



OIL SPILL ANALYSIS IN SÃO SEBASTIÃO CHANNEL- SÃO PAULO (SP) BRAZIL, FROM 1974 TO 1994

Iris R.F. POFFO, Carmen L. MIDAGLIA, Sueli R. HEITZMANN, Nelson CAETANO, Renato F. CANTÃO, Sergio L. POMPEIA, Geraldo G. EYSINK & Akira NAKASAKI

CETESB - Environmental Agency of São Paulo

Av. Prof. Frederico Hermann Jr, 345 - CEP : 05489-900- São Paulo (SP) - Brazil.

INTRODUCTION

The majority of the oil spills on the Brazilian shoreline occur in the southern region where there is the most important of the eight Maritime Petroleum Terminals, the PETROBRÁS (Brazilian State Oil Company) São Paulo coast, which receives more than 55 % of all the oil that arrives in Brazil.

The São Sebastião Channel is situated on the north coast of São Paulo State (Fig. 1), between the latitudes $45^{\circ} 19'$ and $45^{\circ} 30'$, separating the São Sebastião Island (Ilhabela city) from the Continent (São Paulo city). The channel is 25 km long and is 90-120 feet deep; it is 7 km wide in the southern region 6 km in the northern and 2 km in the central section (Furtado, 1974).

This paper was written in order to make a contribution to the management of the future oil spills, so as to protect the most sensitive areas, to give assistance to the oil spot displacement studies, including mathematical models, and to develop ways to assist in the recovery of the degraded areas.

MATERIALS AND METHODS

This paper was elaborated from the CETESB and PETROBRÁS environmental accidents file, and it was based on these items: cause, kind and amount of oil spilled, displacement of the oil spot, affected areas, dispersants used, amount of the oil and contaminated sand removed, waste disposal, and the relation between the wind direction/intensity and the displacement of the oil spot.

Each accident was catalogued in an index and this information was researched for a later tabulation study. At the same time, some maps were made to represent the oil displacement in the channel, and the beaches that were affected, based on 1:50000 and 1:250000 scales (Fig. 2).

The wind direction and intensity data were compiled using meteorological information registered every 3 hours by PETROBRÁS technicians at the meteorological station placed on the Terminal's pier, on the sea. It was not possible to include other items such as maritime current direction and intensity because there is no available daily data, but oceanographic studies were considered to understand the current movement in the channel.

RESULTS AND DISCUSSION

This research showed that there are 210 oil spills accidents registered in the São Sebastião region (1974-1994), but only in 191 did the oil actually reach the sea. In this paper, this data will appear in a summarized form.

CAUSES OF THE ACCIDENTS

The majority of the 191 accidents were caused by the tankers (66%), 17% of them were caused by faulty bottom valves of the ships followed by operational faults (12%), not identified causes (19%), and other causes (50%); pipelines caused only 2% of these accidents (Fig. 2).

KIND AND AMOUNT OF OIL SPILLED

There were 33 different kinds of oil spilled : 16 from Brazilian sources, 16 were foreign (Arabian, African, Chinese, Mexican, Venezuelan, and so on), and the others were derivatives and/or refined oil. Even the Brazilian oil than the foreign were predominantly heavy because their specific density are more than 0.88 mg/l (Neiva, 1986) and their ° API (American Petroleum Institute degree) is between 17,5 to 35. It means that there is a big mix during the first two days but the oil can persist in the marine environment for more or less 4 days (ITOPF 1987).

The majority of the accidents were of unestimated quantities and were less than 1 ton, but in only 5 cases, involving tankers collision, and pipelines they represented 90% of all the oil spilled during these 20 years, or 18200 tons. The tankers were : Takimiya Maru (Jan/1974), Brazilian Marina (Jan/1978) and Marina (Mar/1985).

Only after 1985. PETROBRÁS received adequate equipments for the removal of the oil from the sea. Analysing the totality of the oil spilled among 1986 and 1994 (5306,86 tons) with the amount of oil recovered (1752,1 tons), we can see that 33% of this stayed in the marine environment. It means a serious marine pollution and a big loss of fuel.

The amount of contaminated sand were available during these accidents and the estimative are more than 5693 tons because the response team removed in some cases more sand than oil, for instance, in 1992, after a collision between two tankers, the Penelope ship spilled 280 tons of oil ; 135 tons of oil were removed from the sea and 1340 tons of sand were removed from 19 beaches.

After this case new methodologies have been developed by CETESB, even to decrease this amount of sand though to minimize the ecological effects (Millanelli *et al.*, 1993 ; Lopes *et al.*, 1994). The large quantity of sand removed causes many negative consequences, not only to the environment, but also in the disposal of this waste, mainly because neither there are appropriate areas to do so in the shoreline cities nor appropriated methods have been applied to deal with this waste.

DISPLACEMENT OF THE OIL SPOTS AND AFFECTED AREAS

Analysing the data of the 191 accidents, it was noticed that only in 93 cases there is complete information about the displacement. The São Sebastião channel was divided into 3 sectors so as to help the displacement study : south, central, and north, and these also include the continental and island areas.

In the majority of these cases, the oil spot stayed near the PETROBRÁS' terminal without displacement along the channel because of the small quantities spilled. The data shows that the spots have a greater tendency to displace farther north of the São Sebastião island than to the north of the continent, and the opposite occurs in the southern sector. Furtado *et al.* (1977) had done the same observation.

In those big accidents the heavy oil were able to move for a long time (5 to 19 days) in all the sectors leaving the channel by the north and moving towards some beaches between the north of São Paulo state and the south of the Rio de Janeiro State (140 km far from São Sebastião city), but it was noticed that some spots can returned to the channel until 18 times during 13 days, and that some beaches can be affected more than 10 times in the same accident.

During this 20 years (1974-1994) 83 beaches were contaminated by the oil spills along the four cities of the São Paulo north coast : São Sebastião, Ilhabela, Caraguatatuba and Ubatuba. It means the majority of them.

It could be explained by the hydrodynamics studies made by the Oceanographic Institute of the São Paulo University (Emilson, 1962 ; Furtado, 1978). The results of these studies demonstrated that there is a main flux from the southeast to the northeast of the channel that can be altered by variations in the sea surface. There are some curvelike movements along the channel, one clockwise in the south and other counterclockwise in the north.

THE WIND INFLUENCE IN THE OIL SPOT'S MOVEMENT

It was reported that the horizontal displacement of the oil spots is caused by the combined effect of wind and maritime currents (Grau & Giraldo, 1990). The wind direction and intensity data were analyzed together with the oil movement registered, but in only 54 accidents which had complete information. When

there was a correlation between the wind and the displacement, this was called a concordance and when there is not, a discordance.

The results show that the concordance happened in 63% of the cases when the wind velocity was over 7 knots. When there are not winds or when they are weak, the oil has a tendency to follow the maritime current.

THE USE OF DISPERSANTS

These products were used in the São Paulo shoreline only from 1974 to 1984, because in the next year this utilization was regulated through a CETESB normalization, and there are recommendations to avoid them in the São Sebastião channel.

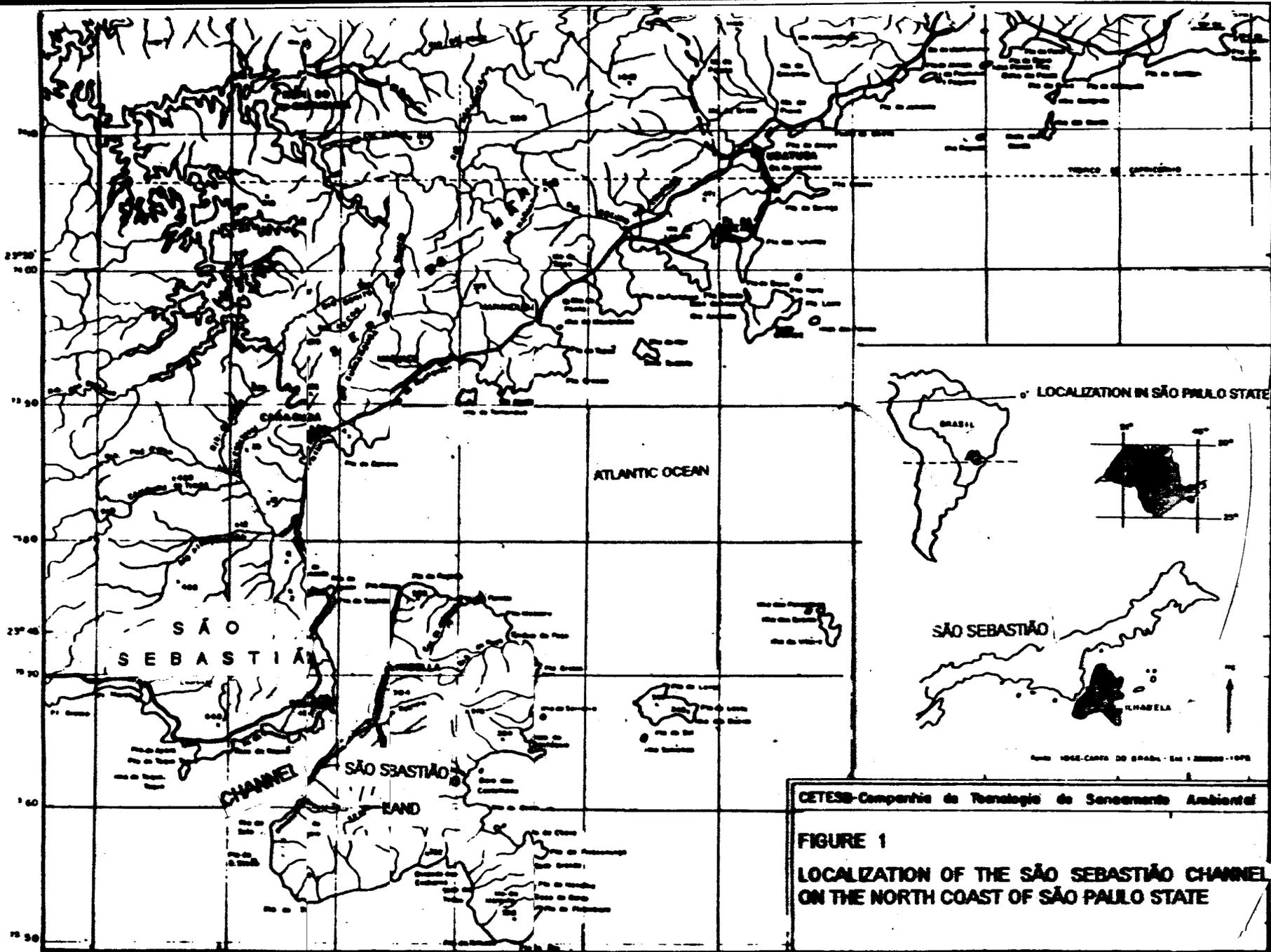
The dispersants were applied during 19 oil spills, above the oil spots, sand beaches and rocks, but only 5 of them could be identified. There are incomplete information about the quantities used.

CONCLUSIONS

The São Paulo's north coast has a great tourist potential because of the beautiful beaches, the conditions for diving, sailing, surfing, fishing, and other aquatic activities. There is also a rich diversity of marine life and many fishermen depend on the good quality of these waters. The study of 20 years oil spills in the São Paulo coast, showed the necessity to improve the efforts to prevent and to answer quickly the accidents, before the oil spots start to affect the marine environment hardly, and became so difficult to be controlled.

In a general way it involves the cares with the old tankers that transport the oil, with the charge and discharge operations and with the pipelines. At the same time, it is necessary to develop new researches and technologies to protect the sensitivity areas, to recover the affected environment and places, the regulamentation of the efficient and non-toxical dispersants, and the destiny of the contaminated sand.

Therefore, it is really important to remember that the extention of the spills damage is not always directly proportional to the oil spilled because it's depends on the toxicity of the product and on the vulnerability degree of the ecosystems affected (Schaeffer-Novelli, 1990) and this region must be further studied.



CETESB - Companhia de Tecnologia de Saneamento Ambiental
FIGURE 1
LOCALIZATION OF THE SÃO SEBASTIÃO CHANNEL
ON THE NORTH COAST OF SÃO PAULO STATE

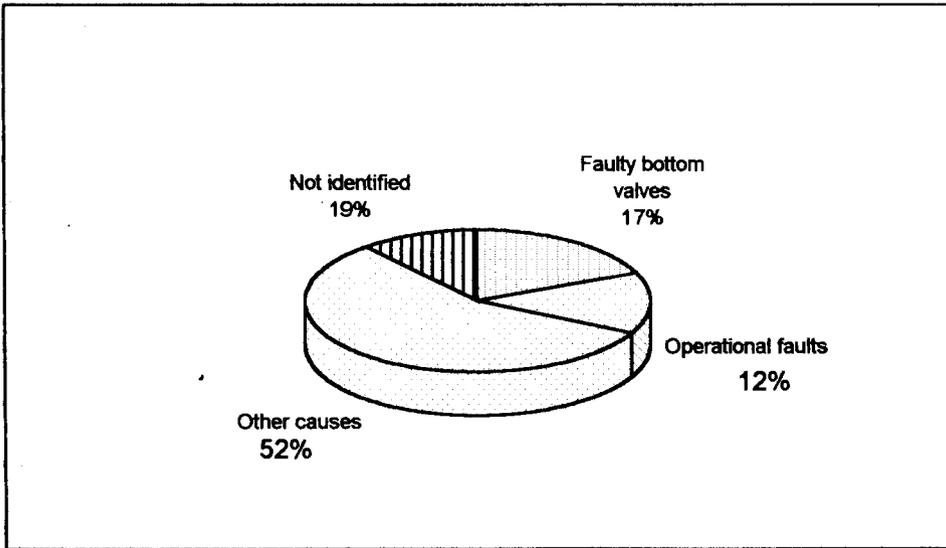
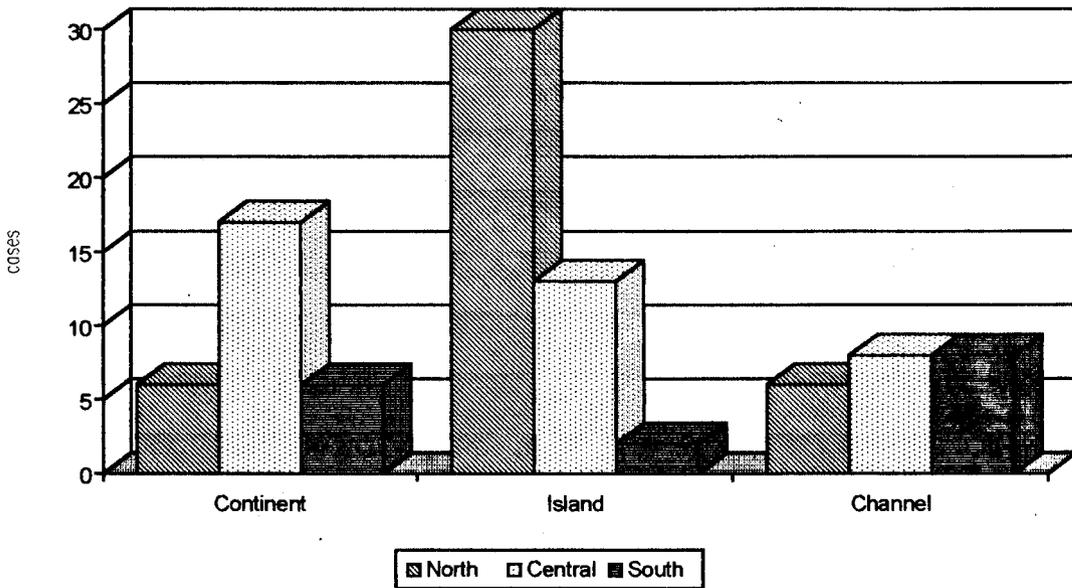


Figure 2 - Cause of the accidents in São Sebastião Channel - São Paulo/Brasil - (1974-1994)



Source: PETROBRÁS/CETESB (1974/1994)

Figure 3 - Displacement of the oil spots in the São Sebastião channel by sections

BIBLIOGRAPHY

- Emilsson, L., (1962). *Cienc.Cultura*, 14 (4) : 269-270.
- Furtado, V.V., (1978). IGUSP, Tese de doutoramento, Inst.Geologico, USP.
- Furtado, V.V., M.C. Bicego & R.R. Weber, (1977). *Acad.Cs.do Estado*, 2 : 371-388.
- Grau, J. & G. Gírald, (1990). *Numerical simulation of oil spills in a generalized domain*, Oil & Chem.Pollut., Elsevier Sci.Publ., vol. 7 : 143-159.
- ITOPF, (1987). Response to marine oil spill. Witherby & Intern.Tanker Owners Pollut.Federat., : 150 pp.
- Lopes, C.F., J.C. Millanelli & G.Johnscher-Fornasaro, (1987). *Acad.Cs.do Estado*, 3 : 293-300
- Neiva, J., (1976). *Conhe a o petróleo*. Rio de Janeiro : Ao livro técnico : 307 pp.
- Millanelli, J.C., C.F. Lópes & G. Johnscher-Fornasaro, (1993). *Estudo de metodologia para recupera ao de costoes rochosos impactados por petróleo*. CETESB, Relatorio : 45 pp.
- Schaeffer-Novelli, Y., (1990). *Acad.Cs.do Estado*, 2 : 375-399.