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On behalf of the organizing committee, we are pleased to announce that the 6th International Conference on Environmental Science and Technology (ICOEST-2020) is held from October 21-25, 2020 in Belgrade, Serbia. ICOEST 2020 provides an ideal academic platform for researchers to present the latest research findings and describe emerging technologies, and directions in Environmental Science and Technology. The conference seeks to contribute to presenting novel research results in all aspects of Environmental Science and Technology. The conference aims to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research results about all aspects of Environmental Science and Technology. It also provides the premier interdisciplinary forum for scientists, engineers, and practitioners to present their latest research results, ideas, developments, and applications in al lareas of Environmental Science and Technology. The conference will bring together leading academic scientists, researchers and scholars in the domain of interest from around the world. ICOEST 2020 is the oncoming event of the successful conference series focusing on Environmental Science and Technology. The scientific program focuses on current advances in th eresearch, production and use of Environmental Engineering and Sciences with particular focus on their role in maintaining academic level in Science and Technology and elevating the science level such as: Water and waste water treatment, sludge handling and management, Solid waste and management, Surface water quality monitoring, Noise pollution and control, Air pollution and control, Ecology and ecosystem management, Environmental data analysis and modeling, Environmental education, Environmental planning, management and policies for cities and regions, Green energy and sustainability, Water resources and river basin management. The conference's goals are to provide a scientific forum for all international prestige scholars around the world and enable the interactive exchange of state-of-the-art knowledge. The conference will focus on evidence-based benefits proven in environmental science and engineering experiments.

Best regards,

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Simulation of Marine Pollution from a Tanker Accident at the Canakkale Strait (Dardanelle)

Hasan Bora Usluer[1], Cem Gazioglu[2], Ali Gokhan Bora [3]

Abstract

The Turkish Strait Sea Area is very important waterway for global maritime transportation. Also TSSA has importances geopolitic, geographic, strategic and economic. Turkish Strait Sea Area is consist of The Istanbul Strait (Bosphorus), The Canakkale Strait (Dardanelle) and The Marmara Sea. The Turkish Straits has great importance during history. With the Montreux convention, The Turkish Strait Sea Area has been governed at 1936. Legally, all marine safety and management process such local maritime traffic, innocent passage, safety navigation and marine environmetal management has been controlled by The Turkish Maritime Authorities during sailing along The Turkish Straits. Istanbul and Canakkale Straits are great natural waterway and seems like valley. Due this characteristics, straits needs survey and measure deply with Marine Sciences and environment sciences. Turkish Straits Sea Area's components have become more importance cause recently increasing of energy transportation from the Blacksea. This working, try to simulation on Tanker Collusion simulation using by PISCES II and try to Show marine pollution effects at Canakkale Strait.

Keywords: Turkish Straits Sea Area (TSSA), Canakkale Strait (Dardanelle), PISCES, Marine Pollutions, Simulation

1. INTRODUCTION

The Republic of Turkey's land has a great importance on the earth with geopolitical, strategical and economical. It has naturally responsible of being gate with Asian and European continents by Turkish Straits. By the way Turkish Straits are important example all over the world. The Turkish Straits are main components of the Turkish Strait Sea Area which consist of the Istanbul and Canakkale Straits and the Marmara Sea. The Straits are not only natural structure but also became natural valley from sea dynamic motions goes along from Black sea to the Marmara Sea. The sea area is consisting of Istanbul Strait (Bosphorus), Canakkale Strait (Dardanelle) and also the Marmara Sea. Bosphorus and Dardanelles names were came from old times. [1] The Straits of Istanbul and Strait of Canakkale are connecting the Black Sea with the Aegean Sea through by Sea of Marmara and also the area has a really importance from the history because of the geopolitics, strategic and geographic situations. All part of the sovereign sea territory of Turkey and subject to the regime of internal waters. [2] These importances are especially strategic one is that the only water route between the Mediterranean Sea and the Black Sea, so the Turkish Strait sea area has been the site of significant settlement area and also city of Istanbul for a long time in the past. All part of the sovereign sea territory of Turkey and subject to the regime of internal waters. The Turkish Straits have been governed by the Montreux convention, since the 1936. Turkey, due to its treaty obligations under the Montreux Convention, first gave annual reports to the League of Nations Secretary-General and, since 1945, has given these to the United Nations Secretary-General. These reports, which also go to the High Contracting Parties, are entitled,'Rapport Annuel sur le Mouvement des Navires a Travers les Detroits Turcs' (Annual Report Concerning the Movement of Ships through the Turkish Straits). Another important point in favor of using the expression the 'Turkish Straits' comes from a UN document. This is the 'Third United Nations Conference on the Standardization of Geographical Names', held at Athens, in 1977, and attended by 152 participants representing 59 countries, with observers from 11 non-governmental

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and international scientific organizations. The basic aim of the Conference was to use national names to standardize the names of geographical locations. The Conference resolutions empower Turkey in the use of the name 'Turkish Straits'.[3,4] This document's title is evidence of the international credence of the expression 'Turkish Straits'. [3,5] From past to recent years this gate is the most important trade way of the world cause of the oil and oil products. Throughout the history, this situation due to the geographical location, has lead to conflicts between Turkey and the countries both coasting and not coasting the Black Sea in terms of political, economic and strategic interests. Straits separating Turkey's land into two as Asian side and European side resulted in the facts that Turkey's territorial integrity and independence are directly related to the legal regime which the straits are subject to. [3,6] In Montreux Conference, representative of Romania, Nicolae Titulescu's expression "Straits are the hearts of Turkey, but also lungs of Romania" affirms the importance of the Straits. [3,7] The Turkish Straits sea area has very special ecological conditions in terms of marine environment which includes atmospheric and oceanographic conditions, plant and animal diversity and also terrestrial environment. Besides strategic, economic and geologic situations, this area also has roles as biological corridor and biological barrier between the Mediterranean Sea and the Black Sea and form an acclimatization zone for migrating species. Due to being the only maritime access for the neighboring Black Sea states and the Central Asian Turki Republics, the Istanbul Strait has been exposed to dense marine traffic for centuries and substantial increase has occurred in size and tonnage of the ships passing through the Strait with hazardous cargo varieties and amounts they carry. Increase in the number of vessels that navigates on the Strait and being on the transportation way of hazardous and dangerous materials pose serious environmental and safety hazards for the Istanbul Strait, Marmara Sea and the surrounding residential areas. Geographic and oceanographic features of the Istanbul Strait makes the navigation on the Strait rather difficult and consequently the Strait has faced many casualties that caused severe environmental problems due to thousands of tons of oil spill occurring in recent decades. [3,8]

Fig. 1 The Turkish Strait Sea Area overview

2. THE CANAKKALE STRAIT OF THE TURKISH STRAIT SEA AREA

The Turkish Straits sea area (TSSA) is consisted from the Istanbul Strait, the Sea of Marmara and the Canakkale Strait. [9] The Canakkale Strait is a oriented on NE-SW directions.It is also 61 km long and less than 6 km. narrow with depression lying between the Biga and Gelibolu peninsulas.[10] Between the highlands of Anafartalar to the north and the Biga ridge to the south,the Canakkale Strait has an average depth of -55 m, and reaches a depth of -90 m in the narrowest central section.[10] It constitutes a shallow sill at about -70 m between two deep marine realms[11]

According to the Maritime Traffic Regulations for the Turkish Straits, Canakkale Strait, which constitutes 22% of the Turkish Straits Sea Area, is the midline of the sea traffic separation lane, 40 ° 26'.00 N - 026 ° 45'.25 E and 40 ° 01'.52 N - 026 ° 11'.18 E between the positions. At the same time with the geographical formation; The sea area between the longitude passing through Zincirbozan Lighthouse in the north and the line between Mehmetcik Cape Lighthouse - Kumkale Cape Lighthouse in the south is also defined as the Canakkale Strait. [12]

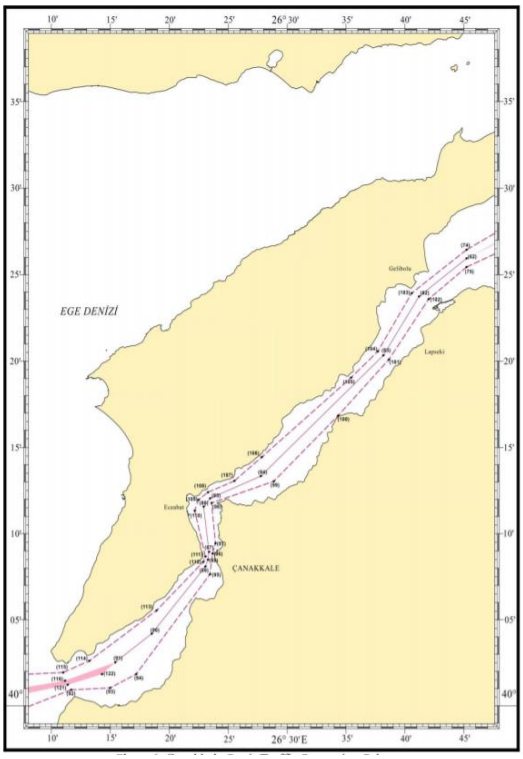

Fig. 2 The Canakkale Strait Traffic Seperation Scheme

Canakkale Strait has a different geography status than the Istanbul Strait. Due to Canakkale's geomorphological structure, it has a rugged structure on the north and south line, in the northeast-southwest line, and is less indented than the Istanbul Strait. Also its length is 2 times longer than the Istanbul.

3. THE CANAKKALE STRAIT'S CHARATERSICTICS

The Canakkale Strait constitutes 37 km of the 164 km long Turkish Straits Sea Area. The narrowest part of the Canakkale Strait is between Kilitbahir and Canakkale at 1300 meters, and the widest place is between the shore of Intepe and Domuz Dere at 8135 meters.

3.1. Current Characteristics of Canakkale Strait

The Canakkale Strait has two different currents like the Istanbul Strait. The first of these is the surface current coming from the Black Sea to the Aegean Sea through the Marmara Sea, and the second is the undercurrent coming from the Mediterranean and passing through the Aegean Sea towards the Marmara Sea direction. In the Turkish Straits; Although approximately 600 km3 of water lost annually due to the surface current coming from the Black Sea, it gains approximately 300 km3 of water per year thanks to the undercurrent coming from the Mediterranean Sea. [13] The current from the Black Sea, where rainfall is high and evaporation is less observed, reaches the Canakkale Strait through the Marmara Sea, forming a surface current of approximately 25 to 30 meters. Thus, approximately 12 600 m3 more water added to the Aegean Sea per second. [14] The speed of the surface current from the Marmara Sea towards the Aegean Sea varies between 0.5 and 5 knots. It has observed that the current speed reaches 2 knots per hour in front of Gelibolu, 4 knots per hour due to the meteorological effect and the narrowing of the strait south of Nara Cape, and even 5 knots per hour in front of Kilitbahir. Further, the surface flow is particularly strong between Canakkale with Kepez.

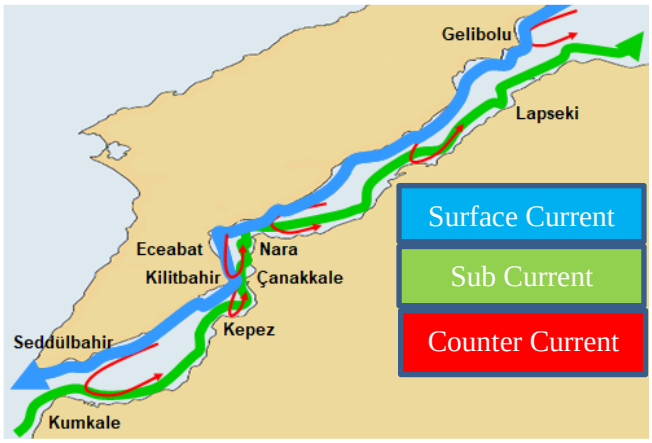

Fig. 3 Current Atlas of The Canakkale Strait

3.2. Salinity of The Canakkale Strait

The surface current coming from the Black Sea reaches the entrance of the Canakkale Strait by rising % 22-26 with the effect of the Marmara Sea and the sea water with % 16-17 salinity ratio. While the salinity value observed to be % 27-28 in the Canakkale Strait, it reaches % 33 towards the south of the strait. The salinity ratio of the sea water mixed with the Mediterranean between the southern exit of the Canakkale Strait and the offshore of the Aegean Sea reaches up to % 36-37.

3.3. Wind Effects of The Canakkale Strait

The prevailing wind in Canakkale is in the North-Northeast direction in all months and annually. The most windy direction after Northeast is South-Southwest direction.

4. SIMULATION AREA SELECTION

According to the data obtained from the General Directorate of Coastal Security, a total of 60 accidents occurred in and around the Canakkale Strait between 2009 with 2018. 36 numbers of these accidents occurred in the middle of the strait, 8 in the North side and 16 in the South of the Canakkale Strait.

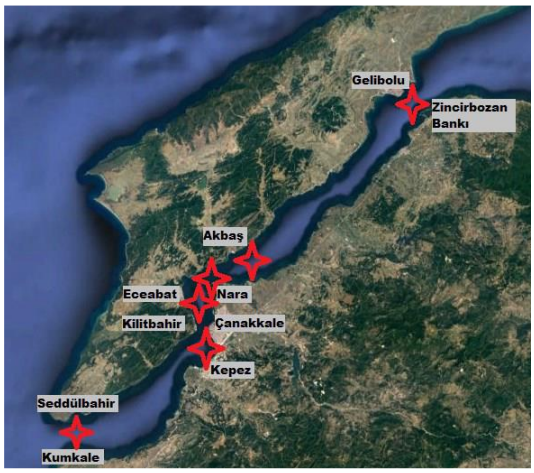

Fig. 4 Accident Chart of The Canakkale Strait.

4.1. Simulation Scenarios and Methods

After a possible tanker accident that may occur in the Canakkale Strait, the dispersion simulation of the leaking crude oil within the current and meteorological effects on the surface depending on time has made and calculated

using the PISCES II program. 4 scenario areas determined considering the accident zones that occurred in Canakkale. In the study, the 4th scenario between Kilitbahir and Canakkale explained from these four regions. In the scenarios, meteorological parameter values such as surface current, countercurrent and wind effect were used in the PISCES II program, was considering the Autumn period data of the Turkish Straits Oceanographic Atlas, the current map Atlas for the Canakkale Strait (September, October and November). Meteorological values taken from Oceanographic Atlas Autumn period. According to these data; The PISCES II program has entered as air pressure 1019 mbar, wind speed 7 knots, wind direction from the northeaster towards Southwest (030 ° -210 ° line), air temperature 25 ° C and sea water temperature 21.7 ° C. For the Ship model used in simulation, the average length and load of tankers passing through the Canakkale Strait between 2009 and 2018 determined. The length of the ship for the simulation determined as 250 meters, its width 44 meters and the amount of cargo it carried was 97 505 tons. In the scenario, at the beginning of the accident, 2 000 tonnes of crude oil poured into the sea and this spill observed based on the pouring of approximately 1 barrel of oil into the sea for 5 hours, 47 400 tonnes of crude oil in total and 49 400 tonnes of crude oil in the sea for 24 to 27 hours.[15]

During the time T + 0 (the moment of the accident), oil spill started due to the collision accident off Mersin Hill at 40 ° 01.727 N-026 ° 16.286 E location.

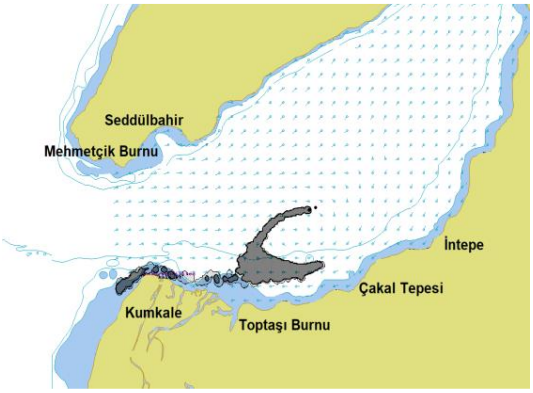

Fig. 5 Simulation Area at T+3 hours 30 minutes later.

At T + 3.30 (3 hours and 30 minutes after the accident), due to the surface and reverse currents in the region, some of the oil left the strait by interacting with the coastline in front of Kumkale Cape. Due to the continuation of the oil spill and the reverse currents in the Toptasi Point-Intepe Bay line, the oil took the form of "C letter" in the strait of the Anatolian coast like Fig 5.

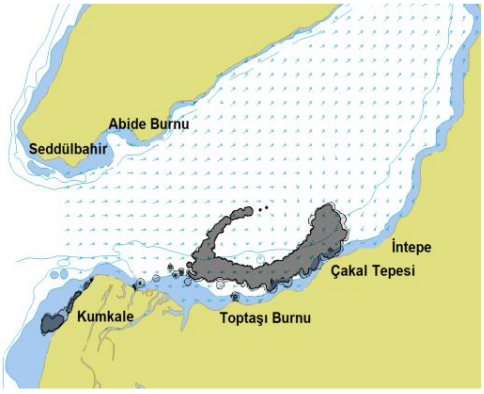

Fig. 6 Simulation Area at T+5 Hours and 15 minutes later.

At the time of T + 5.15 (5 hours and 15 minutes after the accident), some oil affected the eastern part of Kumkale Cape and Topbas Cape. The surface oil layer was originating from the reverse current in the region took the shape of a "U letter" with a northward movement and preserved its density between the front of Cakal Hill and Toptasi Cape. Some of the oil in front of Toptasi Cape moved towards the exit of the strait in particles at Fig 6.

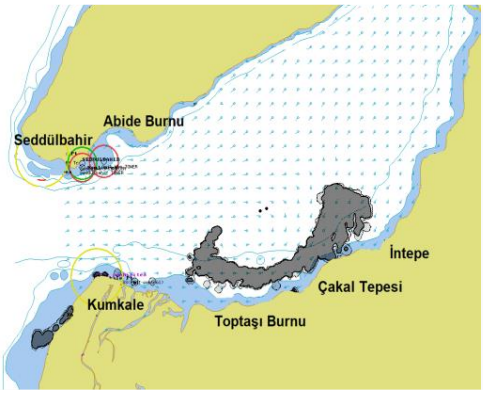

Fig. 7 Simulation Area at T+6 Hours later.

Oil spilled during T + 6 (6 hours after the accident) increased in density in front of Cakal Hill and some oil came into contact in front of Intepe shore at Fig 7.

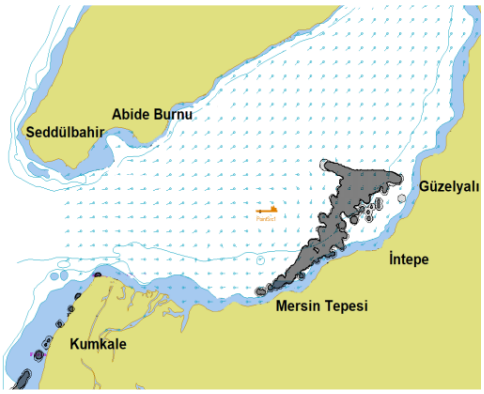

Fig. 8 Simulation Area at T+ 9 Hours later.

During the time of T + 9 (9 hours after the accident), the oil followed a movement in the form of a "T letter" parallel to the Anatolian shores in front of Guzelyali and Mersin Hill and maintained its density by not making any contact on the coasts.

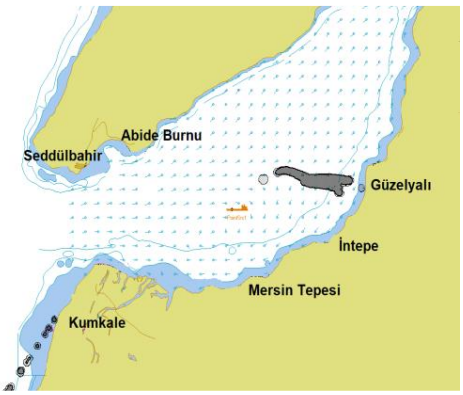

Fig. 9 Simulation Area at T+12 Hours later.

At the time of T + 12 (12 hours after the accident), the great concentration of oil continued to horizontal move in front of Guzelyali with the effect of current. There are some petroleum clusters near the beach in front of Guzelyali and Intepe Bays. The amount of oil found in the Canakkale Strait at the time of T + 12 measured as 44 549 tonnes.

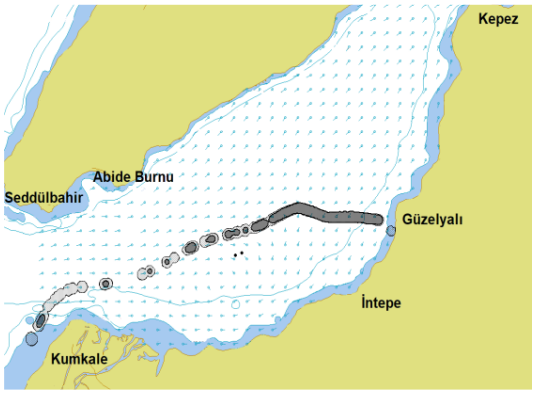

Fig. 10 Simulation Area at T+18 Hours later.

At the time of T + 18 (18 hours after the accident), the dense spilled layer of oil started to move towards the strait outlet due to the surface current effect. Due to the counter current effect, the coastline in front of Guzelyali and Intepe Bay came into contact with some oil.

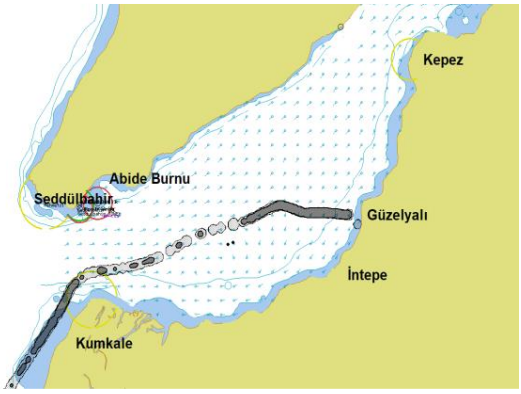

Fig. 11 Simulation Area at T+24 Hours later.

At T + 24 (24 hours after the accident), as in time T + 18, it observed that the dense oil slick surface currents and ground currents separated and moved towards the strait outlet where the surface current was close to each other. At the end of Z + 24 hours, the remaining oil amount in Canakkale Strait calculated as 42 672 tonnes.

5. CONCLUSION AND RESULTS

The data obtained from the simulation results showed that in a possible crude oil accident in the Canakkale Strait, it observed that the effect increased with time when the accident was not intervened according to the location and region where the accident occurred.It has found that it is difficult to interfere with oil, especially on the Nara-Eceabat and Kilitbahir-Canakkale lines, which are one of the narrowest areas of the strait and where the current intensity increases.In case of early intervention within the first hour of the accident; In particular, the European coastline should protected and guided by the coastal protection barriers, and for the Anatolian side coasts, the Kepez region should protected by the coastal barriers and the coastlines should guided towards the wider side of the Canakkale Strait inner side. Thus, it will be possible to hold and clean the oil with a float fence barrier or inflatable fill barrier. In the event of a possible tanker accident that may occur in the Canakkale Strait, Coastal Security Directorate's all other response equipment except the open sea barrier in the Lapseki region is in the Akbas location. It evaluated that it will result in material and moral losses in terms of both the marine environment and humanitarian aspects for the Strait.

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A New Generation Communication System Model That Offers Instant Monitoring Of Environmental Data And Pollution In The Seas

Tayfun Acarer[1]

Abstract

The seas, which have an important place in people's lives for centuries, have been used as waste disposal areas in many countries in recent years. For this reason, the increasingly polluted seas are still the main agenda item of many meetings and conferences. It is extremely important for all countries to act together on marine pollution, which has become one of the common goals of humanity and societies and is one of the only international issues on which a common consensus is achieved. This issue is one of the priority issues of the International Maritime Organization (IMO). For this purpose, special working groups have been established within IMO until today and many regulatory and binding decisions have been taken.Undoubtedly, the most important factor in combating marine pollution is the detection and prevention of pollution from various sources as soon as possible. For this, first of all, it is necessary to install sensors that detect pollution in sea areas at a certain distance from the shore, and then to establish a communication network that will transfer the data produced by these sensors to the centers / centers to be established on the shore. In addition, a computer and software system should be established where the data transmitted to the center will be processed and evaluated, and these data should be processed in an Artificial Intelligence and presented to the relevant units for evaluation. Today, with the developing technology, there are many new generation communication systems to be used in the transmission of marine pollution data on land units. The most important issue in this regard is to determine the technically and economically most suitable of these systems and to operate the communication system to be established in the most healthy way.

Keywords: Marine Pollution, New Communication Systems, VHF systems, 5th Generation systems, Pollution Sensors

1. INTRODUCTION

Pollution of the seas and waste, which is extremely important for the future of humanity, is still one of the most important common problems of societies. According to the data of the International Maritime Organization (IMO), the wastes entering the world seas**;**
8% is from natural resources,
1% is from offshore production,
11% is from sea transportation,
30% from the atmosphere,
40% of the flood and land based discharges,
It is seen that 10% is caused by illegal discharges (wastes generated from ships and aircraft as well as units on land and sea). [1]
Especially many non-governmental organizations and international organizations try to keep up-to-date with marine pollution, and only organizations for this purpose also operate.
In this article, firstly "Marine Pollution and Its Sources" has been explained and the factors causing this pollution have been examined. Later, information was given about "Measurement of Environmental Data Regarding Seas" and the purposes for which these measurements were made were explained.
In Chapter 4, information is given with "New Generation Communication Technologies" and the wireless systems that can be used in the communication infrastructure that will transfer the pollution to the land centers / centers as soon as possible in our surrounding seas are explained in detail.

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In line with these explanations, the subject of how to establish "A New Generation Communication System That Can Be Used In The Transmission Of Different Data Regarding The Sea" is discussed in Chapter 5. In this section, the radio systems that can be used in the project are explained in detail according to their different features and information is given about the capacities and coverage areas of these systems in our country. In this way, the technical feasibility of the proposed wireless communication infrastructure has been revealed and modeled for such a project.

2. MARINE POLLUTION AND ITS RESOURCES

Marine pollution; It can be defined as leaving the substances harmful to the sea and marine life, but also affecting human health, which impair the quality of sea use, especially fishing. Accordingly, marine pollution;
Pollution in the Sea (consisting of settlement centers and industrial facilities established along the sea coasts, platforms and pipelines established in the seas, ships and marine vessels) and
Pollution from ships (pollution caused by accidents and deliberate or uninformed) can be examined in two main groups. [2]
Today, as a result of marine pollution, living resources are damaged, human health is threatened, marine activities such as fishing are negatively affected, the quality of sea water is deteriorating and marine species are decreasing.
Wastes from ships also have an important share in marine pollution. It is possible to say that waste management on board is technically a full time job for the ship crew. The waste produced on some ships reaches thousands of tons per day. These wastes;
Waste generated from operational activities such as oil waste, air pollution, cargo residues, and
Human-induced wastes such as garbage and waste water.
Wastewater produced by the ship generally depends on the number of crew members and the type of ship. When it is calculated that between 0.01 and 0.06 m^3 of wastewater is produced per person per day, large cruise liners can generate 170,000 gallons of wastewater per day.
Sewage wastes produced on board are divided into two categories as black water and gray water and these are defined as "Waste water".
Black water produced on board,
Waste from drainage, toilet and other wastes from waste water,
Wastes resulting from water discharge in bathtubs, sinks and syphilis holes in medical dispensary or ship infirmary and
It arises from live animals in the cargo hold or from waste water mixed with drainage in such areas.
In addition, the widespread production and use of petroleum and petroleum derivatives, discharges, sea transportation and accidents are other factors that have an important role in pollution of the seas.
Gray water produced in ships,
Waste water from dishwater and sinks in the ship kitchen,
Waste water from cabin showers and bathrooms,
Laundry water
Waste water from inner deck networks and
It consists of condensation water of refrigerators and air conditioners.
There are concentrations of nitrate, phosphate and organic matter in untreated waste water. Due to the high density of bacteria in these substances, the oxygen in lakes, rivers and seas is rapidly consumed, it becomes difficult for natural life to remain around the sea, and marine pollution is rapidly increasing.
Undoubtedly, one of the most important sources of marine pollution is oil and oil derivatives leaking into the sea from marine accidents and tankers. Especially, marine accidents caused by tanker type vessels are one of the most important factors in the pollution of the surrounding seas.
The following table shows important statistical information about the amount of oil tanker accidents and oil spills occurring in Turkey coast is given. [3]

Table . Tanker accidents and oil spills

Yil	**Kaza**	**Yayilan Petrol (ton)**
1967	Torrey Canyon	121 000
1978	Amoco Cadiz	227 000
1979	Independenta	96 400
1982	Unirea	66 400
1994	Nassia	13 000
1999	Volganeft	1 500
1999	Erika	20 000
2002	Prestige	77 000
2010	Orcun C	125 000
2016	M/V Lady Tuna	200

3. MEASUREMENT OF ENVIRONMENTAL DATA RELATED TO THE SEAS

Today, there is a need to measure different data regarding the marine environment. These data;
Prevention of pollution of our surrounding seas,
Making the routes and sailing plans of the ships in the most accurate way,
Navigation safety,
Life and property safety,
Activities of Marine Fish Farms,
Providing data needed in various scientific studies,
More effective use of marine resources and
Tracking sea water movements and their energy supply, etc. used for purposes.
Many different sensors have been produced for these purposes, and it is possible to group the main types of these sensors under the following headings.
Sea water level measurement,
Sea water temperature measurement,
Seawater Flow Direction and Speed measurement,
Seawater Salinity measurement,
Sea water flow meter measurement,
Sea water temperature measurement,
Wind direction and wind speed measurement,
Seawater Quality (dissolved oxygen rate, etc.) measurement,
Different sensors for fish pairs,
Seawater pollution measurement.

Nowadays, there are many different prices and quality sensors on this subject. It is easily possible to obtain them from different channels. In addition, these products are ordered and delivered in a virtual environment.

As of our subject, we will not go into the structure, working principle and features of the sensors in question. In this section, only for what purposes these sensors are used, their contribution to safe navigation and life / property safety measures, especially their use as data collection tools in order to measure the pollution in our surrounding seas and to take the necessary measures in time.

4. NEW GENERATION COMMUNICATION TECHNOLOGIES

It is possible to use different systems in the remote control of ships, depending on whether the ship is at close or far distance. For this purpose, mobile phone technologies (3rd Generation, 4th Generation, 5th Generation systems) or VHF systems can be used in short distance communication. It is also possible to use mobile telephones and VHF systems jointly according to the distance of the ships to the shore. In other words, it is technically possible to install a combination structure that will ensure that these systems are used in places where there is mobile phone coverage and the VHF system is used in places where this coverage is not available.

4.1. Wireless Communication Systems

In case the distance between ship and land is far (more than 25 miles), Medium and Long distance systems can also be used. Either the Inmarsat satellite system or the Long distance (HF) Terrestrial systems can be used for this purpose. With both systems, in addition to close seas such as the Mediterranean and Black Sea, it is possible to contact ships in the Ocean regions.
The general operating principles of access via VHF (short distance) systems are given in the figure below. With VHF Systems, access is provided based on the principle that the antennas of these devices see each other (Optical sight). [4]

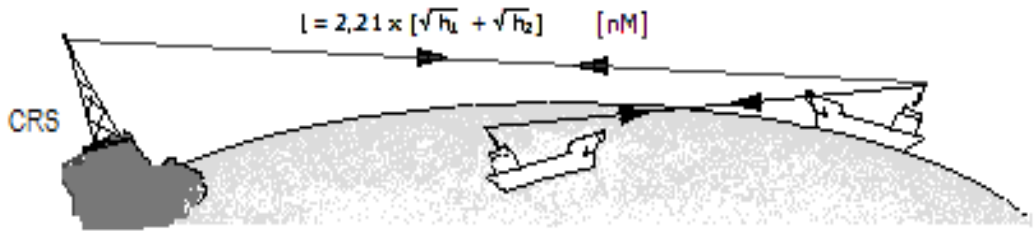

Figure 1. VHF Systems Optical sight

Turkey marine radio is radio systems with significant investments made in the relevant time, these systems are operated by the Police General Directorate of Coastal. Main;
Short Range Radio systems (VHF),
Medium Range Radio systems (MF),
Long Range Radio systems (HF) and
The most important feature of this system, which is grouped as Navtex Radio systems and named as terrestrial systems [4], is that it is free of charge because the communication between them is natural. Although it is technically not possible to transmit large amounts of data through these systems, the small volume of data to be obtained from the sensors will allow these systems to be easily used in the communication infrastructure to be established.
Since the sea areas around our country are aimed in the prepared article, only VHF radio systems are considered among these systems.
Since MF systems cover sea areas 300/400 miles from the shore and HF systems (≥ 500 miles) from the shore [4], they have not been examined as of our topic.
The names of VHF stations operated by the General Directorate of Coastal Safety in Turkey and is located on the map shown in Figure 2 below. [11] The number of VHF stations operated remotely from Istanbul, Samsun and Antalya regional centers is 28 in total. All of these stations are Turk Telekom, TRT, etc. in the mountains along our coastline. institutions and all data are collected in the main center in Istanbul. For this reason, it will be possible to easily collect data from sensors through these stations and transfer them to the desired unit. For

this, it will be sufficient to install data transfer equipment that will provide communication with VHF systems to the pollution monitoring sensors to be placed in our surrounding seas.

Figure 2. The names of VHF Base stations in Turkey

4.2. Mobile Technologies That Can Be Used In Data Transmission

The increasing need for data usage in Wireless Wide Area Networks, especially the demand for faster and larger amounts of Data, has made it necessary to increase the channel widths in the band and to use and develop modulation techniques accordingly.

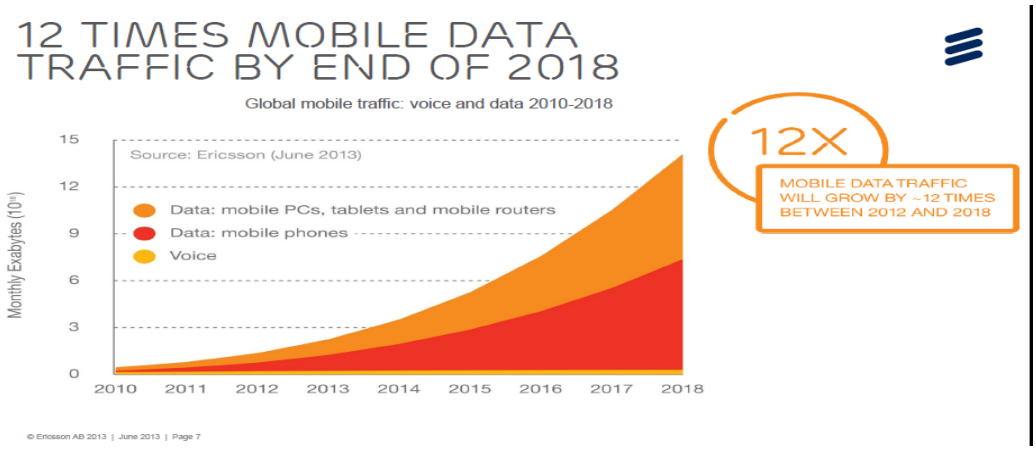

Figure 3. Mobile Data Traffic by End of 2018

For this reason, as can be seen from the table above, the modulation technique used in each new Generation has been different and large increases in Data usage and especially Data speed have been achieved. [5]
The process of generations over time is given in detail in years in the table below. [6] Development in Wireless Infrastructures continues with acceleration with each new Mobile Generation. There is a serious increase in data rate with every advanced Mobile Generation.

These developments are shown comparatively in the chart below.

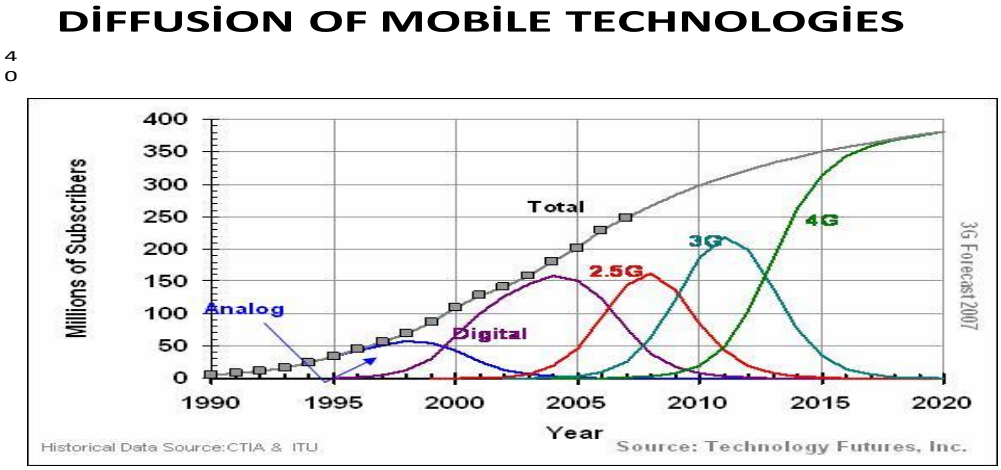

Figure 4. Diffusion of Mobile Technologies

Currently, 1st Generation Mobile systems (1 G) are not used anymore. The number of subscribers of 2nd generation systems (2 G) is also gradually decreasing. Subscriber growth in 3rd Generation Mobile systems (3G) stopped in 2015, and within a few years all Subscribers using this system switched to 4th Generation Mobile systems (4G).
Subscriber growth still continues in 4th generation systems. It is expected that the increase in these systems will first slow down with the 5th Generation systems (5 G) that have been used since 2020, and then leave its place to 5th Generation systems.
The 5G system, which started to be used as of 2020, provides a very different infrastructure in radio communication. Because, with 5G, it has become possible to use applications that require high performance and low latency (delays below 1 ms) in the communication infrastructure.
As can be seen from the graph below, 5 G offers a very good solution for the data traffic that is increasing day by day. From this point of view, 5 G has emerged as a new technology that provides flexibility to multiple industries, devices and applications in a single network at the same time and minimizes the delay in data transmission. [7]

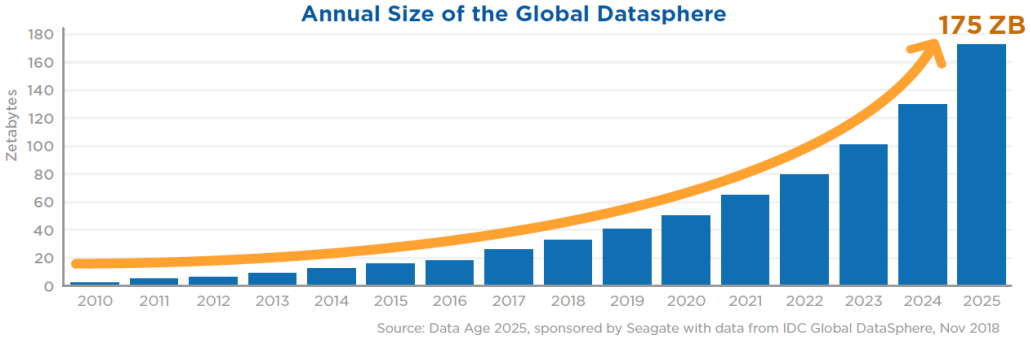

Figure 5. Annual Size of the Global Datasphere

4.2.1. General Features of 5 G

Network bandwidth more than 10 Gbit / s,
Providing simultaneous connection power to 100 million devices in 1 square kilometer,
Data transmission latency (ping) is expected to be less than 1 ms.

4.2.2. Major Services to be Provided by 5G

Sending large amounts of data using Ultra Mobile Broadband (Extreme Mobile Broadband),
Providing internet support of mass media (Massive Machine Type Communications, mMTC) (ultra-broadband communication),
To provide a special class of service with very low delays in very reliable inter-machine communication (Ultra reliable MTC, uMTC).
Applications based on 5G technology will start to enter our lives in 2021-2022. Unlike today's applications, most data will now be accessed directly through cloud systems, not from devices' storage. It will even be possible to access not only data but also operating systems via the cloud. In the near future, internet will be available directly from the base station, not from the modem at home.

With 5G technologies;
smartphone users,
virtual reality players,
autonomous systems and
remote control systems
It is aimed to establish a wireless network that will be the basis of data transmission.

4.2.3. The most important developments in 5G

large increase in data transmission rate,
reduced delay in end-to-end connection and
improvement of coverage
It is possible to define as.
These are the most important pluses, especially for the Internet of Things.

Figure 6. Internet of Things

Mobile data traffic is increasing day by day. Global total mobile data traffic reached approximately 38 exabytes per month by the end of 2019, and it is estimated that this traffic will reach 160 exabytes per month in 2025 and will grow at least 4 times in this process.
In 5 years, more than 6 billion people will access this mobile data using smartphones, laptops and many new devices. Smart phones, which currently have a usage rate of 90% and are expected to reach 95% in 2025, will be the devices that will be used the most in mobile data usage, as they generate most of the mobile data traffic. It is natural to increase data traffic with 5G. It is estimated that 45 percent of the total mobile data traffic will be transported by 5G networks by 2025. It is estimated that 5G networks will handle about half of the world's mobile data traffic by 2025. [5]

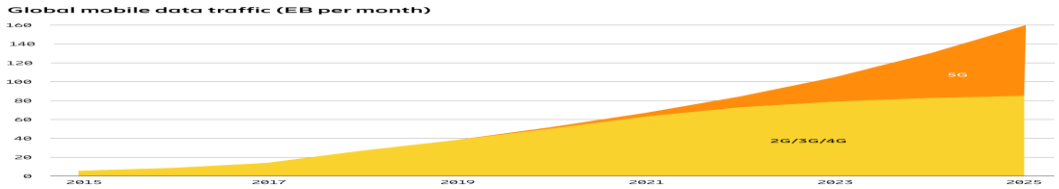

Figure 7. Global Mobile Data Traffic

4.2.4. Frequency Bands to be Used in 5 G

The frequency bands to be used in 5th generation systems were decided at ITU's World Radio Conference held in Sharm El-Sheikh, Egypt between October 28 -22 November 2019. [9] These conferences, which are generally held every 4 years, are the international affair where the most important and binding decisions regarding the business sector are taken.

The most important difference between the bands decided for 5 G in this meeting from the previous generations (1G, 2G, 3G and 4G);

Very high frequencies such as 24 and 36 GHz,

Lower frequencies than existing ones such as 700 MHz, and

It is decided to use frequencies used in mainly Wi Fi systems such as 5.5 GHz as carrier frequencies.

Considering the covarages (coverage areas) of these bands,

High Frequency bands will have less coverage, therefore they will be preferred in densely populated areas,

It is clear that the coverage areas of the Low Frequency bands will be large, so they can be used in rural areas with less population.

If 5th Generation systems are used as Communication Infrastructure in this study, using 700/800 MHz frequency band would be the most technically correct approach.

4.2.5. Using Cellular IoT Segments to Communicate Sensor Data

It is calculated that the most important increase in Next Generation Communication systems will be in my IoT systems in the near future. It is estimated that IoT equipment of 5th Generation systems will make a great contribution to data communication and that at least 5 billion devices will be connected with Cellular IoT systems in 2025. [5]

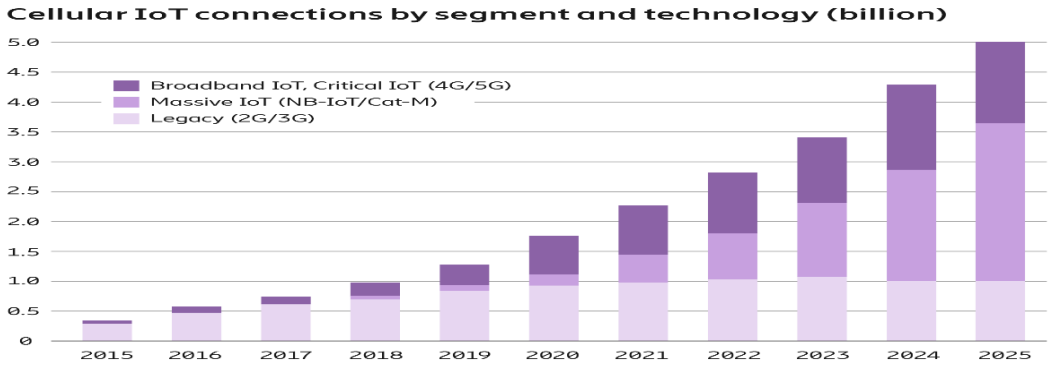

Figure 8. Cellular IoT Connection

4.2.6. IoT / M2M Communication - (Internet of Things / Machine to Machine Communication)

Communication with IoT systems means communication with many simple and inexpensive devices. Therefore, the entire chain per device must be extremely cost-effective end-to-end. Reliability, very low latency and usability are of utmost importance in this communication, and there is a general trend in this regard.

The vision targeted by the "Internet of Things" in the future includes billions of devices driven by the massive IoT market. For this to happen, the end-to-end cost must be reduced. For this, everything must be cheaper and more efficient, and it must also be scaled by volume. In this regard, 5 G systems provide great convenience and technological possibilities.

Low frequency bands such as the 1 GHz range are particularly suitable for residential areas with low population, low bandwidth and large coverage. Higher frequency bands are suitable for residential areas where the population is high, the amount of data needed is high and the coverage area is small. For this reason, using 5G systems in which the 1 GHz frequency band is used in the transmission of Sensor Data as IoT would be a technically suitable solution. [8]

4.2.7. D2D (Device to Device) in 5G (Device to Device) Communication

Device-to-device technology allows direct data exchange of devices located close to each other without the use of 5G network. The advantage of this technology is that the unlicensed part of the spectrum can be used in data transfer and more data can be sent in this band. For this reason, it is technically possible to collect data using

unlicensed frequency bands between sensors close to each other and to transmit it to the Center (one of the centers) from there via the 5G Infrastructure. [8]

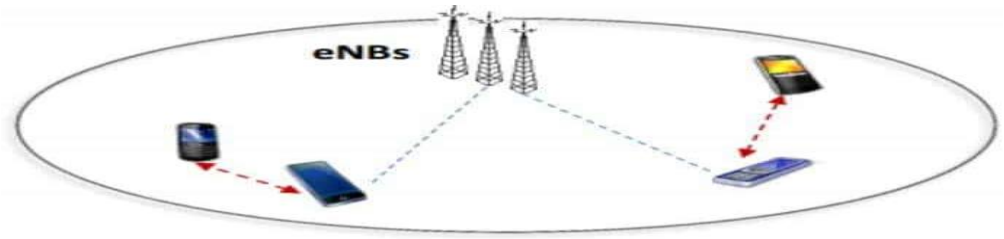

Figure 9. Device to Device in 5 G Communication

4.2.8. AI (Artificial Intelligence)

Artificial intelligence is the development of machines that are produced with completely artificial tools and that can exhibit human-like behaviors and movements without using any living organism. The field of artificial intelligence was developed from the idea that human intelligence can be well defined and a machine can imitate this intelligence.

It is also possible to define artificial intelligence as smart machines that define their environment and act to achieve the goal, and have conceptual features such as problem solving and learning. (8)

Artificial intelligence is an example of a numerical mind that does not develop naturally, loaded on machines and robots made by human hands. There is no clear consensus on the scope of artificial intelligence. As machines become highly capable, some simple tasks that are not considered to require intelligence are excluded from the scope of artificial intelligence.

Today, artificial intelligence techniques undergo many innovations such as developments in the field of computer technology, increase in the number of data and theoretical understanding. Artificial intelligence techniques also form an important part of the technology industry.

Artificial intelligence is still widely used in sports competitions, health, automotive, video games, finance and economics, statistical analysis of big data, etc.

As a result of advances in technology, an increasing and complex relationship is developing between Artificial Intelligence and Machine Learning and Deep Learning. To understand the difference between these terms, it is useful to examine the chronological order below.

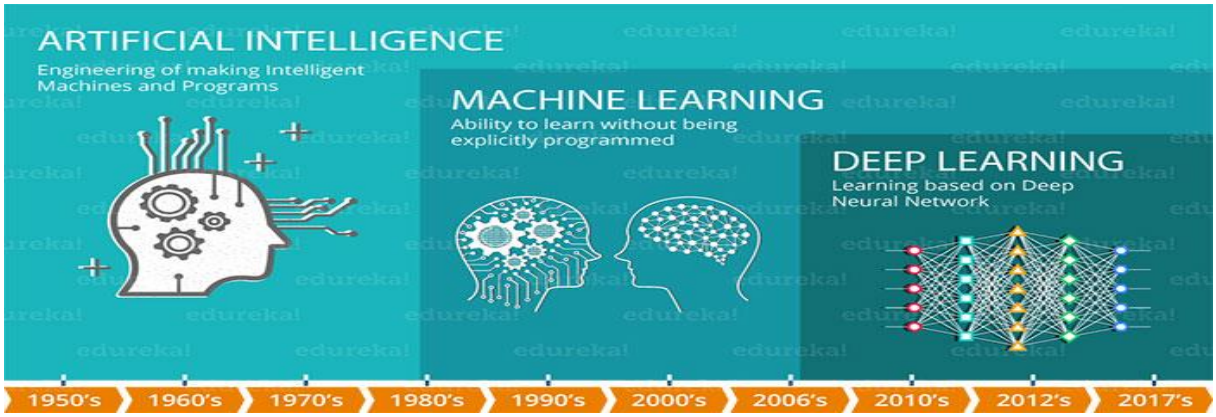

Figure 10. Artificial Intelligence, Machine Learning and Deep Learning

4.2.9. Machine Learning

As can be seen in the chronological order, Machine learning, which is a branch of artificial intelligence, is also another sub-science of artificial intelligence that includes deep learning. Machine learning are algorithms that

enable the machine to derive logical and rational results with the data provided. Machine learning provides us with information that will push the limits of mind in today's technologies.

Figure 11. Artificial Intelligence, Machine Learning, Deep Learning and Data Science

4.2.10. Deep Learning

Deep learning is a technology that can be seen in chronological order, which is the sub-branch of both Artificial intelligence and Machine learning.
Deep learning and Machine learning are very similar structures. Deep learning works in a similar structure to the neurons in our brain.
Reasoning is making and judging by listening to two sides who have arguments against each other. Artificial intelligence is also one of the most difficult areas of reasoning. It is very important that the artificial intelligence created filters a few events and makes the most logical and rational decision.

5. DESIGN OF A NEW GENERATION COMMUNICATION SYSTEM FOR THE TRANSMISSION OF DIFFERENT DATA RELATED TO THE SEAS

For this purpose, in the second part of the study, information is given about the types of data that can be obtained from our surrounding seas for different purposes and the related sensors. In addition, in the third part of the study, New Generation Communication technologies and especially the 5th Generation Communication systems that have been used since 2020 are explained. Again, in Chapter 3, information about IoT (Internet of Things), IoT / M2M (Machine to Machine), Artificial Intelligence, Machine Learning and Deep Learning, which started to find more application areas with 5 G systems given.
With the development of 5th generation systems, very positive improvements have been achieved in the speed and latency of data transmission and the delay time in data transmission has decreased below 1 ms. As a result, it is now possible to collect data on a server, analyze them, evaluate them by processing in an artificial intelligence, and take the necessary action after a very fast decision-making process. The main elements of the system to be established for this;
Sensors regarding the targeted data to be received,
It has a coverage area to transmit data from these Sensors in the sea VHF marine band wireless system and 5th Generation communication network (If this network is in the 700 or 800 MHz Bands,
should be preferred as a coverage area will be provided),
A Computer system (Server) where this data is stored and
An Artificial Intelligence system is required to process and evaluate the collected data.
In addition, according to the data to be evaluated in the Artificial Intelligence system, a structuring should be established to take action as soon as possible. (For example, if sea pollution is detected, it is illustrated by drones, teams to act according to position information, etc. structuring. Mobile communication coverage should be tested in all marine areas on our coasts of the country at the facility of this project. Because the large part of our coasts is outside of the residential areas, it is normal to not have mobile coverage in some of these areas. For this reason, it is possible to work with our existing Mobile Operators in the project, as well as to coordinate with the Information Technologies and Communication Authority, which is the regulatory body of the telecommunications sector.
Since the 5G infrastructure will not be found especially in rural sea areas, VHF short range radio systems can be used in these areas. There is also no need to install a separate VHF system for this. Because the coasts of Turkey Coastal Safety Directorate General and operated by VHF network covering our entire coast lane is available. Since the data collected from the sensors do not contain large data, there is no technical problem in transmitting these data through VHF systems with low data capacity.
For this reason, in the project to be prepared for the design of a new generation communication system that can be used in the transmission of different marine data, the use of a mixed communication system in which 4 G ve 5 G systems and VHF system will be used in the transmission of sensor data is considered as the technically

most suitable infrastructure. In particular, the VHF radio system has been established many years ago in all the coasts of Turkey, this is done by a public company like General of Coastal Safety Directorate of the system's operation also allows to benefit a broad way in the said project from the system. In addition, the fact that communication via VHF Systems is free of charge makes it even more attractive to use VHF Systems in the transmission infrastructure of this project.

6. CONCLUSIONS

In recent years, the most important common problems that the world countries have come to consensus on are environmental pollution and the associated pollution of seas. Considering that three quarters of the world is the seas, the importance of pollution in terms of human health and future is better understood here.

Although there are many sources and causes of marine pollution, due to the subject of this article, only the model for establishing the necessary communication infrastructure to detect possible pollution as soon as possible is presented in this study. For this purpose, in order to detect the pollution that will occur in our surrounding seas, first of all, it is necessary to establish a network of sensors consisting of appropriate distance and number of sensors and to establish a communication infrastructure in order to transfer these sensor data to the center / centers on land in the fastest and most accurate way. Wireless systems and mobile communication systems that are required to establish this communication infrastructure in the healthiest and most cost-effective manner are still available in our country. Therefore, a serious investment will not be required for the establishment of the necessary communication infrastructure. This is an important advantage for the realization of the project in question.

It is possible to use two different systems to transfer the Sensor data to be placed in our surrounding seas to land. The first of these is marine radio systems. In particular, VHF marine radio systems have all the technical specifications and infrastructure required for this project.

Because these systems are still installed in our country and they are operated by the General Directorate of Coastal Safety, which is a public institution. This is another reason for preference for the predominant use of radio systems in communication infrastructure. Again, the fact that data transmission over wireless systems is free of charge increases the attractiveness of these systems.

For this purpose, as a result of a protocol to be signed with the General Directorate of Coastal Safety, which is the owner and operator of the radio systems used for maritime communication (including the participation in the operating costs of the said radio systems), the necessary infrastructure for data transfer from the sea to the land will be provided in a wide area of our country's coasts.

Our country's coast is 8000 km. especially our western coasts are very indented and some areas are outside of residential areas, etc. For some reasons, it is natural that some of our coastlines in some regions cannot be covered by radio systems. For this reason, mobile communication systems will need to be used on our coastline, which is not covered by the radio. It is possible to provide this coverage with the new generation mobile communication systems, popularly known as 3G, 4G and 5G systems. However, it should be kept in mind that communication through these systems is paid. Although it is thought that the communication in question is data transfer and the cost of this will be very low, it is also possible to face a serious price since data will be transmitted from many sensors in total. For this reason, it is recommended to use the existing VHF marine radio communication infrastructure in our country to transfer the sensor data to be installed in our surrounding seas for marine pollution measurements, and to develop a mixed model to benefit from the new generation mobile communication systems, especially 4 G and 5 G, in areas outside the coverage of this system.

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Assessment of Ecological Risk of Heavy Metal Contamination in agricultural soil in Municipality Pljevlja (Montenegro)

S. Krivokapić[1], M. Bigović[1], D. Đurović[2], N. Cupara[1,2], I Nikolić[3]

Abstract

Assessment of heavy metals contamination of agricultural soil is of great importance for human health due to the potential contamination of plants for human nutrition. Lately, with the development of industry, the content of heavy metals in the soil caused by human activities has steadily increased, resulting in environmental degradation. The accumulation of heavy metals in plants from soil leads to accumulation in the food chain and poses a potential risk to animal and human health. Since there is a very little data about agricultural contamination in Montenegro, this study aimed the assessment of ecological risk of heavy metal contamination in agricultural soil of Pljevlja municipality.
Contamination of soil with a five metals (Pb, Cu, Cd, Cr and Zn) was investigated, due to their biological toxicity. Contamination factor (Cf) and ecological risk factor (Er) are used for the assessment of soil contamination. The results based on the mean Cf value and mean Er value indicated the high and considerable ecological risk for pollution with Pb and Zn, respectively.

Keywords: agricultural soil, contamination, heavy metals

1. INTRODUCTION

Due to the rapid industrialization in the last decade special attention is given to the problem of soil pollution by heavy metals. Soil pollution by heavy metals presents a serious risk for human health because these metals may enter the plants [1]. Some of heavy metals are essential for plant growth and human health at all, but when they exceed the prescribed limits, may cause serious health problems since they influence different metabolic processes in humans [2]. However, some of heavy metals (Cd, Pb and Hg) have no biological function and they are extremely toxic for human health.

Contamination factor (Cf) which expresses the degree of metal enrichment in the soil and ecological risk factor (Er) are often used methods for the assessment of soil contamination. These methods evaluate the degree of soil pollution, and help in the interpretation of soil quality [3].

In this study, the results of Pb, Cd, Cu, Zn and Cr concentrations in the agricultural soil of Pljevlja municipality (Montenegro) were presented, Moreover, contamination of soli was expressed through the calculation of contamination and ecological risk factors.

2. MATERIALS AND METHODS

Soil samples were taken from maximum 20 cm depth, from agricultural fields near households in November 2019. The households are located near two sources of pollution, Thermal power plant (TE Pljevlja) and Zinc and lead mine (Gradir, Montenegro). Samples 1, 2, 3, 4, 6, 7 and 11 are located near Thermal power plant.

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Sample 5 is located between Thermal power plant and surface Coal mine. Samples 8, 9 and 10 are located near Zinc and lead mine. For metal analysis, wet soil was dried at 105°C and sieved through mesh 0.25µm. 3g of dried and sieved samples were digested with 25ml of aqua regia, using reflux and heating source (EPA method 3050B). Samples were filtrated through Whatman No. 41 and flasks were washed with 5ml of concentrated HCl and adjusted to final volume of 50ml with distilled water. Concentrations of Pb, Cd, Cu, Zn, Cr were measured using inductively coupled plasma technique (ICP-OES), manufactured by Spectro Arcos.

3. RESULTS AND DISCUSSION

3.1. Assessment of Soil Contamination

The next factors were used for the assessment of agricultural soil contamination, contamination factor (Cf) which expresses degree of metal enrichment in the soil and ecological risk factor (Er) given by Eq 1 and 2.

$$C_f=C_i/B_i \quad (1)$$

$$E_r=T_i/C_f \quad (2)$$

Where Ci is the total metal content in soil, Bi is background level (reference threshold for sensitive soil [4]) and Ti is the toxic-response factor for a given substance by Håkanson [5] (Table 1).

Table 1. Toxic-response factor by Håkanson [5]

Elements	Cu	Cd	Zn	Cr	Pb
Toxic-response factor	5	30	1	2	5

To describe the Cf and Er the following terminology was used:

- Cf < 1 - no metal enrichment; 1< Cf < 3 - moderate contamination; 3 < Cf < 6 - considerable contamination; Cf > 6 - very high contamination.
- Er < 40 - low contamination; 40 < Er < 80 - moderate contamination; 80 < Er < 160 - considerable contamination; 160 < Er < 320 - high contamination and Er < 320 - very high contamination.

Total contents and descriptive statistics for the heavy metals measured in this study are given in Table 2. The order of the total element content was Zn > Pb > Cu > Cr > Cd. The results have shown that the mean content of Pb exceeds the maximum allowed concentration of metals prescribed by National regulation [6] while the values of mean contents of other metals (Cu, Cd, Zn and Cr) are below the prescribed limits.

Table 2. Total contents and descriptive statistics of elements in agricultural soil samples.

Sampling site	**Element (mg^{-1} kg^{-1})**				
	Pb	**Cd**	**Cu**	**Zn**	**Cr**
1	11.73	0.92	15.78	43.3	6.14
2	21.07	0.99	52.35	96.54	16.35
3	20.00	1.26	59.43	129.85	13.8
4	17.43	0.24	22.32	30.73	13.76
5	35.76	1.78	49.67	92.55	17.47
6	23.97	0.63	52.92	117.98	18.86

7	37.65	3.08	56.79	140.27	28.24
8	37.82	0.52	37.82	81.57	15.7
9	837.4	2.8	18.85	1150.3	18.95
10	27.37	0.51	51.76	55.28	13.28
11	39.97	0.75	52.35	80.87	28.53
Min	11.73	0.24	15.78	30.73	6.14
Max	837.4	3.08	59.43	1150.3	28.24
Mean	100.02	1.02	42.73	183.57	17.37
SD*	244.79	0.948	16.225	322.48	6.48

SD* Standard deviation

The results of the Cf and Er are given in Tables 3 and 4. It is evident that with respect to the values of Cf, for Pb, two sampling sites (1 and 4) located near thermal power plant, displayed no metal enrichment, one site (9), placed near old tailings pond near zink and lead mine, displayed very high contamination while the other sites showed moderate contamination. Pollution with Zn showed very high contamination at site 9, while moderate contamination or no metal enrichment was observed at all other sites. Cf for Cr indicate no metal enrichment while Cf for Cu displayed moderate contamination or no metal enrichment. Very high contamination was observed for Cd only on site 7 which is close to thermal power plant, while for other sampling sites no metal enrichment or considerable contamination was observed.

For Cu, Zn and Cr the calculated values of Er were below 40 which indicate the low contamination. However, contamination of Pb is of concern at site 9 since Er value was calculated to be 209.35 which indicates high contamination. This result could be due to the natural soil content, since the zink and lead mine is near the location, or due to the exposure of this agricultural field to old tailing pond which is not remediated by any method. Other sampling sites show low contamination with Pb. Moreover, considerable contamination (Er = 92.4 and Er = 84) with Cd was observed at two sampling sites 7 and 9, moderate contamination at one sampling site (site 5) while other sampling sites displayed low contamination with Cd.

Table 3. Contamination factor (Cf) values of heavy metals in soil.

Sampling site	**Element**				
	Pb	**Cd**	**Cu**	**Zn**	**Cr**
1	0.59	0.92	0.79	0.433	0.205
2	1.05	0.99	2.62	0.965	0.545
3	1.1	1.26	2.97	1.29	0.460
4	0.87	0.24	1.12	0.307	0.459
5	1.79	1.78	2.48	0.93	0.582
6	1.19	0.63	2.65	1.18	0.629
7	1.88	3.08	2.84	1.40	0.941
8	1.89	0.52	1.89	0.82	0.523
9	41.87	2.80	0.94	11.5	0.632
10	1.37	0.51	2.59	0.55	0.443
11	2.00	0.75	2.62	0.81	0.951
Min	0.59	0.24	0.79	0.30	0.20
Max	41.87	3.08	2.97	11.50	0.95
Mean	5.05	1.23	2.14	1.84	0.579

Table 4. Ecological risk factor (Er) values of heavy metals in soil.

Sampling site	Element				
	Pb	**Cd**	**Cu**	**Zn**	**Cr**
1	2.93	27.6	3.95	0.433	0.409
2	5.27	29.7	13.1	0.965	1.09
3	5.00	37.8	14.9	1.30	0.920
4	4.36	7.20	5.58	0.307	0.917
5	8.94	53.4	12.4	0.926	1.16
6	5.99	18.9	13.2	1.18	1.26
7	9.41	92.4	14.2	1.40	1.88
8	9.46	15.6	9.46	0.816	1.05
9	209.4	84.0	4.71	11.5	1.26
10	6.84	15.3	12.9	0.553	0.885
11	9.99	22.5	13.1	0.809	1.90
Min	2.93	7.20	3.94	0.307	0.409
Max	209.4	92.4	14.9	11.5	1.88
Mean	25.2	36.8	10.7	1.84	1.16

4. CONCLUSIONS

Based on the values of Cf no metal contamination or moderate contamination was observed for Cu and Cr, while for Zn, Cd and Pb high contamination was observed at some sampling sites. However, based on the mean Cf values, considerable contamination was observed only for Pb, while for other metals, no metal enrichment or moderate contamination was observed.

The mean values of Er for all metals indicate low ecological risk for pollution, despite the fact that the values of Er for Pb and Cd displayed high and considerable contamination at some sampling sites.

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Water Supply and Sewerage System in the Republic of Croatia and the Republic of Slovenia

Marija Šperac[1], Dino Obradović[2]

Abstract

According to forecasts of various international organizations, it is estimated that by 2040 the Earth will be left with no sufficient quantities of drinking water. Water used for supplying drinking water to the population and industry is obtained from natural resources (i.e., the environment) and is distributed through the water supply system to the consumer. The used, polluted water is returned to the environment through the sewerage system with prior water treatment. During the distribution of drinking water through the water supply system, water losses occur. Such lost water does not reach the end consumers and is not even charged by the water supply company. These interconnected processes of obtaining water used for water supply and of returning polluted water to water resources, directly affect the changes in the quantity or quality of water, as well as the local environment and the local population, and, of course, the Earth in general. This paper will analyze statistical data on water supply (the total amount of water intake, distributed water, water losses, length of the water supply network, the number of water supply connections) and sewerage (total amount of wastewaters, length of sewerage network, number of sewerage connections) in the Republic of Croatia and the Republic of Slovenia. The interdependence of these elements will be presented through correlation coefficients.

Keywords: correlation, sewerage system, statistics, water supply

1. INTRODUCTION

Water covers more than 70% of the Earth's surface. However, 97% of water is salty, 2% is trapped in glaciers, and remains only 1% of fresh drinking water. The role of water is multifaceted: it is a crucial necessity, a habitat for plant and animal species, a local and global resource, a transport corridor and a climate regulator. But for the last two centuries water has become the ultimate destination for many pollutants released into the environment.

We collect water for water supply from natural sources; we use it, and return wastewater back to nature. The characteristic feature of today's world is that the heavily polluted wastewater is increasing and the quality water supply is decreasing. In addition to high water pollution levels, losses occurring in the water supply system have a major impact on water supply. The causes of water losses in the water supply system may be different, e.g. the age of the system, pipe porosity, poor system management, illegal water connections to the system, failures and pipe breaks, system flushing. Such lost water does not reach the end consumers and is not even charged by the water supply company. All of this is due to the "water crisis", which means that a large part of the population on Earth has no access to drinking water or the basic hygienic living conditions. According to the forecasts of various international organizations, it is estimated that by 2040 Earth will be left with no sufficient quantities of drinking water.

Water supply and sewerage are two cyclically connected infrastructures, as can be seen in Figure 1.

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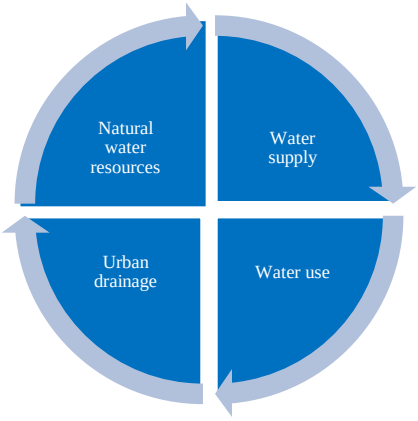

Figure 1. Connection of water supply and drainage

2. STUDY AREA

2.1. Republic of Croatia

The Republic of Croatia is situated in South-Eastern Europe, on the crossroads of Central Europe and the Mediterranean, stretching over 56,594 km^2 with the interior sea water and territorial sea area of 31,479 km^2 [1], [2], [3]. There are five neighbouring countries: Bosnia and Herzegovina, Slovenia, Hungary, Serbia and Montenegro [3]. According to the Koppen's classification, most of the Republic of Croatia has a moderately warm, rainy climate characterised by a mean monthly temperature ranging between -3 °C and +18 °C in the coldest month [2]. The capital of Croatia is Zagreb. Croatia has 4,456,096 inhabitants (according to 2011 census) [4]. Croatia has a total of 128 towns/cities and 6,757 settlements [2]. Also, there are in Croatia 1,620,002 house numbers and 53,096 streets [5].

2.2. Republic of Slovenia

The Republic of Slovenia is situated in Central and South-Eastern Europe, bordering Austria, Croatia, Hungary and Italy. The country has an area of approximately 20,271 km² and has a population of 2,094,060 [6], [7], [8]. According to the Koppen climate classification, most of Slovenia has a warm-temperate humid climate with the warmest month having a mean temperature below 22 °C and four or more months having a mean temperature above 10 °C. The climate of some coastal areas of Slovenia has a warm-temperate Mediterranean climate with the warmest month mean temperature being above 22 °C and humid conditions all year round [9]. The capital of Slovenia is Ljubljana. Slovenia has a total of 6,036 settlements [10]. In Slovenia, there are 558,160 house numbers and 10,400 streets [11].

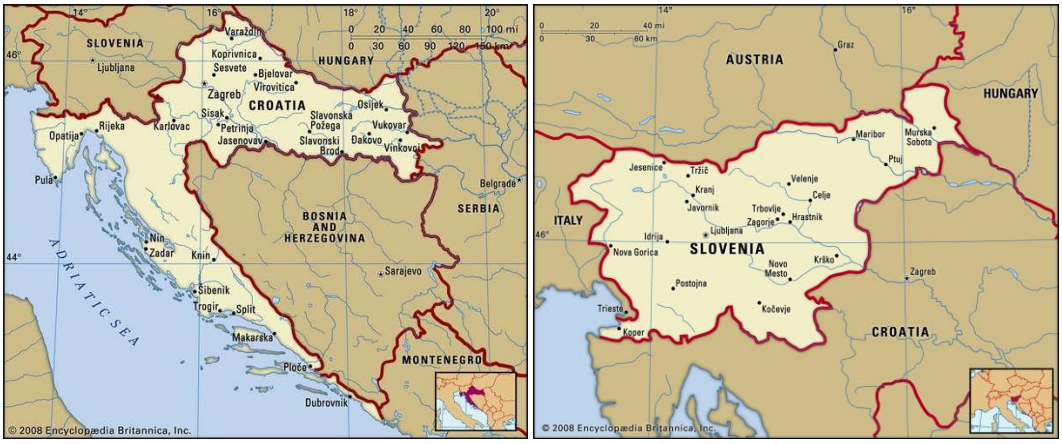

Figure 2. Map of Republic of Croatia (left) and map of Republic of Slovenia (right) [12, 13]

For the purpose of clarity and easy comparison of the two analyzed countries, some of the aforementioned data are presented in Table 1.

Table 1. Basic information about Croatia and Slovenia [1]-[11]

Parameter	Croatia	Slovenia
Land area [km^2]	56,594	20,271
Population	4,456,096	2,094,060
Number of settlements	6,757	6,036
House numbers	1,620,002	558,160
Number of streets	53,096	10,400
Capital	Zagreb	Ljubljana
Number of neighbouring countries	(5+1 on sea)	4
Official script	Latin	Latin
Currency	Croatian Kuna (HRK)	Euro (EUR)
International telephone code	+ 385	+ 386

3. WATER SUPPLY AND SEWERAGE SYSTEM IN CROATIA

3.1. Water Supply

Croatia is a water-rich country split between two river basin districts, the Danube basin and the Adriatic basin. With around 24,495 m^3 of renewable water per capita per year, Croatia is a water-rich country. Surface water quality is, however, a concern, particularly with respect to nutrient pollution in the Danube basin. Water supply comes mainly from groundwater (96%). Surface water provides 4% of overall drinking water supply. Most rivers flow into the Danube or one of its tributaries. Local governments are responsible for water and sanitation services and provide them through 156 public utility companies (140 for water and sanitation service and only 16 for sanitation service). Service quality in Croatia is generally very good by regional standards. Water service is continuous, and drinking water quality is mostly in compliance with national and European standards. The water supply network, which is 4 times as long as the wastewater network, is aging - most of it was installed more than 50 years ago - and its performance could be improved, since the leakage rate is as much as 40% [14].

Table 2. Basic characteristics of the water supply system (part of the analyzed data) [15]

Parameter	Year				
	2014	2015	2016	2017	2018
Total abstracted water (in 1000 m^3)	501188	508541	524063	505029	503503
Total distributed water (in 1000 m^3)	307969	314906	307953	292908	302856
Total water losses (in 1000 m^3)	193219	193635	216110	212121	200647
Total length of water supply network (km)	42609	43104	44627	45603	45676
Number of water connections	1247887	1245376	1245376	1245818	1257773

3.2. Sewerage System

Croatia has traditionally had a high level of service, with near-total access to piped water (99%) and flush toilets (95%). Croatian wastewater infrastructure needs upgrading. Among the 141 wastewater treatment facilities, 46% are equipped with preliminary and primary treatments, 51% with secondary treatment, and only 3% with tertiary treatment [14]. The typical sewerage system is mixed (faecal and precipitation waters together). Only a few smaller cities and residential districts of bigger towns have separate or split sewerage systems (faecal and precipitation waters are split) [16].

Table 3. Basic characteristics of the sewerage system (part of the analyzed data) [15]

Parameter	Year				
	2014	2015	2016	2017	2018
Discharge of wastewater (in 1000 m^3)	333353	327872	334790	312022	335807
Total length of sewerage network (km)	9649	10493	10885	12047	12448
Number of sewerage connections	521882	521882	555147	568842	584243

4. WATER SUPPLY AND SEWERAGE SYSTEM IN SLOVENIA

4.1. Water Supply

Slovenia has good-quality and sufficient water resources. Eighty-one percent of the Slovenian territory belongs to the Black Sea basin, and the rest is part of the Adriatic Sea basin. With 15,411 m^3 per capita per year, there are sufficient quantities of water on average in Slovenia, and most of it is in a good ecological state. However, agriculture has had a severe impact on groundwater quality, and there is a concern about the decreasing groundwater level in certain areas due to overabstraction. Drinking water supply relies almost exclusively on groundwater. Surface water is predominantly used for the production of electric energy in hydroelectric power stations, while groundwater provides 97% of the raw water for potable public supply. Local government units provide water and sanitation services through 98 utilities. Drinking water quality in Slovenia improved during 2004 to 2013 for both microbiological and chemical parameters. The compliance rate has steadily increased over the last decade to 92% in 2013. One-fourth of the Slovenian water network was installed before 1920. From 2000 to 2010, the rehabilitation of water supply systems was boosted by EU grants and funding specifically dedicated to water infrastructure improvement [17].

Table 4. Basic characteristics of the water supply system (part of the analyzed data) [18]

Parameter	Year				
	2014	**2015**	**2016**	**2017**	**2018**
Total abstracted water (in 1000 m^3)	163095	164404	161821	169385	170718
Total distributed water (in 1000 m^3)	117205	117886	116698	122559	121162
Total water losses (in 1000 m^3)	45890	46517	45123	46827	49556
Total length of water supply network (km)	24017	30923	31165	32519	32360
Number of water connections	458305	439736	433305	444041	454487

4.2. Sewerage System

Slovenians have full access to water services. Ninety-nine percent of the Slovenian population has access to piped water and flush toilets. Among the 486 water treatment plants, 72% rely on chlorine disinfection and 13% on mechanical and chemical treatment [17].

Table 5. Basic characteristics of the sewerage system (part of the analyzed data) [19]

Parameter	Year				
	2014	**2015**	**2016**	**2017**	**2018**
Discharge of wastewater (in 1000 m^3)	183285	162540	200653	217726	230638
Total length of sewerage network (km)	8842	9638	8950	9664	9972
Number of sewerage connections	266918	284120	268039	289680	296648

5. RESULTS AND DISCUSSION

In this part of the paper, data on the water supply and sewerage system for the Republic of Croatia and the Republic of Slovenia for a 10-year period was analyzed. The period analyzed is from 2009 to 2018.

Table 6 shows some basic data on the water supply system and sewerage system for both countries.

Table 6. Basic data of the water supply and sewerage system

Parameter	Unit	Croatia	Slovenia
Average water losses per capita	m^3	51.01	23.67
Average water consumption per capita	m^3	78.47	57.86
Average abstracted water per capita	m^3	129.48	81.52
Average amount of wastewater per capita	m^3	67.95	110.14
Average water losses per one km of water mains	m^3	4392.83	1531.40
Average wastewater amount per one sewerage connection	m^3	574.77	777.48
Average water consumption per one water connection	m^3	240.79	266.60
Water supply network density	km/km^2	0.807	1.60
Sewerage network density	km/km^2	0.220	0.50

Programs MS Excel® and TIBCO Statistica™ were used to process the data. All the tables shown below are given in their original form and obtained from the TIBCO Statistica™ software package used for statistical data processing while for diagrams is used MS Excel.

Table 7 shows the descriptive statistics for the data on the water supply and sewerage system of the Republic of Croatia, while Table 8 shows the descriptive statistics for the data on the water supply and sewerage system of the Republic of Slovenia. Eight variables are observed as follows: Discharge of wastewater (m^3), Total length of sewerage network (km), Number of sewerage connections, Total abstracted water (m^3), Total distributed water (m^3), Total water losses (m^3), Total length of water supply network (km) and Number of water connections.

Table 7. Descriptive statistics for the data on the water supply and sewerage system of the Republic of Croatia

	Descriptive Statistics (Croatia.sta)				
Variable	Valid N	Mean	Minimum	Maximum	Std.Dev.
Discharge of wastewater (m3)	10	32445520(	30103000(	34354400(	1445325(
Total length of sewerage network (km)	10	9853	8144	12448	1557
Number of sewerage connections	10	512320	435607	584243	47495
Total abstracted water (m3)	10	53788440(	50118800(	57698500(	3207508(
Total distributed water (m3)	10	33074790(	29290800(	36528100(	2764113(
Total water losses (m3)	10	20713650(	19321900(	22729300(	1063012
Total length of water supply network (km)	10	43111	41246	45676	1619
Number of water connections	10	1229711	1146088	1257773	33884

Table 8. Descriptive statistics for the data on the water supply and sewerage system of the Republic of Slovenia

	Descriptive Statistics (Slovenia.sta)				
Variable	Valid N	Mean	Minimum	Maximum	Std.Dev.
Discharge of wastewater (m3)	10	18677470(	15146500(	23063800(	2517059(
Total length of sewerage network (km)	10	8620	7215	9972	957
Number of sewerage connections	10	263504	231243	296648	22502
Total abstracted water (m3)	10	16555640(	16173100(	17071800(	3212054
Total distributed water (m3)	10	11932680(	11669800(	12255900(	1958004
Total water losses (m3)	10	4622960(	4235200(	4955600(	2309067
Total length of water supply network (km)	7	27899	21656	32519	4875
Number of water connections	7	450271	433305	466461	11620

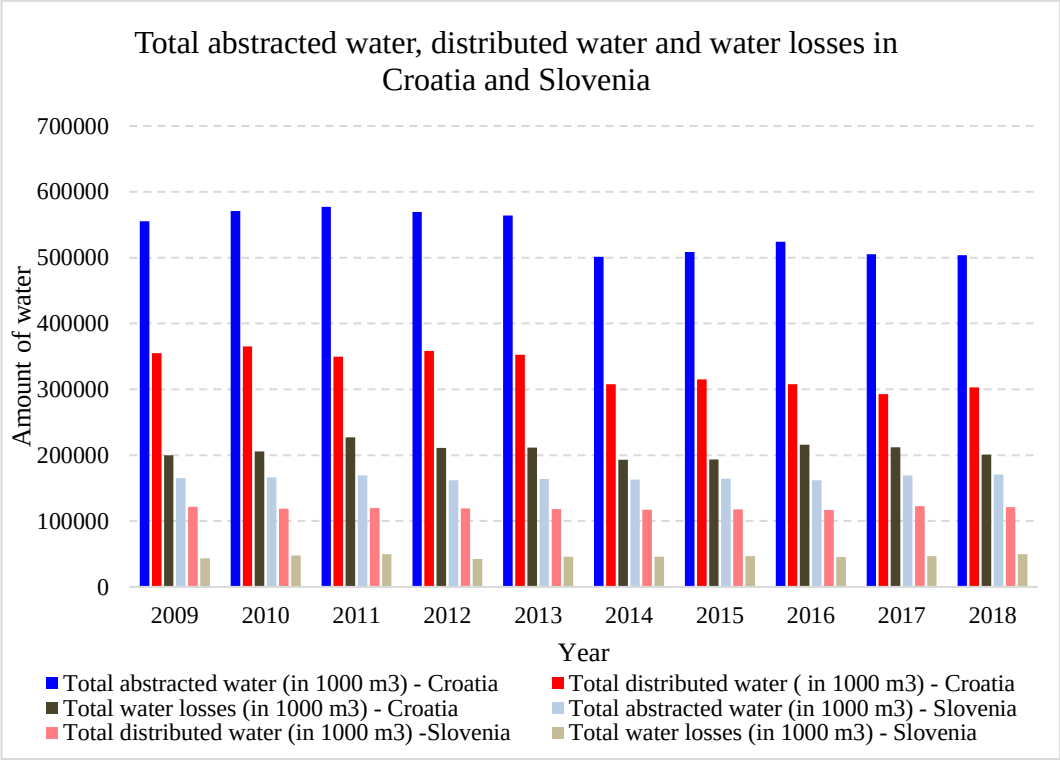

Figure 3. Total abstracted water, total distributed water and total water losses for the Republic of Croatia and Republic of Slovenia for a 10-year period

The following two tables (Tables 9 and 10) show the correlation coefficients for all the eight variables (five variables on the water supply system and three variables on the sewerage system) for the Republic of Croatia.

Table 9. Correlation coefficients for five variables of the data on the water supply of the Republic of Croatia

Variable	Correlations (Croatia) Marked correlations are significant at p < ,05000 N=10 (Casewise deletion of missing data)				
	Total abstracted water (m3)	Total distributed water (m3)	Total water losses (m3)	Total length of water supply network (km)	Number of water connections
Number of water connections	-0,491906	-0,581819	0,028615	0,638773	1,000000
Total length of water supply network (km)	-0,734558	-0,861877	0,024670	1,000000	0,638773
Total water losses (m3)	0,553988	0,258278	1,000000	0,024670	0,028615
Total distributed water (m3)	0,947360	1,000000	0,258278	-0,861877	-0,581819
Total abstracted water (m3)	1,000000	0,947360	0,553988	-0,734558	-0,491906

Table 9 shows the relationship between the Total Length of water supply network and: Total abstracted water (r = - 0.734558), Total distributed water (r = - 0.861877) and Number of water connections (r = 0.638773).

Table 10. Correlation coefficients for three variables of the data on the sewerage system of the Republic of Croatia

Variable	Correlations (Croatia) Marked correlations are significant at p < ,05000 N=10 (Casewise deletion of missing data)		
	Discharge of wastewater (m3)	Total length of sewerage network (km)	Number of sewerage connections
Discharge of wastewater (m3)	1,000000	0,319136	0,360549
Total length of sewerage network (km)	0,319136	1,000000	0,964483
Number of sewerage connections	0,360549	0,964483	1,000000

Table 10 shows the relationship between the Total length of sewerage network and Number of sewerage connections (r= 0.964483).

Tables 11 and 12 show the correlation coefficients for all the eight variables (five variables on the water supply system and three variables on the sewerage system) for the Republic of Slovenia.

Table 11. Correlation coefficients for five variables of the data on the water supply of the Republic of Slovenia

Variable	Correlations (Slovenia) Marked correlations are significant at p < ,05000 N=7 (Casewise deletion of missing data) Total abstracted water (m3)	Total distributed water (m3)	Total water losses (m3)	Total length of water supply network (km)	Number of water connections
Total abstracted water (m3)	1,000000	0,836563	0,837419	0,634198	-0,066432
Total distributed water (m3)	0,836563	1,000000	0,401109	0,371276	0,172839
Total water losses (m3)	0,837419	0,401109	1,000000	0,689979	-0,283524
Total length of water supply network (km)	0,634198	0,371276	0,689979	1,000000	-0,756905
Number of water connections	-0,066432	0,172839	-0,283524	-0,756905	1,000000

Table 11 shows the relationship between the Total abstracted water and: Total distributed water (r= 0.836563) and Total water losses (r= 0.837419).

Table 12. Correlation coefficients for three variables of the data on the sewerage system of the Republic of Slovenia

Variable	Correlations (Slovenia) Marked correlations are significant at p < ,05000 N=10 (Casewise deletion of missing data) Discharge of wastewater (m3)	Total length of sewerage network (km)	Number of sewerage connections
Discharge of wastewater (m3)	1,000000	0,621428	0,650735
Total length of sewerage network (km)	0,621428	1,000000	0,990051
Number of sewerage connections	0,650735	0,990051	1,000000

Table 12 shows the relationship between the Discharge of wastewater and Number of sewerage connections (r= 0.650735), and between the Total length of sewerage network and Number of sewerage connections (r= 0.990051).

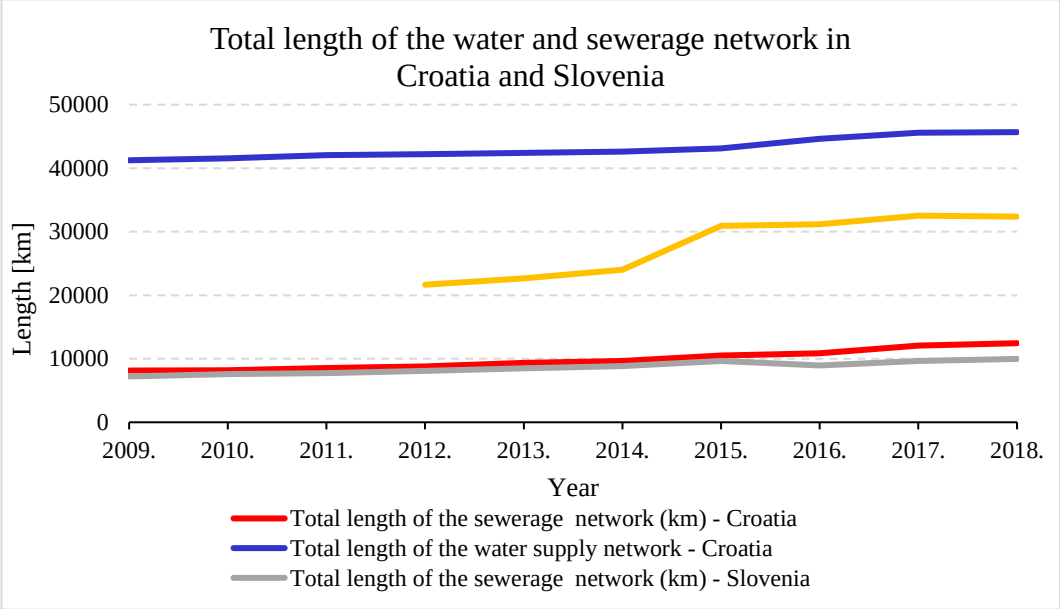

Figure 4. Total length of the water and sewerage network for the Republic of Croatia and Republic of Slovenia for a 10-year period

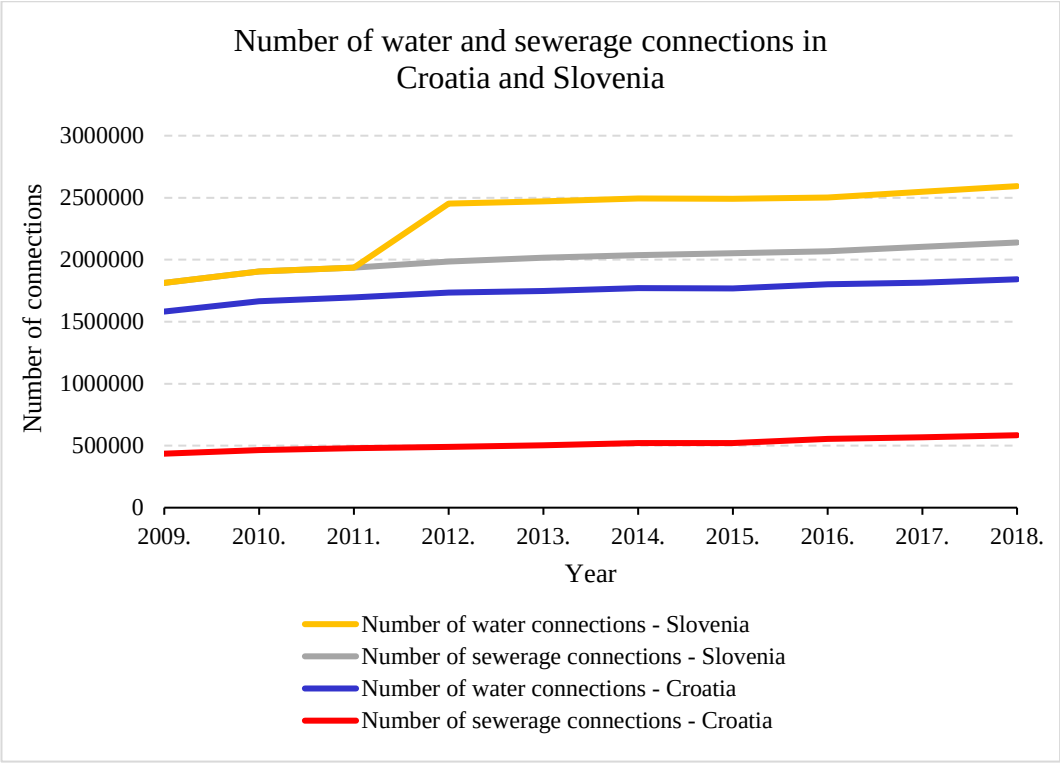

Figure 5. Number of water and sewerage connections for the Republic of Croatia and Republic of Slovenia for a 10-year period

CONCLUSIONS

By analyzing the correlation coefficients between individual parameters of water supply and sewerage, it can be concluded that the parameters with a correlation coefficient higher than 0.7 have a good connection or a significant mutual influence. For parameters between which the correlation coefficient is less than 0.7 we can say that the correlation is small or non-existent, i.e. that they do not have mutual influences. All correlations between the water supply and sewerage system can be used in the development of the model and the calculation of a specific required data if we know some input data. The development of such models is a potential subject of future research. The construction, connection and condition of the water supply and sewerage network are of great importance for the development of each country. The main problems faced by all countries are water losses in the water supply, and the treatment and discharge of wastewater into the environment. Today, we are witnessing declining supplies of drinking water, and large-scale pollution of water and the environment from the discharge of untreated wastewater, and various diffuse sources of pollution. According to the EU Framework Directives (of which Croatia and Slovenia are members) it is necessary to achieve the maximum connection of the population to the water supply and sewerage network, reduce water losses to the limits of permitted losses, build wastewater treatment plants and connect all settlements up to a minimum of 2000 population equivalent, all with the aim of achieving a good water status and a sustainable water management. This paper shows that in Croatia and Slovenia the connection to the water supply and sewerage system is satisfactory. However, it is working on a higher percentage of construction and connection to the networks. Water losses in the water supply system are high in both countries, as a result of the age of the network, inadequate maintenance, failures and damage. In Croatia, an additional problem for water supply and sewerage is a large number of small settlements with less than 500 population equivalent for which it is economically unprofitable to bring sanitary infrastructure. These settlements have water supply from local wells, and wastewater is collected in septic tanks that are water permeable and represent sources of diffuse pollution.

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6TH INTERNATIONAL CONFERENCE ON ENVIRONMENTAL SCIENCE AND TECHNOLOGY
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Smart Scale IoT Application

***Radosveta Sokullu*[1]**

Abstract

The use of electronic and communication devices in homes, factories, cars and many other sectors are increasing day by day, helping us to create a more environment friendly world. There is a growing demand to manage and analyze the collected data in a simple way. Many devices around us are turned into "smart devices". This concept implies that the devices can collect data in a controlled manner, save it and transmit it to other devices either automatically or with minimal human control and minimal effect on the environment. The "Internet of Things" (IoT) has emerged as a new technology which allows devices to connect to a network through various protocols and communicate with each other over wide area networks. Thus the need to collect and analyze the data in a more manageable way has become an important research issue. This paper describes the work for creating a smart scale that can be incorporated in various healthcare, home and industrial IoT systems. The developed prototype system allows transferring weight data, provided from smart sensors, to a data center using the MQTT protocol via ESP32. The user will be able to access the information in the data center from his mobile device or personal computer and follow up and/or analyze the data. A user interface was developed for Android based devices using the Android Studio. The project ensures full integration between the MQTT applications and the Android Studio using the Eclipse-Paho library. The prototype system can find usage in various areas, from personal health, to environmental and industrial sectors. Results from the smart scale can be transmitted electronically, integrated in public healthcare systems, environment monitoring systems and industrial applications.

Keywords: Internet of Things, smart devices, smart scale, MQTT

1. INTRODUCTION

The use and communication of electronic devices in homes, factories, cars and many sectors are increasing day by day. For this reason, there is lot of theoretical and application research going on currently both in the academia and the industrial world. The Internet of Things (IoT) has emerged as the new technology that allows to connect and operate various devices over long distances with minimal or no human intervention for the purpose of collecting and evaluating data and when required carry out actuation of specific operations. The IoT technology has penetrated in different areas of our lives, starting from smart homes, smart appliances, smart traffic, and smart agriculture to smart vital signs collecting systems and industrial applications. Data collected over the IoT can be used in many diverse ways – from personal look-up applications, to vast data analytics systems. The work presented here addresses the issue of collecting weight measurement data and transmitting it over the IoT to be used for personal record tracking. The paper describes the design and prototype of a smart food weighing system created using the internet based technologies. This so called "Smart Scale" will transfer weight sensor data via ESP32 to a data center using the MQTT protocol. The user will be able to access the information in the data center from his mobile device or personal computer and analyze the data. In this way,

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he will be able to determine the daily nutritional requirements and also remotely monitor the amount of food remaining in stock. From here on the paper is organized as follows: in the following section a short overview of some related work is presented. In section 3 the proposed system architecture and main components are described followed by user interface design, evaluation and conclusion.

2. RELATED WORK

An interesting study utilizing a smart weighing system is presented in [1] where the authors use a wireless weighing platform, comprising the latest advances in low power wireless sensor network technology, to better understand the condition of the colony in beehives. One of the main measures of the strength of a beehive is the weight of the colony. Changes in weight can accurately reflect the productivity of the colony. The installed system is able to scale the measurement linearly and has been found successful in terms of energy consumption. A farming related smart scale system is presented in [2]. The authors consider the case of collecting rubber from various small farmers in Malaysia. In the traditional practices, each farmer brings his load, which is weighted and recorded in a logbook manually. However, this practice is very prone to human errors and in many cases physical records are lost. So the authors propose the so called “Smart Rubber Scale” (SRS) System which utilizes cloud storage to ensure long term preservation and accessibility of the data. The SRS prototype consist of load cell sensor, scale sensor, Arduino UNO R3, sensor module HX711, Bluetooth module and an LCD display. A dedicated SRS website is developed by using PHP that allows the staff to store rubber weight information automatically after measurements are taken. Both the farmer and the staff have access to the uploaded data and also detailed monthly records can be downloaded. Another system which presents an example of a smart IoT based personal system is presented in [3]. It describes the design of an IoT application aimed at storing personal vital signs information in a cloud. It provides a possibility to access and evaluate the data via a mobile application. In this process, the data collected from the patient with an embedded sensor device installed with the STM32 card and is then transmitted to a predefined database over the internet. An MQTT based cloud system is used. The saved data can be accessed and processed individually using a custom designed Android based application. As a result, a system with very low power consumption and low latency is designed. More details on how security issues in this type of applications can be handled are to be found in [4]. The work discusses the secure communication model for embedded devices over the Internet of Things (IoT). The goal is to examine innovations in the application layer together with the widely used MQTT protocol to provide secure communication. The basic idea is that the MQTT protocol enrolls using a username and password. In order to prevent this information from being captured by third parties during communication, a modified application logic and unnecessary encryption method is used. With this method, the risk could be partially compensated. In [5] the authors present a remote controlled dog feeding mechanism with changeable and adaptable characteristics. The proposed prototype system allows dog owners to take care of their dogs without interrupting their daily routines. At the same time it provides a good record of the feeding practices over a given period of time by determining the stock information, feeding frequency and consumption. The prototype uses a load cell for remote weight measurement, an Android application and a RFID for realizing control operations. When the feeding process is completed a message is sent remotely providing information about the time and details of the feeding. An example of a system using the ESP32 module for wirelessly transmitting locally collected data is presented in [6]. The authors’ aim is to create an application related to

smart grid technology. The proposed solution allows transmitting and controlling electrical energy consumption by using a smart meter. Thus, the service provider and the consumer are able to obtain information about energy consumption at certain time intervals. The data measured locally is broadcast to an MQTT server with the help of a ESP32 module. Users have the possibility to access their personal recorded information whenever they want via the web over this MQTT server. This is an attractive application, which deploys an IoT network and makes it quite easy to keep track of our electricity consumption intelligently.

3. PROPOSED SYSTEM ARCHITECTURE AND MAJOT COMPONENTS

3.1. System Architecture

The proposed prototype comprises an IoT smart scale which can collect weight data from a smart load cell and transfer it through an wireless unit to a MQTT server. The functional diagram of the developed prototype is presented in Fig.1 below.

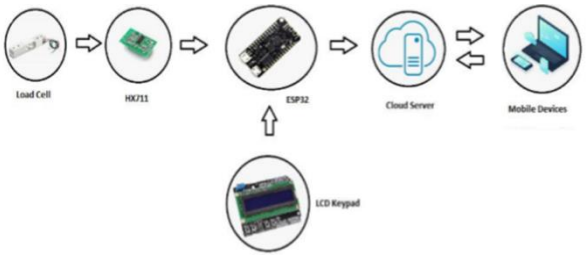

Figure 1. System Architecture

As can be seen from the figure the architecture of the proposed system contains a load cell, an HX711, a wireless transmission module ESP32 for collecting and transmitting the weight data; a cloud server to store the information and an Android based user application which allows access and evaluation of the recorded data. An LCD screen to provide user input when required.

3.2. Major Components

In this section the main components of the proposed system are discussed.

3.2.1. Smart Weighing Module

The smart weighing module is based on a load cell with HX711 shown in Figure 2. Measurement of the weight is done using load cell sensors, which convert the force acting on the load cell into a signal. This signal can be a change in voltage, current or frequency depending on the type of load cell and circuit. Thanks to the strain-gauge structure inside the two 5 kg load cells used in this work, an analog signal is generated by the difference in resistance caused by the load on it. This signal is transferred to the HX711, which is on a 24-bit ADC module. The E + and E- inputs of the load cells are connected to the E + and E- input of the HX711 by mapping. The red ends of the mutual load cells are connected to the A + and A- inputs of the HX711, providing the combined use of load cells.

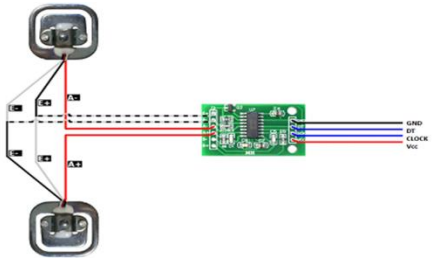

Figure 2. Load Cell with HX711 connection

3.2.2. The ESP32 Module

ESP32 is a microcontroller with a 240 MHZ clock frequency, a programmable WiFi receiver/transmitter with embedded power amplifier, filter and antenna, and is frequently used in IoT applications. It contains peripherals such as I2C, SPI, UART, and can be programmed with Arduino or MicroPython IDEs. ESP32 can be operated over protocols such as TCP, HTTP, MQTT, SNTP. In this prototype, the data from the HX711 is transferred digitally from the data end to the ESP32 with a specific clock frequency. The data is processed by using the "HX711.h" library in ESP32. Thus, the weight data measured from the load cell module is ready to be transferred to the server for use. After the user selects the product, the product information from the LCD keypad is transferred to the MQTT server along with the weight data. The ESP32 is defined to the MQTT server as a publisher. The ESP32 is connected to a WiFi network using the predetermined SSID and password information. Open source Cloud MQTT was chosen as the MQTT server.

3.2.3. The MQTT Module

MQTT is a machine-to-machine (M2M) protocol, one of the most widely used protocols for IoT. It provides a messaging network based on the publish/subscribe principle. The protocol works over TCP/IP, but any lossless, double-sided network protocol will work. It operates with limited data rate and is especially suited for IoT applications, which require low data rate and small data volumes. There are 2 main entities in the MQTT protocol: a MQTT server and a certain number of MQTT clients connected to it. The MQTT server receives messages from all clients and directs them to the addresses to be reached (clients). An MQTT device connects the server to the network and compiles the MQTT library. The MQTT packet consists of a header and message part. The messages are listed under headings. If a title appears on the server and there is no subscriber under this title, the server deletes it. "Publisher" is an MQTT client that sends a message to the server. "Subscriber" is an MQTT client that can view or use the messages under the header by registering for the title sent by the publisher. Three types of MQTT messages are used: Connect, Disconnect and Publish. The connect message is used for establishing the connection between the server and the units; the disconnect message causes the disconnection; publish message is the MQTT client request message. As shown in Figure 4, subscriber devices can reach the server and at the same time publish messages on the server as a "publisher", register in the headers and send messages under the header. MQTT applications use a microcontroller as a "publisher" to save the data it receives.

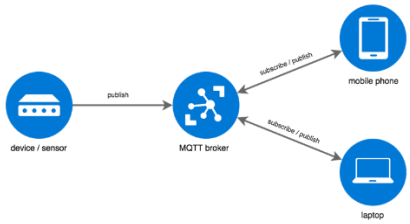

Figure 3. MQTT Protocol Operation

ESP32 is one of the most used and most suitable microcontrollers for this purpose. Devices connected to the server as "subscriber" are devices that provide the data to the user with applications installed on operating systems such as Android, IOS, Windows, usually from sensors. In the project created, a solution was produced for Android devices using Android Studio. The use of Eclipse-Paho library, where MQTT applications are executed for Android Studio, and its integration into the project has been provided.

3.3. System software

Eclipse-Paho library is used for the MQTT protocol in Android programming. A publisher/server application is developed with Java in Eclipse-Paho library. Each interface page for Android consists of activities. Abstract operations are done with the help a similar interface. Interfaces define functions in a way that we can "override". Helper Java classes can also be created for use in activities that execute the interface. For example, MainActivity, AfterLogInActivity, ProgressActivity used in this prototype are examples of activities; AppDatabase, MyAdapter, MqttHelper are examples of Java helper classes. The Android programming was carried out in Java. The interface that welcomes the user when the application is opened is the interface where the user will register, i.e. MainActivity. The classes User, User Alme and AppDatabase, which are connected to the MainActivity, are the classes that perform the operations on the local database to store the information that the user has registered. The User class determines the user's variables, such as email, password, name and surname that the user must save in the system. AppDatabase is the class in which the connection configurations of the database are made. Android Room Database is used as the database.

The main algorithm is given in Figure 4 below. After the user registers with their profile information, they are directed to ProressActivity. ProgressActivity is an activity that offers the user a welcome screen with their first and last name. In ProgressActivity, the name and surname information given by the user while registering to the system is taken from the Room Database (a local database in Android). Following the input of the user's name and surname, a special welcome screen is activated for the user followed by direction to the AfterLogInActivity. MQTT messages are displayed sequentially in AfterLogInActivity. There is a RecyclerView library in this class that allows the functions and messages that receive MQTT messages to be displayed sequentially. The class that allows RecyclerView to connect to the activity is the MyAdapter class. In addition, each message is set up with CardView to print a cloud icon and message. The class in which MQTT functions are defined is the MqttHelper class. The MqttHelper allows integration of MQTT operations and defines the actions to be taken when the message is received.

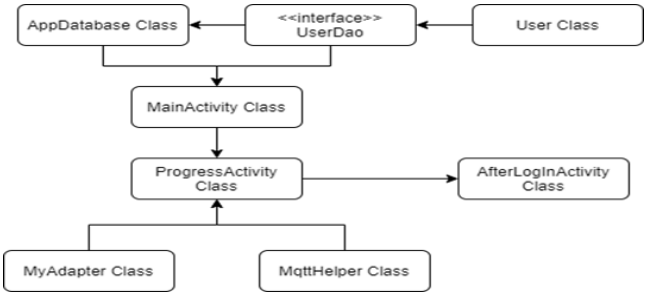

Figure 5. The main algorithm

4. USER INTERFACE DESIGN

An important part of the design is the user interface. The first screen on the LCD that meets the user is given in Figure 5 below and shows the message "Welcome, Press a Key".

Figure 5. The Welcome LCD screen

After connecting to the server, the system offers the user the opportunity to choose a product. While the user selects the desired product by pressing the keys, the scale measures the weight of the product. Each time the user presses a key, the weight data from the scale is updated. Thus, when there is a new user, or the user wants to change the weight, he will be able to weigh the product again and save it to the system with new data. An example regarding the product information and the sensitivity of the scale is shown in Figure.6.

Figure 6. An Example of Weighing a Milk Carton

After the product selection and weighing process is completed, the information on the screen is sent to the MQTT server as soon as the user presses the "Select" button. Thus, it is connected to the MQTT server as "Publisher" with ESP32. When the user connects to the server as a "Subscriber" from any Android device, they can view the messages under the "topic" on their device. The mobile device software was developed using Android studio. Examples of the design can be seen in Figure 7 below.

5. PRELIMINARY RESULTS AND DISCUSSION

The work described in this paper is part of an ongoing project for creating a user-friendly home environment. The described prototype has been tested as a standalone system and the results are presented below. Experiments regarding the input interface and weighing sensitivity of the scale have been developed. Two groups of tests were carried out: the first was testing the connectivity of the system and the proper operation of software. Examples of the user screens at the stage where the user is greeted on the Android device and the profile information is saved to the system are given in Figure 7 below. The second group of tests regarded the measuring systems. The load cell-based system was calibrated and tested with various samples of goods. For a 1.5 lt water bottle it was observed that the weight measurement was had a deviation of 6.25%; in the tests performed with 1 kg tea package, weight measurements were obtained without error; tests performed with a 300 gram snack package showed a deviation of 3.44%. The average error was estimated at below 2.6%. Compared to other similar systems like the ones presented in references [1], [2] and [5] these results are acceptable. The system has met the requirements and smoothly operates over the provided wireless environment. Privacy and protection of the data is secured by the login requiring registration, username and password. Since the goal was to create a simple, low cost prototype using off-the-shelf elements no further protection mechanisms were incorporated.

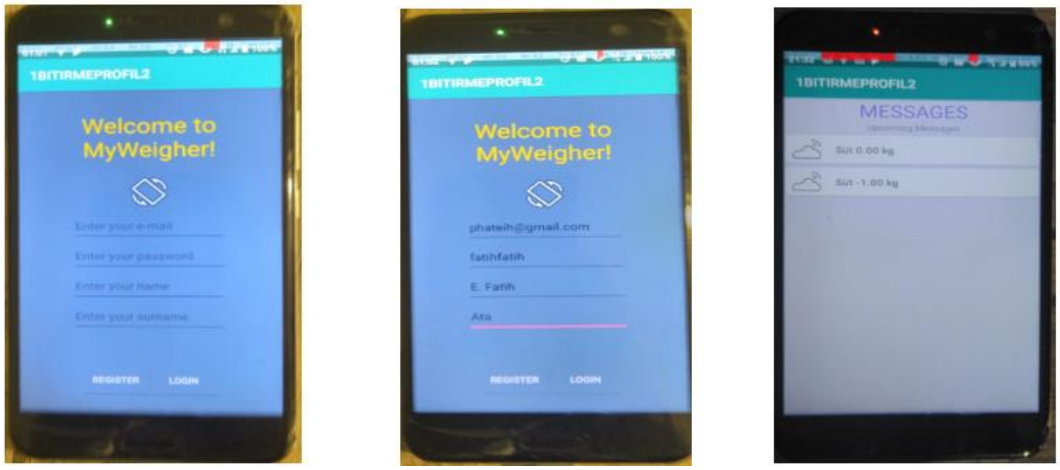

Figure 7. Examples of user interface screens

6. CONCLUSION

This paper discussed the proposed prototype and main components for an IoT based smart scale application. The system provides easy but secured access to food weight information. ESP32 allows evaluation and wireless transmission of the sensor provided data. Together with product information entered by the user through the LCD module the data is stored on Cloud MQTT servers using the MQTT protocol. The data on the server can be accessed through the application developed for Android devices. The designed prototype had in mind a personal food tracking information system, as part of a smart environment project, but with small modifications it can be used in other situations including also agricultural and industrial weighing applications

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IoT Based Forest Fire Monitoring System

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Abstract

This paper describes a prototype system for monitoring forest fire using IoT and drones. Sensors placed in the forest area continuously measure parameters, which can provide early warning about arising fire situations such as temperature, humidity, carbon monoxide and simultaneously transfer the data for processing to a control unit. The control unit aggregates and maps the collected information separately for each parameter and then creates fire danger mapping based on the FFDI index including all parameters. The severity of the situation is reflected on the map using a special coloring scheme. When a certain color level is exceeded, a drone (possibly carrying water supplies) is sent to the transmitted coordinates to provide visual data and help extinguish the fire at as early stage as possible. The wireless sensor network consists of small size sensor nodes, which autonomously cooperate in the physical area and provide information about the current surrounding environment over WAN. The functions of integrating and evaluating the collected data are embedded in the control unit, which is located at a safe distance within communication range. The communication between the control unit and the drone is over WAN. The drone would normally be waiting ready in a monitoring station or fire fighter location. Upon receiving critical information the drone can be dispatched to the determined coordinated to collect visual data of the area and/or if possible to help with extinguishing the fire.

Keywords: Internet of Things, smart devices, forest fire detection, FDDI index

1. INTRODUCTION

One of the first areas where wireless sensor networks and Internet of Things have found application is environment monitoring. In the early stages WSN were custom-designed to provide early warning about possible forest fires. With the development of infrastructure and the standardization of new low cost wireless connectivity protocols, the Internet of Things (IoT) established itself as the main technology in many applications, like environmental monitoring, agriculture, industry etc. From smart homes, smart appliances, smart traffic, and smart agriculture to smart vital signs collecting and industrial applications IoT has become a ubiquitous technology. The paper describes the design of a system for monitoring forest fire using IoT and drones. Sensors placed in the forest area continuously measure parameters, which can provide early warning about arising fire situations such as temperature, humidity, carbon monoxide and simultaneously transfer the data for processing to a control unit. The control unit aggregates and maps the collected information separately for each parameter and then creates fire danger mapping based on the FFDI index including all parameters. When a certain color level is exceeded, a drone (possibly carrying water supplies) is sent to the transmitted coordinates to provide visual data and help extinguish the fire at as early stage as possible. From here on the paper is organized as follows: in the next section a short overview of some related work is presented. In section

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3 the theoretical background on forest fire indices and fire danger calculations is provided. Section 4 presents the system architecture and main components followed by user interface design, evaluation and conclusion.

2. RELATED WORK

In the last decade, together with rising temperatures and unstable weather conditions causing draughts and excessive flooding the number of forest fires all over the world has considerably increased. Incurred forestation destruction, wildlife loss and environmental calamities are becoming more sizeable every year. Studies show that the fires contribute to the rise of global temperatures and negatively affect climate change. [1 - 4]. That is why a lot of work is focusing on monitoring, preventing and detecting forest fires. Depending on the adopted approach research can roughly be divided into 3 groups: based on WSN; using images and image processing techniques; using unmanned aerial vehicles (UAVs).

An interesting study covering the use of WSN and a small satellite to provide early warning about forest fire is presented in [1]. The authors describe a WSN for collecting data about temperature, smoke and CO2 which is transmitted over wireless medium to the small satellite which re-transmits the data to a ground station where they are analyzed. The proposed prototype comprises a set of sensors, a transmission module, a microcontroller with an LCD and a remote control unit. The authors in [2] address the problem faced by wildlife and forest departments due to the reduced forest areas and the increased movement of wild animals into residential areas. The work proposes a system for environment monitoring and alarming the responsible authorities to protect both animals and forests against forest fires. A fire detector using Arduino UNO is designed which is interfaced with a temperature sensor, a smoke sensor and a buzzer. Whenever a fire occurs, the system automatically senses and alerts the user by sending an alert to an app installed a mobile or webpage accessible through the internet. A detailed overview of using artificial neural networks to help in early forest fire warning systems is provided in [3]. The authors define three phases in the development of forest fires: pre-fire when action for controlling the occurrence of fire control can be taken; during arising fire, when early detection and appropriate action is required; post-fire when damage assessment and mitigation planning is done. In many countries satellite-based surveillance system are used to detect forest fire but this approach is usually used when fire has already spread over a large area. The authors propose a model for early fire detection and prediction. Besides Raspberry Pi microcontroller and required sensors the system comprises a centralized server, used for storing the data and analyzing that data. Feed-forward fully connected NN is used for prediction purpose. In [4] the authors present two solutions for early fire detection systems based on emerging new technologies: unmanned aerial vehicles (UAVs) with specialized cameras and LoRaWAN sensor networks. Different scenarios for the possible use of the drones in such cases are presented and analyzed. An interesting angle to detecting forest fire at an early stage using image processing and color schemes is proposed in [5]. The work classifies the characteristic color of the forest fire using image processing techniques. The authors argue that especially during the late spring and summer the fire is easily distinguished from the color of trees and foliage and suggest a new method which combines several predetermined and fuzzy criteria for image segmentation. Another approach that has emerged in recent years is based on incorporating drones. Such options provide lower operational costs and allow UAVs to reach areas that are inaccessible or considered too dangerous for firefighters. The work in [6] describes the application of a real-time forest fire detection algorithm using aerial images captured by a video camera onboard an UAV. The forest fire detection algorithm consists of a rule-

based color model that uses both RGB and YCbCr colour spaces to identify fire pixels. A fire geolocation algorithm is proposed to estimate the location of the fire and transmit the location in terms of latitude (φ), longitude (λ) and altitude (h).

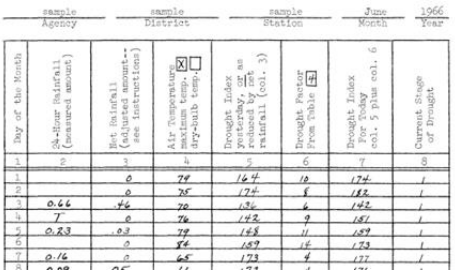
Different than the research presented above, in this work the fire detection is done based on a combination of sensing data, color-scale map using the FFDI index and coordinate determination for drone dispatch. A large number of sensors are used to collect data which is then aggregated and processed by a remote control unit to produce a map of the area with colors depending on the possibility of fire occurrence. Location information is also extracted and a UAV can be sent to the endangered area.

3. FOREST FIRE DANGER ESTIMATION AND DETECTION

Forest fires all over the world cause a lot of damage to the wildlife habitat and human population. During the years various forewarning indicators have been considered for detecting forest fires at an early stage and also evaluating the danger of their occurrence. Scientists have proposed indices which take into consideration parameters from the surrounding environment to evaluate the possibility of fire ignition.

One of the most popular indices is the McArthur Fire Danger Index (FDI), which was proposed by McArthur in 1966. [7] [8] The FDI is a measure of fire initiation, spreading speed and also evaluates how difficult it is to contain it at the source. Later on it has been extended to include other environmental parameters like temperature, relative humidity, wind direction, vegetation type and terrain characteristics. Noble in 1980 proposed a detailed equation form of the index. [9] Besides this index, which has been operational in Australia since 1967, other indices are also used; the Canadian Fire Weather Index (FWI) [10], the American National Fire Danger Rating System (NFDRS) [11], Nesterov index [12], Angstro¨m index [13].

Today many countries use the FFDI (Forest Fire Danger Index) and GFDI (Grassland Fire Danger Index) which also include the draught factor (DF). The DF, provides an estimation of the vegetation fuel available for burning and has values in the range 1-10, where a DF = 10 indicates maximum possible fuel available for combustion. In their centennial paper [14] John J. Keetch and George M. Byram formulated the Drought index (DI), which expresses moisture deficiency in hundredths of an inch. The index is based on 8.00 inches of water available for transpiration, so its range is from 0 to 800. It can be computed for a given level of mean annual rainfall. Since there were no computers at that time, the authors developed detailed tables and recording examples (Fig. 1) for deriving the correct value of DI.


sample Agency | sample District | sample Station | June Month | 1966 Year

Day of the Month	24-Hour Rainfall (measured amount)	Net Rainfall (adjusted amount... see instructions)	Air Temperature ☒ maximum temp. ☐ dry-bulb temp.	Drought Index yesterday, ☰ as adjusted for today's rainfall (col. 3)	Drought Factor From Table ⊞	Drought Index Today col. 5 plus col. 6	Current Stage of Drought
1	0	0	79	164	10	174	1
2		0	75	174	8	182	1
3	0.66	.46	70	136	6	142	1
4	T	0	76	142	9	151	1
5	0.23	0.2	79	148	11	159	1
6		0	84	159	14	173	1
7	0.14	0	65	173	4	177	1

Figure 1 – Drought Index Sample Record (1968)

An ongoing EU funded project, the **H**igh-**E**nd c**L**imate **I**mpacts and e**X**tremes (HELIX) project, which started in 2014, is a collaborative research work of 16 organizations worldwide assessing the potential impacts of climate change. [15] Scientists work together to develop future scenarios of the natural and human world as a

consequence of global warming. Using the McArthur and Keetch-Byram indices as well as the Noble equations they have summarized the following fire index calculations and values for the FFDI:

$$FFDI = 1.25 * D * \exp [(T - H)/30.0 + 0.0234 * V] \quad (1)$$

where D is the drought factor, T is the temperature (ºC), H is the humidity (%), and V is the wind speed (km/h). D is calculated using Eq. 2:

$$D = (0.191 * (I + 104) * (N + 1)^{\wedge} 1.5) / (3.52 * (N+1)^{\wedge}1.5 + P -1) \quad (2)$$

where P is the precipitation in mm/day, N is the number of days since last rain, and I is the Keetch-Byram drought index.

4. PROPOSED SYSTEM AND MAJOR COMPONENTS

4.1 System Architecture

In this study a fire warning and detection system is presented incorporating three major modules. The first is the WSN, which provides sensor data from the environment; the second is the FFDI calculation and color mapping; the third is coordinate determination and drone dispatch (if required). The general system architecture is presented in Fig.2. Sensor nodes transmit through a gateway (also serving as a control unit) over a IoT WAN connection to a server where users can login to view and download the information.

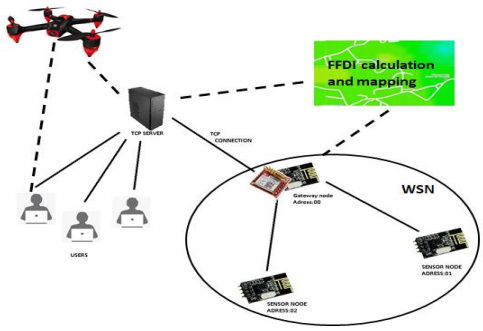


Figure 2. System Architecture

Data collected from the sensor nodes is used in the calculation of the FFDI. Based on the specific temperature, humidity etc. values a mapping is done to a color-scale map. The collected data is also used for determining the local coordinates.

4.2. Major Components

In this section the main components of the proposed system are discussed.

4.2.1. The sensor node

The wireless node and its components are shown in Figure 3. The DHT-11 is the temperature and humidity sensor, MQ-7 is CO2 sensor, connected to an Arduino Nano processor, nrf24l01 wireless module transmission module and the power supply.

The DHT-11 is a common temperature and humidity sensor used in embedded projects. The temperature range is from 0 to 50 degrees Celsius with an accuracy of + -2 degrees. The humidity range is 20 – 80% with an accuracy of 5%. Small, inexpensive and easy to use DHT11 operates with extremely reliable technology, ensures high stability and is used in weather stations to measure atmospheric temperature and humidity.

The sensitive material of the MQ-7 gas sensor is SnO_2 with lower conductivity in fresh air. MQ-7 has high sensitivity to CO but can also be used to detect different gases containing CO.

The NRF24L01 is a single chip radio transceiver for the worldwide 2.4-2.5 GHz ISM band. The transceiver frequency filter consists of a power amplifier, a crystal oscillator, a modulator and protocol engine. Output power, frequency channels and protocol settings can be easily programmed through a SPI interface. The current consumption is only 9 mA at -6dBm output power and 12.3mA in RX mode. It can easily save power with its built-in Power Off and Standby modes. Transmission range is up to 100 meters in open area.

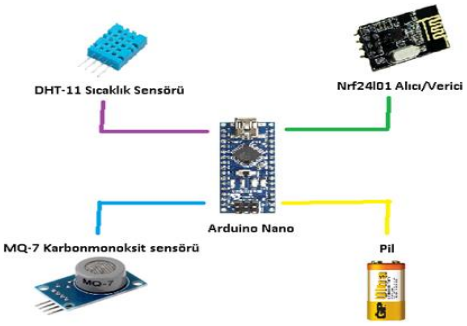


Figure 3. Components of a sensor node

4.2.2. The GSM/GPRS Module

SIM800L GSM/GPRS module is a miniature GSM modem that can be integrated into many IoT projects. This module can do almost anything a normal cell phone can do. It can be connected to the internet via GPRS or TCP/IP. Moreover, the module supports the quad-band GSM/GPRS network, which means it can work almost anywhere in the world. The Sim800L GSM/GPRS module plays the role of a gateway.

4.3. System software

43.1. The NRF24 library

In order to manage the NRF24 sensor network as required, nrf24 network open source library is used. When a transmission occurs from one radio module to another, the receiving radio communicates with an acknowledgment (ACK) packet with the sender to indicate success. If the transmitter does not receive an ACK, the radio automatically switches to a series of timed retries at regular intervals. Radios in this network are connected with the addresses assigned to the channels. Each radio can listen to 6 addresses on 6 channels connected in a logical a tree structure. Nodes communicate directly with their parent nodes to route traffic cross the network.

4.3.2. Phyton Based Interface

Python is an object oriented and interactive high-level programming language. Today it has started to replace the C series programming languages, and it has a wide area of use especially related to IoT applications and interfaces. With Phyton one can easily access the open source codes of many libraries from graphics engines to artificial intelligence. It has been selected as the basis of the interface system designed in this application.

4.3.3. Phyton Based TCP Server

The project uses TCP/IP based communication. In order for the TCP messages to be transmitted, the recipient must be specified. However, if the recipient is a WiFi user, every time WiFi connection is turned on and off, the port addresses of the users on the WiFi change, even if the IP address remains the same. Therefore, in this system a server with fixed IP and port addresses is used to deliver data to the recipient. While the sender transfers data to the server, the receiver receives that data from the server. Thus, there is no need for a fixed port, the receiver and the transmitter can exchange messages over the desired IP address and port.

4.4. Forest Fire Danger Index (FFDI) Calculation

The novelty in this work, different from other similar system is in the use of FFDI and color-scale map. For defining the value of the FFDI the procedures determined by the HELIX project are used (see section 2). The diagram for the calculation process is given in Figure 4. The number of sensor nodes is independent of the map, so the number of nodes can be increased to obtain highly successful predictions in high risk areas. The FFDI index is calculated using the temperature and humidity values received from sensor readings while the wind speed is derived from a regional external source. The obtained FFDI determines the degree of fire hazard. (Figure 5) Values from neighboring sensors are aggregated and averaged to provide easier color mapping. The color scale and an example map are provided in Figure 5.

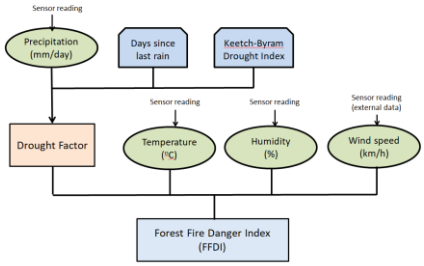


Figure 4. FFDI calculation

Category	Fire Danger Index	
	Forest	Grassland
Catastrophic (Code Red)	100 +	150 +
Extreme	75–99	100–149
Severe	50–74	50–99
Very High	25–49	25–49
High	12–24	12–24
Low–Moderate	0–11	0–11

Figure 5. FFDI and color mapping

5. USER INTERFACE AND SYSTEM EVALUATION

The user interface is designed using Phyton and compatible libraries. Two types of user maps are provided: sensor map, which gives the positions, names and coordinates of the deployed sensors and a color-scale map,

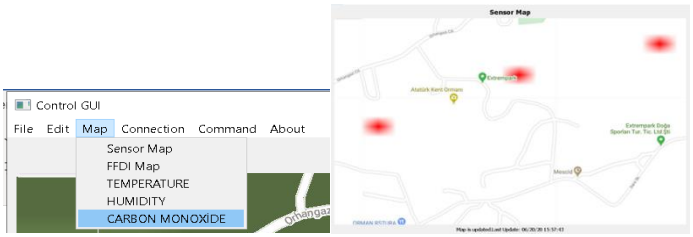


Figure 6. The Sensor map and readings selection

which reflects the degree of fire danger. Figure 6 gives an example of a sensor map. The sensor map provides a selection of different readings like temperature, humidity, CO. The designed interface allows the user to add and delete sensors, to display sensor readings in a table format (Excel) or to edit descriptions of the sensors (Figure 7).

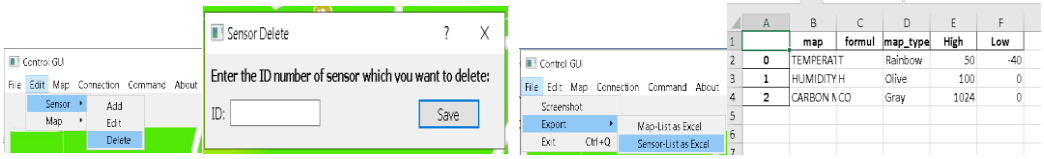


Figure 7. User interface editing and viewing options

Furthermore after the FFDI is calculated, the user is provided with a color-scale map depicting the degree of fire danger. (Figure 8).

Category	FFDI range
Low–Moderate	0–11
High	12–23 (12–31 in Western Australia)
Very High	24–49 (32–49 in Western Australia)
Severe	50–74
Extreme	75–99
Catastrophic	>100

Figure 8. FFDI map with color scale; fire danger level - FFDI range table

Besides the visual features the software allows to calculate the absolute coordinates of the sensors using positioning information. The sensor positions can be mapped on Google maps. Also the coordinates can be calculated in latitude/longitude format to be fed to a drone. The coordinates of the gateway are known and relative to them the nodes coordinates based on the node ID are calculated. A drone can be sent to the coordinates determined to take visual aerial images of the area and/or provide help in extinguishing the fire. (Figure 9) This part depends on the actual implementation.

Figure 9. Sending a drone to take visuals for the calculated coordinates

The operation of the system hardware and software was tested under various environmental conditions in the city of Bursa, Turkey. Sensor operation, control unit operation, FFDI calculations and server connections all proved to be working smoothly without extensive connection delays. System was tested under varying weather conditions (high temperature, low humidity, high humidity etc.) but no real life fire situations were tested.

6. CONCLUSION

This paper discusses an IoT system for Fire Danger Detection. Several different approaches in monitoring and detecting fire danger conditions were incorporated in this work. First of all environmental data is collected using a WSN. A central unit, also serving as a gateway, is used for aggregating and evaluating the collected data. Based on this data the McArthur and Noble FFDI index is calculated, utilizing the procedures suggested by the international HELIX project. Then a color-scale mapping is done to provide a visual expression of the degree of fire danger. A user interface, designed with Phyton provides options to add and delete sensors, to switch between different map options and to export the sensor data information to external (excel) file format. Furthermore, the software allows calculation of the coordinates of the area involved and directing an UAV if required for aerial imaging or to help extinguish the fire.

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Degradation of Phenol in Water by Using TiO_2 Nanotubes

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Abstract

The aim of this study is to investigate degradation of phenol in water by using titanium oxide nanotubes (TNT). TNT's were successfully produced by using Titanium foil (TC4 Grade). Degradation and Adsorption experiments were carried out by using control sample and phenol solution with TNT catalyst. The samples were kept in dark atmosphere to provide adsorption-desorption equilibrium. Photocatalytic degradation performance tests were carried out with 300 W Osram Ultra-Vitalux E27 (%4.53 UVA, %1 UVB, %94.47 Vis) light source under 1, 3 and 5 hours of reaction time. Absorbance measurements were investigated by using Schimadzu UV-Vis Spectrometer. It is noted that the best phenol degradation was reached with 10 mg/L sample as 68,21%. However, it is obtained that he lowest phenol degradation was 1,72% with control sample in 5 mg/L phenol solution. Consequently, TNT's were provided positive contribution to the degradation of phenol in water in comparison with the control sample.

Keywords: Titanium, Nanotubes, Degradation, Phenol, Ultraviole

1. INTRODUCTION

Protection of fresh water resources has become a critical concern for water authorities. The result of the increasing water pollution, consumption and wasting, the irregular water world distribution, the climate changes and the growing number of human activities are larger water crisis (1). Use of huge amounts of chemicals commonly in pharmaceuticals and cosmetics industry, agriculture and even common household resulted with pollution of water bodies with micro-pollutants (2, 3).

The uncontrolled discharge of such chemicals into the environment, even at trace concentrations, contributes to the accumulation of these harmful compounds in the water bodies (4, 5). Dump of drugs in toilet sinks or as solid waste are another sources of micro-pollutants (6).

Phenol is very common organic compound which is effected in pollution of water sources. The molecular formula of the phenol is C_6H_5OH. Mildly acidic and need careful handling (7).

Recently, photocatalytic materials and devices are increased not only in academic studies but also in industrial applications. This dramatic rise accompanies with the population growth and wastes which are increased by them. New technological improvements are invented continuously. Owing to the environmental pollution, these new approaches should be eco-friendly. In 1969, according to a Japan researcher called Fujishima, photocatalysts used for the treatment process. Honda - Fujishima realized a prototype: Fine powders which are doped with metal and/or metal oxide particles were used as a photocatalyst in chemical reactions. These fine powders were semiconductor. Photocatalytic reactions with using TiO_2 were discovered by them. Among these years many research have been done to improve the photocatalytic systems (8).

Exceedingly requested, vertically arranged TiO_2 nanotube-arrays created by anodization of titanium constitute a fabric design that gives a large internal surface zone without a concomitant diminish in geometric and structural order (9).

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2. MATERIALS & METHODS

2.1. Production of Titanium Nanotubes

In order to produce titanium nanotubes, TC4 Grade, 0,1*100*300 mm Titanium Foil was used (Titanium foil, nitric acid (HNO_3, 70%), hydrochloric acid (HCl, 37%), absolute ethanol (C_2H_5OH, ≥99.9), acetone (C_3H_6O, 99.9%), ammonium fluoride (NH_4F, 98%), ethylene glycol ($C_2H_6O_2$, 99.8%), iron (III) nitrate nonahydrate ($Fe(NO_3)_3 \cdot 9H_2O$, ≥98%) and citric acid ($C_6H_8O_7$, ≥99.5%).

Titanium foil was cut as 2,5 cm*2,5 cm. After cutting process, titanium foils anodized by using anodizing reactor which was produced in the center for production and application of electronical materials in Dokuz Eylul University. The design of the anodizing reactor was shown in Figure 1.

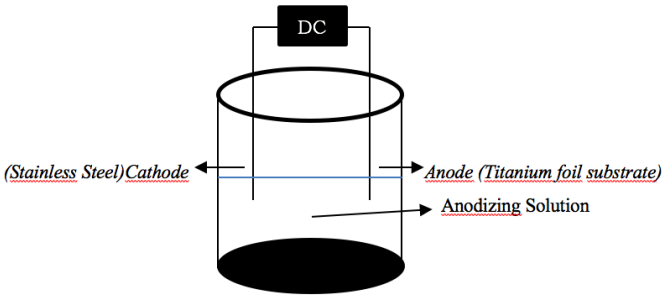

Figure 1. The scheme of the anodizing reactor

Following anodizing process, Titanium foils were annealed by using oven for 2 hours. After annealing and cleaning process, the titanium nanotubes were successfully produced.

2.2. Characterization of Titanium Nanotubes

X-ray diffraction (XRD) patterns of TiO_2 nanotubes were performed by using a Thermo-Scientific, ARL-Kα diffractometer with a CuKα irradiation (wavelength, λ=0.15418 nm). Measurements were performed by applying voltage of 45 kV and current of 44 mA. Scans were made over the range 2θ=2–70o in increments of 2o.

The Scanning Electron Microscope (SEM) is a versatile electron microscope that images a sample by scanning it with a high-energy beam of electrons in a raster scan-pattern. SEM analysis was performed to investigate surface morphology and characteristics of TiO_2 nanotubes by using JEOL JSM-6060 (SEM).

2.3. Photocatalytic degradation tests

In order to provide adsorption/desorption balance samples were kept under 1 hour dark ambient. Photocatalytical degradation of the titanium nanotubes were measured by using Schimadzu UV-mini 1240 (UV-Vis) spectrophotometer. Photocatalytic degradation of phenol tests were performed in UV reactor (300 W Osram Ultra-Vitalux E27 (4.53% UVA, 1% UVB, 94.47% Vis). UV reactor was provided light intensity in both visible and UV area.

3. RESULTS AND DISCUSSION

3.1. XRD results of the Titanium Nanotubes

According to XRD results, the diffraction peaks were intense and sharp, indicating that the obtained titanium nanotubes were well crystallized. The XRD results were shown in Figure 2-3.

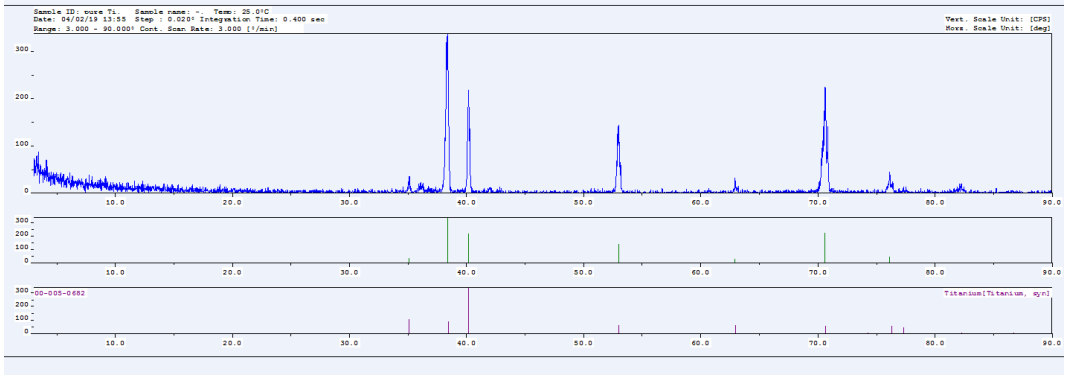

Figure 2. The XRD result of the Titanium Foil

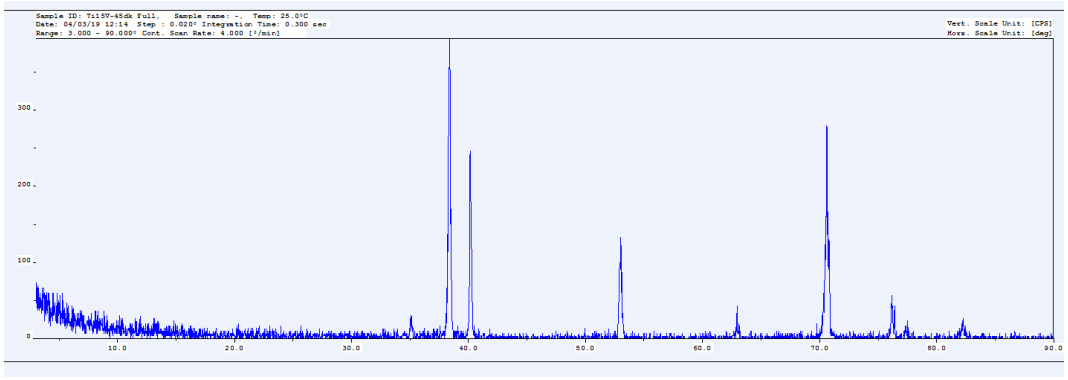

Figure 3. The XRD result of the Titanium Nanotube

3.2. SEM Micrograph of Titanium Nanotube

SEM micrograph results were demonstrated that, obtained Titanium Nanotubes were successfully produced. SEM micrograph were shown in Figure 4.

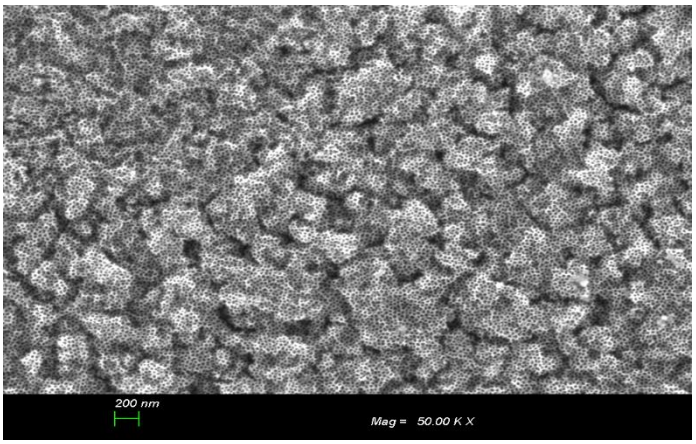

Figure 4. The SEM micrograph of the Titanium Nanotube

3.3. Adsorption Experiments

As a result of the adsorption experiments, it was noted that adsorption was not effected in the degradation of phenol. Adsorption results were shown in Figure 5.

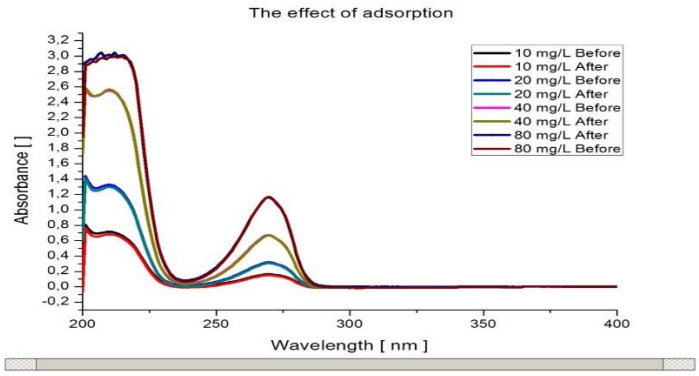

Figure 5. Adsorption experiment of the titanium nanotubes

3.4. Photocatalytical Oxidation Results

The best phenol degradation was reached with 10 mg/L sample as 68,21%. However, it is noted that he lowest phenol degradation was 1,72% with control sample in 5 mg/L phenol solution. 10 mg/L phenol degradation was demonstrated in Figure 6 and 5 mg/L phenol degradation was shown in Figure 7.

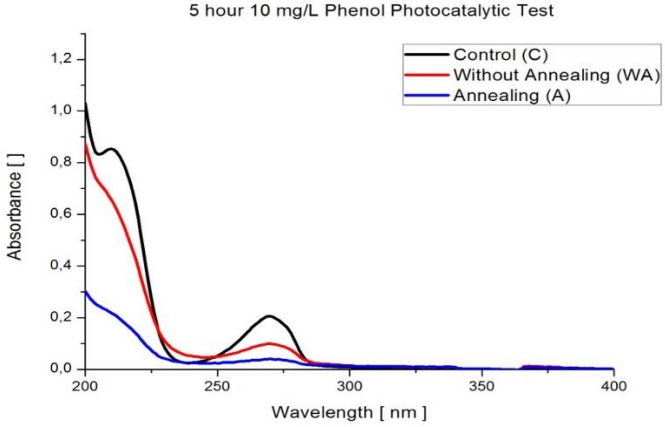

Figure 6. 5 hour 10 mg/L Phenol Photocatalytic Degradation Test

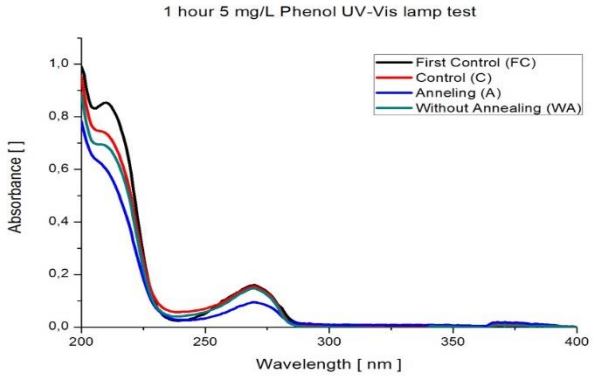

Figure 7. 1 hour 5 mg/L Phenol Photocatalytic Degradation Test

4. CONCLUSIONS

The titanium nanotubes were successfully produced by using Titanium TC4 Grade foils. Photocatalytical degradation results proved that the titanium nanotubes were well-produced and achieved higher photocatalytical degradation. It was noted that the best photocatalytical degradation of phenol was reached in 10 mg/L phenol solution by using the titanium nanotube as 68,21%. However, the lowest degradation of phenol was found in the control sample as 1,72 % in 5 mg/L phenol solution. Consequently, titanium nanotubes were provided positive contribution to the degradation of phenol in water in comparison with the control sample.

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Reuse of urban wastewater effluent for sustainable water production

Aysegul Pala[1], Gunes Kursun[2]

Abstract

The scarcity of water resources brings the reclamation and reuse of waste water in the world. In this study the aim is to investigate the potential reuse of the urban wastewater effluent for use of sustainable water production. The recovery techniques and reuse areas, the required treatment techniques, the current situation in the world and Turkey, and cost analysis of treatment facilities in Turkey were investigated. It is possible to meet the amount of water used in urban, industrial, agricultural and industry with wastewater recovery. Proposals are being developed for the recovery and use of waste water in the world and Turkey. As a result of this study, it should be considered that the various usage areas of treated wastewater, reuse alternatives should be evaluated for large, medium and small scale facilities. Determination of targeted quality parameters in the field of use, and determining the investment, operation and maintenance costs of the applied processes should be considered.

Keywords: Wastewater, Recovery, Reuse, Sustainable, Water Production

1. INTRODUCTION

With the rapid industrialization and population growth in recent years, existing water resources are rapidly being depleted and polluted. This situation brings with it an increase in water and food supply needs and causes water scarcity. Water scarcity is one of the major problems facing many societies in the 21st century and expected to become one of the most sensitive environmental issues in the next decade. The four corners of the world, the southern states of the USA, southern Europe, North Africa, the Middle East and Australia are already facing this problem. It is an increasingly alarming phenomenon affecting at least 11% of the European population and 17% of the European Union (EU) territory (1).

The technology level in the recovery of wastewater is directly related to the usage purpose of the water to be recycled. If it is to be used in agricultural or green area irrigation, good disinfection of the biological treatment outlet may be sufficient. If direct or indirect recovery is in question, further treatment alternatives (membrane technologies, activated carbon and advanced oxidation methods etc.) should be used. Wastewater recovery methods include irrigation in agriculture, irrigation of green areas, industrial recovery, injection underground, recovery in areas used for recreational purposes, indirect recovery and direct recovery can be counted (2).

Turkey in the near term, can be considered as a candidate country to experience water problems. The main reason for the situation is; Turkey's own water resources cannot be controlled due to irregularities in the topography. Groundwater's share fell from 16.9% to 15.5%. Turkey's population would be 100 million in 2030 according to the Turkish Statistical Institute. If it is in that case the amount of water will be around 1,000 m^3/year per capita available can be said for 2030 (3).

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2. MATERIALS AND METHODS

2.1. Wastewater treatment plant pilot scale study

The pretreatment structures consisting of grid, sand trap and parshall weirs. 12 pre-sedimentation tanks with a diameter of 40.9 m, 6 bio-phosphorus tanks of 90 m length, each with a volume of 8200 m³, 12 piece of the 154 m long aeration tanks, each 24790 m³ and 12 final settling tanks with a diameter of 60 m.

It consists of treated water discharge line, sludge treatment system and service buildings. The treated water from the treatment facility is discharged into the sea through an 8 m wide, 2 m high and 2.5 km long reinforced concrete open channel.

Table 2. Wastewater Treatment Plant Influent Water Parameters

Parameter	Mg/L - ºC-mho	ton/day
Suspended Solid Matter	500 mg/L	302 ton/day
BOD_5	400 mg/L	242 ton/day
Iletkenlik	1200 mho	
Winter Temperature	15 ºC	
COD	600 mg/L	363 ton/day
Total Nitrogen	60 mg/L	36 ton/day
Total Phosphorus	6 mg/L	3,6 ton/day
Summer Temperature	22 ºC	

Table 2. Wastewater Treatment Plant Effluent Water Parameters

Parameter	Mg/L
Suspended Solid Matter	<10 mg/L
BOD_5	5 mg/L
COD	20 mg/L
Total Nitrogen	<5 mg/L
Total Phosphorus	<1 mg/L

Wastewater Treatment Plant influent and effluent water parameters shown in Table 1-2.

3. RESULTS AND DISCUSSION

According to the results of influent and effluent wastewater of selected wastewater treatment plant, it is noted that the huge amount of water was lose in the treatment of the wastewater. Before wastewater recovery, the water loses should be avoid. The wastewater should be recovered for the use of the irrigation instead of discharging into the sea.

There are many factors affecting the reuse of water and its acceptability by society. That reuse projects, like other water and projects that affect their results and require capital. Community members are skeptical about health issues they can worry. For these reasons, public consultation and agreement with citizens important for the management and development of water utility projects (7).

72% of the amount of water recovered in agriculture, 16% for drinking water and 12% in industry in Turkey. Nitrogen and phosphorus content is valuable in agricultural use. In Turkey, yet the amount of treated wastewater less. Annual total wastewater potential is around 2.92 billion m^3 (4). As seen that the wastewater potential is quite high in Turkey and it should be recovered as a potential source. However, there is no available data for the recovery of the wastewater in Turkey. The current situation of the recovery of the wastewater should be determined.

The amount of wastewater is change from 60 to 90% of the amount of water consumed drinking and potable water. In addition to the need for an equivalent wastewater, it creates a potential for reuse can be said. Touristic places like the Aegean and the Mediterranean zone of the Turkey where housing and investment are intense outlet water of the facilities, park irrigation and garden in site settlements in irrigation are evaluated (5).

The suitability of treated wastewater for industrial processes depends on the products produced. For example the electronics industry, Water of almost pure water quality is required to wash circuit boards and other electronic components. On the other hand, relatively low quality water is used in the tannery industry. Textiles, pulp and paper and the requirements for metal fabrication are of medium quality. Thus, industrial reuse of treated wastewater Specific requirements in process water are important when investigating the validity of its use (6).

The costs of treatment and reuse of wastewater important in terms of efficiency. Cost depends on the end quality, reliability and environmental and health effects. Besides treatment costs, operating costs, analytical costs and marketing costs must also be taken into account (8).

CONCLUSIONS

The increase of the water demand and urban wastewater discharges generates the demand of the sustainable water production. Waste water recovery and increased reuse, water scarcity lightening, reducing pollution emission, soil quality improvement and production environmental costs, such as savings provides economic benefit.

As a result of this study as a literature review, firstly the regions that are under pressure of drought and many countries of the world, the purified domestic and industrial wastewater is used in agriculture, aquaculture, recreational purposes and domestic purposes. Considering the various usage areas of treated wastewater, reuse alternatives should be considered for medium and small sized facilities.

Developing incentive systems in order to accelerate the applications and the importance of the issue to the practitioners and explanatory activities to users are required.

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Structural, Terrain and Climate Effects on Wood Productivity in Native Mixed Beech and Fir Forests

Azra Čabaravdić[1], Starčević Mirsada[2], Balić Besim[1], Ibrahimspahić Aida[1]
Lojo Ahmet[1], Fazlić Ismet[1]

Abstract

The aim of research is to analyze structural, terrain and climate effects on stand productivity represented by the wood volume current annual increment (CAIv) in native high mixed beech and fir (with spruce) forests. Here are used data from the Second national forest inventory in Bosnia and Herzegovina (B&H) obtained on 153 geo-coded sample plots. Relative density (RD), conifer's and broadleaf's basal area (BA) are used as structural variables. The terrain data were extracted from digital elevation model. Climate variables are co-kriging spatially modelled. The multiple linear regression (MLR) and canonical correlation analyses (CCA) were used for statistical analysis. The MLR and CCA identified structural and climate variables as significant. The CCA confirmed relationships between conifer's and broadleaf's stand productivity and structural variables (conifer's BA and RD) and two climate factors (average minimum temperature and average maximum precipitation). The shared variance between the two variable sets, across all functions was 86.7% (FWilks lambda = 27.4, $p < 0.001$). The first canonical function holds strong correlation with 76.4% shared variance. Conifers CAIv was the most contributing variable with 85.3% influenced by conifers BA related to structural variables ($R = 0.92$). The higher conifers CAIv is related to higher participation of conifers BA and higher RD. Higher broadleaves CAIv is related to higher RD and higher maximum precipitation while lower broadleaves CAIv with minimum temperature decreasing. Significant influence of terrain effects was not obtained. Significant climatic influences on the productivity of mixed stands should be consider in management planning of these forests.

Keywords: Basal area, canonical correlation analysis, extreme temperature and precipitation, relative density, stand current annual increment, terrain variable

1. INTRODUCTION

Forest management planning reexamines continuous interaction between forest stand productivity and changing structural and environmental conditions to support and maintain sustainable forestry. The most important Bosnian native mixed forests are classified in two forest types: the mixed beech (*Fagus sylvatica*, L.) and fir (*Abies alba*, Mill.) forest and the mixed beech and fir with low spruce (*Picea abies* (L.) H. Karst) participation. Those forests are considered as the most productive part of forest resource with the highest contributions in total wood production and increment having good quality structure [1]. The productivity of those forests is represented with the stand current annual increment (CAIv) strongly related to percentage participation of beech and fir (with spruce) in total basal area per ha, stand density, environmental (terrain, climate, soil) and other characteristics. It is generally considered that temperature and precipitation are the most important climate factors whose changes will produce a strong direct impact on both natural and modified forests, bring to changes in commercial forestry and changes in supply and demand [2]. Aim of the research is to analyse forest stand productivity related to structural (basal area, relative density), terrain and climate influences in native mixed beech and fir (with spruce) forests across the west and central Bosnia.

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2. MATERIALS AND METHODS

2.1 Study area

The study area relates to dominant the most productive high mixed beech and fir (with spruce) forest across the west and central Bosnia. The forest stands are situated on dominant low productive forest soils (eutric cambisols, eutric leptosols, lithic leptosols and mollic leptosols). Related to climate, the northern and north-east parts of the study area are under the influence of temperate continental climate. The central parts, which include hilly-mountains region, are under the influence of continental and high-mountainous, while southern parts near Dinarides are under the weak influence of changed Mediterranean climate. Temperate continental climate has lower mean temperature and precipitations, and colder winters. High-mountainous climate affects central Bosnia with short, fresh summer, cold, snowy winter with moderate precipitations during the entire year. Changed Mediterranean climate influences forests on Dinarides higher mountainous positions on the south holding colder summers with a lot of precipitations and winters with frequent snow appearances.

For this research sample data related to forest stand structural variables were obtained from the Second national forest inventory (NFI) plots. Sample plots are located in wider geographical frame (15°44´ – 18°53´E and 43°22´ – 44°50´N) on hilly-mountain positions on low to steep slopes. In this altitude range, the mixed beech and fir with spruce forest stands occupy low productive forest soils (Figure 1).

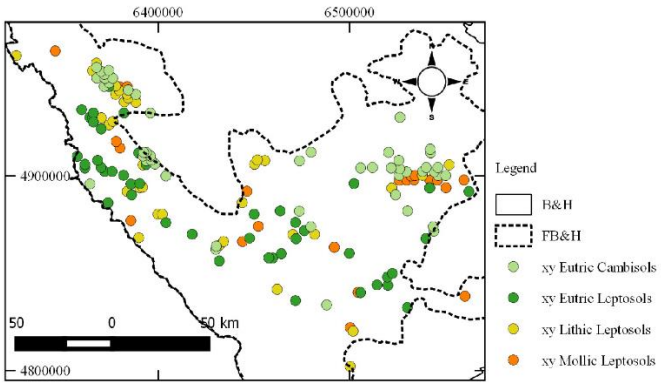

Figure 1. Study area and sample plots distribution

Sample contains plots with more than 20% of stand volume of fir and spruce (conifers) or beech (broadleaves) participation. Structural variables refer to current annual increment of wood volume (CAIv), basal area (BA), and number of stems per unit area were determined summing volume increments, basal areas and counts of selected trees on detailed measured sample plots. Then, relative density (RD) was calculated as ratio of current Reineke's stand density index (SDI) and maximum SDI [3].

Terrain variables used in this research were related to altitude, slope and hill-shade derived from the DEM with 20 meters resolution using SAGA 2.2.0. Slope data were transformed using the equation: slope´ = (2 / π) × (asin(sqrt(slope in degree / 100))). Climate data were modeled using mean minimum temperature, mean maximum temperature, and maximum precipitations from the year before terrestrial measurement. Climate data were found for nine meteorological stations across Bosnia and Herzegovina in hydro-meteorological annual yearbook for year 2006 [4]. Mean minimum (maximum) temperature (°C) refers to the long-term average daily minimum (maximum) air temperature observed during a calendar month and over the year. Mean maximum precipitations (mm) refer to the long-term average daily maximum precipitations observed during a calendar month and over the year. Global co-kriging based on climate data and DEM was performed to create thematic maps of variation for each climate variable using SAGA 2.2.0.\

2.2. Statistical analysis

Basic descriptive statistics (mean, standard deviation, minimum, maximum) were calculated for all variables. Compiled data were divided in two sets: the first set was related to stand productivity (dependent variable set) and the second set was related to stand condition represented with structural, terrain and climate variables (independent variable set). The stand productivity was presented by the current annual increment of conifers and broadleaves groups to differentiate their quantities due to planning needs. The stepwise MLR was applied

to identify significant variables from independent variable set and evaluate their effects. Finally, CCA was performed using SPSS 15.0. Significance of loadings was based on recommendations by Hair et al. (2006) [5].

3. RESULTS AND DISSCUSSION

The descriptive statistics for productivity (CAIv), structural variables (BA, RD), terrain (altitude, slope, hill-shade) and climate variables (mean annual minimum temperatures, mean annual maximum temperatures, mean annual maximum precipitation) are summarized in Table 1.

Table 1. Descriptive statistics for sample (n=153)

Factor	Variable	Mean	SD	Min.	Max.
CAIv (m^3/ha/year)	Total	7.53	3.51	0.57	16.29
	Conifers	4.96	3.56	0.04	15.41
	Broadleaves	2.57	1.88	0.16	8.36
BA (m^2/ha)	Conifers	19.57	12.45	1.49	55.38
	Broadleaves	11.98	8.83	1.28	36.73
RD		0.51	0.21	0.09	1.00
Terrain	Altitude (m)	1126	238.35	427	1692
	Slope	17.20	9.16	1.15	41.67
	Hill-shade	174.2	40.2	66.0	252.0
Climate	Min T	2.09	2.17	-2.54	6.86
	Max T	10.20	2.15	5.40	17.79
	Max P	56.94	19.15	8.20	95.74

T = temperature; P = precipitation

The CAIv for the total sample averaged 7.53 m^3/ha/year and ranged from 0.57 to 16.29 m^3/ha/year. The participation of conifers CAIv was higher (65.9%). The conifers BA had higher participation (62.0%) but wider range then broadleaves (53.9 and 35.5 m^3//ha/year respectively). The mean values of RD (0.51) pointed out moderate density. The altitude range was from about 430 m to 1700 m with 75% plots above 950 m above sea level. Mean maximum temperature showed high variability that still could be expected while variability of the mean min temperature could be qualified as extreme. The mean maximum precipitation showed high variability too.

Multiple linear regression (MLR) was applied to examine relations between productivity and other variables. The evaluation of stepwise MLR and standardized beta coefficients of significant independent variables are given in Table 2.

Table 2. Evaluation of multiple linear regression. Standardized beta coefficients of multiple linear regression

CAIv (m^3/ha/god)	Structural		Climate		R	R^2	adj. R^2	SE
	RD	BA Con.	Min T	Max P				
Total	0.41	0.33	-0.16		0.72	0.51	0.50	0.47
Conifers	-0.17	0.95		0.1	0.84	0.71	0.70	0.45
Broadleaves	0.9	-0.96	-0.16		0.74	0.55	0.54	1.10

T = temperature; P = precipitation

Obtained correlations between CAIv and significant variables ranged from strong to very strong (0.72 to 0.84). The obtained coefficients of determinations ranged from 50% to 70% and were higher for groups CAIv. The higher adjusted coefficients of determinations were found for conifers part of CAIv.

Stepwise multiple linear regressions identified the most significant explanatory structural variables: conifer's BA and RD. Effects of structural variables were greater than other variables, especially conifer's BA. Terrain variables had no significance here. Conifer's BA and RD are identified as the most significant explanatory structural variables. Significant climate variables are mean annual min temperatures and mean annual maximum precipitations.

Standardised beta coefficients are analysed to evaluate relative influences of significant variables in canonical variates (Table 3).

Table 3. The standardised beta coefficients between productivity and stand variables

Variables	CC1	CC2
Set 1. Productivity variables		
CAIv Con.	**0.82**	0.64
CAIv Bro.	**-0.40**	**0.96**
Set 2. Structural and environmental variables		
RD	-0.57	**1.12**
BA Con.	**1.31**	-0.44
BA Bro.	0.04	-0.05
Altitude	-0.08	-0.03
Slope	-0.04	0.05
Hill-shade	-0.05	-0.04
T Min	0.07	**-0.44**
T Max	-0.08	0.21
P Max	0.08	**0.12**
Cumulative Eigenvalue %	76.4	100
Significance (Pr > F)	<0.0001	<0.0001

Bold – significant canonical correlation (loading) (sig. R > 0.45)

It is visible that larger variability effects on total stand productivity have structural variables, firstly conifers BA as the most influential component on conifers CAIv and then RD as the most important for broadleaves CAIv. Minimum temperatures have larger negative effect then positive contributing maximum precipitations on broadleaves increment and consequently to the stand total productivity.

The contribution of environmental and stand variables to height and basal area in mixed stands was investigated in [6]. Similar to our results, the CCA and multiple linear regression results showed that site conditions and environmental variables alone were not strong predictors of stand productivity and BA was stronger predictor.

In assessment of complex mixture of structural and environmental factors and correlation between these two sets of variables was used CCA. Canonical correlation statistical method was found a successful tool for clearer view of the dependent – independent variable interrelationship [6], [7], [8], [9]. The environmental effects on forest growth and productivity with clarification of different climate variables and their role in parts of total productivity were the main topic of many scientific works [10], [11], [12], [13] [14], [15], [16].

In this research, the analysis of canonical correlation between productivity and stand variables resulted in two canonical functions with statistical significance ($p < 0.001$). The shared variance between the two variable sets, across both functions was 86.7% (FWilks lambda = 27.4, $p < 0.001$). The first canonical function holds very strong correlation with 76.4% shared variance (Figure 2).

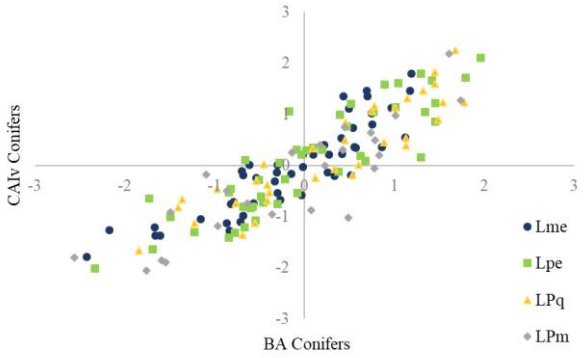

Figure 2. Plot of canonical loadings for the first function

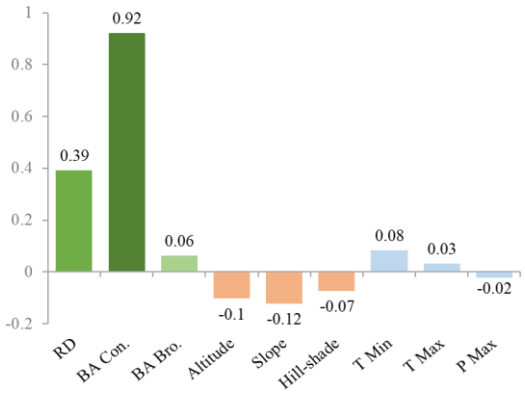

Figure 3 Canonical loadings for the variate of the first canonical function

Related to the first canonical function, conifers CAIv is high positively and broadleaves CAIv moderate negatively correlated with the first canonical variate. Conifers CAIv contributes to stand productivity while broadleaves participation increase leads to decrease of total CAIv. This is consistent with tendencies obtained in MLR models with known relationships related to conifers and broadleaves contribution to total productivity in mixed stands [17].

The higher conifers productivity is related to very high participation of conifers BA and higher relative density while significant influences of terrain and climate effects were not obtained (Figure 3). High positive loading of conifers BA here indicates a strong relationship with conifers productivity and total CAIv consequently. The other variables were found to be of less importance for conifers productivity (Figure 3).

The second canonical function complemented shared variance with 23.6%. The plot of the second canonical variate pair is a bit more scattered (Figure 4).

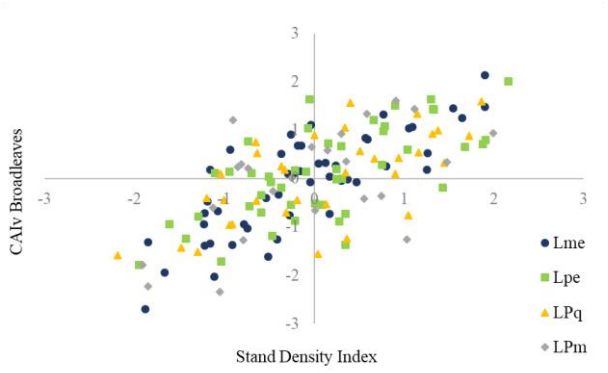

Figure 4. Plot of canonical loadings for the second function

Structural and climate variables appeared both as highly correlated with productivity. Positive high correlations were obtained for RD and mean annual maximal precipitations while negative correlation was found for mean annual minimal temperature. Like in conifers productivity case, terrain effects were not significantly expressed (Figure 5).

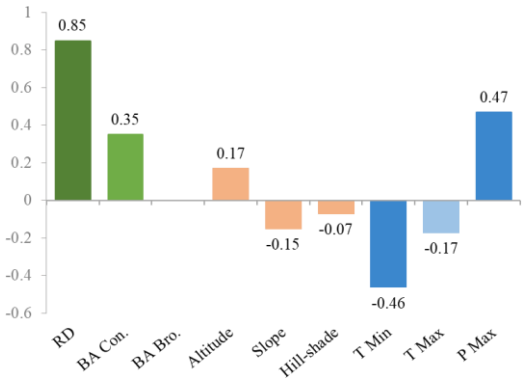

Figure 5. Canonical loadings for the variate of the second canonical function.

Increasing sensitivity in tree growth and increment changes of broadleaves in relation to climate changes on different sites is registered by different authors [18], [19], [20], [21]. According to results of [22] and [23], the climate changes, especially temperatures, have higher affection on European beech which could lead to concentration of its distribution range only on current habitat. The site-specific beech behavior in tree ring growth due to climatic gradient changes are investigated based on modeled results [21]. Also, prediction results showed indication of beech sensitivity to temperature increase that could lead to conversion of broadleaves forest to evergreen needle-leaf forest [18]. Our results are partially similar, with negative dominance of extreme min temperatures. The negative impact of min temperatures had the highest impact in the first half of the vegetation period resulting in beech tree growth reduction [19]. Frost, caused by min temperatures, and max temperatures were the reasons for about 50% of the total variation in increment indexes of beech trees [23]. Based on the results [24], high temperatures in the most part of the vegetation period did not express negative effects and low temperatures were limiting factors for trees near the upper elevation or high latitudinal forest limits. It is also reported that changes in BA increment were greater in colder contexts in Western European forests and with strong correlation with species BA increment changes [25]. However, ref. [26] and [27] indicated that climate changes brought out changes of mixed forests with increasing beech competitivity and higher contribution to stem number over Norway spruce.

In this research, structural variables show higher correlations with conifers and broadleaves CAIv parts, so treatments planning is of priority importance for stand total productivity. It is also concluded in [28] that structural variables (tree size, age and competition site) were stronger predictors than environmental and

climatic explanatory variables except significant positive relation of Standardized Precipitation Index (SPI) to the current spruce basal area increment. The close BA relation to dependent variable, as in our results, is previously revealed [29]. The dominance of structural variables (BA etc.) and impact of climate variables on volume increment in mixed forests of beech, fir and spruce on limestone and dolomite with significant impact of altitude variable is also registered [17]. The altitude importance there can be explained with higher soil type variability and wider altitude range of the sample. The significance of structural stand characteristics and soil condition besides climate-growth relation in conifers stands where conifers positively reacted to winter-spring temperatures was registered in [30]. The insignificance of terrain parameter (elevation), and correlation of climate parameters with tree growth was also registered [31]. The most important climate parameters in that case were summer temperature, summer precipitation, evapotranspiration aridity index, continentally index, which could be taken in consideration for our future investigation. The further research should also include other structural (canopy, species mixture and others), terrain and climate variables relevant for forest stand productivity and examine their individual and interactive effects using advanced multivariate methods.

4. CONCLUSION

In conclusion, considering that forest management planning relies on information of interactions of forest stand variables and environmental conditions, here are analysed the relations between structural, terrain and climate effects on total CAIv stand productivity. Canonical correlation identifies silvicultural manageable stand variables and climate conditions that could be considered in planning.

We found that the highest effect on the total CAIv had higher participation of conifers BA and higher density of trees (especially broadleaves) in forest stands. Significant influence of terrain characteristics (altitude, slope and hill-shade) was not obtained. Higher sensitivity of climate variables was obtained for broadleaves while conifers were less affected in all stands. Significant negative influence of mean minimum temperature and positive influence of mean maximum precipitation was noticed for broadleaf's part of production. Our findings have implications for management and silvicultural treatments planned for increase and maintenance of CAIv respecting environmental influences in mixed forest stands. The orientation of forestry practice should be focused on increasing CAIv through measures that would lead to conifers BA increment, more trees per unit area maintaining multilayer structure generally but with broadleaves participation adjusted to climate stand conditions due to their significant effects on forest stand CAIv.

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Evaluation Of The Extract Obtained From Various Medicinal And Aromatic Plants (Antibacterial/Antioxidant) In The Wood Industry

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Abstract

Throughout the history of mankind, various plants (medicinal aromatics etc.) have been used naturally to prevent all diseases, or they have been used in a wide range of fields, especially in the pharmaceutical industry, by cultivating in agriculture/greenhouse areas. A wide variety of protective impregnation / top surface materials and new methods are developed in order to increase the durability of wood and increase the resistance level against many effects (biotic, abiotic, nature, environment, etc.), and it is important that these materials are friendly to human / environmental health. As well as the advantages of the wood material, it has to be treated with some preservatives and colorants in order to be protected against internal and external influences and to be aesthetic. However, as a result of the protection and coloring of the wood material by chemically, especially the indoor contamination causes negative effects on human health. Recently, several researches have been conducted on the causes of indoor air pollution and it has been determined that these sources of pollution are largely volatile organic compounds (VOC). The main objective of this study is to use the wooden product in wooden child toys, hospitals, sterile areas, pharmacies, wood-based materials used in the kitchen (fork, knife, serving plates and chopping boards etc.), playgrounds, dining table surfaces, nursery and kindergarten furniture, beehives etc. In addition, it will be recommended to use on all surfaces where there is an antibacterial / antioxidant effect, as well as on the surfaces with collective contact such as door handles, cabinet handles, elevator buttons and cash dispenser keys. In research, extracts of Evelik (Rumex patientia L.) and Casir (Ferula comunis L.) herbs (1% concentration) from medicinal aromatic plants were prepared and spruce and mahogany wood were used as wood type. According to ASTM D 143-76 principles, retention and bending resistance properties were determined by impregnation according to the results of the experiment, the highest retention (0.55%) and bending resistance (100.20 N/mm2) were determined in Evelik plant and the optimum increase was determined when the results were compared with the control sample.

Keywords: Human/Environmental, Medicinal Aromatic Plants, Wood, Health, Toys, Furniture

1. INTRODUCTION

It is estimated that there are approximately 1,000,000 plants in the world today. Nearly 500,000 of these species have been identified and named, and as a result of the researches conducted by the World Health Organization (WHO), it has been determined that they consist of medicinal plants used for treatment. The amount of medicinal plants used for treatment in our country is at least 500 [1]. From existence of mankind until recently, human beings provided almost all their needs such as clothing, shelter, food and fuel from within the boundaries of forests. But today, the development of technology, forestry method and forest management has focused the needs of people obtained from forests only on wood raw materials. In our country, this understanding has started to prevail day by day and started to be limited to wood (log, lumber, etc.) production. However, it is an incomparable resource for a healthy life, in which many economic and cultural activities such as many herbaceous plants, wild animals, water resources, recreation areas can be carried out together, except for the tree wealth within forest areas [2]. It is a very old tradition that medicinal plants started to be used in cure of diseases with the settlement of mankind. In many

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developing countries, herbal medicines constitute an important part of the culture and traditions in rural communities. Plants have a wide variety of chemical substances that have important biological activities on humans [3].

In addition to compounds with antioxidant activity in plants, it is known that there are biological activities in essential oils and herbal extracts obtained from various plants. In scientific researches, it has been proven that the antimicrobial substances found in herbal extracts are able to preserve the food safety at a high rate and because of these properties, plants can be used as natural antimicrobials [4]. Many herbs known as medicinal plants have been found by the public through trial and error. The use of such wild plants in the treatment of diseases in the world and in our country lies back to ancient times [5]. It has been reported that wood is subjected to impregnation with some vegetable oil structure and as a result, there are increases in weight and density values [6]. Since the use of toxic component structure in wood preservation has caused the increase of important environmental pressures and prohibitions, it has been necessary to create/develop new environmentally friendly materials [7]. Rapid reduction in forest existence and exposure of human beings to synthetic/chemical effects in the environment they live, cause serious threats. Natural plants are used for various purposes (medical, cosmetic, food, spice, agriculture, animal husbandry, spice, paint industry, etc.); The antioxidant/anti-bacterial properties of the organic wood were determined by obtaining various concentrations (1%) of plant extracts and the impregnation feature and some technological properties, as well as a hygienic structure in wood.).

2. MATERIAL AND METHOD

2.1. *Material*

2.1.1. *Wood Material and Plant Type*

Spruce grown in our country and Mahogany wood which is an imported wood type were used in the study. Processes were carried out by cutting in radial direction according to the principles of TS 2470 [8]. Casir and Evelik plants, whose antibacterial/antioxidant properties have been determined in the literature, were chosen [9].

2.2. *Method*

2.2.1. *Experiment Sample Preparation*

While the samples were being prepared, the smoothness of the fibrous structure of the wood was considered and it was prepared for the sapwood (TS 2471) without any cracks, knots and color defects. Air-dried samples were prepared according to the principles of TS EN 2474 for flexure resistance [10,11].

2.2.2. *Impregnation Process*

The impregnation process was applied in accordance with the conditions in "ASTM-D 1413-76". Experimental samples were prepared in the dimensions of 20x20x300±1mm and subjected to 45 minutes vacuum/45 minutes diffusion process. In order to prevent impregnated material from being affected by wood moisture, the test specimens were completely dried [12].

2.2.3. *Obtaining Plant Extract (Extract)*

The sample weight determined for the experiment is put in 200 ml of hot distilled water or water at least equal to this purity and heated at a temperature below the boiling point in the refluxing apparatus for 1 hour by mixing at certain intervals, after filtering in the previously prepared porous capsule with vacuum, no sample will remain in the balloon. The process was continued to be washed several times with distilled water and the insoluble part was completely left inside the porous capsule. Finally, the residue was washed with 200 ml of hot distilled water and after the residue was dehydrated by a pump or another device that would serve as a suction, the porous capsule and its contents were dried by keeping it in an oven set at 103oC for 16 hours, then cooled in a desiccator and weighed with 0.001 g precision. [13].

2.2.4. *Retention Amount (% Rate)*

After the impregnation process, the remaining substance (tcoao-% retention) compared to the complete dry wood was calculated from the formula [14].

$$R(\%) = \frac{Moes - Moeo}{Moeo} x100 \quad (1)$$

Moes = Sample full dry weight after impregnation (g)

Moeo = sample full dry weight before impregnation (g)

2.2.5. Bending *Strength*

Flexural resistance is based on TS 2474/1976 standard. The samples were prepared in 20x20x360 mm dimensions. The samples were sanded and air-conditioned (20±2 ºC/65±5% relative humidity) to 12% humidity. Before the experiments, all samples were air dried and values were taken by measuring both thicknesses (radial/tangent) with a digital caliper with ±0.01 mm precision. Then, the speed of the loading mechanism of the universal testing machine was adjusted to break in 1.5 ± 0.5 minutes. The flexural resistance was calculated with the help of the equation given below (Citak, 2012).

$$\delta_e = (3 \times P_{max} \times L_s)/(2 \times b \times h^2) \quad (2)$$

Bending strength (N/mm^2)

Pmax : Force at break (N

Ls : Clearance between abutments (mm)

b : Sample width (mm)

h : Sample thickness (mm)

2.2.6. *Evaluation of Data*

SPSS statistics program was applied to evaluate the data. Homogeneity groups were formed by analyzing values resulting from wood type effect and % concentration change and simple variance analysis was applied.

3. RESULTS

3.1. *Solution Properties*

Solution properties are given in Table 1.

Table 1. Solution Properties

Concentration	Extract	Solvent	Temperature (ºC)	pH		Density (g/ml)	
				BI	AI	BI	AI
%1	Evelik	Distilled water	22ºC	6.07	6.07	0.987	0.987
	Casir			7.17	7.17	0.987	0.987

When the table is examined, no significant changes were determined before and after impregnation. It is known that the pH factor being close to acidic character creates a negative structure on the mechanical properties.

3.2. *Retention Amount (% Retention)*

The net dry impregnation material (adhesion) remaining amount as (%) is given in Table 2.

Table 2. % Retention

Wood type	concentration	Extract	Vacumm/diffusion time (min)	Retention (%)
Spruce	%1	Evelik Plant	45 min	0.55
		Casir Plant		0.35
Mahogany	%1	Evelik Plant		0.16
		Casir Plant		0.60

The highest adhesion was detected in mahogany wood in Casir plant (0.60%) and the lowest in mahogany wood in Evelik plant (0.16%). The level of adhesion can vary according to the wood type, anatomical structure, impregnation method and impregnation material; This feature (adhesion) can reveal different interactions in technological properties.

3.3. *Flexural Strength (N/mm^2)*

The bending resistance change is given in Table 3.

Table 3. Change in Bending Strength (N/mm^2)

Wood type	Concentration (%)	Extract	Vacumm/diffusion time (min)	Bending Strengt (N/mm^2)
Spruce	**Control**		45 min	83.15
	%1	Evelik		100.20
		Casir		87.26
Mahogany	**Control**			70.10
	%1	Evelik		88.80
		Casir		82.22

Highest bending resistance is in evelik plant extract from spruce wood (100.20 N/mm^2), the lowest was observed in casir plant extract from mahogany wood (82.22 N/mm^2).

4. CONCLUSION

The retention amount varies according to the wood type and other factors (thickness, wood type, anatomy, moisture, impregnation method, impregnation material). Similar results are observed when the results are compared with the literature. Bal (2006) reported that the process performed with ACQ in wood is effective on the mechanical properties and retention is positively affected and provides rapid penetration [15]. impregnated the scotch pine wood with boron compounds and kebracodan, and reported that the highest retention occurred at 1% concentration [16]. Ozcifci et al. (2009) reported in their study that the highest % retention value was found in the samples treated with pressure-vacuum method in scotch pine, the highest % retention value was in the pressure-vacuum method (6.42%) in the yellow pine, and the lowest in beech immersion (0.30%) [17]. Disli (2018) reported that the highest % retention was on (Al2SO4)3 as (9.90%) and the lowest % retention was on Ba as (1.07%) in scotch pine wood, and the increase in solution concentration increased the amount of retention [18].

In terms of flexural resistance, the flexural resistance value of plant extracts (extract) increased in both types of wood. The results reflects a positive structure when compared with the literature.

Erturk (2011) impregnated some types of wood and the flexural resistance according to chemicals were determined; Imersol Aqua (98.177 N/mm2), Boric acid (95.623 N/mm2), Tanalith-E (94.708 N/mm2) and Borax (85.926 N/mm2). In the F test, which was carried out to determine the flexural resistance of the ash, leafy rowan massive wood materials impregnated with various preservatives; He reported that bending resistance values according to tree species showed statistically significant differences [19]. Citak (2012) impregnated eastern beech (Fagus Orientalis L.) wood with 2.5% boric acid and borax solution, and determined that the decrease in the flexural resistance was higher in experimental samples impregnated with borax. It was determined that the elastic modulus values of the experimental samples that were not subjected to impregnation were lower than the non-impregnated test samples [20]. Cakir (2012) chipped the bond pruning residues and subjected them to impregnation with boron compounds (1% -4%) and it was reported that the impregnation process with boron compounds and the increase in the solution concentration in general caused decreases in the flexural resistance and elastic modulus of the test samples [21].

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Various Protectives In The Wood Industry And Technological Change (Pressure Strength)

Hatice Ulusoy[1], Huseyin Peker[2]

Abstract

In the early ages, forests created a suitable area for life. Utilization of forests is also based on ancient history. The first signs of the use of wood were investigated in the pictures carved on the walls of the tombs between B.C 1350 and 1500 in Ancient Egypt. The first processing of the logs obtained from the forests started with the production of boards cut by hand saw. Later, manual sawmills used by two people were developed. Throughout history, the forest products industry has not showed the same progress compared to the advances in various industries. As environmental pollution increases in our country and in the world, the measures taken for it were increased. Efforts are being made to ensure that the chemicals used in wood do not cause environmental pollution. However, the applied methods brought high costs. Therefore, many features of wood are improved with a single application in wood modification. Another method used for the long-lasting of the wood material is the impregnation process. Although they are durable and long-lasting tree species, tree species with low natural strength must be impregnated to increase the lifetime. Many chemicals are used in the impregnation process of wood material. One of these chemicals is boron compounds. Today, boron compounds used as impregnations are one of the reliable chemicals. The use of boron compounds is increasing as the harm to human and environment is minimal. They are used as an effective method not only against damage caused by living things but also against burning. In the scope of the research, the pressure strength change was determined by impregnation process of scotch pine in 40 minutes vacuum and different diffusion (40 min.) times using various mordants according to ASTM D 143-76 principles. Boric acid, aluminum sulfate, sodium chloride, water-based varnish, water-based varnish + aluminum sulfate, water-based varnish + sodium chloride, water-based varnish+boric acid were applied as a single or combination of two products. According to the results of the experiment, it was determined that the highest pressure strength is 40 min.vacuum and 40 min. diffusion time in boric acid (68.53 N/mm^2) whereas the lowest pressure strength is 40 min. vacuum and 40 min. diffusion time in water-based varnish+aluminum sulfate (47.50 N/mm2).

Keywords: Environment, impregnation, Aluminum sulphate, Sodium chloride, Vacuum

1. INTRODUCTION

Wood material, which has a long and perfect history in the development process of human life and culture, has been used for hundreds of years as bearing elements, siding, flooring and roofing materials in various parts of buildings, bridges in industrial constructions, traverses, piers and many other areas. According to the hundreds of years of use of the wood material, relatively recently, materials such as steel, aluminum, concrete have entered the building industry as an alternative to the construction industry and have been successfully used in many areas. In this case, a wide range of building materials has been arised for consumers to choose from. In the past, the criteria affecting the consumers' choice of building materials were mainly "material suitability", "price", "availability" and "appearance". Nowadays, consumers have begun to question the effects of building materials on the environment. In addition to the criteria listed above when choosing a product, consumers want to establish a material relationship with issues such as global warming, energy consumption, pollution, waste problem and human health, and to recognize and use environmentally friendly products. In determining environmental pollution for life cycle analysis; The amount of solid and liquid wastes, greenhouse gases, toxic substances and particles generated during the production and production phase, the cost of fabrication, waste sites and packaging to the environment, The impact of buildings on the environment due to heating, cooling, lighting during their service life, at the end of the service life of buildings, criteria such as their impact on the environment are used [1]. Wood is a significant raw material that humanity has used in many areas since existence of humankind. With the development of technology in the world, the usage area of wood has increased with the diversification of the use of wood. However, due to the organic structure of wood material, it is destroyed by biotic/abiotic factors. This disadvantage of wood can be reduced by various protection methods and techniques. Wood can become resistant with some precautions without the use of various chemicals. However, the diversity and continuity of risks necessitate chemical processes [2]. Tomak et al. (2012) today, synthetic structure/toxic components continue to be preferred in the protection of wood, but the discovery/development of new environmentally friendly protective materials has become inevitable and the toxic/non-toxic vegetable oil structure creates a hydrophobic layer in the wood cell, thus dimensional stability (water repellency) that has also been determined that it can be considered protective by providing stability [3].

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Aytaskin (2009) investigated the technological properties of "lime, poplar, chestnut" species by impregnating some boron compounds with "borax and boric acid" materials, and determined that the density/thermal conductivity value increased, but there was a decrease in the flexural resistance/elastic modulus [4].

Impregnated wood (biotic/abiotic, etc.) has a siginificant place in the construction industry with its economic, aesthetic appearance, as well as being resistant to factors. Water-based soluble impregnations have increased significantly in railways, traverses, marine support poles, cooling towers, landscaping, outdoor furniture, and construction structures. Water-based impregnating agents generally destroy the odor structure in treated wood, and a wide variety of surface treatments can be performed after impregnation. It can be easily preferred in places of use and during transportation [5].

Within the scope of the study, using various mordants, the environment/human friendly boric acid, aluminum sulphate, sodium chloride, water-based varnish, water-based varnish+aluminum sulphate, water-based varnish + sodium chloride, water-based varnish+ boric acid are used to perform both single and dual processes on the pressure resistance. change is determined.

2. MATERIAL AND METHOD

2.1. *Material*

2.1.1. *Wood Material and Treatment*

Within the scope of the study, Scotch pine (*Pinus sylvestris L.*) wood, which is frequently grown in our country and preferred in the wood/construction industry, was preferred. Transactions were carried out according to TS 2470 principles; The sapwood part is used by cutting in a radial direction. Impregnated and mordan boric acid, sodium chloride (NaCl) and aluminum sulphate ($Al2SO_4$) $_3$ were used; Water-based varnish was preferred as a varnish type [6].

2.2. *Method*

2.2.1. *Preparation of Experiment Samples*

It was paid attention that the wood materials used in the study were sapwood parts with smooth fibers, no cracks, no knots, no density and color difference, no reaction wood, not damaged by fungi and insects, and were processed according to TS 2471 standards. For the pressure resistance test parallel to the fibers, a test sample of 20x20x30 ± 1 mm was prepared according to TS 2595 principles. [7,8].

2.2.2. *Impregnation Process*

The impregnation process was carried out in accordance with the conditions specified in the ASTM-D 1413-76 standard. In the impregnation process, the solution temperature was adjusted to 20 ± 2 ºC and the full-cell method was preferred. The measured samples were subjected to the impregnation process in vacuum and various diffusion times of 20/40 minutes [9].

2.2.3. *Water Based Varnish Application*

The sample Varnishing process has been applied according to ASTM D 3023. The manufacturer's recommendations were taken into account in the preparation and application of varnishes. Without making a different filling layer, the paint and varnish were applied in two coats as filling and top coat. 48 hours were waited between coats for the varnish applied to dry. Considering the solid content of the water-soluble paint and varnish, the application was made at 70 g/m^2 for each layer. Then, the samples were kept in the conditioning cabinet at 20 ± 2 ºC temperature and 65 ± 5% relative humidity until they reached equilibrium humidity [10].

2.2.4. *Retention (%)*

After the impregnation process, the remaining substance (tcoao-% retention) compared to the complete dry wood was calculated from the formula [11].

$$R(\%) = \frac{Moes - Moeo}{Moeo} x100 \quad (1)$$

Moes = Sample full dry weight after impregnation (g)

Moeo = sample full dry weight before impregnation (g)

2.2.5. *Compressive Strength Parallel to Fibers*

In the pressure resistance tests parallel to the fibers, samples with a cross section of 20 x 20 mm and a length of 30 mm (210) were conditioned and brought to air dry (12%) moisture, and then they were subjected to pressure in the wood material testing machine in the direction parallel to the fibers and thus the maximum

pressure value at the moment of breaking was measured. Then, the pressure resistance in kg/cm² was found by dividing the maximal pressure value at the moment of breaking on the machine to the cross-sectional area (TS 2595).

Formula Used in Calculation: (2)

Ow// : Pmax/a.b (N/mm²)

σ w// : Compressive strength parallel to fibers

Pmax : Biggest load (N)

a ve b : cross-sectional dimensions (Citak, 2012).

2.2.6. *Evaluation of Data*

SPSS statistics program was applied to evaluate the data. Homogeneity groups were formed by analyzing values resulting from wood type effect and % concentration change and simple variance analysis was applied.

3. RESULTS

3.1. *Solution Properties*

Solution properties are given in Table 1.

Table 1. Solution Properties

Impregnation material	Solvent	Temperature (ºC)	pH		Density (g/ml)	
			BI	AI	BI	AI
Boric Acid	DS	22ºC	4.72	4,73	1,020	1.020
Aluminum Sulphate	DS	22ºC	3.71	3,71	1,065	1.065
Sodium Chloride	DS	22ºC	7.20	7,22	1.070	1.070

When There was no significant change in solution pH and densities. This situation must be taken into consideration as the change in acidic and basic values will cause hydrolysis in wood. It has been reported in the literature that especially the acidic structure will affect the physical and mechanical properties of wood.

3.2. *Retention Amount (% Retention)*

The net dry impregnation material (adhesion) remaining amount as (%) is given in Table 2.

Table 2. % Retention

Impregnated material	Vacuum/ Diffusion Time (min)	Retention (%)	
		Mean	Standard deviation
Boric Acid	40	7.34	3.39
Aluminum Sulphate	40	9.44	3.33
Sodium Chloride	40	2.47	2.47

The highest % retention was determined in aluminum sulphate (9.44%) and the lowest in sodium chloride (2.47%).

3.3. *Pressure Resistance (N/mm²)*

The pressure resistance change is given in Table 3.

Table 3. Pressure Resistance (N/mm²)

Impegrenated material	Vacuum/ Diffusion Time (min)	Pressure resitance	HG
Control		51,62	F
Boric Acid		68,53	A
Aluminum Sulphate		61,47	B
Sodium Chloride		48,60	G
Water Based Varnish	40 min	55,07	E
Water Based Varnish + Borikasit		57,14	D
Water Based Varnish + Aluminium Sulphate		48,10	G
Water Based Varnish + Sodium Chloride		58,58	C

The highest pressure resistance change was determined in Boric acid (68.53 N/mm²) and the lowest in Water Based Varnish + Aluminum sulphate (48.10 N/mm²).

4. CONCLUSION

There was no significant difference in densities and pH values of the solutions measured before and after the impregnation process. This may be due to working with the new solution with each impregnation variation. It is reported that boric acid, aluminum sulphate and sodium chloride concentrations among the preservatives used are close to the acidic structure, negatively affecting the polysaccharides in the wood and increasing the possibility of hydrolysis [12]. Despite these properties, no negative effects on mechanical properties have been observed. Alkan, (2016) impregnation process of scotch pine (*Pinus sylvestris L.*) wood with a solution obtained from boron compounds and mixtures of natural preservatives. It is found that the amount of retention in bee pine, which is one of the natural preservatives, is lower than that of kebraco, and the total amount of retention increases as the solution concentration increases. The highest retention values were observed in samples impregnated with 1% solution. It is stated that the retention ratio varies due to the properties of the solutions and the anatomical structure [13]. In the results of working; It seems possible that aluminum sulphate, sodium chloride, boric acid materials from our country's resources can be used as preservatives. The use of water-based varnish or impregnation without varnish with the preservatives used positively show the ability to be used in the furniture industry (park, garden, urban furniture, construction industry, etc.) Having positive results in physical-mechanical properties makes it feasible and requires additional studies to be carried out together. It seems possible to investigate the usability status with other water-based preservatives that do not harm human health and to obtain healthier positive structures. It is necessary to use these materials, which seem possible to be used in parks and gardens, pergolas, benches or flower beds in all outdoor areas, together with the top surface treatments and to be tested (gloss, surface adhesion, color, surface hardness, etc.). And also, its effect on human health and the duration of material strength should be determined.

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Impregnation Effect of Medical Aromatic Plant Extract On The Anatomic Structure Of Wood

Huseyin Peker[1], Hatice Ulusoy[2]

Abstract

In Since the beginning of history, the global world structure and medicinal aromatic plants in our country have been used in very rich areas (medical, cosmetic, food, spice, agriculture, animal husbandry, spice, paint industry, etc.). New human / environment friendly wood protective materials are being developed, thus efforts are made to create an antioxidant / antibacterial product structure in various areas such as hygienic furniture structure, children's toys, hospitals, etc. It has been reported by the World Health Organization (WHO) that the number of herbs used as medicinal and spice in the world is around 20,000. Preparing extracts from plants and using them as medicine, in China in BC. It dates back to 2700 BC. Rapid depletion of forest resources and exposure to synthetic / chemical effects in the environment in which human beings have lived pose serious threats. The anatomical properties of this material, which was aimed to create a much more organic structure by obtaining extracts (1%, 3%) of various medicinal and aromatic plants (meadow onion, chives) and bringing it into relationship with borax by double process, were examined and the scale of attachment was determined in relation to this. Due to its anatomical structure, the level of adhesion on spruce wood cross-sectional surfaces was evaluated microscopically and the net dry impregnation amount was calculated. In spruce wood, especially the passage aspiration structure is known to be among the most important elements that make it difficult to hold the material in the impregnation process.

Keywords: Wood anatomy, medicinal aromatic plant, impregnation, adhesion.

1. INTRODUCTION

Due to the wide variety of structure of wood material (aesthetic, penetrability, etc.), it has taken its place in human life in the historical process. The properties of this material (anatomy, technological features, etc.), which are preferred in various fields, facilitate the usage process. Another feature of wood is its ability to grow together with its being in various areas of the earth. However, excessive cutting in tropical forests endangers the forest resource structure during the process. The reproducibility of wood raw material, despite its cutting, cannot eliminate this threat and does not reduce the poverty level. For the efficient use of raw material wood, its wide variety of properties should be well comprehended. In this way, it will be possible to evaluate the wood types at an optimum level and thus, a wide variety of areas can be created. The most significant point in its use depends on the accuracy of the diagnosis. The determination of the type/species of wood is not only in terms of the taxonomic aspect of the plant, but also has significant place in the various fields of use of wood (commercial dimension, artistic, historical, etc.). The property of wood (physics, chemistry, macro/microscopic etc.) is of great importance in recognition)[1]. Mankind since its creation to today, has been appliying almost all of its needs such as clothing, shelter, food and fuel from the borders of forests. However, the development of technology, forestry method and forest management today has focused the needs of people obtained from forests only on wood raw materials. In our country, this understanding started to prevail day by day and started to be limited to wood (timber, timber, etc.) production. However, it is an incomparable resource for a healthy life, where many economic and cultural activities such as many herbaceous plants, wild animals, water resources, recreation areas can be carried out together in addition to the tree wealth within the forest areas [2].

In various studies, the plant material structure reveals that it can contain a very large amount of phytochemical compounds with very strong antioxidant/antimicrobial activity [3].

Impregnated wood (biotic/abiotic, etc.) has an important place in the construction industry with its economic, aesthetic appearance, as well as being resistant to factors. Water-based soluble impregnations have increased significantly in railways, sleepers, marine support poles, cooling towers, landscaping, outdoor furniture, and construction structures. Water-based impregnating agents generally destroy the odor structure in treated wood, and a wide variety of surface treatments can be performed after impregnation. It can be easily preferred in places of usage and during transportation [4].

Rapid decline in forest existence and exposure of human beings to synthetic/chemical effects in the environment they live pose serious threats. Natural plants are used for various purposes (medical, cosmetic, food, spice, agriculture, animal husbandry, spice, paint industry, etc.); It is aimed to create a much more hygienic structure by obtaining extract (extract) (1%, 3%) from the plants of various medicinal aromatic plants (meadow onion, chives) whose antioxidant/anti-

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bacterial properties of the organic wood have been determined in the literature and bringing it into a double process with boric acid. The various properties of this material have been determined and the place/level of use has been revealed.

2. MATERIAL AND METHOD

2.1. *Material*

2.1.1. *Wood Material and Plant Type and Borax*

Spruce wood grown in our country was used in the study. Operations were carried out by cutting in radial direction according to the principles of TS 2470 (1976). Casir (*Ferula comunis* L.) and Borax, whose antibacterial/antioxidant properties were previously determined, were used [5].

2.2. *Method*

2.2.1. *Plant Supply and Extract Preparation*

Drying process was carried out until it reached a constant weight level in the period of approximately (1-2 months) in the Artvin Coruh University laboratory. After the drying process, it is brought to the level of dust in the grinders. The powdered plants were weighed 10.26 g, and the extraction was carried out in water for 24 hours at room temperature with shaking stirring and filtering to the specified volume levels with solvent. It was then filtered using filter paper and completed with water to a final volume of 5 L [6].

2.2.2. *Impregnation Process*

The impregnation process was carried out in accordance with the conditions specified in the ASTM-D 1413-76 standard. In the impregnation process, the solution temperature was adjusted to 20 ± 2 ºC and the full-cell method was preferred. The measured samples were subjected to the impregnation process in vacuum and various diffusion times of 20/40 minutes [7].

2.2.3. *Retention (%)*

After the impregnation process, the remaining substance (tcoao-% retention) compared to the complete dry wood was calculated from the formula [8].

$$R(\%) = \frac{Moes - Moeo}{Moeo} \times 100 \quad (1)$$

Moes = Sample full dry weight after impregnation (g)

Moeo = sample full dry weight before impregnation (g)

2.2.4. *Preparation of Preparates*

The "Preparation Method" was applied in order to examine the anatomical properties of wood species. For general anatomical measurements, 3 preparation samples were taken from each end of each wood species experiment sample. The wood samples to be taken anatomical sections were boiled in distilled water until completely collapsed in order to soften the wood samples and to remove the air from the tissues. Then the samples were incubated in a 1/1/1 ratio alcohol-glycerine-distilled water mixture until the sections were cut. In addition, crystal acid phenol (Phenol) was added to this mixture in a small amount against the effect of fungi. Sectioning operations were performed in the "Reichert" Slide Microtome from the samples brought to this stage. Longitudinal radial and longitudinal sections 15-20 µm thick were taken from each sample. They were made transparent in sodium hypochlorite for 15-20 minutes and washed with distilled water before being made into continuous preparations. Tye were stained with bile,after washing with distilled water with acetic acid for 1–2 minutes to neutralize the medium.

After the painting process, the sections washed thoroughly with distilled water were passed through 50%, 75%, 95% alcohol series, respectively, and the longitudinal radial and longitudinal tangential sections were processed into continuous preparations in glycerin-gelatin with "basic fuchsin" respectively [9,10].

3. RESULTS

3.1. *Solution Properties*

The plant extracts of casir and borax used in impregnation were prepared at a concentration (1% - 3%) and the solution properties are given in Table 1.

Table 1. Solution Properties

Concentration	**Extract /Boraks**	**solvent**	**Temperat.** (ºC)	**pH**		**Density** (g/ml)	
				BI	**AI**	**BI**	**AI**
%1	Casir+Borax	Dest. Water	22ºC	8.10	8.10	0.990	0.992
%3	Casir+Borax			8.75	8.75	0.990	0.990

3.2. *% Retention*

The net dry impregnation material remaining amount as (%) is given in Table 2.

Table 2. % Retention

Wood type	**Plant Extract /Boraks**	**Concentration** (%)	**Vacumm/ diffusion time** (min)	**Retention** (%)
Spruce Wood	Casir+Boraks	%1	45 Dakika	1,12
	Casir+Boraks	%3		1,03

The retention value was found to be higher in a 1% mixture of Casir and Borax than a mixture of 3% Casir and Borax. Baysal et al. (2003) stated that the positive and high level of protection of impregnation depends on the preservative, wood property, retention level (adhesion) and permeability level [11]. Ors et al. (2001) The effectiveness of the impregnation process depends on the impregnation material, wood property, retention level (adhesion), permeability level and the anatomical structure depends on the drying/slit opening process, passage aspiration in coniferous wood and tulle formation in leafy trees, storage of various foreign materials creates difficulties in wood impregnation. They reported that the peeling process before starting the impregnation process decreased the free water level in the lumen to 20% moisture level and thus the depth of impregnation effect increased with drying [12].

Bal (2006) reported that the treatment with ACQ was effective on the mechanical properties and retense was positively affected, providing rapid penetration. Alkan, (2016) impregnated the yellow pine wood with boron compounds and kebracodan, and reported that the highest retention occurred at 1% concentration. Disli (2015) published that the highest % retention at $(Al_2SO_4)_3$ as (9.90%) and the lowest % retention at Ba as (1.07%) in scotch pine wood and the increase in solution concentration increased the amount of retention [13].

3.3. Anatomical Findings

Images of the material retention (anatomical) in various medicinal and aromatic plant extract and borax impregnation in spruce wood are given in Figures 1 and 2.

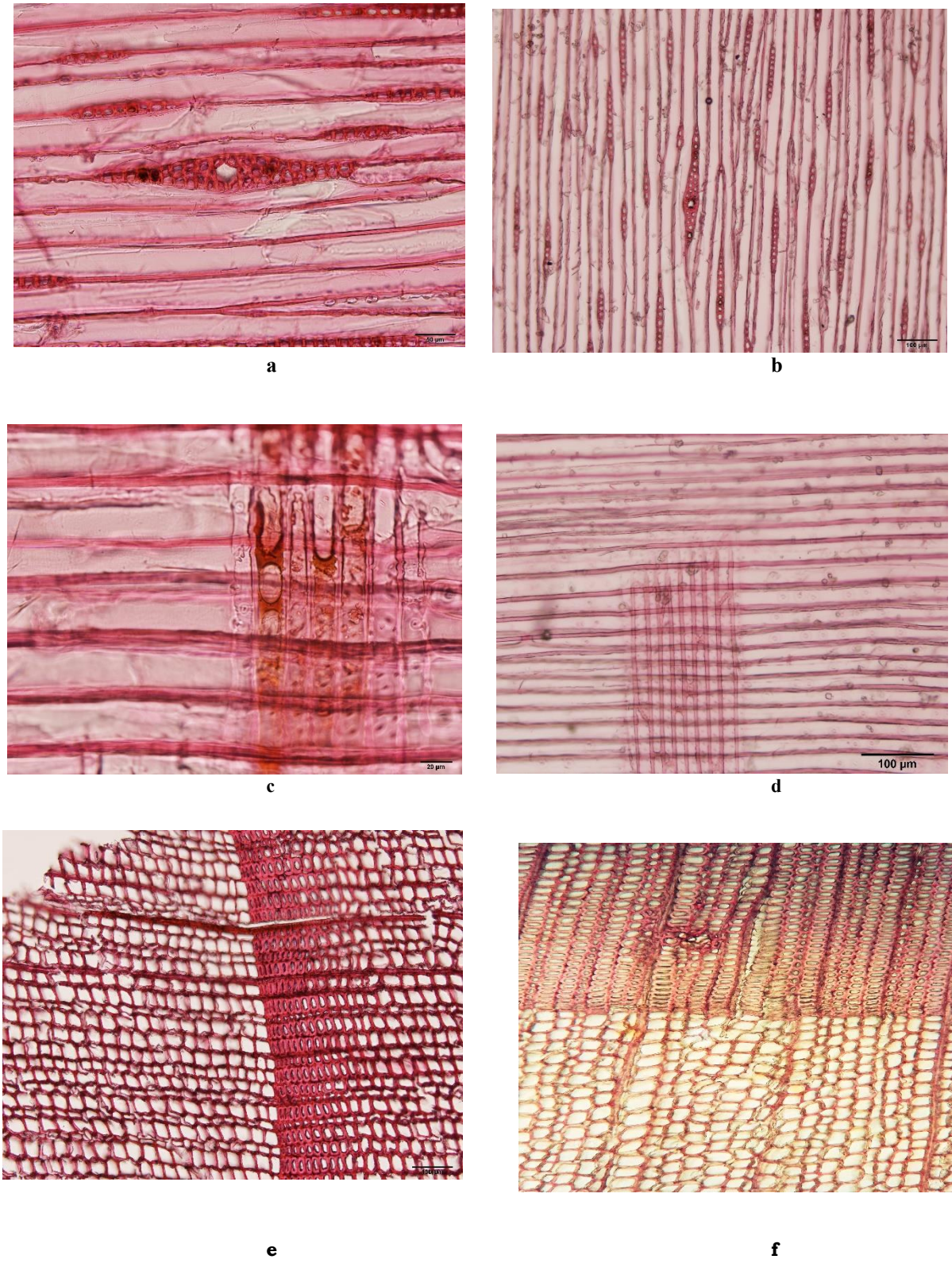
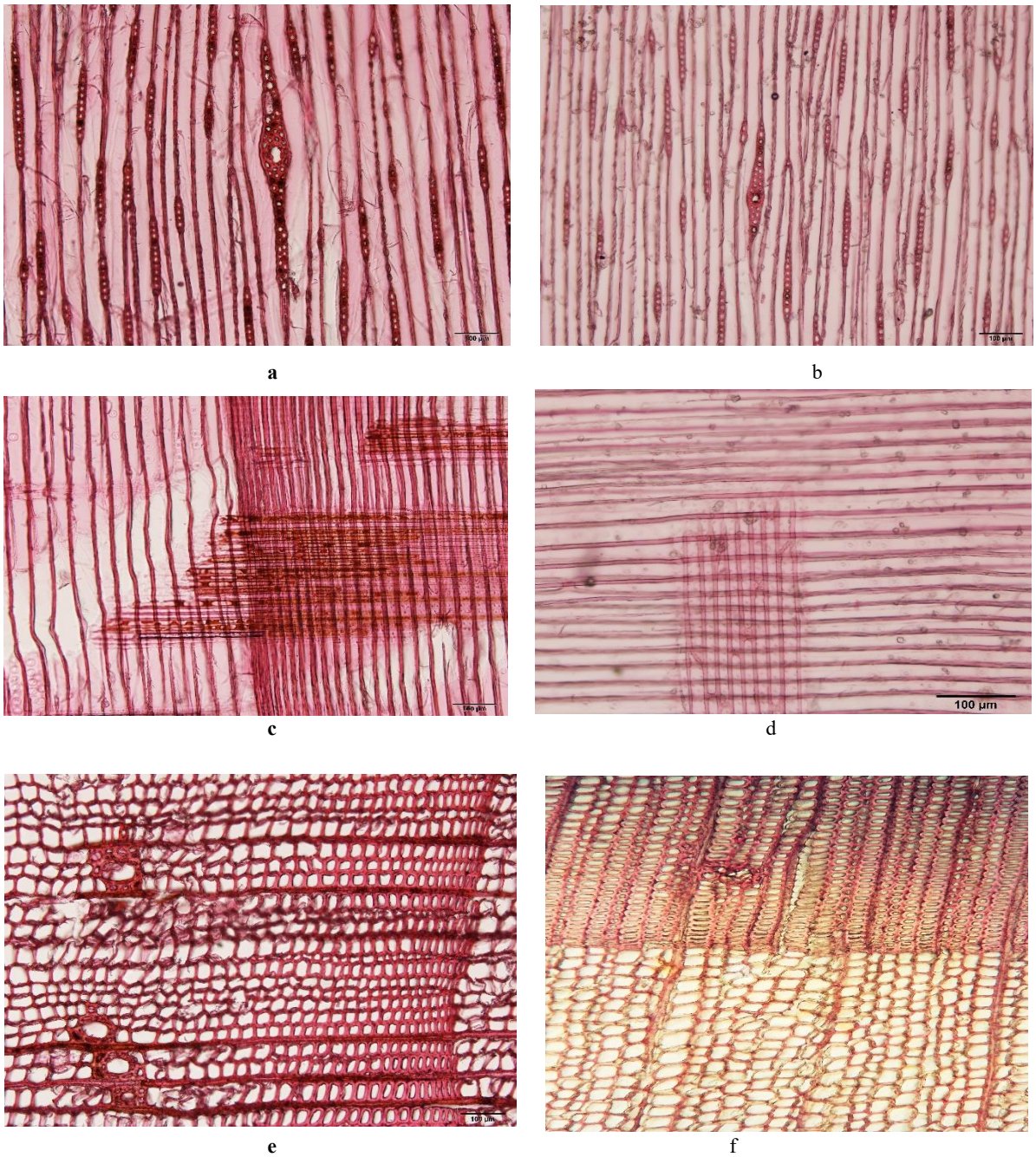


Figure 1. Spruce wood impregnated with a 1% mixture of Casir and Borax; tangent section view (a) radial section view (c) cross section view (e) unimpregnated spruce wood; tangent section view (b) radial section view (d) cross section view (f)

As a result of microscopic examination of preparations prepared from anatomical sections of spruce wood impregnated with a mixture of 1% Casir and Borax; It was determined that the retention occurred in rays, and there was no retention in the traheids. In the tangential (b), radial (d) and transverse (f) section views of the spruce wood control sample and the impregnated spruce wood in tangential (a), radial (c) and transverse (e) directions; Microscopically, it was observed that the best retention was in the tangential section of rays.



a b

c d

e f

Figure 2. Spruce wood impregnated with a 3% mixture of Casir and Borax; tangential section view (a) radial section view (c) cross section view (e) un impregnated spruce wood; tangential section view (b) radial section view (d) cross section view (f)

As a result of microscopic examination of preparations prepared from anatomical sections of spruce wood impregnated with a mixture of 3% Casir and Borax; It has been determined that the retention occurs in the rays and that the traheids do not. In the tangent (b), radial (d) and transverse (f) section views of the spruce wood control sample, the impregnated spruce wood in the tangent (a), radial (c) and transverse (e) sections views; Microscopically, it was observed that the best retention was in the tangential section at the rays. As a result of the impregnation with a mixture of 1% and 3% Casir and Borax; retention was greater in the 1% mixture of Casir and borax. This result is also in parallel with the % retention values. However, retention occurred in both of the rays, and no retention occurred in the traheids.

4. CONCLUSION

There No significant changes in solution properties, pH and densities were determined. It can be mentioned that a certain level of retention can create a positive structure in usage areas and technological features. It is obvious that the acidic/basic material planned to be used in addition to the wood type, wood moisture, wood anatomical structure, wood dimensions, preservative/method will significantly affect all technological properties and surface treatment properties of wood. Both the % retention value structure and the amount of retention material in wood preparations were determined at a very low level. It was observed microscopically that the retention was in the rays and not in the traheit cells. The rays of the parenchyma cells exist in the rays located in the radial direction in coniferous woods and provide the delivery of nutrients in the radial direction by storing the nutrients.

It can be concluded that this feature may have been effective in the intake of the preservative due to the fact that the retention is in the rays and the rays has the task of storing the nutrients. In coniferous trees, passage aspiration occurs especially at the cell wall. The reason for the absence of retention in traheitis may be due to passage aspiration. The study here compared to various researches, it is the production of new natural surface/impregnation materials that are compatible with human/environmental health and contribute to the country's economy from a wide variety of plant/animal/mineral etc. materials included in our country's resources. Thus, the export of this material to other countries of the world will be provided by country resources will be utilized in the most efficient way. By moving away from chemical/synthetic surface and impregnation materials, providing healthy and hygienic materials has come to the fore. Medicinal aromatic plants and other plant varieties have been appplied in a wide variety of areas that humanity needs, besides being for treatment purposes both in our country and other countries since the beginning of history. Today, these plants are used in the perfumery industry, food additives, condiments, and a wide variety of natural oils. In addition, when human/environmental health is taken into consideration, the use of these plants in products such as furniture (indoor/outdoor), paper industry, wooden toy industry, park/garden furniture etc. contributes to the creation of a hygienic structure. Especially the vacuum method is preferred but pressurized, dip, brush applications, etc. other methods can be also applied. A wide variety of concentrations and solvents (methanol extracts. Ethanol, acetone, ether and water) can be tried. A wide variety of other plants or resin derivatives in the processes can be applied. By bringing it into relationship with boron and boron derivatives, prolongation of wood life and fire effects can be investigated. The same analyzes can be made on the same species grown in other provinces and the results between different provinces can be compared. By comparing the amounts of antioxidants in different solvents of the same type of plants, the solvent with the best activity can be investigated.

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Various Medical Aromatic Plant Extract Impregnation Ability and TGA Tests in Wooden Material

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Abstract

In the study, the wood of Scotch pine (Pinus sylvestris L.) was impregnated with the "Esgin Plant" extract (1% -3%) according to ASTM 1413 76 standard; the Thermogravimetric Analyzer (TGA) analyses the change determined. Rapid depletion of forest resources and exposure of human beings to synthetic/chemical effects in the environment they live, cause serious threats. Distilled water was used as a solvent in the preparation of extracts in order to provide a healthier/environmental environment for various medicinal and aromatic plants. All chemical compounds are effective on the burning, physical and mechanical properties of wood material. The flammability, color, density, odor, taste, and resistance to pressure resistance of wood vary depending on the amount of extractive material. As the amount of extractive substance in wood decreases, the burning capability decreases. The increase in lignin and inorganic material (ash) ratio decreases the burning resistance. According to the experiment results; The highest retention rate was determined as 3% extract in 25 minutes vacuum and 30 minutes diffusion (0.41%) as the highest in scoth pine. While 1% structure of Esgin plant gave negative results in terms of burning degrees, decomposition temperature points and residue amount in TGA experiment.

Keywords: Wood anatomy, medicinal aromatic plant, impregnation, retention.

1. INTRODUCTION

There are many prescriptions written for therapeutic purposes on the tablets that have survived from the Hittites in Anatolia. In addition to herbs, herbal drugs brought from other countries; poppy, liquorice, saffron, mandrake, etc. grown in Anatolia were also found in these recipes. Greeks: Hippocrates, born in Kos Island in the 5th century BC, is known as the "Father of Medicine". He talked extensively about herbal drugs in his books written in his period. Galinus, born in Pergamon in the 2nd century, was known both for his medicine and for the drugs he prepared and was accepted as the "Father of Pharmacy". He mentioned approximately 500 herbal and animal drugs in his publications and stated their effects [1]. Medicinal and aromatic plants constitute a siginificant part of the plants that are produced and traded today. While most of these plant species in trade are collected from nature, very few of them are planted in the field and presented to trade. Finding new active ingredients to be used in the treatment of diseases provides the continuation of research on plant properties. 3500 new active ingredients obtained as a result of the studies carried out in 1985, 2618 of them were found to be of plant origin. With such researches to be carried out on plants, it is aimed to reach active substances that can be used in the treatment of diseases such as cancer that have not yet been fully cured. Human beings should take care to collect the plants found in nature and benefit from these plants with the principle of protection and use. This is an important finding not only in terms of maintaining the continuity of plant species, but also preventing the consumption of all natural resources and increasing the usage areas in line with the principle of "sustainable use" and being able to use them for many years [2].

Tomak et al. (2010) Since the excessive use of the toxic component structure in wood preservation causes the increase of significant environmental pressures and prohibitions, it has become necessary to create/develop new materials that are in harmony with the environment and humans. [3]. Peker (2015) subjected the extract (extract) obtained from the waste tea to the impregnation process and subsequently investigated the surface hardness by applying it as a secondary treatment with water-based varnish and determined that the tea extract gave positive results in scotch pine/beech wood when used with water-based varnish. [4].

Kartal (2006) investigated the effects of boron compounds and heat treatment on wood properties (washing boron compounds and fungal and termite resistance), and found that the heat treatment did not have an effect on washing boron compounds; neither boric acid nor disodium octaboratedehydrate-treated samples had increased fungal resistance against brown rot fungi. Baysal et al. (2004) investigated the burning effects of some preservatives used for the protection of wood applied in a wide variety of fields against biotic/abiotic living pests on spruce (Picea orientalis L.) wood and the highest weight loss was as 91% in PEG 400 and the lowest as 9.2% in phosphoric acid [5].

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Thermal resistance ranking of wood components at low temperature; hemicellulose <lignin <cellulose form and there is an order as hemicellulose <cellulose <lignin at high temperatures. Thermal decomposition of hemicelluloses starts at 180-200 °C. Thermal degradation of cellulose starts at 210-220 °C, reaches the highest level at 270-280 °C and is completed between 300 °C and 340 °C. It is repoted that decomposition of lignin begins between 220 °C and 280 °C and is completed between 400 °C and 450 °C [6].

In the study, retention formation was achieved by impregnation with Esgin plant extract (1% and 3%) and the usability of the material and wood material to be used as impregnation material was evaluated by TGA.

2. MATERIAL AND METHOD

2.1. *Material*

2.1.1. *Wood Material and Plant Type*

Scotch pine wood grown in our country were used in the study. Operations were carried out by cutting in radial direction according to TS 2470 principles. Esgin (*Rheumribes* L.) plant, whose antibacterial/antioxidant properties were determined in previous studies, was preferred [7].

2.2. *Method*

2.2.1. *Impregnation Process*

The impregnation process was applied in accordance with the conditions in "ASTM-D 1413-76". Experimental samples were prepared in the dimensions of 20x20x300±1mm and subjected to 45 minutes vacuum/45 minutes diffusion process. In order to prevent impregnated material from being affected by wood moisture, the test specimens were completely dried [8].

2.2.2. *Obtaining Plant Extract (Extract)*

The sample weight determined for the experiment was put into 200 ml of hot distilled water or water at least equal to this purity, and it was heated at a temperature below the boiling point in the refluxing apparatus for 1 hour by mixing at certain intervals. After filtering in the previously prepared porous capsule in the presence of vacuum, the process was continued so that no sample remained in the flask with distilled water several times. The insoluble part was completely left inside the porous capsule. Finally, the residue was washed with 200 ml of hot distilled water and after the residue was dehydrated by a pump or another device that would serve as a suction, the porous capsule and its contents were dried by keeping them in an oven set at 103oC for 16 hours, then cooled in a desiccator and weighed with 0.001 g precision [9].

2.2.3. *Thermogravimetric analysis (TGA)*

According to TGA analysis was applied according to ASTM E1131-08 (104) with about 10 mg wood flour passing through a 40 mesh sieve, not passing through a 60 mesh sieve, under nitrogen gas at a flow rate of 57 for 50 ml/min, by increasing the temperature from 25 °C to 700 °C with the rate of temperature increase as 10 °C/min. As a result of the experiment, the percent weight loss occurred in the sample at the highest temperature point, the time period in which the instant weight loss amount was highest, and the fast pyrolysis temperature points were determined [10].

3. RESULTS

3.1. *Solution Properties*

Solution properties are given in Table 1.

Table 1. Solution Properties

Plant Extract	Solvent	Temperature (ºC)	pH		Density (g/ml)	
			EO	ES	EO	ES
Esgin plant extract %1	water	22ºC	6.92	6.92	0.9226	0.926
Esgin plant extract %3	water	22ºC	6.86	6.86	0.913	0.913

Solution properties did not vary significantly in pH and density values before and after impregnation.

3.2. *Retention Amount (% Retention)*

The net dry impregnation material (retention) remaining amount as (%) is given in Table 2.

Table 2. % Retention

Wood type	**Extract Concentration**	**Vacum time** (min)	**Diffusion time** (min)	**Retention** (%)
Scotch wood	Esgin extract (% 1)	25 min	30 min	0.41
	Esgin extract (% 3)			0.27

The highest retention was determined as (0.41%) in scotch pine wood with 1% Esgin extract, and the lowest as (0.27 %) 3% extract. This situation may be caused from the wood type, anatomical structure, impregnation method, impregnation material.

3.3. *TGA Analysis*

Thermogravimetric analysis (TGA) graphics are given in Figure 1 in scotch pine wood.

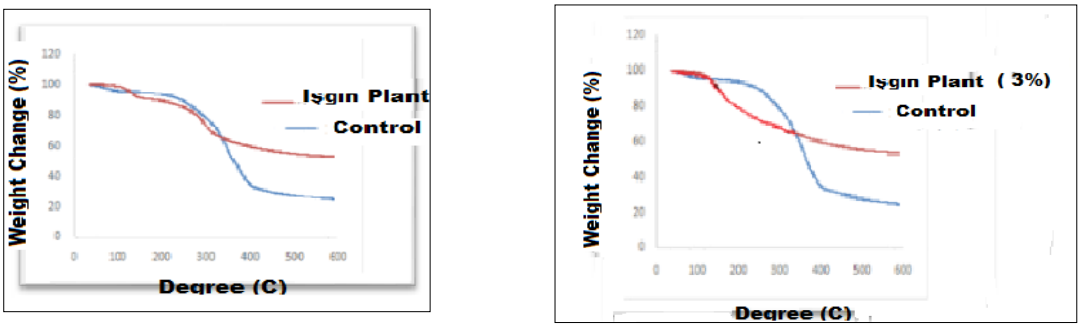

Figure 1. TGA Change in Scots Pine Wood

When the graphics are examined in the TGA analysis, 1% Esgin extract in Scotch pine wood showed a positive result compared to 3% in terms of weight loss.

4. CONCLUSION

In the study, retention formation was achieved by impregnation with Esgin plant extract (1% and 3%) and the usability of the material and wood material to be used as impregnation material was evaluated by TGA. The increase in lignin and inorganic material (ash) ratio decreases the burning resistance. According to the experiment results; The highest retention rate was determined as 3% extract in 25 minutes vacuum and 30 minutes diffusion (0.41%) as the highest in scoth pine. While 1% structure of Esgin plant gave negative results in terms of burning degrees, decomposition temperature points and residue amount in TGA experiment.

TGA results can be applied in the production of wood material such as medium-density fiberboard (MDF), particle board, plywood and wood/plastic composites, to explain some of the behavior of wood material against combustion, to evaluate the performance of fire retardants and to obtain fuel from biomass.

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