Rapport de stage individuel

4ème année

How do land use characteristics affect the ecological integrity of small shallow ponds

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IMA
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Introduction

This is the final report of my internship at the Leibniz-Institute of Freshwater Ecology and Inland Fisheries in Berlin, Germany, (IGB : Institut fur Gewässerökologie und Binnenfischerei) (Germany). This internship took place from May 17th to August 27th 2021 and is part of my 2nd year of my degree in Freshwater Ecology, Rivers and Wetlands engineering.

In March 2021, I spontaneously applied for an internship position at IGB in the research group ' Food Web Ecology and Fish Communities' led by PD. Dr. Thomas Mehner. Thomas immediately responded very positive about my interest and told me that my profile, especially my experience with GIS analyses, would fit perfectly in the ongoing activities his team was involved in as part of the EU funded project PONDERFUL (https://ponderful.eu/). I enthusiastically took this great opportunity and was part of his team for 3 months and a half.

During my internship, I was strongly involved in several activities related to the PONDERFUL project (POND Ecosystems for Resilient Future Landscapes in a changing climate). My work broadened my knowlegde on freshwater ecology in general and I learned multiple practical aspects related to the collection of field data. The overarching aim of PONDERFUL is to develop improved methods for maximising the use of ponds and pondscapes in climate change adaptation and mitigation, biodversity conservation and the delivery of ecosystem services. The research in PONDERFUL will increase our understanding of the ways in which ponds, as a Nature Based Solution, can help society to mitigate and adapt to climate change, conserve biodiversity and deliver ecosystem services. The project is funded by the European Union and brings togehter experience from 18 different teams (including IGB) representing nine European states, Turkey and Uruguay.

This report aims to provide a clear overview of my activities at IGB and explain how these relate to the PONDERFUL project. The document is composed of 4 sections. First, I provide a brief presentation of IGB and the IGB team involved in PONDERFUL. Next, I will provide more information on the PONDERFUL project itself, to subsequently give a detailed overview of my activities and tasks during my internship. In the third section, I will provide an overview of the overall progress of my mission. Finally, I will present the deliverables of my internship.

1. The Leibniz-Institute of Freshwater Ecology and Inland Fisheries

1.1. Presentation of IGB

IGB is the largest freshwater research institute in Germany. It is an extra-university research centre within the Wissenschaftsgemeinschaft Leibniz. IGB is part of the Forschungsverbund Berlin, which represents eigh research institutes in Berlin focusing on natural sciences, environmental sciences and life sciences. IGB's research activities are interdisciplinary and aim at the development of innovative solutions to the most pressing challenges facing freshwater ecosystems and human societies. IGB is actively participating in several ongoing international research projects and a large number of scientific collaborations. IGB is organized into 6 departments that joinly comprise 40 research groups and together host about 200 researchers, approximately 60 research supporting staff members, and a large number of guest researchers, students and volunteers (Figure 1). The activities of the individual research groups are organized around 10 general themes (Figure 2). The research facilities of IGB in Berlin are located in two buildings (main and Riesler building) in the South-East of the the city center close to the shoreline of Lake Müggelsee (Figure 3). My internship was conducted in department 4 in the research team 'Food web ecology and fish communities' led by Dr. Thomas Mehner.

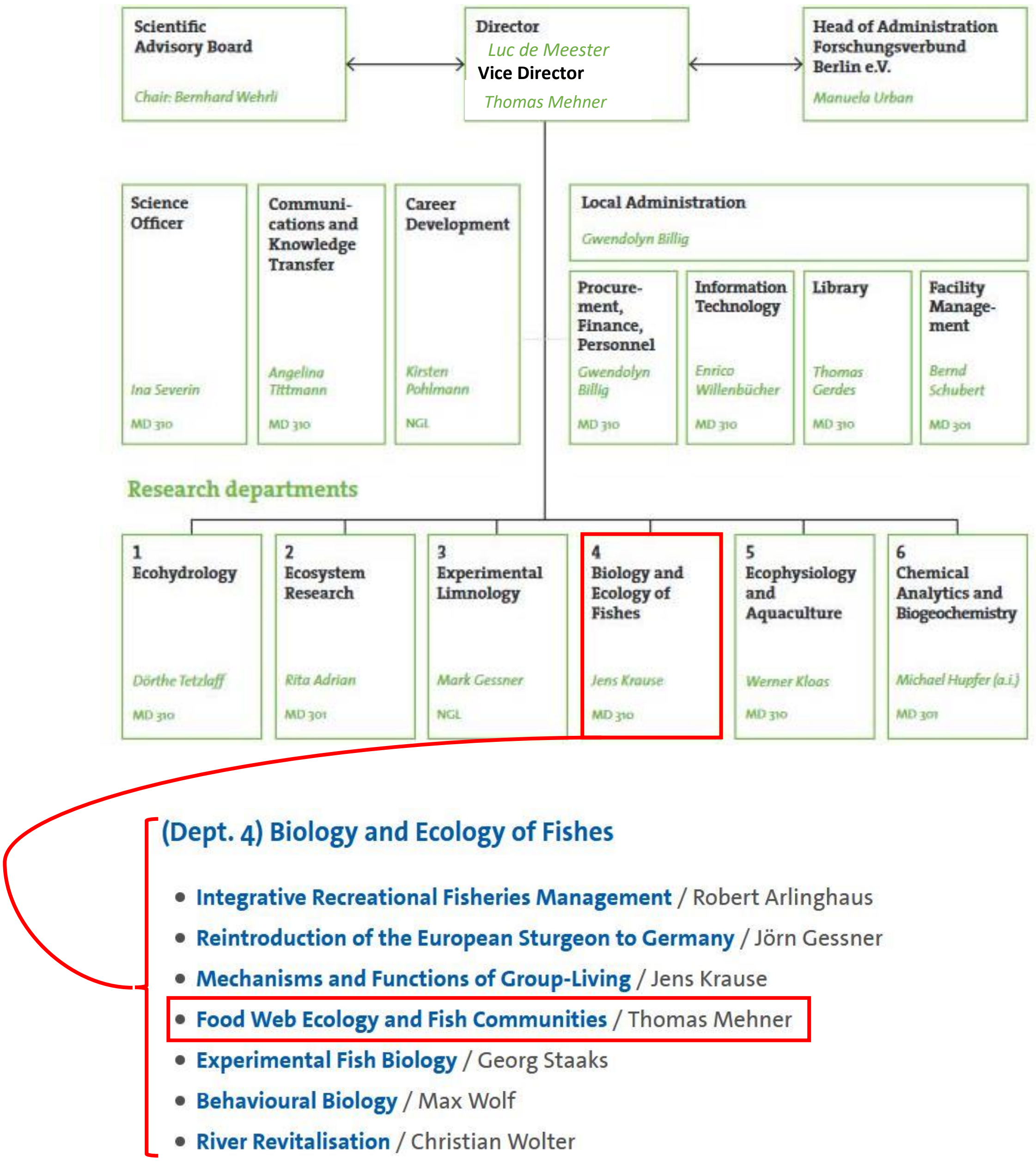


Figure 1. Organigram visualizing the organisational structure of IGB. I was affiliated to dept. 4 in the research group 'Food web Ecology and Fish communities'.

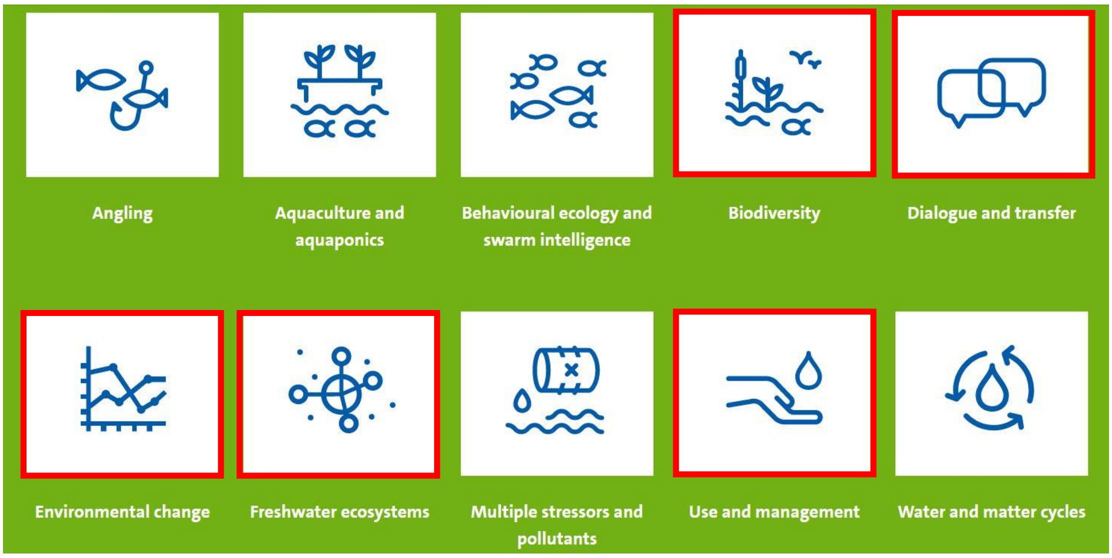


Figure 2. The 10 main themes around which the research of the different research groups at IGB is organized. The topics in red are also targeted as part of the PONDERFUL project (taken from XX SOURCE XX).

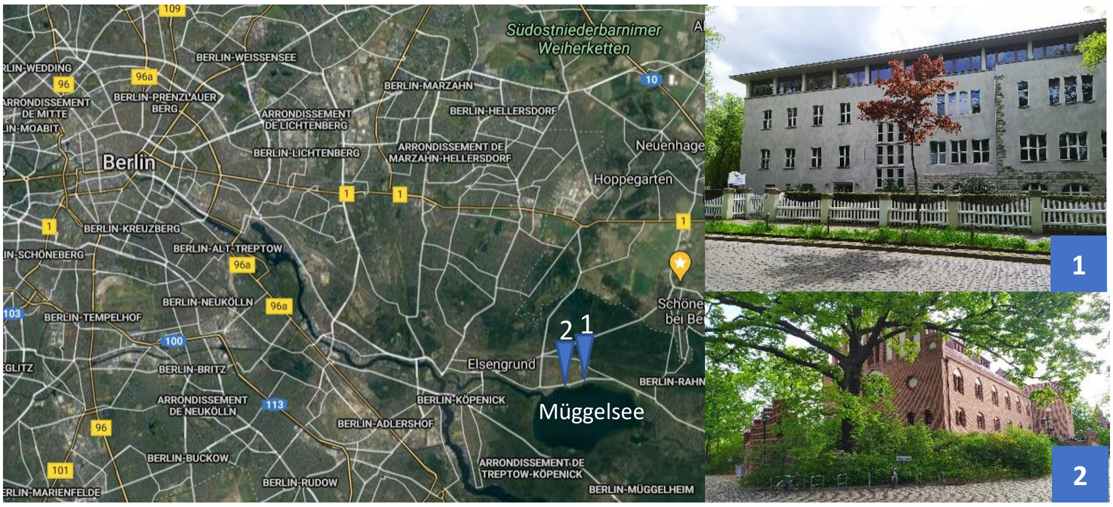


Figure 3. Locations of the main (1) and Riesler building (2) on Berlin map

1.2. Presentation of IGB PONDERFUL Team

The IGB-Ponderful Team I was part of is a highly international team. It gathers people with different positions and with complementary expertises ensuring the success of the project (Table 1). Concerning my role in the team, I was strongly involved in all aspects related to the detailed sampling of 30 ponds in Germany.

Photo	Name/country/Dept	Position	Mission regarding the Ponderful project
	**Thomas Mehner** (Germany)  Dept 4	- IGB Vice Director - Leader of the research group on Food Web Ecology and Fish Communities	- Leader/supervisor of the Ponderful project at IGB - Selection of the 30 German ponds - Contacted pond owners to get permission - Ensures the dialogue with stakeholders
	**Pieter Lemmens** (Belgium)  Dept 4	- PostDoc position at IGB - KU Leuven : department of Biology	- Main investigator hired by the Ponderful project - Author of the sampling protocol used in the 11 countries - Head of the German sampling team - Deals with the biological samples - Coordinates the data management, publication and engagement activities
	**Mareike Brehm** (Germany)  Dept 2	Technician/Lab operator	- Project management : technical and logistic organization from « scratch » - Preparation and order of the sampling equipment - Member of the German sampling team
	**Asja Vogt** (Germany)  Dept 4	Technician/Lab operator	- Supported Mareike for project management - Technical and logistic support of sampling: preparation and order of the sampling equipment - GHG chambers preparation -Lab work : sample processing

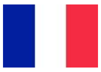
	**Louisa-Marie von Plüskow** (Belgium)  Dept 4 Joined IGB Ponderful Team in mid-June	PhD student	- Member of the German sampling team - Lab work : sample processing - Scheduling - Assists in organising the stakeholder workshops in Germany
	**Louis-Marie Le Fer** (France)  Dept 4	Intern	- Member of the German sampling team - Lab work : sample processing - Responsible of loggers deployment and collection of data - GIS tasks : buffer size assessment, screening of available land use data
	**Sabine Hilt** (Germany)  Dept 2	- Research group leader - IGB Senior researcher - Macrophyte expert	- Help for identification and assessment of macrophyte communities - Scientific discussion and advice on greenhouse gas emissions and primary producers in ponds
	**Renee van Dorst** (Netherlands)  Dept 4	PostDoc in the group of Thomas Mehner	- Not official member of the team but joined several times in the field

Table 1. Presentation of the IGB-Ponderful Team with the detailed role of each member

2. Presentation of my mission as a member of the IGB PONDERFUL Team

2.1. The PONDERFUL project

The overarching aim of the Horizon 2020 project 'PONDERFUL' is to develop improved methods for maximising the use of ponds and pondscapes in climate change adaptation and mitigation, biodiversity conservation and the delivery of ecosystem services. Because of their small size, the significance of ponds has long been underestimated. However, research over the last 10-15 years has shown that, because of their abundance, heterogeneity, biodiversity, naturalness and biogeochemical potency, ponds play a role in catchments, landscapes, and potentially at continental scale which is completely out of proportion to their small size.

The main aims of the research in PONDERFUL is to increase our understanding of the ways in which ponds, as a Nature-Based Solution (NBS), can help society to mitigate and adapt to climate change, protect biodiversity and deliver ecosystem services. The project started in December 2020, and runs for 4 years.

The project has five main components :

1. Developing a strategic approach to engagement with stakeholders, to ensure that they are able to effectively implement the benefits of ponds as Nature-Based Solutions
2. Through the generation of extensive new biodiversity and ecosystem services datasets, to better establish the relationship between pond biodiversity and the delivery of ecosystem services
3. Establish models that enable us to test and optimise practical scenarios for the use of ponds and Nature-Based Solutions
4. Create a set of demonstration sites across Europe which show to practitioners and policy makers how ponds can help to mitigate and adapt to the effects of climate change
5. Ensure that the project's outputs are widely known to policy makes, practitioners and other stakeholder.

The project brings together experienced researchers from nine European states and from Turkey and Uruguay. It is led by the University of Vic (Spain) and involves 18 participants, including IGB (Table 2) .

The project is built around 6 Work Packages (WPs). IGB is involved in several WPs (Figure 4).

Country	Participants
Spain	University of Vic
	University of Girona
	Randbee Consultants
Germany	**IGB**
	Ecologic Institute
	Technical University of Munich
Belgium	KU Leuven
Switzerland	Haute Ecole Spécialisée de Suisse Occidentale
UK	University College London
	Bangor University
	Freshwater Habitats Trust
Turkey	Middle East Technical University
Portugal	Interdisciplinary Centre of Marine and Environmental Research
Denmark	Aarhus University
	Amphi International APS
Sweden	Uppsala University
France	Institut Supérieur d'Agriculture Rhône Alpes
Uruguay	Universidad de la Republica Uruguay
Europe	European Pond Conservation Network

Table 2. Table presenting the participants involved in PONDERFUL

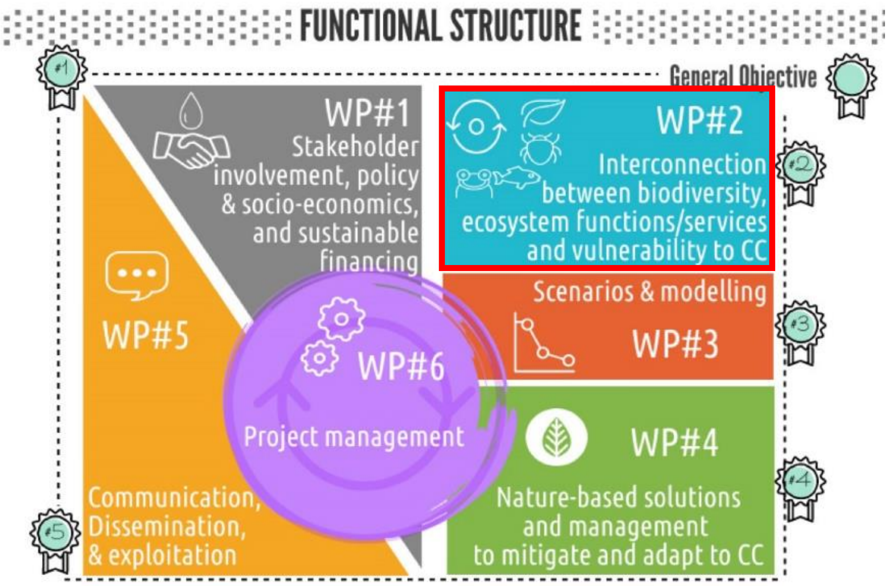


Figure 4. The 6 Work Packages (WPs) Ponderful is built around, in red the WP2 my internship was largely related to

2.2. WP2 : The framework of my mission

The activities of my internship were largely related to WP2. The overall objective of WP2 is to determine how biodiversity, ecosystem state and processes and ecosystem services co-vary and interact in ponds and pondscapes across a broad climatic gradient and along gradient of land use. PONDERFUL specifically aims to determine how climate change may alter the interrelationships between biodiversity, ecosystem functions and services. For this purpose, the PONDERFUL consortium is currenlty conducting a highly standardized stratified survey for biodiversity and ecosystem services in 30 ponds in eight countries (BE, CH, DK, GE, SP, TR, UK and UY). In each country, ponds were selected along a gradient of land use. In Germany, ponds were selected in 4 different regions in North-East Germany (Figure 5). The number of pond in each pond region is variable. The selected set of ponds includes ponds that are permanent, semi-permanent and temporal.

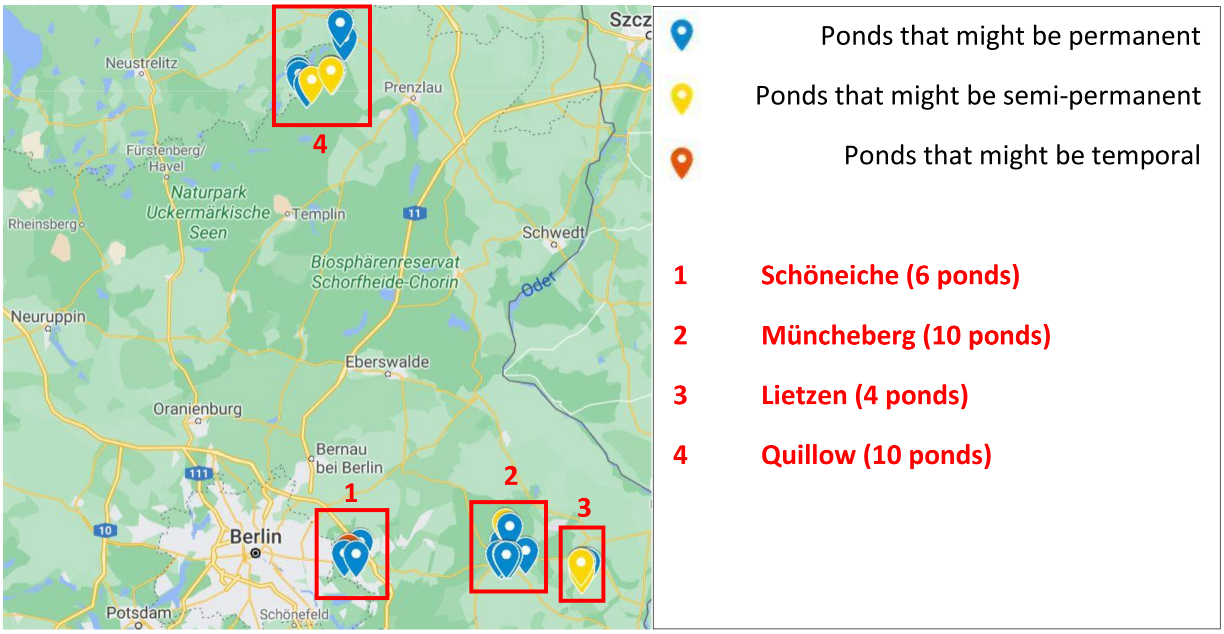


Figure 5 : Locations of the 30 selected ponds in 4 different regions in North-East Germany

3. Presentation of the progress of my mission

As indicated above, my internship activities largely contributed to WP2. More specifically, I was intensively involved in varies tasks related to the field work. In addition, I screened the possibilities to use land use maps to quantify the size and characteristics of the buffer strips around the set of German ponds.

The field work included the sampling of different organism groups (zooplankton, macro-invertebrates, amphibians, fish and macrophytes) and major local environmental pond variables. In addition, we collected samples to quantify GHG emissions, C-sequestration, and decomposition of organic material by the investigated ponds.

The fieldwork was conducted in a specific chronological order (Figure 6) following a highly standardized protocol. We started in April with the sampling for amphibians and fish by eDNA (see below) and subsequently started with the main sampling campaign that involved several organism groups and local environmental pond variables. In July, we collected samples for the quantification of gas emission by ponds.

In the text below, I will provide more details on the methods and approaches we used to collect data and samples (Liemmens. 2020). I will follow the order in which the field work was conducted.

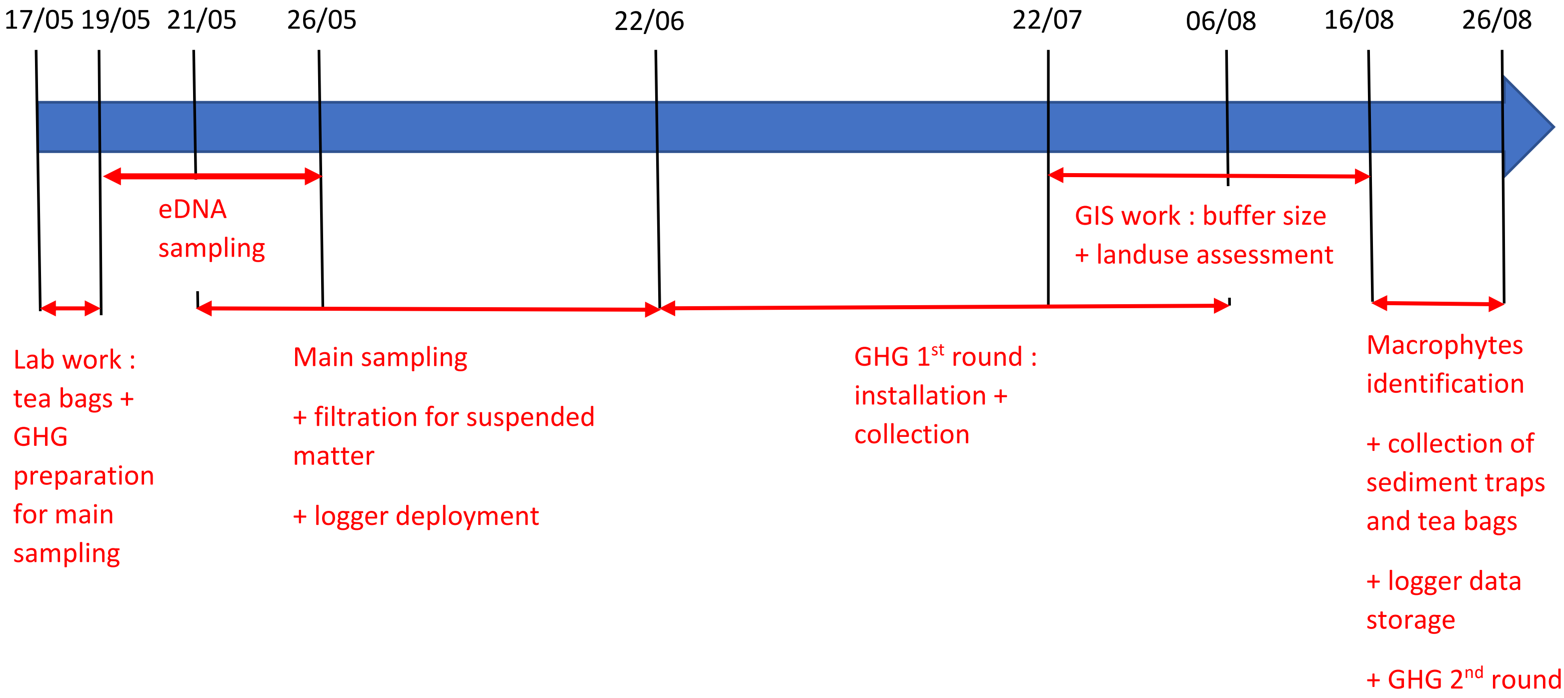


Figure 6. Time line illustrating the progress of my mission

3.1. eDNA sampling for the quantification of fish and amphibian community composition

A first round of pond visits was done in the period May 17th to May 26th 2021 to collect samples for the quantification of fish and amphibian community composition in each pond. The relative abundance of fish and amphibian species will be assessed for each pond using eDNA (environmental DNA). eDNA is

nuclear or mitochondrial DNA that is released from an organism into the environment via its secreted feces, mucous and gametes for example. Performing eDNA sampling in aquatic environments allows us to know which fish and amphibian species are or were present in the pond without the need to catch or see the different species. eDNA typically remains detectable in the water for 21 days.

This method allow to obtain information on the relative abundance species in a pond without capturing or seeing the individual species.

Water samples for eDNA were collected using a sterile plastic bag attached to a telescopic stick (Figure 7). Gloves were used to redudce the risk of contamination. As eDNA is often unequally distributed in the pond, it is important to collect water samples at multiple locations. A plastic bucket (30L) containing a sterile plastic bag was filled with the water samples from different location in the pond. Once 2/3 of the bucket is filled, a sterile seringe with a special DNA filter was used to filter a subsample of the collected water (typically 1L unless the filtered clogged already at smaller volumes) (Figure 8). A sterile prefilter is used to reduce the amount of debris coming into the seringe. After filtering the water, a stable buffer was added in the filter to stabilize the eDNA attached to the filter. A second filter was prepared follewing the same procedure and serves as a back-up. The analysis of the samples will be done by INBO (Institute for Nature and Forest) in Belgium.

Figure 7. Water samples collection

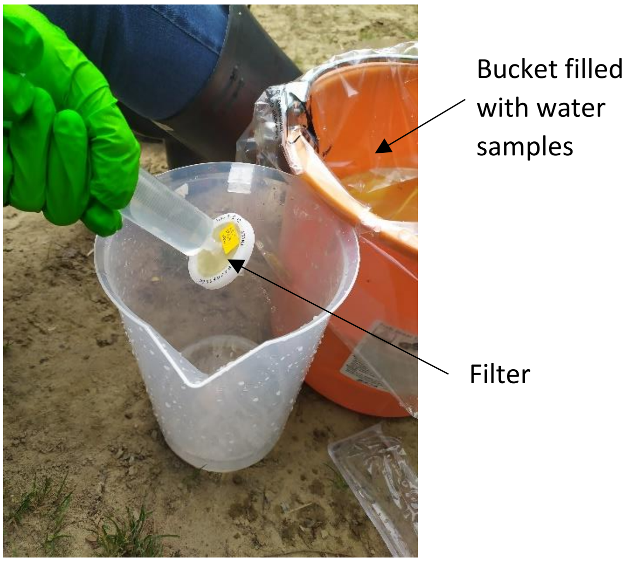


Figure 8. Filtration

3.2. Main sampling

The second round of pond visits (period May 21st to June 22nd 2021) involved the quantification of major local environmental pond variables, the sampling of the zooplankton and macro-invertebrate community, as well as the installation of the tea bags (decomposition), C-sequestration traps and temperature loggers (to assess hydroperiod). I actively participated in the different tasks related to the intensive field work compaign.

3.2.1. Major local environmental variables

First, physical and chemical variables were measured.

Chlorophyll A/phycocyanine concentrations, water turbidity, pH, conductivity, water temperature and oxygen concentration were measured directly on the field from a depth integrating water sample covering the entire column.

On the other hand, nutrient concentrations (Total Nitrogen (TN), Total Phosphorus (TP)), anions (Ca^{2+}, Mg^{2+}, Na and K), Alkalinity/sulphates/chlorides, Dissolved Organic Carbon (DOC) and Total Organic Carbon (TOC), were measured in the lab from sub-samples of the depth integrating water sample.

The same parameters will be measured once again later on during the GHG chambers installation.

Figure 9. Measuring stick

Water depth was also measured along two perpendicular transects (Figure 10) using a measuring stick (Figure 9). Approximately 8 measurements are taken along each transect.

Then, the thickness of the silt layer is measured based on three measurements at the deepest location of the pond. The thickness of the silt layer can be measured by lowering the measuring stick in the water column until you reach the soft sediment (you can 'feel' this), measuring the depth, and subsequently lowering the stick further until you reach the hard substrate and measuring the depth again. The thickness of the silt layer is the difference between both measurements. Water depth measurements should be done at the end of the sampling process to avoid effects of sediment disturbance on other samples and measurements

A field form allowing the collection of background information (pond management, surrounding landuse, information on the flora of the immediate surroundings of the pond and of its shoreline) was also filled in.

3.2.2. Zooplankton community

For zooplankton, two kinds of samples were taken : one quantitative and one qualitative.

Quantitative sample (Crustacean and Rotifers) :

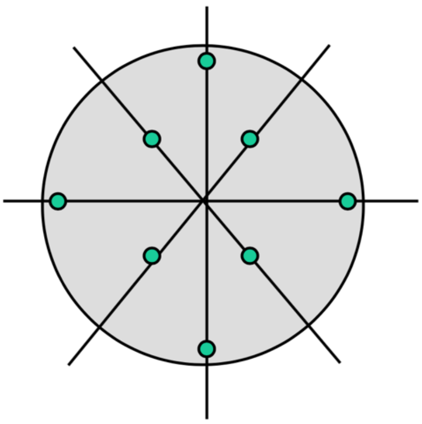


Figure 10 : Sampling locations along predefined grid within the pond

Zooplankton is sampled with a tube sampler (Figure 11 a), which allows efficient sampling of zooplankton both in the open water and in the vegetation. Six litres of ponds water are collected at 8 locations in the pond. The water samples should integrate the entire water column (close to bottom, but bottom material should be avoided). The exact locations within a pond are selected using a predefined grid (Figure 10) to assure that different subhabitats (shallow and deeper zones, open water and vegetation) are represented.

The water taken at the different locations was pooled in a big recipient (48 L). After gently stirring it, a subsample is taken for crustacean zooplankton by filtering 40 L of the water sample through a conical zooplankton net (mesh width 53 µm) (Figure

11 b) and collect the sample in a suitable vial (50 ml). In some cases, less water was filtered (for example in case of very small ponds) but we assured that the exact amount of filtered water was noted in all cases. Rotifers were sampled by filtering 5 L of the remaining water over a 30 µm mesh (Figure 11 c). The sample was stored in a 50 ml vial. Both samples (Crustacean and Rotifers) were fixed with lugol (Figure 11 d).

<u>Qualitative sample :</u>

A sweep net sample (53 µm mesh width, 19 cm diameter) for the assessment of zooplankton taxon richness is taken in each pond, including both pelagic and macrophyte habitats. The absolute number of sweeps is not necessarily the same in each pond (minimum 4 sweeps) but increases with pond size and habitat complexity (pelagic, different types of depths and macrophyte species). The important thing is to try to sample as many subhabitats as possible. The sample is fixed in pure ethanol to allow genetic analysis at a later stage (Figure 11 e).

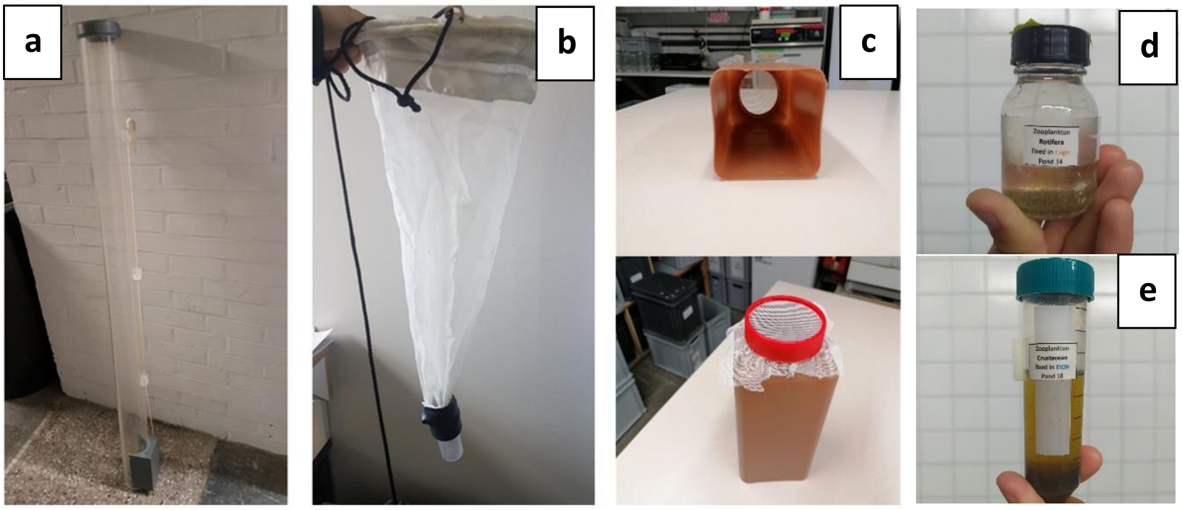


Figure 11. (a) tube sampler (b) zooplankton sweep net (c) rotifer net (d) quantitative rotifer sample fixed in lugol (e) qualitative crustacean sample fixed in pure ethanol for genetic analysis

<u>3.2.3. Macro-invertebrates</u>

Figure 12. Macro-invertebrate net

Macro-invertebrates were samples using a sweep-net sampling with a kick net (mesh size : 500 µm, 25*18cm frame size) (Figure 12). Sweeping was conducted in the different mesohabitats (open water area, among the submerged macrophytes, floating-leaved macrophytes and in the littoral vegetation) The sampling was standardized by conducting 20 sweeps of 1 m in each pond. For some smaller ponds the number of sweeps was lower. The number of sweeps in each mesohabitat was in proportion to its occurrence in the pond. After sweeping with the net at the different sampling stations, all material is pooled. If too many vegetation debris was present in the net, the collected material was carefully washed in pond water in a big recipient. The sample was then fixed with ethanol (70% final concentration) in the field. Organism will be sorted and identified in the laboratory at a later stage.

3.2.4. Decomposition of organic material

The Tea Bag Index was used to quantify the decomposition of organic material in each pond (Keuscamp et al. 2013). Although this method was first developed for soils, it can also be applied in aquatic ecosystems by incorporating a leaching factor (Seelen et al. 2019).

Pre-weighted commercially available tea bags (3 green tea + 3 rooibos tea bags, tetrahedron-shaped synthetic tea bags from Lipton) were placed on top of the sediment and were recovered after 3 months for the measurement of weight loss as a proxy for decomposition of plant material (tea containing lignin and hemicellulose, rooibos being more recalcitrant than green tea). The 3 pairs of tea bags are placed at 3 different sites. To be able to find the bags back after 3 months, the bags are attached to a plastic square that was attached to a floater with a rope. The tea bags were also labelled with a code to distinguish the green tea from the rooibos, but also to know at which spot they were located after being collected (Figure 13). After 3 months, the tea bags will be collected by my collegues and new ones will be installed.

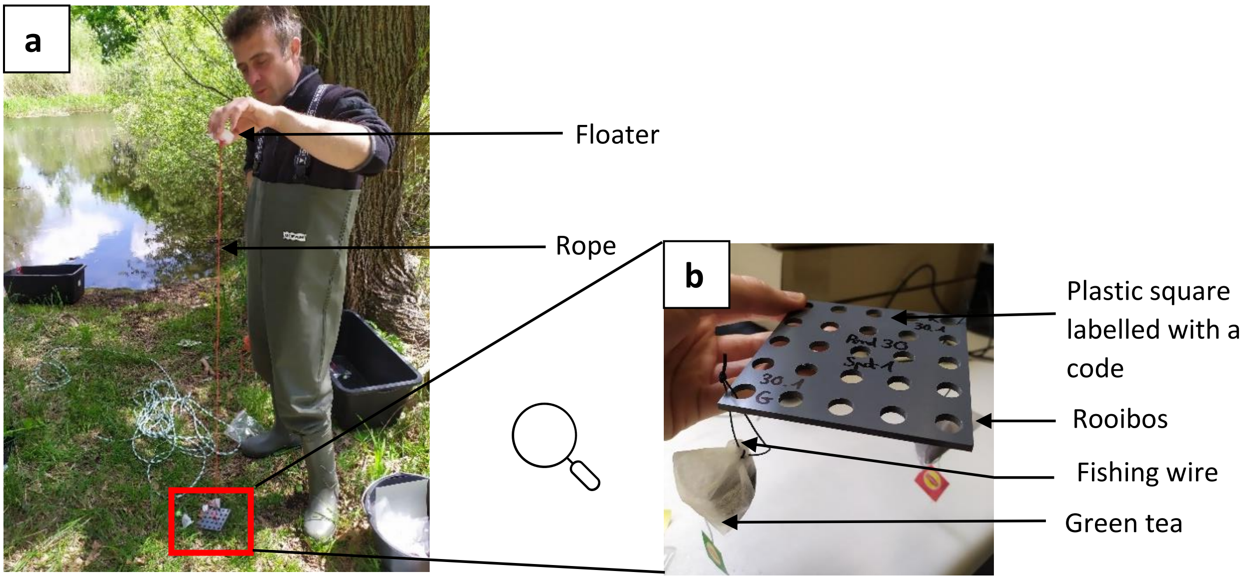


Figure 13. (a) tea bags preparation before being placed in the pond (b) example of a labelled tea bag for Pond 30 spot 1

3.2.5. Carbon sequestration

Carbon sequestration or accumulation is measured using sediment traps (Figure 14 a et b). Three sediment traps were placed in each pond (one trap close to the shore, one trap between shore and centre of pond, and one trap at the centre of the pond). By pushing the metallic rod in the sediments, the trap is placed just above the sediment surface (Figure 14 d). It is important to not disturb the sediments while installing the traps. The installation of the traps was done by hand in shallow ponds, whereas a disc attached to a pole that fits perfectly inside the trap was used for deeper ponds (Figure 14 c). A floater attached to the trap allows to locate the traps in the pond. The 3 sediments traps will be left in the pond for 3-4 months. After this time, their content will be collected and the trap will be replaced in the pond for the next period.

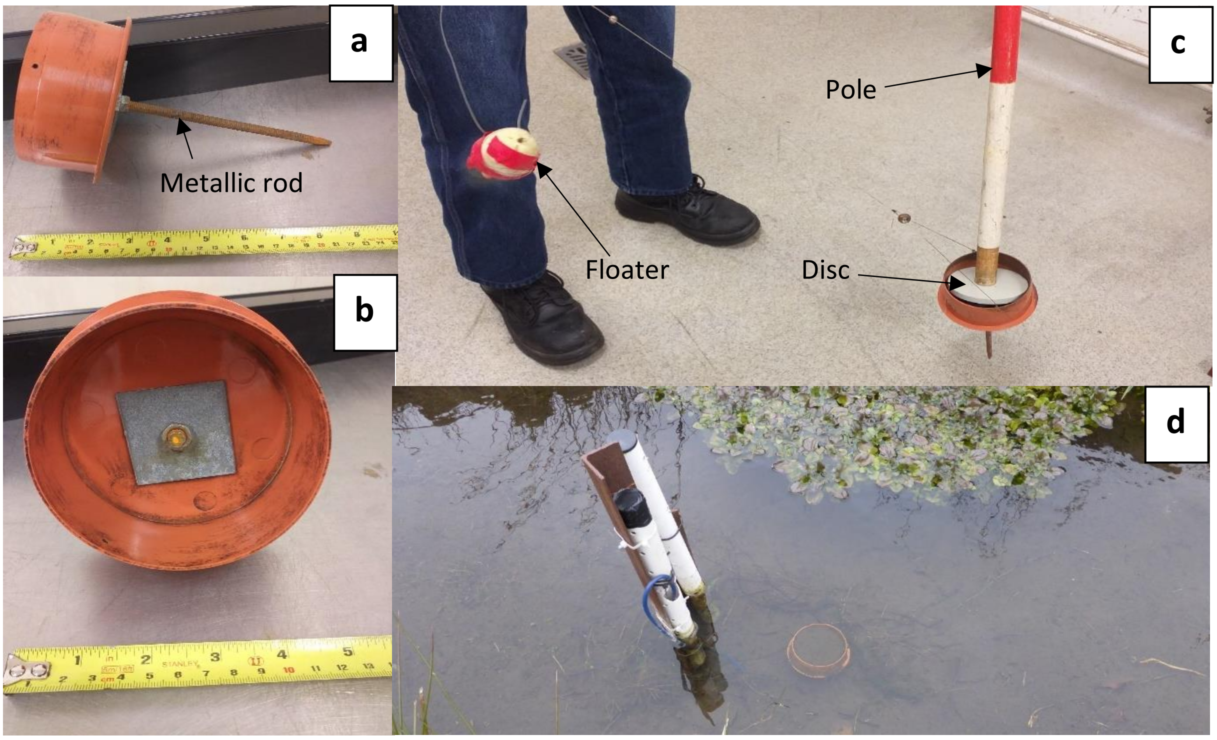


Figure 14. (a) sediment trap with its metallic rod (b) inside of the trap (c) use of disc attached to a pole for deep ponds (d) sediment trap laying just above the sediment surface in a shallow pond

3.2.6. Quantification of water level and water column stratification

We quantify the hydroperiod of each pond separately using 3 HOBO temperature loggers (Figure 15 b).

Water availability in the pond will be measured using a set of two temperature loggers (one just below water surface (Figure 15 a and one outside the water) and comparison of the temperature inside the water with the temperature outside the water. When both temperature profiles are similar, the pond is dry. This approach will give an estimate of the length of the hydroperiod.

In addition, the temperature data from two loggers in the pond combined gives information on water level stratification. Each logger collects temperture data at 1h time intervals.

For 8 deeper ponds located in different regions, we measure variation in water level using a HOBO water level logger (Figure 15 c) This logger is placed at the water bottom as it measures the water pressure so the « weight » of the water column above it. Depth measurement is needed at the spot where the logger is deployed. Then water level variations can be reconstructed using water pressure variations and initial depth measurement. Same settings for recording time interval is applied.

Floaters are attached to both kinds of loggers to know their locations in the pond.

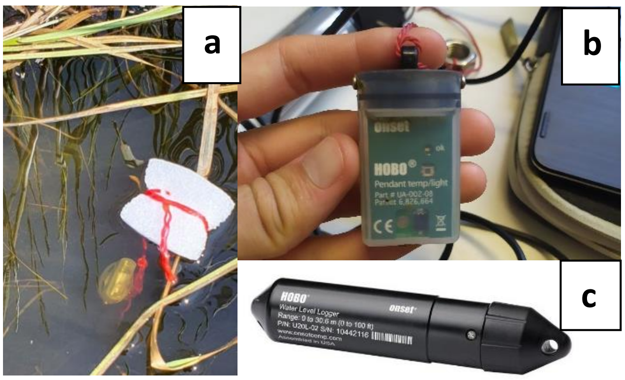


Figure 15. (a) temperature logger placed just below water surface (b) HOBO temperature logger (c) HOBO water level logger

3.3. GHG emissions by ponds

3.3.1. GHG chambers installation and collection

Up to 8 chambers are placed on each but the exact number of chambers depends on pond size. GHG emission by ebullition is highly discrete in space and time, so we need to cover different areas of the pond. The placement of the chambers can use the same strategy as the one for zooplankton sampling (Figure 10) and should include marginal and central areas of the pond (Figure 16 a). GHG chambers are left for 7 days and will be collected after this time.

Additionally, a water sample of 40 ml is drawn into a 50 ml syringe and then 12 ml of air is injected. The sample is shaken for 1 minute and then the 12 ml sample is injected into an exetainer vial. This will enable us to know the concentration and partial pressure of CO_2, N_2O and CH_4 from which we can make an estimate of flux. For ponds which are deeper than 40 cm, two water samples are collected : one for the top and one for the bottom. As we are using air for the headspace equilibration, it is important that we also collect an air sample. For that, 12 ml of air is collected in a seringe and injected into a vial.

Each GHG chamber is attached to a stone laying on the pond bottom so that it can not move on a large distance. (Figure 16 b) However, ropes which are long enough should be prepared in case it rains. Indeed, an intense rain period could fill the pond and water level could dangerously increase leading the chambers to turn over if the rope is too short. In shallow ponds, you should walk in an extreme gently way when installing the chambers, in order to avoid sediment disturbance (Figure 16 c). You can notice when sediments are disturbed as you can see methane bubbles coming out from the pond bottom. In that case, make sure that GHG chambers are not placed just above it. This will provide unreliable data as GHG will start to accumulate in the chamber from its installation. This not a problem for deep ponds as a boat is used and the risk to disturb sediments is much lower.

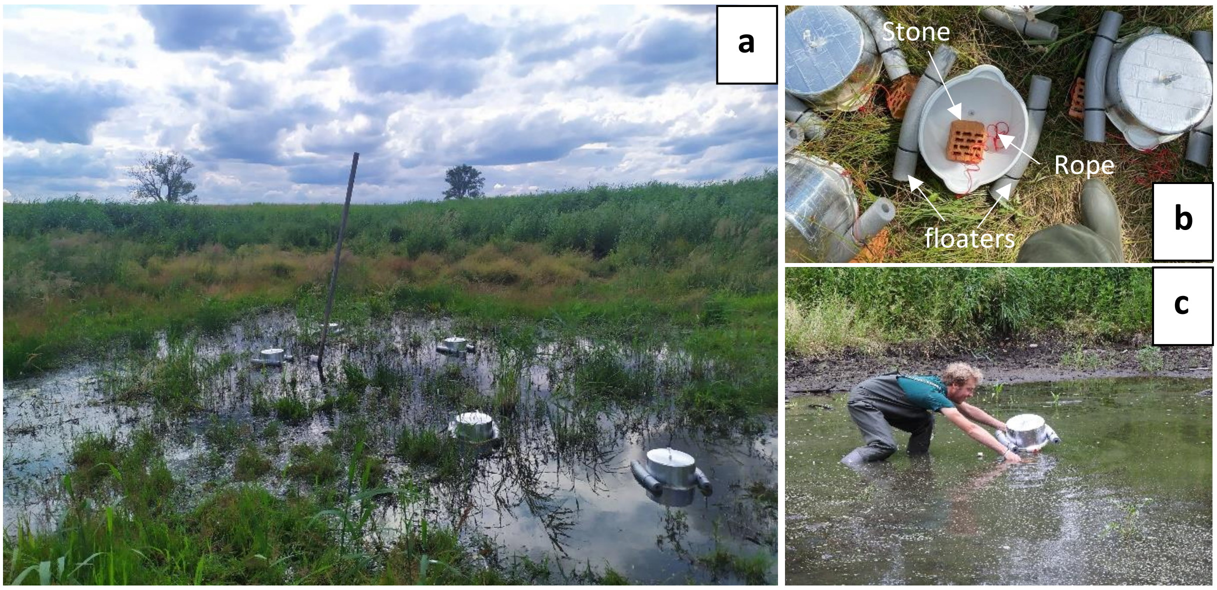


Figure 16. (a) GHG chambers installed on pond 26 (b) GHG chamber attached to a stone (c) gentle installation of a GHG chamber

At the same time, data on depth profiles are collected for pH, conductivity, oxygen concentration and temperature. Depth profile is taken at the deepest spot of the pond. For that, 5 measurements are taken along the depth profile. Depth intervals depend on the depth of the pond. For example, if the pond is 1 m deep, measurements will be taken every 20 cm.

After 7 days a 12 ml sample is extracted from each chamber and injected into an exetainer vial (Figure 17 b). Air and water sample are also collected. When approching the chamber to collect GHG sample, sediment disturbance should be avoided as much as possible (Figure 17 a).

Once all collected, the samples are sent to Aarhus University in Denmark for analysis.

Figure 17. (a) extraction of a GHG sample (b) injection of the GHG sample into an exetainer vial

<u>3.3.2. Pond metabolism</u>

Figure 18. Oxygen logger

Gross Primary Production (GPP) and Ecosystem Respiration (ER) are quantified based on a combination of CO_2 concentration (measured with the GHG chambers) and diurnal variation in dissolved oxygen concentration. For that, an oxygen logger (Figure 18) is installed in the pond during the GHG quantification. All the oxygen loggers placed in the different ponds are placed just below the water surface so that the measurements are standardized. Oxygen concentration is recorded every 10 minutes during 7 days. The logger is collected at the same time as the chambers and the recorded data are stored on my laptop.

<u>3.3.3. GHG chambers on wet sediments</u>

Even if a pond dried out or is too shallow to install gaz chambers, GHG emissions assessment is still possible. For that, a plastic bucket, with the same diameter as a GHG chamber, and from which the bottom was removed, is pushed in the sediments and a GHG chamber is placed on top. 6 gas chambers are installed and should be uniformly distributed around the pond (Figure 19 a). If possible 3 should

be placed in wet sediments and 3 in dry sediments. A GHG sample is collected from each chamber every 20 minutes for 1h30-2h (Figure 19 b).

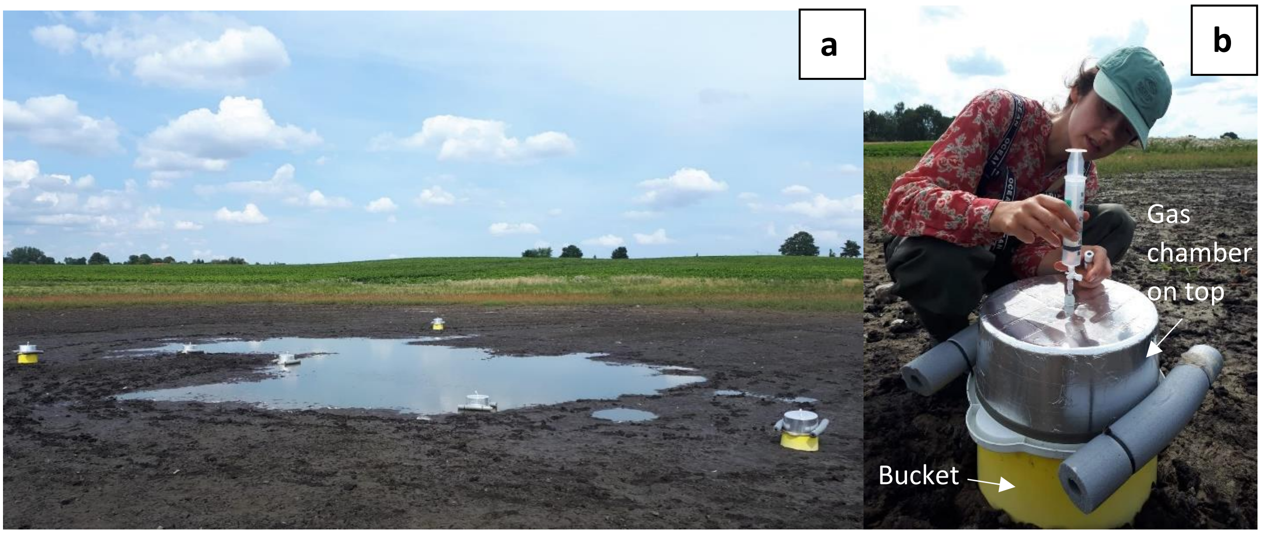


Figure 19. (a) GHG chambers uniformly installed on a dry pond (b) collection of a GHG sample from a chamber installed on wet sediments

3.4. My other missions apart from the fieldwork

3.4.1. Lab work : filtration of water sample to determine the amount of suspended matter

During the main sampling, immediately after coming back from the field, I was responsible for the filtration of a subsample of the water sample to determine the amount of suspended matter contained in it. For that, I filtered as much water as possible from the water sample over a pre-weighted glass fibre filter with a vacuum pump (Figure 20). The volume of water that should be filtered depends on the turbidity of the water (less in turbid ponds as the filter gets quickly cloaqued, more in clear ponds) (on average 500-600ml). It is important that a difference in dry filter weight (before and after filtration) can be determined. The filtration was repeated 3 times for each pond so that an average amount of suspended matter can be calculated. The volume of water that was filtered was noted for each of the 3 filters. After the filtration, the filters were subsequently dried again at 105 °C for 24 hours. The weights will be measured later on. The amount of suspended matter can subsequently be calculated by considering the weight difference and the filtered water volume.

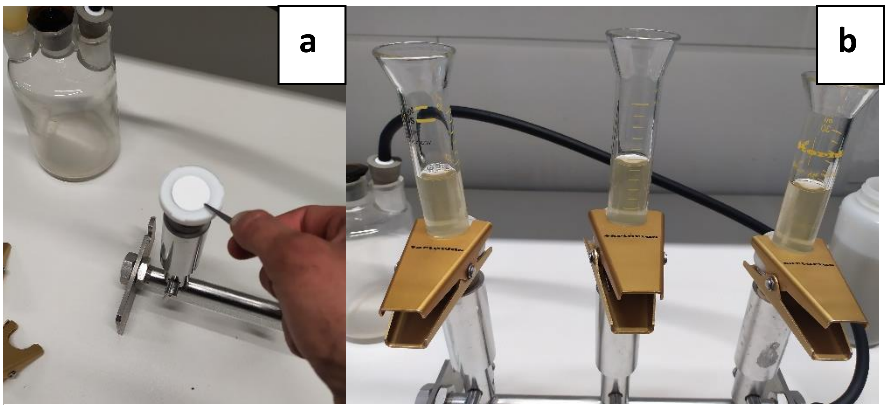


Figure 20. (a) installation of the pre-weighted glass fibre filter (b) filtration of turbid pond water

3.4.2. Data storage of collected loggers (T and O_2)

Each time loggers were collected (T, O_2), I was responsible for the storage of the recorded data. For Temperature loggers, the recorded data could directly be visualized as a graph thanks to the HOBO software (Figure 21). For Oxygen loggers, the data were recorded and stored as a csv file. All the data were stored on my laptop. However, a backup was made on Louisa's labtop and another one was made on the IGB Cloud.

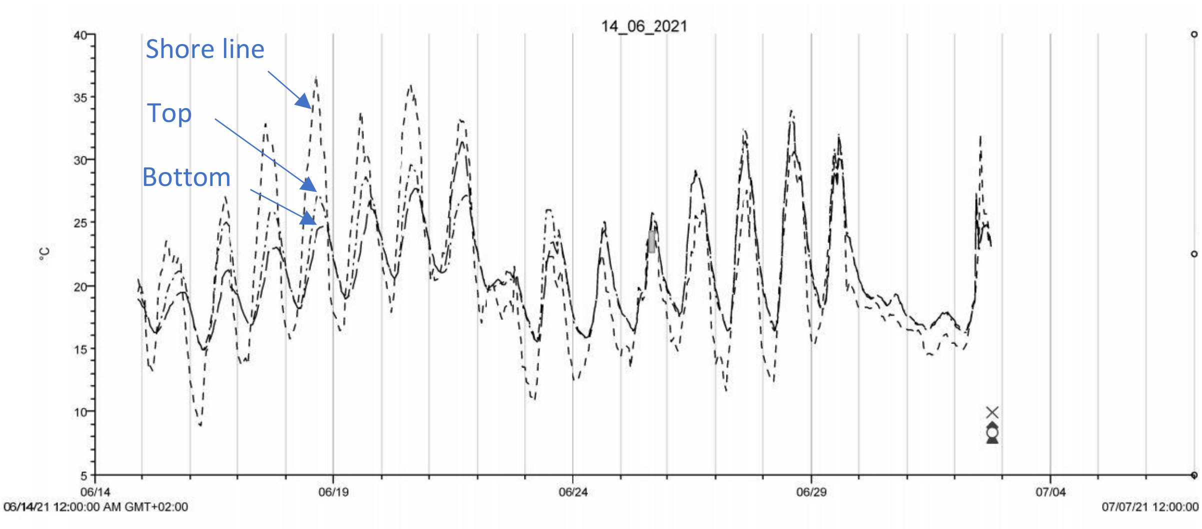


Figure 21. Graph obtained with HOBO software, showing the recorded temperature variations on the shore line, water top and water bottom of pond 2 (you can notice the day/night alternation)

4. Presentation of the deliverables : buffer size assessment and screening of available landuse data

The last part of my mission at IGB comprised the assessment of size of the buffer strip around the selected ponds and conduct a first screening on the availability of suitable satellite images to derive detailed and standardized landuse data on the surrounding of each pond.

4.1. Selection of suitable satellite images to quantify the size of the buffer strip and land use characteristics around each pond

We used 3 criteria for the selection of suitable satellite images. First, we explicitly aimed for satellite images that matched the period of pond sampling (2021) as much as possible because the size of the buffer strip surrounding the ponds might vary considerably between years, especially in intensively managed agricultural land. Secondly, we aimed to use images taken in the same season for all ponds in the different regions to avoid biases in land use estimates related to temporal variation. Third, we had to consider the resolution of the images. This is important as we work with relatively small ponds (typically less than 1 ha).

My first screening resulted in a set of satellite images taken by NASA (landsat) and ESA (Sentinel) in June 2021. Unfortunately, the resolution of these images was not high enough to obtain land use characteristics relevant for our study on relatively small ponds. An additional issue was cloud coverage, which in the end resulted in a set of images taken at different years.

Luckily, I had the opportunity to interact with Vanessa Bremerich, who is an expert on GIS analysis at IGB. She suggested me to use orthophotos instead of satellite images and indicates that theses can be found on the geodata services provided by Brandenburg and Mecklenburg-Vorpommern. Based on our discussion, I decided to check this approach and used the "Digitale Orthophotos" with a 20cm resolution (DOP20) on the Brandenburg viewer. (https://bb-viewer.geobasis-bb.de/, navigation : "Kartenebenen --> Geobasisdaten --> Digitale Orthophotos --> farbig (DOP20c) / Aktualität DOP20")

Based on my assessment, I decided to use a combination (Table 3) of orthophotos from Brandenburg Viewer and Google Earth to assess the size of the buffer strip. The combination is the following : on the one hand, I selected Google Earth satellite images for the pond region of Schöneiche. On the other hand, I chose Brandenburg Viewer orthophotos for the 3 other pond regions. All the pictures I selected are from the most recent spring possible so that the buffer size measurements are as standardized as possible under the assumption that the buffer size did not change a lot from one spring to another over a 2-year period.

Pond region	Date of the most recent orthophotos on Brandenburg Viewer	Date of the most recent satellite images on Google Earth
Schöneiche	12/04/2020	31/05/2021
Müncheberg	21/04/2019	08/2020
Lietzen	21/04/2019	08/2020
Quillow	18/04/2020	06/2019

Table 3 : Dates of the most recent pictures available for the 4 pond regions using 2 different platforms (in yellow the date I selected for each pond region)

I quantified the size of the buffer strip around each pond using a standardized approach using 8 cardinal lines.

Below, I provided details on the method using one pond as an example (Figure 22).

The aim is to evaluate the size of the buffer strip, e.g. the distance to the arable land, along each of the 8 lines. For that, the 8 cardinal lines are placed in a way that they all start from the center of the pond. Each line is numbered from 1 to 8 (always in the same order). Then, each yellow line is measured using the measuring tool available on Brandenburg Viewer and Google Earth. For ponds that do not have any shore line vegetation, the measurement starts on the shore line just after the open water area. For ponds having a shore line vegetation (reeds), the measurement starts just after. In both cases, the measurement ends when arable land is reached. All the lengths are indicated in a dedicated line of an Excel file (Table 4). Finally, a mean buffer size can be calculated for each pond.

This method was applied to the 30 ponds and the dedicated table was filled in. The final resulting dataset can be found in Annex 1. This table is a deliverable.

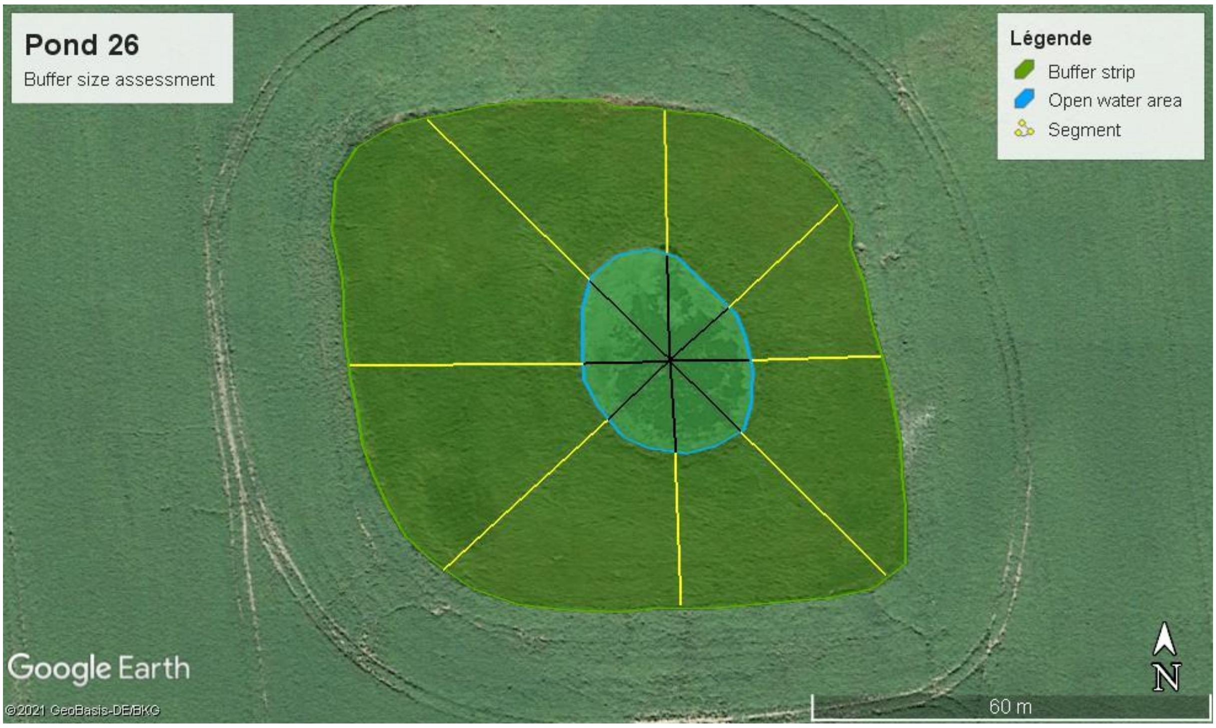


Figure 22. Satellite image of the model pond with 8 cardinal lines to assess its buffer size ***(only the yellow segments are measured)***

Segment length (in meters)								
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Mean length**
21.5	19.5	17.5	26.5	19	30.5	32	33	24.9

Table 4 : Lengths of the 8 cardinal lines placed on the model pond

After I determined the size of the buffer strip around each pond, I conducted a visual analysis to explore the relation between buffer size with phytoplankton biomass (measured as chlorophyll A in the field). This was done using mean values of buffer size from the eight cardinal lines.

For each pond, 3 values of chlorophyll A concentration were measured during the main sampling. I calculated the mean chlorophyll A concentration for each pond. Mean buffer size and mean chlorophyll A concentration of each pond were gathered in an Excel file. I subsequently attempted to establish a correlation between these two variables.

We would expect a negative correlation between buffer size and chlorophyll A concentration. In other words, chlorophyll A concentration should decrease with buffer size increasing.

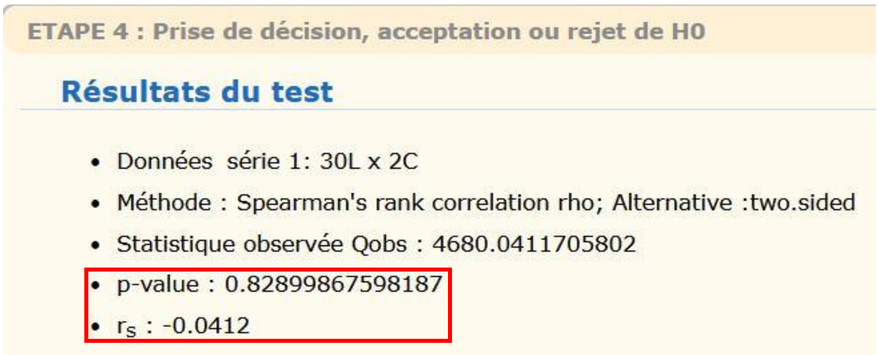
However, the results seem not to show any correlation. A decreasing trend line might be visible but the points are too far apart to say that it is reliable (Figure 24).

To confirm this, a Spearman correlation test was made with the following hypotheses.

H_0 : there is no correlation between buffer size and chlorophyll A concentration

H_1 : there is a correlation between buffer size and chlorophyll A concentration

After running the test on BiostaTGV, we obtain the following results enabling us to make a decision (Figure 23).



ETAPE 4 : Prise de décision, acceptation ou rejet de H0

Résultats du test

- Données série 1: 30L x 2C
- Méthode : Spearman's rank correlation rho; Alternative :two.sided
- Statistique observée Qobs : 4680.0411705802
- p-value : 0.82899867598187
- r_S : -0.0412

Figure 23. Results of the Spearman test run with BiostaTGV

As the Spearman coefficient (r_s) tends to 0 and p-value > 0.05, H_1 is rejected and H_0 is accepted. Thus, we have the proof that there is not any significant correlation between buffer size and phytoplankton biomass for the set of 30 ponds we are working on.

The same was made for phycocyanine (Figure 25), I also tried with the median values, but the result is similar.

This unestablished correlation might be due to different potential sources of error. One explanation might be the lack of accuracy in the measurements using orthophotos or satellite images. Indeed, for some ponds, the vegetation cover is dense seen from above, making hard to know where the buffer starts and ends. Another explanation might be the lack of actual satellite images (spring 2021) adapted to the pond scale. Indeed, we measured buffer size using pictures from spring 2019/2020 while the measurements of chlorophyll/phycocyanine concentration were taken in spring 2021. However, these explanations may not be the main causes.

For these hypotheses, one solution could be to measure the buffer size on the field but this would have required more time or more people.

The most likely explanation is that other factors (food web characteristics of the pond) might also play a role on the biomass of phytoplankton.

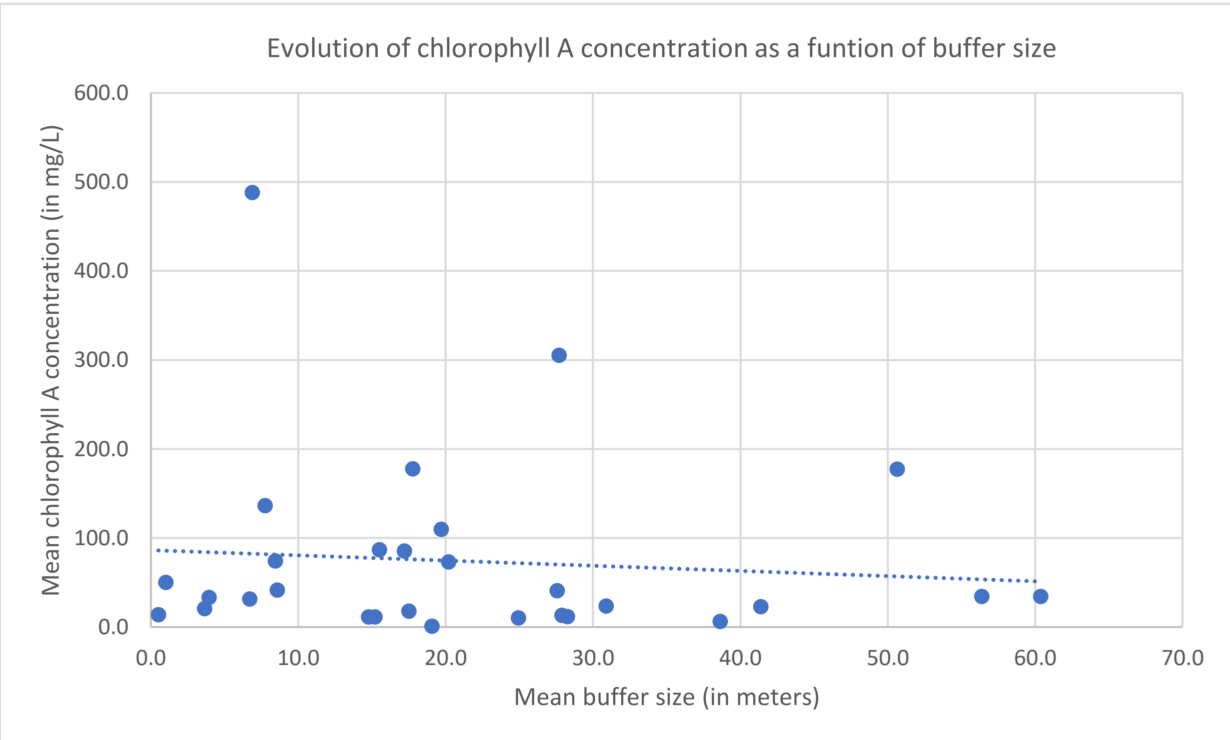


Figure 24. Correlation plot showing the relation between buffer size (mean size along 8 cardinal lines) and phytoplankton biomass (measured as chla concentration) for the set of 30 ponds

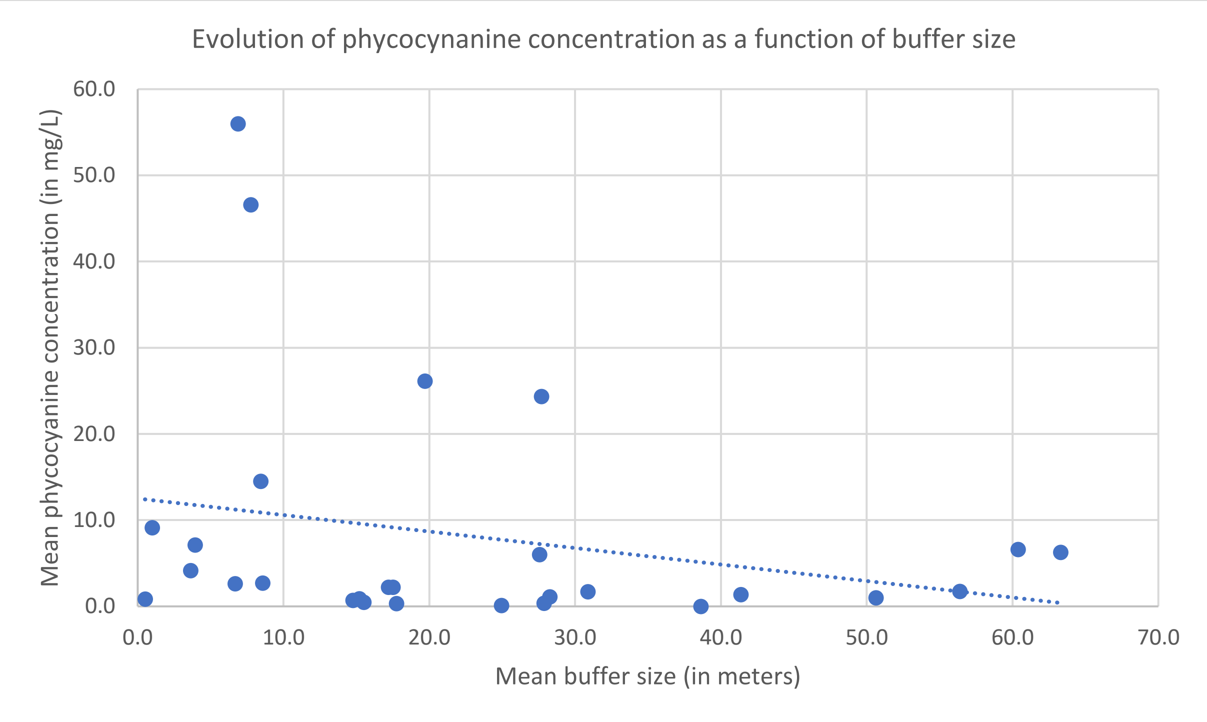


Figure 25. Correlation plot showing the relation between buffer size (mean size along 8 cardinal lines) and phycocyanine for the set of 30 ponds

4.2. Screening of available landuse data around the ponds

My last mission was to make a screening, in other words : a list, of the available landuse data for the surrondings of the ponds. In order to carry it out, I contacted Markus Venohr, an IGB expert on GIS, who helped me to make the list of the following high resolution digital maps available:

- ATKIS-2012   24 GB (stored since 2017 on Mailbox X:\amtliche geodaten)
- LBM-2012 23 GB (stored on Markus Venohr's hard drive but also downloadable from BKG website)
- LBM-2018 2.5 GB (packed as gdb (needs ArcGIS 10), stored on Markus Venohr's hard drive but also downloadable from BKG website)

LBM-2018 should be the map used by IGB later on to assess the landuse around the ponds, as it is the most recent one (Annex 2). Markus Venohr allowed me to download it from IGB Cloud so that I can have a first look at it (Figure 25). The detailed analysis of the land use in the surrondings of the ponds will be carried out by IGB later on. My mission was only targeting the availability of land use maps.

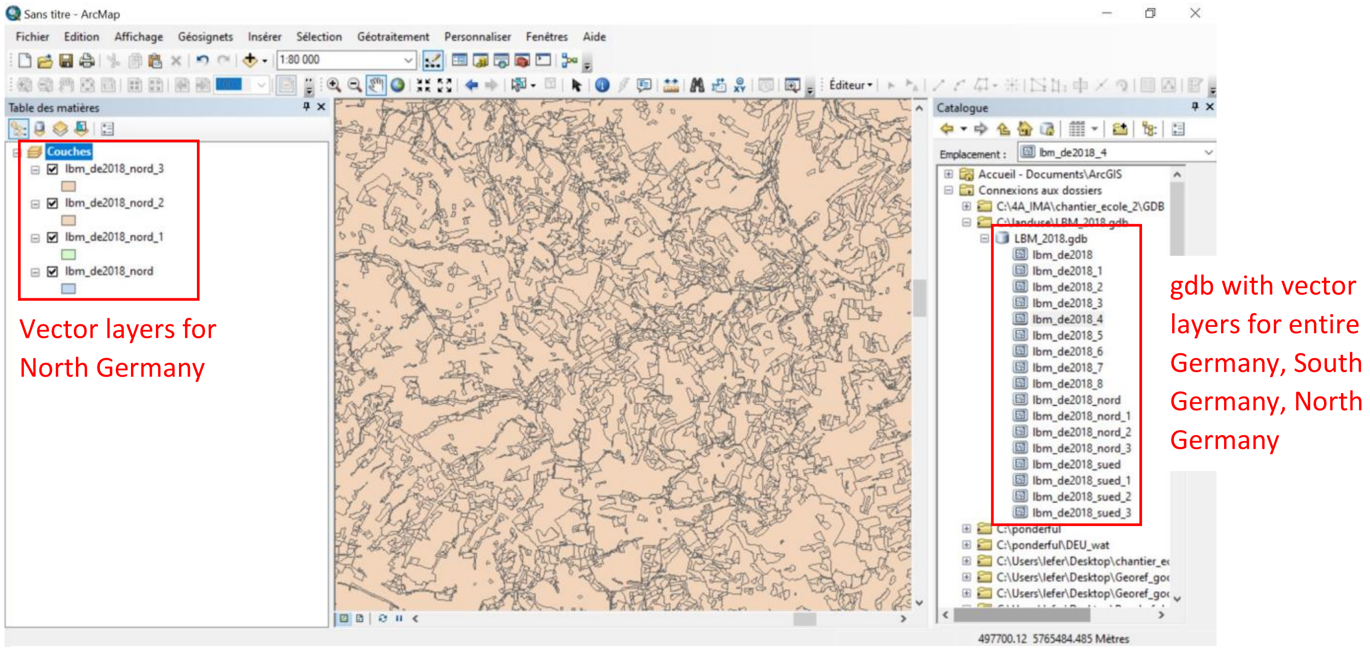


Figure 25. Interface of ArcGIS 10 running LBM-2018 2.5 GB. Only the vector layers for North Germany are activated. Here is a focus on Müncheberg pond region.

Conclusion

The overall aim of my internship was to collect a large dataset of different variables so that we, later on, understand better how land use characteristics affect the ecological integrity of small shallow ponds. For that, my internship was carried out in the framework of the PONDERFUL project.

I was part of an international sampling team. Together, we collected a large dataset of local environmental variables on 30 ponds located in different regions in North-East Germany and selected along a landuse gradient. We also collected samples that allow to assess community characteristics of fish, amphibians, zooplankton, macro-inverterbrates, and macrophtyes. We collected as well samples to quantify GHG emissions and carbon sequestration in the set of investigated ponds.

In additon to the field work, I was asked for specific deliverables. I created a dataset that holds information on the size of the buffer strip, which is an important element in further statistical analysis, and I screened for available landuse maps.

More importantly, this internship contributed strongly to my personal development as it enabled me to discover some aspects of the research process which were completly unknown to me.

For example, it was my real first experience of the fieldwork. This internship was the opportunity to shed light on a stage of the research process that had remained unclear to me for a long time. After, almost 4 months spent on the field, I can now affirm that it is the research stage that I prefer.

However, this was not always easy. The rythm of the sampling campaign was intense and with my team, we had to cope with tireness and responsibilities. This enabled me to know where my limits are.

It also gave me the opportunity to experience a research atmosphere in an international environment. I was part of a highly international team with whom I have created strong links. I was not considered as « an intern » but like « a colleague » and « a real member of the team ». This atmosphere helped me to always give my best.

Taking all this into account, I would say that this internship has given to me a clearer idea on how I see my future job. I definitely would like to combine field work with an international atmosphere. I have met these two criteria during my internship, this is why I am considering to work at IGB if I am given the opportunity.

From left to right : Pieter, Mareike and I

Sources

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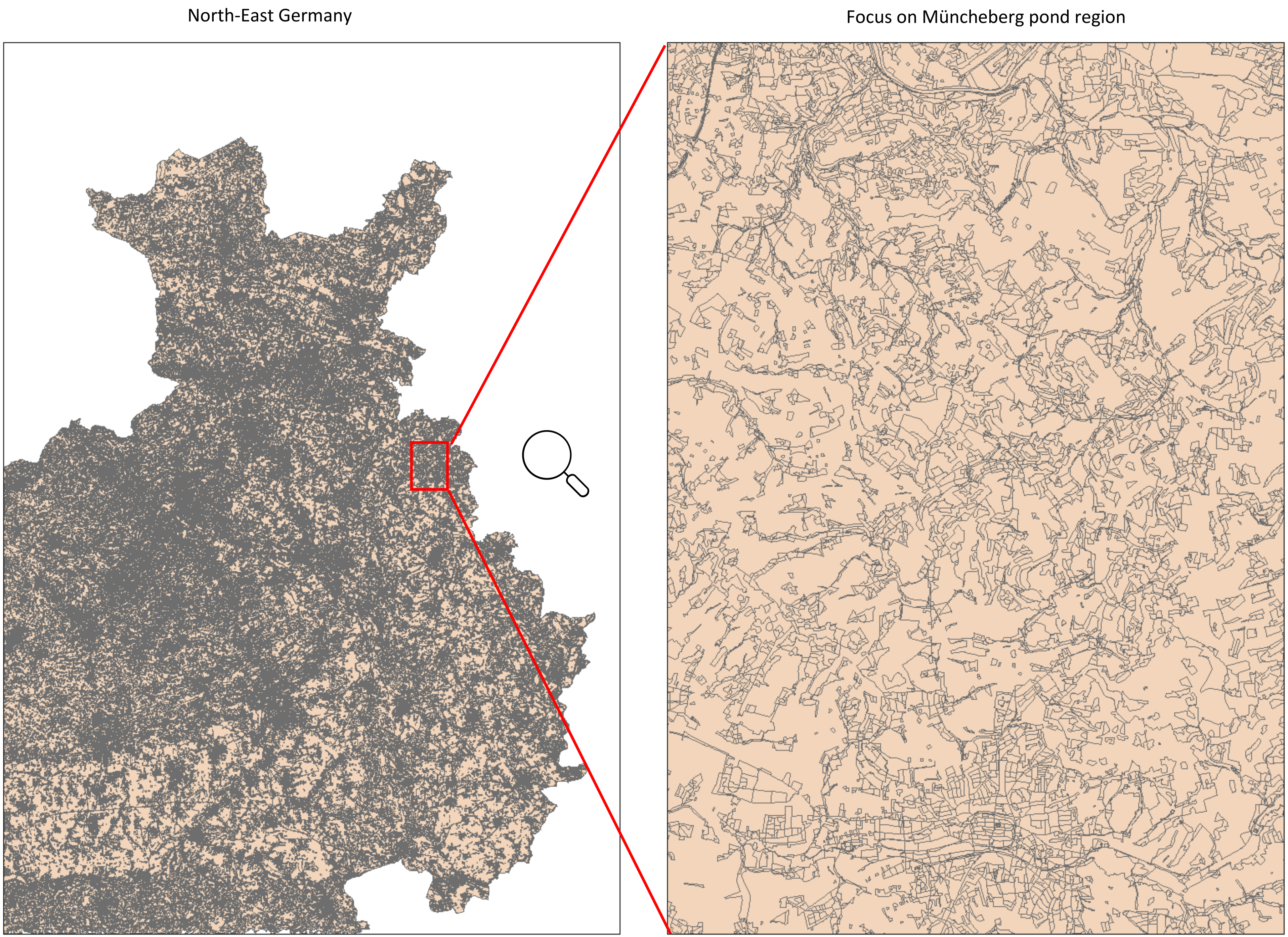
Webography

- IGB webiste : https://www.igb-berlin.de/en

- Ponderful website : https://ponderful.eu/

Pond	Length of the 8 cardinal lines (in meters)								Mean length
	1	2	3	4	5	6	7	8	
1	13	14.5	19	20	27.5	30	18	10.5	19.1
2	25	22.5	12.5	22.5	12.5	19	95	38	30.9
3	11	15	19.5	12	11	14	50	9.5	17.8
4	4	4.5	3.5	3.5	4	3.5	4	4.5	3.9
5	3.5	8	10.5	13	7	2	5	4.5	6.7
6	27	50	4	0	4	4	20	9	14.8
7	130	12	12.5	16	6	31	12.5	6	28.3
8	21	61	18	5	5.5	9.5	4.5	13	17.2
9	9	12	13	43	10.5	6.5	5	25	15.5
10	8.5	39.5	31	5.5	8.5	17	4.5	7	15.2
11	12	18	6	7	5	5.5	4	4.5	7.8
12	8	7.5	6	8.5	6.5	4.5	3.5	10.5	6.9
13	15.5	13	110	9.5	8	16.5	30	18	27.6
14	0	0	0	0	1	1	1	1	0.5
15	15	9.5	26	45	17	12	8	7.5	17.5
16	5	5.5	6.5	2	2.5	2.5	2.5	2.5	3.6
17	1	1	1	1	1	1	1	1	1.0
18	6	9.5	18	14	5	4	2.5	8.5	8.4
19	15	48.5	19	17	22	14.5	11	10.5	19.7
20	45	40	60	65	28	87	55	25	50.6
21	35	42	35	31.5	15	21	21	22.5	27.9
22	108	61	41	61	21	45	52	47.5	54.6
23	75	40	22	21	28	36	42	45	38.6
24	24	0	55	69	145	75	80	35	60.4
25	37	29.5	36.5	41	70	33	36	48	41.4
26	21.5	19.5	17.5	26.5	19	30.5	32	33	24.9
27	48	92	36.5	34.5	68	26	34	112	56.4
28	35	45.5	14	22	22.5	50	18	14.5	27.7
29	10	6	5	10.5	9.5	6.5	11	10	8.6
30	14.5	22	15	18.5	22	27.5	24	18	20.2

Annex 1. Deliverable 1. Final dataset providing an assessment of the buffer size for the set of 30 ponds located in North-East Germany



Annex 2. Part of deliverable 2. Screening for the land use in the different pond regions with LBM-2018 2.5 GB. Here, a focus on Müncheberg pond region.

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Louis-Marie Le Fer
2020-2021

How do land use characteristics affect the ecological integrity of small shallow ponds : a topic as part of the PONDERFUL project

Résumé : This final report aims to give an overview of my internship at the Leibniz Institute of Freshwater Ecology and Inland fisheries in Berlin. During 3,5 months, I was involved in PONDERFUL, a project funded by the European Union which aims to understand to what extent ponds can be used as Nature Based Solutions (NBS) to mitigate and adapt to climate change. The overall aim of my internship was to collect a large dataset in order to understand better how land use characteristics affect the ecological integrity of small shallow ponds. On the one hand, I intensively took part in a field campaign to sample a set of 30 ponds located in North-East Germany. This fieldwork was conducted to assess local environmental variables, community characteristics and ecosystem functions of ponds. On the other hand, I assessed the size of the buffer strip around the selected ponds and I conducted a first screening on the availability of landuse data.

Mots Clés : PONDERFUL, ponds, North-East Germany, land use gradient, local environmental variables, community characteristics, fish, amphibians, zooplankton, macro-inverterbrates, macrophytes, GHG emissions, carbon sequestration, buffer strip size, landuse maps screening

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