Assess the effects of pollutants on the ecological balance of the Caspian sea

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Abstract

Caspian Sea is the opportunities and challenges and its role in shaping subsequent ecological surrounding territories in recent decades, much attention has been. Understanding of factors affecting the marine environment pollutants, and the essential first step to improve and restore these ecosystems is valuable. Water now flowing at 130 River poured into the Caspian Sea and the waters are polluted Caspian Sea is the largest source of pollution. There are various pollutants on the larval stages of fish eggs and creating genetic and behavioral problems, reproductive endocrinology affects them. New threats from other Caspian species invading the shoulder is reduced significantly large population of plankton and geo-plankton, fish eggs and larvae fed from a severe drop in population, especially the Sturgeon fish, food chain disruption and order collide is the Caspian Sea ecosystem. 122 thousand and 350 tons of annual oil pollution, 304 tons of cadmium and lead into the Caspian Sea are tons. Most oil pollution from neighbors that the North Sea due to the slope of the Caspian pollution is advancing toward Iran. Pesticides use and management of biological methods of struggle and integrated pest management, weeds and diseases, an important step in achieving sustainable agriculture and consequently causes a sharp reduction in farm effluent polluting the environment, particularly agriculture. At the same time implementing unit management to protect rivers as he. Also in the framework of cooperation and the annual meeting five
1. Introduction

Given a certain oil spill accident, one would like to quantify its expected consequences. These will depend on various impact factors, such as: the source of contamination, the kind of release, the type of oil that has been spilled, the choice of the strategic concept (type of response), the availability of specialised equipment, the weather conditions during the travel time of the oil slick and at the moment when the response activities take place. Some of these factors will be further discussed.

There are several ways in which huge quantities of oil can end up in the water.

An archival version of the script of "Ocean Planet," a 1995 Smithsonian Institution Travelling Exhibition, whose content reflects the state of knowledge at the time of the exhibition, divides the sources of oil pollution in the following:

- **“Big Spills”** - only about five percent of oil pollution in oceans is due to major tanker accidents, but one big spill can disrupt sea and shore life for miles;
- **“Routine Maintenance”** - bilge? cleaning and other ship operations release millions of gallons of oil into navigable waters;
- **“Down the Drain”** - oil in runoff from land and municipal and industrial wastes ends up in the ocean;
- **“Up in Smoke”** - air pollution, mainly from cars and industry, places hundreds of tons of hydrocarbons into the ocean each year. Particles settle, and rain washes hydrocarbons from the air into the oceans;
- **“Offshore Drilling”** - offshore oil production can cause ocean oil pollution, from spills and operational discharges;
- **“Natural Seeps”** - some ocean oil “pollution” is natural. Seepage from the ocean bottom and eroding sedimentary rocks releases oil.

Figure 1 shows how many millions of gallons of oil each source puts into the oceans worldwide each year:

![Fig. 1. Sources of oil pollution.](http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/peril_oil_pollution.html)

The global situation reflected here, may differ at the regional level. This depends on natural conditions, industrial development, navigation, oil and gas production, and many other activities.
Types of release

Most of the incidents are a combination of actions and circumstances, all of which contribute in varying degrees to the final outcome. They usually happen due to unfavourable weather conditions, like storms or hurricanes, acts of violence, like war and vandalism, or dumping and human mistakes.

As we have already seen, the main “causes” of an oil spill can be divided in two large categories: “operations” and “accidents”.

A large number of spills result from routine operations such as loading, discharging and bunkering which normally occur in ports or at oil terminals; the majority of these operational spills are small, most of them involving quantities of less than seven tonnes.

The largest spills, in which the quantities involved are sometimes exceeding ten thousand tonnes, are caused by accidents.

One can distinguish between several types of accidents, such as: groundings, collisions, hull failures or fires and explosions.

Grounding

There are two types of grounding:

- powered grounding: the contact with the shore or bottom by a vessel underway and under power due to an error in navigational or a steering failure;
- drift grounding: the contact with the shore or bottom by a drifting vessel that has been disabled due loss of propulsion or steering failure;

Generally, a powered grounding is more damaging than a drift grounding. In both cases the grounding can be hard, i.e. grounding on rocks or soft, i.e. grounding on soft ocean beds.

Collision

The striking of a fixed object while a vessel is docking or undocking. Because of its low probability to occurrence and even lower probability of an allision being the cause of an oil spill, this type is not very often considered in the specialised studies.

Vessel collision

The colliding or striking of two vessels due to human error or mechanical failure.

Collision with ice

The collision of an underway vessel with floating ice.

Fire / explosion

Occurrences of a fire or explosion serious enough in itself to cause a fuel or cargo spill.

Structural failure

A structural failure due to hull fracture or corrosion that is serious enough to cause an oil spill.

In some of these cases, for example hard grounding or collision, the possibility of an accident can be predicted with enough time in advance for the closest response vessels to be positioned at a strategic place, before the accident actually happens. The same cannot be said about the case of an explosion or a fire. Nevertheless, technical guidance and specialised response equipment are available as fast as possible, depending on the location where the oil spill took place; some vessels being “on duty” twenty four hours a day.

In most of the accidents, the release of oil will not be instantaneous (like the one corresponding to a blow-out) but rather gradual and chronic, therefore the volume of the oil that is spilled will increase in time with a certain rate.
Types of oil

Most of the people think of oil as being a single substance, but there actually are many different kinds of oil, which differ from each other in their viscosity (oil’s resistance to flow), volatility (how quickly the oil evaporates into the air) and toxicity.

Due to these differences, these types of oil affect the environment in dissimilar ways, when spilled. They also differ in how hard they are to clean up. Spill responders distinguish four basic types of oil:

1. Very Light Oils (jet fuels and gasoline)
   This type can be characterised by high volatility (should evaporate within one or two days) and high concentrations of toxic (soluble) compounds. It can produce severe impacts to water column and inter-tidal resources and no cleanup is possible.

2. Light Oils (diesel, no. 2 fuel oil, light crude)
   Their volatility, as well as their concentration of toxic compounds, is moderate. These can "oil" inter-tidal resources with long-term contamination potential, but cleanup can be very effective.

3. Medium Oils (most crude oils)
   About one-third of these will evaporate within 24 hours. Oil contamination of inter-tidal areas can be heavy and long-term; oil impacts to waterfowl and fur-bearing mammals can be severe and the cleanup is most effective if is conducted quickly.

4. Heavy Oils (heavy crude oils, no. 6 fuel oil, bunker C)
   These are heavy oils with little or no evaporation or dissolution. They can produce heavy contamination of inter-tidal areas, long-term contamination of sediments and severe impacts to waterfowl and fur-bearing mammals. Shoreline cleanup is difficult under all conditions.

Oil spill weathering processes

Released into marine environments, oil and petroleum products are subjected to a variety of weathering processes such as: evaporation, spreading and drift, dissolution and advection, dispersion of whole oil droplets into the water column, water in oil emulsification, microbial degradation, sinking and sedimentation [1].
Evaporation occurs when the lighter substances within the oil mixture become vapours and leave the surface of the water. It is considered the most important weathering process, due to the fact that it has the greatest effect on the amount of oil remaining on water after a spill.

The light and very light oils tend to evaporate into the air, and if the spill is all light, the oil will disappear by itself within one to two days, whereas only a small percentage of heavy oil evaporates. The rate of evaporation is very high just after the spill and then it slows down significantly. The evaporation of the most kinds of oil follows a logarithmic curve in time.

Emulsification is the process by which one liquid is dispersed into another in forms of droplets. The oil/water mixture is sometimes called “mousse”, or “chocolate mousse”. For the emulsion to reach a stable form, a period of evaporation is needed first. Emulsions of all types contain 70% water, hence when the emulsion is fully formed, the volume of the oil spill triples. Moreover the viscosity of the oil increases considerably. These two factors make any cleaning operation extremely hard or even impossible. Emulsification is more likely to occur under strong winds and waves. An emulsified mixture of water in oil indicates a spill that has been on the water for some time.

Natural dispersion is the phenomenon of breaking up of an oil slick into small droplets that are mixed into the water column by breaking waves and other sea surface turbulence. It is dependent on the oil properties and highly dependent on the amount of sea energy.

Oxidation is a process that occurs when water and oxygen combine with the oil to produce water-soluble compounds. This affects the oil slick around its edges. When the oil slick is thick, it may partially oxidise, resulting in tar balls, which can collect in the sediments or wash up on shorelines long after a spill.

Sinking is possible only if the oil is denser than the surface water. When one type of oil reaches this density it can sink to a denser layer of water rather than to the bottom. Sinking of any form is a very rare process.

Spreading is an essential oil movement; this process happens rapidly even without wind and currents. The oil slick reaches its maximum area within one day.

At strong winds (more than 20 km/h) on the open sea, the oil slick is mainly moved by the wind.

For a wind speed below 10 km/h and a slick, which is near land, oil on sea moves with the surface current. An oil slick is elongated in the direction of the wind and currents, and its shape is changing with the spreading.

Very thin layers of oil floating on the water surface, called oil-sheens, precede heavier or thicker oil concentrations. Sheen is the most commonly observed form of oil during the later stages of a spill. Depending on thickness, sheens range in colour from dull brown for the thickest sheens to rainbows, greys, silvers, and near-transparency in the case of the thinnest sheens. On high winds the sheen may separate from the thicker slick and move in a different direction.

Due to the force of gravity, the oil tends to concentrate between the crests of waves. Oil can be alternately concentrated and spread out by the circulation currents to form ribbons or windrows of oil rather than a continuous slick.

**Conclusions**

In this study we concentrate on the type of oil spill accident and on the relationship between meteorological forcing and the region of maximum damage.

The variable of interest is the position of the particle cloud at the end of the simulation (after 480 hours), or after a certain number of days (five, ten) from the moment of the accident, together with its relationship with the weather conditions, characterized by the speed and direction of the wind.

The smaller the values of the wind speed at the moment of the spill, the higher is the uncertainty in the prediction of the final positions of the particles. The extra- information about the direction of the wind can change this fact, making the uncertainty smaller.

Information about the behaviour of the wind in the first hours after an accident will not be of much use, because the values of the wind parameters at the moment of the spill, after five hours and after ten hours from the oil spill accident are highly correlated.

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4 Streaks of oil, that line up in the direction of the wind. Windrows typically form early during a spill when the wind speed is at least 10 knots (5.1 meters per second). Sheen is the form of spilled oil that most frequently windrows. (http://response.restoration.noaa.gov/job_aid/glossary.html)
Looking at the number of particles, which are present in the areas of interest after a period of time, one can be mislead by this information. In many of the cases these numbers are giving the information that in a certain snap shot no particle is present in any of the four regions, which does not necessarily mean that the particles did not already cross the areas; so this information alone is not enough.

If one is interested in the positions of the particles after five days, one can observe that the ranges for these positions are smaller than the ones for the final positions, which tells us that it is easier to make a prediction for the location of the particle cloud after a shorter period of time.

When the assumption that the weather can be predicted for the next six days is made the uncertainty in the prediction of the positions is considerably reduced, especially when one is interested in the positions of the particles after six or ten days. Unfortunately, this assumption is not exactly a realistic one.

Looking at the travel times of the particles it can be observed that in the worst-case scenario (i.e. strong wind in east direction) one of the four areas can be affected in less than two days and be in great danger in 70 hours.

After performing a standard regression model for the coordinates of the final position with predictors being the components of the wind vector at the time of the accident, one can see that the regression model accounts for only 11% of the variability in the x-coordinate and 5% in the y-coordinate and, moreover, the results are showing strong heteroscedasticity.

We can conclude saying that a reasonable way of predicting the position of the particle cloud in certain weather conditions is by looking directly in the data set provided, since the locations of the particles and the components of the wind didn’t seem to fit a classical statistical relationship.

References


Various organisations and companies have developed oil spill computer models, which are able to make predictions about the trajectory and fate of spilled oil, and provide valuable support to both contingency planners and pollution response teams. Some of their publications, which facilitated a familiarisation with the subject, are listed below.
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