Manual for lake-irrigation

for the SEABASED-project

We know today that the necessity for irrigation in the agricultural lands will increase in the nearby future, as well as the need to restore eutrophicated lakes. Irrigation from polymitic lakes (stratified, eutrophic, lakes) have the potential to help to solve a part of both problems. By using water from the deep area of a stratified lake in the summer, up to ten times more phosphorous can be taken from the lake in comprehension to only using surface water. The extra nutrients do not cover the crops need for fertilization, but the removal of those nutrient can help the lakes restoration. Especially if the irrigation is done several years after in a row.

In Östergötland we identified lake Djupsjön (also called Lake Koppetorpsjön), close to the Baltic Sea, as a possible subject for this irrigation project. Lake Djupsjön is eutrophicated, with possible internal loading as main problem, the lake do not have any known polluted areas in the catchment area and there were farmlands och fields close to the shore of the lake. After some search, we quickly found interested farmers as well, meaning that we could start to investigate the lake more closely to find out if the lake was suitable for the project.

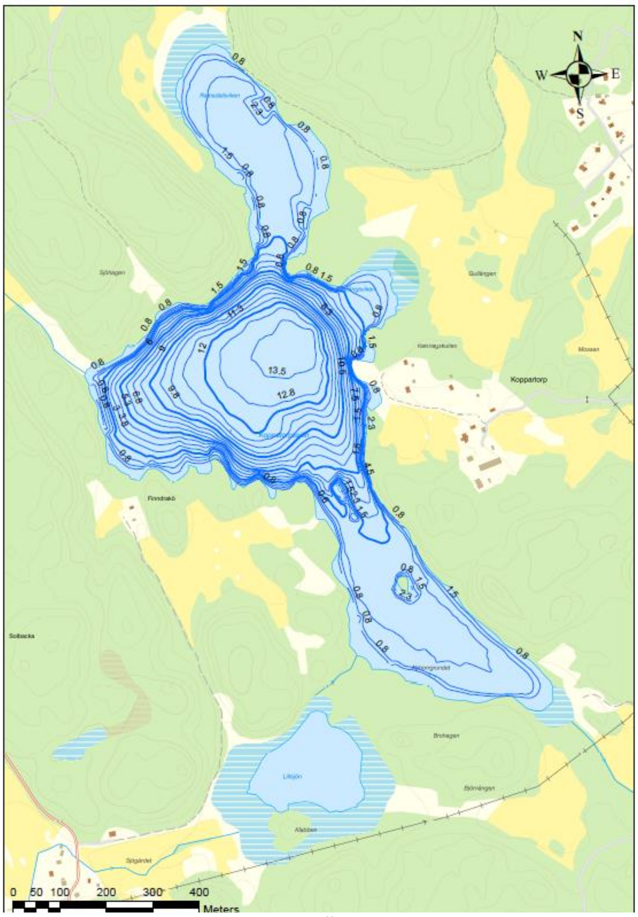

Figure 1. Map done 2020 by CAB Ö, showing the deeps in Lake Djupsjön.

Investigation of the lake

We sampled water and sediment to examine if there could be any harmful substances of heavy metals of environmental toxins but did not find any high levels of them. The levels were within limit values of Swedish lakes. The samples show clearly that the lake is having problems with internal loading with oxygen-deficited bottoms in the deepest area of the lake. Sampling showed up to ten times higher phosphorous levels in the deeps compared to the surface (Table 1). A map showing depths in the lake was done in 2020 (Figure 1), to know where to place the intake of irrigation pump for irrigating deep-water to the field (Figure 2).

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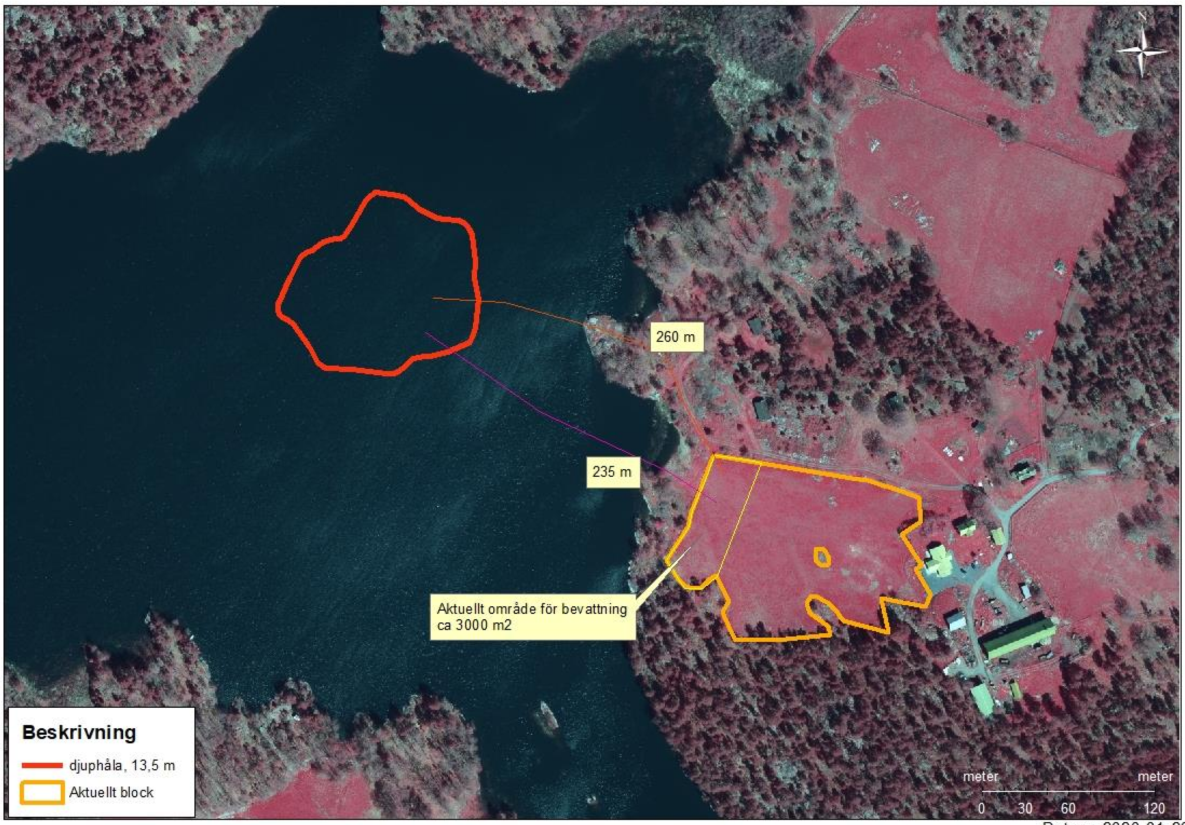

Figure 2. Map showing the deepest area of the lake, where the intake of the irrigation pump was place and the field that was irrigated. The field is grazed by horses and sheep.

Table 1. Results of sampling water chemistry in conjunction with irrigation

Phosphorous content in water summer of 2020	
Bottom	*Surface*
Phosphorous level in water (may-aug) 200-340 µg/l P	Phosphorous level in water (may-aug) Ca 30 µg/l P
Removal from Lake 32-58 mg P/m²	Removal from Lake Ca 4,8 mg P/m²
Removed from the Lake 2020 48-64 g phosphorous	Removed from the Lake 2020 Ca 7 g phosphorous

How the irrigation was done

The field was divided in to two pilot areas, one that was irrigated with water from the oxygen-deficited bottoms (from and now referred to as *the deep area*) and the other was irrigated with water from the surface, close to shore (from and now referred to as *the surface area*). There was also an area left as refence, this area was not irrigated at all but was sampled the same way as the deep area and the surface area (from and now referred to as *the reference area*).

The deep bottom area in the lake is about 100 meters from shore and about 250 meters from the irrigation pilot, *the deep area*. The intake of the surface water was about 50 meters from the irrigation pilot, *the surface area*. The irrigation was conducted at 4 times after the lake was stratified (plus one trial in May).

In order to be able to carry out the project, 2 irrigation facilities were required because a relocation of the irrigation pump will be unwieldly and it was important to carry out the irrigation at the same time in the two pilot sites, to make sure that the weather did not affect the test result. We judged that we would not be able to have a suction line all the way out into the lake, therefore we placed a raft over the deep area in the lake (Figure 3). On the raft we put a diesel-powered high-pressure pump with a 50mm suction line and bottom strainer about 12 meters deep. As a pressure line, we had a 63 mm irrigation hose to prevent pressure drops (Figure 4). It was branched into a nozzle where 3-5 spreaders could be connected, and water samples could be taken. We used 3 spreaders and then got out the equivalent of about 40mm of rain in 3 hours according to the table, we checked with a rain gauge (Figure 5).

The same pumping equipment is used for the surface water, but there a 50mm pressure hose was enough because it is so much shorter, about 50 meters.

Figure 3. Installation of the irrigation pump at the raft.

Figure 4. Installation of hoses and equipment.

Figure 5. Three spreaders gave about 40mm of rain in 3 hours.

Harvest and sampling

Two harvest were taken at the field and the lay was analyzed for respective pilot area: the deep area, the surface area and the reference area. None of the areas was fertilized during this project, nor were they fertilized during 2018-2019.

The re-growth of both irrigated areas, surface and bottom, were visible much larger than in the non-irrigated area, the reference area. We did not see any significant difference in phosphorous content of the lay (Figure 6). We did see a difference in the protein content (Figure 7), but the difference between surface/bottom can just as easily be due to the crop. For example, there was more shamrock in the deep area, which responds very well to water. The same trend could we see in the sugar content, the difference between deep and surface area could be due to the re-growth of different crops.

In conclusion, we could not see any difference between the deep area and the surface area in sugar, protein or phosphorous content. We could however see a clear difference in the re-growth between the irrigated areas and the non-irrigated area, which was to expect.

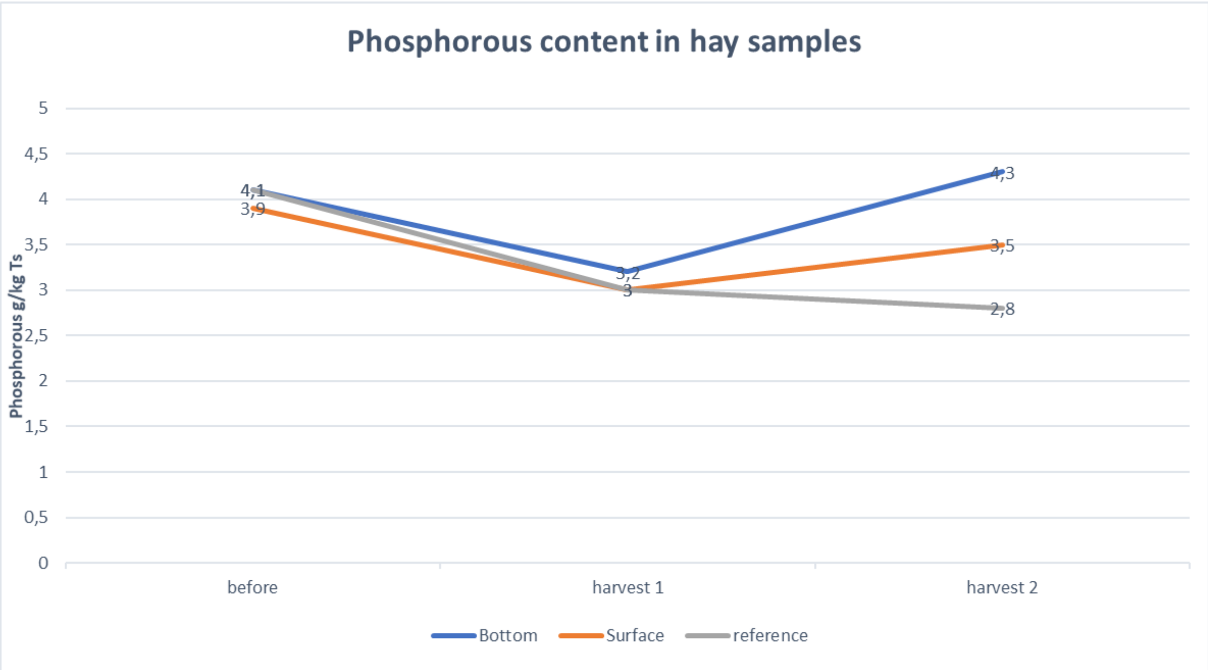

Figure 6. Phosphorous levels in the field

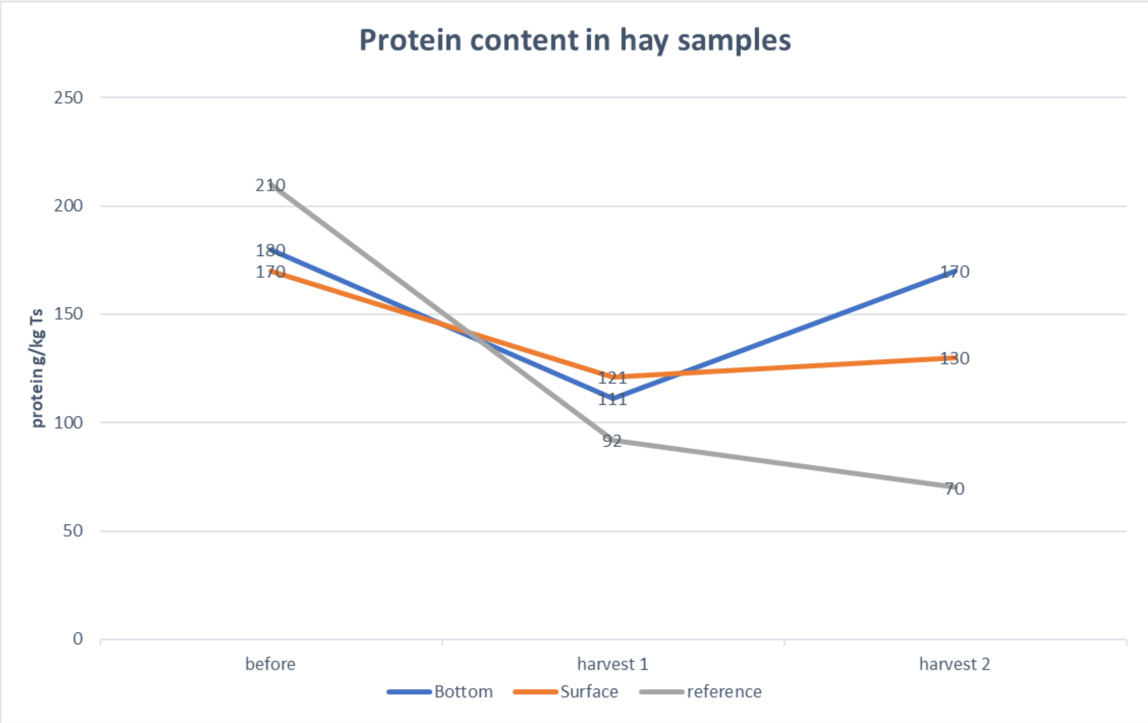

Figure 7. Protein content of lay samples

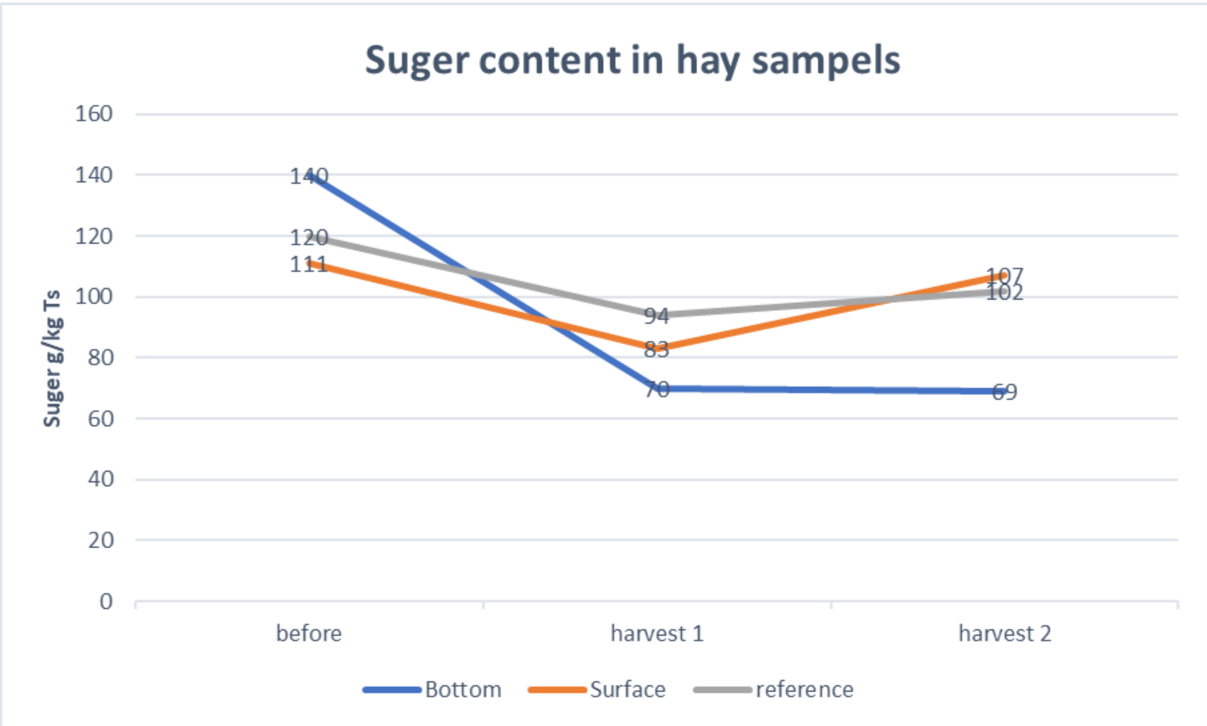

Figure 8. Suger content of the lay.

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Implementations

This project shows great implementations in the future. It worked out well, there were no larger problems that showed up and is was cost-effective in comparison to other irrigation projects.

If this is conducted in larger scales, a lot of phosphorous could be removed from a lake in the same time as we get a more resilient agriculture in a drier future (Table 2).

Table 2. Implementations of irrigations from a polymitic lake.

Implementations	
Bottom	*Surface*
200-340 µg/l P in water	Ca 30 µg/l P in water
Gives P/ha 0,38-0,58 kg P/year	Gives P/ha 0,048 kg P/year
Per field (á 10 ha) 3,8-5,8 kg P/year	Per field (á 10 ha) 0,48 kg P/year

Costs

In this project we used 2 irrigation pumps and more man-hours that what will be needed for implementation in the agriculture in the future. Our cost was in total 312 000 SEK excl. moms, about 30 763 euro (mars 2021). This way of irrigation is a very cost-effective way to irrigate fields. The costs for pumps are purchasing and operating costs, meaning that the following years there is only maintenance and operating costs that occurs.

Important to keep in mind

- One need to investigated heavy metals and environmental toxins in the water body as well as the sediment.
- Place the pump a bit over the bottom to minimize the risk of pump clogged by sediment.
- If possible, place the pump on land for easier maintenance and operating. NOTE then a more powerful pump may be needed
- There is legislation about how much water you can take from a lake. You should also be extra careful during dry summers. Please contact your county administration board for more information for what applies in your area.