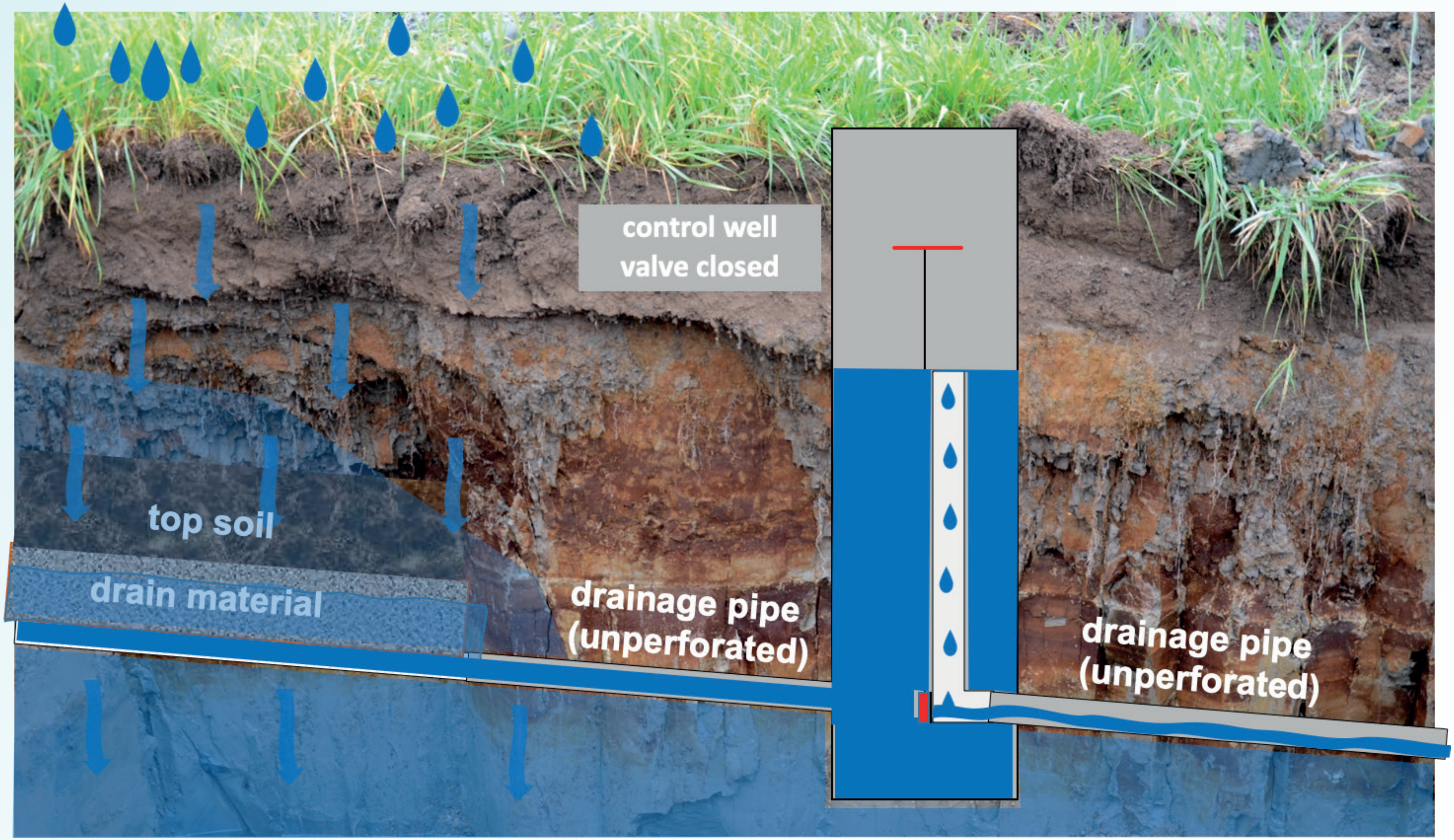
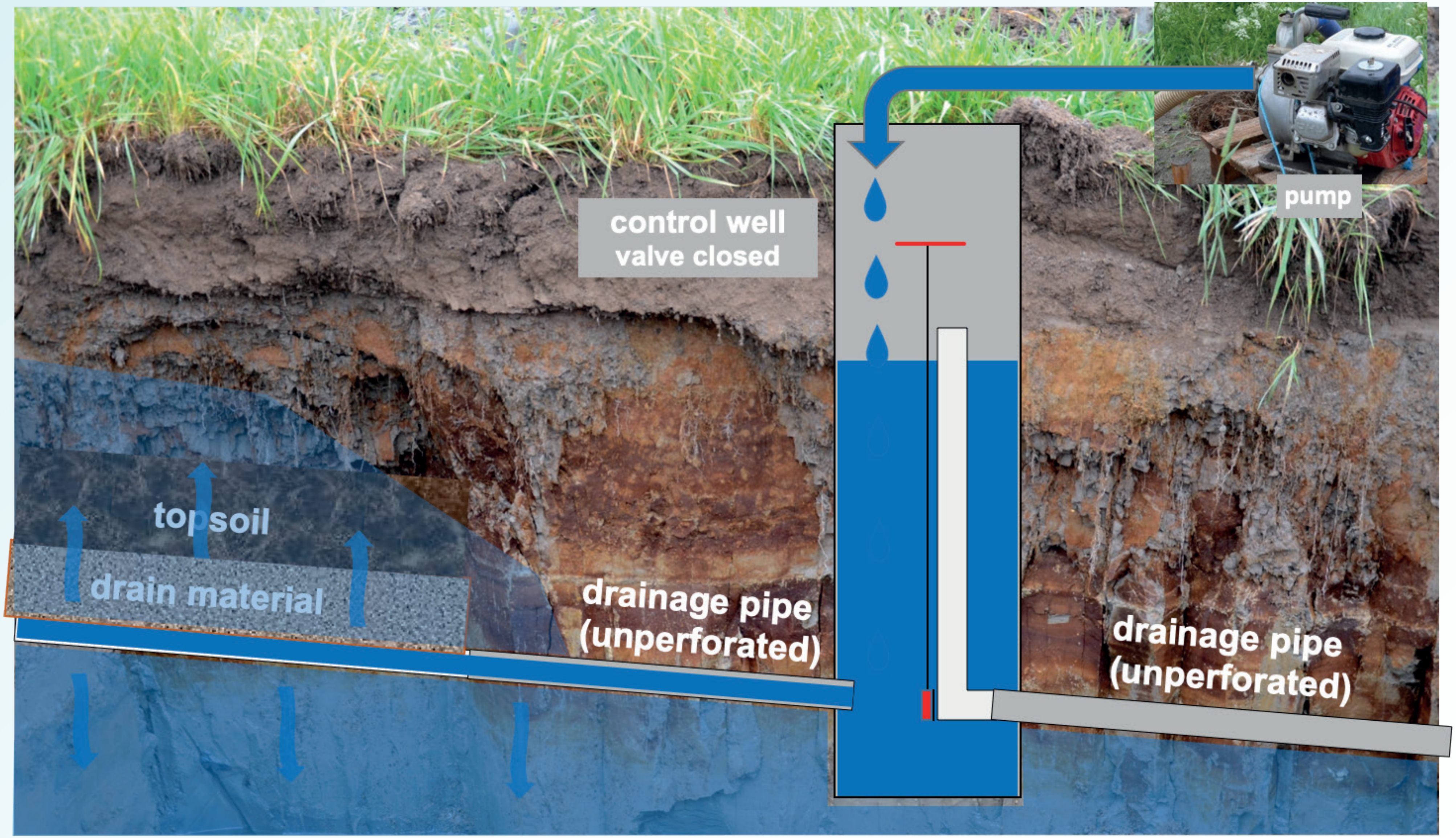


Subsurface drainage + control well - permeable soil



Subsurface drainage - permeable soil



Subsurface drainage + subirrigation - permeable soil

Localisation and implementation

Controlled drainage is best suited for fields with a maximum slope of 2%.

The soil type must be very permeable to water, which is why silt loam, and coarser soil types as well as muddy clays are well suited for controlled drainage.

Poorly permeable subsoil must be relatively close to the ground surface for dams to work.

Control well

Effects, duration and maintenance

Compared to conventional drainage, controlled drainage reduces total runoff, nutrient leaching and rust formation. In acid sulphate soils, acid formation and leaching of metal compounds are reduced. The crop yield, in turn, increases and its quality improves.

To benefit the vegetation and the environment, the control drainage requires appropriate care (esp. dam height adjustment).

Maintenance includes cleaning the wells and flushing pipes in rusty areas.

	Good/positive
	Moderate
	Negative
	Unknown
	Not relevant

Effects								Efficiency	
Water retention	N retention	P retention	Ground-water infiltration	Productivity	Biodiversity	Carbon seque-stration	GHG emissions	Duration	Maintenance
						?	?		

Buffer zones

A buffer zone (BZ) with perennial vegetation cover between an agricultural field and a receiving water body or main ditch has several benefits.

The BZ prevents the application of fertilizers, manure and pesticides too close to an adjacent water body, brook or main ditch.

It not only controls erosion on the slope but also retains sediment, nutrients and other pollutants from surface runoff.

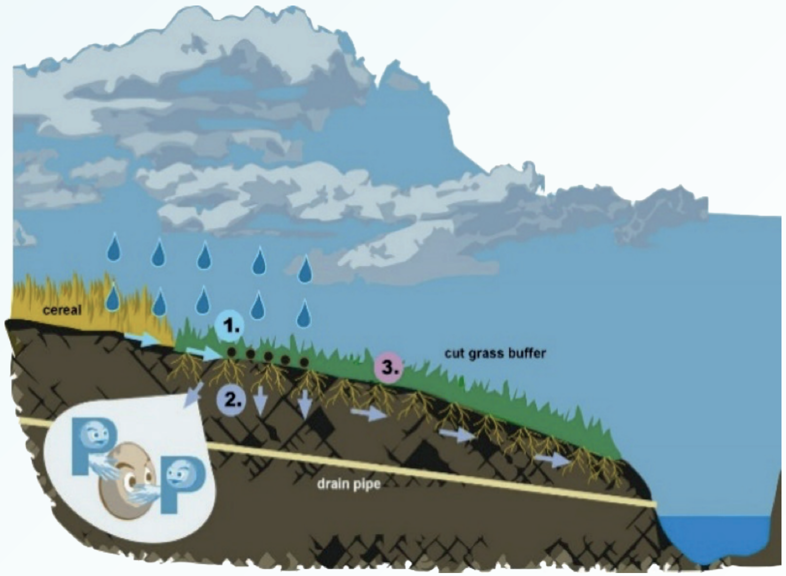
In addition, the BZ enhances the biodiversity and especially can increase the number of pollinators.

A 3-m-wide buffer strip on the left and 1-m-wide headland on the right side of the main ditch. (Photo: Jaana Uusi-Kämppä, Luke

Buffer zones

Buffer zones can control loading in several ways:

- Firstly, dense vegetation in the BZ increases the hydraulic roughness reducing the overland flow velocity and sediment transport capacity. At the same time, eroded soil particles are settled in the BZ and particle bound nutrients and pollutants are retained.
- Secondly, phosphorus is adsorbed in the soil surface whereas soluble nutrients and compounds infiltrate with runoff water into the ground.
- Thirdly, the vegetation in the BZ adsorbs pollutants from the surface runoff and roots take up nutrients from the soil.



Retention processes within buffer zones:
1.Deposition of sediment,
2. Adsorption of phosphorus in soil surface or/and infiltration of runoff into soil,
3. Plant uptake of nutrients.
(Figure: Ulla Jauhiainen, Luke's archive)

Localisation and implementation

- Buffer zones are usually located between lower field edges and main ditches or water bodies.
- It is important to establish and maintain a right kind of BZ in the right place.
- The width of BZ depends on the erodibility of the protected field or slope. The longer, steeper or more erodibility the slope, the wider BZ is needed.
- A narrow headland is enough along the main ditches or a 3-m-wide buffer strip along brooks on flat soils whereas more than a 10-m-wide BZ may be needed on steep and long slopes with high erodibility.
- In some cases, BZs could be left on a field area e.g. to cut a long slope or retain water on a concentrated water flows in the field.

A grassed buffer zone along the River Loimijoki in Jokioinen.
(Photo: Jaana Uusi-Kämppä, Luke)

Effects, duration and maintenance

Buffer zones are effective in decreasing soil particles and particle bound phosphorus (PP) in surface runoff from autumn ploughed soils having high erodibility. They are also useful for grassed and directly drilled fields with low erosion because they maintain sufficient distance between the source field with manure, fertilizer or pesticide application and the water body. The retention efficiency is better in autumn than in spring due to dense vegetation in autumn compared to decaying grass during spring snowmelt and rains.

Biomass harvest is recommended to remove nutrients from the BZs. The P sorption capacity may decrease during time since part of the P from source field and decaying grass is adsorbed in the surface soil.

	Good/positive
	Moderate
	Negative
	Unknown
	Not relevant

Effects								Cost	
Water retention	N retention	P retention	Ground-water infiltration	Productivity	Biodiversity	Carbon seques-tration	GHG emissions	Duration	Mainte-nance
								Crop loss	Mowing

Floodplains

A floodplain is a nearly level land along a stream flooded only when the streamflow exceeds the water carrying capacity of the stream.

Flood plains are naturally very fertile due to the river sediment which is deposited there and therefore they are good for cultivation.

The floodplain cuts peak flows and prevents flooding. Ramp collapses are reduced since sediments partly settle nto the vegetation at high flows.

Flood plains also improve the durability of ramps of the stream. Bottom drift of sediments can be further reduced by making bottom dams.

In floodplains, the complexity of the riverbed can be increased or maintained, which promotes natural recovery.

Floodplains can form naturally around rivers of any kind or size. Even relatively straight stretches of river are found to be capable of producing floodplains.

Localisation and implementation

- The floodplain is e.g. suitable for situations where a river/ditch has become silted up through deposition of sediments.
- In this case, a narrow, meandering low water stream/ditch is dug into the vegetation at the bottom of a wide stream.
- During floods, the rest of the riverbed acts as floodplains where growing vegetation binds both solids and nutrients.
- The operation of floodplains can be improved by construction of hedges to break flood streams, e.g. hedges perpendicular to the river flow that are planted in the restored floodplain to slow down floods.

Rise of river waters in the lower parts of the fields,
photo: Riku Lumiaro

Effects, duration and maintenance

The trees growing along the riverbed and the herbaceous vegetation that binds the riverbed ramp are worth saving because the vegetation and the roots of the trees act as a natural erosion protection. Thus, the structure of the stream banks is more durable and the need for maintenance can be reduced.

The problem is the determination of the height of the flood plain and how to make the crop grow quickly on ramps and plain. It is advisable to transfer vegetation to the plain. In agriculture, the areas can be sown with oats or grass. The plain is compacted with a bucket. The effect is long-term. After incorporation, maintenance includes taking care of the condition of the vegetation and from time to time it must be ensured that not too much sediment accumulates on the plain.

	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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