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CBHE – Erasmus+ programme

ITACAProject

Innovative Training Centre to support a postgraduate 3rd cycle Advanced Course to face Environmental Emergency in Azerbaijan

WP 1. Selection of the main environmental issues, due to the pollution of oil and gas extraction in Azerbaijan, to be investigated and appointment of the working groups.

Task D.1.2. – Identification of the main topics to be investigated. Appointment of a working group for each specific topic, its coordinator and description of the relevant clean-up technologies together with the fixed objectives.

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1. Introduction

This document is based on the report D.1.1., which shows the main environmental issues in AZ due to the gas and oil extraction. One of the main conclusions that can be drawn from D.1.1 report is that the AZ republic has a particularly worrying environmental situation, because of the long extractive tradition of oil production and the low levels of environmental controls that have taken place in the past. Moreover, the quality of the soil and surface, underground and marine waters have been affected by high pollution of hydrocarbons, heavy metals and other pollutants derived from the oil industry. For this reason, it is necessary an improvement in environmental controls and increase restoration studies of areas impacted by pollution with the objective of solving this environmental problem.

In response to these problems and in accordance with the schedule established in the ITACA project, will be developed six research topics by Baku State University (BSU), Baku Higher Oil School (BHOS), Baku Engineering University (BEU) and Azerbaijan University of Architecture and Construction (AzUAC). Each azerbaijani partner institution will develop two research topics, with the exception of BSU, which must take over the analysis and characterization tests for the other three labs and they don't necessarily have their own research topic.

In the following table are shown the laboratories and the main research topics to be developed by each institution:

Table 1. Laboratories and research topics in ITACA´s project.

Responsable partner	**BHOS**
Lab name	Laboratory of Oil degradation in seawater and soil (LOD).
Main research topics	1. Oil fields polluted with heavy metals, Anions (nitrates, arsenate, F, Cl, etc.), Organic pollutant (phenols and others). 2. Caspian-sea polluted by oil spill (surfactants and nano-Fe_3O_4 or polymeric composites, etc.).
Responsable partner	**BEU**
Lab name	Laboratory of treatment of contaminated soil by hydrocarbons and heavy metals (LSR).
Main research topics	1. Impact determination of morphogenetic features of oil contaminated soil and re-cultivation methods in Absheron Peninsula. 2. Bio-remediation of contaminated surface soils in Absheron Peninsula.

Responsable partner	**AzUAC**
Lab name	Laboratory on the treatment of the water produced by oil and gas extraction (LWT).
Main research topics	1. Ground/produced wastewater polluted with oil and gas extraction process products in the area of iodine bromine plant polluted with chlorine, iodine and bromine. 2. Oil pools created by pollution from oils wells.
Responsable partner	**BSU**
Lab name	Laboratory of environmental characterization and analyses (LECA).
Main research topics	1. Investigation of anthropogenic impact on the Absheron Peninsula and the Caspian Sea. 2. Ecological changes of the Absheron Peninsula and the Caspian Sea

2. Description of the research topics

A more detailed description of the research topics will be made on this point.

2.1.Work plan 1 - Baku Higher Oil School (BHOS).

Research topic: Oil fields polluted with heavy metals, Anions (nitrates, arsenate, F^-, Cl^-, etc.), Organic pollutant (phenols and others).

Coordinator of the research: Amir Reza Vakhshouri.

2.1.1. Introduction

In the oil industry water can be polluted along with gas and oil extracted from well. These pollutants mainly contain heavy metals (including mostly Pb^{2+}, Hg^{2+}, Cd^{2+}, etc.), anions (such as, F^-, Cl^-, NO_3^-, PO_4^{3-}, etc.) and organic materials (such as Phenols). It is imperative to remove those pollutants from water to protect marine environment from toxic contamination.

Every year Azerbaijan Republic discharges in the Caspian up to 4000 tons of oil and oil products, 500,000 tons of dry residues, above 70,000 tons of sulphates, above 300,000 tons of chlorides, about 500 tons of nutrients, up to 30 tons of phenolic compounds, mineral acids, diluted iron, nitrates, phosphates, pesticides, etc. 95% of pollution still refers to oil products (National Caspian Action Plan of the Republic of Azerbaijan, 2002).

Most oils have certain content of heavy metals. Starting from gasoline, all fractions of oil include metals. The crude oil extracted from the hydrocarbon deposits of Azerbaijan Republic is dominated by iron (up to 0.74%), chrome, and nickel (often more than n × 10^{-2} mg/l). Asphaltene fraction of some oil fields of Absheron peninsula is rich in such microelements such as Co, Br, Ag, Au, La, Sb, and Sc (Table 2). As a result of neutron activation analysis, 1.2 × 10^{-3}% Rb, 6.3% × 10^{-5}% Cs, and 2.1 × 10^{-5}% Eu were found in the crude oil of the Balakhani oil field. Usually, a majority of heavy metals are found in the asphaltene-tar fractions of oil. They are also found in the composition of oil cuttings and drilling fluids.

Table 2. Metal content of the Absheron oil fields qw2(Aliyev, 2018).

Site	Fe	Ni	Cr	Zn	Ba	V	Co	Hg	Ag	Au	La	Sb	Sc	Hf	Se
	10^{-4} %				10^{-5} %				10^{-6} %					10^{-7} %	
1	600	57	96	750	53	151	110	-	289	140	87	300	1500	28	47
2	138	58	174	270	265	260	64	160	-	8	28	19	20	26	32
3	400	63	68	110	540	142	35	570	-	6	-	4	13	14	-
4	170	8	8	80	5	37	2	14	10	150	4	2	10	23	75
5	34	23	23	3	-	62	10	-	2	6	-	-	2	52	60
6	110	19	19	8	99	47	4	2250	14	4	-	9	11	127	46
7	180	65	65	14	8	53	6	-	-	1	-	1	-	18	-

Beside heavy metals there are other organic and anionic pollutants. Sea waters of Sumgait also contains high level of hydrocarbons, phenols, detergents and nitrites. According to Water quality and pollution level of the area, the Caspian Sea can be described as polluted to very polluted, constituting an environmentally worrying situation.

According to the water control organizations, 169.11 million m^3 of polluted and 240.49 million m^3 of relatively treated sewage could be discharged in the coastal areas of the Caspian Sea (Aliyev, 2018). The most of it was discharged in Absheron district (Baku and Sumgait), 159.73 and 237.11 million m^3 respectively. Particularly in the coastal waters of North Absheron (east from Sumgait) content of hydrocarbons exceeds MPC (Maximum Permissible Concentration) by a factor of 2-10, content of phenols is 8-10 MPC, and other pollutants vary from 0.5 to 1 MPC. Baku bay is the most polluted area of the Caspian. Approximately 155 million m^3 of polluted and 210 million m^3 of relatively treated waste waters can be discharged in the bay. Content of hydrocarbons in the bay is 10-50 MPC, phenols – 18-30 MPC, mercury and detergents – 2-5 MPC. Besides, the concentrations of phosphates (12-15 μg/l), nitrates (2-3 μg/l), ammonia nitrogen (25-60 μg/l) are 40-50% higher than in the other parts of the Caspian (National Caspian Action Plant of Azerbaijan Republic, 2002).

2.1.2. Project Objectives

The aim of this research project is to investigate role of modified zeolites and bio-based polymers in the removal of pollutants including heavy metals, anions and hydrocarbons from polluted water. As a whole concept the goal is to achieve the best methods of pollutant removal from polluted water in ecological clean and economic way. The objectives to achieve this:

• Use of natural polymers such as starch and cellulose to remove contaminants. This method, in which more accessible and sustainable bio-polymers will be used, is more efficient and has the ability to remove a wide range of contaminants.
• Use of zeolites (natural and artificial) to remove contaminants. This method, in addition to being sustainable, also has high efficiency.
• Use of crosslinking agent (such as adipic acid, malic acid, maleic acid *etc*.) to create gel form bio-based and sustainable adsorbents to remove cations and/or anions. In this method bio-agents that do not have a negative impact on the environment will be used.
• Use of different surfactants to create all active and modified adsorbents to increase the absorption efficiency of organic pollutants.
• Use of oxidation agents and methods to eliminate organic pollutants.
• Use of adsorbents and nanoparticles to remove cationic and anionic contaminants.

2.1.3. Work plan and staff involved

Table 3. Plans and staff needed in work plan 1 by the BHOS.

Plans	**Staff needed**
Advanced Literature review	2 professors, 2 experts
Identify the current situation of pollutants in Caspian Sea a. Data collection on pollutants of the Caspian Sea b. Study of data and classification of pollutants	2 professors, 2 experts
Materials a. Find and contact the suppliers b. Provide the materials and instrument	2 experts, 1 administrative affair
Setup of Pilot a. Design the laboratory pilot b. launch of the laboratory pilot	2 professors, 2 experts, 1 lab expert, 2 Technician
Experiments	2 professors, 2 experts, 2 lab experts,
Analytical techniques	2 professors, 2 experts, 2 Laboratory equipment operators,
Concluding and Reporting	2 professors, 2 experts

Table 4. Staff needed by the BHOS ITACA´s project.

Staff Academic	Staff Volunteer	Duration months
Ms. Rena Abbasova, Assoc. Prof. of Chemical Engineering dep.	**Garanfil Ahmadova,** senior research assistant	12
Natavan Səmədova, Lecturer	Nargiz Khalilova**,** senior research assistant.	24

Table 5. Task BHOS in ITACA´s project.

TASK	**PLAN NUMBER**	PLAN START	PLAN DURATION (weeks)	**STAFF NUMBER**	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Advanced Literature Review	1	1	3	4			
Data collection on pollutants of the Caspian Sea	2	2	2	4			
Study of data and classification of pollutants	2	3	1	4			
State of art (1st report and presentation)	3	4	1				
Materials - Find and contact the suppliers	4	5	2	2			
Provide the materials and instruments	4	7	4	2			
Setup - Design and launch of a laboratory pilot	5	11	2	4			
Experiments	6	13	6	6			
Analytical techniques	7	19	3	2			
Concluding and Reporting	8	22	3	4			

2.1.4. Timetable of research topic 1

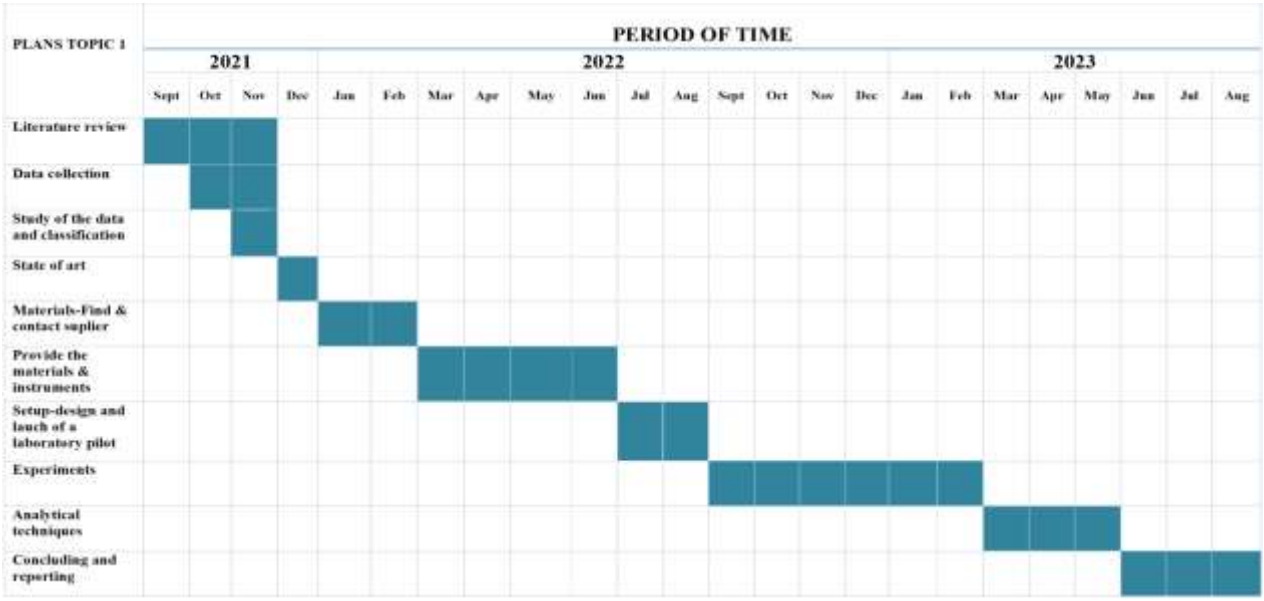

Figure 1. Timetable BHOS in ITACA´s project.

2.1.5. Equipment

Table 6. General equipment will be acquired with funds from the ITACA project.

Equipment name	Application
pH meter	Measuring pH and conductivity in different environments
Conductometer	
Thermometers/thermocouples	Measuring Temperature up to 200 ºC
Overhead Stirrer	Performs the function of mixing samples at different temperatures where the magnetic stirrer cannot mix them.
Lab Homogenizer	To prepare emulsion, suspension or even nano size particles in liquid medium
Ultrasonic bath	To prepare emulsion, suspension or even nano size particles in liquid medium
Oil bath	Applied for experiments required higher temperatures than 120 ºC
Sand bath	Applied for experiments required higher temperatures than 180 ºC
Drying Oven	Drying the samples or curing (calcination) with mid temperatures (up to 400 ºC)
Vacuum Drying Oven	Drying the samples or curing with high temperatures under vacuum condition
Vacuum pump	Filtration of samples under vacuum condition
Vacuum filter system	
Rotary Evaporator	General purposes
Centrifuge	Separation of very small particles and liquids
Analytical Balance 0.0001 gr	General purposes
Water Purification System	General purposes
Rotational Viscometer	To measure the Vis. Of oily compounds
Granulator	To prepare granule of adsorbents
Lab Ozone generator	To AOP of organic pollutant

Table 7. Analytical equipment to be used in workplan 1 by BHOS regarding to external collaborations.

Equipment name	Application
RM-200 Mortar Grinder	Grinding of adsorbents
ICP-OES 5109	Quantitative analysis of heavy metals
ICP-MS 7499	Quantitative heavy metals and organic determinations
UV-Vis spectrometer	Qualitative analysis of organic materials
FTIR spectrometer	Qualitative materials characterization
Elemental Analysis Eq.	Quantitative analysis of materials
X-Ray Diffractometer	Crystal structures study
SEM-EDX	Study of morphology
DSC and TGA	Thermal properties of materials
GC	Quantitative analysis of some materials
HPLC	Quantitative analysis of some materials
Atomic Absorption Spect.	Quantitative analysis of heavy metals
Lab sieve shaker	

2.1.6. External collaboration

For the development of research topic, there will be the collaboration of the Ecology Department of State Oil Company of Azerbaijan (SOCAR), and Petrochemical Processes Institute of Azerbaijan National Academy of Sciences. Both Institutions will decisively contribute to the advice and monitoring of the activities developed throughout the project. In this sense, the information of the results will be shared, establishing a feedback of advice and exchange of information.

2.1.7. Expected results

In the end of plan, it is predicted that the content of heavy metals, anions and organic components will be decreased after applying novel bio-based adsorbents. It is expected that using cross-linked bio-polymers will remove more pollutants than other conventional adsorbents.

The anticipated outcomes are:

- Achieving effectively removal of heavy metal pollutants from seawater with modified creoss.linked biopolymers.
- Effective removal of anions pollutants from seawater with activated cross.linked biopolymers.
- Obtaining high performance zeolites and polymers activated by surfactants, which can adsorb large amount of organic pollutants from water.
- Achieving appropriate (more economical anda higer efficiency) and sustainable methods which can lead to removal of seawater pollutants.

2.1.8. References

Aliyev R. 2018. On the ecological status of the Absheron Peninsula. Journal of Gynecology and Woman`s Health. 12: Issue 4.
National Caspian Action Plan of the Republic of Azerbaijan, 2002

2.2.Work plan 2 - Baku Higher Oil School (BHOS).

Research topic: Caspian-sea polluted by oil spill (surfactants and nano-Fe3o4 or polymeric composites etc.).

Coordinator of the research: Sevda Zargarova.

2.2.1. Introduction

It is well known that demand for crude oil and petrochemical product and usage of them increase from year to year. Such increase of demand to crude oil and products of its refining results in ecological instability and disbalance. In order to improve ecological balance of the nature, surfactants are used in industry including oil production and refining (Humbatov et al., 2001; Asadov 2009). Thin oil layers on the surface of the water become one of such ecological problems which may occur during transportation of crude oil and its refining products.

According to satellite survey conducted in 2019, oil pollution has been the primary enviromental problem of Caspian Sea. As a result petroleum hydrocarbon films pollute the surface of the sea. All these component mix with aquatic area in four different ways: i) from natural marine hydrocarbon emission from the seabed; ii) from the mouths of numerous mud volcanoes; iii) from offshore oil production and transportation; iv) from oily wastewaters discharged by ships (Mityagina et al., 2018). Azerbaijan started development of shelf and offshore oilfields in 19th century. Main pollution of Caspian Sea in Azerbaijan region can be classified into two parts. The first is that main oil transportaion through the seaport occur between Kazakhstan, Azerbaijan and Russia. The second is about accidents on the oil-producing sites. For example, due to storm condition at the Guneshli field on December 2015, caused a rupture of a high-pressure gas pipeline. Because of fire for several days, oil and air pollution were detected in this area.

It is know that hydrophobic and hydrophylic parts of the surfactants have a great influence on property of surfactants. By variation of the sizes of the hydrocarbon part and alkoxy-chain, large variety of suurfactants may be synthesized. According to the literature, higher aliphatic amines may be used for synthesis of surface-active compounds (Asadov et al., 2018; Fan et al., 2013). Beside surface activity, such components are able to decrease surface area of thin pertoleum layers several times on the surface of water (Asadov et al., 2018; Asadov et al., 2017).

Although surfactants have been known more than 50 years, they have been used more in the last 20 years due to their high efficiency. About 10 % of the demand for surfactants, which is more than 12 million tons, falls on nitrogen compounds (Fan et al., 2013).

2.2.2. Project objectives

The main goal of the project is to equilibrate ecological balance of Caspian Sea and clean polluted area from oil spill using surfactants, nano and polymeric components. The objectives mentioned below are planned to realize cleaning of water of Caspian Sea from pollutants:

- Using different nitrogen base (amines) and epoxy group in order to synthesize oligomeric surfactant.
- Using carboxylic acid and inorganic acid to modify salts of oligomeric surfactants.
- Using Fe_3O_4 to modify nano scale component.
- Synthesizing polymeric surfactants by modifying oligomeric components.

All obtained compositions should have surface activity property in order to be able to collect thin oil film on the surface of salty water (Caspian Sea). Furthermore, one of the main objectives for the project is that all synthesized component should have environmentally friendly property.

2.2.3. Work-plan and staff involved

Table 8. Plans and staff needed in work plan 2 by BHOS.

Plans	Staff involved
Literature review	1 professors, 3 experts
Collecting and analyzing of data related of pollution of Caspian Sea	1 professors, 3 experts
Suppling materials, equipments and chemicals	1 experts, 1 administrative affair
Setup and conducting laboratory experiments	1 professors, 3 experts, 2 lab expert, 1 Technician
Analytical techniques	1 professors, 3 experts, 2 laboratory equipment operators,
Concluding and Reporting	1 professors, 3 experts

Table 9. Staff needed by the BHOS in ITACA´s project.

Staff Academic	Staff Volunteer	Duration **months**
Nasir Sultanov, PhD, Laboratory Manager of Chemical Engineering dep.	**Elmira Hamidova,** Lecturer	24
Hajar Nabiyeva, Lecturer	**Arzu Behbudova,** Senior research assistant	24

Table 10. Tasks work plan 2 by BHOS.

	Task	Activity	Plan Start	Plan Duration (month)	Actual Start	Actual Duration	Percent Complete
1	**Advanced Literature Review and documentation**	1	1	3			
2	**Data collection on pollutants of the Caspian Sea**	2	2	2			
3	**Study of the data and classification of the pollutants**	2	3	1			
4	**State of Art (1st Report and presentation)**	3	4	1			
5	**Materials - Find and contact the suppliers**	4	5	2			
6	**Provide the materials and instruments**	4	7	4			
7	**Setup - Design and launch of a laboratory pilot**	5	11	3			
8	**Experiments**	6	14	6			
9	**Analytical techniques**	7	19	3			
#	**Concluding and Reporting**	8	22	3			

2.2.4. Work-plan and staff involved

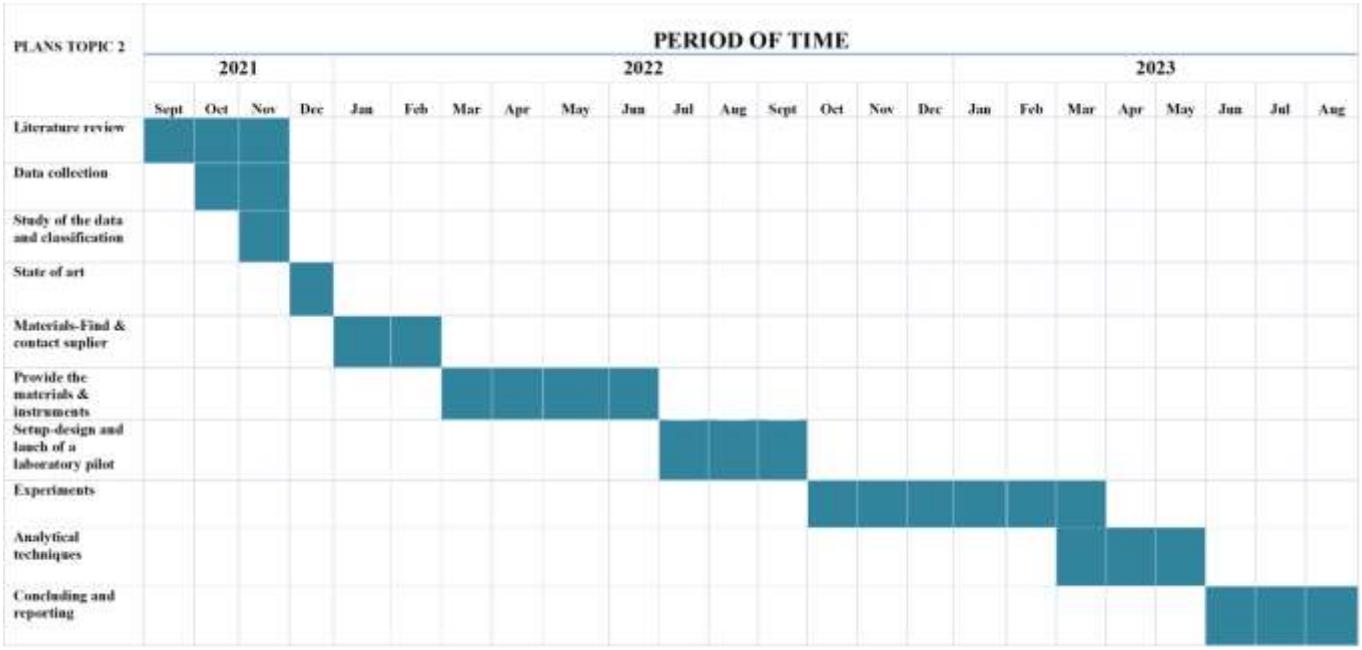

Figure 2. Timetable BHOS in ITACA´s project.

2.2.5. Equipment

Table 11. General equipment will be acquired with funds from the ITACA project.

Equipment name	Application
pH meter	Measuring pH and conductivity in different environments
conductometer	
Thermometers/thermocouples	Measuring Temperature up to 200 ºC
Overhead Stirrer	Performs the function of mixing samples at different temperatures where the magnetic stirrer cannot mix them.
Lab Homogenizer	To prepare emulsion, suspension or even nano size particles in liquid medium
Ultrasonic bath	To prepare emulsion, suspension or even nano size particles in liquid medium
Oil bath	Applied for experiments required higher temperatures than 120 ºC
Sand bath	Applied for experiments required higher temperatures than 180 ºC
Drying Oven	Drying the samples or curing (calcination) with mid temperatures (up to 400 ºC)
Vacuum Drying Oven	Drying the samples or curing with high temperatures under vacuum condition

Vacuum pump	Filtration of samples under vacuum condition	
Vacuum filter system		
Rotary Evaporator	General purposes	
Centrifuge	Separation of very small particles and liquids	
Analytical Balance 0.0001 gr	General purposes	
Water Purification System	General purposes	
Rotational Viscometer	To measure the Vis. Of oily compounds	
Granulator	To prepare granule of adsorbents	
Lab Ozone generator	To AOP of organic pollutant	

Table 12. Analytical equipment to be used in workplan 2 by BHOS.

Equipment name	Application
UV-Vis spectrometer	Qualitative analysis of organic materials
FTIR spectrometer	Qualitative materials characterization
Elemental Analysis Eq.	Quantitative analysis of materials
Tensiometr	Measuring surface tension of materials
^{1}H and ^{13}C NMR	Alaysing the stucture of the materials

2.2.6. External collaboration

For the development of research topic, there will be the collaboration of the Ecology Department of State Oil Company of Azerbaijan (SOCAR), and Petrochemical Processes Institute of Azerbaijan National Academy of Sciences. Both Institutions will decisively contribute to the advice and monitoring of the activities developed throughout the project. In this sense, the information of the results will be shared, establishing a feedback of advice and exchange of information.

2.2.7. Expected results

At the end of project it is expected to clean salty water of Caspian Sea from oil spills pollutants by appling surfactants. It is predicted that new synthesized surfactants will be able to achieve substantial results in term of cleaning process. The following outcomes are prognosticated to achive:

- Cleaning the surface of Caspian Sea from oil spill by applying nitrogen base oligomeric surfactant.

- Cleaning the surface of Caspian Sea by applying different salts of oligomeric surfactantas.
- Cleaning the surface Caspian Sea by applying Fe_3O_4 nano scale component.
- Cleaning the surface Caspian Sea by applying polymeric surfactants.

2.2.8. References

Asadov Z., Ahmadova G., Rahimov R. et al. Synthesis and Properties of Quaternary Ammonium Surfactants Based on Alkylamine, Propylene Oxide and 2-Chloroethanol, Journal of Surfactants and Detergents. 2018,21. p.247-254.

Asadov Z.H. New petrocollecting and petrodispersing surfactants based on ecologically-clean and reproducible kinds of feedstock. Azerbaijan oil industry. 2009, №2, p. 60-65 (in Russian).

Asadov Z., Zarbaliyeva I., Zargarova S. Propoxylation of Aliphatic Amines by Propylene Oxide, Journal of Chemical Problems, 2017,1. p.44-50.

Chauhan S. A, Kumar K., Rana D., Kumar R. et al. comparative Study on the Aggregation and Thermodynamic Properties of Anionic Sodium Dodecylsulphate and Cationic Cetyltrimethylammonium Bromide in Aqueous Medium: Effect of the Co-solvent N-Methylacetamide // Journal of Surfactants and Detergents, 2016. Volume 19, issue 1, p.193-200.

Fan Z., Tong W., Zheng Q., Lei Q., Fang W. Surface Activity and Micellization Parameters of Quaternary Ammonium Surfactants Containing a Hydroxyethyl Group, Journal of Chemical and Engineering Data, 2013. 58 (2), p.334-342.

Ju H., Jiang Y., Geng T., Wang Y. et al. Equilibrium and dynamic surface tension of quaternary salts with different hydrocarbon chain length of counterions. Journal of Molecular Liquids, 2017. 225, p.606-612.

Mityagina M., Lavrova O., Kostainnoy A. Main Pattern of the Caspian Sea Surface Oil Pollution Revealed by Satellite Data. Ecologica Montenegrina, 25. 2019. p. 91-105.

2.3.Work plan 1 - Baku Engineering University (BEU).

Research topic: Bio-remediation of contamined surface soils in Absheron Peninsula.

Coordinator of the research: PhD Parviz Hasanov, PhD candidate Etibar Gahramanov

2.3.1. Introduction

Bioremediation method is most important used for the treatment of all hydrocarbons-polluted materials including drill cuttings. This method is used for the treatment and disposal of oil-polluted wastes. In a number of countries bioremediation in open soil – *land farming* – is considered to be more efficient from economic and ecological point of view compared with other existing methods. This technology has been successfully used and is being used under different natural-climatic conditions in many countries.

Drill cuttings are collected in drill mud when oil and gas wells are drilled. These are small fragments of reservoir rocks and non-dispersed clays in drill mud. Drill cuttings contaminated with chemical substances are referred to the wastes hazardous for the environment. Pollution may lead to the contamination of soil, underground and surface waters by causing an adverse impact on the ecological condition of the environment.

2.3.2. Project Objectives

The main purpose of implementation of drill cuttings bioremediation work is to treat hydrocarbon substances contained in them and reduce their toxicity. Activities carried out are of environmental nature. Intended targets can be achieved in accordance with the major principles of bioremediation methods. These methods are based on the capability of micro-organisms to decompose the hydrocarbon (or synthetic) substances contained in drill mud (oxidation, degradation, modification, etc.).

2.3.3. Work plan and staff involved in the research topic

Table 13. Plans and staff needed by the BEU in work plan 1.

Research Topics	Staff (academic)	Staff (volunteer students)	Duration	BEU will cooperate with relevant organizations
Bio-remediation of contaminated surface soils in Absheron Peninsula	Mr. Rashail Ismayilov, Assoc. Prof. of Industrial Engineering Department of BEU	Mr. Shahmar Guliyev, PhD. Student "SUKANAL" Scientific-Research and Design Institute	24 months	"BP. AAS-EKOL" Limited Company Adviser: Mr. Rashad Ismayilov

	Ms. Bahar Akhmadova, Teacher of Industrial Engineering Department of BEU	Ms. Pervane Geybullayeva, master student of Environmental Protection and Efficient Use of Natural Resources of BEU		"LEAN Consulting" Adviser: Mr. Ilgar Khurshudov

2.3.4. Timetable of research topic 1

Figure 3. Timetable BEU in ITACA´s project.

2.3.5. Equipment

The following analyzes are planned to be carried out in the soil samples taken during the field visits: pH, Ec (via pH and Ec meters), HCO_3, CO_3, Cl, SO_4, Ca, Mg, Na, K, (Flamephotometer and Spectrophotometer), organic carbon (Walkley-Black method), total nitrogen (Keldal system), common phosphorus (Spectrophotometer), heavy metals - chromium, zinc, nickel, copper, lead, cobalt, molybdenum, mercury - (ICP-OES).

Table 14. Equipment to be used by BEU.

№	Lab Equipments	Research Topics	
1	**T85 UV/Vis Spectrophotometer** - Tungsten Lamp & -Deuterium Lamp	Research topic 1	Research topic 2
2	**Digital Flame Photometer /FP910** -FP910 Touch Station-Pro data collection software -Standard Solutions for Flame Photometer FP910-5 -Recommended Spares and Accessories	Research topic 1	Research topic 2
3	**Automatic Kjeldal Analyzer System** -K1100F Automatic Kjeldal Analyzer -SH420F Programmable Kjeldahl digester with suction hood -S402 Kjeldahl Digester's scrubber with pump	Research topic 1	Research topic 2
4	**Fume hood laboratory SHVL-05.3** -Externally controlled flammable gas valve	Research topic 1	Research topic 2

5	**Orbital shaker, Standard 3500, EU-plug** -Stainless steel Erlenmeyer flask clamps 50 ml -Stainless steel Erlenmeyer flask clamps 125 ml -Stainless steel Erlenmeyer flask clamps 250 ml -Stainless steel Erlenmeyer flask clamps 500 ml -Flask clamps, stainless steel 1000 ml	Research topic 1	Research topic 2
6	**Digital burettes, Titrette Volume10 ml Accuracy±0,10 %** Division0,001 ml Imprecision Digital burettes, Titrette Volume 25 ml Accuracy ±0,07 % Division 0,001 ml Imprecision Digital burettes, Titrette Volume 50 ml Accuracy±0,06 % Division 0,002 ml Imprecision Laboratory bottles, round, amber	Research topic 1	Research topic 2
7	**Electric bidistiller BE-2**	Research topic 1	Research topic 2
8	**Vortex mixer, VV3 , EU-plug**	Research topic 1	Research topic 2
9	**Analytical balance LA214i -C**	Research topic 1	Research topic 2
10	**pH/mV/°C meters, handheld, pH 3310 pH 3310 set SenTix® 41**	Research topic 1	Research topic 2

2.3.6. External collaboration

BEU will collaborate with below listed organizations for successfully implementation "Bio-remediation of contaminated surface soils in Absheron Peninsula":

- "BP. AAS-EKOL" Limited Company;
- "LEAN Consulting" Company;
- Relevant resident companies of Sumgait Chemical Industrial Park (https://scip.az/en/page/rezidentler).

2.3.7. Expected results

Implementation of drill cuttings bioremediation work is to treat hydrocarbon substances contained in them and reduce their toxicity.

As a result of the analysis, determine impacts on the ecological condition of the environment and relevant bioremediation method will be proposed for the research area.

2.4.Work plan 2 - Baku Engineering University (BEU).

Research topic: Determine impacts of morphogenetic features of oil contaminated soil and re-cultivation methods in Absheron Peninsula.

Coordinator of the research: PhD Yusif Abdullyev, PhD candidate Etibar Gahramanov.

2.4.1. Introduction

The main purpose of this research is determine the impacts of oil pollution on soil morpho-genetic indicators in the Absheron Peninsula. In this regard, soil samples will be taken in the research area (oil pollution lands and crude lands) in the Absheron Peninsula. The soil samples will be analyzed in the laboratory and the soil pH, hygroscopic moisture, humus, nitrogen, phosphorus, potassium, volume by mass, specific gravity, granulometric composition, etc. will be determined in appropriate ways.

The coordinates of the research area will be determined via GPS and it will be maps of the area in GIS software basis on this coordinates. After the selection of the case study area, plots of land are made from case study areas (crude land, lightly polluted and heavily polluted) for studying the morphological properties of the soils. The plots are drilled to a depth of 1.5 m and samples are taken at intervals of 0-0.25 m, 0.25-0.50 m, 1.0-1.25 m, and 1.25-1.50 m.

2.4.2. Project objectives

The Absheron Peninsula is a historically oil-producing region during 200 years. Lack of advanced oil production technology in this period, non-compliance with even the simplest requirements of environmental protection has led to the creation of lands on the peninsula contaminated with oil and oil products. During the extraction of oil, the fertile layer of soils was degraded. As a result, mechanical disturbance of the soil surface, loss of vegetation of fertile lands is observed. These lands are polluted to varying degrees with oil wastes.

2.4.3. Work - plan and staff involved

Table 15: Plans and staff needed in work plan 2 by the BEU.

Research Topics	Staff (academic)	Staff (volunteer students)	Duration	BEU will cooperate with relevant organizations
Determine impacts of morphogenetic features of oil contaminated soil and re-cultivation methods in Absheron Peninsula	**Mr. Ali Ibrahimov**, Assoc. Prof. of Industrial Engineering Department of BEU	**Mr. Tarlan Vahabzade**, PhD. student of Azerbaijan Scientific Research Vegetable Institute	24 months	"Azerbaijan Scientific Research Vegetable Institute" Adviser: **Mr. Eldar Mustafayev**
	Mr. Mammad Huseynov, Teacher of	**Ms. Sara Alizade**, master student of Environmental		"AZGREEN-Engineering and Environmental

	Industrial Engineering Department of BEU	Protection and Efficient Use of Natural Resources of BEU		Services" Adviser: **Mr. Tural Maharramov**

2.4.4. Timetible of research topic 2

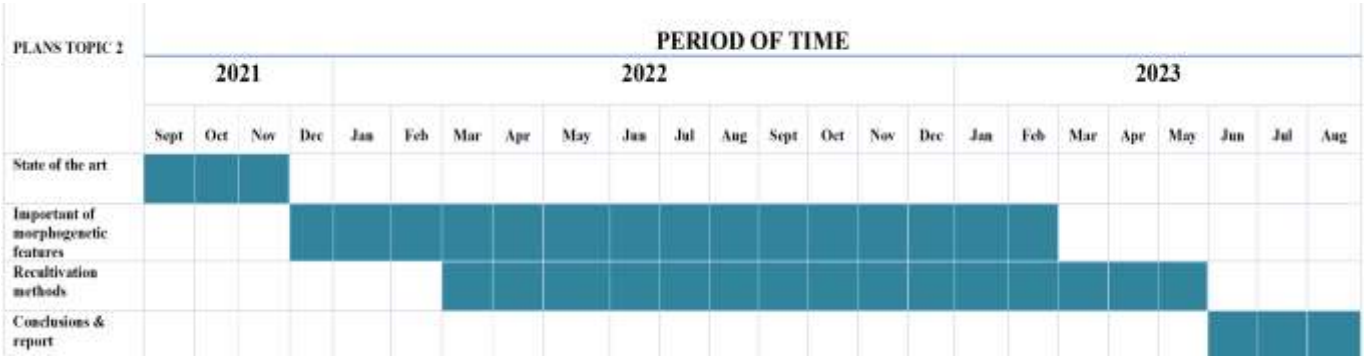

Figure 4. Timetable BEU in ITACA´s project.

2.4.5. Equipment that will be used in each research topic

The Contaminated soil samples will be mixed with distilled water, and under continuous stirring, the resultant soil-water content will be etracted with various organic solvents. Then the organic layer will be separated and dried with sodium sulfate. The resultant organic samples will be analyzed with GC-MS.

Table 16: Equipment to be used by BEU.

№	Lab Equipments	Research Topics	
1	**T85 UV/Vis Spectrophotometer** - Tungsten Lamp & -Deuterium Lamp	Research topic 1	Research topic 2
2	**Digital Flame Photometer /FP910** -FP910 Touch Station-Pro data collection software -Standard Solutions for Flame Photometer FP910-5 -Recommended Spares and Accessories	Research topic 1	Research topic 2
3	**Automatic Kjeldal Analyzer System** -K1100F Automatic Kjeldal Analyzer -SH420F Programmable Kjeldahl digester with suction hood -S402 Kjeldahl Digester's scrubber with pump	Research topic 1	Research topic 2
4	**Fume hood laboratory SHVL-05.3** -Externally controlled flammable gas valve	Research topic 1	Research topic 2

5	**Orbital shaker, Standard 3500, EU-plug** -Stainless steel Erlenmeyer flask clamps 50 ml -Stainless steel Erlenmeyer flask clamps 125 ml -Stainless steel Erlenmeyer flask clamps 250 ml -Stainless steel Erlenmeyer flask clamps 500 ml -Flask clamps, stainless steel 1000 ml	Research topic 1	Research topic 2
6	**Digital burettes, Titrette Volume10 ml Accuracy±0,10 %** Division0,001 ml Imprecision Digital burettes, Titrette Volume 25 ml Accuracy ±0,07 % Division 0,001 ml Imprecision Digital burettes, Titrette Volume 50 ml Accuracy±0,06 % Division 0,002 ml Imprecision Laboratory bottles, round, amber	Research topic 1	Research topic 2
7	**Electric bidistiller BE-2**	Research topic 1	Research topic 2
8	**Vortex mixer, VV3 , EU-plug**	Research topic 1	Research topic 2
9	**Analytical balance LA214i -C**	Research topic 1	Research topic 2
10	**pH/mV/°C meters, handheld, pH 3310 pH 3310 set SenTix® 41**	Research topic 1	Research topic 2

2.4.6. External collaboration

BEU will collaborate with below listed organizations for successfully implementation “Determine impacts of morphogenetic features of oil contaminated soil and re-cultivation methods in Absheron Peninsula”:

- Azerbaijan Scientific Research Vegetable Institute;
- AZGREEN-Engineering and Environmental Services;
- Relevant resident companies of Sumgait Chemical Industrial Park (https://scip.az/en/page/rezidentler).

2.4.7. Expected results

The agrochemical and agrophysical properties of oil-contaminated soils in the case study areas located on the Absheron Peninsula will be studied (the results will be compared with crude soils).

As a result of the analysis, the morphological features and ecological characteristics of oil-contaminated soils will be studied and treatment technologies will be proposed for the relevant research area.

The GC-MS analysis of the samples will deliver the following outcomes: The soil organic content, e.g., macromolecular aromatic hydrocarbons, phenol derivatives, and long-chain saturated hydrocarbons mass spectra will be analyzed in detail. The obtained M+ signals and fragmentation pattern will support us in determining the organic soil contaminant at the molecular/structural level. We believe the research will throw light to develop a proper remediation procedure for the specific land that is taken as a target. The research will also give us valuable data to publish research papers.

2.5. Work plan 1 – Azerbaijan University of Architecture and Construction (AZUAC).

Research topic: Produced wastewater polluted with oil and gas extraction process products; Polluted with organic compounds-BTEX.

Coordinator of the research: Fegan Aliyev; Seynura Hasanova.

2.5.1. Introduction

Experience in the development of oil and gas and gas condensate fields has shown that in the process of formation of oil and gas and gas condensate fields in the sedimentary rocks of the subsoil, along with the accumulation of oil, gas and gas condensate in productive strata, water accumulation fields are formed. These water assemblies are called produced water of oil and gas and gas condensate fields. During the operation of production wells, produced water in various ways leads to the irrigation of the influential product in them, a decrease in hydrocarbon production and a decrease in the technical and economic performance of the field compared to the project.

Chemical analysis of produced water of Absheron oil fields was first performed and interpreted in 1874 by B. Eichler. In 1875, researcher Hent found that Na and Cl in the formation waters of oil fields the ratio of ions is less than one.

The following ions are mainly observed in the produced waters of hydrocarbon deposits:
Positively charged ions (cations) H^+; Na^+; K^+; Mn^{2+} ; Mg^{2+} ; Ca^{2+} ; Fe^{2+} ; and so on.
Negatively charged ions (anions) - OH^-; Cl^-; SO_4^{2-}; HCO^{3-} ; SiO_2^{2-} ; PO_4^{3-} and so on.

Produced waters are characterized by a high content of salt and oil that render necessary to device a specific treatment train in order to decontaminate them, as for example with respect to a municipal wastewater. Typically, produced water contains high

concentrations of aromatic hydrocarbons e.g. BTEX (benzene, toluene, ethylbenzene, xylene), NPD (naphthalene, phenanthrene e dibenzothiophene) and PAH (polycyclic aromatic compounds), minerals, radioactive substances, dissolved gases, scale products, waxes, microorganisms and dissolved oxygen.

Their presence in water can create a hazard to public health and the environment. One of most common sources for BTEX-contamination of soil and groundwater are spills involving the release of petroleum products such as gasoline, diesel fuel and lubricating and heating oil from leaking oil tanks. Because of their polarity and very soluble characteristics, the organic chemicals (BTEX) of petroleum products will be able to enter the soil and groundwater systems and cause serious pollution problems. In present study, we report about the BTEX contaminant and their characteristics and also try to provide information on what BTEX s are, why they are a risk to human and environment and how they might be removed through bioremediation from the contaminated site.

The BTEX group of contaminants consists of benzene, ethylbenzene, toluene and three isomers of xylene.

Table 17: The physical-chemical properties of BTEX.

PARAMETERS	**BENZENE**	**TOLUENE**	**ETHYLBENZENE**	**XYLENES**
Formula	C6H6	C6H5CH3	C6H5CH2CH3	C6H4(CH3)2
Molar weight	78.12	92.15	106.18	106.18
Density	0.8765	0.8669	0.8670	0.8685
Polarity	N.polar	N.polar	N.polar	N.polar
Solubility	1780	500	150	150
Soil-water partitioning coefficient	97	212	622	570
Henry's law constant	0.55	0.67	0.70	0.80

- Benzene can be found in gasoline and in products such as synthetic rubber, plastics, nylon, insecticides, paints, dyes, resins-glues, furniture wax, detergents and cosmetics. Auto exhaust and industrial emissions account for about 20% of the total nationwide exposure to bencene. Benzene can also be found in cigarette smoke.
- Toluene occurs naturally as a component of many petroleum products. Toluene is used a solvent for paints, coatings, gums, oils and resins.

• Ethylbenzene is used mostly as a gasoline and aviation fuel additive. It may also be present in consumer products such as paints, inks, plastics and pesticides.
• Xylene is a member of the BTEX group of pollutants. Ortho-xylene is the only naturally ocurring form of xylene; The other two forms ar man-made. Xylenes are colorless liquids, used in gasoline and as a solvent in printing, rubber and leather industries.

2.5.2. Project objectives

The main goal of the project is to purify organic matter in the wastewater generated during oil and gas production. The sequence of this process is as follows:

• Initial water sampling and analysis of its composition.
• Selection of methodology to be used in the cleaning process. Research of nanothechnology for the purification process.
• Selection of reagents to be used in the research and production of TIO_2 in nanoscale.
• Determination of the principle of operation of the set-up to be used during the research.
• Analysis of treated water in the final stage and comparison with the initial stage.

2.5.3. Work - plan and staff involved

Table 18: Plans and staff needed in work plan 1 by the AZUAC.

Plans	Staff involved
Literature review	1 professor, 2 experts
Exploration of oil wells of the Absheron Peninsula	2 professors, 2 experts
Supplying materials, equipment and chemicals	1 professors, 2 experts, 1 lab expert, 1 administrative affair
Setup and conducting laboratory experiments	1 professors, 2 experts, 1 lab expert, 2 Technician
Analytical techniques	2 professors, 2 experts, 2 Laboratory equipment operators
Concluding and Reporting	2 professors, 3 experts

2.5.4. Timetable of research topic 1

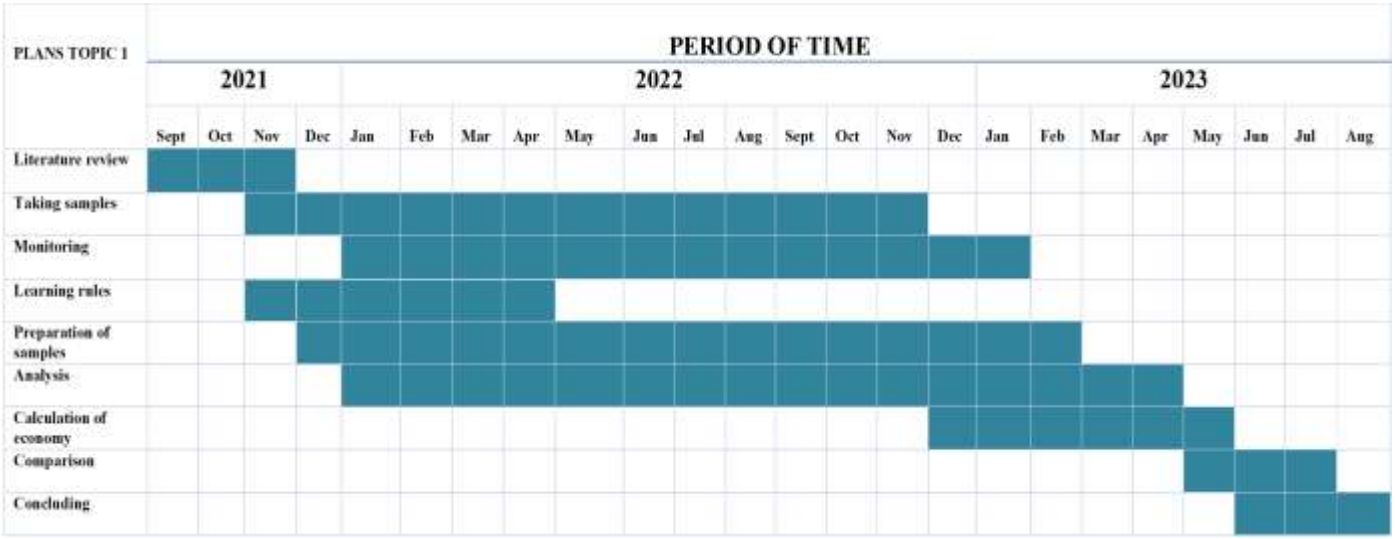

Figure 5. Timetable AZUAK in ITACA´s project.

2.5.5. Equipment

Table 19: Equipment to be used in work plan 1 by the AZUAC.

Equipment name	Application
pH meter	Measuring pH
Conductometer	Measuring conductivity
Thermometer	Measuring Temperature up to 200 ºC
Magnetic stirrer	General purposes
Membrane filtration system	Filtering of purified water
Analytical Balance 0.0001 gr	General purposes
Centrifuge	Separation of very small particles and liquids
Drying Oven	Drying the samples or curing (calcination) with mid temperatures (up to 400 ºC)
SEM	Analysis TiO_2
X-RAY	Analysis TiO_2
Chromatograph	Organic analysis of water
Radiometer dosimeter	Determination of radiation

The gas chromatography and radiommeter dosimeter equipment will be purchased with funds from the ITACA project. The gas chromatography and radiometer equipment will be purchased with funds from the ITACA project. Both equipments are essential for the

analysis of samples in the proposed research topics. Specifically, the gas chromatograph will be used in the determination of organic samples in water samples, while the radiometer will be used for the determination of radioactivity in the different samples. Both teams are therefore essential in the development of the Training Center.

2.5.6. External collaboration

For the development of research topic, there will be the collaboration of the Ecology Department of State Oil Company of Azerbaijan (SOCAR), and International Ecoenergy Academy. Both Institutions will decisively contribute to the advice and monitoring of the activities developed throughout the project. In this sense, the information of the results will be shared, establishing a feedback of advice and exchange of information.

2.5.7. Expected results

At the end of the project, it is expected that wastewater generated during oil and gas production will be treated with organic pollutants using nano-sized substances. It is predicted that the newly synthesized nano TiO_2 can achieve significant results during the purification process. The following results are predicted to be successful:

- Synthesis of 10-20 nm TI $TIO_{2.}$
- Cleaning benzene in the produce water.
- Cleaning toluene in the produce water.
- Cleaning ethylbenzene in the produce water.
- Cleaning xylene in the produce water.

2.5.8. References

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F.A.Huseynov, S.P.Kazimov. Ground water of carbohydrogen deposits and technical and economic indicators of processing. 2008.

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Srijata Mitra and Pranab Roy. BTEX; A Serious Ground-water Contaminant. Research Journal of Environmental Sciences 5 (5); 394-398, 2011.

2.6. Work plan 2 – Azerbaijan University of Architecture and Construction (AZUAC).

Research topic: Caspian-sea polluted by hydrocarbon deposits (methanol, total solids, COD, BOD, etc.

Coordinator of the research: Fegan Aliyev; Seynura Hasanova.

2.6.1. Introduction

Presently, the Republic of Azerbaijan is undergoing a historical period of social, economical and political changes. These reforms are bringing about problems that require immediate solutions. The pivotal point of the reforms taking place in Azerbaijan is the closure of agreements with foreign companies who are contracted for oil exploitation in the Caspian Sea region. The environmental situation in the Caspian Sea is one of great pressure. Some areas have become dead zones, and the Caspian shelf mainly loses its validity as a place for spawning of the Caspian Sea fishes. The sturgeon fishery is a traditional and well-known activity because of the value of the caviar and fish. However, in recent times, there has been a drastic decline in the sturgeon catch. Landings have decreased from around 30,000 tons in 1985 to 13,300 tons in 1990, down to 2,100 tons in 1994. In May 2000 there was a mass loss of seals in Northern and Southern Caspian - about 3000 died. In May 2001 a mass loss of the Caspian sprat was observed. The oil reserves of the Caspian region are huge. There are many estimates made on oil reserves in the Caspian basin. At present it varies from 17 bln. brls up to 250 bln.brls. (2,3-34,1 bln.tons). More than 150 years ago oil was extracted onshore in Azerbaijan. Since the 19th century the caspian sea entered a petroleum era. The first offshore well on the Absheron shelf of the Caspian sea was drilled in 1820. In 1870 the Caspian region attracted strong attention of foreign companies, among which especially the Nobel brothers and Rotshield have become famous. Shell was also among those pioneers. First oil supply to international markets started in 2000.

Table 20: Hydrocarbon resources of the Caspian Sea, mln. tons

Country	The area of the caspian sector, km^2 (%)	Quantity of oil-and-gas-bearing frames	Prognostic resources	Drawn resources	Estimation of crude oil production	Quantity of commercial deposits
Azerbaijan	78(20.7)	137	3600	1600	650	**24-27**
Kazakhstan	113(29.9)	82	3400	1200	500	**1**
Turkmenistan	79(19.2)	65	600	250	100	**5-7**
Russia	64(15.6)	20	400	150	50	**1**
Iran	44(14.6)	43				
Total	**378(100)**	**347**	**8000**	**3200**	**1300-1310**	**30-36**

The wastewater produced from the oilfield is chemically corrosive due to high salinity in combination with high temperatures. It is also rich in oil emulsion, grease, suspended solids, bacterial content, and polymeric content, which could cause serious membrane fouling. The low oil–water density difference and existing of surfactants make the separation of oil from the water difficult. Since large volumes of the produced water are being generated in many countries with oilfields, there are increasingly focused efforts to find efficient and cost-effective treatment methods to remove pollutants. Reuse and recycling of the produced water include underground injection to increase oil production, use for irrigation, livestock or wildlife watering and habitats, and various industrial uses (e.g., dust control, vehicle washing, power plant makeup water, and fire control. Therefore, intensive treatment is required to meet regulations in the wastewater management or for wastewater recycling.

The main aim in treatment of oilfield produced water is to remove hydrocarbon components in terms of the chemical oxygen demand (COD). Oil content of the produced water can be reduced through various physical, chemical, and biological methods. In offshore oil extraction facilities, the compact physical and chemical treatment technologies are preferred, but they are limited due to the high capital cost of physical methods and high treatment cost of hazardous sludge generated from the chemical treatment. Biological treatment is a cost-effective method for removing dissolved and suspended compounds from onshore oilfield wastewater. Several conventional methods have been used to treat the produced water for decades, which include flotation, coagulation, and biological treatment. Both flotation and coagulation are physicochemical methods, and biological treatments utilize anaerobic and aerobic methods to reduced COD and biological oxygen demand. However, current methods cannot remove minute suspended oil and/or hazardous dissolved organic and inorganic component.

Oil and gas operators sometimes inject methanol into pipelines to prevent methane hydrate formation and to dissolve hydrates in producing oil and gas wells, platform and subsea hydrocarbon systems. Hydrate formation inhibits flow within oil and gas pipelines. The primary use of methanol in gas and condensate production is to inhibit the accumulation of hydrate in flowlines containing a mixture of natural gas, waste gases, gas condensate, and formation water (produced water). Prior to discharging of the produced water to surface waters adjacent to the platforms, it generally treated to remove hydrocarbons. Methanol, however, is not completely removed during the treatment process. About 50% of the methanol remains in the discharged produced water, and the rest vaporizes into the gas phase.

2.6.2. Project objectives

The aim of this research project is to equilibrate ecological balance of Caspian Sea and clean polluted from the hydrocarbon by the nanotechnology. The sequence of this process is as follows:

- Using different chemical reagents in order to synthesize nano size chimical.
- Selection of methodology to be used in the cleaning process. Research of nanotechnology for the purification process.
- Selection of reagents to be used in the research and production of TIO_2 in nanoscale. Use of the TIO_2 to remove contaminants.

- SEM and x-ray analysis of produced nano.sized reagents which of the applyed to treatment procedure.
- Determination of the principle of operation of the set-up to be used during the research.
- Analysis of treated water in the final stage and comparison with the initial stage.

2.6.3. Work - plan and staff involved

Table 21: Plans and staff needed in work plan 2 by the AZUAC.

Plans	Staff involved
Literature review	2 professors, 3 experts
Exploration of oil wells of the Absheron Peninsula	2 professors, 2 experts
Supplying materials, equipment and chemicals	1 professors, 2 experts, 1 lab expert, 1 administrative affair
Setup and conducting laboratory experiments	1 professors, 2 experts, 1 lab expert, 2 Technician
Analytical techniques	2 professors, 2 experts, 2 Laboratory equipment operators
Concluding and Reporting	2 professors, 3 experts

Table 22: Staff needed for each process in work plan 2 by the AZUAC.

Staff	Number	Needed for Plans (work plan number)
Professor or faculty member in the field of chemistry and chemical engineering or environmental engineering	2	All process
Expert in Chemistry and Chemical Engineering	2	All process
Laboratory expert	2	3 and 4
Administrative and Business affairs	1	3
Technician for pilot design and commissioning	2	4
Laboratory equipment operators (out of TC)	2	5

2.6.4. Time Table of research Topic 2

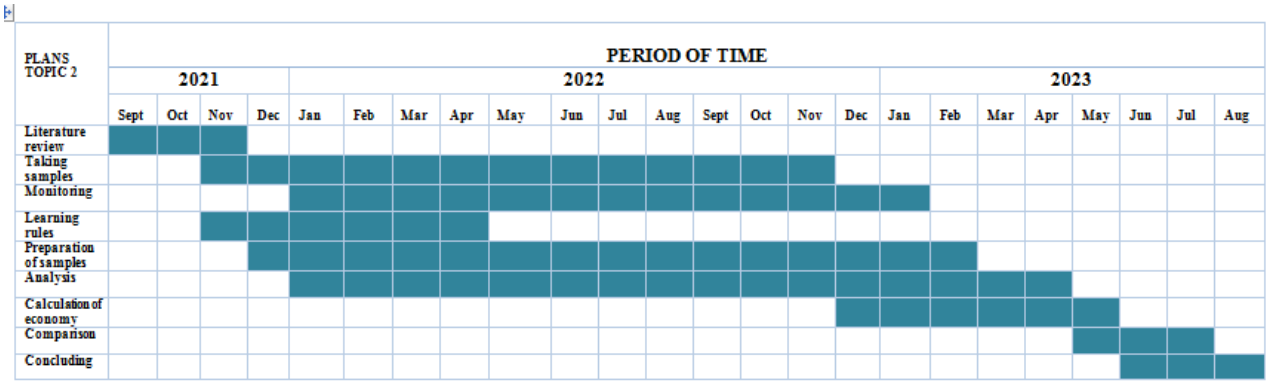

Figure 6. Timetable AZUAK in ITACA´s project.

2.6.5. Equipment

Table 23: Equipment needed in work plan 2 by the AZUAC.

Equipment name	Application
pH meter	Measuring pH
Conductometer	Measuring conductivity
Thermometer	Measuring Temperature up to 200 ºC
Magnetic stirrer	General purposes
Membrane filtration system	Filtering of purified water
Analytical Balance 0.0001 gr	General purposes
Centrifuge	Separation of very small particles and liquids

2.6.6. External collaboration

For the development of research topic, there will be the collaboration of the Ecology Department of State Oil Company of Azerbaijan (SOCAR), and International Ecoenergy Academy. Both Institutions will decisively contribute to the advice and monitoring of the activities developed throughout the project. In this sense, the information of the results will be shared, establishing a feedback of advice and exchange of information.

2.6.7. Expected results

In the end of plan, it is predicted that the content of Methanol, total solids, COD, BOD, will be decreased after applying new nano size reagents. The following results are predicted to be successful:

- Cleaning of Caspian Sea from methanol by applying $TIO_{2.}$
- Cleaning of Caspian Sea from total solid by applying flotation method.
- Cleaning of Caspian Sea from COD by applying $TIO_{2.}$
- Cleaning of Caspian Sea from BOD by applying $TIO_{2.}$

2.6.8. References

F.A.Huseynov, S.P.Kazimov. Ground water of carbohydrogen deposits and technical and economic indicators of processing. 2008.

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National Caspian Action Plan of the Republic of Azerbaijan, 2002.

Xiaodong Dai, Jian Fang, Lei Li, Yan Dong, and Jianhua Zhang. Enhancement of COD removal from oilfield produced wastewater by combination of advanced oxidation, adsorption and ultrafiltration. Int J.Environ Res Public Health. 2019 16(17) 3233.

2.7. Work plan 1 – Baku State University (BSU)

Research topic: Investigation of anthropogenic impact on the Absheron Peninsula and Caspian Sea.

Coordinator of the research: Sevinj Hajiyeva, Flora Hajiyeva and Gunay Valiyeva.

2.7.1. Introduction

Extraction and transportation of oil and gas result to increasing air, soil and sea costal pollutions in Absheron Peninsula and also the emission of greenhouse gas such as methane. Carbon dioxide can also enhance the global gases. It is estimated that fuel production of the Caspian environment will emit about 20-15 million tons of carbon dioxide per year. Crude oil and the steam of the gas field in north Caspian have a very large content of sulfur (Simonett, 2006). Since oil leakage to the sea is inevitable, this problem can threaten fauna and flora inhabiting there. Unlike the Caspian Sea, the oceanic water can let away oil while the Caspian region cannot scatter it (Rodman, 1996). Oil wastes are broadcasted on the sea and reduce the evaporation of surface water and reduce the oxygen exchange of the sea with atmosphere.

The greenhouse gas (GHG) emissions arise from the burning of fuels in internal combustion engines, heaters and flaring of unrecoverable gas. In 2014, BP emitted about 4,067,000 tons of gross GHG, which is almost 29% higher than in 2013. The main reason for this increase was higher volumes of flaring at the West and East Azeri platforms, as well as the start-up of the West Chirag. The NOx emissions increased by 26% compared to 2013 reaching 11,179 tons. This correlates with 19% increase in fuel gas use. There was a similar increase in SOx emissions. This was influenced by a 26% increase in diesel usage due to increased drilling activities and the subsequent higher intensity of logistics operations. Other main contributors to SOx emissions include the Shah Deniz platform and the Sangachal terminal.In 2014, BP in Azerbaijan recorded six oil spills, five of which were fully contained. BP continue formally reporting all material releases of hydrocarbons to the Ministry of Ecology and Natural Resources, as well as to the State Oil Company of the Republic of Azerbaijan. BP operations in Azerbaijan generated a total of 368,839 tons of solid and liquid waste in 2014. The notable increase in the total volume of hazardous waste was caused by a significant amount of produced water sent for treatment and disposal as liquid waste. About 42% of the non-hazardous waste (5,690 tons) and20% of the hazardous waste (63,314 tons) was recycled or reused by our contractors.

To date, many technologies have been used for metal-contaminated sites, such as stabilization, solidification, soil flushing, chemical reduction/oxidation, electrokinetics, low temperature thermal desorption, incineration, excavation/retrieval, disposal and landfill. However, these technologies are typically expensive and destructive. Phytoremediation may be a better option and less perturbing, but can be time consuming and disposal of the metal-contaminated plant material can be problematic. All available options therefore have benefits but also limitations and the need for new methods is pressing.

Recently, nanotechnology has been shown to provide a potentially cheap and effective solution for environmental remediation. Reactive nanomaterials such as nanoscale zeolites, metal oxides, carbon nanotubes, and bimetallic nanoparticles have been used for metal remediation. Iron oxide nanoparticles are widely used for metal remediation due to their low toxicity and easy separation from water media; in addition, where the NP is composed of magnetite, a facile magnetic separation of NPs, along with associated contaminants, can be performed.

Within the framework of the ITACA project, we are planning to purify oil-contaminated areas from heavy metals using magnetic nanoparticles, bimetallic nanoparticles and other types of catalytic nanoparticles. At the Department of Chemical Physics of Nanomaterials of Baku State University magnetic nanoparticles will be synthesized and stabilized, soil samples taken from the oil-contaminated area of Absheron Peninsula will be prepared, control works will be carried out to remove heavy metals in samples using nanoparticles, etc.

During the year, 9,745 tones of cuttings were injected into re-injection wells at the Azeri-ChiragDeepwater Gunashli (ACG) field. The remaining 31,252 tones of cuttings (8% more than in 2013) were delivered to Serenja hazardous waste management facility. In 2014, there was a further reduction (from 21 to 12) of sewage treatment plant outages that result in untreated sewage releases offshore. However, the volume released increased by 5% from 195m3 to 204m3. At the Sangachal terminal, monitoring results of treated sewage showed compliance with all required parameters throughout the year. Along the export pipelines, an issue with elevated fecal coliforms parameter at the reed beds continued in 2014. A special monitoring was initiated to assess water quality across the reed beds area. Produced water volumes at the ACG field continue to rise. A total of 5,263,662 tones from ACG were separated at the Sangachal terminal in 2014. This represents an 18.5% annual increase. After treatment, 5,077,256 tones were exported back offshore for re-injection (M.M.Ramazanov, İ.S.Ahmadov, et al.,2018).

2.7.2. Project objectives

In order to research the ecological situation of the Absheron Peninsula and the Caspian Sea, it is necessary to analyze the soil, water and bottom sediments. Human impacts on the environment negatively affect the state of soil and sea water. Soil pollution by oil production wastes leads to such adverse effects as disappearance of necessary minerals, microelements and, especially, humus. Oil hydrocarbons are considered hazardous pollutants and lead to degradation of ecosystems, therefore, it is necessary to conduct a detailed analysis to identify them. Spillages of oil onto the ground surface have the potential to create serious problems in terms of both soil and groundwater contamination. Lighter oil fractions penetrate into the deep layers of soil, while heavier and more toxic hydrocarbons remain on the surface.

2.7.3. Work - plan and staff involved

Table 24: Plans and Staff needed in work plan 1 by the BSU.

Plans	Staff involved
Literature review	2 professors, 1 experts
Measurements of air pollutants to control the atmosphere quality on the Absheron Peninsula	2 professors, 1 experts
Monitoring of Contaminants in Seawater of Caspian Sea	2 professors, 1 experts, 1 administrative affair
Soil analysis in the Absheron Peninsula and Bottom sediments analysis of the Caspian Sea	2 professors,1 experts, 1 Technician
Application of nanotechnology for removal of heavy metals in oil-contaminated areas in the Absheron Peninsula.	2 professors,1 experts, 1 Technician
Concluding and Reporting	2 professors, 1 experts

Table 25. Staff needed in wor plan 1 by the BSU in ITACA´s project.

Staff Academic
Professor Sevinj Hajiyeva
Assistant professor Flora Haijeva
Expert - MS, Gunay Veliyeva

2.7.4. Timetable of research Topic 1

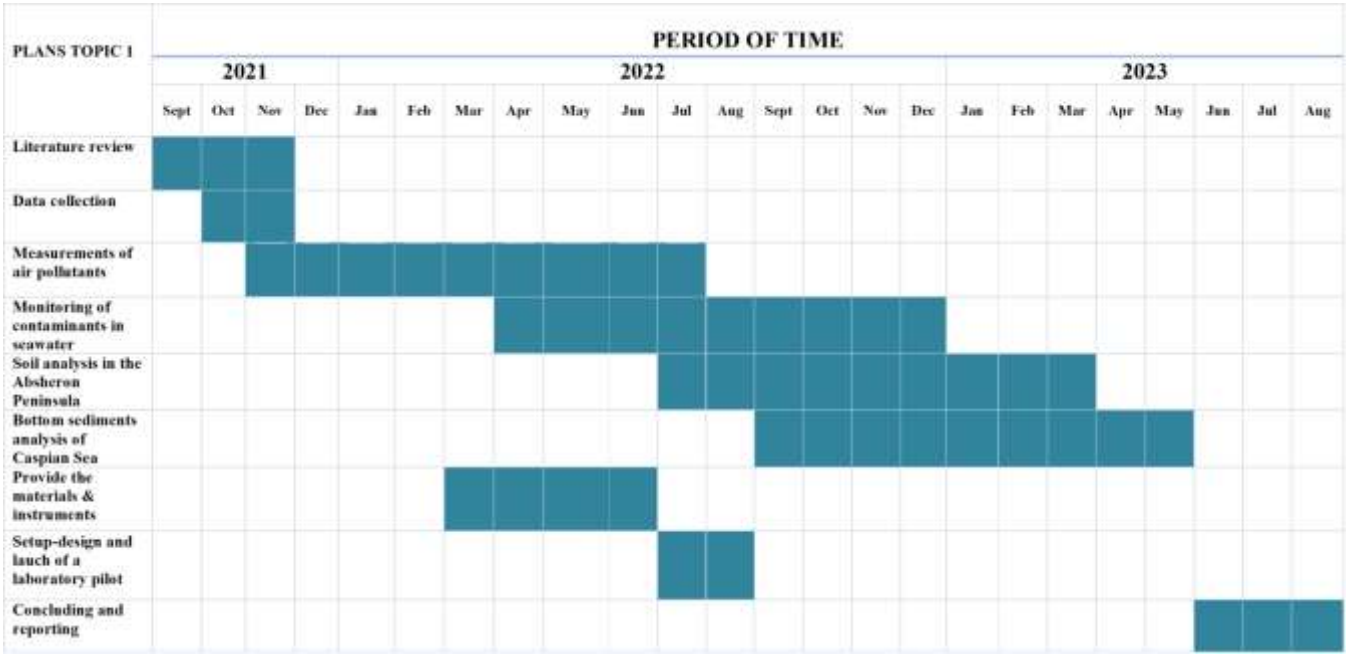

Figure 7. Timetable BSU in ITACA´s project**.**

2.7.5. Equipment

Table 26: Equipment to be used by the BSU.

Equipment name	Application
Analytik Jena MULTI N/C 3100, including AS vario ER autosampler , Sample rack 47 positions, HT 1300 solids combustion module , Consumables kit , Preventive maintenance kit , Consumables Set for HT 1300 and multi N/C duo systems, installation and 1 year warranty	Water, soil, air analysis
Spektrofotometer, Hach Lange DR3900	To move along the selected routes
SPECORD210 including software and cells	Mark contaminated areas
KNF N 840.3 FT.18	Sample analysis
Automatic titrator	for wtaer samples
Analytical Balance	General purposes
Centrifuge 5430	Separation of pollutants
Vacuum oven	Drying the samples
Ultrasound Cleaner GSONICA -Q700	For the clean of micro particles
Оксиметр Milwaukee	air analysis
Solaxx Salt Dip analoqu- ST10S	Soil analysis
pH/C meter	Measurement of pH
PCS 1 950.00 950.00 Bi -distiller: SC	For the chemical reactions

2.7.6. External collaboration

For the development of research topic, there will be the collaboration of the Institute of Petrochemical Processes of the National Academy of Sciences of Azerbaijan, Ministry of Ecology and Natural Resources, the Ecology Department of State Oil Company of Azerbaijan (SOCAR), Eological department of BP and Relevant foreign companies operating in Absheron and the Caspian Sea. Collabarated Institutions with in this project will help in analysis of oil contaminents in soil, water and decisively contribute to the

advice and monitoring of the contaminents in Absheron and Caspian Sea. In this sense, the information of the results will be shared.

2.7.7. Expected results

The oil-contaminated samples will be taken from 10 selected routes and 11 points of littoral areas and analyzed by using physicochemical methods. The level of pollution and nature of these territories will be established. The presence of such contaminants as phenols, polyaromatic hydrocarbons, surfactants can be determined by using chromatographic and spectrophotometric methods of analysis.

2.7.8. References

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2.8. Work plan 2 – Baku State University (BSU)

Research topic: Ecological changes of the Absheron Peninsula and the Caspean Sea.

Coordinator of the research: Ismet Ahmadov, Habiba Shirinova and Almara Rahimli.

2.8.1. Introduction

The capital – Baku city and a number of densely populated surrounding areas of Azerbaijan Republic are located in the Absheron Peninsula and occupy more than 222 thousand hectares (ha). Approximately 40% of the country's population and 70% of the industrial potential of the Azerbaijan is concentrated in the Absheron peninsula and most of the ecological problems exist in this area are caused by this fact.Absheron Peninsula is rich with the oil and gas resources and since ancient times the minerals are extracted in these places. In 1901-1905, half of the total volume of oil in the world was extracted in Absheron. In 1940-1945, during the Second World War 70.1% of all oil in the former Soviet Union wasextracted in Azerbaijan. The long history of oil exploration

has left the country with a massive legacy of oil and other chemical pollution, both land-based and offshore. Now in the territories of Absheron Peninsula are located: thousands of running and abandoned oil wells; more than 3200 hectares of territories polluted by oil products and residual waters; the area of 3325 hectares including more than 200 small and big lakes the natural resources (salt, fishes etc.) of which are widely used by population.Main environmetal problems of the Absheron Peninsula is contamination of land by oil and layer waters during oil-gas extraction, formation of artificial lakes, accumulation of wastes, bad sewage systems. Absheron Peninsula and The Caspian Sea are under constant threat of pollution because the major industries and oil production, refining and transportation are located in these areas.The basic pollution sources of the Absheron Peninsula are the slops of the capital city Baku which has many different industrial objects, transport communication resources and urban transport, refineries and onshore and offshore exploitation of oil and gas wells. The increased density of anthropogenic load capacity in the Absheron industrial region based on energy consumption is more than 32–45 times higher than the normal level. The index of sustainable development is more than 33 times higher than the allowable value. Over 3 million tone of gum brine containing up to 25% of oil and 170000 tone of acid sludge have been disposed at the territory of the Baku Oil Processing Plant (Ismaylov et al. 2015). Currently, in Absheron Peninsula transport is considered to be the main source of air pollution, responsible for increase in NOx, organic chemical, and CO emissions. There is stationary sources of atmospheric pollution such as the release of associated gases by power plants, burning of untreated garbage; oil refineries, and factories in Sumgait. In Baku, emission of industrial pollutant unrelated to oil industry is relatively small with exception of releases of chlorofluorides from air conditioners; refrigeration industries; and cement production (Essays UK, 2013).At present, oil production, chemical and mineral resources extraction and processing, power plants, and hospitals are the major generators of solid and hazardous wastes. Absheron Peninsula soil is known for having them most acute oil degradation with more that 10,000 hectares of land heavily contaminated. Copper, lead and zinc mines are the main sources of heavy-metal soil pollution. Steel plants produce dust containing 15-30% zinc, 3-5% lead, 0,1% cadmium. (Vandergraaf et al., 2011). In some areas of Baku average concentrations of zinc in soils are up to 50-60 times the acceptable levels.

2.8.2. Project objectives

The aim of this research project is to identification and mapping of oil-contaminated sites will selected ten routes including suspected contaminated areas on the Absheron Peninsula and 11 point of littoral areas of Caspian Sea. The routes are along established roads and the sites are locations of past or current industrial activity and will selected on the basis of their economic and commercial importance to Azerbaijan. Once the routes have been identified, the sampling sites will be marked on a map of the Absheron Peninsula. The total length of the routes will be about 500 km. Samples will be taken from highly polluted areas along selected routes.

The sequence of this process is as follows:

1. Identification and mapping of oil-contaminated areas in the Absheron Peninsula.
2. Characteristics of oil pollution in the Azerbaijani part of the Caspian Sea
3. Determination of oil pollution in the Caspian littoral areas

2.8.3. Work - plan and staff involved

Table 27: Plans and staff needed in work plan by the BSU.

Plans	Staff involved
Literature review	1 professors, 2 experts
Identification and mapping of oil-contaminated areas in the Absheron Peninsula.	1 professors, 2 experts
Characteristics of oil pollution in the Azerbaijani part of the Caspian Sea	1 professors, 2 experts, 1 administrative affair
Determination of oil pollution in the Caspian littoral areas	1 professors, 2 experts, 2 Technician
Concluding and Reporting	1 professors, 2 experts

Table 28. Staff needed in wor plan 2 by the BSU in ITACA´s project.

Staff Academic
Professor Ismet Ahmadov
Assistant professor Habiba Shirinova
Expert - MS, Almara Rahimli

2.8.4. Timetable of research Topic 2

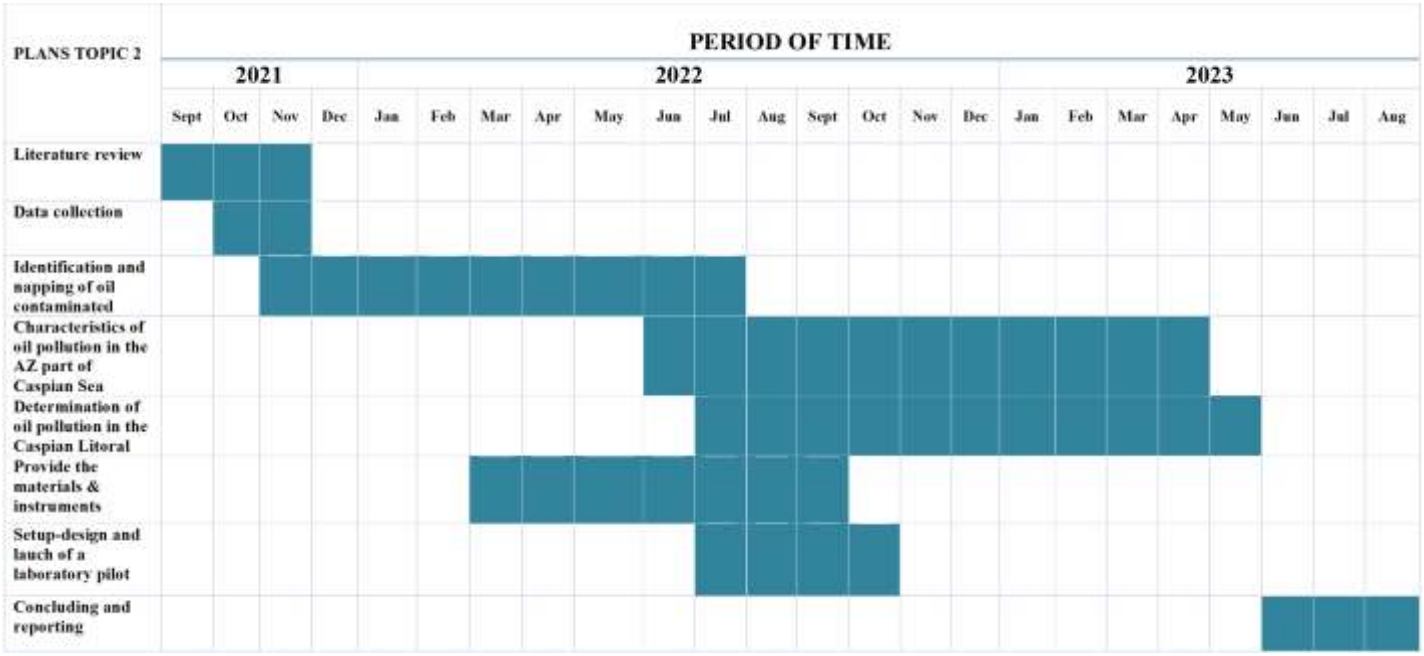

Figure 8. Timetable BSU in ITACA´s project**.**

2.8.5. Equipment

Table 29: Equipment to be used by the BSU.

Equipment name	Application
eTREX Legend CX GPS	The determination of coordinates and the locations of contaminated areas
Vehicles	To move along the selected routes
Map of the territory of Absheron	Mark contaminated areas
Containers	for water samples
Containers	for soilr samples
Analytical Balance	General purposes
Centrifuge	Separation of pollutants
Drying Oven	Drying the samples
Оксиметр Milwaukee	air analysis
Solaxx Salt Dip analoqu- ST10S	Soil analysis

2.8.6. External collaboration

For the development of research topic, there will be the collaboration of the Ministry of Ecology and Natural Resources, the Ecology Department of State Oil Company of Azerbaijan (SOCAR), and Relevant foreign companies operating in Absheron and the Caspian Sea. Collabarated Institutions with in this project will help in determination the contaminent areas, and decisively contribute to the advice and monitoring of the sits in Absheron and Caspian Sea. In this sense, the information of the results will be shared.

2.8.7. Expected results

As a result, the exact location of the regions of the Absheron peninsula most polluted with oil and oil products will be determined and a map will be drawn up. If necessary, the map will be a sampling tool. A map of the most polluted areas of the Caspian Sea coast will also be prepared.

2.8.8. References

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