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Information Bulletin

Centre of Documentation, Research and Experimentation on Accidental Water Pollution

FEATURE: Grounding of the *MV Wakashio*

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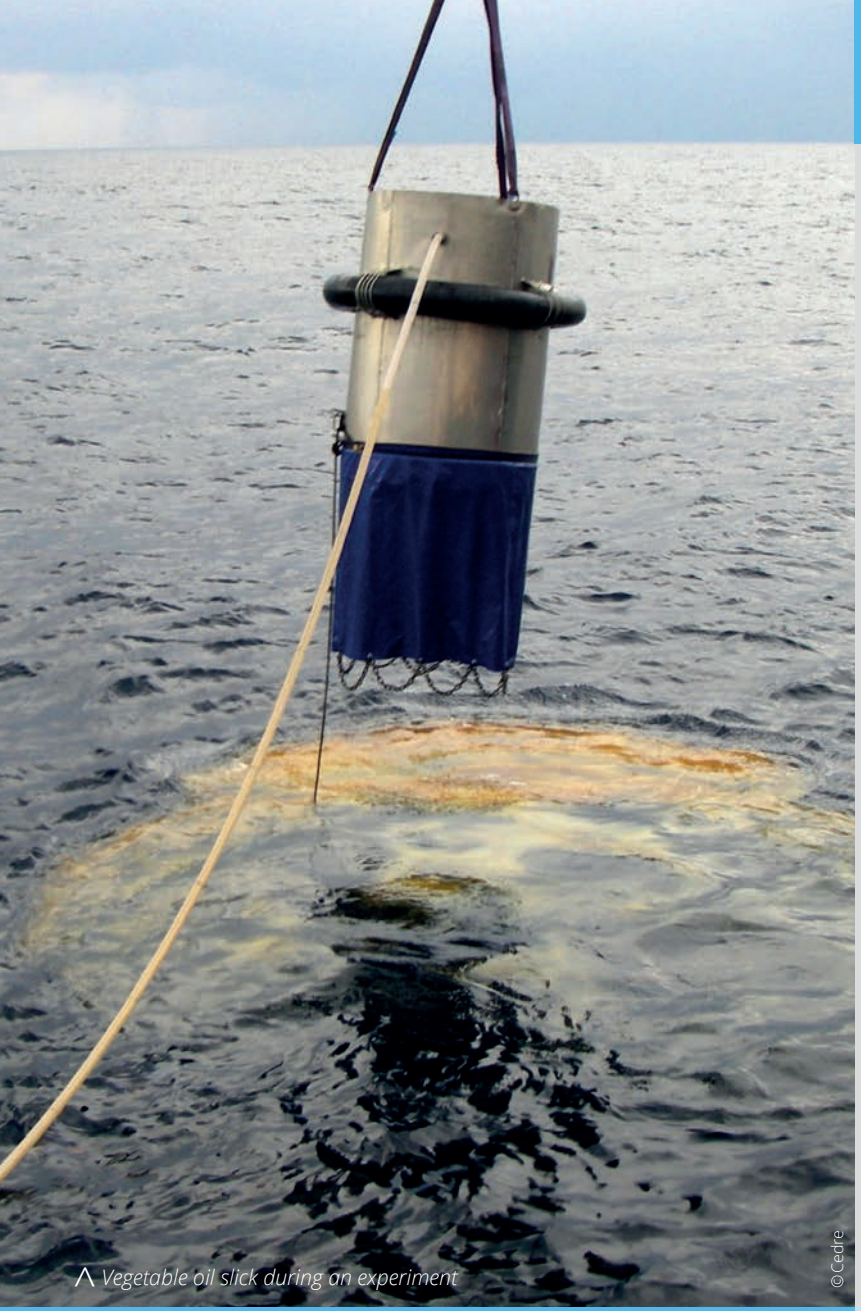

Vegetable oil slick during an experiment

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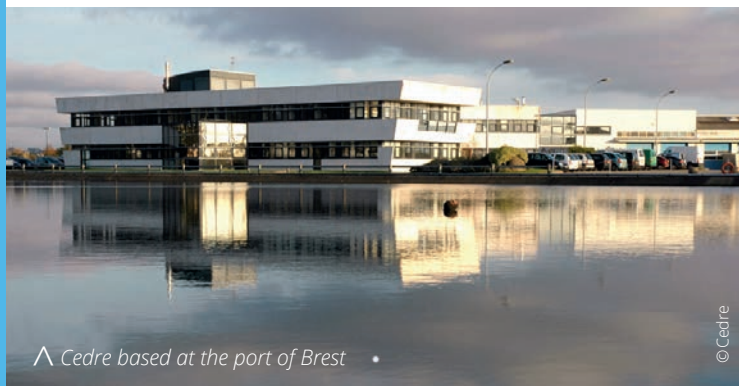

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EDITORIAL

The Republic of Mauritius was faced with an unprecedented oil spill on 6th August 2020 following the grounding of the *MV Wakashio*. The spill was estimated at approximately 800 tonnes of very low sulphur fuel oil and affected some 30 km of coastline. The sites affected included several major coastal ecosystems such as coral reefs, islets, mangroves and seagrass beds. In addition, two important international Ramsar sites–Blue Bay Marine Park and Pointe d'Esny–located near the site where the ship ran aground, were threatened by the oil spill. Various socio-economic activities such as fishing, tourism and watersports were also affected.

My ministry activated the national oil spill contingency plan following the ship's grounding on 25th July 2020, with immediate measures taken to deploy booms to protect sensitive coastal areas as a preventive measure. The National Crisis Committee chaired by the Honourable Prime Minister led the whole operation, while the National Oil Spill Contingency Plan Coordination Committee led by my ministry was in charge of coordinating the response, clean-up and monitoring.

The national authorities, with the support of the public and private sectors, civil society organisations and volunteers, were actively involved the oil spill response. Assistance was also provided by friendly countries, namely France, India, Japan, China, the United States, Australia and the United Kingdom and by international organisations to deal with the oil spill. In the early stages of the incident, Cedre assisted my ministry with the fingerprinting of oil samples.

In order to ensure that the clean-up objectives were met by the contractors selected by the P&I clubs appointed in late December 2020, my ministry requested technical support from Cedre, through the French Development Agency. Dr Ivan Calvez, an engineer at Cedre, conducted site visits with the relevant national stakeholders and clean-up contractors to conduct site assessments and establish clean-up objectives. During these visits, the national stakeholders benefited from practical experience in establishing oil spill clean-up objectives. The recommendations made by Cedre's expert and the results of the monitoring work carried out by national laboratories were critical for lifting the restrictions and reopening the areas affected by the oil.

I would like to reiterate my sincerest thanks and deepest gratitude to all local and international stakeholders, including Cedre, for assisting Mauritius during this major incident.

Hon Kavydass Ramano, Minister of Environment, Solid Waste Management and Climate Change, Republic of Mauritius

Grounding of the *MV Wakashio*: one year on

The MV Wakashio *grounded on a coral reef off Mauritius*

By Nicolas Tamic, Operations Manager at Cedre.

On 25th July 2020, near Mauritius, the *MV Wakashio* ran aground on the Pointe d'Esny coral reef, located close to Blue Bay Marine Park. Although the National Contingency Plan was activated and attempts were made to refloat the vessel, an estimated 800 tonnes of low sulphur fuel oil leaked into the water. Carried by marine currents, this oil quickly reached the coast, mainly in mangrove areas. More than one year on, Cedre has decided to run a feature on this spill which sent a shockwave through the local population and the Government of Mauritius.

The human factor: the root cause?

Although investigations are still in progress, it appears that the human factor was responsible for the grounding. During the hearings before the Court of Investigation set up on 19th January 2021 to determine the causes of the incident, the captain of the *MV Wakashio* told the court on 17th February that he had ordered his first officer to steer closer to the coast to be within range of a 4G signal so that the crew members could communicate with their families. Some of the crew had been at sea for several months without being able to disembark due to the Covid-19 pandemic. These initial conclusions are pending confirmation during the trial of the captain and first officer.

Dismantling of the wreck

The *MV Wakashio*, stranded since 25th July 2020 on the coral reef at Pointe d'Esny, broke in two on 15th August due to its position on the reef and adverse weather conditions. On 19th August, two tugs were ordered to tow the bow section out to sea to scuttle it. The choice of location took account of the French recommendations on scuttling, although this was not France's preferred scenario. Following preliminary decontamination operations conducted by SMIT Salvage, the bow section was finally scuttled on 24th August in harsh weather conditions. The 75 m-long stern section, weighing almost 7,500 tonnes, was handed over to Chinese experts from Lianyungang Dali Underwater Engineering for dismantling. With the help of the *Hong Bang 6* barge, some 50 operators began dismantling and removal operations. The operations, initially scheduled to last 30 days, were considerably delayed by the cyclone season. By 27th November 2021, 1,000 tonnes of steel had been removed from the grounded stern section. The Mauritian authorities indicated that the dismantling operations would last a few more weeks without specifying the exact date of completion, as the conditions in tropical areas are too unpredictable to be able to set a firm deadline. Although the size of the wreck is not comparable, you may recall the *Kea Trader*, grounded in July 2017 on the Durand Reef in the Loyalty Islands in New Caledonia, for which dismantling operations lasted 4 years.

Cedre in charge of clean-up site closure

Clean-up operations in the mangrove and along oiled shores were contracted to Greek firm Polyeco and French firm Le Floch Dépollution.

IN SHORT

25TH JULY 2020: GROUNDING SOUTH OF MAURITIUS ON A CORAL REEF

Panama-flagged bulk carrier • MV Wakashio

These two contractors kindly agreed to contribute to this issue of the Cedre Information Bulletin and outline their clean-up and waste management actions in the following pages. During these operations, the Government of Mauritius chose to call upon Cedre's expertise in order to prepare the site inspection process. Considerable interaction took place between Cedre and the Mauritian authorities in the last quarter of 2020 in order to plan this mission. Cedre would like to highlight the important role played by the French Development Agency and its local office in Mauritius, which greatly facilitated the financial arrangements. The clean-up site inspections were conducted in January 2021 and showed the excellent quality of the work carried out by the contractors appointed by the polluter's P&I Club.

Hair as a floating hydrophobic sorbent

For many years, the question of hair as a hydrophobic floating sorbent has regularly cropped up in the media and now more so on social media. Faced with the *MV Wakashio* oil spill, Mauritians found themselves at a loss to deal with the pollution that hit the country in July 2020. The idea of contributing to the response by donating hair hit home for a large number of people who volunteered to collect human hair and make sorbent booms. This material, which was readily available on the island, offered the opportunity to take action from the very first days after the pollution began to reach the coast and to compensate for a lack of manufactured sorbents. In order to assess its performance in terms of retention capacity and to provide an opinion on the use of hair as a hydrophobic floating sorbent, Cedre procured hair and conducted laboratory tests. The results showed that:

- when in contact with water, loose hair or hair booms soak up 1 to 2 times their weight in water. There are therefore not considered to be hydrophobic. They soak up water and sink;
- when in contact with oil, loose hair or hair booms soak up 2 to 3 times their weight in oil.

Despite strong media coverage, the results obtained in the laboratory indicate that the use of hair as a sorbent is a good initiative that can be implemented pending the supply of manufactured sorbents. It is not however sufficiently effective to be used in the same way as recommended hydrophobic floating sorbents, which have higher retention capacities than those measured with hair.

Behaviour of hair in contact with water and oil

By Pascale Le Guerroué,
Head of the Laboratory at Cedre.

On-site assistance from ITOPF

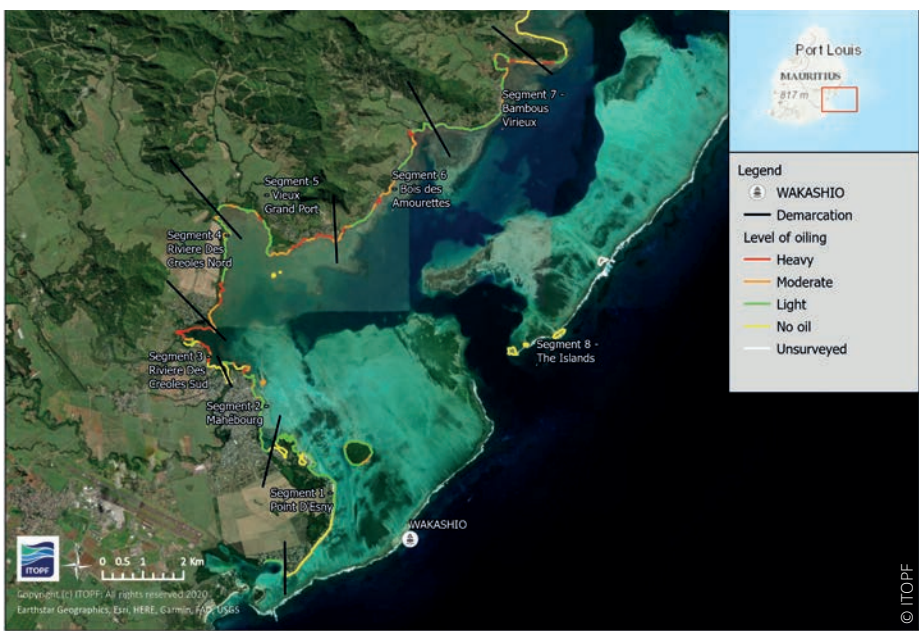
By Dr. Conor Bolas, Technical Adviser, ITOPF.

ITOPF was mobilised on 6th August 2020 following the initial oil spill but only arrived on site in Mahébourg on 12th August, due to the limitations on travel as a result of the Covid-19 pandemic. Entry into Mauritius, after a negative PCR test, was by charter plane alongside clean-up contractors and was followed by an initial confinement period in a hotel room for 24 hours and a further negative PCR test before being allowed to access the affected areas.

For ITOPF, the initial few days of the incident focused on getting an overview of the contamination during the emergency phase and identifying many of the anticipated challenges ahead for the multiple stakeholders in the incident. With residual oil still floating within the lagoon and uncertainty on the quantity of oil remaining in the vessel, it was a fast-changing and dynamic situation. The first formal survey was undertaken with Government of Mauritius officials as a bus tour alongside other stakeholders including the contractors, the Japanese coastguard, the Mauritian coastguard and surveyors for the Japan P&I Club. Due to the disordered nature of the bus survey organised by the Government and the length of affected shoreline, there was insufficient time to carry out a full detailed survey in this manner. Therefore, further surveys were done in several teams.

Independently, ITOPF walked and surveyed the entire affected shoreline, creating a comprehensive map of the level of contamination (see below). This detailed survey allowed previously unrecorded contaminated sites to be located as well as some of the challenges of the terrain to be anticipated. In conjunction, small survey teams consisting of ITOPF, the contractor, a Ministry of Environment official and surveyors for the P&I Club undertook detailed surveys of affected sites and discussed measures to clean-up the oil contamination in more depth.

The extent of contamination was very heavy in certain areas, particularly large areas of mangroves and along the waterfront of several villages. During these surveys, volunteers and groups from the Civil Defence agency in Mauritius were observed removing bulk oil from the shoreline. These volunteer clean-up attempts, whilst well-intentioned, were generating large volumes of waste that proved very hard to transport and were also causing a large degree of secondary contamination.



Level of oiling of the affected coastline

Oiled mangrove

While performing the surveys, a number of challenges, both anthropogenic and natural, were encountered that hindered progress. To properly define the clean-up strategy of each site and to get approval from the Government for the chosen techniques, it required a number of individuals to be present and it often proved difficult to organize a time that suited everyone. Often there were last minute cancellations or changes that meant that a decision was delayed for as much as several weeks. Performing shoreline surveys was often hampered by tidal restrictions which prevented access or being able to see oil in the sediment. Indeed, much of the coastline is dense mangrove forest and mud-flat which are not conducive for access. Access from the sea was also often not possible as the water is shallow and littered with obstacles to navigation. Additionally, many of the access points were private residences or in public areas that required permission to access or a security presence once clean-up operations had started.

Oil and floating shoreline debris

Following a full survey of the entire affected shoreline, it was possible to split the area into different segments, zones and sites and establish an official clean-up plan. Each segment contained between three and four zones and within zones there were varying numbers of worksites. Each contractor was responsible for four segments. The sites within the zones were chosen to reflect land vehicle access points, the extent of contamination and natural collection points or natural landmarks in the area. Prioritization on the sites took into consideration the extent of contamination, the likelihood of oil remobilization and the potential for that site to be used by members of the public, for example a public beach or the waterfront of a town. In this regard, the first sites to be cleaned were Mahébourg waterfront and the public beaches of Rivières des Créoles, Vieux Grand Port and Bois des Amourettes as well as commercial properties at Bambous Virieux.

During this time, there was immense pressure from the Government to begin the formal clean-up by the contractors as soon as possible. The organized shoreline clean-up was delayed both by the need to first remove and dispose of the waste that had been collected by volunteers that was stored haphazardly around the coastline mainly in large metal drums and also by the need to remove the improvised bagasse booms of which the total length was almost 50 km.

All the information gathered in the various surveys was compiled in a Clean-Up Plan, produced for the Government of Mauritius by ITOPF and Le Floch Depollution to outline the shoreline segmentation, the anticipated clean-up techniques and potential associated challenges.

With the implementation of clean-up operations and a daily presence on the sites, the question of the remobilization of the oil and various coastal debris due to tidal currents, and thermal shifts of the wind quickly arose. Booms and systems isolating the sites being cleaned up were thus deployed to prevent re-contamination of areas already treated. Throughout the operations, regular follow-up surveys were carried out mainly by ITOPF, representatives of the Ministry of the Environment, and P&I Club Surveyors until the termination of the shoreline clean-up operations in January 2021.

Clean-up operation monitoring team

MV Wakashio: clean-up of mangroves and beaches

Clean-up operations by Le Floch Dépollution

By Pauline Morvan, Le Floch Dépollution.

This incident marked a new turning point in the field of oil spill response. Indeed, the pollutant spilled is a new type of oil known as VLSFO (Very Low Sulfur Fuel Oil), with a different behaviour compared to the type of oil with which we are usually confronted, therefore requiring an adaptation of our cleaning techniques. Furthermore, this disaster occurred during the COVID pandemic, complicating the intervention and organization of our team to respect the strict protocol imposed by the Mauritian Government.

The clean-up operations were carried out in 2 phases:

- **Phase 1**: manual collection to recover the oil liable to be washed back out to sea in order to prevent the contamination of unpolluted areas. This technique is tedious but allows selectivity when recovering the pollutant, thus limiting waste.

- **Phase 2**: once phase 1 was completed, where further cleaning was required, we used mechanical techniques (flushing, high-pressure cleaning with heated sea water, skimming) depending on the amount of oil and the nature of the substrate, while respecting biodiversity. Given the proven effectiveness of these techniques, we are proud to never have used any chemicals, even biodegradable ones.

For this spill, the main technique used was flushing, notably due to the nature of the pollutant, which is much more liquid and therefore infiltrated the ground very quickly. This technique proved very effective in rocky and sandy areas.

As high-pressure cleaning is very aggressive, it was not used in the mangroves but only on "hard" surfaces with low ecological sensitivity (such as docks, concrete walls, rocks...). Other techniques were used in very specific places during these operations, such as mechanical skimming, cleaning of pebbles and gravel with a concrete mixer...

⋀ High-pressure cleaning of a dock

Particular attention was paid to the mangroves. Manual collection was essential in this ecosystem, which had already been heavily damaged by the oil. This involved removing the bulk of the oil from the roots and leaves with sorbents, then rinsing with a very large volume of water at low pressure in order to remove the remaining traces of oil. Clean-up of the mangroves was the most time-consuming operation, involving meticulous work by a limited number of operators to minimise trampling in these areas.

⋀ Clean-up using the flushing technique

⋀ Before and after: clean-up of the Pointe d'Esny site

The problems encountered during this operation were:

- limited access due to the site configuration (e.g. along busy roads) or tides (difficult access to mangroves or rocky areas at high tide);

- manual collection was slowed further as we encountered a lot of waste (plastic litter, scrap metal, tyres, etc.) which had to be sorted (separation of oiled and unoiled waste).

A dozen people were mobilised from France to supervise these operations, which required the recruitment of more than 400 operators in total, with a daily average of 200 operators, all of whom were trained by our team of supervisors and worked in difficult conditions (heat, adverse weather conditions, difficult access). In total, more than 40 km of coastline was cleaned in less than 6 months.

The role of Polyeco in the clean-up operations

Polyeco undertook the triple role of performing shoreline clean-up work, protecting the Lagoon area and managing the solid hazardous waste collected during Phase 1 of the *MV Wakashio* Grounding Project.

During the shoreline clean-up operation, a strong mobilisation of more than 250 local people was required in order to deliver 21 km of clean shoreline in the south-east of Mauritius, one month prior to its January 2021 due date. Twenty-one sites were cleaned including environmentally sensitive areas such as mangroves, nature reserves, as well as popular tourist destinations.

The three-stage methodology was followed by the collection of floating oil on the sea surface and of bulk oil ashore during the emergency phase, removal of oiled shoreline material and stranded oil during the project phase and clean-up of light contamination and removal of stains during the polishing phase. A plethora of techniques were employed depending on the type of shoreline and the level of contamination including manual collection of oiled debris, sieving of beach material to recover tarballs, flushing and flooding, high pressure washing of infrastructure, and wiping with absorbents and brushing with soft brushes on delicate surfaces.

The greatest challenge for Polyeco was finding a way to recover buried oil from mangrove areas. The issue remains under-researched with few methodologies in the literature revolving around flooding to reduce the disturbance to the roots of the mangroves, avoiding trampling and substrate erosion. When combined with the facts that the effects of VLSFO on mangroves are practically unexplored, the low viscosity of VLSFO allows it to soak very quickly into the sediment, the use of a geo-slicer coring device revealed that the oil had penetrated to depths up to 15 cm, together with the extent of the affected area (1,800 m^2), an innovative solution was necessary.

The Polyeco Incident Management Team overcame this challenge by designing a nozzle that sprays medium/low pressure water into the sediment in various directions. The nozzle penetrates the sediment at a maximum depth of 15 cm so that disturbance to the roots is reduced as far as practicable. This method was proven to be the most effective in recovering buried oil without significant disturbance to the sediment.

Regarding the protection of the Lagoon, Polyeco deployed oil booms in the wreck area in order to maximise the amount of oil contained and recovered at the source. Utilising skimmers and the low draft (0.80 m) skimmer vessel capable of safely operating in the Lagoon that was airlifted to Mauritius, 340 m^3 of oil mixed with sea water were collected. Additional booms were deployed to protect biologically sensitive areas such as river mouths and RAMSAR sites.

The total quantities collected during the shoreline clean-up operation were approximately 2714 tonnes of contaminated solid hazardous waste in 4045 FIBCs of 1 m^3, 241 IBCs of 1 m^3 and 5108 drums of 220 litres comprising non-pumpable oily sludge, contaminated soil and debris, absorbent materials, contaminated drums and IBCs etc.

These were transported to the Interim Storage Facility for Hazardous Waste, which is the only licensed facility to accept solid hazardous waste in Mauritius. The Interim Storage facility is operated by Polyeco SA, located at La Chaumiere Bambous, approximately 50 km from Blue Bay area, and comprises inter-alia four separate hazardous waste storage buildings of floor area 4500 m^2 and a laboratory for the analysis of hazardous waste accredited by ISO 17025:2017.

More than 60 people (Haz-Mat Experts, Supervisors, Foremen, etc.) worked for more than 6 months in order to sort, repack and safely store the collected waste in 3980 FIBCs of 1 m^3.

Clean-up in a mangrove

The exportation of the waste was scheduled to start by the beginning of July 2021 after the approval of all relevant permits in accordance with the Basel Convention for the Control of Transboundary Movements of Hazardous Waste.

The exportation of waste from Mauritius to licensed facilities in Europe for energy recovery will be carried out by a specially chartered ship due to their large volume.

By Konstantinos Chatzatoglou and Nikos Vlachos, Polyeco.

Clean-up effectiveness

Back to the question of *"How clean is clean?"*

By Ivan Calvez, engineer, Research Department at Cedre.

From an environmental protection perspective, shoreline clean-up strategies following an oil spill are increasingly factoring in the need to avoid inflicting more severe environmental damage than that caused by the spill itself. This preoccupation includes the question of whether or not to implement response actions, and if so, the level of cleanliness to be achieved.

This means assessing the need to continue or terminate operations, based on cleanliness levels beyond which it is reckoned that the induced benefits, in terms of promoting site restoration processes, will be trivial or in fact lower than the risk of causing further environmental damage by jeopardising these same processes.

This question of "How clean is clean?", which underpins the definition of endpoint criteria, appeared notably following the *Exxon Valdez* spill in the United States.

The definition of cleanliness levels requires various contextual factors to be taken into account, in order to make decisions reflecting a compromise between what is ecologically, economically and socially acceptable, and technically feasible. These factors require knowledge of the potential impacts of spills, response techniques but also the unique specificities of each spill: type and quantity of oil; site characteristics and affected habitats (natural degradation potential, type of substrate, etc.); sensitivities (ecological, economic) of these sites, etc.

Sensitive mangrove site featuring heavily oiled Rhizophora mucronata *in August 2020 (treated using the flooding technique and manual wiping): checking for the absence of oiled debris or layers of remobilisable oil on silt substrates or on/between the roots. Positive signs can be observed (young shoots, open lenticels, crab burrow openings, etc.)*

Uses/functions	Guidelines – Possible objectives
Shoreline (ecological function)	At the water surface/in the water: • no visible slick or major sheen liable to significantly oil wildlife (birds, mammals, etc.) upon contact Shoreline as a habitat (e.g. mangroves, marshland, foreshores, etc.): • does not require to be "visually clean" (sensitivity to response); • residual oil (e.g. distribution, thickness) must not inhibit ecological restoration due to toxic or physical effects (smothering). Shoreline as an element of the ecosystem (interactions with other coastal habitats): • residual oil must not be mobile or at risk of contaminating adjacent habitats (coastal waters, other sites, etc.).
Port structures (walls, quays, etc.)	• No visible floating oil; • no possible oiling of people or boats due to rubbing/contact.
Tourist beaches	• No tar residues (bathing); • no visible oil; • no odour, visual detection, or greasy feel to the sediment; • no possible oiling of people due to rubbing.

A few examples of possible clean-up objectives, according to uses or sites concerned (taken from various studies by Cedre, a compilation of discussions and concrete cases on the theme of "How clean is clean?")

In the absence of a universally accepted methodology, the general approach to the "How clean is clean?" concept is that clean-up operations are not longer deemed necessary when all the following conditions are met:

- there is no longer any mobile oil visible on or in the water, or on the nearby shores;
- all actions required/adapted to prevent new damage have been implemented;
- any residual oil has no evident impact on the functioning of ecosystems or on site uses;
- the continuation of clean-up operations would risk leading to environmental damage outweighing the benefits;
- the possible techniques are no longer able to successfully or significantly promote natural restoration processes on the affected sites, in particular the most sensitive sites (e.g. mangroves in this particular case).

Yet it is important to bear in mind that the notion of "clean", and therefore the achievement of a sufficient level of cleanliness, can evidently be perceived in different ways according to the type of interest in the affected sites, stakeholders, etc. Consequently, there is no universally accepted benchmark, even less so a strict standard, but rather rough guidelines developed based on discussions and past experience, which can be used as a reference to define certain clean-up objectives according to the site characteristics (ecological value, uses, etc.).

These objectives and the corresponding clean-up endpoints proposed should be tailored to each spill according to local specificities (environment, specific issues, etc.).

Some five months after clean-up operations began on the shoreline segments affected by the *MV Wakashio* spill, the Mauritian authorities sought technical assistance from Cedre to provide on-site advice on the achievement of satisfactory clean-up levels, with a view to deciding on clean-up site closure.

The method adopted in this context was to make direct, mainly qualitative observations in the field (with supporting notes, photographs, etc.) working jointly with the stakeholders. This consensus-seeking approach is relatively flexible, fast and adaptable to many cases of spills to assess whether or not to continue clean-up operations. It was applied to more than 40 sites, including a large number of ecologically sensitive fringe mangroves, but also sediment foreshores including sandy beaches that are popular tourist attractions, and sections of hard substrates, i.e. rocks or structures, linked to various uses.

The field surveys conducted aimed to assess, at each of the cleaned sites, the presence or absence of residual oil and, where present, its state (e.g. free oil, oiled debris, sheen, etc.), form (viscosity/fluidity, film/residual stains, accumulations, etc.) and its location on the substrates and habitats. Based on a detailed report of these observations, comprising the characteristics of each site (e.g. habitats/substrates; presence of vegetation, associated wildlife, etc.) and the status of the pollution at the time of the survey, we were able to check the clean-up levels achieved against the guidelines, in terms of objectives and endpoint criteria, according to the type of environment concerned.

Subsurface inspections to check the level of cleanliness of a sediment foreshore (stones on sandy mud) treated by flushing (with low pressure hoses) to extract the infiltrated oil

Checking for any oil that may be remobilised or likely to cause oiling due to rubbing, present on the surface or in the cracks/pores of a port structure (here: grouted stone wall treated by rinsing followed by high-pressure cleaning)

ULSFO and VLSFO: low sulphur fuel oils

Fuel oil from the MV Wakashio *after 1 week of weathering in the Polludrome®*

The European project IMAROS *(Improving response capacities and understanding the environmental impacts of new generation low sulphur MARine fuel Oil Spills*, 2020-2022), funded by the European Union's Civil Protection Mechanism and involving partners from 6 different countries (Norway, Sweden, Denmark, Belgium, Malta and France), aims to gain a better understanding of the characteristics and behaviour of low sulphur fuel oils in order to develop operational recommendations in case of a spill. An appropriate operational response will mitigate the impacts on the marine environment as well as the socio-economic impacts on the affected coastal communities.

By **Fanny Chever**, engineer,
Analysis and Resources Department at Cedre.

The bunker fuels used by vessels are generally heavy fuel oils, produced through the distillation of crude oil. Sulphur, which is naturally present in crude oil, is often present in these fuels in high concentrations. When used in combustion engines onboard vessels, sulphur oxides (SOx) are emitted into the atmosphere. These SOx emissions have harmful effects on human health and the environment. New regulations aimed at lowering the sulphur content of marine fuels are therefore necessary in order to protect humans and the environment.

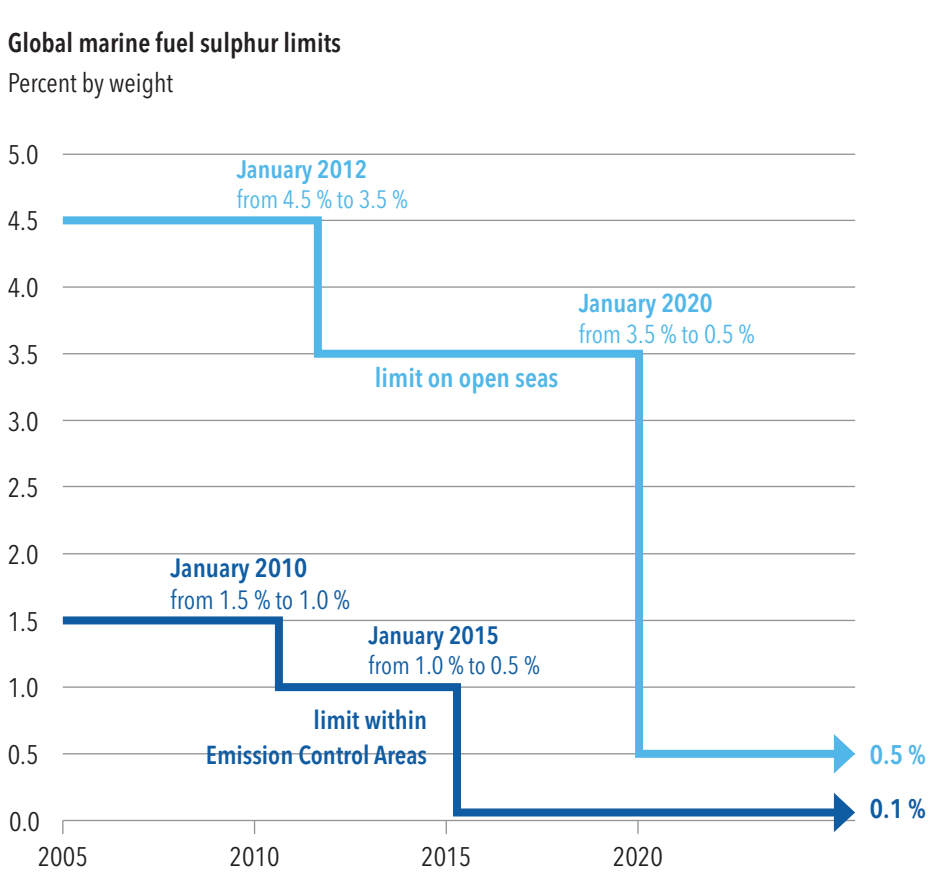
New regulations, new Sulphur Emission Control Areas (SECA)

International Maritime Organization (IMO) regulations to reduce sulphur oxide emissions from ships first came into force in 2005 under Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL Convention). Areas known as SECA (Sulphur Emission Control Areas) where sulphur emissions are more tightly controlled (and where the sulphur content of the fuel oils used must be lower) have been defined. Within these SECAs (North American coastal areas, the US Caribbean Sea area, the North Sea and the Baltic Sea), the sulphur limit is lowered to 0.1%. In addition, since 1st January 2020, the overall sulphur limit for fuel oils used on board ships has been lowered to 0.5% (mass by mass).

New issues

These regulatory changes have led to new generation bunker fuels. Fuel oils with a sulphur content of less than 0.5% are referred to as VLSFO (Very Low Sulphur Fuel Oil), while those with a sulphur content of less than 0.1% are known as ULSFO (Ultra Low Sulphur Fuel Oil).

These fuel oils are difficult to categorise based on existing standards and can be a real challenge if they are spilled at sea. The categories VLSFO and ULSFO comprise fuel oils with very different physico-chemical properties and therefore with very varied behaviour and potential toxicity, resulting from mixtures of products with only one specific criterion in common: their sulphur content. A previous study carried out by one of the project partners on a limited



Global marine fuel sulphur limits.
Source: U.S. Energy Information Administration, based on IMO

panel of fuel oils had already evidenced the diversity of products, the complexity of the operational response in the event of a spill and the uncertainties regarding the environmental impact of these products. The IMAROS project is a continuation of this project and aims to study around ten products.

IMAROS project organisation

The project focuses on three scientific activities. The first, now completed, consisted in carrying out a state-of-the-art review of LSFO products transported off the European coasts. Discussions were held with LSFO producers and distributors by each project partner to obtain as much information as possible on these products (market share, composition, manufacturing process, etc.). Thirteen 2-litre samples were obtained following this collaborative dialogue. A sample of VLSFO from the *MV Wakashio* was also sent to Cedre to be studied as part of the project.

The second activity consisted of an initial experimental phase devoted to the physico-chemical characterisation of the 13 samples and the study of their behaviour when released at sea. The samples obtained were analysed in the laboratory to characterise their sulphur content, viscosity, density, pour point, flash point, chemical fingerprint, asphaltene and paraffin content, evaporation rate and potential chemical dispersibility. Two temperatures representative of European waters were chosen: 5 °C and 15 °C. The results showed considerable variability between the products for all the parameters measured, meaning that they will behave differently if spilled at sea. These results alone highlighted the need for better knowledge of the products in order to adapt response strategies according to the properties of the individual product. Three of these 13 products, representative of the variability in the panel of samples collected, were then selected for a second, more in-depth experimental phase. Their weathering and behaviour are to be studied at pilot scale, as well as their ecotoxicity. The *MV Wakashio* bunker fuel was also selected for this test phase.

The final activity focused on assessing the efficiency of various response techniques. Using the same three products, a range of response techniques will be tested: recovery, sorption, chemical dispersion, in-situ burning, and clean-up of rocky substrates.

The operational recommendations developed through this project will help to enhance response capabilities in the event of a spill of this type of new generation fuel and improve response methods and equipment in the future.

Rapid dispersibility test

Regional cooperation

By CEPPOL and the Réunion naval base.

On 25th July 2020, the *MV Wakashio* ran aground on a reef off the south-east coast of Mauritius. The French armed forces for the Southern Indian Ocean (FAZSOI) were mobilised to support their Mauritian partner to respond to the oil spill caused.

On 6th August, at the request of the Mauritian authorities, an incident management unit was activated, bringing together the FAZSOI office for State Action at Sea, the South Indian Ocean Sea Directorate (DMSOI), the Maritime Rescue Co-ordination Centre (CROSS), FAZSOI, the diplomatic unit and the French military staff for the defence zone.

Thanks to this inter-administration organisation, spill response equipment was immediately dispatched, as of 8th August, simultaneously:

- by aircraft, with two trips by a CASA CN-235*, carrying 5.5 tonnes of equipment, including 600 m of boom, and a team of military and civilian experts;
- by vessel, departing from the naval base in Port-des-Galets. The *BSAOM** *Champlain* carried onboard 700 m of sorbent and offshore booms, several types of skimmers and pumping equipment, accompanied by a team of specialists in onshore and offshore oil spill response, later reinforced with experts from CEPPOL* and Cedre.

⋀ *The* BSAOM Champlain *loading response equipment*

The Mauritian Prime Minister thanked the Minister for Overseas Territories during his visit and praised France for its rapid and effective response and its logistical, technical and organisational expertise for this major international incident.

⋀ *Loading containers of spill response equipment onboard the* BSAOM Champlain

SAY WHAT ?

***CASA CN-235**
Tactical transport aircraft

***BSAOM**
French overseas support and assistance vessel

***CEPPOL**
French Navy Centre of Practical Expertise in Pollution Response

Assistance from France

By Antony Abeilard, DMSOI/Phares et Balises - POLMAR and Emmanuelle Poupon, Studies and Training Department at Cedre.

Towing an offshore boom towards the wreck of the MV Wakashio

After the *MV Wakashio* ran aground, the Mauritian authorities requested France's assistance as of 6th August under the sub-regional oil spill contingency plan of the Indian Ocean Commission member States. From 6th August, France prepared to dispatch equipment and personnel. The POLMAR stockpile in Reunion prepared and packed containment and recovery equipment: 600 m of medium-sized inflatable boom, 400 m of offshore inflatable boom, 2 skimmers (with motor pumps, hoses and fittings), 340 m of sorbent boom, 100 m of suction hoses, 120 m of discharge hoses.

Given the urgency of the situation (need to protect the Blue Bay Marine Park) and the restrictions on air transport (limited capacity in terms of weight, combustion-powered equipment must not contain any fuel), it was agreed that the 600 m of medium-sized boom, weighing approximately 5,100 tonnes, would be transported by plane (CASA mobilised by FAZSOI) and that the rest of the equipment (approximately 30 m³) would be transported to Mauritius by ship (onboard the *BSAOM Champlain*). On Saturday 9th August, 1 container and 3 reels, each carrying 150 m of boom, were transported by road to Roland Garros airport in Saint-Denis, Reunion. They could not be loaded as is onto the aircraft in their usual form. The booms had to be unrolled before manually loading them onto the aircraft. A first trip was made on the Saturday morning, carrying 300 m of boom, a POLMAR shoreline expert from DMSOI and a POLMAR maritime liaison officer from the State Action at Sea division. The second flight was organised in the afternoon. The *BSAOM Champlain* set sail on the Saturday afternoon and arrived in Port Louis the following morning.

Upon arrival in Mauritius, the equipment was transported to Pointe d'Esny by the National Coast Guard. On the Sunday afternoon, the 600 m of medium-sized boom was deployed to protect Blue Bay Marine Park. Meanwhile, the offshore boom was towed to the *MV Wakashio* to contain the oil escaping from the breach. Given the adverse weather conditions and limited towing capacities, the offshore boom was finally positioned between the vessel and the reef.

Loading a boom onto the plane

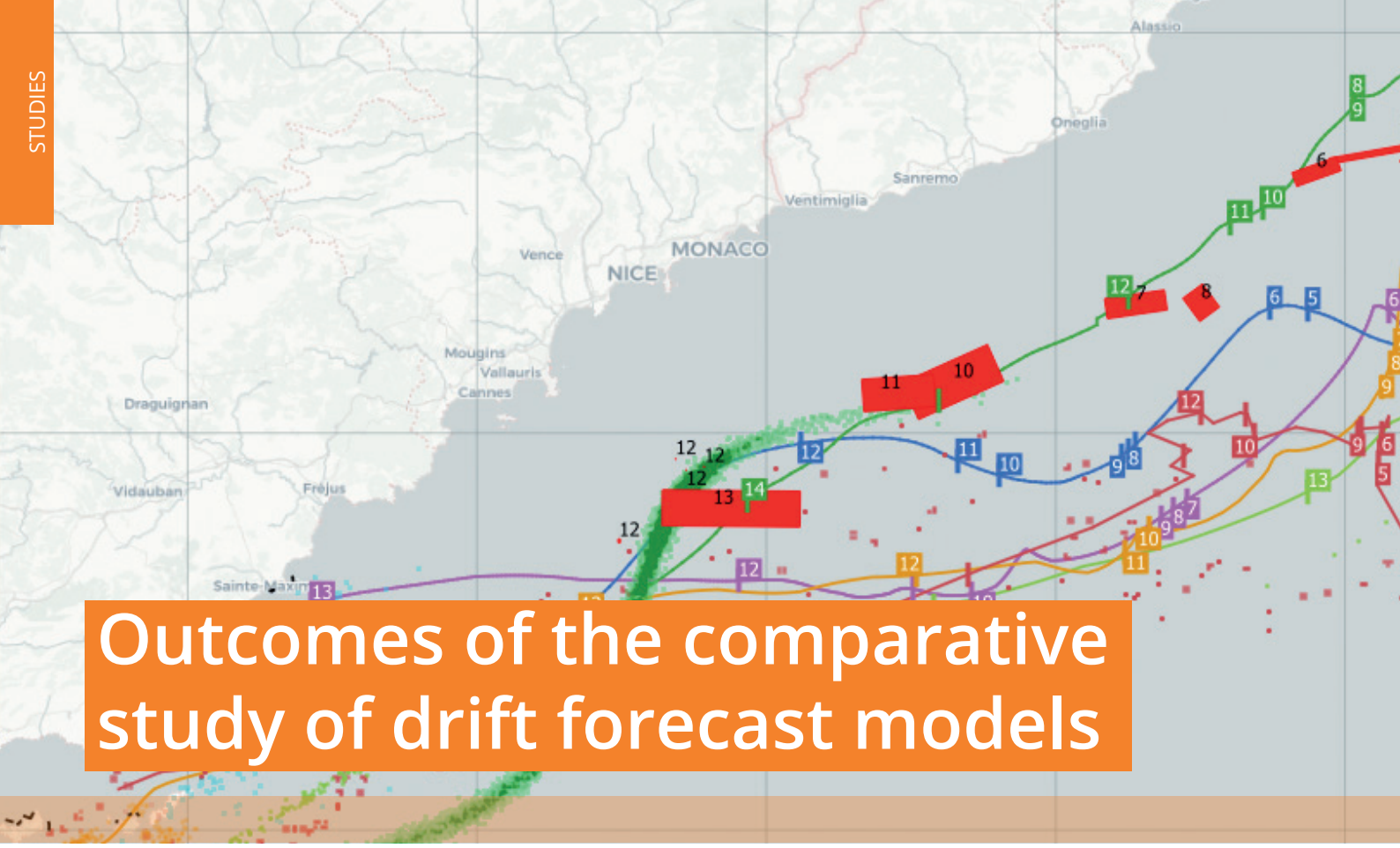
DRIFT COMMITTEE

The Drift Committee was consulted to find a solution that would take into account environmental protection

The French slick drift monitoring and prediction committee studies how spills evolve in time and space, in order to support incident management decision-making by the maritime authorities. Led by Cedre, this Committee is composed of representatives of Météo-France, Ifremer and SHOM (French Naval Hydrographic and Oceanographic Service). It can also include representatives of any other relevant national or foreign organisation. The Committee modelled oil leaks for several potential scuttling locations for the bow section of the *MV Wakashio*. Based on these results, the French authorities were able to argue in favour of areas that would result in the least impact on the coastline of Reunion and Mauritius.

By **Vincent Gouriou**, GIS specialist, Information Department at Cedre.

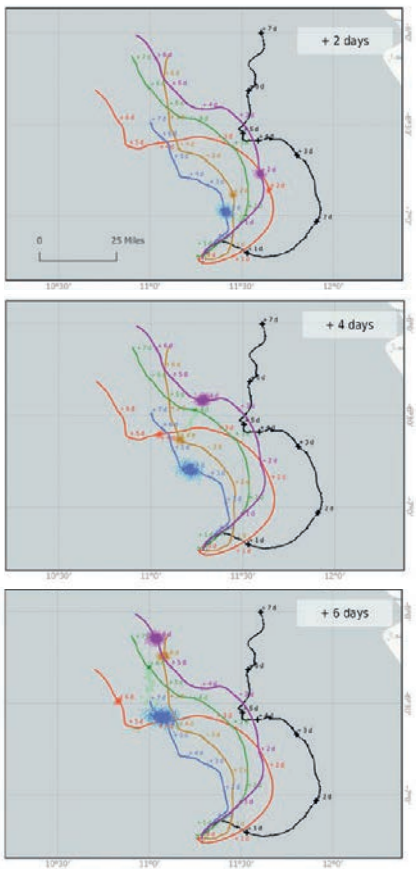
Outcomes of the comparative study of drift forecast models



Comparison of drift forecast models for the Ulysse/CSL Virginia *incident*

By Vincent Gouriou, GIS specialist, Information Department at Cedre.

When an oil spill occurs, it is essential to determine and anticipate slick drift and behaviour (physico-chemical evolution) in order to support decision-making by the incident commander who will direct vessels at sea and prepare resilience for shoreline sites. Today many slick forecast models exist that each use a broad range of metocean data. The aim of this study was to test and compare different models, based on 5 different scenarios including the sinking of the *Grande America* and the *Ulysse/CSL Virginia* collision. The performances and limits of 11 models (institutional and commercial) were analysed via an operational approach. This study, funded by the French Navy and Total Energies, was carried out with support from and on behalf of France's Drift Committee: Cedre, Météo-France, SHOM and Ifremer.



Comparison of drift models for the Argos *incident off Angola*

The models already used by the Drift Committee gave good results and the many configuration tests together with in-depth discussions with modellers and developers led to better knowledge and improvement of these tools: Météo-France's MOTHY transport model, NOAA's ADIOS oil weathering model and the RPS OILMAP transport and behaviour model.

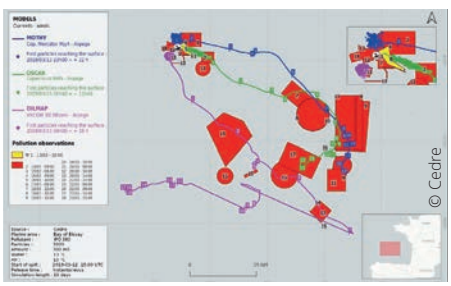
In general terms, the importance of using different oil drift models was highlighted so that the drift committee can compare several modelling outputs and discuss their relevance.

The quality of transport modelling is of course dependent on the quality of the metocean data. Many tests and fruitful discussions with the modellers led to better knowledge of these data and their influence on drift.

The study also confirmed the importance of refitting models based on observation data (aerial and satellite) and emphasised the need for accurate information associated with these observations (slick contours, estimated quantity, etc.).

Many other parameters are responsible for drift forecast quality: wind factor, Coriolis effect, wave action, changes in the physico-chemical characteristics of the oil, etc. Certain models can be configured manually while others have directly integrated these parameters. Through this study, we were able to identify and understand their influences on drift and configure their settings.

Finally, this study also provided an opportunity to gain a better understanding of data and model accessibility and availability, and to solve technical problems relating to data input, in order to be as operational as possible in an emergency.



Comparison of drift forecast models for the Grande America *incident*

In 2021, Cedre organised two exercises (in French Guiana and in the Mediterranean) during which drifter buoys were launched, with the assistance of CEPPOL, to simulate an oil spill. The Drift Committee was activated and used the various modelling tools selected based on this study. Cedre was thus able to test the models and data access as well as the dissemination of the results in the form of maps.

Marine litter hotspots along the coastline of mainland France

By Silvère André, engineer, Aquatic Litter Monitoring and Studies Department at Cedre.

All along the coastline, there are specific areas where marine litter is most likely to accumulate. It is important to identify these sites in order to accurately characterise the litter that washes up on the shores, to pinpoint the most affected areas, and to organise clean-up. Beach clean-up currently remains the main solution implemented by local authorities to remove litter washed up on the coast. Marine litter hotspots are therefore a major concern for coastal municipalities as they require additional resources and effort in terms of cleaning and to manage the litter collected.

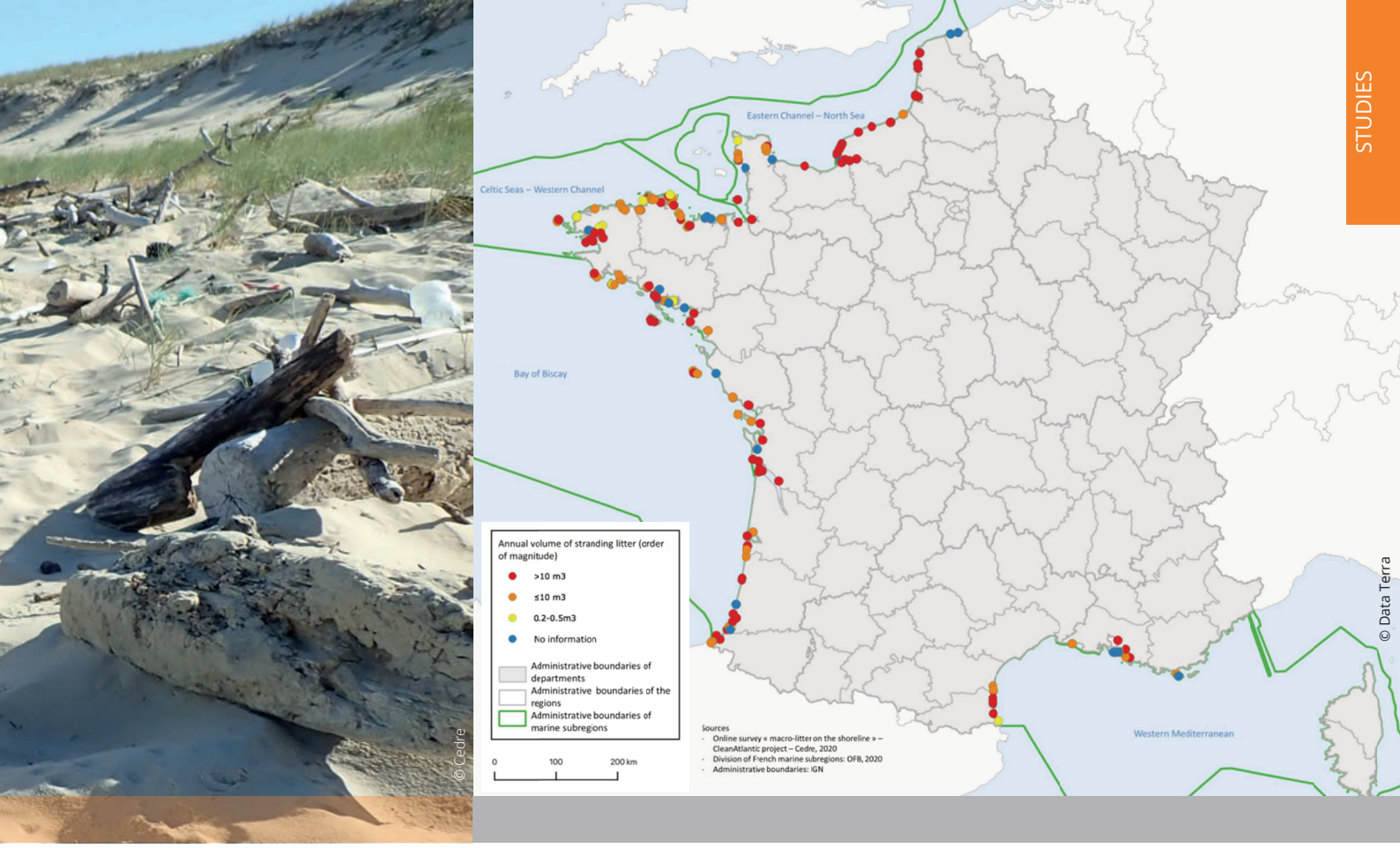
An online survey

In order to identify marine litter hotspots along the coastline of mainland France, an online survey was prepared and sent out in late 2020 with the support of the consultancy firm Data Terra. This survey targeted the national stakeholders involved in organising, implementing and financing coastal clean-up, in particular local authorities, marine protected areas as well as public establishments, associations and cooperatives specialised in marine litter.

This work was carried out through the European Interreg Atlantic Area project CleanAtlantic* aimed at protecting biodiversity and ecosystem services within the Atlantic Area by strengthening marine litter monitoring, prevention and removal capacities. It also comes under action 19 "Conduct an inventory of coastal litter hotspots" of France's "Zero Plastic Waste at Sea" Action Plan (2020-2025)* as well as actions 55 and 56 of the OSPAR Convention's Regional Action Plan for Marine Litter*.

A total of 105 responses to the survey were received. The answers given provide information on the geographical distribution and nature of these litter accumulation sites. The respondents were mainly municipalities, site managers and associations covering limited geographical areas, and gave a good overview of the situation and of local issues associated with these litter accumulation sites.

Foamed polystyrene collected from a 100 m-long stretch of beach



Main litter hotspots identified along the coastline of mainland France

Sites dotted along the entire coastline, with geomorphological differences between regions

Sites along the entire coastline of mainland France

The survey respondents identified 207 litter accumulation sites along the coastline of mainland France. These sites are mainly in the Bay of Biscay (79 sites) and the Celtic Sea - Western English Channel area (63 sites). Fewer sites were identified in the Eastern English Channel - North Sea marine sub-region with 41 sites. Finally, the Western Mediterranean marine sub-region was not originally targeted by the online survey as it was outside the scope of the CleanAtlantic project. Fewer sites were therefore identified in this marine sub-region with a total of 24 sites.

Numerous hotspots

In terms of quantities, almost half of the sites identified showed annual quantities of litter estimated at over 10 m^3. These sites where vast quantities of litter are washed up can be considered hotspots. They are mainly located on the shores of the Celtic Sea and Western English Channel, where they represent 80% of the litter accumulation sites identified.

Litter accumulated on the upper foreshore

Specific characteristics in each area

The analysis of the typology of the sites identified in the survey shows that litter is liable to accumulate on any type of shore: sandy beaches, shingle beaches, rocky coves, etc. Coves will tend to trap litter while wide open coasts have multiple accumulation points which are dependent on currents and waves. The survey nevertheless showed that the nature of accumulation sites is dependent on the local geomorphological characteristics. In Aquitaine, accumulation sites are mainly located on vast dune belt, while in Upper Normandy they are mostly found on shingle bars.

Various negative effects identified

Different levels of environmental impact

Environmental impacts are the negative effects that are most associated with litter accumulation sites by respondents, ahead of economic impacts. The presence of litter exerts additional pressure on coastal systems that are sometimes already impacted by climate and weather conditions as well as human activities. Litter is liable to become buried and to interact with coastal vegetation by entanglement or covering. It becomes integrated in dune systems and is remobilised with every storm during the erosion phase. Litter also has an impact on wildlife (ingestion, entanglement, presence of litter in nests).

Litter accumulated and trapped in the dune

A blemished image leading to more vigorous cleaning

Litter hotspots also have economic impacts, in particular on the image of the local area, which can be tarnished when large quantities of litter are present, triggering a drop in tourism. Many clean-up actions are therefore organised, at great expense. Among the shoreline clean-up techniques mentioned by respondents, manual litter collection is the favoured solution, although certain local authorities implement mechanical collection using beach cleaners or mechanical raking machines. These clean-up actions represent an additional pressure on the coastal environment. Based on this knowledge, practices are now changing, with a focus on justified and discriminate use of machinery for cleaning. This calls for the development of good practices, including, for example, carrying out selective cleaning that does not include driftwood, or taking into account the breeding seasons of certain species, particularly birds.

Acknowledgements

We would like to thank all the organisations and individuals who took the time to complete the survey, as well as all those who agreed to share the survey link via their own networks.

SAY WHAT ?

*CleanAtlantic Interreg Atlantic Area project

Project co-funded by the European Interreg Atlantic Area programme involving 18 partners representing five member countries: France, Ireland, Portugal, Spain and the United Kingdom.
More information at: www.cleanatlantic.eu

*"Zero Plastic Waste at Sea" Action Plan (2020-2025)

A set of 35 measures resulting from the French Interministerial Sea Committee (CIMER) meetings, aimed at reducing the input of macro- and micro-litter, particularly plastics, into the seas and oceans by 2025, with a view to reaching the target of "Zero plastic at sea by 2025" set by the French Ministry of Ecological Transition's Biodiversity Plan.

*OSPAR Regional Action Plan for Marine Litter (RAP ML)

OSPAR Commission Action Plan for Prevention and Management of Marine Litter in the North-East Atlantic, including 23 national actions and 32 collective actions to address land-based and marine sources, as well as education and awareness-raising actions and elimination actions.

Cedre's laboratory

By Julien Guyomarch, Analysis and Resources Department Manager at Cedre.

Pending the launch of the laboratory extension project, planned for 2022, the last few years have allowed us to consolidate our practices, to develop new analytical capacities by equipping existing systems, or by replacing measuring equipment with more efficient tools. These improvements go hand-in-hand with the development of the services we offer, which include an ever-expanding range of analyses and tests, both routine and bespoke.

The laboratory's activities can be divided into three main categories which reflect the evolution of the issues tackled by Cedre over the past 20 years. Cedre's long-standing testing and analysis activity on oil products was supplemented, some ten years ago now, by a major analytical development to include organic micropollutants, before being more recently extended to plastics and other associated additives.

Oil, and in particular crude oil, is studied at laboratory scale after distillation then emulsion formation. These samples, representative of different durations at sea, are then characterised by chemical measurements (detailed and overall compositions) and physical measurements (viscosity, density, flash point), followed by dispersibility tests (Cedre is equipped with the main devices developed in Europe and the United States), biodegradability tests and even in-situ burning tests. In addition to these tests, spill response products (sorbents, dispersants and washing agents) are also tested and subsequently included in the lists published by Cedre if the results meet the defined criteria.

The analytical equipment covers a wide range of target molecules, relating to oil and chemical spills, but also to chronic pollution in the case of organic micropollutants or plastics.

Gas chromatography coupled with mass spectrometry (GC-MS) is used to quantify the most volatile dissolved compounds in the samples, either directly or after Stir Bar Sorptive Extraction (SBSE) of dissolved molecules for semi-volatile compounds. This system is also equipped with a pyrolyser, meaning it can now identify the nature of plastics, in addition to infrared spectroscopy (FTIR).

The second GC-MS system is used for pollutant identification, either by comparing an oil sample taken from the natural environment with a potential source of contamination, or by determining the nature of an unknown product (paraffin or solid vegetable oil in most cases). Using this equipment, it is also possible to perform GCxGC analyses, in particular to monitor the evolution of an oil product exposed to degradation processes. Gas chromatography–tandem mass spectrometry (GC-MS/MS) analyses are performed for trace molecules in the environment, by SBSE, but also to quantify them in more complex matrices such as biological tissues.

The preparation and analysis equipment also includes: an automated Accelerated Solvent Extraction (ASE) system used to analyse biological tissue and sediment samples; a ball mill; and a chamber for weathering materials under controlled conditions.

Cedre's laboratory

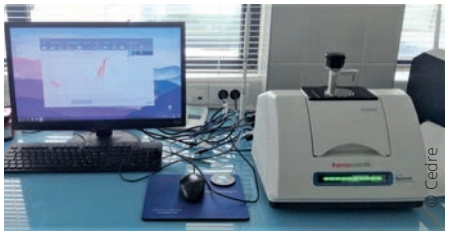
Samples analysed in the laboratory

Finally, Cedre conducts various ecotoxicity tests in the laboratory, in particular tests conducted in compliance with OSPAR protocols, on algae, copepods and amphipods. Our dispersant testing procedures also include tests on shrimps, while the Microtox test on luminescent bacteria is a valuable screening tool, regularly used in our studies.

New equipment

By Marie Babinot and Anne-Laure Cassone, engineers, Aquatic Litter Monitoring and Studies Department Manager at Cedre.

Cedre recently invested in two new pieces of equipment. The first is a Fourier-Transform Infrared (FTIR) analyser equipped with a microscopy unit. It is used to analyse the chemical composition of different substances. In particular, it is able to identify the type of polymers present in plastics (polyethylene, polypropylene, polystyrene, etc.). It is used to determine the nature of samples collected on the shoreline as part of the litter monitoring networks led by Cedre.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Fourier-Transform Infrared (FTIR) analyser

The second is a weathering chamber designed to simulate the weathering of litter in the environment under controlled conditions, by exposing it to radiation (reproducing intense sunshine) and a constant and continuous temperature. This chamber is used in particular within the framework of the European project OceanWise to carry out accelerated weathering of expanded and extruded polystyrenes as well as biosourced and/or biodegradable plastics, in order to study and compare their physical, mechanical and chemical evolution.


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Weathering chamber

more info
www oceanwise-project.eu

Facilities recreating a port area

By Loïce Dagorn, engineer, Studies and Training Department engineer, Cedre.

Cedre has developed facilities characteristic of port areas to train personnel in the containment and recovery of oil or chemical spills liable to occur in these complex environments, in order for trainees to gain hands-on experience during practical sessions.

Two aluminium pontoons, brought from Concarneau harbour where development work is in progress, have been given a second lease of life at Cedre. This 54 m² floating platform is equipped with a power supply pedestal and a fuel station. With a diesel storage tank under removable grating, as well as a gutter system along the banks, new spill scenarios can now be simulated using real oil for training purposes.

The following facilities have also been installed:

- a walkway to offer trainees safe access and to facilitate the deployment of response equipment;
- permanent booms;
- various mooring and tidal/water level compensation systems;
- various emergency containment systems so that trainees can tackle a variety of leak and spill scenarios by implementing different technical solutions.

This new facility will allow us to meet the growing demands of our port sector partners and clients for spill response training for their personnel.


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Port zone at Cedre's technical facilities

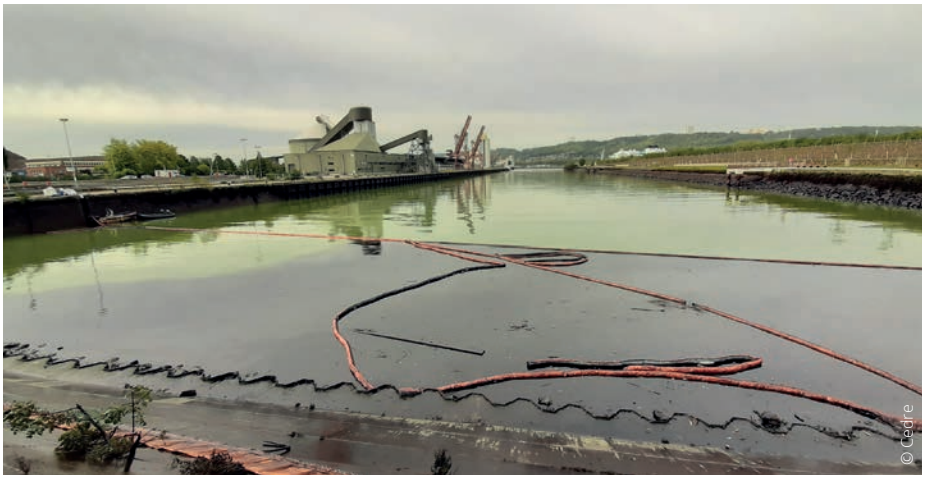
Blaze at the Lubrizol plant

By Anne Le Roux, Emergency Response Coordinator at Cedre and Arnaud Guéna, Production Manager at Cedre.

On 26th September 2019, a fire broke out affecting the Lubrizol chemical plant and Normandie Logistique warehouses in Rouen (Seine-Maritime). The blaze and the extinguishing operations resulted in the pollution of a nearby harbour basin. Cedre assisted the authorities and Lubrizol during clean-up operations.

The fire and emergency measures

A major fire-fighting effort was undertaken. The fire and rescue service also secured and cleared the site. The extinguishing equipment was demobilised on the evening of 7th October.



Pollutant contained at the end of the Bassin aux Bois harbour basin

On 26th September, the authorities identified the risk of contamination of the Seine River via the Bassin aux Bois harbour basin, close to the site of the blaze. A boom belonging to the port of Rouen (GPMR) and a POLMAR boom were deployed to contain the pollutants inside the harbour basin. A tug equipped with fire-fighting equipment was also positioned at the basin exit channel where it created a water flow to prevent the floating pollutants from escaping from the basin.

Operators from GPMR and the berthing cooperative also recovered (using skimmers and sorbents) and trawled the bulk of the floating pollutants. Many facilities were contaminated, while the exact nature and behaviour of the pollutants was known. The Safety Data Sheets (SDS) for the products stored by the two companies were promptly made available online, however it was not possible to determine all the possible interactions between the different products, especially during a fire and extinguishing operations.

Cedre's role in the field

The authorities requested Cedre's advice on the various products released into the Bassin aux Bois harbour basin, in particular effluents from oil products. Cedre sent two people on site for a first mission on 1st and 2nd October 2019. A survey, conducted jointly with the relevant authorities and agencies (Polmar-Terre correspondent, DDTM and AFB, now OFB), revealed the presence of remobilisable pollutant and deposits (ranging from a thin film to thicker layers) at various locations in the Bassin aux Bois basin. Thicker layers of pollutant as well as large amounts of floating and stranded debris were contained inside the boom. The presence of outfalls raised questions about the possibility of new inputs of pollutants from the Lubrizol site. The other areas visited (notably the grain and forestry terminals) did not appear to be affected, indicating that containment operations inside the harbour basin were effective. Recommendations were issued by Cedre's representatives.

During this first on-site mission, samples of water and floating pollutant were taken. The analysis results showed the presence of mineral oils and other compounds, some of which could not be identified by Cedre's laboratory.

Lubrizol then contracted *Séché Environnement* to clean the dock walls and structures in the Bassin aux Bois harbour basin. Cedre subsequently visited the site several times to fine-tune its initial recommendations and adapt its technical advice based on the evolution of the situation on site. Many different types of sites were affected: gabions, riprap, vegetated areas, walls, solid or hollow quays, and outfalls. Moreover, the area is affected by tides and some of the structures are old or even fragile. Some clean-up sites would be particularly complex, such as the south quay, under which pollutants were trapped.

In total, Cedre carried out 7 field missions from 1st October 2019 to 15th October 2020, ranging from initial surveys to clean-up site closures.

South quay (hollow) at low tide

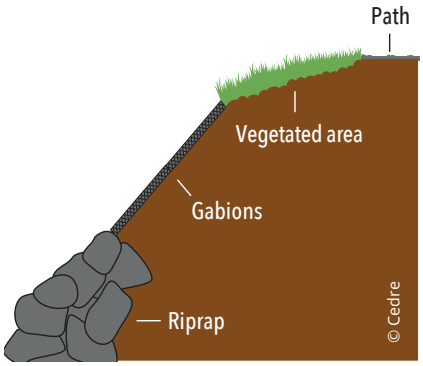
Clean-up operations

Pumping operations on the water and the cleaning of the quay walls were conducted by *Séché Environnement* after dividing the area into segments. Several segments with different pollution and substrate characteristics requiring different techniques and equipment were identified.

On the water, the first step consisted in containing the pollutant with the initially deployed POLMAR boom, with an additional inshore boom as well as skirted sorbent booms. The pollutant was recovered by skimming and pumping, then stored in a tanker truck before being evacuated from the site. In addition, a vessel belonging to the company Efinor was mobilised to facilitate the recovery of small slicks and floating debris drifting in the containment area driven by the tides and wind.

Onshore, three main segments were identified:

- The north wall, which had recently been reconfigured by the local authority and is made up of boulder riprap, gabions, a vegetated area and a pathway along the entire length of the basin. The main techniques implemented in this segment were manual collection and storage of stranded debris and large accumulations of pollutant in big bags; washing of riprap and gabions with impact lances and fire hoses; mowing of vegetation and rinsing of the vegetated area with a fire hose. Effluent from washing operations was contained and recovered from the water using skirted sorbent booms and sorbent pads. At the end of operations, geotextile was laid over the riprap and gabions to protect them from further contamination.

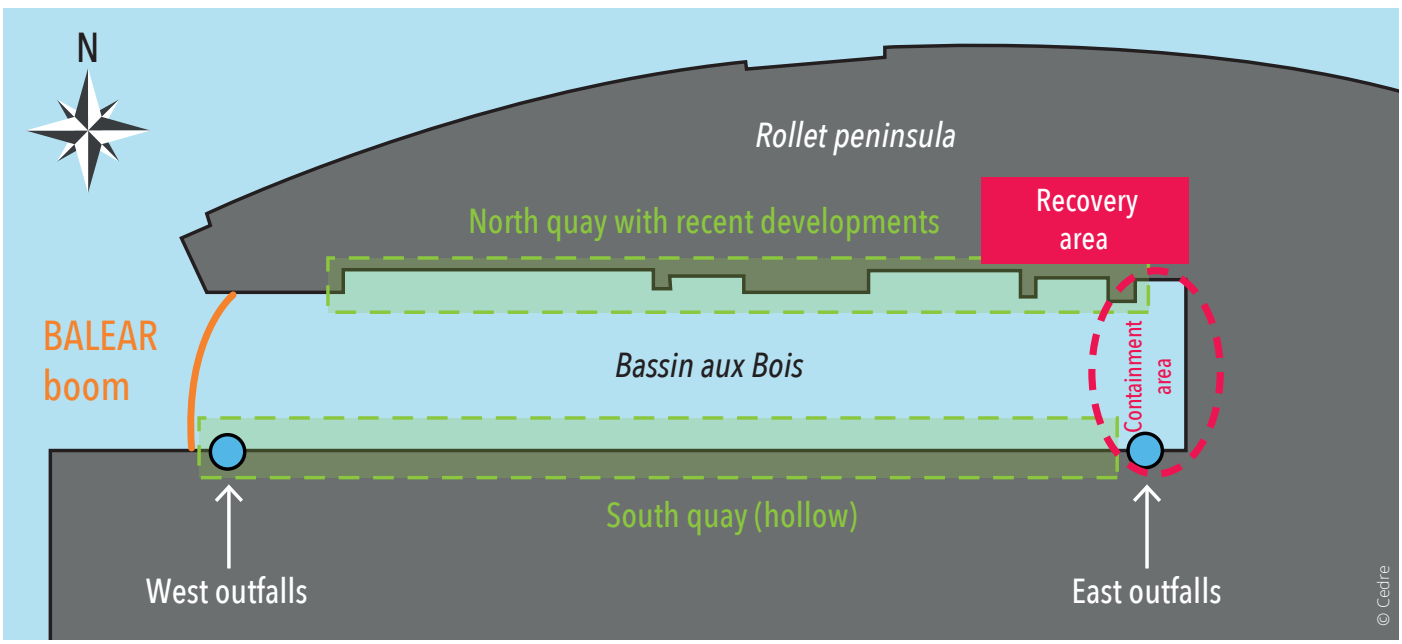


Cross-sectional view of the north quay embankment

- The far end of the harbour basin, which constituted the containment area as prevailing winds tended to push the thickest layers of floating pollutant and largest quantities of floating debris towards this end. The main pumping area for floating pollutant was set up here. It consists mainly of loose boulders and mixed sediments, topped with a smooth concrete slope. In the northern part of this segment, the response techniques consisted in manual collection of debris and small pieces of driftwood, removal of washed up stumps and trunks with a hoist, washing of boulders with impact lances and finally washing of the concrete wall with a high-pressure cleaner. As previously, the effluent was contained and recovered on the water.

- The southern wall, which is part red brick, part concrete, is in fact the front of a hollow quay through which several outfalls pass. This is where the most complex operations were carried out. Firstly, surveys were conducted by operators and by video camera around the outfalls, where pollutant was liable to accumulate. These surveys indicated that cleaning operations were not necessary, as natural rinsing by tidal movements was sufficient. The quay front was cleaned with fire hoses and high pressure cleaners. The most difficult operations were inside the hollow quay, for which divers were required to carry out investigations and deploy pumping equipment, mainly a skimmer that had to be adapted to be deployed inside the quay. A ROV (remotely operated underwater vehicle) was required to validate clean-up.

Clean-up operations on the north wall and the far end of the harbour basin were mainly carried out until November 2019, following the spring tides in late October. Operations on the south quay took considerably longer, as pumping operations inside the quay were only



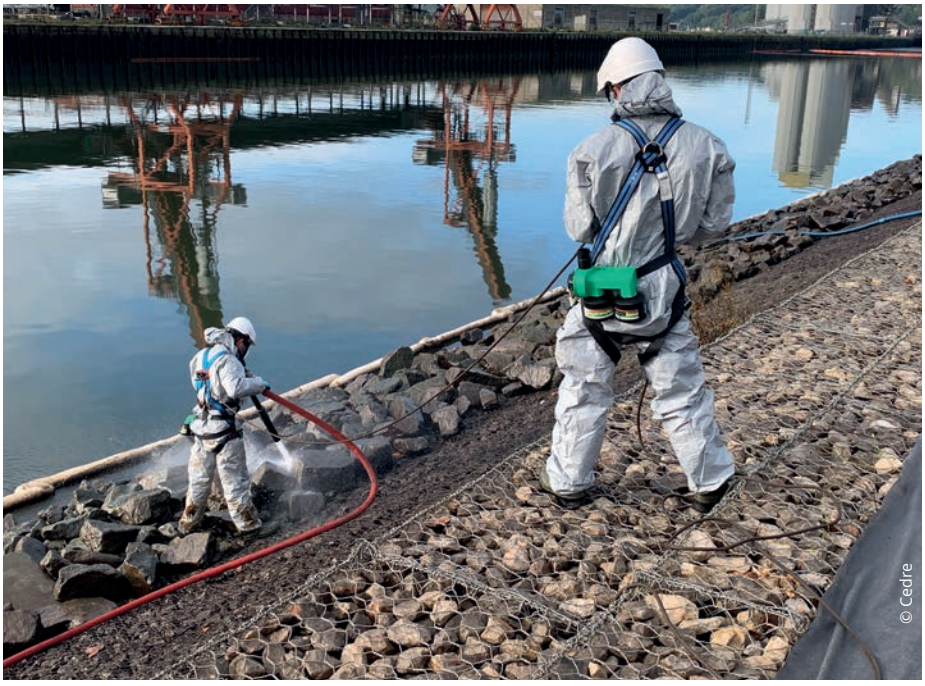
Site plan showing spill response set-up

possible in certain tidal conditions. It was not until 18th September 2020 that the operations were validated by the various stakeholders after inspection of the inside of the structure by a ROV. It was recommended however that a floating boom be left in place to contain any possible release of pollutant that may have escaped the investigations by divers and the ROV, especially in certain areas where neither could enter due to structural disorder. A final visit to the site was organised on 15th October 2020 and revealed no pollutant within the boom, indicating that no pollution remained in the area. Clean-up operations were thus definitively validated one year after the incident.

Certain difficulties encountered

From the outset, various factors complicated cleaning operations:

- Poor knowledge of the nature of the pollutant meant that maximum precautions had to be taken by the operators, in particular by wearing filtering facepiece respirators, which slowed down operators and required them to take regular breaks.
- The presence of large quantities of stranded or floating litter and wood meant that it had to be collected prior to pollutant recovery and clean-up operations. Lifting equipment was even required to move tree stumps from the harbour basin. Not only did their presence reduce the efficiency of the pumping equipment, it also increased the amount of waste generated.
- The large tidal range in the Bassin aux Bois meant that the pace and schedule of the operations had to be worked around tide times and durations, which are particularly variable in river areas, and required the operators to constantly adapt.
- The fragility and the hollow structure of the south quay, which, although these difficulties had been previously encountered on several occasions in relation to other spills, were in this case aggravated by the fact that the quay was not completely open, but had a front wall covering the upper section. The only way to access the polluted area was therefore by passing underneath, which required divers.



Cleaning the north quay

Pollutant recovery vessel

- Given that the use of this harbour basin is shared, with the southern half being used as a port and industrial area while the northern half has been restored as a recreational area open to the public, there was higher demand in terms of clean-up in order to re-open the northern part to the public.

View of the upper part of the north bank

Collaboration agreement signed with OFB

By Camille Lacroix, Aquatic Litter Monitoring and Studies Department Manager at Cedre.

At the end of 2020, Cedre and the French Biodiversity Agency (OFB) signed a collaboration agreement geared towards strengthening their partnership on the theme of aquatic litter. This agreement is set to contribute to better coordination of aquatic litter monitoring actions conducted on a national scale by Cedre and on a more local scale within marine protected areas, particularly marine nature parks. More generally, this agreement will foster dialogue between Cedre and OFB and will promote synergy in the implementation of public policies for litter reduction in aquatic environments.

New members join our aquatic litter monitoring networks

By Silvère André and Marine Paul, engineers, Aquatic Litter Monitoring and Studies Department Manager at Cedre.

Cedre currently coordinates three national monitoring networks relating to macro-litter on the shoreline (RNS-MD-L), macro-litter from drainage basins (RNS-MD-BH) and microplastics in beach sediment (NMN-MP-P). Eight new operators recently joined these networks to monitor new sites: *CPIE Bassin de Thau*, the *Groupe Associatif Estuaire (du Payré)*, the association Environat, the association Explore & Preserve, the association Marineland, the association *Nature Libre*, Port-Cros National Park and the company Veolia. Welcome aboard!

CPIE Bassin de Thau, Environat, Explore & Preserve and Marineland will be involved in monitoring sites on the Mediterranean coast, in Villeneuve-lès-Maguelone, Hyères and Antibes. The *Groupe Associatif Estuaire* will be monitoring a site on the Vendée coast, at Jard-sur-Mer, while Veolia will supervise a site on the beach at La Baule in Loire-Atlantique. Meanwhile, Environat and *Nature Libre* will contribute to the monitoring of sites on the banks of the Gironde and Liane estuaries.

Our networks now comprise 57 monitoring sites, supervised by our 37 partner operators.

Finistère fire brigade training centre

By Natalie Monvoisin, Training and Studies Department Manager at Cedre.

As part of its prevention, protection and fire-fighting duties, the Finistère fire and rescue service (SDIS29) is required to train its 2,500 professional and volunteer firefighters. Plans are currently afoot to build a departmental training centre in the heart of Finistère, close to the Quimper/Brest highway. This specialised training centre for fire, technological and industrial risks will include classrooms, accommodation and a technical platform. Cedre has been involved in discussions since the launch of the studies for the establishment of this centre. In particular, we are involved in the design study for the training centre where conditions will be recreated for operational manoeuvres and the deployment of oil and chemical spill response equipment. This project is an excellent opportunity for Cedre and the fire brigade to seal a partnership which has existed for many years, to pool their resources and thus widen the scope of possibilities in terms of training.

Taiwan EPA: ongoing cooperation on the topic of inland waters

By Natalie Monvoisin, Training and Studies Department Manager at Cedre.

In December 2020, an online training course on pollution in inland waters organised by private Taiwanese firm GI Tech was run by Cedre via its online training platform (**elearning.cedre.fr**). Drawing on its experience in this field and its knowledge of the Taiwanese context, Cedre ran two half-days of classes for just over 70 participants, 60 of whom were from Taiwan's Environmental Protection Agency (EPA) with which Cedre has now been working in close collaboration since 2012. This collaboration was in fact strengthened in November 2016 with the signing of a Memorandum of Understanding.

The aim of this course was to provide participants with an overview of the issues involved in managing such events and in response actions in inland waters by presenting response strategies, decision-making processes and spill behaviour in complex environments. The course ended with a presentation focusing on a past example of a spill in a mangrove.

Theory training via a video conference

ISMI: an IMO 2 training course for 13 countries in the Gulf of Guinea

By Natalie Monvoisin, Training and Studies Department Manager at Cedre.

Faced with recurring threats to maritime security in the Gulf of Guinea, the African and international maritime community has introduced various instruments at regional and international levels. Côte d'Ivoire thus created the Interregional Maritime Security Institute (ISMI) with the support of key partners such as France and the Regional Academy of Marine Science and Technology (ARSTM).

Under its mission to train and strengthen the capacities of civilian and military managers from administrations and private entities with maritime expertise or activities, ISMI decided to include a spill response training course in its 2021 training programme. Following on from our successful cooperation in 2018 for the organisation of a seminar on "Marine environment and offshore hydrocarbons resources exploitation", Cedre was called upon to run the 2021 training course. Two theory sessions were run virtually, for French and English-speaking audiences. Two trainers from Cedre then travelled to Abidjan to run tabletop exercises, as well as a one-day practical session carried out with the support of the port and SIR (*Société Ivoirienne de Raffinage*). 25 trainees representing 13 countries in the Gulf of Guinea were trained to IMO 2 standards, thanks to this initiative financed by French cooperation.

Balex Delta 2021 exercise

By Anne Le Roux, Emergency Response Coordinator at Cedre.

At the invitation of the Finnish Border Guard, two engineers from Cedre took part in the Balex Delta 2021 exercise organised near Kotka, in Finland.

This large-scale exercise, organised annually by the HELCOM contracting parties, was based on an ambitious scenario: a collision between a chemical tanker and an oil tanker resulting in a xylene leak and a spill of 20,000 tonnes of oil. The marine response part was carried out by vessels belonging to HELCOM contracting parties and an EMSA vessel played the casualty chemical tanker. The inshore response and shoreline clean-up were implemented by the emergency services and volunteers. Cedre was an observer and assessor for the activation of MAR-ICE by the Finnish authorities, the HNS response at sea, the preparation phase for shoreline clean-up and the setting up of a bird rehabilitation centre. We were also able to observe some of the oil spill response operations at sea.

This exercise was the first operational test for the Marine HNS Spill Response Manual, whose production was coordinated by Cedre as part of the West MOPoCo project (see page 29).

Members of the Maritime Incident Response Group plugging a leak

Cedre coordinates a new European project

By Laura Cotte, engineer, Research Department and Stéphane Le Floch, Research Department Manager at Cedre.

MANIFESTS: MANaging risks and Impacts From Evaporating and gaseous Substances To population Safety

Funded by European Union Civil Protection and Humanitarian Aid

Approximately 2000 different Hazardous and Noxious Substances (HNS) are regularly transported by sea in bulk or packaged form. The quantities transported are constantly increasing, with approximately 200 million tonnes of HNS traded each year by merchant ships. As an upshot, there is a heightened risk of accidents and spills at sea. HNS spills at sea can lead to the formation of clouds of toxic, flammable or even explosive gases. Response to such spills is extremely difficult to manage as there is little data available to assess the hazards for responders or the risks of impact on coastal communities by providing a place of refuge for a casualty vessel.

Co-funded by the EU Civil Protection Mechanism (DG-ECHO), the 2-year project MANIFESTS (MANaging risks and Impacts From Evaporating and gaseous Substances To population Safety) aims to address these uncertainties and improve the response capabilities of spill responders by developing innovative decision support tools and operational guidelines, and by facilitating access to knowledge and relevant databases on spills of volatile HNS at sea.

The main expected outputs include:

1. operational guidelines;
2. experimental data on the fate of gas clouds;
3. experimental data on the evaporation/dissolution kinetics of HNS;
4. a fire and explosion modelling module.

All these elements will be compiled in a decision support tool which will be directly accessible online and which, by definition, will provide essential elements to support crisis management in the event of a spill.

The MANIFESTS project has received strong support from the national authorities of the different countries involved, and will also benefit from the technical and logistical expertise of the French Navy during practical exercises and trials at sea.

PARTNERS

MANIFESTS is coordinated by Cedre and involves 8 other partners:

- CETMAR (*Centro Tecnologico del Mar*) – Spain
- DG-ENV (*Direction Générale pour l'ENVironnement du Service public fédéral*) – Belgium
- ARMINES (*Association pour la Recherche et le Développement des Méthodes et Processus Industriels*) – France
- RBINS (Royal Belgian Institute of Natural Sciences) – Belgium
- IST (*Instituto Superior Tecnico*) – Portugal
- INTECMAR (*Instituto Tecnologico para el Control del Medio Marino de Galicia*) – Spain
- MET.NO (Norwegian Meteorological Institute) – Norway
- PHE (Public Health England) – United Kingdom

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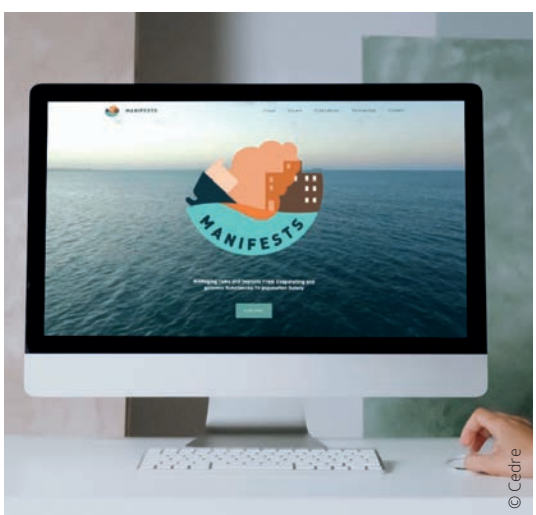

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⋀ *Communication materials for the MANIFESTS project*

more info
www manifests-project.eu

NEW Aquatic Litter Monitoring and Studies Department created

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By **Camille Lacroix**, Aquatic Litter Monitoring and Studies Department Manager at Cedre.

Against a backdrop of increased activity on the theme of aquatic litter over recent years, Cedre created a new department devoted to this issue at the beginning of January, entitled "Aquatic Litter Monitoring and Studies". The main missions of this department, with its five-strong team, are:

- to provide the authorities with scientific and technical support for the implementation of public policies on aquatic litter,
- to improve knowledge of its fate and impacts in aquatic environments and of solutions;
- to contribute to the development of methodologies to quantify litter in the environment;
- to raise awareness and inform stakeholders.

The department is strongly focused on the coordination of national monitoring of beach litter and litter from drainage basins under the Marine Strategy Framework Directive (MSFD) and the Regional Sea Conventions OSPAR and the Barcelona Convention. It also offers its expertise within various national and European working groups and is involved in national and international projects.

These actions are carried out in collaboration with many partners, in particular the French Water and Biodiversity Directorate under the Ministry of Ecological Transition, the French Biodiversity Agency (OFB), Ifremer, as well as with European experts working on aquatic litter and many other national partners, members of monitoring networks and the scientific community working on plastic pollution.

NEW RECRUITS

Silvère André

After obtaining a bachelor's degree in physics and chemistry, Silvère graduated with a master's degree in Analytical Chemistry, focusing on "Optimisation of experimental protocols" with a specialisation in spectroscopy and chemometrics. He then went on to pursue a PhD at the LASIRE laboratory at the University of Lille and presented his thesis on "Contributions of Raman spectroscopy and chemometrics to in situ cell culture monitoring" in December 2016. He completed his research work during a 6-month post-doctoral position at the LASIRE laboratory before creating and managing the company LENSKEM with two associates, offering services in chemometrics and data analysis. He first worked at Cedre in March 2019, analysing physico-chemical data collected during in-situ burning experiments conducted by Cedre and Ineris on behalf of TotalEnergies. In September 2019, he worked on litter characterisation in the North-East Atlantic (European project CleanAtlantic), and then on the management and analysis of data collected by aquatic litter monitoring networks. In January 2021, he joined the new Aquatic Litter Monitoring and Studies (SEDA) team as a data management and analysis engineer.

Marine Paul

Marine chose a multidisciplinary course of study, including a degree in biology and earth sciences, a master's degree in geosciences and a master's degree in environmental and coastal expertise and management with a specialisation in coastal geomorphology through her internships. She started her career with Brittany's regional environment directorate DREAL where she worked on the risks along Brittany's coastline, before joining the Litto3D® unit at the French Naval Hydrographic and Oceanographic Service (SHOM) to contribute to data production and processing. When Marine first joined Cedre she was tasked with conducting an inventory of marine litter initiatives in the Atlantic area (European project CleanAtlantic). Her role was later broadened to encompass the management of the monitoring networks for beach litter and for litter from drainage basins. On 1st January 2021 she joined the new SEDA department as an environmental engineer in charge of managing and overseeing the aquatic litter monitoring networks. Following intensive in-house emergency response training, she has just joined Cedre's duty team, bringing her mapping software skills to the task.

Fanny Jouannin

Fanny trained as a risk prevention and environmental engineer at ESAIP in Angers. Under a work-study programme, she worked at EDF CNEPE (*Centre National d'Équipement de Production d'Électricité*) where she studied the external flooding risks at nuclear power plants. She completed her internship at the Environmental Protection Agency (EPA) in Cork, Ireland. Fanny then went on to pursue a Master's degree in Marine and Coastal Science, with a specialisation in "Coastal Environment Expertise and Management" at the *Institut Universitaire Européen de la Mer* (IUEM). As part of her Master's course, Fanny completed an internship at Cedre in March 2019 in the Studies and Training Department, where she helped to restructure and modernise the training materials used for the exercise that wraps up the marine pollution crisis management course. In August 2019, Fanny joined Cedre's Research Department, before moving to the Analysis and Resources Department in February 2020 where she has worked as a research engineer ever since. In this position, she is involved in the evaluation of spill response technologies and knowledge development projects, while providing support to other departments at Cedre.

Morgane Le Gall

With a technical diploma in Management, with a specialisation in "Accounting and Management", Morgane started her career as an accounting clerk and then as an accountant in the supermarket sector and the construction sector for 2 years. She then worked as an accountant in charge of general accounting, including preparing the balance sheet, and in charge of human resources administration in the clothing industry for 8 years. On 12th October 2020, she was appointed Chief Accountant at Cedre, a position in which she is responsible for general accounting, including the preparation of the accounting closing process, social management (payroll and human resources administration), planning supervision and dashboard management.

Pierre Parenthoine

Pierre trained at the SeaTech School of Engineering in Toulon, where he specialised in maritime engineering, marine systems and marine technologies. After an internship as an oceanographic engineer at the Bedford Institute of Oceanography in Canada, he became a metocean studies officer for offshore sites for MRE projects at Nass & Wind Offshore, before landing a position as an offshore deep-water installation analysis engineer at SAIPEM. He volunteered under the Voluntary Civic Service scheme as a logistics coordinator for scientific missions in the Kerguelen Islands. Pierre then took the lead on the design project for the 1:10 prototype of the Eolink floating wind turbine, before becoming project manager for the scientific operations of the French Polar Institute in the sub-Antarctic islands. In March 2021 he joined Cedre's Studies and Training Department.

Alexandre Le Paih

Alexandre studied accounting, starting out with a diploma in Business and Administration Management, specialising in Finance and Accounting, before going on to earn a Bachelor's degree in Accounting and Management followed by a Master II in Control, Accounting and Audit. Following a one-year work-study programme working with a financial audit and accounting firm, Alexandre worked in an accounting firm for 3 years. Since 12th July 2021, he has been in charge of Cedre's accounts payable, including the management of purchase orders and supplier payments. He is being trained in the use of our internal management tools in order to contribute to management dashboards and planning and production administrative monitoring.

Maryline Porhel

To complete her studies at Bourges Higher National School of Engineering, where she specialised in industrial environmental risk management, Maryline carried out an internship with Cedre's Research Department working on an impact study on spills of acids and bases in seawater and fresh water. For ten years she worked as an engineer then project manager for polluted sites and soils with Inovadia in Quimper. In September 2021 she joined the team of engineers in the Studies and Training Department.

Loïc Harang

A graduate of ESAIP Graduate School of Engineering in Angers, Loïc also has a professional Bachelor's degree in Quality, Health, Safety and the Environment and a university diploma in Technological Studies in Health, Safety and the Environment. After a first experience as an HSE assistant in the industrial sector, he became an HSE engineering apprentice, with two successive positions in the agri-food sector and a position in the transport and logistics sector. Fully fluent in French and English, he joined the Studies and Training team in September 2021.

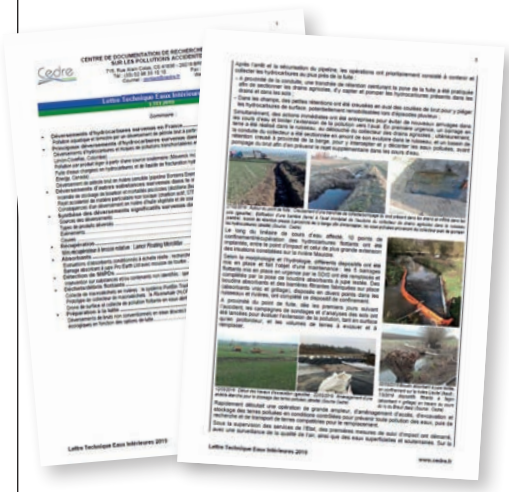
Mélanie Le Gall

Perfectly fluent in French, English and Spanish, Mélanie has a diploma in tourism and leisure which she was able to put into practice with several cruise companies and a hotel group at the beginning of her professional career. She then worked as a secretary and then as an executive assistant at DCNS and in a hospital. Mélanie joined the Studies and Training Department in October 2021 as an assistant.

NEW PUBLICATIONS

Marine HNS Response Manual

As part of the "Western Mediterranean Region Marine Oil and HNS Pollution Cooperation" (West MOPoCo) project co-funded by the European Commission and led by REMPEC, Cedre coordinated the drafting of the "Marine HNS Response Manual, Multi-regional Bonn Agreement, HELCOM, REMPEC". This operational manual provides a comprehensive approach for first responders and decision-makers in the event of marine incidents involving chemicals. This English-language document, produced in collaboration with ISPRA and ITOPF with contributions from the secretariats and Contracting Parties of the Bonn Agreement, HELCOM and REMPEC, was published in April 2021 and is available in print format and in an interactive version available online (www.westmopoco.rempec.org/en/project/specific-objectives-and-activities/hns-marine-response-manual).



Inland Waters Technical Newsletters

Our biannual "Sea & Shoreline" and "Inland Waters" Technical Newsletters, available in both French and English, are a gold mine of information. They provide a summary of our technology intelligence activity on past and recent spills in marine and inland waters. They include data on past incidents, a review of spills around the world, statistics, information on response preparedness, oil recovery, response techniques and recent innovations, compensation, environmental impacts, lessons learnt and slick drift, as well as details of recently published guidelines and recommendations. See all our Technical Newsletters on our website (Resources > Publications > Technical Newsletters).

2020 Annual Report

Cedre's 2020 annual report was validated at the General Assembly in June 2021 and published thereafter. It provides an account, supported with images, of the main incidents, projects and events that mobilised the team throughout the year. It reflects the scope of our activities and the diversity of our staff's skills, as well as a including a report on the association's general budget. It is available online at wwz.cedre.fr/Menu-secondaire/Rapport-d-activite and can be posted out upon request.

Pollustats 2020

This bilingual French-English document, published annually in a handy format, presents data obtained from an inventory of incidents around the world made known to Cedre and having resulted in an oil or HNS spill in surface waters. Our team of engineers with specialist knowledge of this data is at your disposal for further information. This document is available on our website (Resources > Spills > Statistics) and can be posted out upon request.

ALL OUR PUBLICATIONS ARE AVAILABLE FOR DOWNLOAD from our website

www cedre.fr

Resources section

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50 people

€5.5 million budget

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60 contingency plans delivered in the past 10 years

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150 emergency activations each year

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