Skien
VIDEREGÅENDE SKOLE

Monitoring of restoration process in Stormyr 2024-2025

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1.0 Abstract

This project monitors the restoration process of Stormyr, a marsh area that formerly served as an ice dam and was later drained for forestry. Through automated measurements of water level and temperature from December 2024 through April 2025, we document the marsh's hydrological conditions and follow the restoration efforts. The results show higher water levels during winter and lower, highly fluctuating levels in spring. This suggests that the restoration efforts have not yet fully restored the marsh's capacity for water retention. The data reveals an inverse correlation between temperature and water levels, which has implications for the marsh's potential to store carbon. Technical challenges were addressed throughout the project. Based on our findings, we recommend monitoring the marsh's conditions over a larger time period, with expanded parameters and measurements to come to a better understanding of the marsh's restoration chances.

2.0 Theory

2.1 Purpose

Restoration of marshlands is a relevant area for climate and nature conservation, as wetlands are very important for carbon storage, water management, and biodiversity conservation. Marshlands act as natural carbon stores, with Norwegian marshlands storing a total of approximately 1 billion tons of CO_2 (Nibio, 2020), which corresponds to 20 years of greenhouse gas emissions from the entire Norway. In addition, wetlands have a regulatory function in hydrological cycles, where they absorb and filter water, help mitigate flooding, and improve water quality in the surrounding area.

This project aims to monitor the restoration process for Stormyr, a former ice dam dam that has been exposed to human activity and is now undergoing restoration. Stormyr represents a typical example of degraded marshland; it was first filled to create an ice dam dam, then drained to serve as a logging area, which has reduced the marsh's capacity for carbon storage and ecological functionality. The focus of the restoration work is to monitor Stormyr's hydrological conditions in order to assess whether Stormyr will return to being a sustainable carbon store.

Our project will collect data on water levels, temperature, and peat bog volume in order to document Stormyr's development and see if it can become a functional bog again. This is particularly important given that bogs act as natural carbon stores.

2.2 Technology

This project used a combination of automated and manual work to collect good results. Data on temperature and water level were measured with sensors connected to an Arduino. pH values and peat volume were recorded manually to provide a comprehensive picture of the environment in the marsh area.

For data collection, Arduino PLSC, Arduino MKR NB1500, and Arduino MKR Environmental Shield were used for processing in the system. This platform was chosen because of its low power consumption and easy connection of different sensors.

2.2.1 Arduino PLSC

Arduino PLSC (Power Loop Sleep Control) is a circuit board solution designed to control the power consumption of connected devices and implement sleep functionality (Hansen, 2024).
It was used as the main processing unit in the measuring station.

Specifications:

- Battery holder for two 18650 cells (capacity for 5000mAh in 1S2P configuration)
- Sleep control and loop function for Arduino MKR NB 1500
- Programmable wake-up interval (5, 15, or 30 minutes)
- 5V voltage booster for stable power supply to MKR.

The PLSC card was chosen for projects because of its ability to reduce power consumption through its sleep function. This leads to longer measurement periods with less manual work for us.

2.2.2 Arduino MKR NB1500

Arduino MKR NB1500 was used for communication with the server to transfer data wirelessly.

Specifications:

- ARM Cortex M0+ 32-bit low-power processor
- Module for NB-IoT/LTE-M communication
- Low power consumption – ideal for field installations
- Easy connection with Arduino PLSC

The MKR NB1500 was chosen because it has the ability to communicate via the NB-IoT (Narrowband Internet of Things) network, which is designed specifically for IoT devices with low power consumption. NB-IoT is a mobile network optimized for sensors and devices that send small amounts of data and require long battery life (Arduino, 2025). This network provides good coverage in Stormyr and is less affected by obstacles.

2.2.3 Arduino ENV SHIELD

Arduino ENV SHIELD was used to store data locally at the measuring station (Arduino, 2025).

Specifications

- Integrated sensors for temperature, humidity, air pressure, and light
- Low power consumption and easy integration with Arduino.
- SD card input

ENV SHIELD was used to store data locally as a backup in case of communication problems with the server. The temperature measurements from the ENV shield were also used to verify the accuracy of the DS18B20 sensor, which made the data collection more reliable.

2.2.4 DS18B20 Temperature Sensor

The DS18B20 temperature sensor was chosen for temperature measurement (Elkim, 2025).

Specifications:

- Measuring range: -55°C to +125°C
- Accuracy: +-0.5°C
- Waterproof enclosure

The DS18B20 uses the OneWire protocol, which makes connecting it to the Arduino setup easy. Reading data from the temperature sensor was as simple as including the One-Wire library and using a built-in function.

The sensor was chosen because it could withstand varied weather conditions, had low power consumption, and good
accuracy for the project's purposes. In the project, the DS18B20 was placed near the water surface to measure the air temperature in the hole.

2.2.5 HCSR04 Ultrasonic Distance Sensor

For distance measurement, an ultrasonic sensor, HCSR04, was used (Unknown, Ultrasonic Ranging Module HC-SR04, 2025). It worked by emitting sound waves and measuring the time before they returned after hitting the measurement surface.

Specifications:

- Measuring range: 2-200 cm
- Accuracy: Approx. 1-2 cm in ideal conditions
- Frequency 40 kHz

During testing of the sensors, it was discovered that an insufficient pipe diameter caused the sound waves reflected off the pipe wall and returned incorrect measurements. This was solved by using a PVC pipe with a diameter of 130 mm, which ensured that the sound waves did not reflect anywhere other than the measurement surface.

2.2.6 DS3231 RTC (Real-Time Clock)

A DS3231 RTC clock was used to accurately time stamp the measurements (fruugo, 2025).

Specifications:

- Accuracy +-2 ppm (+-0.432 seconds per day)
- Temperature-compensated crystal oscillator (TCXO)
- I2C interface for communication with Arduino
- Integrated backup battery for continuous time measurement

The RTC card was chosen because it was the simplest solution for dating the measurements in the project. It provided the necessary dating without overcomplicating the system.

2.2.7 Data transfer and power supply

The data was sent wirelessly to a server at NTNU, using a SIM card and antenna connected to the measuring station. The data was also stored locally on an SD card to ensure that data continued to be stored if something went wrong with the wireless setup. The system was powered by two 3.6-volt batteries connected together to supply the Arduinos and sensors with power. To maximize the system's lifespan, the Arduino was programmed to turn on only every 30 minutes to measure, send, and store the data, and then turn off again for 30 minutes. This extended the battery life by several weeks.

2.3 Background on bogs - Basis for restoration

2.3.1 What is a bog?

A bog is an ecosystem with constantly or periodically waterlogged soil, where organic material accumulates faster than it decomposes (Larsen, 2024). This creates peat, a material consisting of partially decomposed plant material. Bogs are normally found in northern areas with cool and humid climates.

Stormyr at Lakåsen in Porsgrunn is a typical example of a bog that has undergone many man-made changes. Originally, Storemyr functioned as a typical bog area with a normal peat layer and hydrological properties. Man's desire to exploit the area led to the degradation of the marshland.

Mires are classified according to their water source and nutrient content:

- *Rainfall bog (ombrotrophic):* Receives water and nutrients only from rainfall, very nutrient-poor and acidic.
- *Groundwater bog (minerotrophic):* Receives water that has been in contact with mineral soil and is more nutrient-rich.
-

2.3.2 How do bogs work?

Marsh hydrology

Bogs function as natural water reservoirs. They absorb water during periods of heavy rainfall and gradually release it during dry periods. This is possible due to the structure of the peat, which can be divided into two layers

- *Acrotelm*: the top layer that performs active decomposition. This layer has high permeability, which means that water flow is high
- *Katotelm*: the lower, permanently water-saturated layer with low permeability

Peat bogs can absorb up to 20 times their own weight in water. Since the water in the bog drains slowly, the bog acts as a natural and effective flood regulator. In Stormyr's case, this flood regulation was reinforced by sealing the ice dam, then draining it for forestry purposes, and then sealing the drainage holes in the hope of restoration.

Ecological processes

The special conditions in bogs (water saturation, low oxygen availability, and often acidic pH) create unique ecosystems:

- The low decomposition rate leads to continuous peat accumulation (typically 0.5-1 mm per year).
- Specialized plant communities develop, adapted to the demanding conditions
- Nutrient limitation (especially in precipitation bogs) has led to the evolution of adaptations such as insectivorous plants

2.3.3 Why are wetlands important?

Carbon storage and climate regulation

Wetlands act as large natural carbon stores, accounting for approximately 30% of all carbon in the soil globally, even though they only cover 3% of the Earth's surface (Statsforvalteren, 2018). This makes them an important resource in the fight against climate change.

Biological diversity

Wetlands are unique habitats for many species that have adapted to wetland conditions.
The vegetation in marsh areas has developed characteristics that enable it to live in waterlogged and acidic areas. The disappearance of marshes means that we are losing habitats for these species.

Water regulation and water quality

Wetlands act as a natural sponge for surrounding areas, retaining large amounts of water during periods of heavy rainfall. By acting as a large sponge, wetlands help prevent
flooding and even out water discharge during dry periods. Wetlands also filter water by trapping pollutants, which improves water quality in the surrounding area.

The extent and consequences of bog degradation

Norway has lost more than one-third of its marshlands, mostly through agriculture, forestry, and peat extraction for garden soil and fuel. A large part has also disappeared due to the construction of new neighborhoods.

The consequences of degradation are serious: draining wetlands releases all the CO2 stored in the marsh, and the area will be unable to store new carbon for many years after any restoration. Changes in hydrology also lead to a greater risk of flooding and reduced water quality.

2.3.4 Why restore wetlands?

Climate measures

In the long term, restored wetlands will regain their natural ability to store carbon, which we consider a climate benefit. Mire restoration is considered one of the most cost-effective climate measures we can take, with high impact and extremely low costs compared to other climate measures (Nibio, 2020).

Biodiversity

By restoring marshlands, we open up habitats for species that depend on the marsh ecosystem. Marshes strengthen the species' ability to move and adapt to change. Marsh restoration also meets national goals for nature and biological conservation.

2.3.5 Conclusion

Wetlands are unique ecosystems with important functions for climate, biodiversity, and water management. Degradation of marshland has significantly reduced these values. Restoration of marshes is a cheap and effective climate measure.

3.0 Methodology

To monitor the restoration of Stormyr, a measuring station was set up to document changes in the environment over time. The measuring station is based on Arduino technology and records important parameters such as water level and temperature.

3.1 Equipment

The following devices were used in the monitoring system:

Control units:

- Arduino PLSC, which functions as a processing unit.
- Arduino MKR NB 1500 for wireless data transmission.
- Arduino ENV SHIELD
- RTC for reading time.
- SD card for local storage.

Sensors:

- DS18B20 temperature sensor with waterproof cap (uncertainty +- 0.5°C).
- HCSR04 ultrasonic distance sensor (measuring range 2-200 cm, accuracy 2 cm).
- RTC real-time clock.

Protection:

- Plastic box (dimensions 30 cm * 20 cm * 20 cm).
- PVC pipe (dimensions, radius – 130 mm, depth – 480 mm).
- Wooden box (dimensions 850 mm * 650 mm * 600 mm)
- Wooden pallet (800 * 600 mm * 100 mm)

3.1 Calibration and Testing

3.1.1 Preliminary calibration:

Both sensors were tested prior to installation. The distance sensor was placed 20 cm away from a flat measuring surface, where it measured 19.8 cm. The temperature sensor measured 22°C in a classroom and corresponded well with the temperature sensor on the Arduino ENV SHIELD, confirming that the sensors were measuring correctly. We therefore decided that the calibration of the sensors was good enough, and no further calibration was performed.

3.1.2 Test phase:

After installation, the system was tested to confirm that all components and the mounting of the pipe were functioning properly. During the test phase of the project, a problem was discovered with the use of the ultrasonic sensor for distance measurement. The ultrasonic sensor emits sound waves with a certain angle of dispersion (angle not specified in HCSR04 documentation). During the first tests with a pipe with a smaller diameter, we observed that the measurements were unstable.

The problem was that when the distance from the sensor to the measurement surface became too great, and the diameter of the the pipe too small, the sound waves would reflect off the walls and be read before the waves reflected off the measuring surface.

After testing different pipes, we chose a PVC pipe with a diameter of 130 mm and a length of 48 cm. This provided enough clearance for the sound waves to reach the measuring surface without disruptive reflections from the walls.

Figure 1 illustrates the setup with a short distance to the measuring surface and a large diameter, so that the waves do not reflect off the pipe wall. This provides more accurate and reliable data.

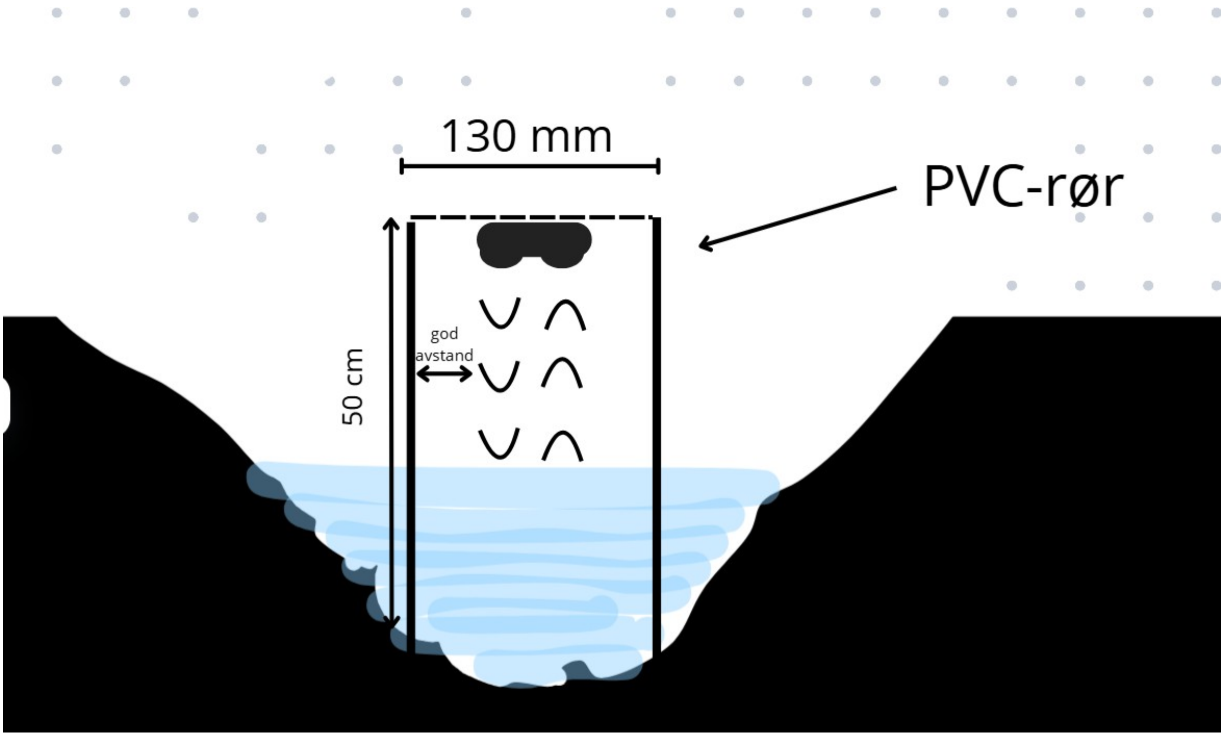

Figure 1: Illustration of pipe installation.

3.2 Field installation

3.2.1 Excavation and placement:

Before deployment, the marsh area was observed to identify a good location for the measuring station. The most important factors were groundwater level and accessibility. An area on the edge of the marsh was chosen due to its easy access and short distance to dig to
groundwater level.

A hole with a diameter of approximately 30 cm and a depth of approximately 60 cm was dug in the marsh area. The hole was dug until the groundwater level was reached, which was approximately 22 cm below the surface.

3.2.2 Installation of measuring pipe:

A PVC pipe with a diameter of 130 mm and a length of 48 cm was placed vertically in the hole so that:

- 20 cm of the pipe was above the water surface
- The top of the pipe was level (measured with a spirit level)
- Wooden blocks were placed between the soil and the pipe to ensure that the pipe remained parallel to the groundwater.

See Figure 1 for illustration

3.2.3 Installation of distance sensor:

A simple but effective solution was used to mount the distance sensor, using the materials that were available. Two nails were hammered into a small piece of plank so that the distance between them was slightly greater than the width of the HCSR04 sensor.

The HCSR04 sensor has small mounting holes in each corner of the circuit board. A thin metal wire was threaded through the holes on each side. The metal wires were stretched out to the nails on piece of plank and hung around the nail head, forming a kind of suspension system.

This mounting had several advantages:

- The metal wires made it easy to fine-tune the angle of the sensor.
- The solution was simple and quick to install.
- It was expected that the pipe would move during winter and spring, and this solution provides easy access to readjust the angle of the distance sensor, instead of the pipe itself, which was difficult to level.
- The piece of plank was placed across the top of the pipe so that the sensor hung down and was centered in the pipe. To ensure that the sensor was level, a spirit level was used during installation.
- The wires from the sensor were routed out behind the piece of plank and up through the gaps in the wooden pallet. The distance between the piece of plank with the sensor and The crack in the box was so small that there was no need to worry about weather, wind, or moisture. Since the box has a waterproof lid, it acted as a kind of umbrella.

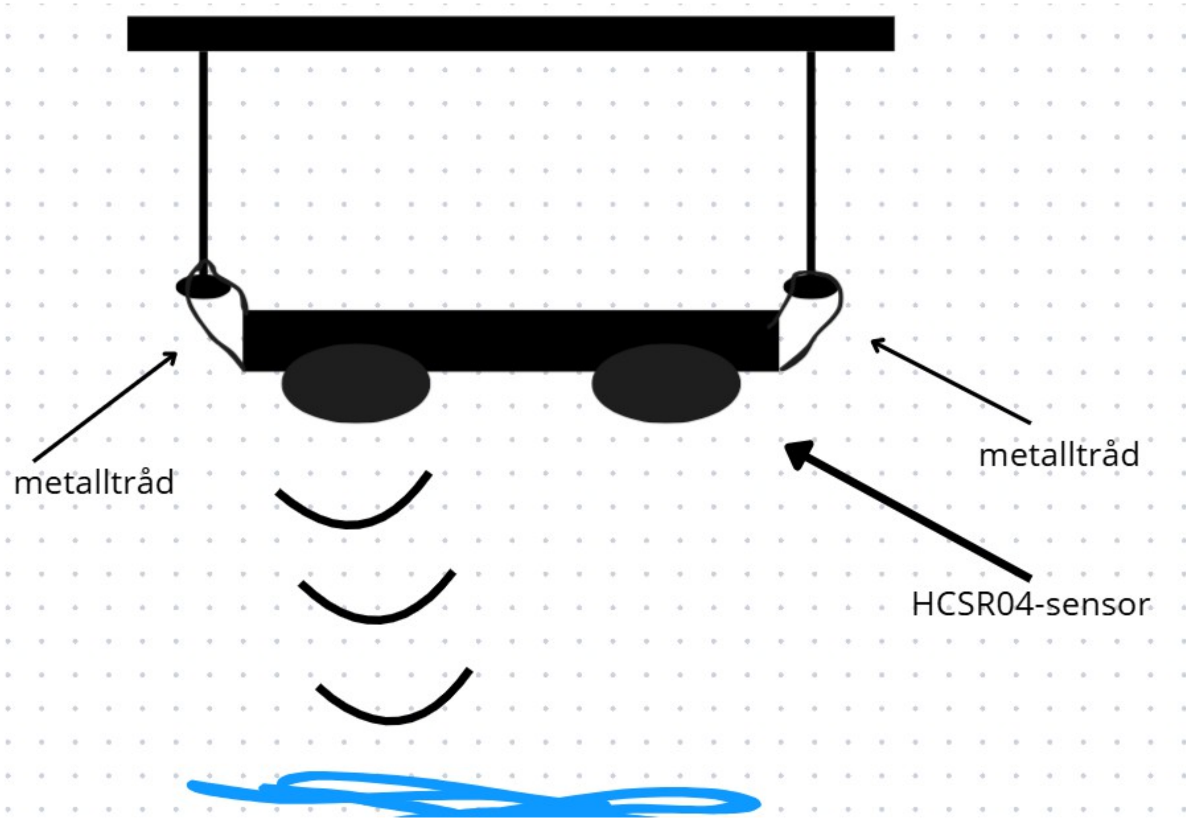

Figure 2: Illustration of distance sensor installation

3.2.4 Placement of temperature sensor:

The DS18B20 temperature sensor was placed in a dry area next to the pipe, so that we get a good indication of the temperature in the area without the influence of the sun and greenhouse effect.

3.2.5 Protection of electronics:

To ensure the safety and protection of the electronics against moisture, snow, weather, etc., several layers of protection were used

- **First layer – waterproof plastic box:**

  The Arduino MKR ZERO and MKR NB 1500 were placed in a waterproof plastic box.
  The electronics were loose in the box. The wires from the distance and temperature sensors were fed out through the top of the plastic box lid.

- **Lower layer – wooden pallet:**

A wooden pallet measuring 800 x 600 x 100 mm was used as the mounting platform for the entire system and was placed directly on the ground above where the pipe was installed.
The plastic box containing the electronics was placed on top of the pallet. The sensor wires were routed from the plastic box down through the gaps between the pallet boards.
This provided easy access to the sensors while protecting the cables.

- **Outer layer – Wooden box:**

A wooden box measuring 850 × 650 × 600 mm was placed over the entire system. The box had a hinged lid for easy access to the electronics. The wooden box was equipped with two ropes, one on the lid and one attached to the box itself. A metal wire was then wrapped between the ropes so that the hinged lid would not open during strong gusts of wind, and to prevent curious animals from getting in.

3.3 Data collection and communication

3.3.1 Automated sensor reading:

The system was programmed to retrieve data from DS18B20 and HCSR04 at regular intervals of thirty minutes. Arduino is programmed with a function where it turns on for a short period to read data from the sensors, then sends it to the server, and then turns off again for thirty minutes to conserve battery power. If Arduino fails to send data to the server, it will give up and turn off again before trying again in 30 minutes. This prevents the Arduino from staying on and draining its power.

3.3.2 Manual measurements:

In addition to the automated sensor readings, pH values were measured manually. Manual measurements of the amount of peat moss in the area were also taken. Random samples were taken to document the amount of peat moss in Stormyr. The random samples were taken in the peat moss layer to check the depth of the moss. This data was logged together with the automated measurements to obtain a comprehensive picture of the state of the ecosystem.

3.4 Code

3.4.1 Python Code

The Python code can be found in the appendix

First, we import all the necessary libraries to make the work easier. We add a URL that points to the NTNU database to which the measuring station sends data. The path to the backup data is also added here. Reads the values in the file and processes them (converts Unix time to normal date), also divides data from NTNU and the SD card into two different elements so that we can look at the differences later. Runs a cleaning function to filter out obviously incorrect measurements, which reduces graph noise. Last in the code
We plot the data from the NTNU server and from the SD card.

In the temperature graph, we calculate the average and set the value to 0.0
average, which gives us the deviations and a complete picture of the change over time. We also add an uncertainty range where the two different temperature sensors measure differently.

3.4.2 Arduino Code

The Arduino code can be found in the appendix

The code starts by importing the necessary libraries to read the sensors. The data is retrieved through functions and formatted as a String data type that is sent to a server at NTNU and sent locally to an SD card. The code has a watchdog timer that causes the board to turn off automatically if
Sending data to the server failed. The program turns on the Arduino, runs all functions to read the sensors, formats a string with the data, and sends it to the server, then turns itself off and waits for the next cycle.

4.0 Results

4.1 Water level

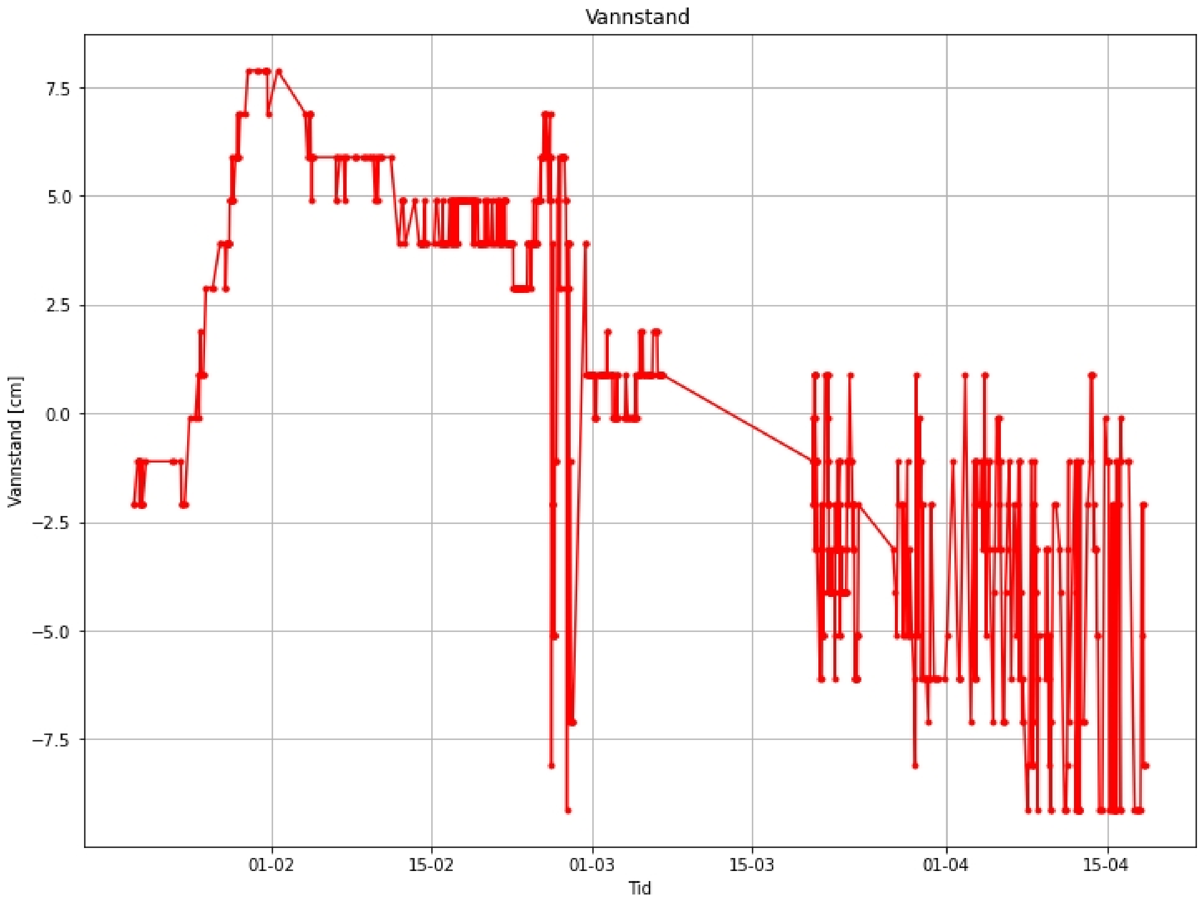

Figure 3: Relative changes in water level over time at Stormyr (January-April)

Figure 3: The graph shows relative changes in the water level at Stormyr, not the actual height of the water level. The zero point (0.0) shows the average for the measurement period. The water level shows positive deviations in January and February and negative deviations with large fluctuations from March onwards.

4.2 Temperature

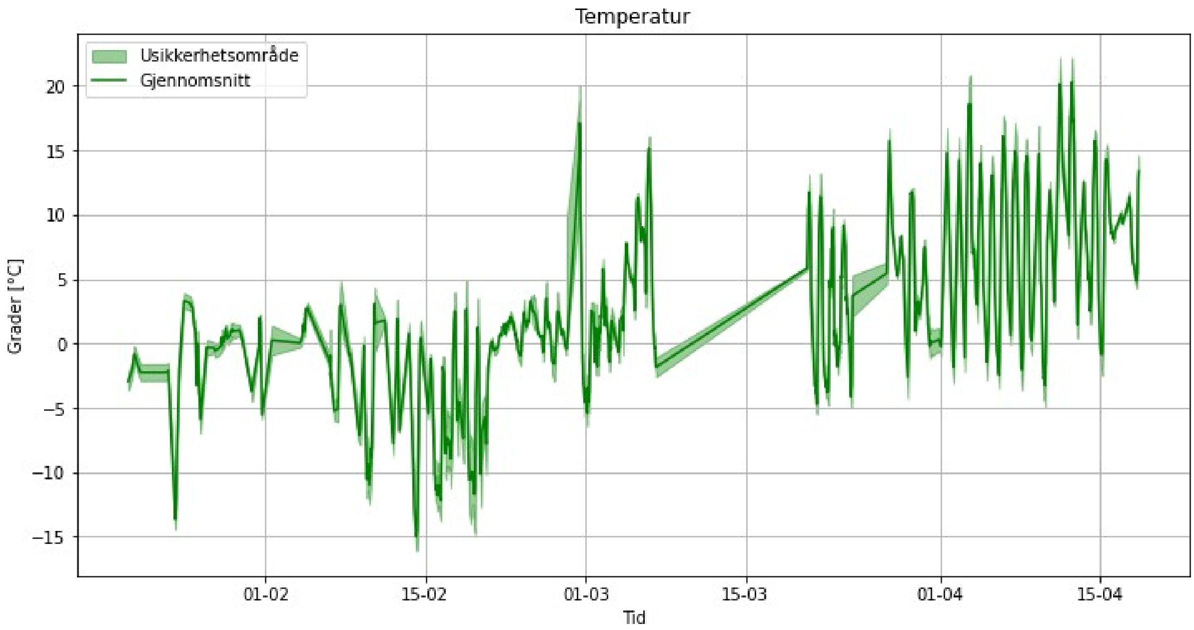

Figure 4: Temperature measurements

Figure 4: Temperature measurements show the lowest values in February, when temperatures dropped to around 15°C. Temperatures rise from March onwards, with clear temperature fluctuations in April. The light green area shows the measurement uncertainty of the sensor.

4.3 Temperature vs. Water Level

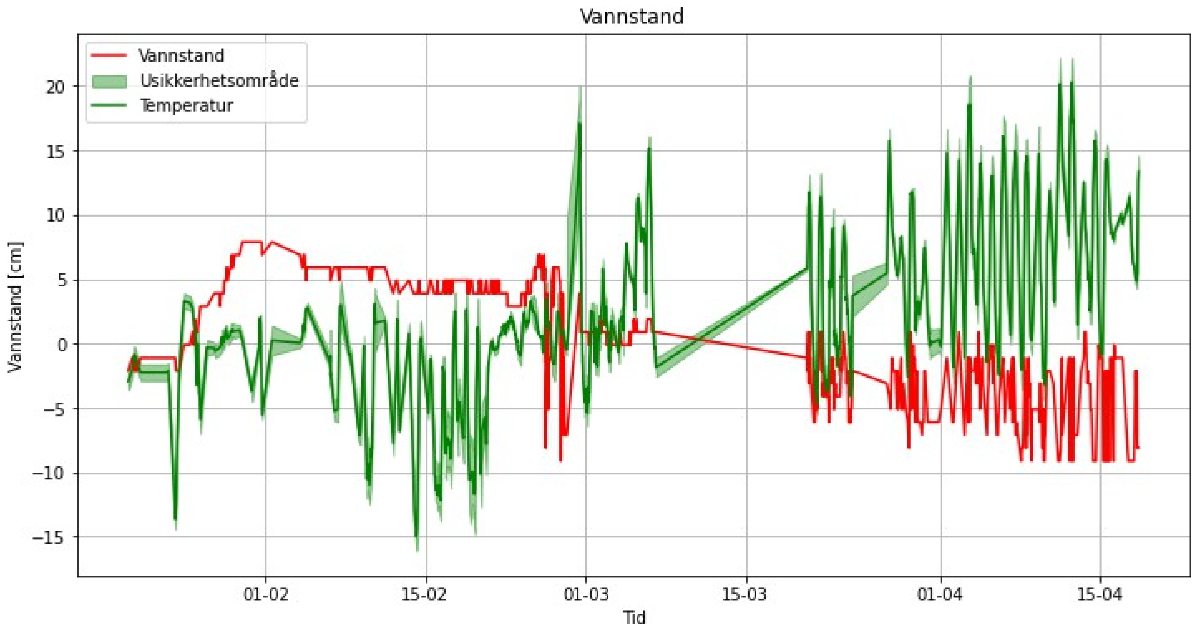

Figure 5: Comparison of water level and temperature

Figure 5: The red graph shows water level, and the green graph shows temperature. The graphs were plotted together to find any correlations. The graph shows an inverse relationship between temperature and water level. When the temperature rises from March onwards, the

water level falls below average

4.4 Battery voltage

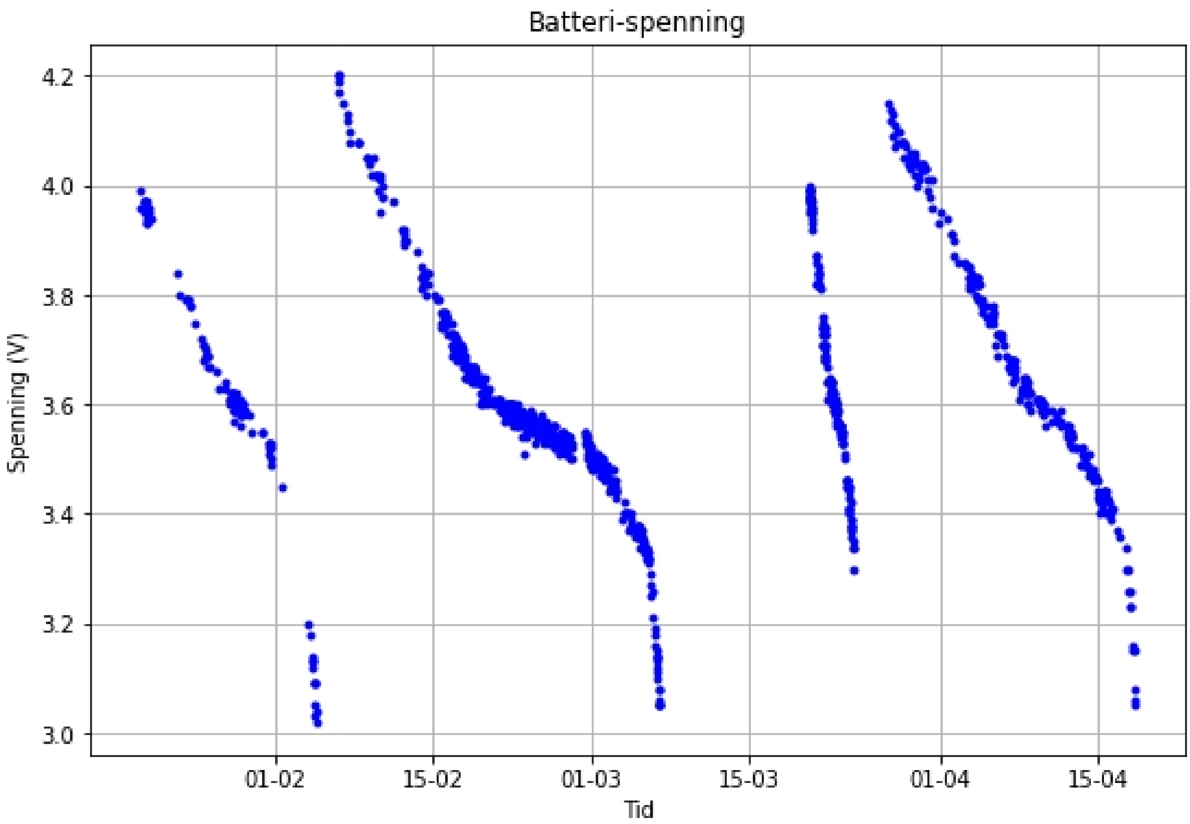

Figure 6: Battery voltage

Figure 6: The battery voltage shows three discharge cycles. The voltage starts at around 4.2V and drops to approx. 3.0V before the batteries are replaced.

4.5 pH values

Manual measurements of pH in Stormyr showed a reduction from the start of the measurement period to 6 at the end of the measurement period. Stormyr is becoming more acidic.

5.0 Discussion

5.1 Interpretation of results

Based on data from the Stormyr measuring station, we can see several patterns that provide insight into Stormyr's condition.

Water level variations: Figure 3 shows that the water level has a large positive deviation in January and February, and negative deviations in March and beyond. There is a clear seasonal pattern, which is common in marsh areas.

The marsh acts as a natural water reservoir that is continuously emptied via the stream that flows out of the marsh. This reservoir acts as a delay to the runoff, and it is this
the depletion we observe in the measurements. The water level naturally drops over time due to constant runoff.

Historical precipitation data show that the spring of 2025 has been dry (Meteorological Institute, 2025), which means that water is not being replenished at the same rate as it is being drained away. With normal precipitation, the marsh would "slurp up" the rainwater that falls in the Stormyr catchment area and maintain a more constant water level. See (Figure 7) for an overview of the Stormyr catchment area.

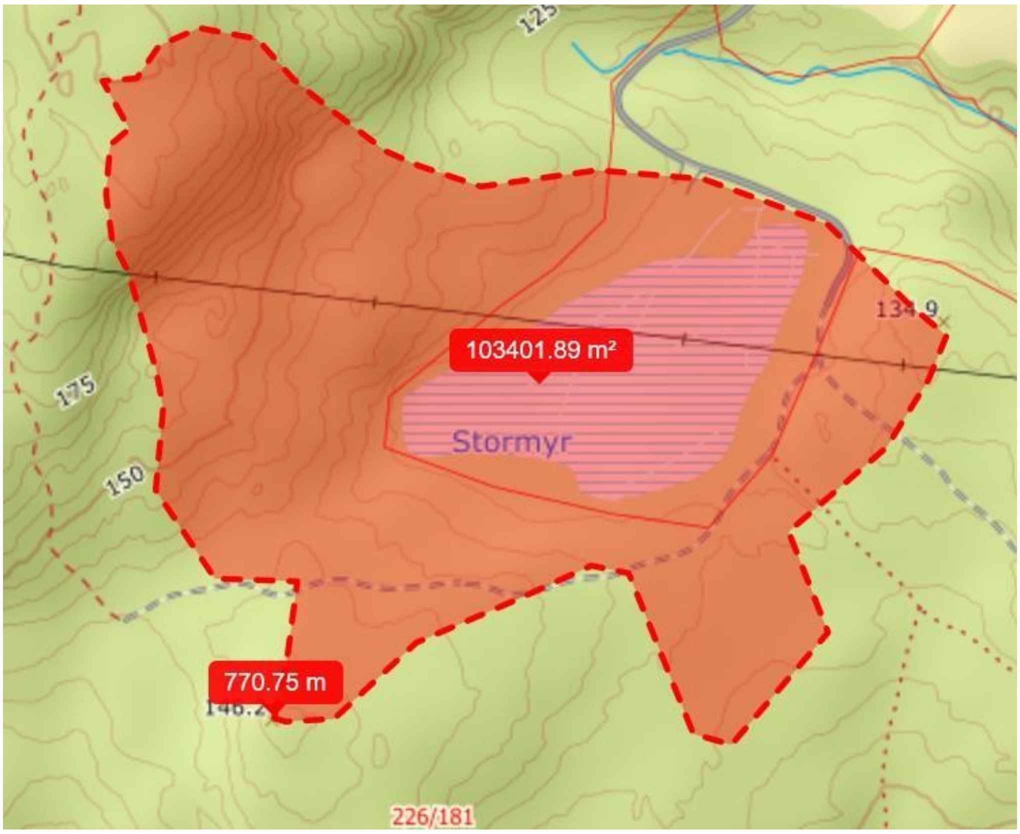

Figure 7: Overview of the Stormyr catchment area

Temperature fluctuations: from March onwards, we see large daily variations in temperature. (Figure 4). This is normal and typical for spring conditions in Norway, and affects the water level throughout the daily cycle.

Varying peat moss layer: measurements of the thickness of the peat moss vary within Stormyr. In some areas, the layer is over 30 cm thick, which qualifies the area as a bog, while other parts are in an early stage of the restoration process where peat formation has not yet started and consist mostly of water. This indicates an uneven restoration process where some areas are defined as bogs and other areas are still in an early stage of development.

Hydrological and chemical indicators: water level and pH measurements point in a positive direction for mire formation. Although there are large seasonal variations, the data indicate that the rest of Stormyr is developing into an independent mire.

5.2 Assessment of the measuring station's functionality

The measuring station experienced several technical faults during the operating period. The battery voltage in Figure 6 shows a connection fault in the middle of March. One of the batteries was connected the wrong way round and was useless, which is why the battery life on discharge cycle 3 was significantly shorter than the others.
Apart from this incident, the power saving function in the program worked as planned, resulting in a long battery life per deployment. We can see that the graph stopped recording data when the battery voltage reached 3V, because the sensor system could not operate at voltages below 3V.

The biggest challenge was data transmission via the NB-IoT network. At the beginning of the measurement period, there were major problems establishing a connection to the server. The measuring station sent data very infrequently, which led to large gaps in the data set.

We suspected that the antenna was not strong enough to send or receive signals from the nearest TV tower, which led us to replace the antenna. After connecting the new antenna, data was sent every 30 minutes. This underscores the importance of thoroughly testing equipment in field installations, in the field to be measured, and not just under ideal conditions.

There was also a period of unstable water level measurements at the end of February. The fluctuations in the data were caused by an irregularly shaped lump of ice that formed in the measuring tube. The sound waves from the ultrasonic distance sensor reflected in unpredictable directions, which led to unreliable measurements.

5.3 Interpretation of the figures

5.3.1 Unstable water level measurements in February

The large fluctuations in water level measurements at the end of February (see Figure 3) do not represent the actual change in water level in the marsh. These deviations are due to a strangely shaped lump of ice that formed in the measuring tube. The sound waves from the ultrasonic sensor reflected in random directions and gave incorrect measurements.

This problem highlights an important limitation of measuring distance with an ultrasonic sensor. For future measurements, the tube should be insulated to prevent ice formation.

5.3.2 Battery voltage drop in March

The third discharge cycle in Figure 6 shows a shorter duration than the first two. This is not due to changes in the setup, but rather a connection error where one of the batteries was installed incorrectly and provided no power. This explains the short battery life.

5.3.3 Missing data in the early phase

The large gaps between measurement points at the beginning of the measurement period are due to problems with the antenna. The antenna was too weak to establish a connection to the server on every attempt.
This was resolved by replacing the antenna later in the measurement period. The problem does not affect the validity of the measurements that were collected, but reduces the amount of measurements early in the work.

5.3.4 Temperature vs. Water Level

Temperature vs. Water Level: the data show an inverse correlation between temperature and water level (Figure 5). This correlation strengthens confidence that the main trends are correct, even though some measurements may be incorrect.

5.4 Reduction of uncertainty in the measurements

Several methods were used to reduce uncertainty in the measurements. The temperature was measured by two different and separate temperature sensors, one built into the Arduino ENV Shield and one external sensor. If both sensors measure the same values, this indicates that the uncertainty in the measurements is low.
The temperature sensor was also placed in a location where the sun and wind did not come into contact with the sensor, so that the temperature measurements were only affected by the air temperature.

To reduce uncertainty in distance measurement, the sensor was calibrated during the test phase. A a large-diameter pipe was chosen so that the sound waves were not reflected by the wall of the pipe. There were still uncertain and unreliable distance measurements due to ice formation.

Several measures could have been taken to reduce the uncertainty in the distance measurements. Insulating the measuring tube would prevent ice formation, giving the distance sensor a clear view of the measuring surface.

An additional set of water level measurements should also be used to ensure that the measurements match each other, as was done with the temperature sensors.

5.5 What could have been done differently?

5.5.1 Measuring station design

- The pipe should have been insulated to prevent ice formation during cold periods.
- Additional water level measurement using a different method. (e.g., accelerometer floating on the water surface.
- Measuring stations in areas with more peat bogs to obtain a more comprehensive picture of the development of the entire stormyr.

5.5.2 Data collection

- More manual pH measurements during the measurement period, especially during transitional periods (such as snowmelt), would have provided better insight into the chemical changes in Stormyr.
- Include additional parameters such as turbidity and oxygen measurement. This would have enhanced understanding of the condition of Stormyr.
- Mapping vegetation and peat bog changes through images would have provided better insight into the restoration stages that different areas of the bog are going through.

5.5.3 Continuation of the project

If further work is to be carried out, these changes should be implemented. This will provide a better and more comprehensive picture of Stormyr's development and may yield more accurate results where other conclusions can be reached. No definitive conclusions can be drawn from the data in this measurement period, only indications of the direction in which Stormyr is developing.

6.0 Conclusion

The measuring station has measured conditions in Stormyr from December to April, providing insight into the restoration process in the area. The project shows that it is possible to set up a measuring station, even in challenging conditions.

Based on our measurements, we can see that Stormyr is in a heterogeneous state when we try to define the area. Parts of the bog have a peat layer thicker than 30 cm and meet the requirements to be defined as a bog. Other areas have a thin peat layer or consist only of water without a significant peat moss layer. Since most of Stormyr does not function as an independent bog, it can be argued that the area as a whole cannot be defined as a bog at present. The varying peat moss layer indicates that the restoration process is not proceeding evenly across the entire area. The water level drops when the temperature rises, which can be explained by a dry spring with little rain, which means that the water that evaporates or is used in other natural processes is not replenished.

The short measurement period of only five months does not provide enough data to conclude definitively whether the restoration work in Stormyr will be successful in the long term. The lack of data for the summer and autumn seasons, as well as trends over several years, makes it difficult to give a definitive conclusion about the development of the marsh. It is necessary to compare the same season over several years, because measurements from a single year can distinguish between long-term changes and temporary weather phenomena. A longer monitoring period will make it possible to see whether the restoration process actually leads to increased peat formation and a fully restored mire.

However, the pH values show that Stormyr has become more acidic during the measurement period, which is common for areas undergoing mire formation. This indicates that the restoration process is moving in the right direction. The discovery of peat moss in some areas, together with acidification during the measurement period gives reason to be optimistic that the entire Stormyr area can become an independent mire in the long term.

Our results suggest that parts of Stormyr already function as a bog, while other parts are still in an early stage of development. Long-term monitoring, with a particular focus on areas with thin or no peat layers, is needed to confirm that the entire area will become an independent mire.

7.0 References

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