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Numerical modeling of oil pollution

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ABSTRACT: *Oil Transporting is a frendly environmental activity. But environmental stress and human accident activity introduce oil pollution in the environment area. Water and beach soil is another natural resources and rehabilitation of oil pollution si very dificulties. Oil pollution has a catastrophic effect on marine and soil life, the rehabilitation of the affected environment being long lasting and involving high costs. This paper presenting a model to the risk assement and vulnerabilty Blac Sea Area to oil spill pollution.*

KEYWORDS *– oil, pollution, risk assessment, water*

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I. INTRODUCTION

Given that a quantity of about 2.5 million barrels of petroleum products is transported daily in the Black Sea region [1], and forecasts estimate that this quantity will be maintained in the next 10 years, Romania is one of the countries that has recognized increasing the potential risk of accidental spills of petroleum products.

That is why knowing the vulnerability index of the coast to the action of oil pollution is a desideratum of those who simulate the loss of oil products and accidents with spills of oil products on land and at sea.

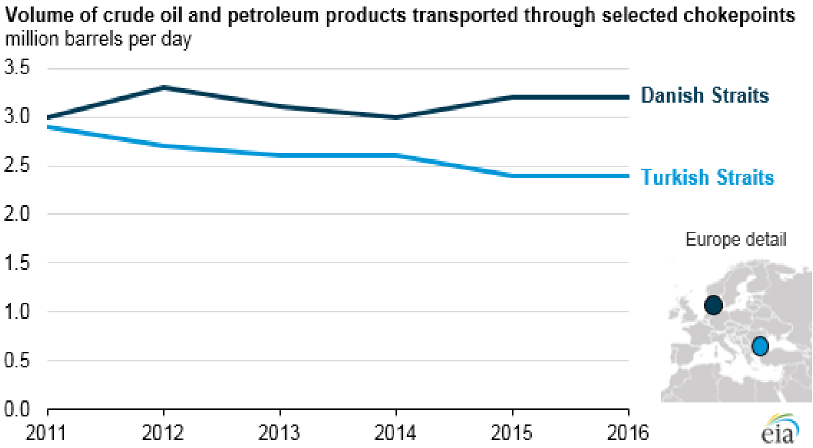

Fig.1. The volume of oil transported through the Danish and Turkish Straints [1]

Finding a working scheme for determining the risk coefficient is subjective and this material offers a personal view on assessing the risk of pollution and the vulnerability of the Romanian coast.

II.RISK ASSESSMENT

There are a finite number of ways in which the coast can be contaminated with petroleum products.

These "modes" of damage must be identified and classified [2].

The questions "what could go wrong" and "how likely is pollution" are answered by analyzing the system.

In this risk model the causes of pollution can be grouped into four categories[3]:

-accidental on-shore oil pollution.

-accidental offshore oil pollution.

-pollutions due to the population in the studied area.

-pollutions due to economic activities in the area.

Within each of these categories any possible element of risk is quantified.

That is why every element in the risk index is "an element of risk". This is either an existing condition or a risk-related activity.

The classifications are based on the amplitude of the contribution of the elements, either positive or negative to the risk picture. Items that have a high risk tangency are classified as having a high risk factor. Figure 2 gives the logical scheme of the proposed risk assessment model.

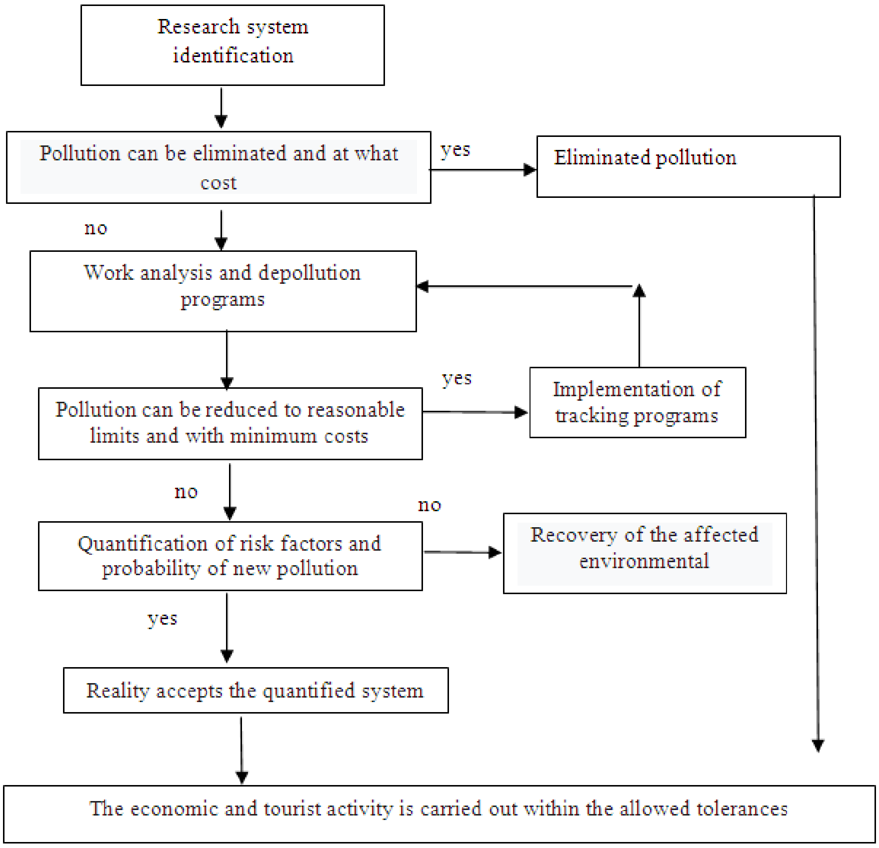

Fig.2. Scheme for determining the risk coefficients

Table 1. Assessing the risk of a site to the possibility of on-shore pollution

Nr.	Item name	scores	%
1.	Existence in the area of oil pipelines	0-20	20
2.	Existence in the area of the rutes of oil supply	0-20	20
3.	Educating the public about the tasks that arise in the event of pollution	0-20	20
4.	Advertising regarding the location of oil transport routes	0-15	15
5.	Compliance with the conditions imposed by the standards in force	0-15	15
6.	Patrol frequency for the observation of possible pollution	0-10	10

Table 2. Assessing the risk of a site to the possibility of of-shore pollution

Nr.	Item name	scores	%
1.	Existence in the area of oil pipelines	0-20	20
2.	Existence in the area of the rutes of oil supply	0-20	20
3.	Educating the public about the tasks that arise in the event of pollution	0-20	20
4.	Advertising regarding the location of oil transport routes	0-15	15
5.	Compliance with the conditions imposed by the standards in force	0-15	15
6.	Patrol frequency for the observation of possible pollution	0-5	5
7.	Ways of communicating pollution due to naval accidents, international collaboration	0-5	5

Table 3. Assessing the risk of a site to the possibility of pollution due to human activity

Nr.	Item name	scores	%
1.	Ways of use and storage of petroleum products by the population and quantities used	0-50	50
2.	Educating the public on the tasks involved in the event of pollution	0-25	25
3.	Compliance with the conditions imposed by the standards in force	0-25	25

Table 4. Assessing the risk of a site to the possibility of pollution due to industrial activity

Nr.	Item name	scores	%
1.	Ways of use and storage of petroleum products by the population and quantities used	0-20	20
2.	Compliance with the conditions imposed by the standards in force	0-10	10
3.	Design of installations and identification of causes that could cause damage	0-10	10
4.	Construction a. Inspection of materials used b.Materials used	0-20	20
5.	Operating a. Existence of procedures b. The existence of automation and control elements c. Anti-alcohol tests d. Work safety program e .Operation inspection f. Preparation of operators g. Prevention of operating errors	0-20	20
6.	Maintenance a.Documentation b.Procedures c. Work programs	0-20	20

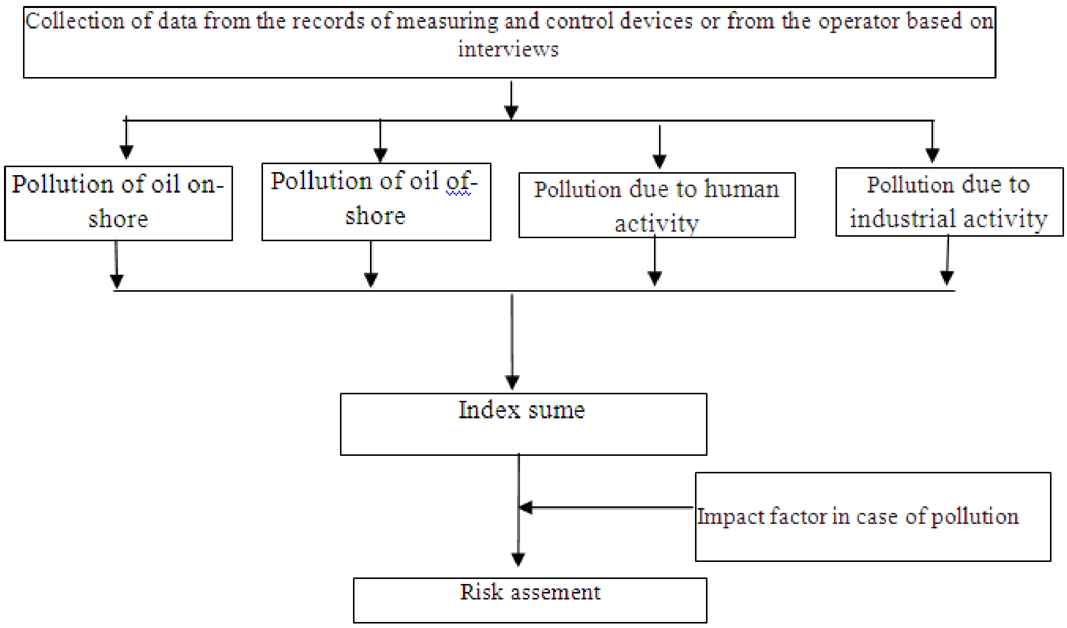

Fig. 3. Logical scheme of the evaluation model

Table 5. Physical processes that act on the oil product stain

Nr.	Phenomenon	Action time in combination with other processes	Action time without other processes
1.	Evaporation	100 hours	10.000 hours
2.	Biodegradation	-	10.000 hours
3.	Dispersion	10 hours	100 hours
4.	Emulsification	10 hours	10.000 hours
5.	Deposition of the botton	100 hours	10.000 hours
6.	Photo-oxidation	1000 hours	-
7.	Dispersal	100 hours	-
8.	Floating	-	10.000 hours
9.	Dissolution	1 hour	10 hours

III.RISK CALCULATION

The risk calculation will be done by summing the scores resulting from the addition of the coefficients in tables 1,2,3,4 and figure 3.

The impact factor in the event of a breakdown is also added.

Impact factor in case of damage

a. Accidents caused by the polluting fluid

-acute 0-20 points,

-chronic 0-10 points.

b. Fluid dispersion in the populated area

-loss or gaseous product losses 0-6,

-population density in the area 0-4.

As can be seen, risk management does not necessarily mean cost management.

Smart spending is needed to reduce operational risk.

The final risk classification can have values between 1 (the case of a site located in the central area of the Danube Delta - with controlled human access) or 400 points (the industrial area of Refinery).

IV.NUMERICAL MODELING OF PETROLEUM POLLUTION

In oil pollution of marine waters there are a number of known processes (dispersion, biodegradation, evaporation, emulsification) that will change the characteristics and behavior of the stain.

As data for modeling are required;

- quantity discharged (tonnes) Q discharged,
-time elapsed since the date of the accident (hours),
-thickness of pollutant stain H pollutant (cm),
- volatile fractions of pollutant F (% of total quantity),
- pollutant density (gm / cc),
-kinematic viscosity of water (cP),
-kinematic viscosity of the pollutant (cP),
-water temperature °C.

Calculation example

Crude oil: density 0.875 viscosity 10 cSt.

a. The evaporated quantity is given by the formula:

Qevaporated = Q spilled * F / 100 (tons)

b. Quantity of crude oil remaining on water:

Qramas on water = Qdeversat-Qevaporat (tons)

c. Infestation area (sqm):

A = Qramas on water * 100 / H pollutant

d. The volume of crude oil left on the water (m^3):

Vtitei left on water = Qramas on water * Density

e. The amount dispersed in the water is 20% of the total amount of crude oil remaining on the water.

f. The speed of the film is equal to:

Voil films = Vwind + Vcurrent * 0,3 (coefficient of attenuation of the current).

g. Oil-in-water emulsion (depending on wind, currents and oil viscosity) (Table 6).

h. The amount of crude oil left to reach the shore

Q = The volume of crude oil left on the water-the crude oil dispersed in the water

i. probable date of arrival of the film on the shore:

Date (s) = distance from the shore where the accident / speed of the film took place

j. The amount of fish destroyed is considered to be the ratio between the density of fish in the polluted area and the polluted area.

It is estimated that 20% of fish die from oil asphyxiation.

k.The amount of green mass destroyed (mollusks, seagrass, oysters, etc.) is considered to be the ratio between *the density of green mass in the polluted area and the polluted area.*

This natural resource is considered to be 100% destroyed.

Table 6. Crude oil emulsification rate in water

	Low viscosity	Medium viscosity	Hight viscosity
Lower currents that 1 m/s	2	3	5
Equal currents whith 1 m/s	4	6	10
Greater currents that 1 m/s	6	9	15

Table 7. Dispersion of the petroleum product on water without wind and current

	Duration of discharge	The amount discharges 5 kg	The amount discharges 50 kg	The amount discharges 500 kg	The amount discharges 5000 kg	The amount discharges 50000 kg
Infested area kmp	1h	0.006	0.016	0.076	0.360	1.14
	2 h	0.016	0.023	0.107	0.496	2.28
	5 h	0,065	0,065	0,169	0,784	3,64
	10 h	0,183	0,183	0,24	1,11	5,15
	24 h		0,518	0,68	1,72	7,98
	48 h			1,93	2,43	11,3

	72 h 96 h 500 h			3,54 5,45 64,8	3,54 5,45 64,8	13,8 15,6 64,8
Film thickness mm	1h 2 h 5 h 10 h 24 h 48 h 72 h 96 h 500 h	0,980 0,348 0,088 0,031	3,6 2,5 0,9 0,3 0,1	7,5 5,3 3,4 2,4 0,84 0,30 0,16 0,105 0,009	15,8 11,5 7,0 5,1 3,3 2,4 1,6 1,05 0,09	50,1 25,1 15,7 11,1 7,2 5,1 4,1 3,6 0.9

V.CONCLUSIONS

In table 7 we calculated the infestation area according to the quantity of petroleum product.
It is observed that we can reach 64 kmp if we do not intervene in time (drain 500 h, 50 tons discharged and film thickness of 0.9 mm
Analyzing the coastal areas, the following can be observed:
- ports are high risk areas;
-the area between the port of refinery is at high risk;
-the area between ecologically protected area, has the lowest risk of hydrocarbon pollution, the currents helping the oil films to move away from the shore.
Thus, pollution in the area would lead to difficulties in restoring the affected environment, the area being difficult in infrastructure.
-the Romanian coast is an area with moderate risk, but with maximum effect both media and human.
-this material shows both a risk assessment and a simulation of accidental pollution.

REFERENCES

[1]. The Danish and Turkish Straits are critical to Europe's crude oil and petroleum trade, https://www.eia.gov/todayinenergy/detail.php?id=32552,

[2]. T.Chis, Risk Assement in Oil Industry, International Conference Oil and Environment, Ploiesti, Romania, 3-5.06.1999,

[3]. S. Petrache, Cr. Jugastreanu, T.Chis, Modeling of separation processes and chemical removal of paraffin, International Journal of Scientific & Engineering Research, Volume 12, Issue 7, July-2021, ISSN 2229-5518,

[4]. M.Petrache, Cr. Jugastreanu, T. Chis, Oil pollution of groundwater in Dobruja Area, Quest Journals Journal of Research in Environmental and Earth Sciences Volume 7, Issue 7 (2021) pp: 50-61 ISSN(Online) :2348-2532 www.questjournals.org,

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