

Utilizing Volunteers to Save the Văcărești Wetlands



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1.0 Introduction

Climate change threatens the stability of ecosystems and increases biodiversity loss. The International Panel on Climate Change (IPCC) predicts that global temperatures will increase by 1.5 °C between 2030 and 2052 (Angearu, 2020). Warmer temperatures increase the frequency of droughts, leading to a lack of water available to fragile ecosystems. Europe has several water-dependent ecosystems, including wetlands. Wetlands possess multiple environmental benefits, including promoting biodiversity, mitigating flooding, and aiding in climate mitigation through the regulation of the nitrogen and carbon cycles (Keddy, 2013). Furthermore, wetlands provide other economic and social benefits to surrounding communities by promoting recreational activities and increasing local property value (Keddy, 2013; Czembrowski, 2016).



Figure 1.1: View of the Văcărești Nature Park (Ignat, 2011)

Beginning in 2019 and continuing into 2021, the Balkans has been experiencing a drought. Due to this drought, Romania lost two million hectares of arable crop land last year and

desertification threatens many other Romanian ecosystems (Chirileasa, 2020; Copernicus, n.d.). One such ecosystem is the Văcărești Nature Park (VNP), an urban wetland and green space park in Bucharest, Romania shown above in Figure 1.1. Even though the park's water levels fluctuate naturally with the seasons, the drought worsened the dry season resulting in the loss of lakes within the park (Bărbulescu & Marin, 2021). Inaction of the local government and Ministry of the Environment, who failed to provide funding and park protection, exacerbated the effects of the drought. The lack of regulations contributed to increases in invasive species and expansion of water vegetation, such as reeds, which deplete water levels faster than they can recover (Bărbulescu, 2020). Compounding this problem is the lack of statistics surrounding water and wildlife loss in the VNP. The severe water level change and drier conditions within the park threatens aquatic biodiversity, decreases visual appeal, and increases the risk of vegetation fires which pose a potential threat and decrease in land value to the surrounding residential and commercial areas (Bărbulescu, 2020).



Figure 1.2: VNP volunteers in the park (Văcărești Nature Park, 2021)

Despite these challenges, the Văcărești Nature Park Association (VNPA), the organization managing the VNP, recognizes that the park serves as a cultural heritage site and

offers residents and tourists a variety of activities, such as walking and cycling trails, nature observation, and educational programs (Rando et al, 2020). To make this possible, the VNPA has recruited volunteers, “Urban Rangers,” to assist in park patrols, sanitation, and guiding tourists as shown in Figure 1.2 (Văcărești Nature Park Association - *Urban Rangers*, n.d.). In addition, the VNPA hosts volunteer-led educational events to reach out to the public and engage city residents in ecology (Văcărești Nature Park Association - *Projects*, n.d.). While these programs make a positive impact, the VNPA currently does not have plans to utilize the volunteers in water management projects to address the issue of the VNP’s decreasing water levels.

The goal of the project is to recommend water collection systems that utilizes park volunteers to aid the VNPA in addressing the falling water levels in the VNP. The team has defined three objectives to achieve the goal:

1. Investigate the VNPA's current water management practices, financial and physical resources, and volunteerism practices.
2. Research how other conservation groups manage water and recruit and utilize volunteers.
3. Evaluate water collection systems that help to manage the water levels in the VNP.

The outcome of this project will be to present and review with the VNPA a set of recommendations aimed at increasing the VNPA’s ability to effectively use volunteers to address water management solutions. An evaluation and comparison between the water management and volunteerism methods utilized by the VNPA and other established wetland conservation groups along with technical research of water collection systems accomplishes this goal.

2.0 Background

This chapter introduces the general problem regarding wetlands conservation, beginning with a description of urban green spaces and wetland ecosystems. The chapter then discusses the history of Văcărești Nature Park (VNP) and examines the environmental and administrative problems facing the Văcărești Nature Park Association (VNPA). The following sections review how the VNPA uses volunteerism to carry out projects for the betterment of the park. The chapter concludes with two case studies on examples of potential water collection systems and discussion of locations of interest in the VNP for future implementation of these systems.

2.1 The Importance of Urban Green Spaces and Wetland Ecosystems

Urban green spaces are areas in cities containing natural or artificially planted vegetation (World Health Organization, 2017). The presence of green spaces provides numerous environmental, social, and economic benefits to the people living in the surrounding area. Green spaces improve pollutant filtration and climate mitigation in cities (Kabisch, 2015). In addition, green spaces promote better mental and physical health by reducing feelings of anxiety or isolation and providing recreational activities and easy means of exercise (Maund, 2019). The presence of green spaces draws tourists to the area and closer proximity to green spaces improves property value (Cianga, 2013; Czembrowski, 2016).

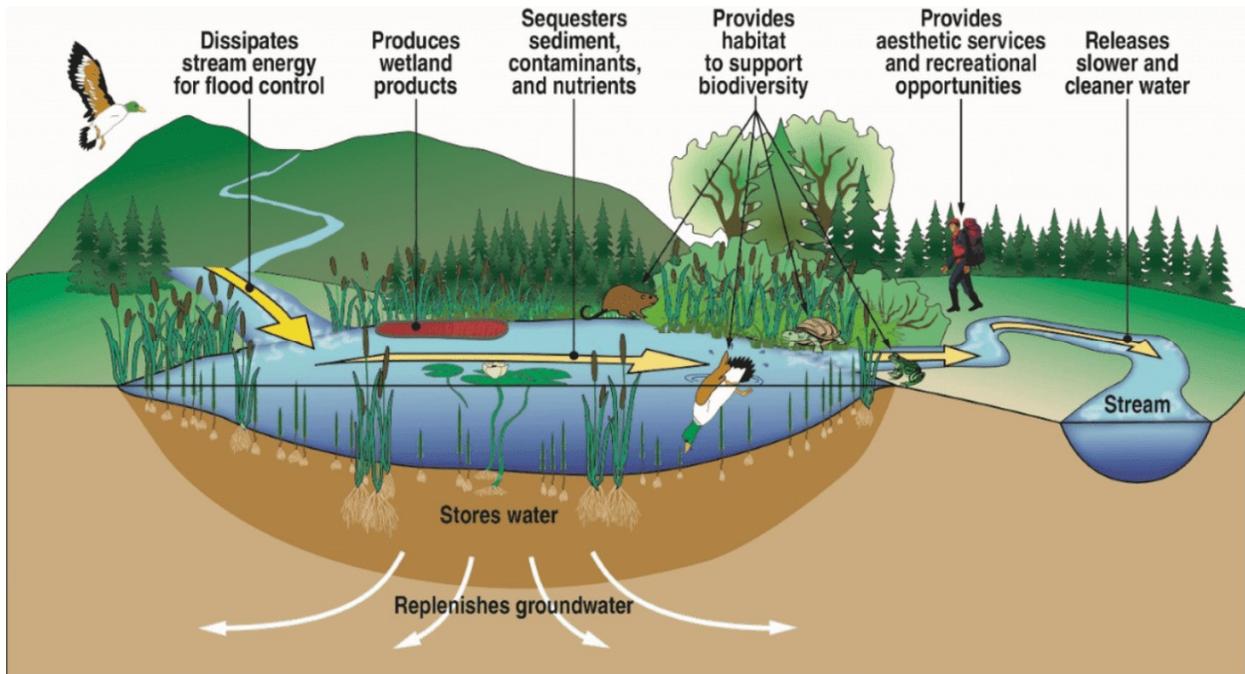


Figure 2.1: Diagram of the benefits of wetland ecosystems (Brockton Conservation Commission, n.d.)

Among the different types of urban green space environments are wetlands, which are ecosystems inundated with water that have characteristics of both aquatic and terrestrial environments (Keddy, 2013). Wetlands, diagrammed above in Figure 2.1, are productive ecosystems that provide the surrounding area with environmental benefits through supporting high levels of biodiversity, cycling groundwater recharge and discharge, aiding in water purification, and regulating the nitrogen cycle (Lambert, 2003; Keddy, 2013). Additionally, wetlands regulate the climate through carbon storage (United Nations, 2018). Outside of these environmental impacts, wetlands promote recreation and cultural heritage for the local area (Keddy, 2013).

Climate change, urbanization, and water drainage are just a few factors contributing to wetland loss, making wetlands vulnerable ecosystems and sensitive to changes in water quality, precipitation levels, and temperature among other environmental aspects (United Nations, 2018; Erwin, 2009). Between 1970 and 2015, countries around the globe lost 35% of wetland

ecosystems, and according to the Ramsar Convention, an intergovernmental treaty for wetland use and conservation, wetland destruction is three times faster than that of forests (United Nations, 2018).

2.2 A Brief History of Văcărești's Wetlands to Present Day

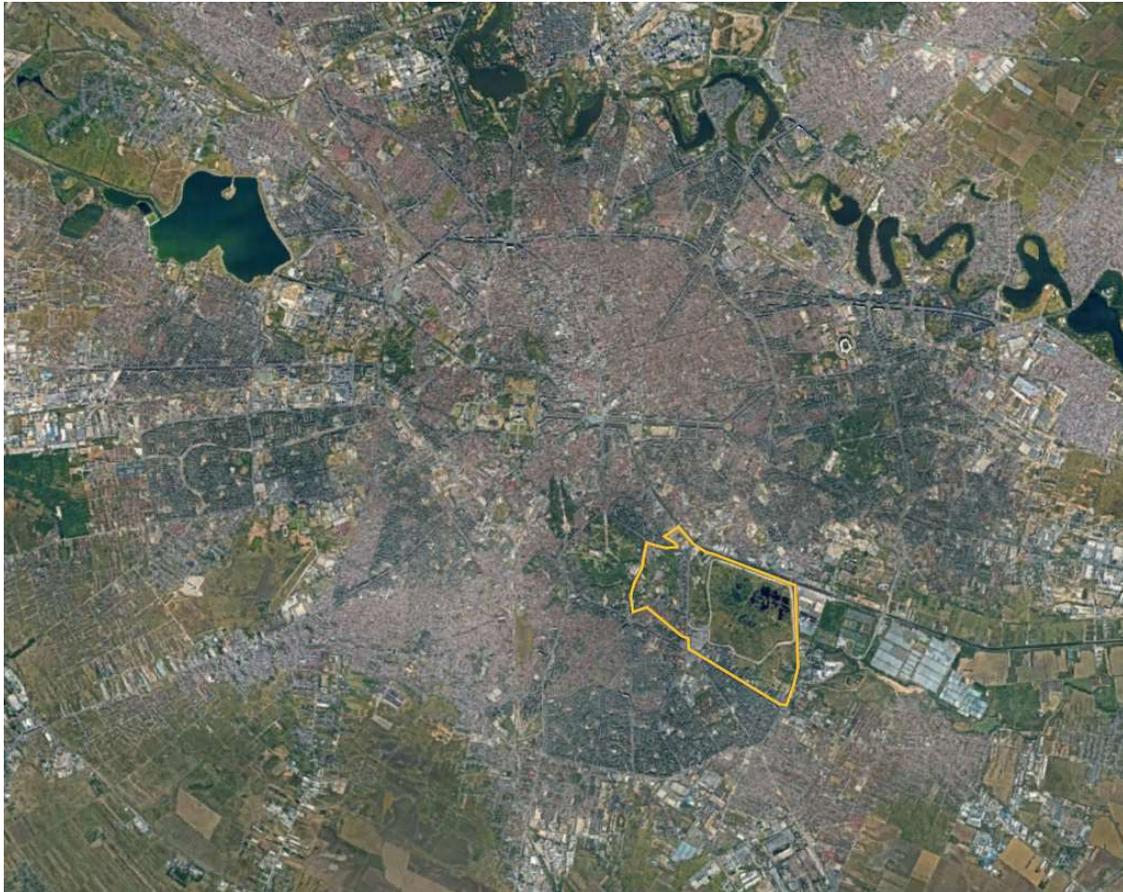


Figure 2.2: Location of Văcărești Neighborhood and Nature Park in Bucharest (Google Earth, 2021)

Prior to 1989, the Văcărești neighborhood, located on the banks of Dâmbovița River, consisted mostly of farmland and individual dwellings. Figure 2.2 displays the former Văcărești neighborhood in present-day Bucharest. The neighborhood once contained the Văcărești Monastery, a church built between 1724 and 1728 shown below in Figure 2.3. (Paduretu, 2014)

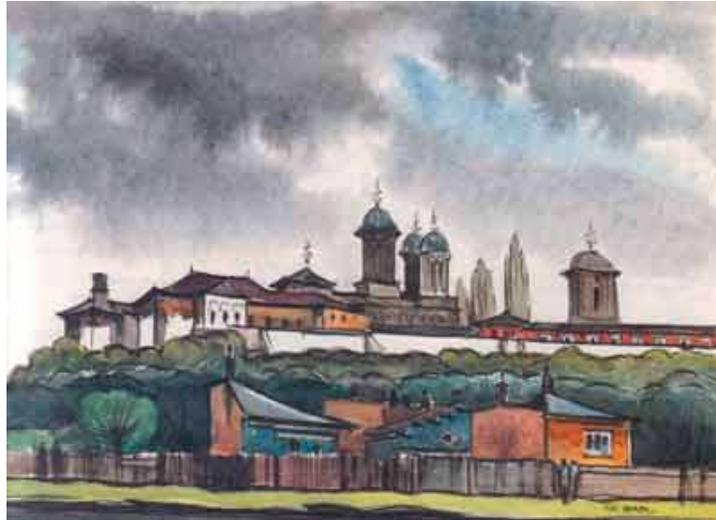


Figure 2.3: Painting of Vacaresti Monastery: “The Văcărești Monastery before the Storm. (Petrescu & Pintilescu, 2017)

In 1989, the Ceaușescu regime ordered the destruction of the Văcărești neighborhood to make space for a massive 184-hectare hydrological project known as Lake Văcărești. The communist government justified the project as a means to control flooding in Bucharest and intended for it to function as a small port in the heart of the city. While the area was mostly farmland, the project still displaced a number of residents living in the Văcărești neighborhood. Construction on the lake halted in 1989 when the Romanian people overthrew the communist regime. Though 90% complete, the lake sat abandoned by the new government for the next 25 years until the founding of VNP in 2016 (Ianoș et al., 2014; Ianoș et al., 2017).

Efforts to revitalize the park began in 2012 when Cristian Lasuc published “The delta among the blocks” in the May edition of National Geographic Romania. The article revealed the biodiversity in the park and called for the government to classify it as a protected area. After the publication of Lasuc’s article, a group of four, including Dan Bărbulescu, set out to perform a Scientific Substantiation Study required to declare the park as a protected area. The study necessitated classifying biodiversity and documenting the ecosystem. After a year of field work, the Romanian Academy, the most prestigious scientific institution in Romania, endorsed the

study and recommended the Romanian government declare protection for the VNP. After three years of lobbying and garnering public support with photography exhibitions, environmentalism and urbanism conferences, and projects in the field with volunteers, Government Decision no. 349/2016 formally established Văcărești Nature Park in 2016 (Văcărești Nature Park Association - *Who we are*, n.d.).

Along with the formation of the VNP, the National Agency for Protected Natural Areas (ANANP) granted park administration to the VNPA in a 2017 government contract (Romanian Ministry of Environment, Water and Forests, 2017). The Ministry of Environment, Water and Forests finalized regulations for the VNP in 2020, but the VNPA still faces legal hurdles in acquiring park protection and support from the ANANP (Romanian Ministry of Environment, Water and Forests, 2020; Bărbulescu, 2020). The VNPA is currently the lead organization of the park, but they must appeal to the ANANP for funding and large-scale projects.

2.3 Present Day Văcărești



Figure 2.4: Aerial view of the Văcărești Nature Park (Gillet, 2021)

The VNP (see Figure 2.4) is a wetland surrounded by commercial and residential areas in the heart of Bucharest, spanning approximately 200 hectares (Bărbulescu, 2021). Apartment complexes, medical centers, sports and wellness clubs, and a variety of stores comprise the assorted buildings just outside the park. A five-meter dam around the area, constructed during the original Lake Văcărești project, isolates the VNP from these city areas and the park itself sits eight to ten meters below street level. The dam interrupts the natural hydraulic system and disrupts the flow of groundwater into and out of the park (Bărbulescu & Marin, 2021). While the VNP's environment developed naturally, additional park infrastructure allows the local community, school groups, and tourists to access the area for recreational and educational purposes, including walking and cycling trails, birdwatching platforms, and a boardwalk (Gillet, 2021; Văcărești Nature Park Association - *Who we are*, n.d.).



Figure 2.5: *Wolffia arrhiza* (Fryš, 2019)



Figure 2.6: *Salix alba*, also known as the white willow (*White willow*, n.d.)

The VNP harbors a high level of biodiversity for both plants and animals. Of the species found within the park there is a wide range of common, rare, and exotic organisms, such as the threatened *Wolffia arrhiza* (see Figure 2.5) and the native *Salix alba* (see Figure 2.6) (Văcărești Nature Park Association- *Biodiversity*, n.d.). There is a variety of aquatic life consisting of seven species of fish and six species of amphibians, including the protected fire-bellied toad and great

crested newt, found among the park's several lakes (Văcărești Nature Park Association- *Văcărești Nature Park*, n.d.; Văcărești Nature Park Association- *Biodiversity*, n.d.).

2.4 Problems Facing the Văcărești Nature Park

There are a number of serious issues currently facing the VNP, including declining infrastructure from the original lake project, invasive species, poaching, illegal logging, and decreasing water levels (Gillet, 2021; Bărbulescu, 2020). While environmental changes cause several of the problems, other issues stem from improper park management to maintain and monitor the infrastructure and landscape. Compounding these issues is the lack of statistics in biodiversity and water levels, which makes quantifying change difficult.

2.4.1 The Causes and Impacts of Decreased Park Water Levels



Figure 2.7: Satellite images of the VNP from 2016, 2018, and 2021 (left to right) (Google Earth, 2021)

A recent drought beginning in 2019 affected much of the Balkans area, though Romania in particular suffered major losses (Vilcu, 2020). A USDA report on Romanian agriculture predicts a 19% decrease in wheat production and 16% decrease in barley production between 2020 and 2021, giving a sense of the severity of the drought's effects (Dobrescu, 2020). Alongside the agricultural impacts, the drought affects other natural environments in Romania, including the VNP. Open water accounts for about 29% of the VNP's surface area (Bărbulescu & Marin, 2021). These water levels naturally fluctuate with yearly dry seasons, but the drought dramatically altered the natural cycle (Bărbulescu & Marin, 2021). The vegetation in the VNP is another contributing factor to the lower water levels, as increasing amounts of invasive species and reed areas have begun overtaking the available surface water (Văcărești Nature Park Association & et al, 2020). Figure 2.7 illustrates that the decrease in water levels is so severe that lakes in the park are beginning to dry up, which threatens the park's aquatic species (Văcărești Nature Park Association & et al, 2020).



Figure 2.8: A VNP fire in February 2020 (Văcărești Nature Park Association - A year of fire, 2021)

The combination of lower water levels and increased vegetation creates a higher amount of dry vegetation, therefore increasing the amount of flammable fuel in the park (Bărbulescu, 2020; Littell, 2016). Consequently, higher levels of fuel may increase the risk of vegetation fires in the VNP, which is most prevalent in the dry season which typically lasts from September to March (Bărbulescu, 2020). Not only do these fires pose a risk to the park's wildlife, but they threaten the surrounding area. A VNP fire in February of 2020, seen above in Figure 2.8, damaged more than 90 hectares of the wetland, over 50% of the park area (Bărbulescu, 2020). Given the VNP's location in Bucharest, surrounding buildings are at risk when in close proximity to massive fires (Bărbulescu, 2020).

2.4.2 Problems with Park Administration and Management

Since gaining authority of the VNP, the ANANP has not implemented widespread park regulations nor assembled scientific and advisory councils to properly protect the park ecosystem and improve the declining infrastructure (Văcărești Nature Park Association - *Authorities decline responsibility*, 2020; Bărbulescu, 2020). To address the lack of effective administration, the VNPA sent a joint letter in 2020 to the ANANP and the Ministry of Environment, Waters, and Forests requesting emergency intervention in the park, including implementation of park regulation, a management plan, and a park guard (Văcărești Nature Park Association & et al, 2020). Despite the letter, the ANANP provided no timeline on implementation of the proposed intervention implementation nor procedures on how the organization would approve such interventions. (Văcărești Nature Park Association - *Authorities decline responsibility*, 2020). Furthermore, the ANANP is unclear on the potential use of monetary funding for the park (Văcărești Nature Park Association- *Authorities decline responsibility*, 2020).

2.5 Volunteerism in Văcărești Nature Park

Despite facing several problems, the VNPA has been active in garnering public support to make the protected area a reality. They have done this through various educational efforts, including a park visit app, where the user can virtually tour routes in the park with guided information. The app highlights many of the trails that the VNPA created for cyclists and hikers to encourage Bucharest residents and tourists to visit the park. Additionally, the park hosted awareness days for specific problems, such as “Journey to the Hive,” where kindergarten students participated in guided tours about how pollinators help the park. These educational components promote awareness of the park’s benefits, such as biodiversity, which is key to increasing interest in the VNPA’s volunteer projects.



Figure 2.9: Volunteers for the OMV Petrom collaboration project (Văcărești Nature Park Association - 600 trees, 2019)

The VNPA utilizes volunteerism for day-to-day management as well as larger scale projects. The most recent project was with the OMV Petrom company, an energy company who

financed planting 600 trees (see Figure 2.9). The result was two-fold because the VNPA started conserving 30 hectares and exposed more than 100 volunteers to their mission (Văcărești Nature Park Association - *600 trees*, 2019).

Additionally, the VNPA has an Urban Ranger program, where volunteers can help patrol the park, give tours, and contribute to projects. One of the projects that the Urban Ranger's assisted in was the "The Living Water of the City," a day event to raise awareness about the importance of the wetlands (see Figure 2.10). This project produced an infographic about urban wetlands as well as installed a play panel in the park for children to understand the water table in VNP (Văcărești Nature Park Association - *Projects*, n.d.). Volunteers greatly support the VNPA, and without them, the park could not remain clean and would lack much of its infrastructure (Văcărești Nature Park Association - *Urban Rangers*, n.d.). The result of bolstering community involvement is a positive feedback loop that propels the park into becoming a communal center.

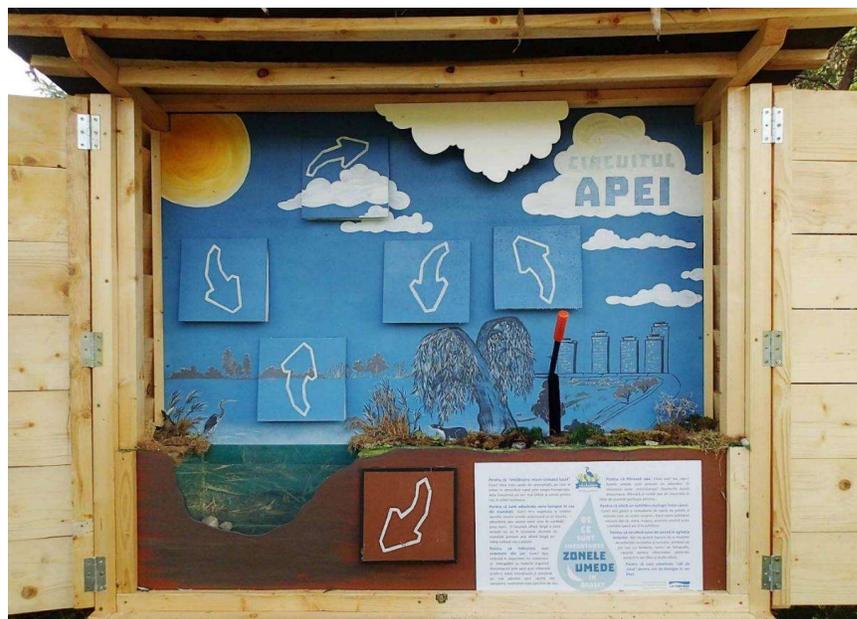


Figure 2.10: *Living Water of the City* (Văcărești Nature Park Association – *Living Water of the City*, 2019)

2.6 Water Collection Systems Case Studies

Though the park has many volunteer programs and event days, the VNPA has yet to fully explore water management projects because the drought is so recent. There are numerous existing water collection systems, but the team's collaborators at the VNPA suggested rain gardens and roof runoff collection systems as possible water collection solutions (Bărbulescu, 2020). This prompted the team to research two case studies that use these water collections systems.

2.6.1: Rain Gardens in Kyoto, Japan

The first is a case study from Japan, where researchers in Kyoto Prefecture sought to reduce the impact of heavy rainfall through the construction of rain gardens. The case study focuses on designing the optimal tank model to accompany two types of general rain gardens (see Figure 2.11).

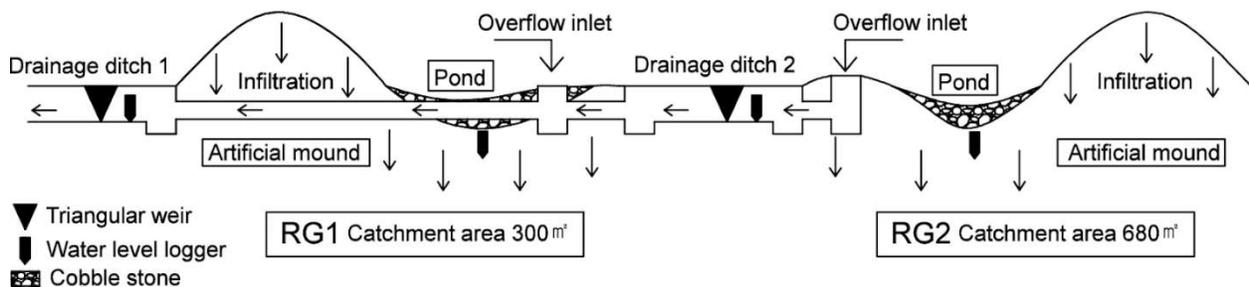


Figure 2.11: Diagram of the rain garden designs used in the Kyoto Prefecture study (Zhang et al., 2020)

The designs for rain garden one (RG1) and rain garden two (RG2) consist of the same fundamental parts. The inundation areas (namely, the artificial mounds) capture water and provide surfaces for trapping rainwater. The runoff then flows into a catchment area (shown as the cobblestone pond) that collects runoff and supplies the plants in the rain garden with water. After sufficient water collects in the catchment area, an overflow inlet allows the transfer of excess water from the catchment area to the drainage system (shown as the drainage ditch). The

drainage system then carries water to the desired destination. This case study outlines the general parts that go into rain gardens, which are just one example of the many types of water collection systems possible (Zhang et al., 2020).

2.6.2 Roof Runoff in Ringdansen, Sweden

The second case study is from Ringdansen, a residential area of Norrköping, Sweden. The study, the Ringdansen Project, sought to evaluate a method of using rainwater collection systems to cut down on the water consumption of the Ringdansen neighborhood. The project utilized roofs of buildings to collect and funnel rainwater into storage tanks. The researchers selected the roofs of houses because roof infrastructure does not disturb the surrounding community and provides large impermeable surfaces that can divert water. Additionally, the study took into consideration locational factors, such as roof material and pollution from the surrounding environment, as these factors impact the quality of the collected water (Edgar & Andrew, 2005). Location was key to the case study, as implementation of this water collection system was dependent on the impermeable surfaces of the nearby buildings.

2.7 Potential Areas for Water Collection in and Around VNP

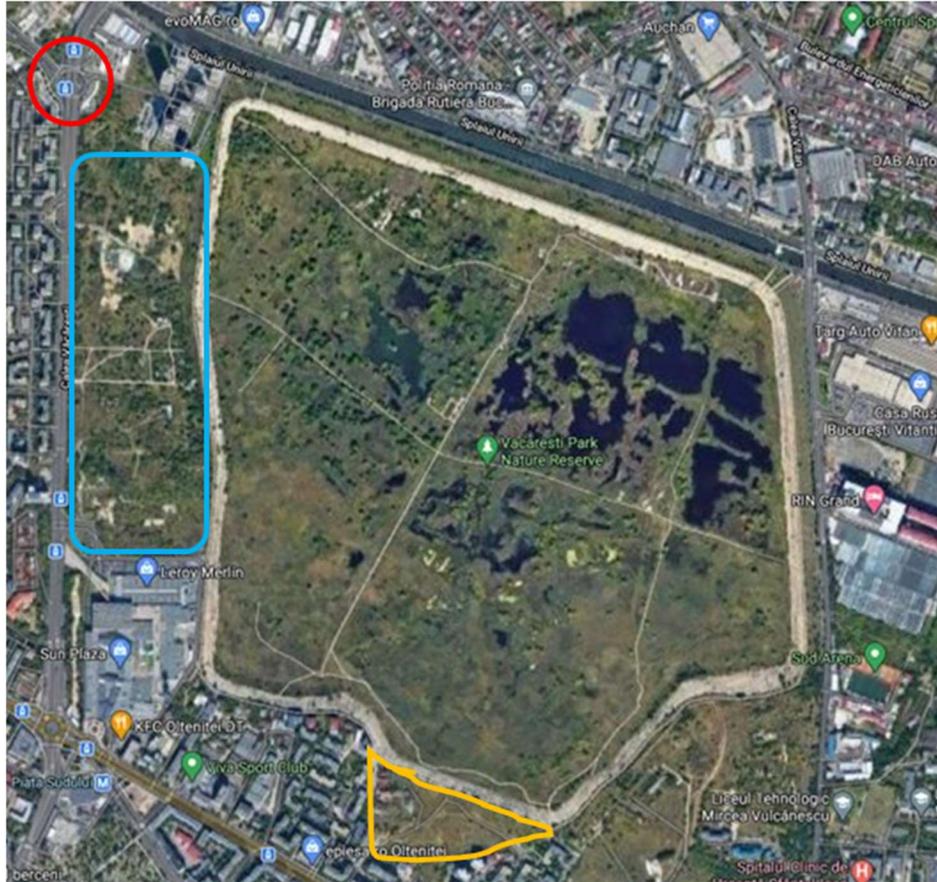


Figure 2.12: Locations of interest for water collection systems (Google Earth, 2021)

There are three locations around the VNP that the team's collaborators in the VNPA indicated as areas for potential water collection systems (see Figure 2.12). The first area (Red) is an intersection that frequently floods when it rains heavily. This is a location of interest because water naturally funnels here. The collaborators suggested that funneling the flood water into the park could be a solution. The VNPA also mentioned that when flooded, the intersection is difficult to cross and causes traffic backups (Bărbulescu, 2020).

An unknown private company owns a large undeveloped area (Blue) south of the VNPA offices. The collaborators called attention to this area because the lot provides a large surface area for rain to fall on, which would make the implementation of a water collection system like a

rain garden viable (Bărbulescu, 2021). Because this location is owned by a private company, the VNPA would need to collaborate with the landowners to implement water collection systems.

The third location (Orange) is a smaller undeveloped lot to the south of the park that another unknown private company owns and is frequently inundated with groundwater. The VNPA emphasized this area because of its natural ability to funnel groundwater to one location. The area is constantly muddy because the groundwater wells up to the surface. They proposed placing possible groundwater collection systems in this location to take advantage of this fact. Similar to location 2, the VNPA would have to collaborate with the landowner to implement water collection systems (Bărbulescu, 2020). The team will gather more information about the three locations and fill any knowledge gaps from further conversations with collaborators.

3.0 Methodology

The goal of the project is to recommend water collection systems that utilizes park volunteers to aid the VNPA in addressing the falling water levels in the VNP. The team has defined three objectives to achieve the goal:

1. Investigate the VNPA's current water management practices, financial and physical resources, and volunteerism practices.
2. Research how other conservation groups manage water and, recruit and utilize volunteers.
3. Evaluate water collection systems that help to manage the water levels in the VNP.

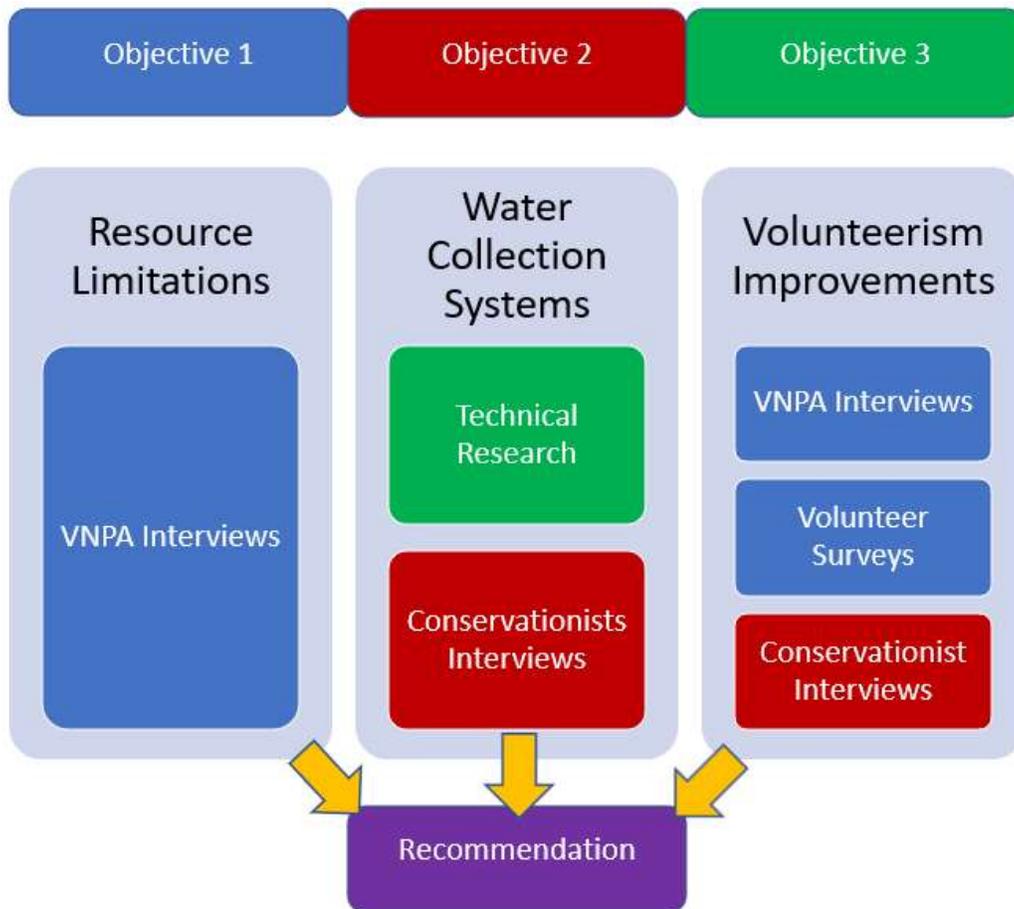


Figure 3.1: Flow chart of the building blocks to reach the final deliverable.

The team intends to complete these objectives through a series of tasks conducted remotely during the IQP term from March 24 to May 13. Figure 3.1 shows a flow chart of the objectives, tasks and deliverables, and Figure D.1 shows a more complex chart of how the objectives, tasks, and outcomes relate to each other and the final deliverable. The plan is to distribute surveys and conduct interviews to reach VNP volunteers, VNPA officials, and other wetland conservationists. Then, findings from these interviews will direct technical research on water collection systems. The project members recognize that the government and general public surrounding the park are unaddressed stakeholders who remain outside the scope of the project given that there are no effective remote methods of reaching them. Each of these tasks will yield necessary information on the three components necessary to create recommendations that address the goal. These aspects are water collection systems, volunteerism practices, and resource limitations, and will build recommendations for how the VNPA can utilize these practices in future volunteer-based projects to maintain park water levels.

3.1 Surveys

The survey of park volunteers provides insight on the efficacy of the VNPA's current volunteerism practices and an evaluation of VNP volunteer's awareness of the decreasing park water levels. This method addresses the first task of objective one: assessing the opinions and knowledge of current VNP volunteers. The anonymous and confidential survey on Qualtrics should take approximately 10 minutes to complete and contains 16 questions (see Appendix A). Survey questions A.1 through A.4 collect volunteer demographic information, A.5 through A.9 assesses volunteer interest and understanding of park water levels, and A.10 through A.16 collects volunteer experience information.

The survey will be a convenience sampling of the VNPA's Facebook followers, as the team will distribute the survey online to volunteers through a post on the VNPA's Facebook page. To increase response rate, the initial posting gives respondents a deadline of two days to complete the survey, followed by an additional repost giving two more days for completion. Furthermore, the team's collaborators will distribute the survey on site to those in the park. Qualtrics security settings will prevent double responses from the same devices.

The results gained through analysis of survey responses contribute to the compilation of findings on ways the VNPA can utilize volunteers in future water management projects. The team's findings will determine the demographics of the VNP's current volunteers, the feelings towards the volunteering experience, and the potential existence of a knowledge gap pertaining to the issue or importance of park water levels. An assessment of these findings factors into areas of volunteerism incorporation and improvements in the project recommendations, alongside the findings from the interviews discussed next.

3.2 Interviews

Interviews with VNPA members and other wetlands conservationists will yield in-depth responses on volunteerism practices not gained through the limited survey results and allow for an open discussion on potential avenues for water management based on the expertise of the interviewees. The project interviews will be semi-structured and held over Zoom with an anticipated length of 30 minutes, and at least two team members will be present to conduct the interview. The team plans to record the interviews with the permission of the interviewees, requested before the interview takes place and to transcribe the recording afterward. If an interviewee does not consent to the recording, one member of the team will transcribe while the second member conducts the interview. For interviews in which the interviewee's first language

is not English, the team's interviewer needs to be prepared to reword questions if any misunderstandings from a language barrier arise. If interviewees are not comfortable speaking English, the team will contact WPI's IGSD to recruit a translator or conduct the interview over email. The interviews shape the project recommendations through providing an understanding of VNPA resource limitations, any pre-existing VNP water management infrastructure, potential water collection systems to research further, and effective volunteerism practices. The short data collection timeframe dictates that the team complete the interviews for objectives one and two in parallel.

3.2.1 Interviewing VNPA Leadership

The VNPA comprises four founding members and eight other employees, all with various administrative and field duties (Văcărești Nature Park Association- *Team*, n.d.; Marin, 2021). Of these members, the team plans to prioritize interviews with Florin Stoican, the President and a founding member of the VNPA with knowledge of park geology and sustainable developments, Vlad Cioflec, a biologist well-versed in the park's aquatic biodiversity, and Marius Stoican, the coordinator of park infrastructure projects (Văcărești Nature Park Association- *Team*, n.d.). If time within the research period permits, the team will interview the remaining seven VNPA members.

The interviews with VNPA leadership will obtain data on the park's current water management and monitoring practices, financial and physical resources, and volunteer projects (see Appendix B). Through analysis of the interview data, the results will accomplish the second task of objective one: assessing the limitations and pre-existing strengths of the VNPA's resources and practices. After assessing the interviewees' background in questions B.1 and B.2, questions B.3 and B.4 evaluate VNPA resources, B.5 to B.8 investigate the current status of VNP

water levels, and B.9 to B.12 assess current volunteerism practices. Along with these questions, the team's interviewer needs to be prepared to follow up topics brought up since a VNPA member is more aware of the capabilities of the organization than the interviewer.

Findings from the interviews will establish the VNPA's financial and physical resource limitations. In conjunction with the survey responses and the wetland conservationist interviews, the VNPA leadership interviews will contribute to the understanding of the current volunteerism practices and areas for improvement.

3.2.2 Interviewing Other Wetland Conservation Groups

The team identified the sole task of interviewing wetland conservationists to complete objective two. From these interviews, the team will learn how other wetland conservationists manage water and utilize volunteers, if at all (see Appendix C). Questions C.1 and C.2 are background questions about the interviewee and their role in their organization. The remaining questions, C.3 through C.12, are almost identical to the VNPA interview questions in Appendix B and ask about water management and volunteerism practices, with VNP-specific content removed. The team purposely designed the interviews with the VNPA and other conservationists to be similarly structured to streamline the data analysis process. To determine wetland conservation groups to interview, the team will contact WPI Civil and Environmental engineering professors to use their expertise and network with wetland conservation groups, including the Boston Conservation Commission. Additionally, the team will ask members of the VNPA for wetland conservationists within their network and region. This method of sampling will enable the team to collect data from a wide range of wetland conservation groups and will offer multiple perspectives on water management solutions for the VNP. The results from objective two will frame the technical review process described next.

3.3 Technical Research

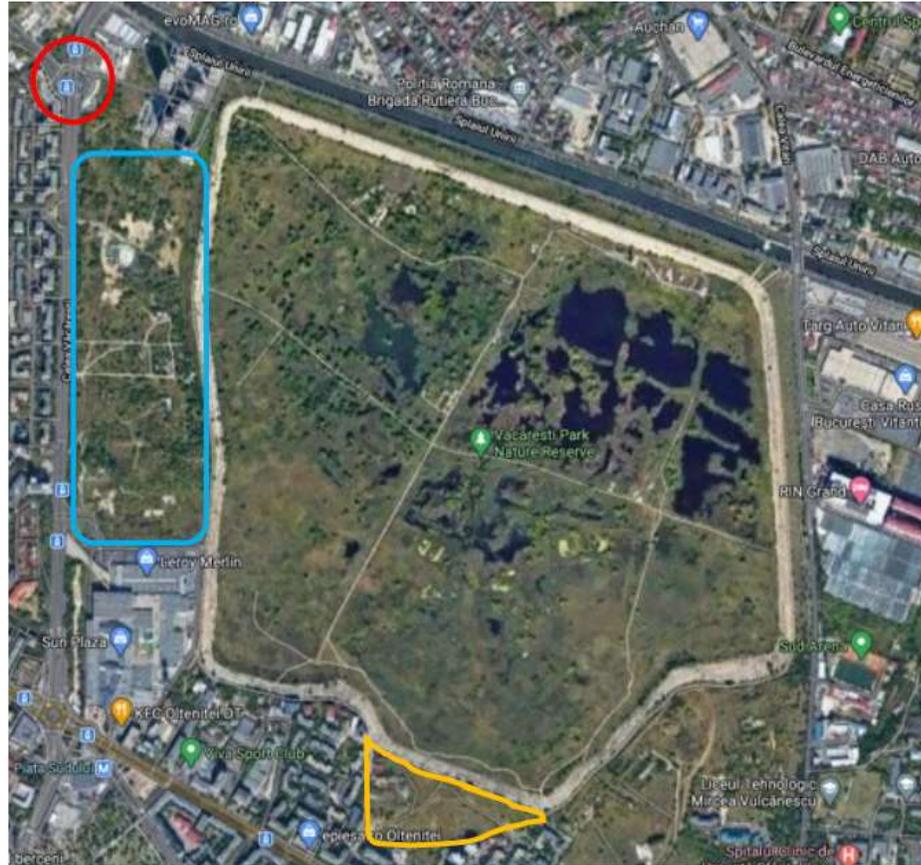


Figure 3.2: Aerial view of Văcărești Nature Park with the three locations of interest for implementing a water collection system circled in red, blue, and orange (Google Maps, 2020)

Technical research yields information on different types of water collection systems, including the construction process, resources needed for construction, and characteristics of locations for implementation. Findings from this research aid the team in accomplishing objective three: evaluating water collection systems to manage water in the VNP. The plan is to begin by researching rain gardens and roof runoff collection systems, such as those described in *Section 2.6*, as the team’s collaborators specifically identified these systems as potential avenues for VNP water management at the locations discussed in *Section 2.7*. Furthermore, the team plans to research water collection systems discussed in the interviews conducted for objectives one and two, described in *Section 3.2*, through this method. Drawing from examples of systems

other parks use expedites and focuses the technical research to systems that other conservationists specifically use and recommend.

The research will consist of searching for technical journals and books online that details the implementation of water collection systems and factors to consider when constructing them, such as cost and locations best suited for the system. The team will ask where to begin researching water collection systems during the interviews with wetland conservationists. Additionally, the team will inquire about and search for water management organizations to contact for information on the systems. The findings from the technical research, alongside those from the wetland conservationist interviews, will factor into the water collection systems the team considers for the VNPA's recommendations.

3.4 Data Analysis

After the project collects the above data, the plan is to develop an appropriate system for processing data to effectively compare and compile results across all methods. First, this analysis will use cross tabulation on the close-ended responses in the survey. Then, the analysis system will apply a deductive analysis to the open-ended survey and the interview responses. A relational analysis will compare answers from selected questions between the two interview populations. Finally, the project will apply a qualitative analysis framework to the technical research based on the codes and results obtained in the two former methods.

3.4.1 Survey Analysis

To analyze the survey results, the team will first use a cross tabulation method, a method to observe statistical significance between two or more variables, to compare the demographic information about class, age, and location to attitudes about water levels and volunteer involvement. In the water levels section, an inter-cross tabulation will determine if there are quantitative trends between those who are more environmentally conscious, e.g., those who believe biodiversity is an important issue, and those who are interested in volunteering. The survey analysis will conclude by analyzing the raw statistics of the close-ended volunteerism questions to determine levels of involvement and reasons for volunteering. The team plans to deductively code the responses to the two open-ended responses based on expected categories for likes and dislikes from the D20 IQP findings on VNP public opinions. The expected categories for volunteers' likes will be nature, education, uniqueness, and personal reasons while the expected categories for dislikes will be safety concerns, declining infrastructure, and lack of information (Rando, et al., 2020). If the responses for these categories vary, then at the time of data processing the analysis procedure will include subdividing these broad bins. As a result, from this analysis, the team expects to find the average volunteer's perspective of the VNPA's volunteer practices, completing an aspect of objective one.

3.4.2 Interview Analysis

The project will code both the VNPA leadership interviews and the wetlands conservationists' interviews using near identical systems for the majority of the questions so that the team can perform a relational analysis between the datasets. The purpose of a relational analysis is to draw important connections between practices mentioned in the VNPA interviews and those mentioned in conservationist interviews. The general bins for connections will be the

philosophy behind the volunteer's role and how the VNPA approaches water management. The sections to be analyzed in parallel are the water management questions, B.6 and B.7 which mirror C.3 and C.4, and the volunteer questions, B.9 through B.12 which mirror C.7 through C.12. As the research process continues, interview responses will narrow the bins into useful subcategories.

The rest of the questions in each interview not part of the relational analysis will follow a general deductive coding scheme. For these questions, the expected bins are government, personal background, financial resources, and physical resources. The early interviews with the VNPA leadership will help to subdivide these bins, but another phase of redrafting these categories may happen after interviews with other wetland conservationists. At the end of this task, these experts in the field will aid the team in fully completing objectives one and two.

3.4.3 Technical Research Analysis

After completing objectives one and two, the analysis of technical research takes place, using information about the resource limitations, volunteer capabilities, and water management ideas to develop a water level solution. The first step is the creation of a water system evaluation criteria of solutions based on the research. The evaluation categories are effectiveness and cost. Effectiveness is a measure of how much water the system collects, feasibility of implementation and maintenance, and impact while cost is a scale factoring in money, development time, and physical space taken up. In the IQP term, the results from interviews with the VNPA and other conservationists will help the team refine criteria for effectiveness and cost.

Once the team finishes the criteria, the created evaluation will process the data from objectives one and two to determine the best solution for each VNP location of interest (See

Section 2.7). This will complete the third and final objective, finalizing the team's gathering of water collection information.

3.5 Conclusion

The purpose of surveying volunteers and interviewing the VNPA in objective one is to understand the volunteerism practices and capabilities of the VNPA as well as their physical and financial resources. The wetland conservationist interviews in objective two will reveal how other wetland conservation groups manage and collect water and how they utilize volunteers, if at all. The resource limitations of the VNPA evaluated in objective one and knowledge on water collection systems gained from objective two frame the technical research performed to complete objective three. A proposed schedule for the IQP term research can be found in Figure D.2. Upon the completion of all three objectives, the team will prepare a set of recommendations on water collection systems that the VNPA can partially or fully implement utilizing their volunteers (see Figure D.1).

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Appendices

Appendix A: VNP Volunteer Survey Questions

Informed Consent

To continue please confirm you are 18 years or older.

- a. Yes (proceeds to survey)
- b. No (exits the survey)

We are a group of students from Worcester Polytechnic Institute, Massachusetts, United States and are working on a collaborative project with the Văcărești Nature Park Association (VNPA). We are conducting a survey to understand volunteer efforts in Văcărești Nature Park to help us design a system to address the falling water levels in the park. This project is a collaboration between Parcul Natural Văcărești and Worcester Polytechnic Institute, and we aim to improve and enhance the visitor experience of Văcărești Nature Park (VNP).

This survey will take approximately 5 minutes to complete. Your participation is completely voluntary, and you may skip or not answer questions. You may also exit the survey at any time. Your responses will remain anonymous and confidential, meaning no identifying information will be collected. We will publish the aggregate data. If you have any questions or concerns, we can be reached at gr-vacaresti-d21@wpi.edu.

For more information about this research or about the rights of research participants, in case of research-related injury, contact the WPI IRB Manager Ruth McKeogh at (508) 831-6699 or irb@wpi.edu and the Human Protection Administrator Gabriel Johnson at (508) 831-4989 or gjohnson@wpi.edu.

Check this box if you agree to the terms of the survey ____

Demographics

- A.1. What is your age?
 - a. 18-24
 - b. 25-34
 - c. 35-44
 - d. 45-54
 - e. 55-64
 - f. 65+
- A.2. What is your highest level of education?
 - a. High school
 - b. Associate's degree
 - c. Bachelor's degree
 - d. Master's degree
 - e. Prefer not to say
 - f. Other
 - i. Please specify: ____
- A.3. What is your occupation? [open response]
- A.4. What is your proximity to the VNP?

- a. I live within 1 km of the VNP
- b. I live within 10 km of the VNP
- c. I live within 50 km of the VNP
- d. I live greater than 50 km from the VNP

VNP Water Levels

- A.5. It is important to protect biodiversity in the VNP.
- a. Strongly Disagree Disagree Neutral Agree Strongly Agree
- A.6. Fires in the VNP are a pressing issue.
- a. Strongly Disagree Disagree Neutral Agree Strongly Agree
- A.7. Before taking this survey, I was previously aware of the falling water levels in the VNP.
- a. Strongly Disagree Disagree Neutral Agree Strongly Agree
- A.8. I am interested to learn more about falling water levels in the VNP.
- a. Strongly Disagree Disagree Neutral Agree Strongly Agree
- A.9. I have an interest in participating in a project specifically to address decreasing water levels in the VNP.
- a. Strongly Disagree Disagree Neutral Agree Strongly Agree

VNP Volunteerism

- A.10. How often do you volunteer in the park?
- a. Once a week
 - b. Once a month
 - c. A few times a year
 - d. Only volunteered once before
 - e. I have not volunteered before
- A.11. How did you learn about the volunteering opportunity?
- a. While visiting the park
 - b. Social media
 - c. News coverage
 - d. Physical advertisements
 - e. From friends/family
 - f. Other
 - i. Please specify: _____
- A.12. What motivated you to volunteer? Select all that apply.
- a. Value of the park
 - b. Personal connection to the park
 - c. Concern for the current state of the park
 - d. Interest in the environment

- e. For school
 - f. For your profession
 - g. Looking for volunteer experience
 - h. Looking to do community service
 - i. For social connections
 - j. Other
 - i. Please specify: _____
- A.13. What projects have you volunteered for in the past, or are currently involved in?
Select all that apply.
- a. Urban Rangers
 - b. Clean up of trash
 - c. Planting native species
 - d. Building infrastructure
 - e. Other
 - i. Please specify: _____
- A.14. How would you rate your satisfaction with the volunteer experience (1 being very dissatisfied and 10 being very satisfied)?
- a.
- A.15. Was there anything you particularly liked about your experience as a volunteer?
[open response]
- A.16. Was there anything about your experience as a volunteer that you did not like?
[open response]

Appendix B: VNPA Leadership Interview Questions

Informed Consent

We are students from Worcester Polytechnic Institute, Massachusetts, United States, and we are here to talk more in depth about the Văcărești Nature Park Association's (VNPA) current process of water management, resources, and volunteerism practices. This interview will take approximately 30 minutes. Your participation is completely voluntary, and you may stop the interview at any time or refuse to answer any question that we ask. This interview is confidential unless you agree to have your name published. We will publish the results, though the respondent has the right to retract any statements said during the interview before May 1st, 2021. We can be reached at gr-vacaresti-d21@wpi.edu.

For more information about this research or about the rights of research participants, in case of research-related injury, contact the WPI IRB Manager Ruth McKeogh at (508) 831-6699 or irb@wpi.edu and the Human Protection Administrator Gabriel Johnson at (508) 831-4989 or gjohnson@wpi.edu.

By typing your name below, this will be an electronic signature stating that you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

Study Participant Signature

Date: _____

Signature of Person who explained this study

Date: _____

Sign here if you consent to having your name published

Date: _____

Interviewee Background

- B.1. Describe your role at the VNPA.
 - a. How long have you worked at the VNPA?
 - b. Why did you first get involved with the organization?
- B.2. Describe your involvement in the park's volunteer-based projects.
 - a. Do you work directly with park volunteers? If so, how?

VNPA Resources

- B.3. Describe the financial resources of the VNPA
 - a. Where does the VNPA get its budget from (i.e. government, other organizations, donations, etc.)?
 - b. How has financial resources impacted VNPA projects?
- B.4. Describe the physical resources of the VNPA (i.e., people, networking, equipment, etc.)?
 - a. What connections does the VNPA have with other organizations?
 - b. Describe the public's perception of the park and how it impacts the VNP or VNPA.
 - c. How has physical resources impacted VNPA projects?

VNPA Water Levels

- B.5. How has the recent drought specifically impacted biodiversity, fire risk, and water levels in the park?
 - a. Has this impacted tourism or public perception of the park? Please describe.
 - b. Has this led to more or less support towards the park? Please describe.
 - c. Has the government stepped in to aid in drought relief? Please describe.
- B.6. What are the current measures in place to lessen the drought's effects and improve water levels?
 - a. How have the water levels been monitored thus far?
 - b. What were the obstacles facing these measures?
 - c. What resources were used to complete these measures?
 - d. Did finances play a role in the project, if so how?
 - e. Were these projects successful? Please explain why or why not.
- B.7. What is the most difficult aspect of managing water levels?
- B.8. What locations are at highest risk from falling water levels?
 - a. Are there any critical areas within the VNP that should be prioritized in terms of increasing the water levels?

Volunteer Specific Questions

- B.9. How does the VNPA recruit volunteers? Describe your current volunteer outreach efforts.

- a. Is there anything in particular that the VNPA is looking to improve in terms of volunteerism (i.e., expand volunteer pool, create more volunteer projects, etc.)?
 - b. Are there any problems that you have had with volunteers?
- B.10. What are ways in which the VNPA uses volunteers? In what ways do you find volunteers most useful?
- B.11. Tell me about the success of previous volunteer projects and how volunteers helped to achieve the goal of the project.
- B.12. Have any of these projects not achieved the intended goal? Describe a particular example.

Appendix C: Conservationists Interview Questions

Informed Consent

We are students from Worcester Polytechnic Institute, Massachusetts, United States, and are working on a collaborative project with the Văcărești Nature Park Association (VNPA). We are here to talk more in depth about your park's role in wetlands conservation and how you utilize volunteers. This interview will take approximately 30 minutes. Your participation is completely voluntary, and you may stop the interview at any time or refuse to answer any question that we ask. This interview is confidential unless you agree to have your name published. We will publish results, though the respondent has the right to retract any statements said during the interview before May 1st, 2021. We can be reached at gr-vacaresti-d21@wpi.edu.

For more information about this research or about the rights of research participants, in case of research-related injury, contact the WPI IRB Manager Ruth McKeogh at (508) 831-6699 or irb@wpi.edu and the Human Protection Administrator Gabriel Johnson at (508) 831-4989 or gjohnson@wpi.edu.

By typing your name below, this will be an electronic signature stating that you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

Study Participant Signature

Date: _____

Signature of Person who explained this study

Date: _____

Sign here if you consent to having your name published

Date: _____

Interviewee Background

- C.1. Describe your role at [name of organization]
 - a. How long have you worked at the [name of organization]?
 - b. Why did you first get involved with the organization?
- C.2. What is your involvement in the group's projects?
 - a. Do you directly work in these projects?

Water management and water levels

- C.3. Tell me about the current state of water management in [park]
 - a. Do you monitor park water levels, if so how?
 - b. Does nature regulate water, or have you had to do any infrastructure projects to manage water? Describe them.
 - i. What were the obstacles facing these measures?
 - ii. What resources did you need to complete these?
 - iii. Did finances play a role in the project, if so how?
 - c. Were these projects successful? Please explain why or why not.
 - d. What was the biggest challenge in carrying out this project?
- C.4. In general, what is the hardest part about managing water levels?
- C.5. In your water management projects, did you utilize volunteers, and can you describe why or why not?

Volunteer Specific Questions

- C.6. Do you utilize volunteers in your organization?
 - a. *(If interviewee indicates that their park does not use volunteers, skip to question C.9)*
- C.7. How does [name of organization] recruit volunteers?
 - a. What are your current volunteer outreach efforts like?
- C.8. Tell me about a project where you were able to successfully use volunteers.
 - a. Has this project achieved its intended goal, or have at least made good progress? (Describe a particular example)
- C.9. In your opinion, why was the project a success? How instrumental were the volunteers in making it so?
- C.10. Tell me about a project where you were unable to successfully use volunteers.
 - a. In your opinion, why were you unable to utilize volunteers for this project?
- C.11. Has [name of organization] faced any issues with volunteers (i.e., lack of interest, volunteers not able to fulfill project needs, etc.)?
 - a. Does the current public opinion of [name of organization] play a role in volunteerism?
 - i. Was there ever a time in which the public did not support [name of organization]? Describe any strategies used to improve public opinion.
- C.12. Is there anything in particular that the [name of organization] is looking to improve in terms of volunteerism (i.e., expand volunteer pool, create more volunteer projects, etc.)?

Appendix D: Methodology Supplemental Figures

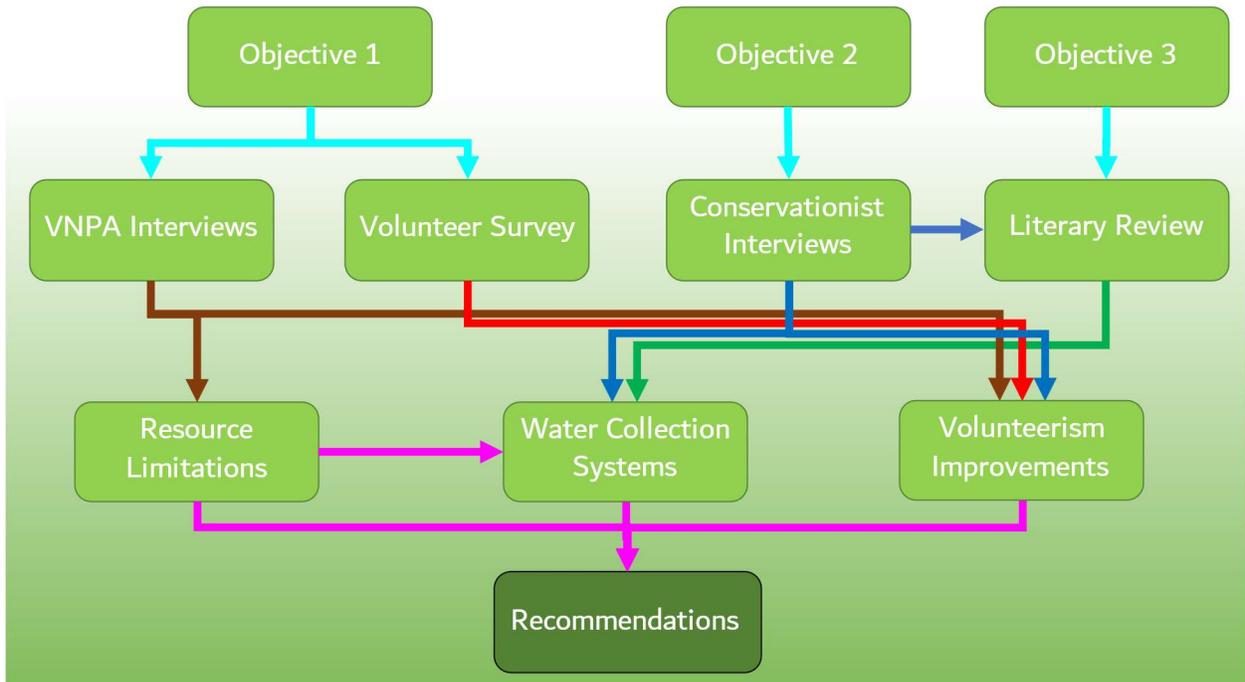


Figure D.1: Flow Chart of Objectives into Deliverable

Objective	Task	Week 1 (3/24-4/2)	Week 2 (4/5-4/9)	Week 3 (4/12-4/16)	Week 4 (4/19-4/23)	Week 5 (4/26-4/30)	Week 6 (5/3-5/7)	Week 7 (5/10-5/13)
1	Volunteer Survey	On	On	Off				
1	VNPA Interviews	On	On	On				
2	Conservationist Interviews	On	On	On				
3	Technical Research		On	On	On			
N/A	Data Analysis		On	On	On	On		
N/A	Project Writing				On	On	On	
N/A	Project Editing				On	On	On	On

Figure D.2: Gantt chart detailing the objective's timeline. Off color tiles represent that the task might be started at that time or end before that week.