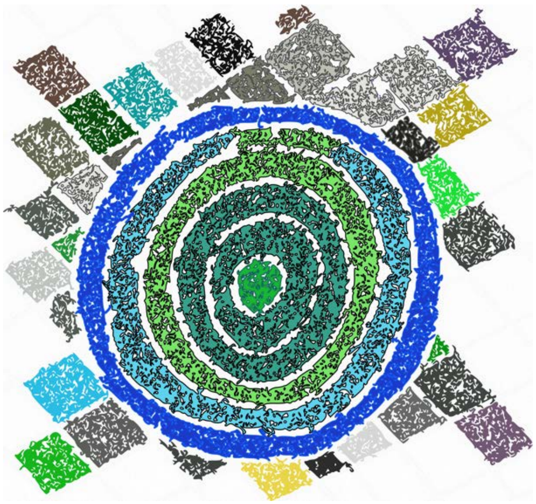
Urban Algae

Final project report



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European Federation for Freshwater Sciences (EFFS)

European Fresh and Young Researchers (EFYR)

Fresh Blood for Fresh Water (FBFW)

This report has been written by:

Cleo N. Stratmann (PI) - c.stratmann[at]posteo.de

Dr. Sonia Herrero (PI) - sonia.herrero2[at]hotmail.com

Dr. Mandy Velthuis (co-PI) - mandy.velthuis[at]ru.nl)

Susanne Stephan (co-PI) - s.stephan[at]igb-berlin.de

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Urban Algae is funded, under the umbrella of the European Federation For Freshwater Sciences (EFFS), by eight limnological associations and societies:

- The Group of Austrian Members of SIL (Verein Österreichischer Limnologen) (Austria)
- Czech Limnological Society (Czech Republic)
- French Limnological Association (France)
- Deutsche Gesellschaft für Limnologie e.V. (Germany)
- The Italian Association of Oceanography and Limnology (Italy)
- Iberian Association for Limnology (Spain and Portugal)
- Swiss Society for Hydrology and Limnology (Switzerland)
- Freshwater Biological Association (United Kingdom

The project Urban Algae (2nd FreshProject of the European Federation For Freshwater Sciences [EFFS]) aims to foster collaboration among young scientists. Since the project start in June 2018, Urban algae joins about 100 young and international researchers who have been carrying out research on urban ponds.

This final report describes the overall project realization, achievements, scientific results and expected publications. Overall the project has achieved its main goals and has been completed in July 2020. A scientific publication in a peer-reviewed journal is expected to be submitted in 2021.

Counts of signs (including spaces), pages 1-8: 19.477

Table of Content

Figures

Tables

1 Project structure and objectives

The Urban Algae project aims to acquire novel knowledge about ecosystem services and the ecological status of ponds in urban areas. Specially, the project links natural and social science to bridge important gaps between science, society and management of small freshwaters. The project teams have been conducting field samplings and developing a citizen survey on the perception of urban ponds.

The Urban Algae project ran from May 2018 until June 2020 (Figure 1). The one-year project report (Jun 2019) is available here. In the initial period of the project (June 2018 – July 2018) team assembly, organization and preparation took place. This was followed by the main period of data collection (July 2018 – November 2019), data analyses and reporting (Nov 2019 – June 2020).

The project is structured in a natural science and a social science part. The first part was completed in September 2018 with 58 pond samplings in European urban areas, the second part ended in November 2019, after a three-months online survey sampling.

1.1 Team assembly

To set up the project consortium, a call to join the project was released in March and April 2018 using distribution platforms such as Twitter, ResearchGate as well as the scientific network. Urban Algae aimed to sample ponds in different European urban nuclei and therefore aimed to include teams (≥2 persons) all over Europe. A final of 30 teams, in 15 countries, comprising 103 young scientists were assembled (Table 1, Figure 2).

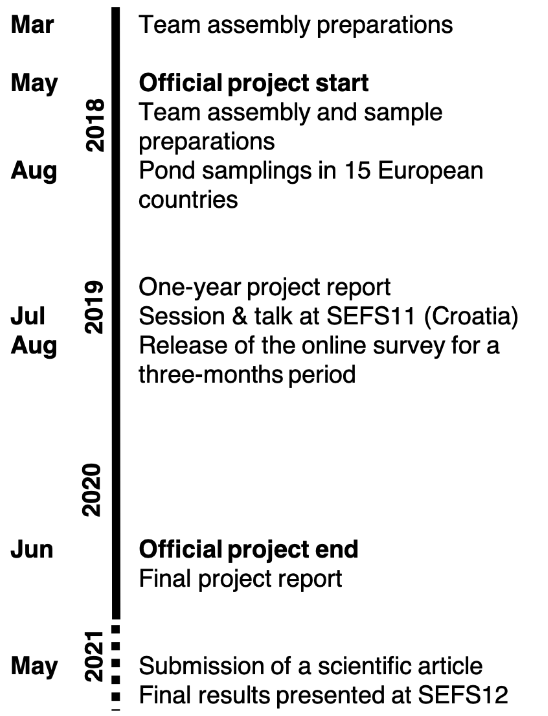

Figure 1 Timeline of Urban Algae

According to the requirements, there is at least one participant affiliated to each funding association in the Urban Algae consortium. One team (Tirana, Albania) had to withdraw due to time constrictions and another team (Munich, Germany) was accepted after the team application deadline. Table 1 displays team ID, sampled urban nuclei (city name) and country. The country with highest team coverage was Spain with a total of eight teams. Although the consortium included members from the French limnological association (AFL), no team from France applied.

Table 1 Assembled teams of the Urban Algae project. Order by Team ID. Team ID 23 had to withdraw before sampling.

Team ID	Urban nuclei (city)	Country
1	Berlin	Germany
2	Berlin	Germany
3	Blanes	Spain
4	Bucharest	Romania
5	Bucharest	Romania
6	Cambridge	United Kingdom
7	Ceske Budejovice	Czech Republic
8	Cluj-Napoca	Romania
9	Debrecen	Hungary
10	Granollers	Spain

11	Innsbruck	Austria
12	León	Spain
13	London	United Kingdom
14	Málaga	Spain
15	Milano	Italy
16	Motril	Spain
17	Poznan	Poland
18	Reggio Emilia	Italy
19	Santander	Spain
20	Skopje	Republic of Macedonia
21	Sofia	Bulgaria
22	Székesfehérvár	Hungary
23	Tirana	Albania
24	Trento	Italy
25	Umeå	Sweden
26	Uppsala	Sweden
27	Valencia	Spain
28	Viladecans	Spain
29	Wageningen	Netherlands
30	Zagreb	Croatia
31	Munich	Germany

1.1.1 *Working collaboratively*

An introduction was given by the PIs to the teams in May 2018 using Zoom. Working Groups (WGs) were organized for different tasks and Google drive was used as a common online working space. WGs had separate virtual meetings when needed and were able to work independently. We made use of the advantage of working collaboratively, joining the expertise of different Urban algae members and at the same time allowing non-experts to gain new knowledge in a certain working area (e.g. macrophytes sampling). Communication was done mainly by mail and Google drive shared documents. At the start of the project a data policy was set up to assure responsible and proper handling of the data. Also, the project consortium was regularly informed about updates and news by sending update emails.

1.2 Hypotheses

Ponds in urban areas are often artificially created, actively managed and strongly impacted by anthropogenic activities. From an ecological perspective, urban ponds are important, as they provide several ecosystem functions (EF) such as biological diversity, nutrient cycling and carbon sequestration. To humans, ponds provide provisioning, regulating, cultural and supporting ecosystem services (ES) (MEA, 2005). Understanding the feedbacks between environmental characteristics of ponds and how they are perceived (or valued) by citizens has rarely been studied. Urban Algae aims to fill this gap by testing the hypotheses, that (i) the ecological status (i.e. water quality, trophic status, primary producer diversity) of ponds in urban nuclei differ along a latitudinal gradient across Europe, (ii) the ecological status, and in particular the composition, abundance and biomass of phytoplankton and macrophytes, is reflected by the perception (valuation) of ponds (i.e. a good ecological status is reflected by high valuation). We further assume that the ecological status of ponds in urban environments is often poor, reflected by low macrophytes abundance, and high phytoplankton biomass compared to non-urban systems. In addition, it is expected, that some lesser-known ES (such as storm water retention) may not be recognized by the citizens and that cultural differences will affect the ES perceptions. The latter is hypothesized to vary among urban densities and geographically across Europe.

1.3 Data collection and analyses

In order to answer the hypotheses, the project encompassed two different sampling parts: the pond identification and sampling to determine the ecological status (natural science) and the development and release of a questionnaire about urban ponds perception by citizens (social science) which was mainly based on the prior part. The survey questions were adapted to characteristics of the sampled ponds and included a part on visual perception, using actual pond pictures.

1.3.1 *Pond sampling across Europe*

First, a common sampling protocol was developed. Physiochemical, biological and infrastructural parameters of the ponds were sampled. Physiochemical and biological parameters included chlorophyll-*a*, particulate and dissolved nitrogen (N) and phosphorus (P), submerged, emerged and floating macrophyte cover and species identity, temperature, dissolved oxygen content (DO), Secchi depth.

Parameters concerning the pond infrastructure and environment included shore structure, tree cover, accessibility, existence and size of fountains. As these indicators were used for the public perception, it was important that they were 1) visible parameters and 2) indicators regarding the ecological status. In addition, photographs of the ponds were taken following a common methods protocol.

All teams were provided with a sampling package, including main materials (e.g. sampling vessels and labels) to carry out the field sampling. Pond samplings took place in July and August 2018. Each team sampled two ponds in one urban area, except team 1 (no sampling) and team 20 (1 pond). Field samplings were successful, and laboratory analysis were started at NIOO (Netherlands Institute of Ecology) and at IGB (Leibniz-Institute of Freshwater Ecology and Inland Fisheries) after samples arrived. Last water sample analyses were completed in June 2019.

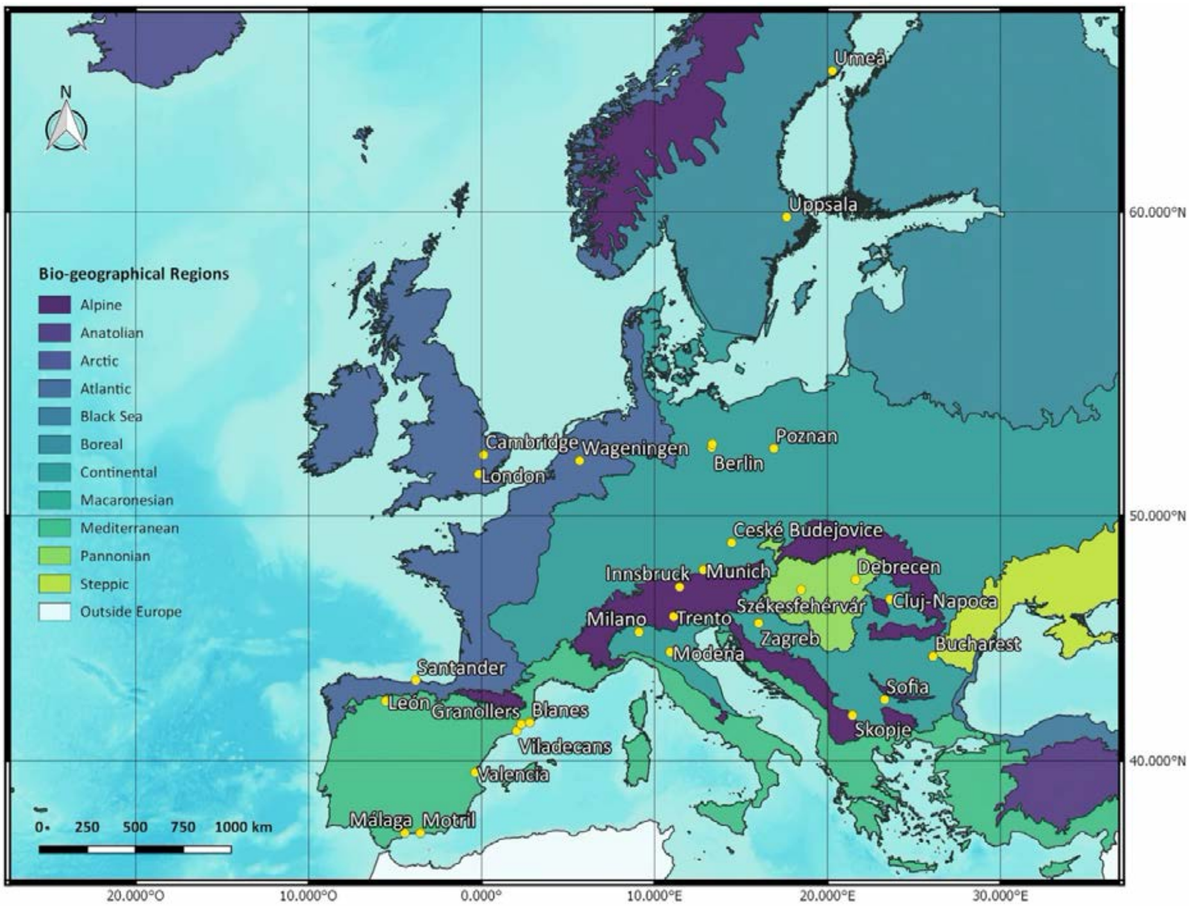

Figure 2 Distribution map of the urban nuclei corresponding to each team, except for Bucharest and Berlin, where two teams each are based.

Differently to the plan described in the original proposal, we did not hold a workshop on image analysis for the identification of phytoplankton samples. Instead, the image analysis was planned to be done by each team using a common methodology protocol and imaged provided using a FlowCam instrument. Unfortunately, difficulties with the sample recognition appeared and this parameter could not be included at the moment. Instead, flow cytometry data will be used to cover this part of the hypotheses.

1.3.2 *Social science survey*

A citizen survey was developed to obtain new insights about the perception of urban ponds by society. The development of the survey started partially parallel to the pond sampling preparation, and has extensively been progressing since fall 2018. Expertise from both, social and natural scientists have been merged. The survey has been translated by working groups in 14 languages, spoken in the countries where ponds were sampled. The survey was distributed to the public from 5th of August to 30th of October 2019. We obtained data almost 2000 valid, completed surveys.

The survey content and approach has been developed by a WG. The survey links the perception of citizens on urban ponds with (visually perceptible) environmental characteristics by ecosystem services valuation.

1.4 Budget and finances

The total budget of the project was 8.600 €, from which 8.000€ were provided by the FreshProject 2.0 call, and 600 € from the department of aquatic ecology (AKWA-AqE, NIOO-KNAW). The Leibniz-Institute of Freshwater Ecology and Inland Fisheries provided technical support and analyses free of charge. Figure 3 shows the expenses by topic/activity.

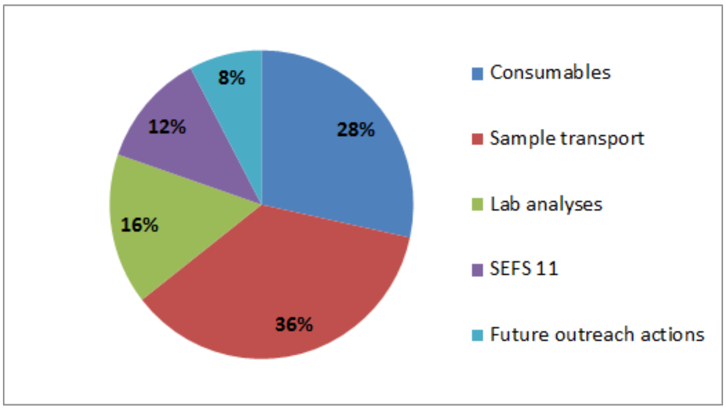

Figure 3 Budget distribution of Urban algae (8.600€). SEFS 11 = 11th Symposium of European Freshwater Sciences (2019)

2 Scientific results (preview)

2.1 Natural data

2.1.1 *Biogeochemistry*

Ponds where sampled between 14th July and 18th of August 2018. During the sampling period a heatwave happened across central Europe (Herring *et al*., 2020). Water temperature at the surface during sampling was 25.3 ± 3.3 ºC (mean; SD). The **57** ponds sampled were small in area, 0.01 – 3.74 ha (min; max) and shallow, 1.5 ± 1.2 m depth (mean; SD).

Pond groups characterization (clustering)

13 visual features recorded during sampling were used to cluster the ponds. Parameters were selected on data quality and relation to social perception as well as to pond ecology (Table S 2).

A total of 56 ponds were used for the visual classification. The cluster analysis resulted in five groups of ponds and one outlier, that was excluded (pond 26) (Figure S 1)

Ecosystem services and pond ecology relationships

The visual features used for clustering the ponds were used as proxies of the ecosystem services studied (Table S 1). The visual features related to the ecosystem services of climate change, disease and pest control and water purification were studied in relation with the biogeochemical parameters.

The ES proxies that were found to be related to the visual features were chlorophyll a content and cyanobacteria percentage, proxies of algae blooms (disease and pest control). The presence of islands was related to higher levels of both parameters. As most of the sampled ponds are man-made, presence of islands indicates artificial structures, that together with a positive correlation of artificial shoreline with cyanobacteria percentage (rho=0.30, p=0.03), indicates that less naturalized ponds presented higher algae concentration.

2.1.2 *Macrophyte diversity*

The urban ponds in the dataset harboured an average of 3.5 macrophyte species. The majority of those were emergent species (75% ± 92; mean ±SD), while a considerably lower percentage of floating and submerged species were observed (12% ± 21 and 12% ± 28, respectively, Figure 4). A higher diversity of emergent species compared to submerged species can be commonly observed in freshwater habitats (Lukács et al. 2015, Teurlincx 2019). The distribution of macrophyte life-forms in urban ponds

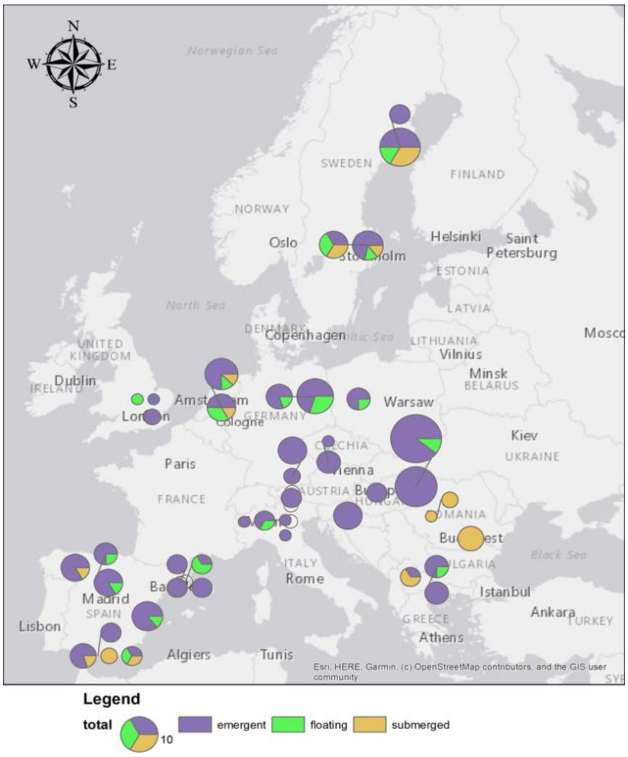

Figure 4 Macrophyte diversity in urban ponds across Europe. The number of observed species is indicated by the size of the pie-chart, while the distribution of macrophyte life-forms is marked with the different colors.

thus seems to resemble those of other, more natural water bodies.

There is a high variability in macrophyte diversity between ponds (apparent from the high SD-values). Interestingly, some urban ponds contained only submerged macrophyte species (e.g. urban nuclei in Romania), whereas other ponds only had emergent vegetation. One urban pond in the UK only contained floating macrophyte species.

The majority of observed macrophyte species are not classified as invasive alien species according to the EU Union list (European Union 2014). One occurrence of *Elodea nuttallii* was recorded in an urban pond in Umea, Sweden, which is considered an invasive alien plant species in some countries.

2.2 Social data

A total of 1966 valid responses were collected within three months (August-October 2019). Citizen participation was left skewed by age classes towards younger people (median=33 years; min-max= 4-85 years). This could be due to the online distribution of the survey, thereby making it less accessible to older persons of the population, a bias we anticipated in the survey design. Gender distribution was 60% female, 38% male and 2% other (Figure S 2 and Figure S 3).

Habitat refuge, local climate and flood regulation were among the highest valued ES, while drinking water and commercial fish provisioning were the least valued. 94% of respondents agreed that habitat refuge is an important ecosystem service provided by urban ponds, and 29% perceived ponds as a source of pests and diseases.

The survey results show homogeneous results for the three sets of images (1, 2, and 3, randomisation, Figure S 10, Figure S 11, Figure S 12) for each ES, except for replicates C3 and D2, that were deviated from their cluster answers (Figure S 4-Figure S 9). Results for ES perception based on the images was not conclusive. No significant differences were found when the outliers (C3, D2) were excluded from the analyses. All the cluster groups were highly valued for habitat refuge (Figure S 8), local climate regulation (Figure S 7), flood prevention (Figure S 4), climate change mitigation (Figure S 5) and water purification (Figure S 9). Disease and pest control were valued equally in all clusters (Figure S 6).

2.3 Literature

MAE, 2005 Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC.

Herring, S. C., N. Christidis, A. Hoell, M. P. Hoerling, and P. A. Stott, Eds., 2020: Explaining Extreme Events of 2018 from a Climate Perspective. Bull. Amer. Meteor. Soc., 101 (1), S1–S128, doi:10.1175/BAMS-ExplainingExtremeEvents2018.1.

European Union. 2014. Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. Official Journal of the European Union 57:35.

Lukács, B. A., B. Tóthmérész, G. Borics, G. Várbíró, P. Juhász, B. Kiss, Z. Müller, L. G-Tóth, and T. Erős. 2015. Macrophyte diversity of lakes in the Pannon Ecoregion (Hungary). Limnologica 53:74-83.

Teurlincx, S. 2019. Connecting the ditches: a spatial perspective on biodiversity in Dutch polder landscapes. 162 NIOO Thesis.

3 Project dissemination

Final scientific results regarding the hypotheses of the project will be published in a scientific article. After publication of that article, all data collected during the project will be publicly available (open data) and are of free use.

3.1 Public media

For project dissemination in general and in preparation of the online survey sampling, a twitter account, a ResearchGate (RG) project and a project website were created. The media content was managed by working groups of Urban Algae.

Twitter:

The Urban Algae twitter account @Urbanalgae2018 was activated on March 17, 2018. Until end of April 2020 Urban Algae has 305 followers. Over the course of two years the account earned 169k impressions. During the survey sampling period (August 5 – October 31, 2019) 33k impressions, with to major tweets on August 5 (8986 impressions) and on September 17 (10474 impressions). Apart from distribution for the survey sampling, twitter was used to create awareness of the project, link other important collaborators and funding societies and release updates.

ResearchGate (RG):

A project was created on the platform RG to open Urban Algae for the wider scientific community and allow the consortium members to add the project to their RG profiles.

Website:

The website https://freshproject-urbanalgae.jimdofree.com was created to present Urban Algae to the wide public and allow access without the need to register at any platform (e.g. RG).

Other media awareness:

Several articles, blogs or mentions about the project were published by external or partner platforms and are listed here: IGB annual report 2018 and IGB webpage.

In 2019 the Diatom society published an interview about the urban algae project as well.

3.2 Conference participation:

2018:

A project poster was prepared from different Urban algae team members. The poster was presented during the AIL (Iberian Association of Limnology) 2018 meeting (Portugal), the DGL (Deutschen Gesellschaft für Limnologie e.V.) 2018 meeting (Germany) and a presentation about the project was given at the IGB science day (Germany).

2019:

During the 11th Symposium of European Freshwater Sciences in 2019 (SEFS 11, in Zagreb, Croatia), a special session (SS.6) was presented by the core team of Urban Algae. The session “Linking natural and social science in freshwater ecosystems” hosted talks related to the topic of the project. During the session, an oral presentation about Urban algae was given, also showing preliminary results of the project. Several posters were presented by consortium members.

3.3 Expected scientific publications:

We intend to publish a manuscript that englobes the main hypotheses of the project combining the natural and social data. One additional manuscript about the diversity of macrophytes in urban ponds across Europe is in preparation as well.

4 Conclusion

In summary, the following milestones have been completed:

- Team assembly
- Pond sampling
- Citizens survey

- Analysing data (partially)

Ongoing milestones are:

- Analysing data (partially)
- Preparing a manuscript

Major challenges that we came across during the last year were specially the communication with a large number of people involved. For group calls we used Zoom, for smaller meetings also Skype. As free Zoom accounts have time limitations, we had to renew the connection after some time. Email communication was sufficient for most purposes, however, changes in email addresses from project members during time needed to be considered and constantly updated. Also, the amount of email sent should always be kept as little as possible.

We have not experienced any problems concerning collaboration and team work of many people with various backgrounds, languages and cultures. The opposite, we have found many interesting and new inputs and possibilities learning from each other.

We found it very important giving all project members the chance to give their input to abstracts, common protocols and ideas by planning sufficient time for commenting or correcting documents. This is crucial for good and involved teamwork and we all have improved our skills on how to manage working in a large consortium.

Logistics for sending water samples from the field samplings were especially challenging, as not the same logistic companies work and function in the same way in different European countries. Express sending was very expensive in some regions, and sometimes took longer than promised. Due to transportation difficulties we will not able to use the water samples from four out of 60 ponds.

5 Acknowledgements

We would like to thank all members of the Urban Algae consortium for their efforts and commitments, as well as their supervisors and affiliative institutions. We like to express our appreciation for additional resources provided by IGB and NIOO. We thank Tim Walles and Stella Berger for support with FlowCam and image analysis. We thank Evanthia Mantzouki for the access to the protocol for collaborative water samplings, and Sabine Hilt and Sven Teurlincx for expert input on macrophytes. We want to mention the great opportunity given by the SoSci platform to develop and use scientific surveys to full extent and free of charge. We thank the EFYR, FBFW and EFFS Team for their overall support during the project duration.

6 Supplementary

Figures

Tables

Table S 1 Condition parameters used the cluster analysis and their indication on ecosystem services.

#	Condition parameters (visually, quantifiable; used in UA project)	Indication of condition parameters for ecosystem services by Question ID (Fehler! Verweisquelle konnte nicht gefunden werden.), no entry means no indication, - contradicts statement, ± could be either way (depending on thresholds)					
		C102_03 **Flood control**	C103_03 **Climate change**	C104_03 **Disease and pest**	C105_03 **Local climate**	C106_03 **Habitat**	C107_03 **Water purification**
1	Fountains			-	+		
2	Islands					+	
3.1	Shore line structure – grassland	+			+	+	
3.2	Shore line structure – artificial[1]	-			-	-	
3.3	Shore line structure – sand and soil				-	-	
3.4	Shore line structure – Reed	+	+		+	+	
3.5	Low woods and bushed coverage surrounding (<10m)	+			+	+	
3.6	Tree coverage surrounding (<10m)	+			+	+	
4.1	Macrophytes – emerged cover		+			+	
4.2	Macrophytes – floating cover		+			+	
4.3	Macrophytes – emerged height		+			+	
5	Surface area	+			+		
6	Secci depth		-	-			+

[1] Artificial shore line refers to very urban structures, e.g. concrete.

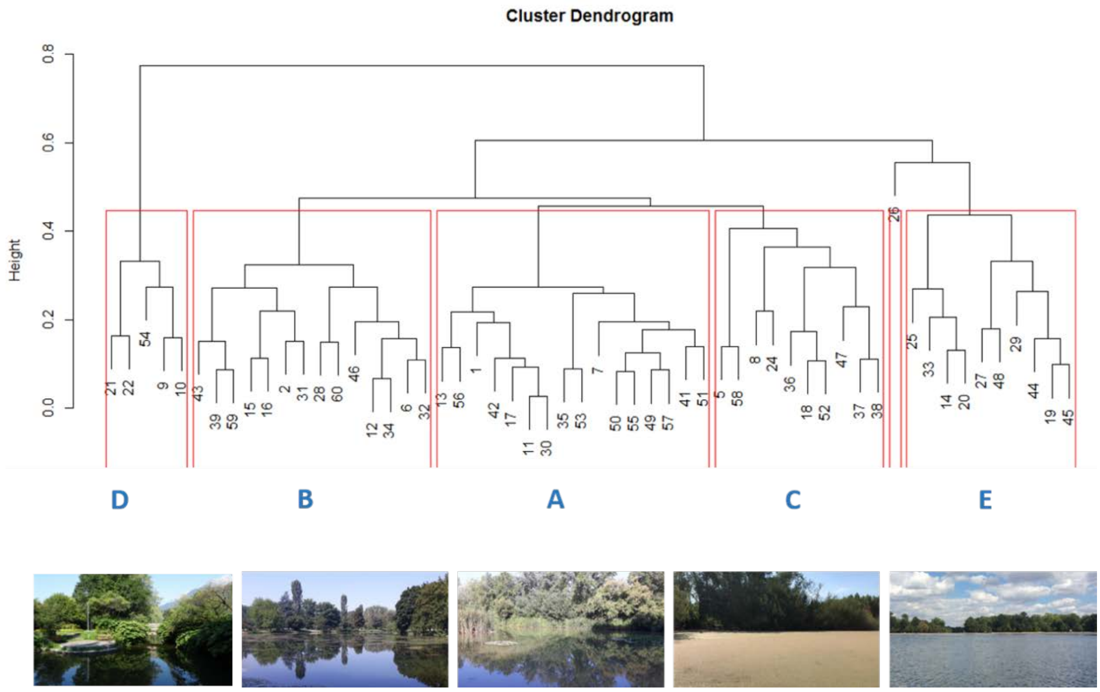

Figure S 1 Letters represent the cluster ID; numbers are the pond ID. Images under each cluster represents the stereotype pond from each cluster.

Cluster A (N=16) is characterized by high reed (61-80%) and low grassland (0-20%) shoreline cover. Abundance of emerged macrophytes with a height of 36.4 ± 13.8 (mean; SD). Only two ponds presented Islands.

Cluster B (N= 14) is characterized by high grassland shoreline cover (61-80%). No presence of islands nor fountains. Minimal floating macrophyte cover, low emerged macrophyte cover and with low above surface height. Even though there was no significant difference with other clusters, cluster B presented the highest secci depth, 0.9 ±0.5 m (mean;SD).

Cluster C (N=10) presented heterogeneous shorelines except for artificial or sandy shorelines, that were not represented in this group. Some ponds presented reed in more than 40 % of the shoreline. The emerged macrophyte surface coverage was 36.8% [12.5 – 100] (median; min – max), with an average height of 24 cm. Floating macrophytes coverage was the highest among the clusters 12.5 % [0-100] (median; min-max). Only two ponds presented fountains.

Cluster D (N=5) is characterized by a high artificial (81-100 %) and low grassland (0-20%) shoreline coverage. Emerged macrophytes was present in only one pond representing the 25% of the surface and with a height of 6.75 cm while floating macrophytes were absent. All ponds presented islands, and three presented fountains.

Cluster E (N=10) is characterized by the biggest areas of all the sampled ponds, 2.51 ± 1.15 ha (mean; SD), presence of islands in six ponds and the absence of floating macrophytes. The shoreline presents heterogeneous composition with grasslands, artificial structures and sandy areas. Emerged macrophyte surface cover was low, 12 % [0 – 75] (median; min-max)

The **water biogeochemistry by cluster** is summarized in the following table:

Table S 2 Water biogeochemistry data by cluster.

	Cluster A (N=16)	Cluster B (N=12)	Cluster C (N=10)	Cluster D (N=5)	Cluster E (N=8)
pH	7.94 [7.01, 8.83]	8.24 [6.87, 9.29]	8.04 [7.23, 8.87]	8.57 [7.76, 9.75]	8.66 [7.48, 9.55]
EC (μS cm^{-1})	600 [257, 9120]	635 [132, 3160]	484 [240, 1000]	578 [301, 1520]	538 [174, 11800]
DO surface (mg L^{-1})	7.83 [0.750, 13.4]	8.61 [0.880, 16.2]	9.86 [0.500, 15.7]	10.5 [8.65, 16.8]	11.7 [5.65, 15.6]
DO bottom (mg L^{-1})	0.940 [0, 10.5]	2.20 [0.0400, 8.51]	3.00 [0.0100, 10.2]	9.48 [4.40, 15.0]	10.2 [4.83, 18.0]
Total Phosphorous (μg L^{-1})	75.0 [12.8, 829]	84.1 [13.9, 577]	71.5 [34.5, 806]	23.0 [18.3, 56.8]	28.3 [14.5, 346]
Total Nitrogen (mg L^{-1})	1.48 [0.640, 5.87]	1.08 [0.443, 5.85]	1.26 [0.613, 3.33]	2.57 [1.43, 5.93]	1.26 [0.633, 5.97]
Chlorophyll *a* (μg L^{-1})	6.84 [0.355, 60.5]	3.85 [0, 21.7]	3.67 [0.711, 36.7]	6.86 [0.237, 14.1]	2.36 [1.07, 18.5]
Cyanobacteria < 90μm (%)	7.50 [3.50, 81.0]	12.5 [0.500, 58.5]	10.3 [1.00, 47.0]	26.0 [5.50, 54.0]	16.5 [3.00, 58.0]

Part of the total **social survey data** is displayed in the following graphs:

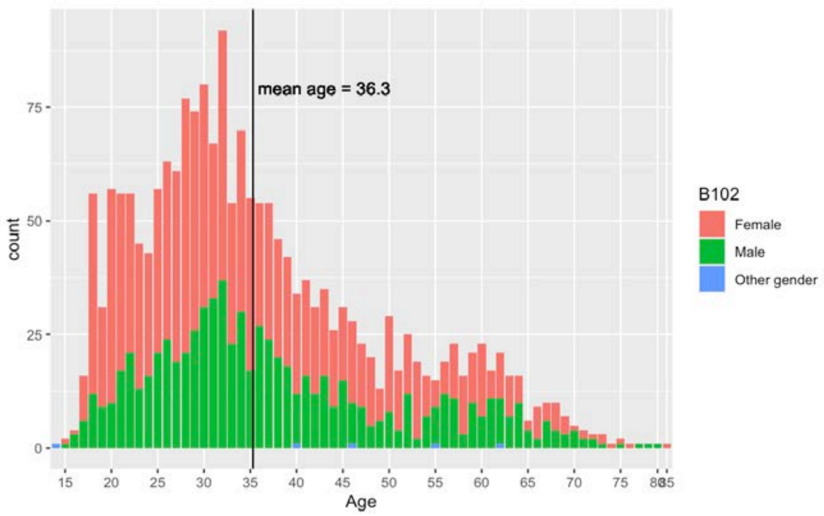

Figure S 2 Age and Gender distribution of survey respondents.

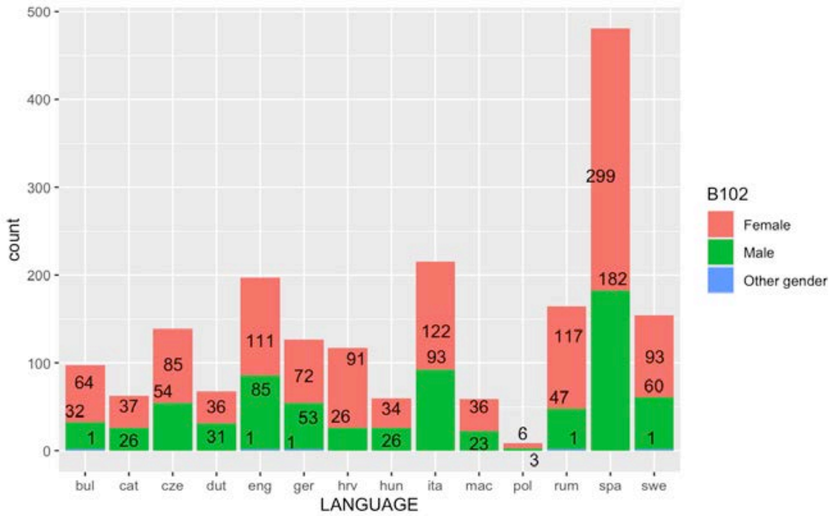

Figure S 3 Languages of surveys completed, by gender and number of respondents per language.

In the image part of the survey, we displayed 5 images (the 5 images [=one image group] relate each to one of the 5 clusters) and gave 6 different statements about ecologically relevant aspects. For each statement and each image, we asked the respondents to: „Please indicate how much you agree with the following statement."

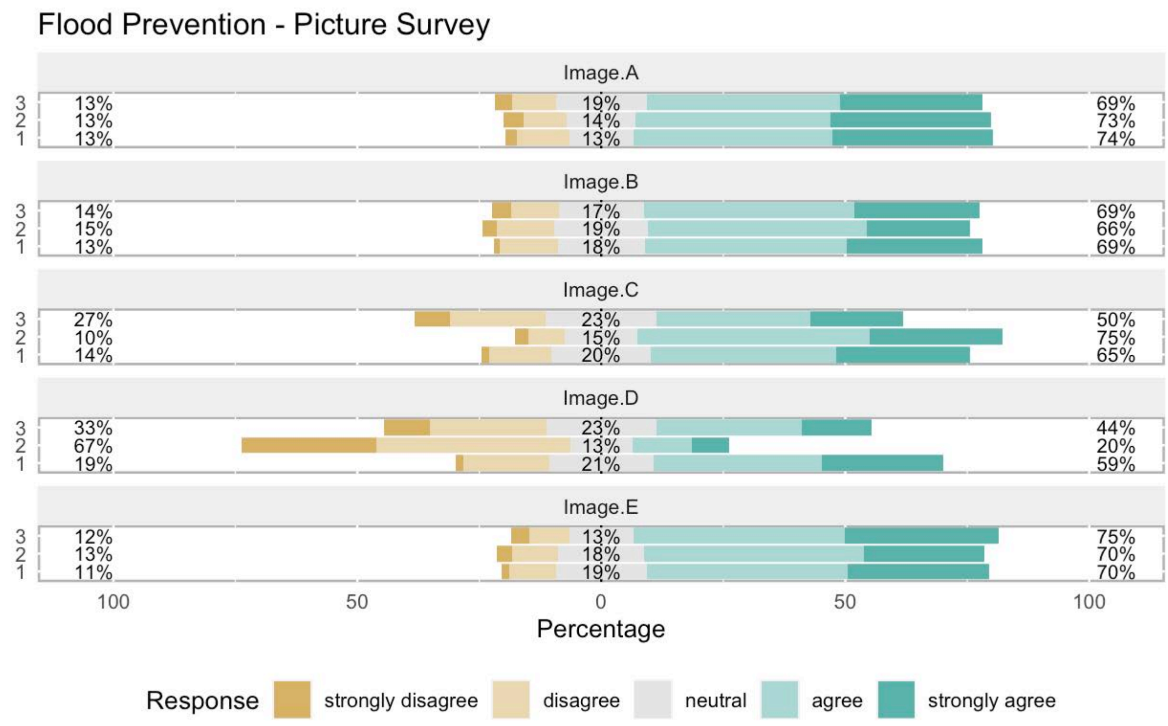

Figure S 4 Valuation of pond images for flood prevention, 1,2,3 on y-axis represent randomized image groups. Statement: The urban pond depicted in the image helps to control floods, i.e. retains water and therefore can help to prevent flooding when there are heavy rains.

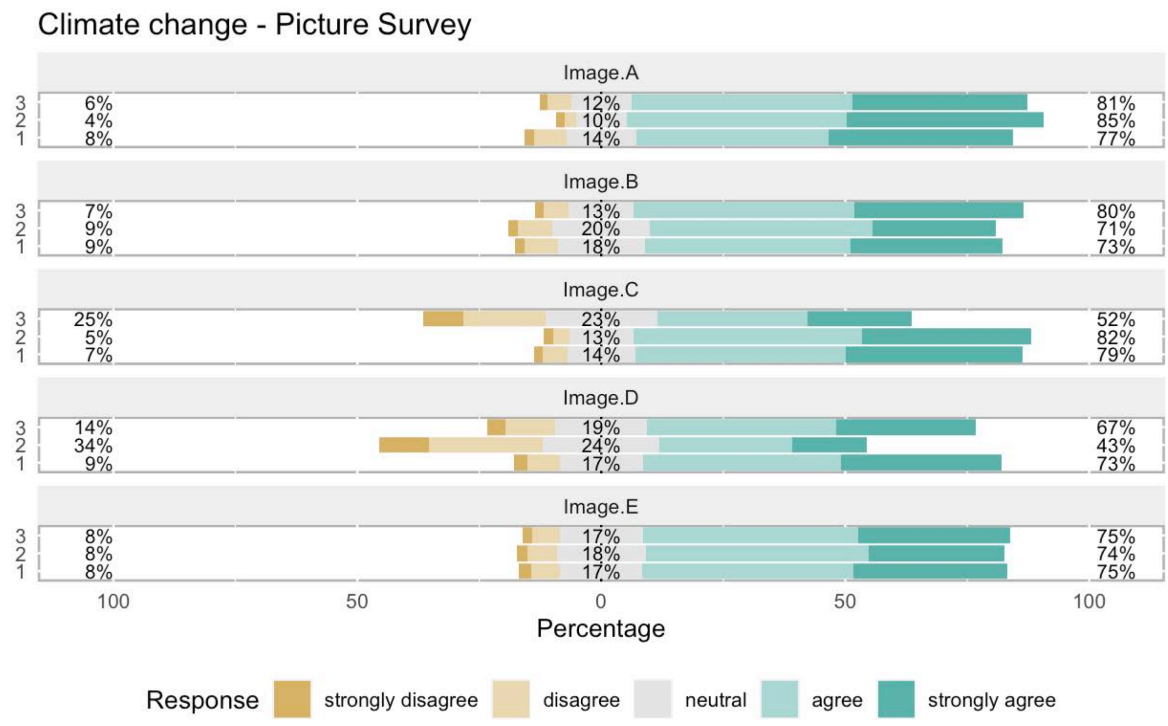

Figure S 5 Valuation of pond images for climate change, 1,2,3 on y-axis represent randomized image groups. Statement: The urban pond depicted in the image helps to mitigate climate change, i.e. stores carbon.

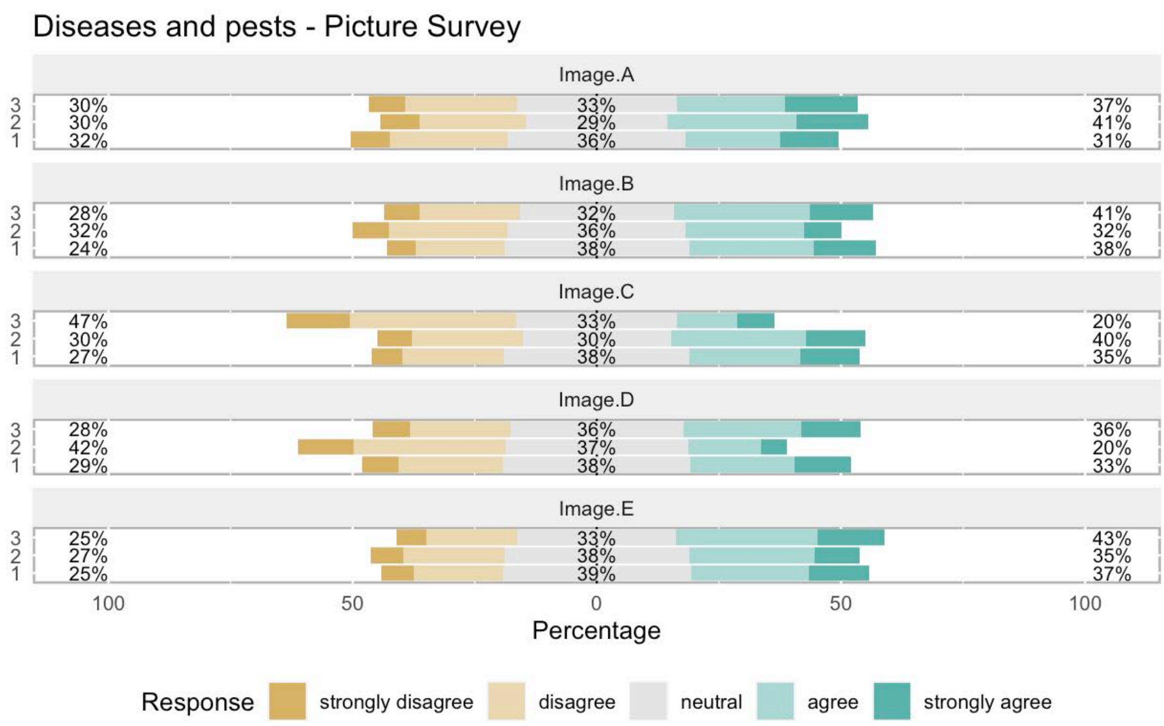

Figure S 6 Valuation of pond images for diseases and pests, 1,2,3 on y-axis represent randomized image groups. Statement: The urban pond depicted in the image controls diseases and pests.

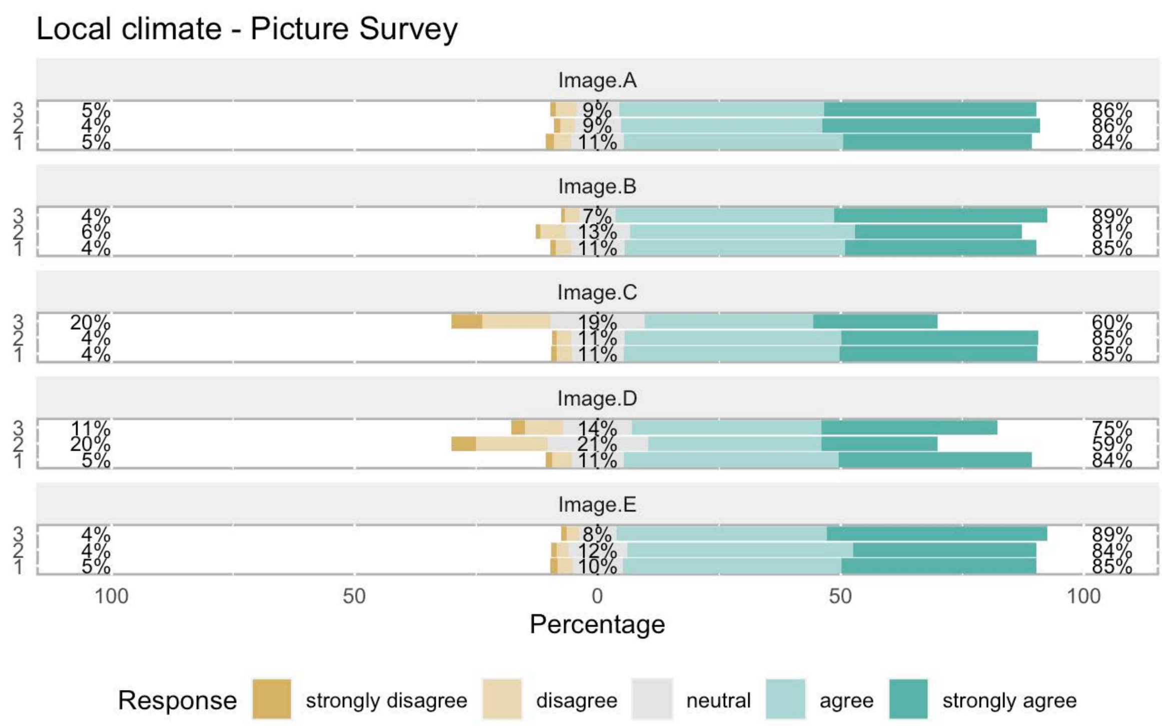

Figure S 7 Valuation of pond images for local climate, 1,2,3 on y-axis represent randomized image groups. Statement: The urban pond depicted in the image regulates the local climate, i.e. is a place where the local climate is different than the urban surroundings.

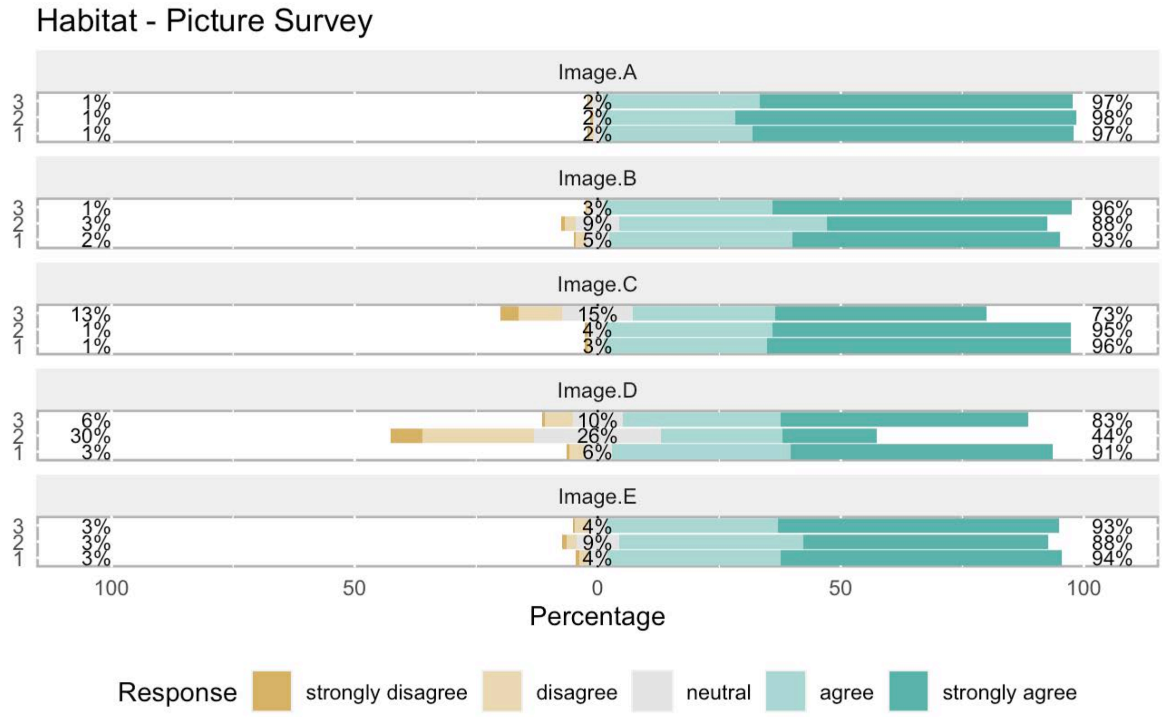

Figure S 8 Valuation of pond images for habitat, 1,2,3 on y-axis represent randomized image groups. Statement: The urban pond depicted in the image provides habitat, i.e. is a refuge for animals and plants.

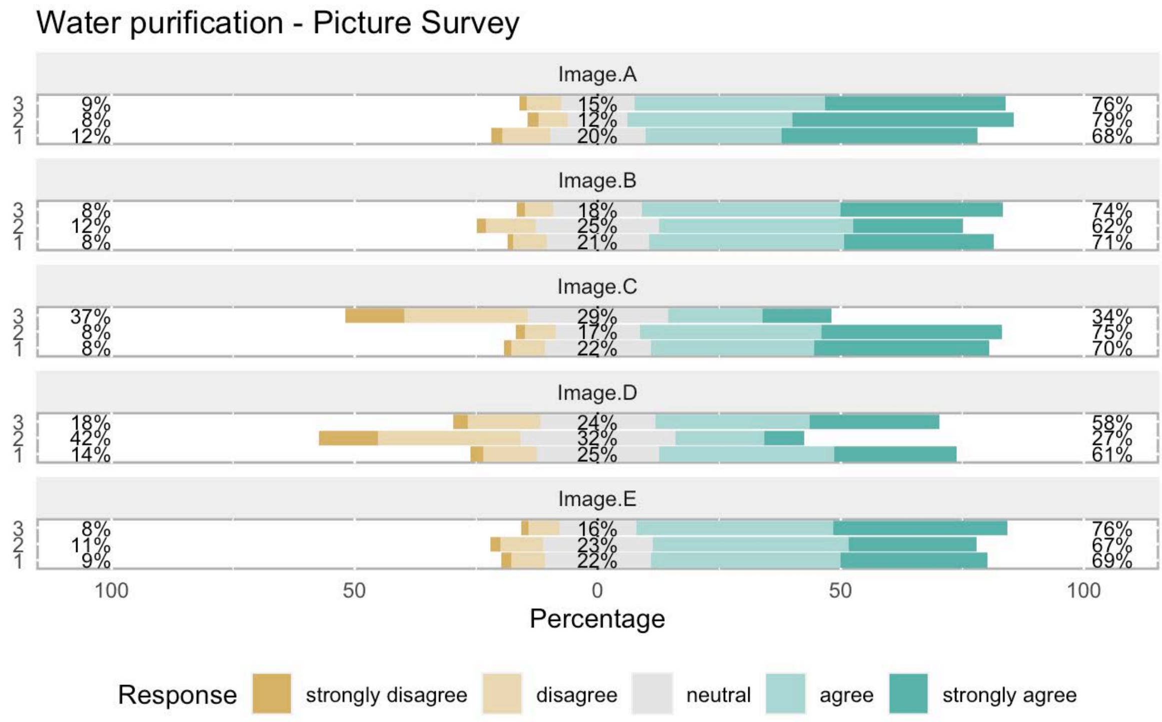

Figure S 9 Valuation of pond images for water purification, 1,2,3 on y-axis represent randomized image groups. Statement: The urban pond depicted in the image helps to clean water, i.e. the pond improves water quality through natural processes.

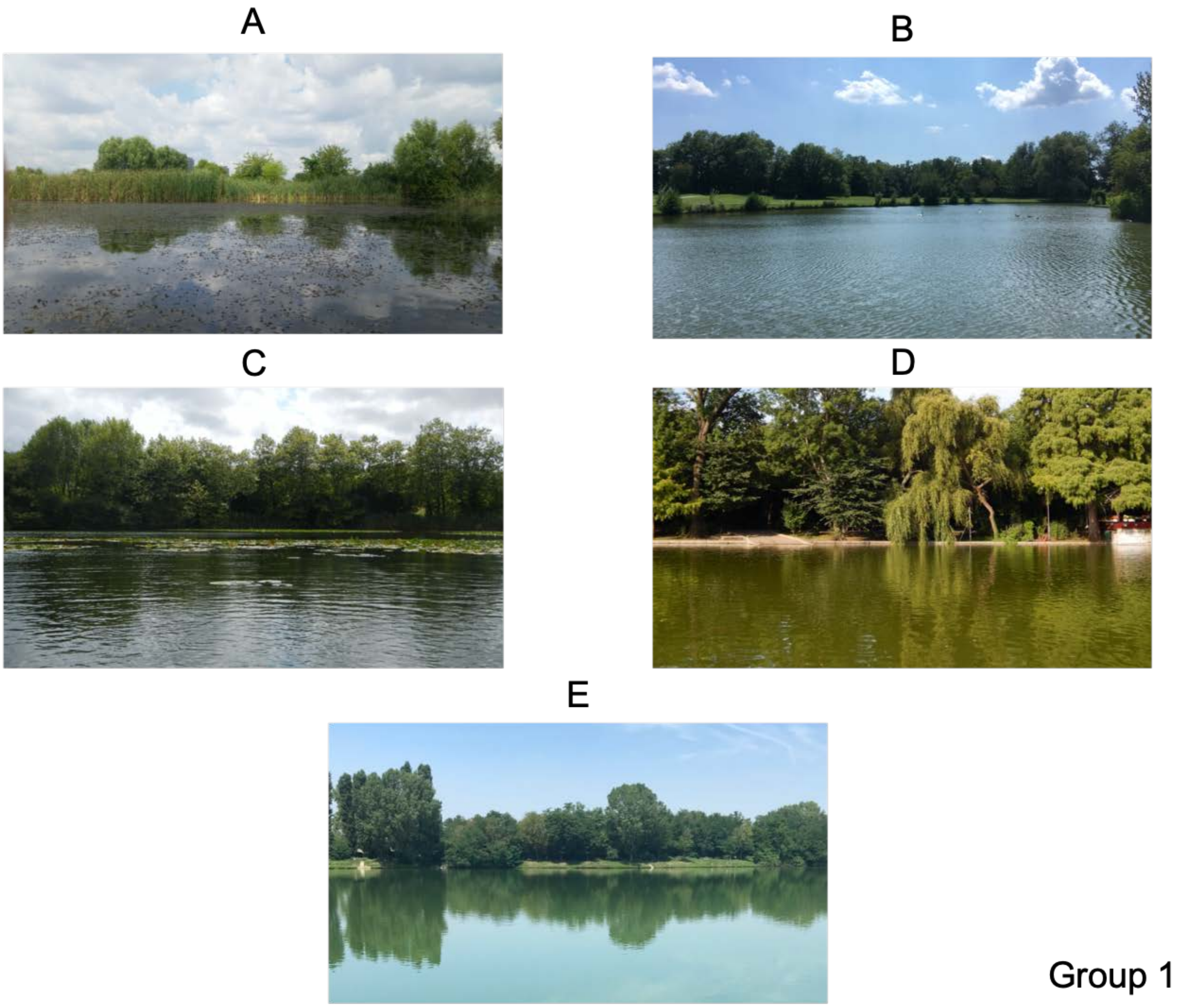

Figure S 10 Images from the 5 cluster each (A-E), image randomization group 1.

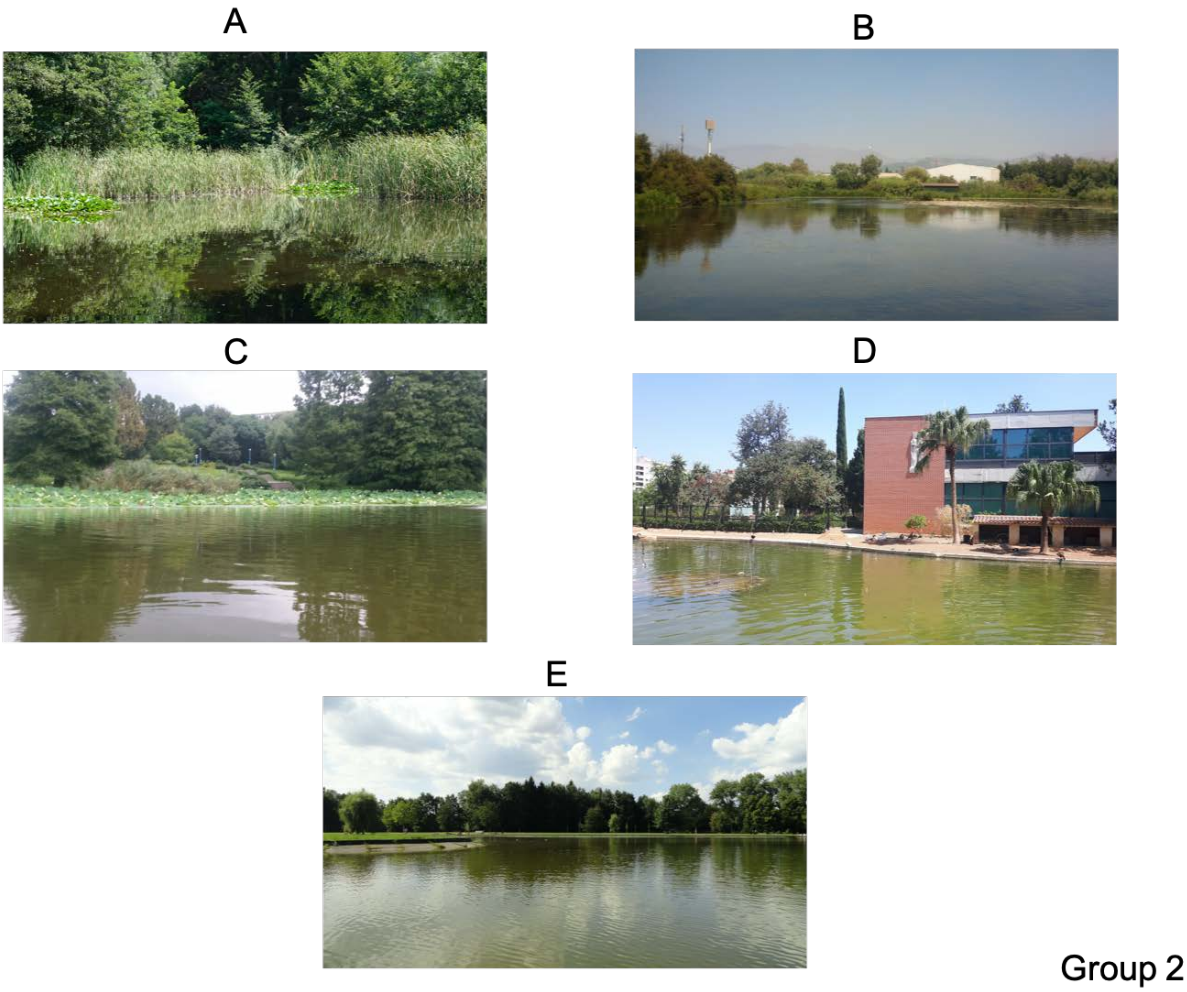

Figure S 11 Images from the 5 cluster each (A-E), image randomization group 2.

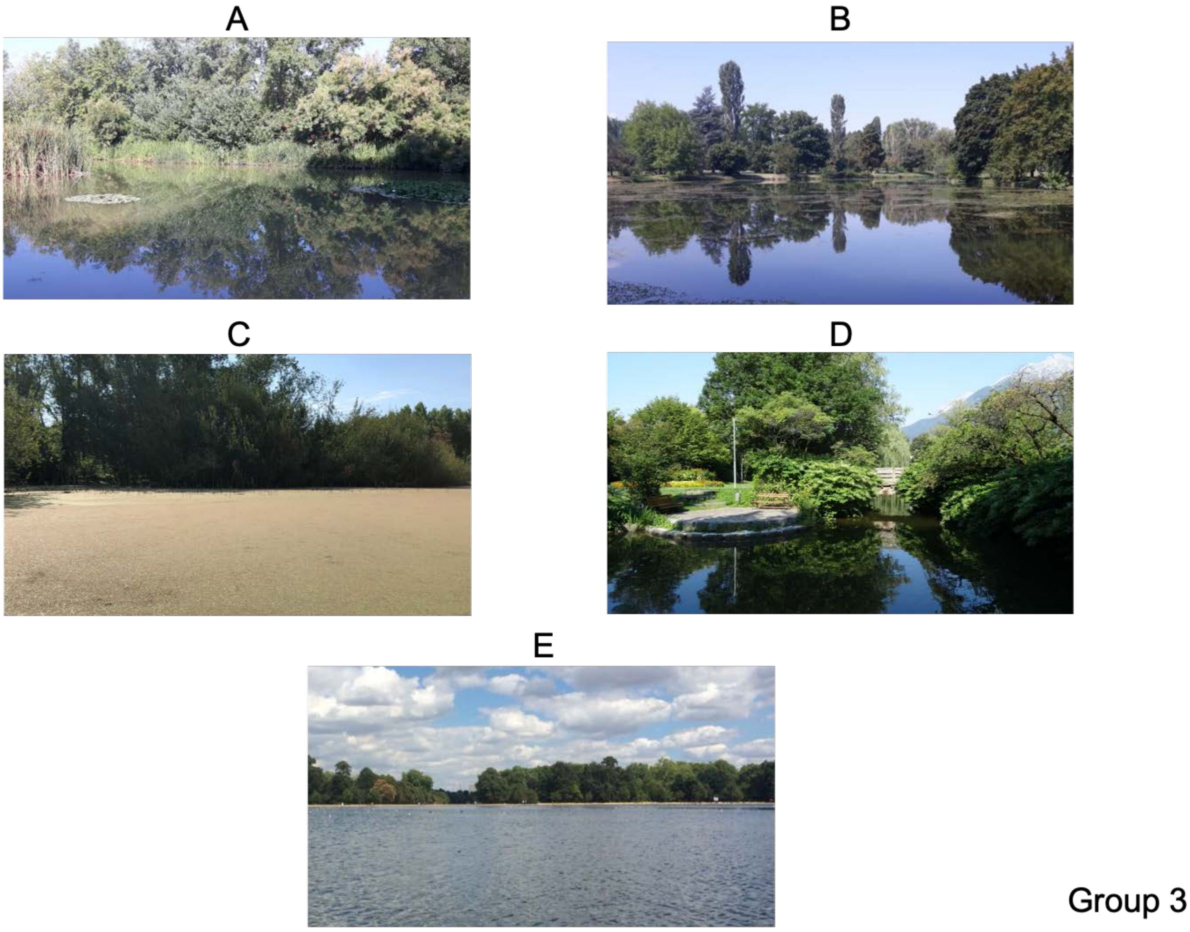

Figure S 12 Images from the 5 cluster each (A-E), image randomization group 3.