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From Knowledge to Wisdom

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An Overview of Industrial Source Discharges into Water in the Albanian Territory

Joana Gjipalaj, Kleant Semema, Ledia Aleksi and Entela Çobani

Department of Environmental Engineering, Faculty of Civil Engineering, Polytechnic University of Tirana, Rruga, "Muhamet Gjollesha", No. 54, Tirana, Albania

Abstract: Direct and indirect discharges are released in the environment by many economic entities which operate in the territory of Albania. Different installations release many substances from separated sources or widespread, affecting the environmental quality and often causing pollution. Each economic entity that discharges substances in the environment is equipped with an environmental permit which is granted according to a system composed by two categories, A and B. Each Albanian citizen has the right guaranteed by the constitution to collect information regarding the city or country environmental conditions by this system. Furthermore, this system provides data regarding the state of the environment, polluting activity, different chemical components discharged, etc. The purpose of this study is to identify different sources of industrial discharge into water bodies, aiming to provide information that can be useful for the environmental protection, its preservation and improvement, the prevention and reduction of risks related to human and animal health and the improvement of the life quality. Data gained from the identification of economic entities equipped with an active environmental permit type A and B showed the various sources of waste discharges in the Albanian territory. The study was conducted using the QKB (National Business Center) database for a period of eight years from 2014 to 2022. Data show that an increase of technical unit discharging substances into water has increased over years due to a major number of installations of polluting economic entities in the country territory.

Key words: Industrial discharge, water, active environmental permits, Albania.

1. Introduction

Environmental pollution from different industries operating worldwide is a major source of water and soil pollution [1-5]. Each state individually or united under different intrastate agreements has been taking measures to prevent and reduce environmental pollution in the last decades such as Kyoto Protocol. Albania as a candidate state to the European Union is following European legislation and measures to reduce water and soil pollution coming from various economic entities. For this purpose, a system has been created in order to identify all entities that cause direct or indirect pollution. Thus, all economic entities that cause direct or indirect pollution to the environment are constricted by the country legislation framework to be equipped with an environmental permit which is classified in A and B permits in order to prevent any serious environmental pollution. Types A and B of permits are classified according to Appendix 1 of Law no. 10448, 10.14.2011 [6]. The type of the permission depends on the production capacity of the industries which is classified on a list with a descending order of impacts on the environment. The lowest direct or indirect pollution are listed in the lower part of this list taking into consideration different factors affecting the environment.

Different substances are discharged by the industries into the surface or sewage waters in respect to the country legislation. However, we presumed that a deeper analysis was needed to correctly identify all economic entities that operate, causing the discharge of different substances into the environment in general, by identifying the number of permits given in a period of

Corresponding author: Joana Gjipalaj, PhD, research field: environmental remediation.

time, in order to evaluate exact number of technical units causing indirect or direct pollution into water. Thus, the main aim of this study was to analyze all polluting industries with an active type A and B permit in the territory of Albania, at region and municipal level for a specific period of time.

2. Material and Methods

For the identification of industrial sources discharging into water in the Albanian territory the data published in the National Register of Licenses, authorizations and permits provided by the QKB (National Business Center) database were used.

Identification of the polluting economic operators equipped with an A or B environmental permission was done using the national open and available databases for a period of time beginning from 01.01.2014 to 31.12.2022 involving all the country territory. After that, each of the acts of approval of type A and B environmental active permits has been verified if there are discharges into water from industrial sources. Geospatial data (coordinates according to the Albanian coordinate system 1986/Gauss-Kruger Zone 4) which are located inside the act of approval of environmental permits of type A and B have been verified using the State Authority for Geospatial Information "ASIG", through which the region and municipality are defined, for each source of industrial discharges [7].

A specific model has been created using Microsoft Excel in which all the collected information has been placed. Data analysis and processing was carried out by verifying each activity of polluting operators who are holders of an active environmental permit type A or B through the official site qkb.gov.al [8], searching in the national register of licenses and permits issued through QKB—by means of the serial number, and then for each operator, the relevant data are entered in the excel database. Then the obtained geospatial data were verified through the National Geoportal "ASIG" [7] and the Geographic Information System "GIS" [9].

3. Results and Discussion

The data gathered from the QKB for the entire territory of Albania, for the active environmental permits of type A and B during the period 2014-2022, are reported in Table 1.

As can be seen, all years' active environmental permits of type A are less than those of type B. The highest number of type A environmental permits is issued in 2016, while the highest number of type B environmental permits is issued in 2022, respectively 23 and 582.

From the data analysis and processing an evaluation of the distribution of each industrial discharge source was done related to regions and municipalities of Albania.

The distribution of industrial discharge sources into water in the region level of Albania is shown in the map in Fig. 1.

It is evident that Dibër and Durrës region has the highest number of industrial discharge sources, with 142 sources in Dibër region and 124 sources in Durrës region, followed by Elbasan region with 117 sources. While the lowest number of industrial discharge sources is in Tirana region with 25 sources, followed by Gjirokastër region with 42 sources. From the analysis of the industrial discharge sources presented in Fig. 1 it results that the north-eastern and central region of the territory of Albania has the highest number of industrial entities discharging into waters.

Table 1 Active environmental permits of type A and B in Albania during the years 2014-2022.

Year	*Type A*	*Type B*
2014	4	127
2015	12	205
2016	23	402
2017	16	213
2018	12	165
2019	3	187
2020	5	137
2021	7	550
2022	5	582

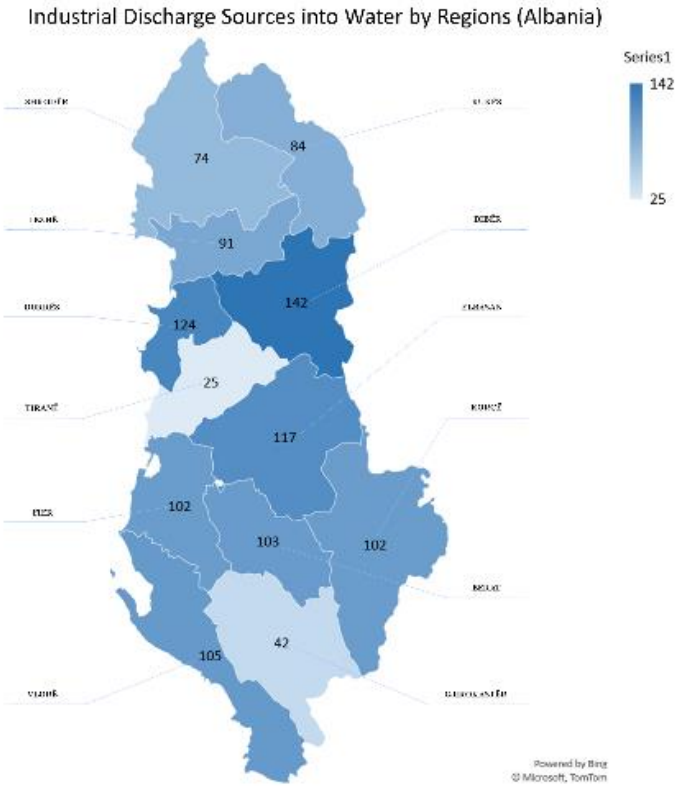


Fig. 1 Distribution of industrial discharge sources into water in the region level of Albania.

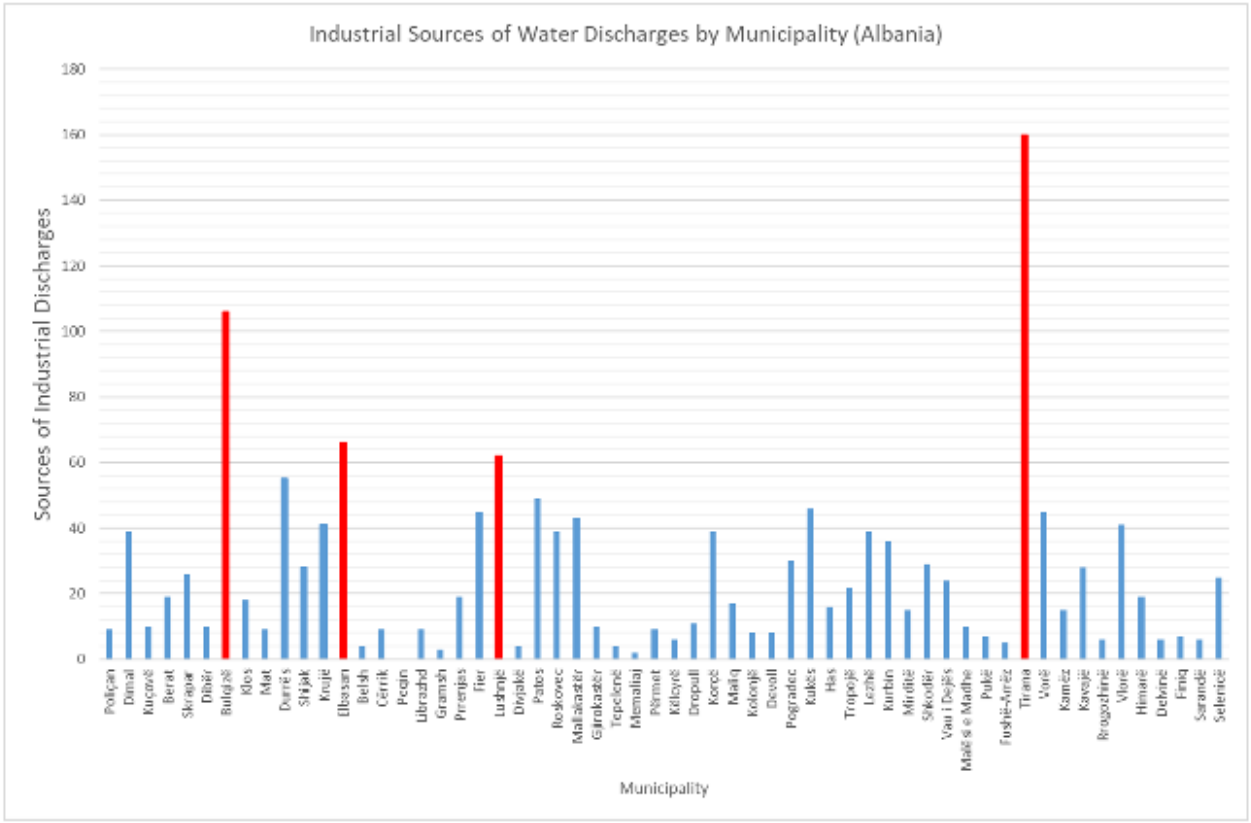


Fig. 2 Industrial discharge sources into water discharges for all Albanian municipality.

The Fig. 2 shows the distribution of all industrial discharge sources from type A and B installations, for each respective municipality of the territory of Albania.

From the data analysis, the highest number of industrial sources discharging into water is in the municipality of Tirana with 160 sources, followed by the municipality of Bulqizë with 106 sources, the municipality of Elbasan with 66 sources and the municipality of Durrës with 55 sources. Industrial discharges into water are the result of polluting economic activities for the extraction of minerals from surface and underground mines, concrete production plants, textile treatment factories, slaughterhouses, production of alcoholic and non-alcoholic beverages, management of waste (storage of scrap/scraps), vehicle services, etc.

4. Conclusions

This investigation has been carried out as a first step for the identification of industrial sources discharging into water in Albania. All data were gathered from public institutions responsible for issuing environmental permits for each economic operator.

From the results of this study, we can conclude that the highest number of active environmental permits issued for each year is the type B. At the region level for the period 2014-2022, in the territory of Albania, Dibër and Durrës regions have the highest number of industrial discharge sources, with 142 and 124 sources, respectively, followed by Elbasan region with 117 sources. While the region of Tirana has the lowest number of industrial discharges into water with 25 sources, followed by Gjirokastër region with 42 sources.

While, referring to the classification at the municipality level, for the period 2014-2022, the municipalities with the highest number of industrial discharges into water are: the municipality of Tirana with 160 sources, followed by the municipality of Bulqizë with 106 sources, the municipality of Elbasan with 66 sources and the municipality of Durrës with 55 sources.

The industrial discharging into water is the result of economic activities in the field of extraction of minerals from surface and underground mines, concrete production plants, textile treatment factories, slaughterhouses, production of alcoholic and non-alcoholic beverages, management of waste (storage of scrap/scrap), vehicle services, etc.

The detailed information about industrial sources discharging into water gives a complete overview of all polluting activities and related environmental issues. Moreover, this information has to be taken into consideration by the authorities responsible for the environment during the preparation of national and/or local strategies and environmental plans.

Further studies have to be carried out in order to classify the industrial discharges based on their specific activity and type of pollutants discharged into water.

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Phytoremediation of Mine Acid Water Using Aquatic Plants

Agung Laksana[1], Dedik Budianta[2] and Sarno[3]

1. Program Study of Environment Management, Post Graduated Programm, The University of Sriwijaya, Palembang 30139, South Sumatera, Indonesia

2. Department of Soil Science, Faculty of Agriculture, the University of Sriwijaya, Indralaya, Ogan Ilir 30662, South Sumatra, Indonesia

3. Department of Biology, Faculty of Mathematics and Natural Science, the University of Sriwijaya, Indralaya, Ogan Ilir 30662, South Sumatra, Indonesia

Abstract: One of the impacts resulting from mining process is the occurrence of AMD (Acid Mine Drainage), which is rainwater or groundwater mixed with rock. AMD contains specific sulfides in coal, leading to highly acidic water with elevated concentrations of iron and manganese. Furthermore, phytoremediation offers a method to enhance specific contaminant levels in various environmental mediums, including soil, sediment, dirt or sludge, groundwater, and surface water. This waste treatment approach employs readily applicable, efficient, and effective plant species, such as burhead or Amazon sword, Melati air (*Echinodorus palaefolius*), Water hyacinth or eceng gondok (*Eichhornia crassipes*), and globe fimbry or Mendong (*Fimbritylis globulosa*) which are aquatic plants in South Sumatra with the capacity to absorb heavy metals. Therefore, this study aims to measure the growth response of each aquatic plant (*Echinodorus palaefolius*, *Eichhornia crassipes*, and *Fimbritylis globulosa*) in each treatment. It also analyzes the amount of heavy metal uptake in the form of Fe and Mn by each aquatic plant (*Eichhornia crassipes*, *Echinodorus palaefolius*, and *Fimbritylis globulosa*) used. Additionally, it investigates the ability of these plants to facilitate the phytoremediation of AMD using compost derived from OPEFB (Oil Palm Empty Fruit Bunches) to reduce the presence of Fe and Mn elements. The study employs a bioreactor and encompasses two treatment factors, namely the type of aquatic plants (*Echinodorus palaefolius*, *Eichhornia crassipes*, and *Fimbritylis globulosa*) and the composition comparison between OPEFB compost and limestone. The result shows that the combination of treatments in terms of plant types and media composition yields the highest growth, with a weight of 286.25 g in T2K1 treatment. This involves Eceng gondok and a media composition of compost to limestone in a ratio of 50% to 50%. Moreover, Mendong exhibits the highest absorption of Fe metal, with a value of 0.82 g, followed by Eceng gondok with 0.55 g, while Melati displays the lowest at 0.38 g. Regarding the absorption of Mn, Eceng gondok demonstrates the highest uptake, measuring 0.36 g, followed by Melati and Mendong at 0.11 g and 0.06 g, respectively.

Key words: AMD, phytoremediation, OPEFB, constructed wetland.

1. Introduction

Coal mining is a mineral extraction activity that involves excavating the surface of the earth using heavy equipment or the blasting method. The open pit mining system employed in the process can result in significant alterations to the natural topography, leading to a reduction in environmental quality. Additionally, one of the adverse consequences of mining is the emergence of AMD [1]. The formation of AMD is influenced by three main factors, namely water, air, and materials containing sulfide minerals. Dissolved pyrite compounds cause the pH of the water to decrease and also have high Fe and Mn elements [2].

AMD occurs in coal mining activities as rainwater or groundwater mixed with rocks containing certain sulfides in coal, which causes water to be very acidic and contains high concentrations of iron and manganese [3].

Corresponding author: Agung Laksana, S. Si., research field: environment management, phytoremediation.

One method for dealing with pollution due to AMD is phytoremediation. This biotechnology is used to repair certain contaminants in soil, sediment, dirt or silt, groundwater, surface water, and wastewater. Plants with the potential as phytoremediation agents include *Eichornia crassipes*, *Eleocharis dulcis*, *Typha latifolia*, *Salvinia* sp., *Fimbritylis globulosa*, and *Chrysopogon zizanioides* [4].

Eichhornia crassipes has a fast growth rate, hence the plant is considered a weed that can damage the aquatic environment. *Eichhornia crassipes* floats in water and takes root in the ground. The ability to adapt and grow quickly makes water hyacinth a good phytoremediator. *Eichhornia crassipes* has been proven to reduce pollution caused by AMD (Acid Mine Drainage) [5]. Meanwhile, *Echinodorus palaefolius* can absorb and decompose pollutants which can reduce the pollutant content. It also absorbs oxygen and air through the leaves, stems, and roots released back into the area around its roots (rhizosphere). This happens because the plant has spaces between cells or air passages as a transport medium from the atmosphere to the roots. The oxygen released by this water jasmine is used by microorganisms in decomposing organic matter [6]. *Fimbritylis globulosa* is a hyperaccumulator plant that can extract heavy metals due to its fast growth, and high resistance. Mendong is also used for phytoremediation to reduce iron, manganese, and mercury levels in mine wastewater. It is reported that the plant can reduce mercury levels in the wastewater of people's gold mines. The concentration of mercury in the gold mine before treatment with *Echinodorus palaefolius* was 4.019 mg/L. Subsequently, the concentration of mercury dropped to 0.170-0.340 mg/L. The highest absorption at 96% was found in the treatment using 2 kg of *Echinodorus palaefolius* [7].

Constructed wetlands are wastewater treatment systems that use vegetation, soil, and microorganisms to replicate natural wetland processes. There are two main types of waste treatment systems, namely: surface (Surface Flow Constructed Wetland or FWS) and sub-surface flow systems (Sub-Surface Flow Constructed Wetland or SSF-Wetlands). Surface-flow artificial wetlands offer a range of advantages over sub-surface artificial wetlands, including lower construction and operating costs, simpler design, improved flow control, and other benefits [8].

OPEFB (Oil Palm Empty Fruit Bunches) can improve the physical, chemical, and biological properties of the soil when administered in large quantities. The waste can be used as a source of organic fertilizer needed by soil and plants. OPEFB has a fairly high nutrient content such as N, P, and K, and a pH of 10.9 [9]. The availability of empty fruit bunches as a source of organic matter in South Sumatra is very abundant, considering there are 73 oil palm processing factories operating in the area. The availability and abundance of palm bunches must be considered when considering their use as a material for AMD. The quality of the organic matter contained within the palm bunches must also be evaluated before their use in AMD treatment. Recent studies have demonstrated that OPEFB possesses the ability to reduce turbidity and metal content in water, particularly iron (Fe) and manganese (Mn). The presence of functional groups, including hydroxyl and carboxylic acids, is thought to be the primary mechanism behind the adsorption of dyes and metal ions through chelation. Metal ions, such as iron (Fe), manganese (Mn), and lead (Pb) experience strong adsorption to increase the stability of the bonds [9].

2. Materials and Methods

2.1 Materials and Methods

This study was conducted at the Greenhouse of the Department of Biology, Faculty of Mathematics and Natural Sciences (MIPA) of Sriwijaya University from August to September 2022. AMD samples were taken from void PIT 2 PT. Baturona Adimulya, Musi Banyuasin Regency. Furthermore, measurement of the parameters of acid mine water under South Sumatra Governor Regulation No. 8 of 2021 was carried out at the Environmental Laboratory, South Sumatra Province.

Eichhornia crassipes, *Echinodorus palaefolius*, and *Fimbritylis globulosa* were taken from wetlands in Ogan Ilir Regency while the Organic Material of Empty Oil Palm Bunches was obtained from the Palm Oil Plantation of PT. Guthrie Pecconina Indonesia III, Musi Banyuasin Regency.

2.2 Experimental Design

This study used a CRD (Completely Randomized Design) with two treatment factors. The first factor was the type of aquatic plants, namely Water Hyacinth (*Eichhornia crassipes*), Water Jasmine (*Echinodorus palaefolius*), and Mendong (*Fimbritylis globulosa*). The second factor was the ratio of empty palm fruit bunches compost to limestone at 25%:75%, 50%:50%, and 75%:25%, respectively. The experiment involved treating each type of aquatic plant with varying ratios of empty palm fruit bunch compost to limestone, with each treatment being repeated three times. The control treatment consisted of a comparison of empty palm fruit bunch compost without any aquatic plants.

2.3 Data Analysis

Data obtained from observations were analyzed using ANOVA (Analysis of Variance) to test the effect of concentration on the parameters. The LSD (Least Significant Difference) test with a level of 5% was performed when the ANOVA results had a significant effect.

3. Results and Discussion

3.1 Analysis Result of AMD

AMD used was obtained from the void of PIT 2 PT. Baturona Adimulya, located in Musi Banyuasin Regency, South Sumatra. The quality was determined by analyzing its Fe, Mn, TSS, and pH levels in PT. Binasawit Makmur. Samples of AMD were obtained using the grab method, in which the waste was collected in jerry cans at specific time intervals. Similarly, samples for testing the quality of AAT were obtained by collecting them from the voids.

The results of the AMD quality test can be seen in Table 1 and the pH value of the waste is very low at 4.0 causing acidity. The pH data show that AMD originating from voids is a "net acid" type acid mine water. This can be seen from the low pH, which is < 4.5, where at pH < 4.5 the alkalinity can reach zero [10]. Furthermore, the high acidity of AMD also causes metal to dissolve Fe and Mn. The Fe content of 1.87 mg/L and Totas Suspended Solid of < 13.5 mg/L met the quality standard while the Mn metal parameter of 10.88 mg/L still exceeded the quality standard. For 4 parameters analyzed, only Fe and TSS have met the quality standards, while pH and Mn exceeded the quality standards stipulated in the Minister of Environment and Forestry Regulation No. 5 of 2022 concerning Wastewater Treatment for Businesses and/or Activities Mining Using the Artificial Wetland Method.

3.2 Laboratory Analysis Result of Compost of OPEFB

The results of the content of N, P, K, Fe, and Mn on OPEFB are presented in Table 2.

Based on the analysis in Table 2 above (check the table), OPEFB compost has a relatively high Fe metal with a value of 2,830.62 mg/kg and Mn metal of 139.02 mg/kg. Meanwhile, the N, P, and K contained in OPEFB compost are very useful as a nutrient source for aquatic plants.

Table 1 Result of analysis AMD in laboratory.

Parameter	Analysis result	Standards*
pH (unit)	4	6-9
TSS (mg/L)	< 13.5	400
Fe (mg/L)	1.87	7
Mn (mg/L)	10.88	4

* PermenLHK No. 5 of 2022 concerning Wastewater Treatment for Mining Businesses and/or Activities Using the Artificial Wetland Method.

Table 2 Laboratory analysis result.

Result				
N	P	K	Fe	Mn
(%)	(%)	(%)	(mg/kg)	(mg/kg)
2.02	0.190	0.21	2,830.62	139.02

Table 3 Aquatic plants biomass.

Treatment	Observation parameters after application				
	Biomass of aquatic plants (g)	Fe reduction (g)	Mn reduction (g)	pH enhancement (Unit)	TSS enhancement (mg/L)
T1K1	143.75[b]	8.03	8.46	2.00	1,006.75
T1K2	197.5[b]	6.98	9.30	2.25	540.00
T1K3	150.00[b]	4.98	9.92	2.50	1,134.00
T2K1	286.25[b]	2.17	9.55	2.00	308.00
T2K2	282.50[b]	2.76	10.04	1.75	568.50
T2K3	235.00[b]	2.76	10.39	2.00	537.50
T3K1	27.50[a]	2.95	9.51	2.50	377.50
T3K2	52.50[ab]	0.99	10.15	2.50	85.75
T3K3	27.50[a]	1.15	10.41	2.50	29.50

* T1: *Eichhornia crassipes*, T2: *Echinodorus palaefolius*, T3: *Fimbritylis globulosa*
K1: 25% compost: 75% limestone, K2: 50% compost: 50% limestone, K3: 75% compost: 75% limestone

3.3 Aquatic Plants Biomass

In this study, the effect of the treatment on the growth response of the three aquatic plants was measured based on the total growth weight in units of grams after treatment for 30 days. The total weight of growth was calculated by subtracting the weight after treatment from before.

Based on the results, it can be concluded that the growth response of aquatic plants in the constructed wetland system was significantly influenced by the type and ratio of the compost and limestone used. The treatments that used a higher ratio of limestone (superscript 'a' or T3K1 and T3K3) showed a lower growth response compared to others. On the other hand, the treatments that used a lower ratio of limestone (superscript 'b' or T1K1, T1K2, T1K3, T2K1, T2K2, and T2K3) showed no significant difference in growth response, with the T2K1 treatment showing the highest. And treatments that used same ratio of compost and limestone (superscript 'ab' or T3K2) showed no significant difference in growth response with (superscript 'b' or T1K1, T1K2, T1K3, T2K1, T2K2, and T2K3) and (superscript 'a' or T3K1 and T3K3). Therefore, a lower ratio of limestone is more suitable for the growth of aquatic plants in constructed wetland systems. The study also showed that Melati air and Eceng gondok are suitable aquatic plants for constructed wetland systems due to their fast growth rate and ability to use nutrients in the planting medium. The compost from OPEFB also proved to be a good source of nutrients for the plants, specifically nitrogen, phosphorus, and potassium. Overall, the study provides valuable insights for the development of effective and sustainable wastewater treatment systems using constructed wetlands [11].

3.4 Effect of Treatment Combinations on Reduction of Fe (Only One Table above Is Used)

In Table 3, the effect of the combined treatment factors on the reduction of Fe was significantly different between T1K1, T1K2, T1K3, T2K1, T2K2, and T2K3 to T3K1. Meanwhile, the T3K2 treatment was not significantly different from the T1K1, T1K2, T1K3, T2K1, T2K2, T2K3 and T3K1. The findings reveal that the optimal consecutive reduction of Fe was achieved through the combination of various treatments. Specifically, treatment T1K1 at 8.03 mg/L, T1K2 at 6.98 mg/L,

T1K3 at 4.98 mg/L, T3K1 at 2.95 mg/L, TT2K1 at 2.17 mg/L, T3K2 at 0.99 mg/L, and T2K2 and T2K3 at 2.76 mg/L produced significant results. The variance in the decrease of Fe observed in each treatment was primarily attributed to the distinct plant types employed, which exhibited varying abilities in Fe absorption. Additionally, the media composition used also played a significant role in the outcome of the treatments.

The highest result of Fe reduction by the aquatic plants shown in Table 3 above was *Eceng gondok*, with a reduction of 8.03 mg/L. The utilization of this plant's capabilities in wastewater treatment, specifically in the context of AMD, is widely recognized due to its remarkable efficiency. *Eceng gondok* (water hyacinth) exhibits favorable properties, making it an excellent choice for such applications. This plant possesses the ability to effectively absorb heavy metals and sulfide compounds. Moreover, it boasts a protein content exceeding 11.5% and a significantly higher cellulose content of 64.51% compared to non-cellulosic components like lignin, ash, fat, and other substances [12]. *Eceng gondok* can be used to remove pollutants, because of its function as a biological filtration system, removing mineral nutrients, to remove heavy metals such as cuprum, aurum, cobalt, strontium, lead, and tin. In addition, water hyacinths can absorb heavy metals such as Fe and Mn [13].

For the T1K1 treatment, the final Fe content was 8.03 mg/L above the quality standard of 7 mg/L. This may be caused by the uncovering of the surface of the water in the treatment with plants, causing the re-oxidation of the metal sulfide formed and increasing the concentration of Fe metal. The increased concentrations of Fe and Mn were caused by biotic, abiotic, and photo-oxidation of metal sulfides on the surface of the wetlands [14].

3.5 The Effect of Treatment Combinations on the Reduction of Mn

From Table 3 above, the combined factors between treatments were not significantly different. The experiment resulted in the highest and lowest metal reduction in the T2K3 and T1K1 experimental combinations of 10.39 mg/L and 8.46 mg/L, respectively. Variations in the reduction of Mn metal occur because each type of aquatic plant has different abilities.

In Indonesia Minister of Environment Regulation No. 5 of 2022 concerning Wastewater Treatment for Mining Businesses and Activities Using the Construction Wetland Method, the quality standards for Fe and Mn metals are 7 mg/L and 4 mg/L. The Mn content at the end of the treatment (day 30) was above the quality standard due to the high Mn content in the OPEFB compost used. The results of laboratory analysis showed that the Mn content is 139.019 mg/L.

The combination of treatments (type of aquatic plants and media composition) resulted in almost the same decrease in Mn. This is because compost is mature organic material containing humus and can be used to minimize heavy metals. The substances in compost include humic and fulvic acids used to adsorb heavy metals due to the carboxyl or –COOH functional group. In decomposed compost, the functional groups are subjected to a deprotonization process to release the H^+ ions from the compounds and the functional groups will be negatively charged. This is the mechanism that occurs in the binding of the heavy metals Fe and Mn by organic matter. Furthermore, compost containing humic substances (fulvic acid, humic acid, and humin) can adsorb heavy metal complexes through cation exchange, chelation formation, and electrostatic bonding [15].

3.6 The Effect of Treatment Combinations on pH Enhancement

The combined treatment in the experiments carried out is presented in Table 3. In the table, changes in pH resulted in an increase that was not significantly different between treatments with each value increasing in T1K1, T1K2, T1K3, T2K1, T2K2, T2K3, T3K1, and T3K2 by 2, 2.25, 2.50, 2.0, 1.75, 2.0, 2.50 and 2.5, respectively.

Under stagnant conditions, a reduction process takes place whereby Fe^{3+} ions are transformed into Fe^{2+}. This process releases OH ions, which subsequently combine with H^+, resulting in a decrease in ion acidity and an increase in pH. Compost as an organic material subjected to maturation, is rich in organic acids. Sulfate-reducing bacteria use these organic acids as electron donors, thereby expediting the sulfate reduction process and facilitating a more pronounced pH increase. Furthermore, the pH of the water rises proportionally with an increased composition of compost in the mixture.

3.7 The Effect of Treatment Combinations on TSS Enhancement

The effect of plant factors in the experiment on Fe metal uptake was significantly different between the three types of plants used in the experiment. The highest absorption of Fe metal was 0.82 g using T3 (*Fimbritylis globulosa*), 0.55 g using T2 (*Eichhornia crassipes*) and the lowest was 0.38 g using T1 (*Echinodorus palaefolius*). From the treatment, plant species had a significant effect on metal uptake with different absorption between T1, T2, and T3.

For the effect of plant species on Mn metal uptake in the treatment, the table 3 shows significantly different results between the three media used. Plants T1, T2, and T3 differ significantly in absorbing Mn metal. Plant factors also have a significant effect on the reduction of Mn metal, where the Fcount is greater than Ftable. The highest Mn absorption by T2 (*Eichhornia crassipes*), T1 (*Echinodorus palaefolius*), and T3 plants (*Fimbritylis globulosa*) was 0.36 g, 0.11 g, and 0.06 g, respectively.

4. Conclusion

1. The study evaluated the effects of different combinations of aquatic plants and media composition on plant growth. Among the treatments, T2K1, which comprised *Eceng gondok* and compost-limestone mixture in a 50:50 ratio, yielded the highest growth, reaching a weight of 286.25 g. It can be inferred that the use of this combination can be a promising strategy for enhancing aquatic plant growth.

2. Among the aquatic plants evaluated, Mendong exhibited the highest absorption of Fe metal, with a recorded value of 0.82 g. *Eceng gondok* followed with an absorption of 0.55 g, while Melati air demonstrated the lowest at 0.38 g. These findings highlight the varying capacities of different aquatic plant species in absorbing Fe metal, with Mendong displaying the greatest potential for this function.

3. *Eceng gondok* exhibited the highest absorption of Mn, with a recorded value of 0.36 g. Melati air followed with an absorption of 0.11 g, while Mendong displayed the lowest at 0.06 g. Therefore, *Eceng gondok* may be a more effective option for Mn absorption compared to Melati air and Mendong.

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Probabilistic Study of Landslide Susceptibility in the Sagrado River Watershed, Brazil

Maiely Minozzo and Vitor Pereira Faro
Federal University of Paraná, Curitiba-PR, 82590-300, Brazil

Abstract: In this paper, we present a probabilistic study of landslide susceptibility at the Sagrado River Watershed in Morretes, Brazil. The area is characterized by slopes higher than 20% in a large part of the relief, variable soil depths, and by strong rainfall intensities due to orographic rains. Taken together, these factors promote the occurrence of translational landslides. Anthropic occupation is distributed along the lowlands and on the less inclined slopes of the Serra do Mar. The infinite slope method was used to determine the distribution of susceptibility to landslides. Input parameters of the model consisted of geotechnical soil parameters, soil layer thickness, slope of the hillside, and matric suction, and the analysis implemented a Monte Carlo probabilistic method. As such, this method allows the quantification of uncertainties due to the variability in geotechnical parameters, which enables the determination of a probability of rupture. The elaboration of susceptibility maps to landslides for unsaturated soil conditions represents a useful tool to support the identification of critical events occurrences in this location.

Key words: Monte Carlo method, landslides, susceptibility assessment, probabilistic analysis.

1. Introduction

Gravitational mass movements are natural processes that are part of the geomorphological evolution of mountain regions. In Brazil, these mass movements are common and recurrent in the south and southeast regions, mainly in the Serra do Mar region. However, the growth of disordered urban occupation in hillside areas has caused a progressive increase in the number of geological accidents associated with these processes. In March 2011, there were more than 2,500 geological accidents on the coast of the State of Paraná [1]. From 1988 to 2022, mass movement resulted in the deaths of 4,146 people, and is the geological process that caused the most fatalities in Brazil [2].

Due to recurring disasters in Brazil, Federal Law No. 12,608 [3] was introduced in 2012 providing guidance for the National System of Civil Defense and Protection and the National Council for Civil Defense and Protection. Additionally, Federal Law No. 12,608 authorized the creation of a disaster information and monitoring system. This law encouraged the Union, states, and cities to adopt necessary actions to reduce the risks caused by natural disasters.

The topography, geology, geomorphology, and processes that lead to instability of an area and the properties and resistance of the soils must be evaluated to carry out adequate analysis of susceptibility to landslides. Due to their high degree of uncertainty, geotechnical problems have been treated through probabilistic analyses. For slope stability studies, probabilistic analyses are conducted using the variability of geotechnical parameters and rainfall events. Furthermore, the use of GIS (Geographic Information Systems) enables the georeferencing of the collected data and assists in the environmental and territorial decision-making processes.

1.1 Definition of the Study Area

The Sagrado River Watershed, with an area of approximately 58.62 km², is located in the city of Morretes, in Serra do Mar (between coordinates UTM-

Corresponding author: Maiely Minozzo, B.S., Civil Engineering, research field: landslides and laboratory tests.

E 714.043 and 724.997 and UTM-S 7.173.191 and 7.164.240, time zone 22S).

This watershed is characterized by high slopes, shallow soil depth, frequent vegetation removal by humans and significant orographic rainfall. These conditions promote the occurrence of translational landslides [4]. The anthropic occupation in the Sagrado River Watershed is distributed in the valley bottoms and lower slopes of the hills adjacent to the Serra do Mar.

This area is formed by large deposits of colluvium and talus. The colluvium in this region is highly unstable, prone to planar and rotational landslides, can deliver large volumes of sediment, and form debris flows. Despite being more stable than the colluvium, the talus has a high probability of toppling blocks, providing sufficient material for mass flow. The combination of these unstable materials with high slopes and the vegetation removal results in favorable conditions for gravitational mass movements with high destructive power [1].

2. Material and Methods

The landslide susceptibility distribution is based on infinite slope method, derived from Fiori and Carmignani [5]. Any slope of great extension and with the same soil profile can be considered a slope of unlimited extension. The slope consists of a soil mass subjected to forces due to the weight of material, forces due to water flow, and forces due to shear resistance. These forces act in equilibrium, since the first two add up and tend to move the massif downwards, while the latter resists this movement.

The safety factor of a slope can be calculated using Eq. (1).

$$FS = \frac{C_S + (u_a - u_w)tan\phi^b + \left[\left(\gamma - \frac{h_w}{h}\gamma_w\right) h \cos i\right] tan\phi}{(h\ \ \gamma) \sin i} \quad (1)$$

where C_S represents the cohesion of the soil (kPa); ϕ is the friction angle (degrees); γ is the unit weight of soil (kN/m^3); γ_w represents the unit weight of water (kN/m^3); h_w is the depth of the saturated soil zone perpendicular to the hillside (m); h is the soil thickness perpendicular to the hillside (m); i is the slope of hillside (degrees); $(u_a - u_w)$ is the matric suction, and ϕ^b represents a parameter that quantifies an increase in resistance due to an increase in suction.

The input parameters of the model consist of the geotechnical parameters of the soil, soil layer thickness, slope of the hillside, and matric suction. To simplify the model, the present analysis omitted the pressure portions of the weight of vegetation on the slopes and the pressure exerted by the wind on the vegetation cover. The saturated soil zone depth was also omitted, as it is generally understood that the water level has no influence on the safety factor in flat areas or in places where the water level is outcropping. In areas with a significant slope, the water level is deep enough so that it does not reach the failure surface adopted in this study [6].

The geotechnical parameters of the soil were determined from laboratory tests of characterization and resistance, and data from previous research. The failure surface depths were estimated from a helicopter flyover of the Sagrado River Watershed. The slope map was prepared from the DEM (Digital Elevation Model) provided by ITCG (Institute of Land, Cartography and Geology of Paran á).

To verify the influence of slope on the susceptibility distribution, Table 1 was used to classify the slope map.

The landslide susceptibility distribution was based on an algorithm developed in Python and inserted into a GIS environment. The algorithm generates the

Table 1 Classification of land relief [7].

Land relief class	Slope (%)
Flat	0-3
Soft wavy	3-8
Wavy	8-20
Strong wavy	20-45
Mountainous	45-75
Steep	>75

necessary files for calculating FS based on the infinite slope method. The generated files are saved in a File Geodatabase (*.gdb) and from this *.gdb the calculation of the probability of occurrence of unstable areas starts from the scenarios generated through Monte Carlo simulations. The variable input parameters used to generate the scenarios are estimated from random numbers within a pre-established range of values. Since the input parameters are independent, that is, the value of one parameter does not influence the value assumed for the other. The developed algorithm is divided into three stages.

2.1 Raster Creation from the Initial Parameters

The average of the unit weight, cohesion, and friction angle parameter values obtained for a given coordinate within the Sagrado River Watershed through laboratory tests were spatialized through a map simplification of rocky substrate and unconsolidated material. The soils were classified according to their origin as sedimentary or residual; however, the group of residual soils was further subdivided based on the original rock due to the significant difference in the properties of the resulting soils. In this way, the following division was obtained: sedimentary soil, residual granite soil, and residual diabase soil.

The value of the suction parameter was determined from the average of data in the literature for a tensiometer installed in Serra do Mar [8-13]. Fixed values of soil depth, unit weight of water, and suction were used for all soils present in the watershed in the form of raster files. These were generated by the algorithm based on the slope raster inserted at the beginning of the model.

2.2 Variation of the Input Parameters and Calculation of the Factor of Safety, FS

The variation ranges of the cohesion and friction angle parameters were given from statistical data analysis obtained in the laboratory and literature. The standard deviations were obtained for each of the soil classes considered, and then the number of pixels present in each of the classes was verified. A weighted standard deviation was carried out to obtain a single range of variation for all soils.

Once the variation range of each of the input parameters has been defined, the safety factor was calculated for each pixel from random variables within the pre-established range of values. When the pixel safety factor was less than 1, the pixel was coded as 1, and when the value of the safety factor was greater than or equal to 1 in a given pixel, it was coded as a 0. Said another way, safety factors considered stable did not make up the sum for determining the probability of rupture. This process was repeated until the established number of iterations was obtained.

2.3 Probability of Rupture

At the end of the iterations, each pixel had a probability of rupture given by Eq. (2).

$$P = \frac{n_i}{n} \tag{2}$$

where P represents the probability of rupture; n_i is the probability of the event occurring or the sum of the number of unstable safety factors; and n is number of elements of the event, namely, number of iterations.

The result of the simulation consisted of a raster of failure probabilities that were classified according to Table 2 to obtain the susceptibility map to landslides of the studied area.

Probability of unsatisfactory performance is the probability that the value of performance function will

Table 2 Adaptation of classification of susceptibility from the reliability indices [14].

Probability of unsatisfactory performance	Degree of susceptibility
0-0.0000003	Null
0.0000003-0.00003	Very low
0.00003-0. 001	Low
0.001-0.006	Below average
0.006-0.023	Average
0.023-0.07	Above average
0.07-0.16	High
0.16-1.0	Very high

approach the limit state or that an unsatisfactory event will occur.

Based on the normal distribution function, the input parameters were classified into fixed parameters and variable parameters. Cohesion, angle of friction, and suction were defined as variable parameters, and fixed parameters were slope inclination, thickness of the soil layer, and unit weight of the soil.

Validation of the susceptibility distribution was obtained from records of landslides in the Sagrado River Watershed from the ITCG database and on-site visits.

3. Results and Discussion

To determine the standard deviation of the input parameters of cohesion and friction angle, data compiled from the literature on soils with the same characteristics as those studied in the Sagrado River Watershed were used [6, 12-13, 15-18].

The values used in the model correspond to the average of the samples for the diabase residual soil due to the absence of laboratory tests. As for sedimentary and residual granite soils, the weighted average of the results of laboratory tests performed with samples obtained in the field was used. The standard deviation corresponded to the weighted average of the standard deviation for each type of soil.

The depth of the soil layer used in the model was 4 m. This value was determined based on the average of estimated depths in the landslide inventory of the Sagrado River Watershed and validated by literature data for translational landslides.

Susceptibility maps were generated after 385 iterations, after which it was considered that there was no significant variation in the susceptibility map based on pixel sensitivity analysis.

The summary of the model's input parameters is presented in Table 3.

Input raster generated determining the probabilistic distribution of susceptibility to gravitational mass movements in the Sagrado River Watershed is shown in Fig. 1.

From the comparison between the results obtained for the susceptibility map and with the slope, it was noted that areas with high and very high susceptibility occurred only in reliefs considered mountainous and steep. It was also observed that below average, average, and above average susceptibility classes occur practically only in mountainous relief. Slopes lower than 45% did not influence the determination of susceptibility, as they presented null susceptibilities.

Subsequently, the "buffer" tool was used in the GIS environment to analyze landslides and residences. When comparing the landslide points with the susceptibility map, it was observed that only 34.5% of the movements occurred in unstable areas, being: 5.6% in below average susceptibility areas, 3.0% in average areas, 4.3% in areas of above average susceptibility, 7.3% in high and 14.3% in areas of very high susceptibility. Therefore, 65.5% of mass movements in the area with susceptibility to gravitational mass movements are considered null.

The results of the quantitative analysis of the occurrence of each susceptibility class in terms of percentage of area is shown in Fig. 2.

For validation consideration, when only the polygons resulting from the mapping of scars from the 2011 event were used, the percentage of null susceptibility area affected by landslides decreases to 55.1%. Thus, the susceptibility distribution in unstable areas becomes: 6.3% in below average susceptibility areas, 3.2% in average areas, 6.3% in above average susceptibility areas, 10.8% in high susceptibility and 18.3% in areas of very high susceptibility.

Table 3 Summary of the model's input parameters.

Type of unconsolidated material	Cohesion (kPa)	Friction angle (degree)	Unit weight (kN/m^3)	Suction (kPa)
Sedimentary soil	15.0 ± 6.0	27.0 ± 6.0	16.3	9.0 ± 7.0
Residual soil—granite	7.0 ± 6.0	38.0 ± 6.0	16.8	9.0 ± 7.0
Residual soil—diabase	11.0 ± 6.0	28.0 ± 6.0	14.1	9.0 ± 7.0

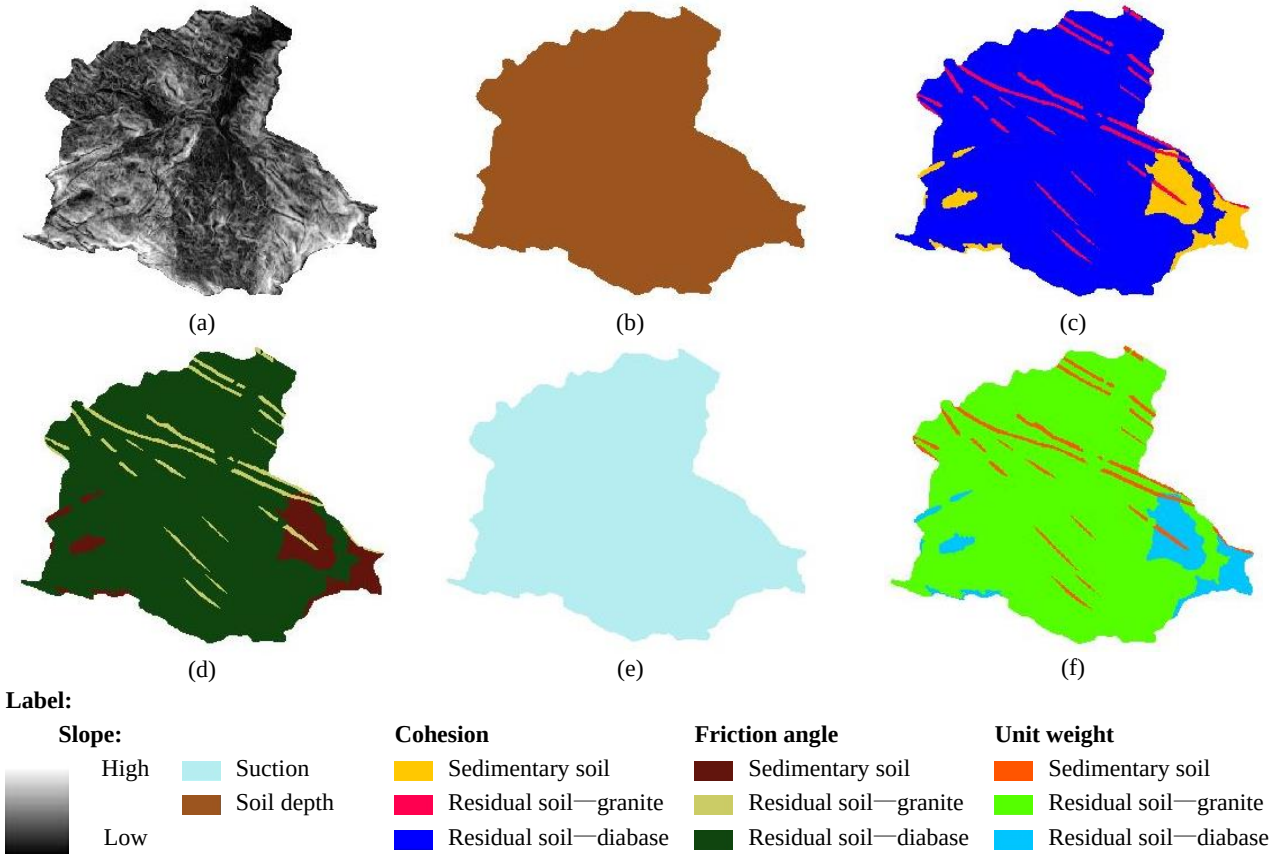


Fig. 1 Input raster. (a) slope; (b) soil depth; (c) cohesion; (d) friction angle; (e) suction; (f) unit weight.

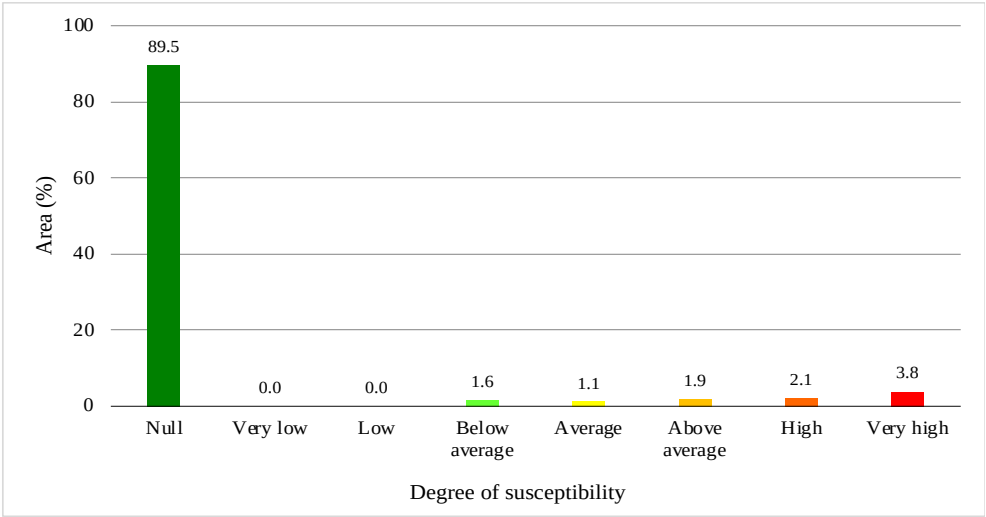


Fig. 2 Distribution of susceptibility classes.

3.1 Back Analysis

Due to the low representativeness of the map generated for the Sagrado River Watershed for the unsaturated soil condition, a back analysis of the resistance parameters for this soil saturation condition was also conducted, considering the same criteria as the original analysis. Table 4 presents the summary of the input parameters used in the back analysis, and Fig. 3 illustrates the susceptibility map obtained as a result of the back analysis with a 30%* reduction in resistance parameters.

Table 4 Summary of the model's input parameters.

Type of unconsolidated material	Cohesion (kPa)	Friction angle (degree)	Unit weight (kN/m^3)	Suction (kPa)
Sedimentary soil	10.5 ± 6.0	18.9 ± 6.0	16.3	9.0 ± 7.0
Residual soil—granite	6.0* ± 6.0	26.6 ± 6.0	16.8	9.0 ± 7.0
Residual soil—diabase	7.7 ± 6.0	19.6 ± 6.0	14.1	9.0 ± 7.0

* The reduction of the cohesion parameter of the granite residual soil was restricted to 25% of the initial value due to the limitation of null cohesion.

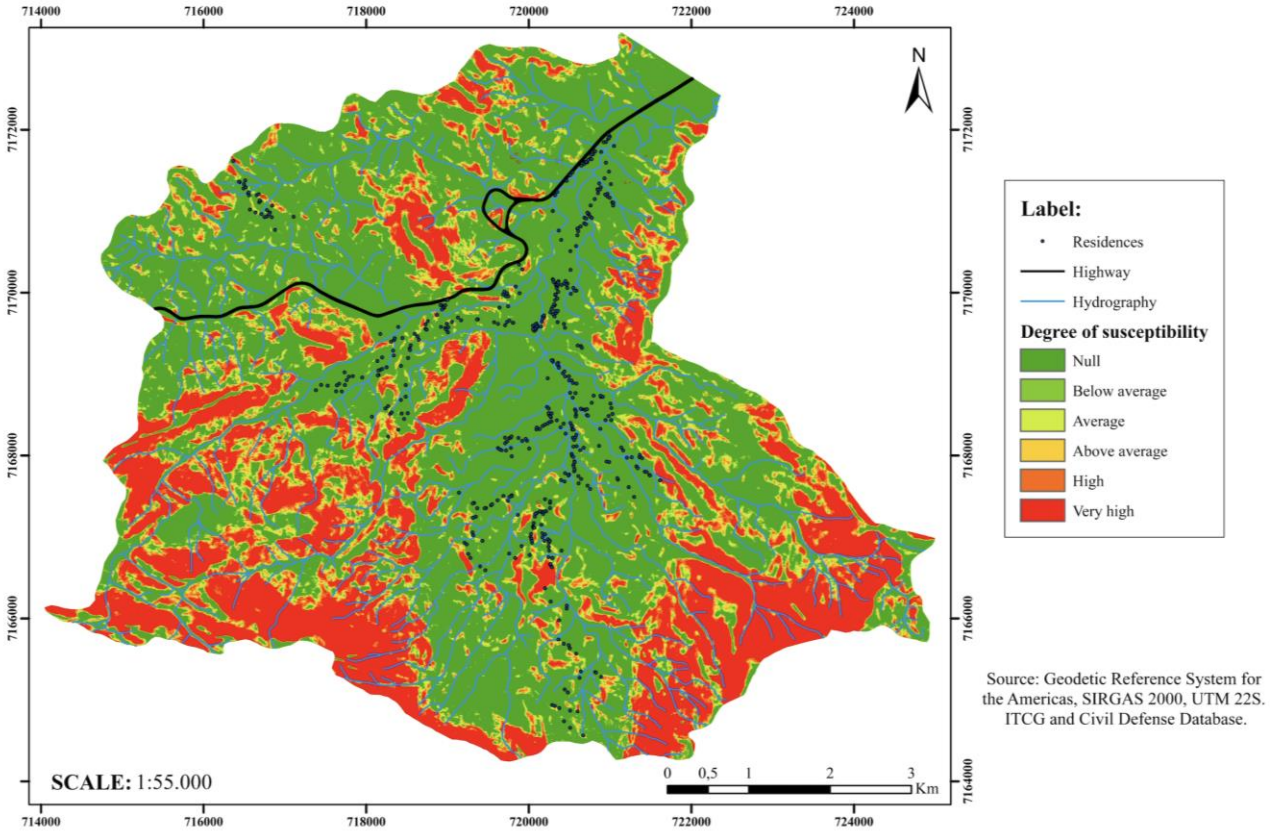


Fig. 3 Landslide susceptibility map obtained from back analysis of resistance parameters.

Fig. 4 summarizes the results of the quantitative analysis of the susceptibility class occurrences in terms of percentage of area from the back analysis. When comparing these values with the percentages obtained with the original parameters, we see a reduction of 32% in the area that was considered null susceptibility. The increase in the area of very high susceptibility was approximately 17%, evidenced by the fact that the parameters obtained in the laboratory do not reflect *in situ* characteristics. Moreover, suction significantly influences the susceptibility of the region since it increases the soil resistance to shear.

Comparing the points of slippage with the susceptibility map generated with a 30% reduction in the resistance parameter values, it is observed that the distribution of susceptibility in the scars of the landslides became: 12.8% in an area of null susceptibility, 2.8% in below average susceptibility, 4.6% in average areas, 4.9% in areas of above average susceptibility, 8.7% in high susceptibility and 66.2% in areas of very high susceptibility. Therefore, 87.2% of gravitational mass movements occurred in unstable areas, a significant increase in adherence when compared to the map generated with parameters obtained in the laboratory test.

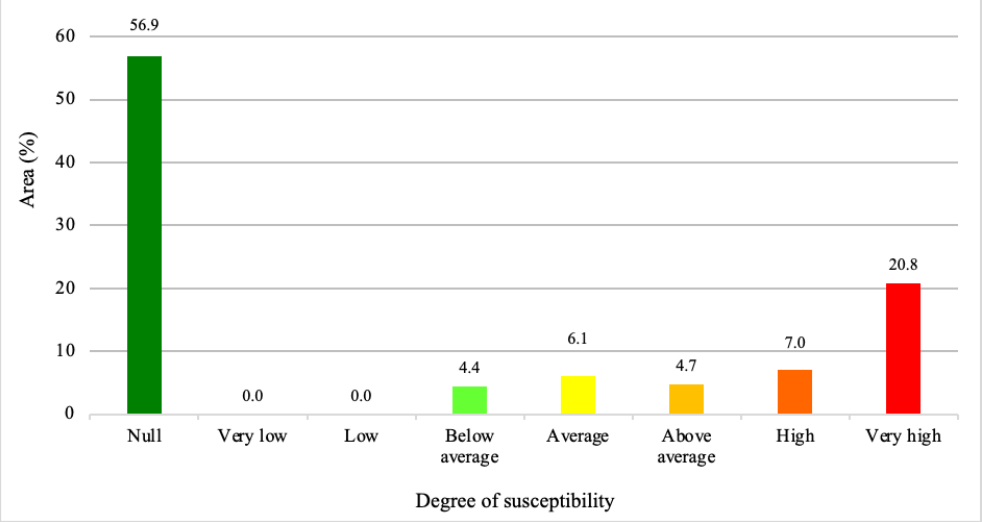


Fig. 4 Distribution of susceptibility classes resulting from the back analysis.

Regarding the areas of registered residences in the Sagrado River Watershed, we found that 95.4% of the area in places of null susceptibility, 1.4% in areas of below average susceptibility, 1.2% in places of average susceptibility, 0.5% in above average susceptibility, 0.6% in high susceptibility and 0.8% in areas of very high susceptibility. In summary, 4.6% of this area is in places with some degree of instability, showing the need to monitor residences in this location.

5. Conclusions

The elaboration of landslide susceptibility scenarios in the Sagrado River Watershed was the main challenge of this work, due to limited computational capacity which constrained cohesion, friction angle, and suction variable parameters, as well as the number of iterations. Despite the difficulties in determining the susceptibility distribution, the results obtained through the back analysis of the soil resistance parameters are considered satisfactory. Approximately 87.5% of the percentage of scar pixels mapped in areas have some degree of instability. Finally, it is concluded that the algorithm used for the elaboration of susceptibility map from the Monte Carlo probabilistic method, inserted directly in the GIS, has a high potential for development and enhancement to increasingly refine subsequent susceptibility analyses.

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First Successful Nesting of Black Oystercatchers among Endangered California Least Terns along the West Coast of North America

David L. Riensche[1,4], Ben Pearl[2] and Susan Ramos[3]

1. East Bay Regional Park District, 2950 Peralta Oaks Court, Oakland, California 94605, USA

2. San Francisco Bay Bird Observatory, 524 Valley Way, Milpitas, CA 95035, USA

3. Doug Siden Visitor Center at Crab Cover, East Bay Regional Park District, Alameda, CA 94501, USA

Abstract: A pair of Black Oystercatchers (*Haematopus bachmani*) established a nest in June 2022 at "Tern Town", an island located in Hayward, California along the eastern side of the San Francisco Bay. This is the first documented occurrence of oystercatchers successfully nesting and fledgling young in association with California Least Terns. The island provides nesting habitat for three special status species. Since 2015, and for a total of six breeding seasons, the endangered California Least Tern (*Sternula antillarum browni*), the threatened Western Snowy Plover (*Charadrius alexandrinus nivosus*) and species-of-special-concern Black Skimmer (*Rynchops niger*), have nested successfully, in association with American Avocet (*Recurvirostra americana*) and Black-necked Stilt (*Himantopus mexicanus*). We collected shells near the oystercatcher nest to assess their diet. Diet data showed the oystercatchers foraged on, in decreasing order of abundance, Japanese Little-necked Clams (*Ruditapes philippinarum*), Ribbed Mussels (*Geukensia demissa*), Bent-nose Clams (*Macoma nasuta*), Limpets (*Patellogastropoda sp.*) and Bay Mussels (*Mytilus edulis*). This new report on breeding Black Oystercatchers indicates that managing habitat for California Least Tern, Western Snowy Plover, and Black Skimmer can also benefit Black Oystercatcher. This site-specific information on breeding Black Oystercatchers supports recovery plan tasks that are consistent with managing habitat for California Least Tern, Western Snowy Plover and Black Skimmer.

Key words: Black Oystercatcher, reproduction, diet, endangered species, California Least Tern, Western Snowy Plover, Black Skimmer.

1. Introduction

The East Bay Regional Park District manages California Least Tern, Western Snowy Plover and Black Skimmer nesting habitat at the Hayward Regional Shoreline (37 °37′47″ N, 122 °8′46″ W), located along the eastern shore of San Francisco Bay along the West Coast of North America [1-3]. Black Oystercatchers have been documented nesting near gulls and terns (Sterna spp.) and have been observed using their bills to jab at other species chicks that wander into their territory [4, 5]. We conducted this study on Island Five (also known as "Tern Town") to document the first occurrence of Black Oystercatchers nesting within an active California Least Tern colony. The habitat area on Island Five was established for the endangered California Least Tern in 2001 and is 0.24 ha (0.6 ac) in size. Volunteers primarily built the island [2, 3] and the area is off limits to the public.

The California Least Tern (*Sternula antillarum browni*) is a migratory species, nesting along the Pacific Ocean beaches, lagoons, and bays of North America from Baja California north to the San Francisco Bay [6]. Least terns are typically on nesting colonies from mid-April through late September [7, 8]. Colony nesting density can vary from 3-7 nests per ha

Corresponding author: David L. Riensche, masters, main research fields: wildlife management, endangered species conservation and natural resources stewardship.

[9] to more than 145 nests per ha (1.9 ac) [10]. This bird was listed as a federally endangered species in 1970 [11, 12] and as a state endangered species in 1971 [13].

The Western Snowy Plover (*Charadrius alexandrinus nivosus*) is a small light grayish-brown shorebird with black legs and bill, that wears an incomplete dark breast band [8]. The Western Snowy Plover is federally listed as threatened and is a California Species of Special Concern [14, 15]. The Pacific Coast population of the Western Snowy Plover range extends from Damon Point, Washington, USA to Bahia Magdalena, Baja California, Mexico [16, 17].

The Black Oystercatcher, a large black shorebird with a bright red, chisel-shaped beak [8], is currently listed on Audubon's Priority Birds 2021 [18], which lists species of conservation concern; the species is particularly vulnerable to nest site disturbances or destruction, predators, and oil spills [19]. Additionally, it has been declared a special status species in the United States of America, Canada, and Mexico due to its small global population size (roughly 10,000 to 12,000 individuals), low overall reproductive success and complete dependance on rocky intertidal shorelines which are impacted by human use and sea level rise [19]. The species is uncommon within its range along the west coast of North America and is typically limited to the rocky intertidal. Their nesting habitat ranges from mixed sand and gravel beaches to exposed rocky headlands [4]. Paired members are known to use the same nest site for many consecutive breeding seasons and may remain together for years [4]. Common to all oystercatcher breeding habitat is the presence of low-sloping or level substrate for feeding [4]. Oystercatchers frequently forage in the mid-intertidal zone where sea mussel (*Mytilus californianus*) and bay mussel (*M. Trossulus*) are dense [20, 21]. Sea mussels taken by oystercatchers in California average 47 mm in length [21].

2. Methods

Nesting and reproductive success data (nest chronology, clutch size, hatching success) were collected using the Type 1 Colony Survey Method [22, 23]. In this method, permitted biologists entered the colonies twice a week to mark nests using numbered 5-cm diameter washers vertically cemented into a small plaster of Paris base. This type of intensive, in-colony monitoring yields data on clutch size, hatching and fledging success, and evidence of any predation. The oystercatcher diet data were gathered by collecting, identifying, and measuring dropped bivalves and mussels at their nest site to determine the percentage of prey fed to their offspring.

3. Results

The Black Oystercatcher established a nest on June 6, 2022, on the eastern edge of the "Tern Town" island (37.629739 N Lat., 122.146039 W Long.), located at the Hayward Regional Shoreline, in California, USA, and ultimately produced one fledgling (Fig. 1). The diet data that were gathered by collecting dropped bivalves and mussels at their island nest site showed that the percentage of prey fed to their offspring was composed of, in decreasing order of abundance, Japanese Little-necked Clam (*Ruditapes philippinarum*), Ribbed Mussel (*Geukensia demissa*), Bent-nose Clam (*Macoma nasuta*), Limpet sp. (*Patellogastropoda* sp.). and Bay Mussel (*Mytilus edulis*) (Table 1).



Fig. 1 Nesting Black Oystercatcher (*Haematopus bachmani*) at Tern Town located at the Hayward Regional Shoreline, California, USA. (Photographed by David L. Riensche).

4. Conclusion

The Black Oystercatcher is a locally fairly common resident of the rocky Pacific coastline [24] and known to breed in just a few locations within the East Bay Regional Park District, which manages landholdings in Alameda and Contra Costa Counties in California. The majority of identified nesting sites were in the Central San Francisco Bay, which provides some similar habitat conditions to the rocky intertidal. Nesting occurred at Bird Rock, a small rock adjacent to Brooks Island in the Richmond area of Contra Costa County, and at the West Brother Island near Pt. San Pablo [25]. Within Alameda County they have nested on the breakwater islands west of the United States Hornet at the former Alameda Naval Air Station, and they have also nested at Alameda's Ballena Bay (Ramos, personal observation), as well as along the Emeryville Crescent [26]. Black Oystercatchers have been documented breeding at two locations in the South San Francisco Bay, which provides a very different habitat from the rocky intertidal, including at Eden Landing Ecological Reserve, a California Department of Fish and Wildlife property located directly south of Hayward Regional Shoreline. Since 2016 they have nested at Eden Landing on a small island in pond E10 near riprap that provides suitable foraging habitat and were confirmed to fledge chicks in most years (Pearl, personal observation).

Young European Black Oystercatchers have been shown to exhibit high rates of breeding philopatry [27], and it has been hypothesized that American Black

Oystercatchers do as well [28]. Considering the proximity of the Eden Landing nest site to Hayward Regional Shoreline, it is possible that at least one of the oystercatchers from the "Tern Town" pair hatched in prior years from Eden Landing. Oystercatchers have also been documented nesting farther south in the bay in San Mateo County at pond SF2 in the Ravenswood Complex of Don Edwards SF Bay National Wildlife Refuge (Pearl, personal observation). These oystercatchers were first documented breeding at SF2 in 2018 when they nested on the same constructed island (island 17) as a colony of Caspian Terns (*Hydropogne caspia*) and Black Skimmers, and they have since nested on this and other islands in the pond each year (Pearl, personal observation). Riprap located in the pond and along water control structures provides suitable foraging habitat.

In central California more than 90% of Black Oystercatcher foraging habitat is washed occasionally by waves; wave-splashed mussels' gape more frequently and thus are more susceptible to oystercatcher attacks [21, 29]. In such locations, an individual bird visually locates a mussel with its shells partially separated, then quickly jabs its bill to sever the bivalve's adductor muscle. With the tip of its bill the bird either removes the soft parts of the mussel to consume on site or detaches the mussel from its substrate for processing elsewhere. Parenting birds will detach and carry whole mollusks away from the surf zone to feed their young [4]. The nesting pair of Black Oystercatchers at Tern Town carried whole mollusks, ranging from 334-712 m from a breakwater area adjacent to the Cogswell Marsh, at the Hayward Regional Shoreline, to feed their young (Fig. 2).



Fig. 2 Black Oystercatcher adult and chick (*Haematopus bachmani*) at Tern Town located at the Hayward Regional Shoreline, California, USA. (Photographed by David L. Riensche).

Table 1 Percentage of prey, determined from collections of used shells, in diet of a Black Oystercatcher (*Haematopus bachmani*) pair breeding in a California Least Tern Colony at Hayward Regional Shoreline, California, USA, 2022.

Prey species	Sample number	% of Diet	Average size
Japanese Littleneck Clam *Ruditapes philippinarum*	34	46.5	33.97 mm
Ribbed Mussel *Geukensia demissa*	23	31.5	61.74 mm
Bent-Nosed Clams *Macoma nasuta*	9	12	50.67 mm
Limpets *Patellogastropoda* sp.	5	0.06	20.6 mm
Bay Mussels *Mytilus edulis*	2	0.02	36 mm

While Black Oystercatchers are known to nest near gulls and terns (*Sterna* spp.), occasionally less than 3 m away [4, 5] this is the first documented occurrence within an active California Least Tern colony. Adult oystercatchers are known to use their bills to jab at gull or tern chicks that wander too close to their territory [4, 5], yet we witnessed no such incident. This site-specific information on breeding Black Oystercatchers near endangered California Least Tern, threatened Western Snowy Plover and species-of-special-concern Black Skimmer will assist in developing management programs that identify special site protection plans and aid in the recovery of these special status species.

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Stray Dogs Problem and Right Approach to Prevent Attack

Halil Ecel[1] and Serap Gönczü[2]

[1]*Department of Work Safety, the University of Çukurova, Adana 01330, Türkiye*

[2]*Department of Animal Science, the University of Çukurova, Adana 01330, Türkiye*

Abstract: In this study, it is aimed to examine the knowledge level of reading stray dogs' behavior and the correct approach. Understanding the aggression of dogs and understanding their behavior is very important for stray dogs and dog owners in social life. Questionnaires prepared online were shared with 279 people of different ages and genders working in different fields in 50 provinces located in different regions, and the feedback obtained by answering voluntarily was taken into consideration. As a result of the study, when a dangerous-looking dog is encountered, it is necessary to stay as calm as possible and start to walk away slowly, without losing sight of the dog, with short steps, and without running under any circumstances. But without turning your back, because turning your back on the dog is a sign of weakness and an invitation to attack. While 36% left unanswered the question of what should be done at the time of the dog attack, 20.1% replied by saying that they would stand calmly and shout and scare, and 20.9% would shout and stop. The results of the survey show that there are inaccuracies and deficiencies in both the body language of the dogs and the way they approach the dog. The participants answered the frequency of encountering stray animals by saying 75.9% daily. A safe approach to dogs or knowing the suitable approaches to calm a dangerous dog is very important in eliminating the dangers. These results show that there is a need for correct, informative activities on dog behavior and the right approach.

Key words: Stray dogs, problem, approach, knowledge.

1. Introduction

The man appeared on earth about a million years ago. It is reported that around 10,000 plant and animal species were domesticated to meet their specific needs and adopted a sedentary lifestyle [1]. For animals, domestication first started with dogs to warn the enemy or assist in hunting, and then sheep, goats, reindeer, cattle, donkeys, and giant house horses are thought to have been domesticated [2]. Dogs have always been seen as a friend in the transition from hunter-gatherer to settled life next to humans. The fact that the first dog breed was named 200 years ago during the domestication process of dogs and the establishment of breed standards suggests that man was the biggest factor in the evolution of the dog. Today, dogs still serve people in many areas, such as walking aid, shopping, drug detection, and guiding in earthquakes. However, dogs that are left unattended and born into city life carry a big problem.

The probability of the occurrence of hazards in terms of occupational health and safety is expressed as a risk. Risk assessment includes examining the environment and informing and educating the people living there about the risks. While performing risk analysis in any field, risk control steps are used to control and eliminate hazards and risks. There are six steps in risk control: elimination, replacement, separation, engineering methods, administrative controls, and personal protective equipment. The best way to control risk is to eliminate it. However, in some cases, the risks cannot be completely eliminated, in which case other steps are taken. A hazard is defined as a source, situation, or process that may cause injury to people, deterioration of health, damage to the environment, or a combination

Corresponding author: Serap Gönczü, PhD in Animal Science, Professor, research fields: cattle husbandry.

of these. Risk is the combination of the probability of a hazardous event or exposure occurring and the severity of the injury or ill health that the event or exposure may cause. Risk has two basic features, which are the probability of an undesirable event occurring and the effect of the occurrence of the risk on the result. With the increase in the number of stray dogs, the elements of danger and risk have increased. The magnitude of the risk arising from the danger of stray dogs can be understood from the cases experienced. For this reason, knowing the protection methods for stray dogs personally, in addition to what to do at the city level, is an important step in risk assessment.

The concept of stray animals is defined in the Implementing Regulation on the Protection of Animals. According to this, stray animal means “pets that have no shelter or are outside the boundaries of the owner’s or guardian's home and land and are not under the control or direct control of any owner or guardian”. These animals can be animals such as cats, dogs, birds, or turtles in general. While the regulations regarding stray animals are strictly enforced in Europe and the USA, those who do not comply with the rules receive heavy fines, and certain conditions are required to be met in order to adopt an animal. In addition, it is obligatory to pay taxes for those who keep pets and to receive training for certain species. In some countries, only animals on the list determined by the government can be adopted, while those outside the list cannot be adopted due to illness, safety, or health reasons.

In some countries, according to regulations made in recent years, people with 20 aggressive dog breeds such as Rottweilers or Pitbulls are required to undergo some training on the care of animals. In some places, dog species that are considered “dangerous” are required to be on a leash in public places. Those who do not comply with this rule are subject to fines. In addition, animal rights are guaranteed by the Animal Protection Law, and it has been determined how animals will be treated, how they will be housed, and what to do in case of emergency. There is no stray dog problem in the USA, EU member countries, England, Japan, Switzerland, and Australia. The legal regulations regarding the welfare conditions of dogs in these countries prevent this problem. In Turkey, the Animal Protection Law No. 5199 was adopted in 2004 in order to ensure the comfortable lives of animals, to treat animals well and appropriately, to ensure that animals are best protected against pain, suffering, and torture, and to prevent all kinds of victimization. Following this law, the Implementing Regulation on the Protection of Animals was issued in 2006. However, existing regulations do not provide for the welfare of stray dogs and are insufficient to solve the problems experienced by humans and other living things. In Turkey, the stray dog problem continues to exist as a serious safety and health problem, and its impact is increasing gradually.

Stray animals, on the other hand, move with their herds. In fact, domestic dogs begin to become aggressive in their survival instincts by living on the street, accessing food and drinking sources, and competing [3]. Aggressive animals, on the other hand, pose a threat to humans, other dogs, and other creatures. Stray dogs cause thousands of deaths [4, 5] and injuries to millions of people [5] due to the attacks they carry out, rabies and other zoonotic diseases they carry, and the accidents that occur due to their sudden movements. In addition, since it is a dominant species, it does not allow other mammals such as cats, squirrels, rabbits, and many other species such as birds nesting on the ground to survive and may cause the complete extinction of these species [4]. Kılıç and Sarıerler [6] evaluated 114 bite cases in dogs treated between 1999 and 2003 according to age, bite type, bite time, and bitten body area of dogs and cats bitten by dogs. As a result of the study, it was found that male dogs were bitten more frequently than female dogs; 61% of the bitten dogs were small in size, around 2 years old; and most bite injuries occurred in May (16%), April (11%), and October (10%).

Morzycki et al. [7] examined a total of 475 dog bite waxes and found that the majority of bites (140.30%)

occurred in the summer months. Pitbulls bite wax (27%), was encountered most frequently, the majority of the patients were female (295, 62%), and occurred on the hands (264 cases, 56%). It is stated that bites on the head and neck constitute 11% of all injuries; 50% of wounds were treated with dressing alone, while others required varying levels of intervention. Dog bite wounds range from minor to extremely complex [8]. Therefore, stray dogs pose a serious threat to city life. The domestication of the animal made the animal dependent on humans, and the animal was taken to settlements by humans. This situation brought some negative aspects to the agenda. The number of stray dogs continues to increase, and in parallel with this, dog attacks also continue to increase. On the other hand, when the number of stray dog number increases or when there are complaints, it is not enough to collect them and take them to shelters.

In Turkey, stray animals are frequently seen on the streets despite all this. While the number of registered stray dogs in Turkey is around 1 million, it is estimated that there are around 10 million stray dogs. Street dogs can give birth to between 2 and 12 puppies in one litter, depending on their breed. Considering the environment, shelter, and healthy nutritional conditions, at least four of the puppies born to stray female dogs manage to survive. In order for the number of stray dogs to start decreasing, at least more than 70% of them must be neutered in the first place. In the catch-neuter-raft method used in places where there are few stray animals in the world, the dog is caught, spayed, and then left at the place where it was collected. However, this method is insufficient in places where the number of dogs is high, and more effective methods are used. There are more than 1,300 municipalities and only about 250 animal shelters in Turkey. Accordingly, the news of dog attacks has increased rapidly in the last few years. According to the survey titled “Overview of Street Animals”, conducted by the Ministry of Interior with 1,105 participants in March 2022, 34.3% of the people in Turkey find stray animals dangerous. According to the survey, the rate of those who were attacked by stray animals by themselves or a relative was determined to be 40.5%. However, street animals are also alive, and more humane and effective methods should be used under the umbrella of animal welfare and moral values.

This study was carried out as a survey study to determine the public level of knowledge of dealing with stray dogs with the right approach.

2. Material Method

In this study, the questionnaire method was used to determine the level of knowledge about how to approach stray dogs. The primary data for the research consisted of observations and answers given to the prepared survey questions. In the process of conducting the surveys within the scope of this study, the COVID-19 pandemic has emerged. The online survey method, which provides advantages in terms of prolongation of the pandemic process, cost, speed, and convenience, was used. Questionnaires prepared online were shared with 279 people of different ages and genders working in different fields in 50 provinces located in seven different regions of Turkey, and the questions answered voluntarily were evaluated.

In the survey, there are 5 questions about the age, gender, and education level of the participants; 5 questions about the experience of a stray animal attack; 4 questions about animal feeding and animal love; 4 questions about the reasons for the attack of dogs; 4 questions about dog agression; and 3 questions about the signs of a dog attack. There were 3 questions about dog warning body signs, and 3 questions about before attack behavior, 4 questions about during attack behavior, 4 questions about encountering a dangerous dog. The prepared questions were first applied face-to-face to a volunteer group; the duration and clarity of the survey were tested; and after the necessary corrections were made, it was implemented in a wide area.

In this context, the data obtained through face-to-face surveys and on-site observation formed the data of

the study. In the evaluation of the data obtained in the research, analyses were made using the Excel program and IBM SPSS STATISTIC 20.

3. Findings and Discussion

The distribution of the participant's age, gender, education, and place of residence is summarized in Table 1. It is understood from Table 1 that 54.6% of the participants are female, 37.6% are in the 35-40 age range, 55.9% are university educated, and 41.9% live in the city center. The participants answered the question about the frequency of encountering stray animals by saying 75.9% every day.

In the survey conducted by the Ministry of Interior, 67.3% of the participants stated that they encountered stray animals almost every day, while 39.5% stated that they encountered cats and 33.1% dogs [9]. Pursuant to Animal Protection Law No. 5199 and the Regulation on the Identification and Registration of Cats, Dogs, and Ferrets, it is required for pet owners to be registered in the Pet Registry System (PETVET) [9]. In this context, as of December 31, 2022, in Turkey, a total of 1,429,370 pets, 855,105 cats, 574,240 dogs, and 25 weasels, had been registered with the Jeep method. Looking at Table 2, which shows the distribution of information on the participants' stray animal attack experience, 39.4% stated that they were not attacked, 22.9% said they were attacked, and 37.6% left this question unanswered. Were you injured in the attack? 37.6% of the respondents left the question unanswered, 48.4% answered yes, and 14.0% answered no. In addition, it is understood that 16.8% of those who were attacked received treatment after the attack. Have you seen a stray animal attack someone? 37.6% left the question unanswered, 38.4% saw it as yes, and 24.0% answered no.

According to According to Centers for Disease Control and Prevention (CDC) data, children aged 0-4 are the age group that experiences the most dog bites. Again, according to the same data, dogs bite the head and neck regions of children of the same age group, and can be life-threatening; 6.7 out of 10 people die each year due to infection as a result of dog bites. In the survey conducted by the Ministry of Interior, "Have you or a relative of yours been attacked by a stray animal?" The rate of those who answered the question "I stopped by" was 13.6 percent, the rate of those who said "Yes, a relative of mine came by" was 26.9 percent, and the rate of those who said "No" was 61.8 percent.

Do the participants keep pets at home? 37.3% of them went unanswered, 19.0% answered yes, and 43.7% answered no (Table 3). Do you feed street animals?

Table 1 Distribution of participants' age, gender, and educational status.

Age	Percent	Gender	Percent	Education level	Percent	Living area	Percent	Frequency of encountering stray animals	Percent
18-24	22.6	Female	54.6	Unanswered	37.3	Unanswered	37.3	Often	15.3
25-30	6.5	Male	45.4	Lycee	5.7	District	19.4	Sometimes	5.7
35-40	37.6			Middle school	1.1	Village	1.1	Rarely	3.1
40-50	12.5			University	55.9	City	41.9	Daily	75.9
50+	20.8					Other	0.4		

Table 2 Distribution of information about the stray animal attack experience of the participants.

Seeing a stray animal attack	Percent	Street Animal	Percent	Post attack	Percent	Did you get injured	Percent	Injured body part get	Percent
Unanswered	37.6	Unanswered	37.6	I received treatment	16.8	Unanswered	37.6	Head	29.8
Yes	38.4	I've been attacked	22.9	there was no need	12	Yes	48.4	Neck	33.9
No	24.0	I was not attacked	39.4	I ran away	32.1	No	14.0	Arm	27.1
				I didn't stop	39.1			Leg	9.2

Table 3 Distribution of information about the participants' pets keeping at home, feeding animals on the street, having pets in their immediate surroundings, and liking animals.

Pet feeding	Percent	Feeding the street animal	Percent	Do relatives have pets?	Percent	Do you like animals?	Percent
Unanswered	37.3	Unanswered	37.99	Unanswered	37.3	Yes	60.2
Yes	19.0	Yes	7.53	Yes	29.1	No	2.2
No	43.7	No	6.81	No	33.6	Depends	37.6
		Never	3.58				
		Sometimes	20.07				
		frequently	24.01				

37.99% of them went unanswered, 7.53% answered yes to the question, and 6.81% answered no, 3.58% of them went never, 20.07% answered sometimes and 24,01% answered frequently. Do any of your relatives have pets? 37.3% of them went unanswered, 29.1% answered yes, and 33.6% answered no. Do you like animals? While 60.2% yes, 33.6% no answer to the question, 37.6% replied that it changes according to the appearance of the animal.

In the survey conducted by the Ministry of Interior, the rate of those who said "I love animals" was 82.3%, while the rate of those who gave the opposite answer was 9.2%, and the rate of those who said "I am undecided" was reported as 8.5% [9]. Adapting to city life is very important for pets and stray animals, just like humans. Attacks caused by stray animals mostly occur when basic needs (food), and habitats are violated. Domestic animals, on the other hand, can harm their own species and other domestic animals as a competitive or defensive behavior. Aggressive behavior in dogs, which is the most common pet species, requires precautions [10].

In this sense, the distribution of the answers given to the questions to determine the level of awareness of the participants of the survey about the reasons for the attack of the dogs is summarized in Table 4. When the table showing the distribution of answers given to the knowledge levels of the participants about the causes of attacks on dogs is examined, it is understood that 58% gave correct answers, 3% incorrect answers, and 38.0% left the question unanswered.

When Table 5 shows the distribution of answers regarding the knowledge of the participants on dog aggression examined, the majority (49%-60%) marked it as correct. However, 37%-38% of the participants left unanswered questions about the reasons for attacking stray dogs.

In fact, animals can become aggressive for different reasons. The dog tells what affects what in which situation with body language. The condition of the aggressive dog should be evaluated by taking into account the body language and the conditions of the

Table 4 Distribution of answers to the level of knowledge of the participants about the reasons for the attacks on dogs.

Dog area protection	Percent	Dogs instinct to protect against puppies	Percent	Defending objects and food in dogs	Percent	Response to sensory pain in dogs	Percent
Unanswered	38.0	Unanswered	37.6	Unanswered	37.6	Unanswered	38.0
Correct	58.8	Correct	60.2	Correct	58.8	Correct	49.8
False	3.2	False	2.2	False	3.6	False	12.2

Table 5 Distribution of responses on participants' knowledge of dog aggression.

Aggression is just a symptom	Percent	Aggressiveness of a docile dog is a sign of illness.	Percent	The mistreated animal is aggressive.	Percent
Unanswered	38.0	Unanswered	38.7	Unanswered	37.6
Correct	58.4	Correct	48.7	Correct	48.7
False	3.6	False	12.6	False	13.7

animal. However, the fact that 37%-38% of the participants in Table 5 left the water unanswered about their knowledge of dog aggression can be considered as an expression of lack of knowledge or uncertainty.

Borchelt [11] states that more aggression occurs in male dogs than female dogs, in general, approximately 2/3 of the aggression cases are detected in males. This shows that it is not compatible with the balanced distribution of non-aggressive behaviors. A higher incidence of aggression in males is common in many species, including dogs [12] due to genes, gonadal and non-gonadal hormones, neural organization, body size, and weight [13, 14]. In general, the most sexually dimorphic types of aggression occur in the context of reproductive behavior. Thus, in many species, male aggression is associated with seasonal changes in androgens and correlates with adult androgen levels [15].

3.1 Dog Body Language

It is important to know what sounds like barking, howling, groaning, and growling means in dogs [16]. Looking at Table 6, which shows the distribution of the answers given by the participants to the questions about dog body language, it is understood that in general, 37%-38% of the participants left unanswered and their correct answers were wrong.

What does it mean for a dog to wag its tail? While 37.6% of the participants left unanswered, 38.7% gave the wrong answer by saying happy. Wagging the tail only means that the dog is emotionally aroused. Understanding the dog's emotions is as important to the speed and direction of the wagging as the position of the tail [17]. The position of the dog's tail relative to the ground gives important clues about their emotional state, the higher the tail, the more assertive the dog. Dogs with their tails pointing down or even tucked between their legs are in fear and stress. Dogs that raise their tails like a flag can be confident, perhaps even aggressive. What about body movements in dogs, such as licking their lips, growling, fluffing their fur, and yawning? The movement of a dog's fur is also an important sign, and any hair on the back of their head, neck, or body indicates that they should stay away. If dogs lick their lips, growl, fluff their fur, and yawn, punishing them is the wrong answer, as it will increase aggression. If the dog has movements such as yawning, blinking, nose licking, and turning his head, he expresses that he is uncomfortable. While 41.9% of the surveyed participants answered that they were comfortable, the rate of those who left unanswered was determined as 38.7%.

Since dogs are herd animals, they tend to react immediately in case of danger. As with other animals, dogs may choose to fight, run, freeze, and exhibit different behaviors in case of stress. Looking at Table 7, which shows the distribution of answers to the questions about the body signs of dogs at the moment of attack, 38% of the participants left the questions unanswered in general, and it is understood that their correct answers were wrong.

Table 6 Distribution of the answers given by the participants to the questions about dog body language.

What does dog tail wagging mean?	Percent	What does lip licking, growling, fluffing and yawning mean in a dog?	Percent	What does blinking, nose licking, eyebrow raising, head tilting mean in a dog?	Percent	Not making eye contact, head turned away, ears tilted back, what does it mean to show the neck and abdomen area by lying on the back, nose and forehead area straight, mouth edges backwards, tail between legs	Percent
Unanswered	37.6	Unanswered	39.4	Unanswered	38.7	Unanswered	38.4
Happy	38.7	Comfortable	54.1	Comfortable	41.9	Comfortable	1.4
Excited	9.3	Stressful	6.5	Uncomfortable	15.1	Uncomfortable	34.4
Disappointment	9.1			Attack	1.8	submission	14.0
Attack	5.3			Defense	2.5	Defense	11.8

Table 7 Distribution of the answers to the questions about the body signs of the dogs at the moment of attack.

Ears tilted forward, forehead and nose area and wrinkled, lips, mouth open, curled teeth and gums may be visible, tense legs, body tilted forward, tail fluffed in the air, back feathers fluffy	Percent	Ears are sloping forward, weight is mostly on the front paws, tail is straight, no wrinkles on the nose and forehead, what does it mean if the mouth is closed, the body is slightly tilted forward?	Percent	Fluffy back feathers, ears tilted back, enlarged pupils, nose wrinkled, lips curled—perhaps teeth visible, tail between legs—almost no movement, what if body is lowered stance?	Percent
Unanswered	38.0	Unanswered	38.41	Unanswered	38.4
Attack	2.5	Comfortable	5.70	Comfortable	1.4
Love	44.4	Carefully	9.60	Carefully	14.0
Attack	13.3	will attack	24.48	will attack	34.4
Warning	1.8	Frightened	21.81	Frightened	11.8

Do you know dangerous dog breeds? 38% of the participants left the questions unanswered and 85.2% called the Pitbull dog breed dangerous. Although fighting is seen as a threat and obedience in the animal kingdom, it is of great importance in establishing the herd hierarchy. At this point, body language, as an expression of social status, is critical in relations within and between herds. A dog has body language signs that express emotions such as relaxed, excited, attack, threat, and afraid. Animals send messages to each other using these body language signs. Other animals, on the other hand, choose the fight or obedience sign by displaying an attitude according to the body sign given by the other side. Individuals in the herd show their status in the herd by using their body language and minimizing conflicts.

Can you tell the difference between a dog's desire for attention and a bark when it detects danger? 38.4% of the participants left the question unanswered, and 8.10% answered yes, while 53.50% answered no. Dogs, like other animals, can express their emotional states, social relations, and wishes and desires (Table 7). The frightened dog puts its ears back completely, tucked its tail tightly between its legs, and begins to tremble, its mouth is tightly closed. In the meantime, she may miss her toilet, release scent from her anal glands and lower her hips, moaning pathetically. When Table 8, which shows the distribution of answers to the question of what the dogs mean by posture, is examined, they answered the relaxed posture at 49.1% and the attack posture at 34.4% correct. However, it is understood that 38% of the participants left the questions unanswered and confused the attack stance with the dog stance that threatens to attack.

Dog behavior to attack is different. Understanding that dogs are signaling to attack provides the necessary time and opportunity for protection. To the questions asked about the pre-attack body language signs of dogs, Table 9, which shows the distribution of the answers given, is examined. Do the dogs give a warning signal before they bite? They answered the question as 42.7% yes, 18.3% no. Is the unsocialized dog more aggressive? 56.3% answered as correct. And 55.9% of the respondents answered that dog warning signs and anxiety/fear signs are similar. However, it is understood that 38%-39% of the participants left the questions unanswered.

Knowing the dog's body language and the meaning of the sounds it makes will help to take precautions in terms of danger to be protected. However, in some cases, excessive drooling in the mouth, a strange staggering and gait, short breaths, any bleeding and other signs of injury should be kept in mind as body language signs to be avoided. In signs of dog attack, the signals that dogs give before attacking are growling, showing teeth, ear and tail signals, left foot standing in front of right foot. Children are the most common victims of dog attacks; and are more likely to be seriously injured. Most of these attacks occur during normal daily activities and interaction with familiar dogs [10].

Table 8 Distribution of the question of what the dogs want to express with their body shapes.

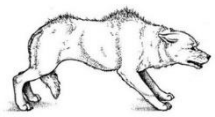
What does the following posture mean?	Answers	Percent
	Unanswered	38.4
	Comfortable	1.4
	Uncomfortable	14.0
	Attack	34.4
	Defense	11.8
	Unanswered	38.0
	Comfortable	49.1
	Attack	3.2
	Defense	9.7
	Unanswered	38.4
	Comfortable	1.4
	Uncomfortable	14.0
	Attack	34.4
	Defense	11.8

Table 9 The answers given to the questions asked about the body language signs of the dogs before the attack.

Dogs give warning signals before they bite.	Percent	An unsocialized dog becomes aggressive.	Percent	Dog warning signs and anxiety/fear signs are similar.	Percent
Unanswered	39.1	Unanswered	38.0	Unanswered	39.1
Correct	42.7	Correct	56.3	Correct	55.9
False	18.3	False	5.7	False	5.0

3.2 In Case of Attack

While 37.3% of the participants left unanswered the questions of what to do when a dog attacks, 11.5% answered I don't know, 1.8% I would run away, and 6.5% I would change my direction. When encountering a dangerous-looking dog, it is necessary to stay as calm as possible and start slowly, without losing sight of the dog, with short steps, and without running under any circumstances. But don't turn your back because turning your back on the dog is a sign of weakness and an invitation to attack. Regarding what to do in case of a dog attack, while 36.3% left unanswered, 20.1% responded by saying, "I stand calmly and shout and scare", and 20.9% say "stop by shouting". The rate of those who said they would ignore it was determined as 7.5%. Regarding the only thing dogs are afraid of, only 1.8% of the participants answered correctly by saying being out of breath.

In the event of a dog attack, it is absolutely necessary not to run or run; the fleeing person becomes the direct prey. People usually flee from dog attacks in herds, and in this case, the animals turn to the predator position and bite. When dogs attack in a pack, leaning slightly to the ground and pretending to pick up a stone, walking with both arms open, and shouting increase the risk that dogs will panic. Turning to look at him, waving his hand or arm towards the dog as if threatening, shouting loudly, and looking directly into the eyes are approaches that create a perception of threat to the dog. If such wrong approaches are avoided when faced with a dangerous dog posture, the dog will not be threatened and forced to attack it.

To the question of how to speak softly to the dog during the attack, 52.47% said yes, to the question of suddenly shouting and stepping towards him; 50.25% I don't know, to the question of ignoring.

Table 10 Responses of the participants to the questions of what to do when a dog attacks.

Distract the dog	Percent	In dog attack	Percent	The only thing dogs are afraid of	Percent	What to do in a dog attack	Percent
Unanswered	37.3	Unanswered	36.3	Unanswered	39.4	Unanswered	37.6
I don't know	11.5	Escape	12.5	Push	3.6	Put a barrier between	41.6
Escaping	1.8	Go over	2.8	Escaping	33.7	Suffocate.	7.5
Clapping your arms to the side as big as you can	21.1	Keep calm, shout, scare	20.1	Being out of breath	1.8	Push	5.7
Stand calmly towards him and loudly command the stop	21.9	Say stop	20.9	Hit	21.5	Escape	4.7
Change your direction on the road	6.5	Ignore	7.5			Hit	2.9

Table 11 Distribution of the answers given to the suggested behavior questions in case of encountering a dangerous dog.

Talking softly to dogs	Percent	When coming towards you, he should suddenly shout and step towards you.	Percent	I will ignore	Percent	I make eye contact	Percent
Unanswered	38.6	Unanswered	37.6	Unanswered	37.8	Unanswered	38.7
Yes	52.47	I don't know	50.25	I don't know	41.77	I don't know	47.55
No	8.93	Yes	3.12	Yes	8.26	Yes	6.41
		No	9.03	No	12.17	No	7.34

On the other hand, 41.77% responded by saying they don't know. On the other hand, 6.41% answered yes to the question of making eye contact incorrectly; 37%-38% of the participants left the suggested behavior questions unanswered in case of encountering a dangerous dog.

4.Conclusion

The results of the survey show that there are inaccuracies and deficiencies in both the body language of the dogs and the way they approach the dog. The participants answered the frequency of encountering stray animals by saying 75.9% every day. No living thing is aggressive; they also have an important place in this ecological system. The right approach to living things, understanding their body language is important in terms of protecting both ourselves and them. When faced with a dangerous dog:

- Standing still
- Not running
- Keeping your hands at your sides
- Being quiet, not making noise
- Avoiding eye contact with the dog
- Looking down while observing the dog

The right approach is to retreat in slow, short, calm steps when the dog loses interest.

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Conflicts of Interest

The authors declared that there is no conflict of interest.

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