

Final Project Report

1. Contestant profile

▪ Contestant name:	Serpil ODABAŞI
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▪ University / Organisation	Çanakkale Onsekiz Mart University
▪ Number of people in your team:	3

2. Project overview

Title:	The Biodiversity and Rehabilitation of Bozalan Clay Quarry Wetland Area
Contest: (Research/Community)	Turkey and International
Quarry name:	Bozalan

Abstract

Bozalan Clay Quarry is located in Ezine, Çanakkale Province, Turkey. This quarry has a new established wetland at the pit. In this study, carried out at the wetland area, we aimed at determining the aquatic biodiversity including invertebrates, amphibians, macrophytes as well as birds. Moreover, physico chemical and microbiological water quality were investigated. Four sampling visits were carried out to the study area in early Spring, Spring, early Summer and Summer. Some water quality parameters such as temperature, pH, dissolved oxygen, total dissolved solids were measured *in-situ* while some elements and ion parameters were analyzed in the laboratory. Microbiological tests were performed in the laboratory by 24 and 48 hours incubation. Identification of macroinvertebrates were done under stereo and binocular microscopes equipped with light source. Furthermore, we tried to make an observations of birds that visit to the wetland. In addition, some bird nests set up in the study area to make an attractive site for breeding. Beyond the scientific study, University and Secondary School classes were joined the samplings and field visits in order to rising environmental awareness. According to the data, all the *in-situ* measured parameters were varied in normal range. Among elements and ions of water, Cd and Cl concentrations were categorized as class II and IV respectively. Except these, all the concentrations were found in acceptable ranges. The water of the Bozalan wetland was not suitable for drinking purpose due to the total germ counts (TC) over the threshold limits. Given the biodiversity data, totally 21 taxa were determined; 14 taxa of macroinvertebrates, 5 of macrophytes, 2 of vertebrates as well as many bird species. In order to increase environmental awareness of the younger generation especially, two different technical visits to the study area were organized. In conclusion, this ecological study revealed the aquatic biodiversity and water quality of the quarry wetland. Raising environmental awareness of the young generation (especially of secondary school class) is the most important outcome of our study.

Final report

INTRODUCTION

Anthropogenic disturbances to habitats influence the local faunal assemblages, the abundance of their populations, and the species composition of their communities (Sievers, 2017). A clay quarry is a pit for mine extraction generally used for manufacturing primarily pottery or cement. There is a subsequently established wetland at the base of the open-pit mining area. The creation of wetlands during and following clay or sand extraction processes is inevitable, and thus, such quarries have the potential to support aquatic animals.

Although typically not designed to support and conserve wildlife, these artificial wetlands can attract animals, as they superficially resemble natural wetlands (often termed as secondary wetlands; Dolny and Harabis, 2012). Therefore, secondary wetlands may provide critical habitat, enhancing landscape-level connectivity and promoting biodiversity and population persistence (Bendell-Young et al., 2000; Scheffers and Paszkowski, 2013; Thiere et al., 2009). For some organisms, properly managed secondary wetlands may provide a better habitat than that of natural wetlands. Given this potential, there has been considerable interest in simultaneously satisfying industrial needs and promoting wildlife within secondary wetlands (Benyamine et al., 2004).

BACKGROUND INFORMATION

The study area, Bozalan Clay Quarry operated by AKÇANSA Cement, is located near the Bozalan village, Ezine district of Çanakkale (Northwestern Turkey). The mining area is established on an area of 99,27 Ha close to Çanakkale Akçansa cement plant. Operation area is a forest status and there is a 1st degree natural protection zone approximately 650 m. far from the license border of the quarry (Fig. 1).

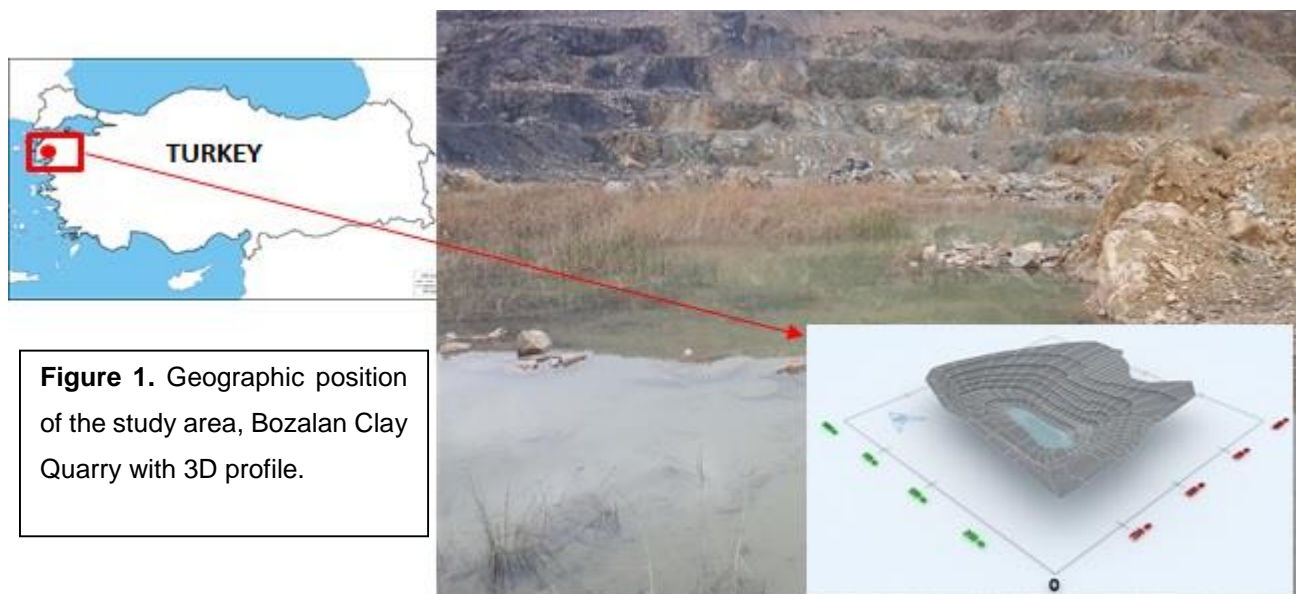


Figure 1. Geographic position of the study area, Bozalan Clay Quarry with 3D profile.

In the region, Mediterranean climate condition is prevailing so surrounding flora is low bush and there are some interspersed oak and pine trees. Besides, some fields are planted by olive trees for agricultural purposes. Birds, mammals, invertebrates and reptiles are some of the animal species around the region.

The raw material of cement has been extracted as open-pit operation since 1980. Thus, there is a pond in the middle of the lowest bench of the quarry. The water in the pond has been periodically pumped out if necessary.

The pond area was rehabilitated in order to form an artificial wetland serving biodiversity (including bird and aquatic species) and recreational site by a Quarrylife Project in 2014 (Güçlü et al., 2014). The water source of the wetland

is mainly rainfall and small amount of groundwater. In the construction plan, a spillway was designed against flooding the pond. But the wetland's water level has been kept in a constant level in order to avoid potential damage to biodiversity. So this wetland has a capacity of water retention all year round.

OBJECTIVES

We aimed at in the Bozalan Clay Quarry Wetland,

- stating the water quality of the wetland by physicochemical and microbiological parameters,
- revealing of aquatic macroinvertebrates biodiversity and calculating of some biodiversity indices,
- determining aquatic and semi aquatic vertebrata such as fish and amphibian,
- identifying of aquatic submersible and emersible macrophytes,
- determining of bird species that frequently used the wetland,
- field trips were arranged in order to raising awareness to students of secondary school and university.

METHODS

Sampling Periods and Field Studies

In total, four field studies were realized in the study area. Following the start of the project, we performed our first field study in 5th of March 2018. Following the first sampling, other sampling periods were 5th of April, 29th of May and 30th of July in 2018.

Firstly, we measured the *in-situ* water quality parameters such as water temperature (T), pH, electrical conductivity (EC), dissolved oxygen (DO) and total dissolved solids (TDS) by multiparameter probe (Hanna HI98194) from three different sampling points in the study area (Fig.2). Meanwhile, water samples were taken into polyethylene bottles for determination of some elements (Zn, P, Pb, Co, Cd, Ni, Ba, Fe, B, Mn, Cr, Mg, Ca, Cu, Al, Na, K) and ions (Cl and SO₄²⁻). Element and ion analysis were performed by ICP-OES and classical method (TS4164 ISO9297, SM4500 SO₄²⁻D) respectively in Çanakkale Onsekiz Mart University, Science and Technology Application and Research Center.



Figure 2. In-situ measurements of water

For microbiology water samples were taken into sterile-dark sampling bottles (250 ml). All water samples were kept under cool conditions using insulated box while transferring to laboratories. Within this scope, Total Bacteriological Count (log-n cfu/ml), Total Coliforms (log-n cfu/ml), Fecal Coliform (log-n cfu/ml), Fecal *Streptococcus* (log-n cfu/ml) and yeast-mold counts were investigated. Microbiological analyses were applied in



Figure 3. Microbiological sampling and inoculation..

Laboratory of Microbiology, Faculty of Marine Science and Technology (ÇOMU) (Fig. 3).

After the water quality implementations (sampling and measuring) occurred, benthic samplings were carried out from the same points that water quality samplings done. These samplings were performed by D-Frame net based on multi habitat method to reveal the biodiversity and indices for habitat quality. The benthic samples taken from an unit area (1 m²) (Fig.4).



Figure 4. Benthic macroinvertebrates sampling.

Aquatic macrophyte observations were done since the first sampling period. Macrophytes assemblages showed rising its' density in the wetland toward early summer. Some of the macrophytes were sampled in order to make identification (Fig.5).



Figure 5. Submersible macrophytes..

Apart from the sampling above, we set up 10 bird nests on the study area in 05.04.2018. After this period, nests were checked out whether used by birds or not in the area (29th of May and 12th June 2018). On the other hand, birds occurring the study area were observed in the same periods (Fig 6).



Figure 6. Setting up of the bird nests.



In the two of the sampling periods, students were accompanied from secondary school of Hüseyin Akif Terzioğlu (50 students joined) and Çanakkale Onsekiz Mart University Faculty of Marine Science and Technology (20 students joined) in 05.04.2018 and 29.05.2018 respectively (Fig.7,8). All photographs used in this study are original taken both study site and the laboratory.



Figure 7. Technical visits with the secondary school students.



Figure 8. Technical visits with the University students.

RESULTS

Water Quality (Chemistry and microbiology)

Physical and Chemical Parameters

Water quality parameters which were measured *in-situ* are showed very limited fluctuation between sampling periods. All parameters are in acceptable ranges according to the Water Quality Criteria Legislation SKKY (Anonymous, 2015) of Turkey. pH levels were varied between 7.39 and 7.74. DO concentrations were also in normal ranges and classed in II and III, varied between 3.63 and 5.08 ppm. T of water fluctuated in parallel with atmospheric temperature. EC values were nearly constant in first three sampling period, the values were declined at the last period. All EC levels were categorized as class II. TDS values of water were in line with that of EC (Table 1).

Table 1. Water quality parameters measured *In-situ*.

Date	Station	pH	DO (ppm)	T (°C)	EC (µS/cm)	TDS (ppm)
5.03.2018	1	7.7	3.63	15.3	1530	767
	2	7.74	4.09	17.3	1583	791
	3	7.42	4.48	14.01	1480	740
5.04.2018	1	7.39	5.08	14.1	1467	729
	2	7.69	3.92	21.96	1429	738
	3	7.54	4.46	16.3	1355	678
29.05.2018	1	7.47	4.48	23.1	1567	424
	2	7.55	4.21	22.76	1412	518
	3	7.36	4.01	21.3	1511	387
30.07.2018	1	7.7	4.41	29.5	589	288
	2	7.75	4.18	29.06	591	296
	3	7.62	4.09	28.8	542	270

Element and ion parameters of the water were analyzed in the laboratory by ICP-OES and classical methods. According to SKKY, Cd and Cl concentrations were categorized as class II and IV respectively. Except these, all the concentrations were found in acceptable ranges (Table 2).

Table 2. Water quality parameters analyzed in the laboratory.

Parameter	Value			Analyze method
	29.05.2018	12.06.2018	30.07.2018	
Zn (µg/L)	ND	ND	ND	ICP-OES
P (mg/L)	0.122	0.121	0.117	ICP-OES
Pb (µg/L)	ND	ND	ND	ICP-OES
Co (µg/L)	ND	3.527	ND	ICP-OES
Cd (µg/L)	ND	2.116	ND	ICP-OES
Ni (µg/L)	ND	ND	ND	ICP-OES
Ba (µg/L)	69.24	34.55	125.70	ICP-OES
Fe (µg/L)	8.226	20.98	11.36	ICP-OES
B (µg/L)	30.33	19.69	ND	ICP-OES
Mn (µg/L)	13.29	4.298	10.58	ICP-OES
Cr (µg/L)	ND	ND	ND	ICP-OES
Mg (mg/L)	27.84	25.34	32.68	ICP-OES
Ca (mg/L)	40.54	37.80	44.81	ICP-OES
Cu (µg/L)	6.951	4.992	ND	ICP-OES
Al (µg/L)	ND	ND	ND	ICP-OES
Na (mg/L)	34.19	24.32	35.30	ICP-OES
K (mg/L)	1.821	1.184	2.155	ICP-OES
Cl (mg/L)	60.27	58.49	65.58	TS4164 ISO 9297
SO ₄ ⁻² (mg/L)	71.78	84.29	46.93	SM 4500 SO ₄ ⁻² D

ND: Not detected.

Microbiological Parameters

Microbiological values of the water were also compared with the SKKY. In the study area, total aerobic bacteria (TAB), total coliforms (TC), fecal coliforms (FC), fecal *Streptococcus* (FS), yeast and mold (YM) were investigated. FC and FS bacteria were not detected in the area throughout the study period. Absence of these parameters could be indication of no domestic discharge into the area. Although the TC values were not suitable for drinking and domestic use, the wetland has a second class of water quality by this parameter. YM values were firstly determined in the second period (5th of April) as temperature rising. This parameter measured between 10 and 40 (cfu/mL) in all stations throughout the study period. The water of the Bozalan wetland was not suitable for drinking purpose due to the total germ counts (TC) over the threshold limits (Fig.9).

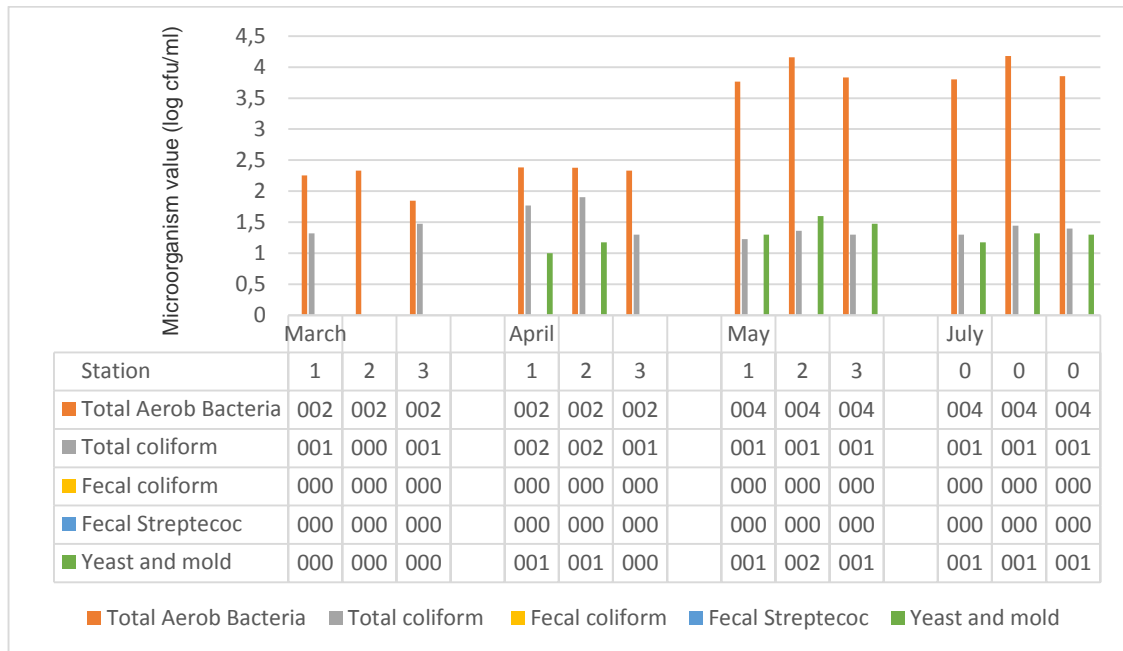


Figure 9. Microbiological data of water obtained from Bozalan Clay Quarry Stations.

Macroinvertebrates

After sampling, we transferred the benthic samples to the laboratory. Firstly, the samples washed by tap water then the macroinvertebrates separated from organic matter. Organisms were sorted and then fixed by ethanol (%80). Identification were made under binocular and stereo microscope. For Identifications Şahin (1991), McCafferty (1981), Glöer (2015) were used (Fig.10, 11).

In the study area, 14 taxa of benthic macroinvertebrates were determined. These taxa are belonging to Gastropoda (1), Insecta (12) and Malacostraca (1) class. The most dominant taxon was *Coenagrion* sp. with %42.31 and the least one were *Corixa punctata* and *Erythemis* sp., *Potamon ibericum* and *Psectrocladius* (*P.*) *limbatellus* with %0.77. According to the data, insect class were dominated the benthic macroinvertebrates fauna (Table 3).

Figure 10. Sieving and ID of the benthic sample.



Some biodiversity indices of the benthic macroinvertebrates were calculated including Shannon wiener, Margalef and Evenness (PASTver1.75). Shannon wiener is varied between 0 and 5 in general from the poor to the richest of diversity.

Table 3. List of the macroinvertebrates of the Bozalan Clay Quarry Wetland.

Class	Family	Species	IUCN Status	5.03.2018	5.04.2018	29.05.2018	% D
Gastropoda	Physidae	<i>Physa acuta</i>	LC	10	–	3	10
Insecta	Coenagrionidae	<i>Coenagrion</i> sp.	-	40	2	13	42.31
	Libellulidae	<i>Libellula</i> sp.	-	8	–	–	6.15
		<i>Erythemis</i> sp.	-	1	–	–	0.77
	Tabanidae	<i>Tabanus</i> sp.	-	3	2	2	5.38
	Chironomidae	<i>Procladius</i> (<i>Holotanypus</i>) sp.	-	–	9	1	7.69
		<i>Cladotanytarsus mancus</i>	-	–	1	–	0.77
		<i>Einfeldia carbonaria</i>	-	–	–	2	1.54
		<i>Polypedilum aberrans</i>	-	–	–	4	3.08
		<i>Psectrocladius</i> (P.) <i>limbatellus</i>	-	–	–	1	0.77
	Ceratopogonidae	Ceratopogonidae	-	–	4	2	4.62
	Corixidae	<i>Corixa punctata</i>	-	–	–	1	0.77
	Baetidae	<i>Baetis rhodani</i>	-	–	–	20	15.38
Malacostraca	Potamidae	<i>Potamon ibericum</i>	NT	-	1	-	0.77



Figure 11. a. Chironomidae, b. *Ph. acuta*, c. *Coenagrion* d. *B. rhodani* e. *P. ibericum* f. Tabanidae

In this study, Shannon wiener was the highest in May with 1.723. Evenness is varied between 0 and 1, means that stability of taxa number occurring in the study area. In the study area, the highest value was detected in the second period of the sampling. The Margalef indices is also used to demonstrating the richness and diversity of the taxa in a region. The highest value of the Margalef was in third period of the study, similarly with the Shannon wiener (Table 4).

Table 4. Index values of macroinvertebrates biodiversity of the Bozalan clay Quarry Wetland.

	March/2018	April/2018	May/18
Taxa_S	5	6	10
Individuals	62	19	49
Shannon_H	1.054	1.33	1.723
Evenness_e^H/S	0.574	0.756	0.5603
Margalef	0.9692	1.384	2.313

Vertebrates

In the study area, we observed the occurrence of an amphibian; European Marsh Frog (*Pelophylax ridibundus*). Another vertebrate of the wetland is a small fish, namely Mosquito Fish (*Gambusia holbrooki*). Both are treated as LC category in IUCN (Fig.12).



Figure 12. Mosquito fish and European Marsh Frog.

Macrophytes

In the study area, four taxa of macrophyta were determined. The cost line of the study area was covered by a reed (*Thypha* sp.) stripe. This emerging macrophyte is harboring plenty of aquatic and semi aquatic biodiversity. Another emerging plant is *Juncus* sp. clusters that spread over littoral and supralittoral zone of the area. On the other hand, there are some submerged macrophytes in the wetland such as *Potamogeton natans*, *Valisneria spiralis* and *Chara* sp.. These macrophytes showed patchy distribution in the wetland (Fig.13).



Figure 13. Aquatic macrophytes in the study area.

Bird Observations

In this time of bird observation, we were equipped with professional camera for distant shots of some bird species in the area. Fortunately, we got a few beautiful shots belong them including: sparrows, sand martins, finches, goldfinches, sea gulls. On the other hand, some of birds' voices were recorded in the study area. These birds were aquatic warbler and moorhen that always hidden in the reed bed when the time of sampling. For identification of the birds, "Birds of Turkey" visual book by www.trakus.org and web site (for bird signings) were used. Another amazing development was welcomed us while checking the artificial bird nests placed in the area about one month before. Some of the nests actively used by resident birds were observed (Fig.14.).

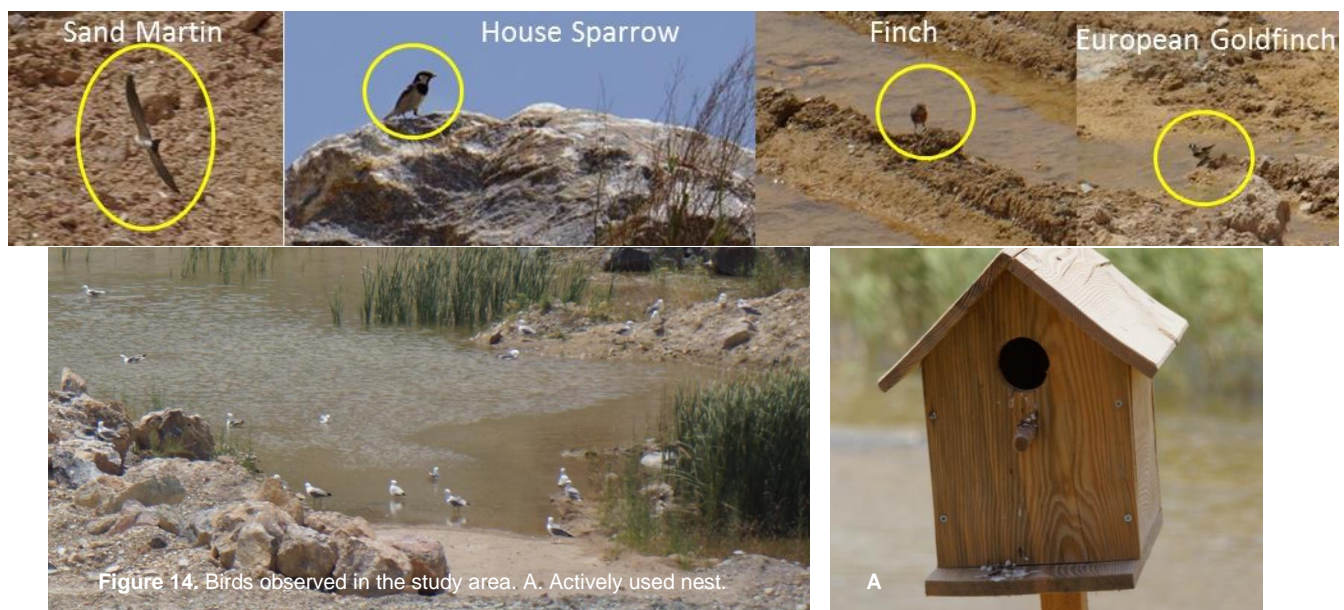


Figure 14. Birds observed in the study area. A. Actively used nest.

Technical Visits by Students

After our first sampling survey to the study area, we organized a technical visit for University and Secondary School classes at separate dates.

At first, 20 undergraduate and graduate students of Faculty of Marine Science and Technology, Çanakkale Onsekiz Mart University were taken to the Bozalan Clay Quarry Wetland in 5th of April. Notebooks and seed-pencils arranged by the project were given to the students. When we arrived to the area, a brief site description

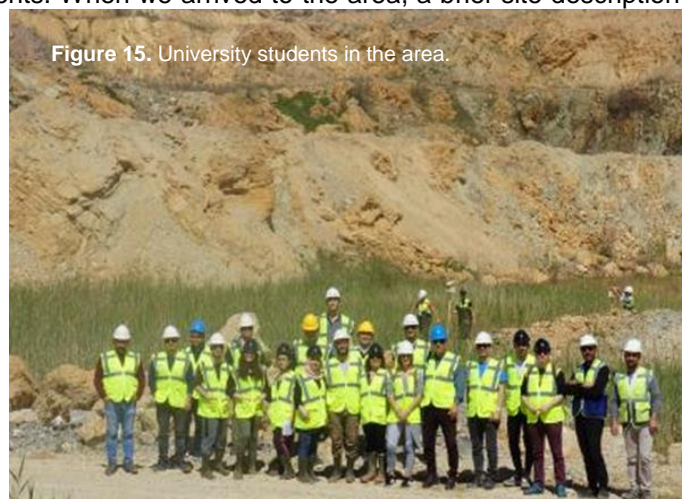


Figure 15. University students in the area.

was made and sampling equipment of water quality, microbiology, macroinvertebrates were demonstrated. Normal sampling procedure was applied in accompanied with the students. They were taking notes and photos while the sampling (Fig.15.).

In the 29th of May, secondary school class of Hüseyin Akif Terzioğlu was organized to another technical visit to the study area. Before visiting to Bozalan Clay Quarry Wetland, preliminary information about the project was given to the secondary school students. While the presentation, name tags, notebooks, hats and the seed-pencils were handed out to the students one by one. In the wetland, some chemical and physical water quality measured by in situ and sampling of macroinvertebrates were demonstrated. On the other hand, microbiological sampling was performed by the students. Our students were very interested in the activity and learned much by enjoying way (Fig.16.)



Figure 16. Secondary School students in the area

DISCUSSION

In the open-pit operation sites, a water holding habitat can be formed at the middle of the lowest bench. The pond area of the Bozalan Clay Quarry site was rehabilitated in order to form an artificial wetland serving biodiversity (including bird and aquatic species). In this project, we examined the water quality of the wetland. Our data was compared with the Water Quality Criteria Legislation of Turkey (Anonymous, 2015). Among ion concentrations the Cl was found in critical level along the study (class IV). Thus, the surface water source can be used for only recreational purpose.

In the microbiological analyses, TAB counts might be show probable contamination to the water source. Especially in surface waters winds, precipitation and rising temperature can be caused an increase of the TAB. According to the Ministry of Health, our TAB values were over the limitation of human consumption purpose about waters legislation (Anonymous, 2016). Coliform bacteria are considered as coliform or fecal coliform according to their sources. Fecal coliform (FC) comes from digestive systems of the hot blooded animals and humans (Halkman, 2005), so it could be indication of a contamination. On the contrary, Total Coliforms (TC) does not indicate contamination of fecal matter. Given our data, no FC contamination was detected. On the other hand, TC values categorized as less polluted (class II) water. Microbiological water quality of the Bozalan Clay Quarry is not allowed to use drinking and household purpose.

An herbivorous species *Physa acuta* among the macroinvertebrates is North American origin and widespread distribution in the world (Coffman et al., 1971, Zhadin, 1965). This species has been recorded from near locations of lotic and lentic ecosystems by several authors (Odabaşı, 2011). The most dominant taxon of the region is *Coenagrion* sp.. This genus and close relative taxon *Libellula* sp. are both known as dragonflies which are susceptible to environmental changes, thus they are highly useful ecological indicators (Simaika and Samways, 2011). Also these dragonflies are playing a vital role in the ecological restoration of post-mining freshwater wetlands (Tichánek, 2016). *Baetis rhodani* is a frequently sampled species in the region. *B. rhodani* is a widespread

Ephemeropteran (mayfly) that occurs throughout the West Palaearctic. According to Meyer (1987), species belonging to *Baetis* can be found in less-polluted regions of freshwaters, categorized as I-II. Larvae of Chironomidae mostly found in stagnant waters (Şahin, 1984). In this study, we observed several Chironomidae members in the wetland. Similarly, larvae of Ceratopogonidae lives in stagnant or slow flowing freshwaters, marshes and temporary waters (Bouchard, 2004).

Various aquatic birds use animals and plants in lakes, rivers and brackish waters as food. Marsh and wetlands are usually nesting and feeding areas of them. Aquatic birds are characteristic of the shallow waters (Tanyolaç, 2011). In this study, 7 different bird species were observed around the wetland which ensuring ecological integrity.

Amphibious organisms such as frogs are common in all fresh waters. The amphibian larvae are fed with drift, the adults, unlikely are fed with insect worms and other small creatures. Amphibian species can be used as bioindicators of ecosystem health. In terms of monitoring, identifying amphibian species presence and population size and quantifying individual fitness by measuring limb lengths are economically and logistically feasible methods that can be used to assess the health of quarry wetlands (Sievers, 2017).

Involving the young generation in the scientific study period is a keystone of the project. According to our observation, especially secondary class students were very interested the scientific work integrated in the nature. University students were applied their courses as well.

FINAL CONCLUSIONS

In conclusion, the Bozalan Clay Quarry wetland becomes ecologically highly attractive site for aquatic, semi-aquatic species as well as bird species. Several management practices could further enhance the role quarry wetlands play in promoting aquatic species, amphibian and bird biodiversity, such as planting out emergent zones with native vegetation. In the future project, doing studies about biodiversity, biomonitoring in this quarry wetland is recommended. In addition, in order to increase environmental awareness especially of the younger generation, technical visits to the study area should be organized by such ecological studies.

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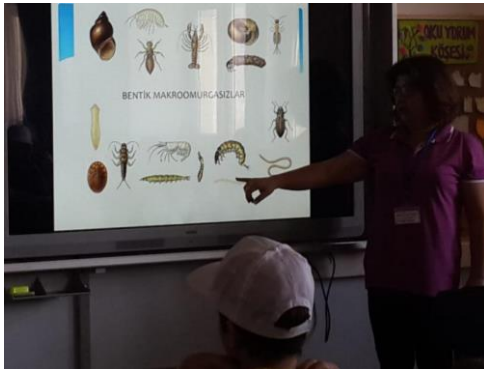
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APPENDIX

Moments from the project





To be kept and filled in at the end of your report

Project tags (select all appropriate):

This will be use to classify your project in the project archive (that is also available online)

Project focus:

- ☐ Beyond quarry borders
- ☐ Biodiversity management
- ☐ Cooperation programmes
- ☐ Connecting with local communities
- ☒ Education and Raising awareness
- ☐ Invasive species
- ☐ Landscape management
- ☐ Pollination
- ☐ Rehabilitation & habitat research
- ☒ Scientific research
- ☐ Soil management
- ☒ Species research
- ☐ Student class project
- ☐ Urban ecology
- ☐ Water management

Flora:

- ☐ Trees & shrubs
- ☐ Ferns
- ☐ Flowering plants
- ☐ Fungi
- ☐ Mosses and liverworts

Fauna:

- ☒ Amphibians
- ☒ Birds
- ☒ Insects
- ☒ Fish
- ☐ Mammals
- ☐ Reptiles
- ☒ Other invertebrates
- ☐ Other insects
- ☐ Other species

Habitat:

- ☐ Artificial / cultivated land
- ☐ Cave
- ☐ Coastal
- ☐ Grassland
- ☐ Human settlement
- ☐ Open areas of rocky grounds
- ☐ Recreational areas
- ☐ Sandy and rocky habitat
- ☐ Scree
- ☐ Shrub & groves
- ☐ Soil
- ☐ Wander biotopes
- ☒ Water bodies (flowing, standing)
- ☒ Wetland
- ☐ Woodland

Stakeholders:

- ☐ Authorities
- ☐ Local community
- ☐ NGOs
- ☒ Schools
- ☒ Universities