Circular Economy Lab & Observatory

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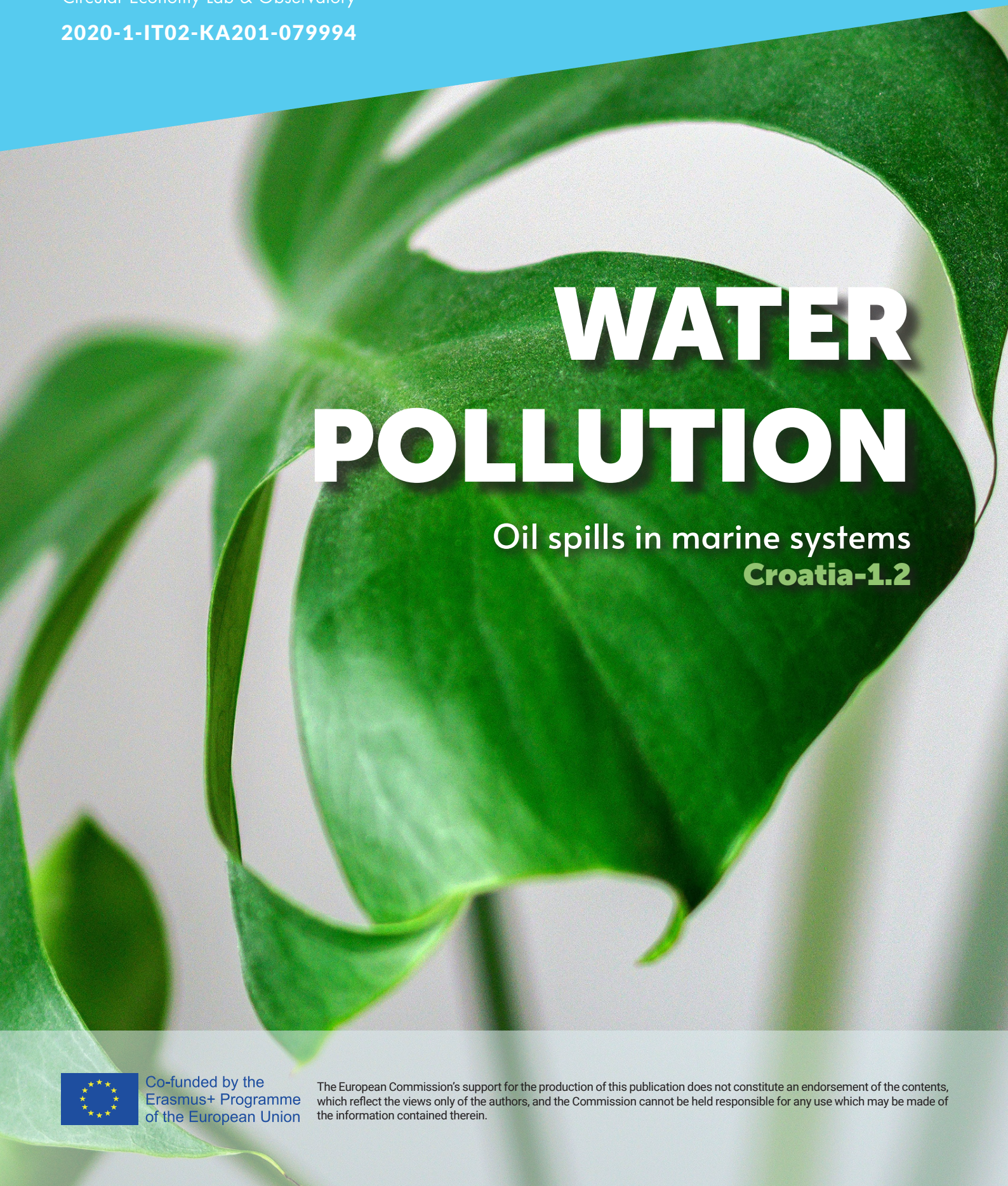

WATER POLLUTION

Oil spills in marine systems

Croatia-1.2

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Oil, alongside with gas and coal, is a product of fossil degradation. Fossils are structures consisting of dead animals and plants preserved over long periods of time under great pressure. Oil, gas and coal are therefore structures consisted purely of organic material. Oil sources are vast and numerous. Considering that, oil is expected to be one of humanity's greatest sources of energy. To the world's bad fortune, that energy source is not renewable and people tend to abuse it. It is used in great amounts for various purposes such as petroleum in the car industry and heating systems inside buildings. It even takes form as plastics produced in the chemical industry all over the world, and you can detect it in many things we use on a daily basis such as chewing gums, toothpaste and deodorant.

Picture 1.1. Extraction of oil from beneath the sea. (https://unsplash.com/)

Oil can be found in extensive underground reservoirs all over the world (Picture 1.1.). Its discoveries are noted in many countries of the world, but as of right now countries with the largest oil reserves are Venezuela, Saudi Arabia, Canada, Iran and Iraq.

One of the most dangerous ways people abuse oil is manifested throughout the world through oil spills (Picture 1.2.). An oil spill is the release of a liquid petroleum hydrocarbon into the environment that can either remain on the surface of water or get dispersed. It happens primarily and is so dangerous because, as mentioned before, oil is formed of organic molecules.

When released into water, which is not an organic molecule, it cannot be dissolved in it because only similar material dissolves in a similar way.

Any type of oil spill, no matter its size, destroys the habitat that it comes in contact with. They can have both immediate and long-term effects on coastal and marine environments [1].

Picture 1.2. An oil spill site. (https://unsplash.com/)

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Even though the number of oil spills each year is decreasing, there are still roughly about 10,000 tons of oil being spilled in the waters of the world annually [2].

Oil spills are mostly caused by land-based runoffs (the draining away of water or substances carried in it) and waste from city industries.

Additionally, polluted rivers can carry oil into the ocean. Furthermore, a third of the oil pollution in the oceans is caused by accidents which include tankers or drilling rigs.

Since technology is evolving every day, there are a few tools that now exist for cleaning up oil spills.

Each oil spill has its own characteristics that then determine which tool is best to be used for the clean-ups. There are various tools and methods that can be used to clean up oil spills such as skimming, in-situ burning and using chemical dispersants or sorbents (substances which have the property of collecting molecules of another substance).

Picture 2.1. Most of the oil ends up in waters through industries. (https://unsplash.com/)

Oil spills are caused by various things, all of them human-related. Only a small fraction of them is caused by ship and tanker explosions, collisions, failures in the body or running aground.

The most consequential causes of oil spills in marine environments are land waters such as rivers and lakes, which are being massively polluted due to diverse industries, and whose waters end up in bigger bodies of water, such as seas and oceans (picture 2.1.). In addition, there are oil spills accumulating in the ground and on the roads which also end up in the seas.

How fast and how efficiently oil will disappear once it has polluted a marine ecosystem depends entirely on the consistency and properties of oil and the weather conditions. The changes that oil goes through immediately after being released are known as the process of weathering. Weathering will occur through evaporation, degradation of microbes, oxidation and some photochemical reactions [3].

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There are five factors that determine the destiny of oil once it has been spilled. They all mostly occur during the first few days or weeks after the oil spill has formed and change its form on a chemical level. These include spreading, evaporation, dispersion, dissolution and emulsification.

Spreading comes about in three phases during which the oil spill, as a result of gravity, grows. Evaporation is one of the most important reasons why an oil spill loses its mass as the particles in oil go up into the air.

Some biotic factors such as temperature and wind speed affect this process greatly. Dispersion is affected by sea waves which separate the oil into smaller particles. These can then be more easily and efficiently dissolved by water due to their smaller volume and have a better chance of biodegradation.

Dissolution is similar to dispersion but actually involves dissolving oil particles in water. Emulsification is the opposite of dispersion. Water droplets become surrounded by oil and oil incorporates water into itself. That affects oil's ability to stick to other surfaces (adhesion). It makes it harder for oil to stick to other objects in the water or to the shore. Oil spills have a ruinous effect on all life around them. They can damage and completely destroy everything they come in touch with.

As oil spreads through water, it clings to marine lives habituating in and around the waters and causes their untimely demise.

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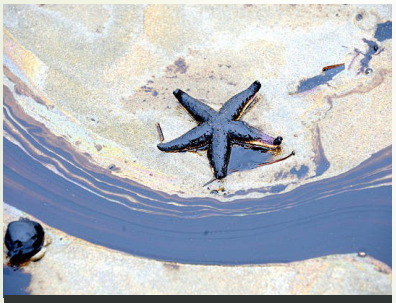
Marine habitats most devastatingly affected by oil spills include coral reefs (one of nature's major sources of life in the ocean), sand and cobble beaches which soak up the oil, salt marshes, and even tropical mangrove forests with their immensely long roots.

When it comes to animals, oil can affect them in a few ways (Picture 2.2.). Through physical touch oil damages birds' feathers by sticking to them which weighs the birds down and enhances chances of drowning. Some species can inhale oil vapours which affects their nervous system, or they can ingest it and later be unable to feed because of damaged intestinal tracts.

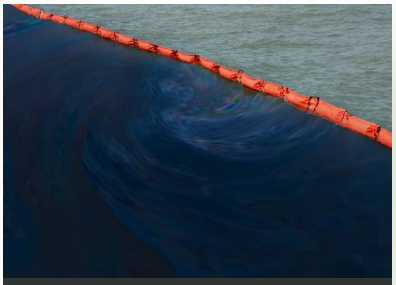
Animals who eat other things or animals contaminated by oil become intoxicated and therefore endangered.

It has been thoroughly observed and proven that intoxication by oil can have long term effects on animals' reproductive systems which directly endangers the whole community [4]. Concerning fish and marine-based industries, oil-contaminated fish are growing to be an enormous problem because they can't be sold nor eaten, so the industry loses profit.



Picture 2.2. Impact of oil spills on marine life. (https://unsplash.com/)

Unfortunate dead animals washing up on the shore in addition to losing their lives disturb ships and other vessels and are very timeconsuming to clean up.



Picture 3.1. Containment boom. (https://oleology.com.au/news/water-treatment/containment-boom-oil-spill-response/)

Although oil is one of the main pollutants in the oceans and other waters and is unnecessarily hazardous and threatening towards any and all marine life-forms, there are many ways it can be cleaned up. One of the more popular ways of containing the dangerous oil spills is with oil containment booms (Picture 3.1.). They act like a fence to stop the oil from further spreading into the ocean. Containment booms consist of three parts: a freeboard, a skirt and a sort of cable that connects the two parts and stabilizes them.

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Sadly, oil booms are only effective when the oil is in one spot and when it is accessible within only a few hours of the spill. Alongside booms, the most common way of cleaning and removing oil from the sea are skimmers. They are specially designed machines used to collect and suck up all the oil from the water. After booms are set in place, skimmers are deployed onto boats to remove the contaminants. Using skimmers, also called oil scoops, is economically viable because they can clean most of the spilled oil effectively. An alternative way of removing oil from the water is with sorbents.

They are materials used to soak up the oil through absorption or adsorption. While particles soak into another material during absorption, adsorption includes particles only staying on the surface of materials. Some of the materials used for absorption are vermiculite, peat moss and hay. Sorbents are more commonly used to clean up leftover oil after removing most of the spill. The only downside to them is that, after absorption, they can become quite heavy causing them to sink, and it makes the process of retrieving them much more difficult.

An additional way of cleaning up oil spills, mostly the ones occurring near the shoreline is using manual labor (Picture 3.2.).

This process requires hand-held tools used to help remove the oil and put it in special containers to be taken away from the shore. It is very labor intensive and time consuming, but it's also economically viable because even unskilled workers, or workers with minimal training, can be helpful during the process of cleaning up and removing the oil.

The downside to this method is that it is only applicable to cleaning slick shorelines and the use of heavy machinery can inflict damage upon them.

Picture 3.2. Manual labour in removing oil spills.(https://response.restoration.noaa.gov/about/media/how-do-oil-spills-get-cleaned-shore.html)

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Of course, there are many other ways of containing and removing the spilled oil from the marine areas such as burning in-situ, using dispersants, high pressure-washing and hot water, chemical stabilization by elastomers, bioremediation and many more, but those methods are mostly used if the spilled oil is in an accessible location. Natural recovery is the simplest and cost-effective way of dealing with the oil spill cleanup because it leaves the oil to decompose in the environment naturally. This is by far the most unreliable and timeconsuming process that requires constant monitoring. However, this method is only used if the oil spill is too remote or inaccessible [5].

To sum up, oil is one of the products of fossil degradation, and thus it takes a long time to be formed, which is why it is considered a non-renewable source of energy.

Picture 4.1. Oil sticks to other living beings. (https://unsplash.com/)

Regardless, today it is an essential energy source, and people tend to misuse it. One of the most dangerous ways of misusing oil is shown through oil spills which can have instant consequences and distant future outcomes.

As oil spreads in water, it sticks to living beings in and around the sea, destroying habitats and causing death, and thereby affecting the balance of the whole ecosystem (Picture 4.1.). However, there are ways to clean up polluted water, such as oil containment booms, skimmers, and sorbents. Even though oil spills can have disastrous consequences for the environment and the economy, both directly and indirectly affecting huge amounts of people, the human population is still dependent on it and it cannot be expected to completely stop being used.

As with everything, accidents like oil spills can always happen, but as much as possible should be done to reduce their frequency and control the consequences. Also, there are many ways to reduce the use of oil, which would directly lead to a reduction of risks and less frequency of oil spills. One of them is replacing vehicles that use petrol and diesel as fuels with vehicles running on electricity that comes from renewable energy sources, like solar or wind energy.

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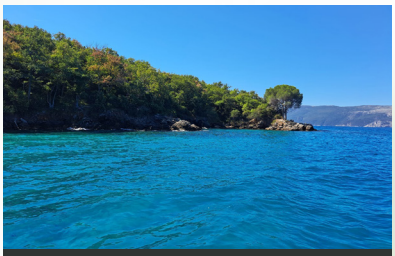
The other way would be using long-lasting or multiple recyclable materials such as glass, steel, or even paper and cloth, instead of using plastic, which is the most widely used form of refined petroleum [6].

Furthermore, of all the listed alternatives, plastic takes the longest time to decompose if not disposed of correctly which is why it often ends up in seas and oceans, and even in food.

Unfortunately, even though a lot has been done recently to raise people's awareness about oil's disadvantages and the consequences of misuse, people still often do not seem to be aware of all the problems that accidents including oil can bring, both in the present and in the future.



Picture 4.2. What all the oceans and seas could look like one day. (photo by Lara Višnjić, the sea off island Cres, Croatia, summer 2022)

Although it is difficult to change one's way of living and habits, we believe people will accept that if we want a better, safer, and healthier place to live, both for us and for our descendants, we should try to reduce the use of oil.

Also, we hope that, in the nearer future, people will advance to using renewable energy sources in greater amounts and it is only then that our home, our beloved planet Earth, will become a merrier place (Picture 4.2.).

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GROUP

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