FIGHTING TOGETHER AGAINST MARINE POLLUTION

Four detailed contingency plans of pilot EPSs developed

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Summary:

A. LEAD PARTNER – ZADAR COUNTY DEVELOPMENT AGENCY ZADRA NOVA

Executive Summary

As part of the contingency plans, the establishment of the Sali Operations Center is proposed. Its purpose would not only be early detection but also working to limit the spread of marine pollution in accordance with the County Operations Center.

In the event of a most likely earthquake, no significant marine pollution is expected. In the event of a strong earthquake, a rupture of the water supply and sewage pipes, submarine outfall pipes and a possible shutdown of the pumping stations are expected. This will be causing marine pollution until the repair of the said infrastructure. Remediation comes down to fencing and collecting pollution from the sea surface.

In the event of a major open fire, ash is expected to enter the sea by soil leaching and torrents. Prevention includes the maintenance of fire roads that can also be used for sightseeing in the presence of tourist guides. Action in the event of a sudden fire comes down to limiting the spread of pollution, collecting and disposing of macro-pollution from the sea surface.

In the event of a backwater, the preventive action is to raise the coastal fringe and install valves on the outlets into the sea so that sea water does not penetrate into the sewer. Preventive action against the occurrence of torrents is reduced to the construction of stairs and gratings that slow down the flow of water and thus reduce the ratio of materials from the ground. Action after the onset of sudden pollution comes down to limiting the spread and collecting macro-pollution from the sea surface.

Regarding the waste oil container, the best preventive measure that will significantly reduce the risk of marine pollution is the construction of a storage tank plant. In the event of an oil spill, a quick reaction in limiting the spread and collecting oil is paramount.

Preventive actions regarding ammonia containers in the “Mardešić” factory include regular control of the correctness of automatic mechanisms for reporting and stopping spills.

In the event of an ammonia spill, the affected soil on the way to the sea should be collected and disposed of.

Preventive actions regarding submarine outfalls include regular control of the correctness of the pipes to the outfalls and the operation of the outfalls themselves. In addition, it is necessary to rehabilitate the outfall of the “Mardešić” factory, i.e. to enable its operation as scheduled. In the event of sudden marine pollution, macro-pollution that has started to drift should be collected and adequately disposed of as soon as possible.

Macro-pollution is heavier than sea water and it will sink to the bottom, so divers should inspect the bottom after a sudden event, collect any pollution and dispose of it.

In case of a maritime accident, the Contingency Plan for Accidental Marine Pollution in Zadar County (2010) should be followed. The establishment of the Sali Operations Center (SOC) would be useful because it would add to the speed of detection and action until the arrival of forces from the County Operations Center.

The following is a description of a geographic information system consisting of a GIS database, a GIS data server (Geoserver) and a web page with a GIS module for visualizing spatial data.

At the end of the chapter there is a proposal for the procurement of equipment: AIS systems and cameras, recommended early petroleum and oil detection systems on the sea surface and proposed locations; a non-contact water level meter and proposed locations; GSM Smart Observer Datalogger and proposed locations; HydroCam and proposed locations; meteorological station; ship traffic monitoring system and proposed locations; drones, a floating protective dam and proposed locations.

At the end of the chapter there is Appendix 1 which contains key legal and natural persons for action in DCP with a list of available equipment, and Appendix 2 which contains the activation scheme of the Headquarters and the County Operations Center, as well as the notification flow scheme according to the Contingency and Action Plan for Oil and/or Oil Mixture Contamination.

Contingency plans in the event of accidental marine pollution

Introduction

Contingency plans for accidental marine pollution (hereinafter “Plans”) propose procedures and measures for preventive activities, preparedness for interventions in case of accidental marine pollution and exceptional natural events at sea within the pilot site or other areas within the scope of Zadar County.

The plans derive from the risk assessment model and are harmonized with the Contingency Plan for Accidental Marine Pollution in Zadar County (2010) and the National Response Plan of the Republic of Croatia for Accidental Marine Pollution (OG 92/08), and are based on measurements and assessments within the PEPSEA project - Pilot Study of Sali Bay.

Purpose

The purpose of the plans is to ensure effective, appropriate and timely preventive and intervention measures in case of accidental marine pollution or threat of pollution in order to reduce damage to the sea and coast, as well as reduce harmful effects of accidental pollution on the economy and protection of life, health and quality of life in Sali and Sašćica Bay, taking into account the existing contingency plans for accidental marine pollution adopted by the Government of the Republic of Croatia and the Zadar County Assembly. The plans are the result of a multidimensional analysis of the pilot location of Sali and Sašćica Bay in order to increase the efficiency of the existing and accepted plans.

RECOMMENDATION ON THE ESTABLISHMENT OF THE SALI OPERATIONS CENTER

Responsibility for the implementation of the plans lies with the County Operations Center (*Croat.* Županijski operativni centar – ŽOC).

Recommendation:

It is recommended to establish the Sali Operations Center (SOC) in Sali within the organization of civil protection which would perform the following tasks: propose preventive measures to the Municipal Council, be able to perform initial monitoring of the sea in case of accidental pollution in Sali Bay and Sašćica Bay and be the closest unit that could act to limit the spread and collect pollution until the arrival of manpower and equipment from the ŽOC. This is very important because rapid identification and action is key to effective remediation.

The Commander of the Sali Operations Center (SOC) in case of marine pollution is the Port Captain of the Port of Sali who would perform his authority and activity until the arrival of the SOC commander.

In the event of an accidental marine pollution, the SOC could assist in the following tasks and activities, in agreement with the ŽOC commander and until the arrival of the ŽOC forces:

- Implementation of plans
- Initial assessment of the extent and intensity of marine pollution
- Initial assessment of the necessary manpower and resources for emergency intervention
- Initial implementation of measures to prevent further marine pollution
- Informing the ŽOC about the generated pollution and measures taken to prevent the spread of pollution.
- Engaging people and available equipment from the sea, land and air in accordance with the ŽOC
- Consultation with ŽOC on how to remove pollution from the sea and coast
- Monitoring the contaminated area
- Implementation of urgent measures for remediation of marine pollution until the arrival of manpower from the ŽOC
- Temporary disposal of pollution until the arrival of manpower from the ŽOC
- Keeping a diary on the course of action on remediation, collecting evidence and documents on the cause of pollution until the arrival of manpower and equipment from the ŽOC
- Reporting to the local community on the pollution in consultation with the ŽOC

In addition to the above tasks and activities, the SOC may undertake other tasks that ensure and facilitate solving the tasks within these plans.

Participants in the implementation of the plans

Professionally and technically qualified legal and natural persons, who are registered according to special regulations and have a permit for waste management or monitoring the state of the marine environment, participate in the implementation of the plans.

If necessary, volunteers can also participate in the work of limiting the spread and removing the pollution.

Organization and coordination of the participation of the Civil Protection Headquarters of the Municipality of Sali and volunteers in the removal of marine pollution is carried out by a member of the SOC until the arrival of the representative of the ŽOC.

Predicting, preventing and limiting the spread of marine pollution

Preventive action to prevent marine and maritime domain pollution:

- Supervision over the application of legal regulations;
- Regular maritime and land patrols of the waters and the coastal zone;
- Compliance with environmental protection measures during construction and use at sea or in the coastal zone;
- Continuous improvement of residents' knowledge of the need to protect the sea and the coastal zone,
- Investing in infrastructure whose defects can lead to marine pollution, such as wastewater drainage;
- Removal and prevention of new illegal dumps of bulky waste and illegal dumps of construction waste that can cause marine pollution in torrents;
- Appropriate solution for the stormwater drainage system;
- Cleaning sewage from fields to the sea and constructing retardants to reduce the flow rate with gratings for collecting natural and municipal waste;
- Construction of a system for collecting wastewater from vessels;
- Organizing the installation of containers on the shore for the collection and separation of marine waste from nautical tourism;
- Education of tourists and sailors on environmental protection;

- Providing legal and natural persons with the necessary tools and resources on the island that can be used to urgently prevent the spread and remediate pollution;
- Fires consequently cause soil erosion which can lead to incidental marine pollution, so during the fire season it is necessary to maintain fire roads and patrols (observation posts) in order to react to the fire in time and warn people found in forested areas about the possibility of fire;
- Performing regular action drills in emergency pollution situations of various scenarios.

Contingency forecasting in the event of pollution includes:

- Monitoring the state of the marine environment;
- Monitoring and collecting meteorological reports;
- Monitoring the state of traffic during the prevention, limitation or remediation of pollution;
- Ensuring the readiness of equipment, resources and manpower for the implementation of measures to prevent, limit and remediate marine pollution.

Monitoring the state of the marine environment is an important precondition for the beginning of the remediation action and it is performed by:

- Planning and regular patrols of the plan implementation area;
- Emergency patrols based on alerts;
- Results of seawater sampling analysis
- Receiving reports from available official and international networks on possible pollution (for example: CleanSea and SafeSeaNet).

The need for expert advice

In case of need for expert advice, the SOC Command shall contact:

- the associated GIS system of Sali Bay;
- the associated GIS system of Zadar County, i.e. ŽOC;
- the ŽOC Command;
- Zadar Port Authority, neighboring port authorities and county port authorities;
- State Hydrometeorological Institute Zagreb, Department of Maritime Meteorology Split, Rijeka branch office;
- Croatian Hydrographic Institute, Split;
- Institute of Oceanography and Fisheries, Split;

- Ruđer Bošković Institute,
    - Division for Marine and Environmental Research, Zagreb
    - Center for Marine Research, Rovinj;

In addition to the above sources, the SOC Commander, in cooperation with the ŽOC Commander, may also contact any other person or organization whose knowledge or experience may assist in the prevention, limitation and remediation of marine pollution.

The SOC Secretariat takes care of the up-to-dateness of the associated GIS system.

Preparedness measures for the reduction and removal of marine pollution

To reduce and eliminate the risk of pollution, the following preparedness measures may be required:

- Tugboats and vessels with traction and offshore assistance equipment;
- Cleanup ships, equipment and professional staff for pollution removal;
- Civil protection unit;
- Emergency services: firefighters, ambulance, rescue service;
- Red Cross to provide accommodation for ship crews and other vulnerable persons;
- Trained voluntary associations;
- Other measures appropriate to the pollution risk.

Proposal for securing the area at sea where pollution has occurred, i.e. a ban on fishing, a ban on the movement of unauthorized persons in the area. The ban itself is enforced by the Zadar Police Department.

Commencement of action according to emergency pollution contingency plans

Action according to the contingency plans begins:

- After receiving news of marine pollution;
- After receiving news of a maritime accident that could result in marine pollution;
- If the SOC Commander has knowledge of possible pollution based on reconnaissance at sea, from the coast or from the air.

Action at sea begins with a decision of the SOC commander and in consultation with the ŽOC commander.

Pollution status assessment

The assessment of the marine pollution circumstances should take into account the following:

- Location of the accident site;
- Types of pollutants;
- The amount of pollutant discharged or which may be discharged;
- State and weather forecast (wind direction and speed, clouds, precipitation, temperature and humidity) and the sea (sea condition, tides, sea temperature, sea currents, waves);
- Possible and expected movements of the pollutant;
- Possible degree of danger to human life and health;
- Possible fire and explosion risk;
- Possible damage to the marine environment;
- Possible costs of preventing the spread and removal of pollutants.

The SOC commander may request information on the movement of ships in the area from the Navigation Surveillance Service (MRCC).

Communication

Data transmission during marine assessment and remediation (restriction of spread and removal of pollution) is performed using the public mobile and land line network and VHF channel 16 or 10.

In addition, other forms of communication can be used.

Transfer of authority

Upon arrival at the location of the ŽOC representatives, the emergency pollution intervention activity is taken over by the ŽOC.

Measures and procedures during emergency marine pollution

The following procedures and measures are applied:

- Preventing the possibility of an explosion;
- Stopping the release of pollution;
- Preventing the spread of discharged pollution;
- Collecting discharged contaminants from the surface, water column, bottom and shore;
- Disposal of collected pollution.

The decision on the manner and scope of action is made by the SOC commander in agreement with the ŽOC commander.

When making a decision, the SOC commander is obliged to take into account the following:

- Type and quantity of substance discharged;
- Biological characteristics of the endangered area;
- Time elapsed since the discharge of the pollutant into the sea;
- Hydrometeorological conditions;
- Infrastructure built in the sea and on the coast;
- Available manpower, equipment and other material resources;
- The possibility of disposing of pollutants and especially hazardous substances;
- Possible damage to the sea, air and coast.

The SOC commander, in cooperation with the ŽOC commander, is obliged to choose the manner and scope of action that is optimal for the remediation of marine pollutants.

If it is probable that the pollutant will spread to the shore, the SOC commander, in cooperation with the ŽOC commander, is obliged to choose the method of remediation that will cause as little pollution of the coastal fringe as possible.

When it comes to cleaning the coastal fringe and removing marine pollution, it is necessary to follow the instructions of the Emergency Contingency Plan for Marine Pollution in Zadar County, 2010.

Supervision

Supervision over the operation according to the contingency plans is carried out by the competent inspector of Zadar Port Authority, who is appointed by the ŽOC commander.

The ŽOC commander may, as necessary, assign to the inspector other persons who, with their experience, can assist in assessing the situation and supervising the implementation of operational activities.

Termination of action

The decision to terminate the action according to the contingency plans is made by the ŽOC commander.

Termination of action can be permanent or temporary.

The decision on temporary termination of action is made:

- When weather conditions or other problems endanger persons working to remove pollution or threaten exceptional material damage that cannot be prevented;

- When, due to ignorance of the key facts, it is not clear how the pollution should be treated.

The decision to continue action is made when the circumstances that led to the temporary suspension of remediation have ceased or are expected to cease.

The decision to terminate the action according to the plans is made:

- When the marine pollution is remedied and the collected waste is disposed of;
- When the threat for which the action was initiated has ceased;
- When continued cleaning with available means does more harm than good to the marine environment.

The decision on temporary or permanent termination of operations shall be delivered by the ŽOC commander as soon as possible to all persons participating in the activities for the remediation of the sea from pollution.

After termination of action, all used equipment must be cleaned, inspected and brought to a state of readiness for re-operation.

Records of action according to contingency plans

The SOC commander or the person in charge appointed by him is required to keep a record of the course of action until the ŽOC takes over the coordination of the action.

The log is the main source of information for preparing the final report and submitting a request for reimbursement by a known perpetrator.

The action log contains:

- Information on measures taken;
- Information on used equipment and means of work;
- Information on all authorized and other participants (responsible person, time of start and end of the assignment);

- Information on all other events, actions taken, circumstances and outcomes that may have an impact on the sea or on other participants in future actions.

The log can also be kept with a dedicated software application.

The SOC commander is required to submit all data that may be relevant for the preparation of the final report to the ŽOC commander upon completion of the action.

Training and drills

Training program

Improving the effectiveness of all persons who participate or could participate in the implementation of contingency plans is done through training and drills.

Training programs are professional programs that aim to educate participants to improve the activities of remediation of accidental marine pollution, familiarization with technical means, acquisition of skills needed to act and perform tasks from contingency plans.

The decision on the implementation of the training program is made by the ŽOC commander, taking into account the needs of the SOC.

The organization of the program is carried out by the ŽOC secretariat.

The costs of implementing the training program are financed from the funds intended for the implementation of contingency plans.

Drills

Drills are practical work programs that are carried out with the aim of practicing action in case of accidental marine pollution and in accordance with the selected possible scenarios.

The goals of the drills are:

- Improving cooperation and harmonization of the work of staff and especially authorized participants;
- Coordination check in case of accidental marine pollution;
- Checking and improving communication primarily between the SOC and ŽOC;

- Checking the readiness of staff and the correctness of the participants' equipment;
- Checking other equipment and available resources;
- Gaining experience in handling equipment, products and means of operation.

The drill consists of the following:

- Preparation of a marine pollution template including the cause, type of discharge, location and rate of discharge;
- Communication systems checks;
- Inspection of equipment and resources;
- Implementation of actions to limit or eliminate marine pollution.

After completing the drill, the SOC command must:

- Analyze the success of procedures performed during the drill;
- Analyze procedures that could not be performed due to the nature of the drill;
- Analyze the effectiveness and efficiency of all subjects who participated in the exercise;
- Evaluate the success of the drill to implement contingency plans.

Drills are conducted at least once a year whether they are organized by the SOC, ŽOC or are at the state level.

Informing the public

The ŽOC commander or the person in charge appointed by the commander is required to inform the public about the following:

- Place, time and amount of the pollutant;
- Measures taken to prevent the spread, control and removal of pollution;
- Areas for which an access ban has been declared;
- Predictions on when the measures under contingency plans will end.

Transitional and final provisions

The SOC commander shall adopt rules of procedure within one year from the date of adoption of the contingency plans.

The following updated lists are kept by the SOC secretariat:

- Contact information of SOC members, ŽOC commanders and members;
- Legal and natural persons who can help at a very short notice in case of accidental marine pollution;
- Institutions, organizations, legal and natural persons who can provide expert advice;

All written documents related to the action under the contingency plans are kept in the SOC for five years.

The plans come into force after the establishment of the SOC and the date of acceptance by the Sali Municipal Council.

1. EARTHQUAKE CONTINGENCY PLAN

Preventive action

As is well known, an earthquake cannot be predicted but represents a completely sudden event.

However, the probability of an earthquake occurrence can be estimated and is estimated in a statistical sense.

As noted, a 95-year earthquake event of a VI MKS magnitude is as likely as a 475-year earthquake event of a VIII MKS magnitude: ALFA-ATEST, 2018 should be consulted about possible damage to the infrastructure.

Preventive action can be taken by building infrastructure that can easily withstand a VI magnitude earthquake and not sustain significant damage during a VIII magnitude earthquake that can be dangerous to people. Construction practices and construction protocols exist and are available in Croatia and should be followed.

Preventive action for significant accidental marine pollution includes periodic checks of the correctness of water supply and sewerage, as well as the readiness of equipment and the maintenance of regular SOC personnel drills.

Action in case of accidental marine pollution

As mentioned above, a significant earthquake can induce rupture of water supply and sewage pipes. The rupture of the water supply system leads to the outflow of drinking water into the soil and to the surface, both of which leads to marine pollution through runoff. Sewage pipe ruptures lead to wastewater spills and significant microbiological marine pollution in the bay until the sewage pipe is repaired. Since sewage pipe repair is usually not a priority after an earthquake, microbiological marine pollution in the bay can last for months and jeopardize economic activities related to the sea.

Therefore, the quality of the sea in the Sali Bay and Saščica Bay should be examined as soon as possible, and the need for further monitoring of the sea condition should be assessed according to the obtained results.

Should monitoring show that significant microbiological or other marine pollution has occurred, measures should be taken to identify the source of the pollution as soon as possible, the sewage or water supply system should be repaired and the pollution collected and adequately disposed of.

In case of visual pollution of the sea surface, the pollution should be constantly collected and adequately disposed of until the repair of water supply, sewage or submarine outfalls.

2. CONTINGENCY PLAN IN CASE OF OPEN FIRE

Preventive action

As is well known, an open fire cannot be predicted either but it also represents a sudden event. However, the occurrence of fire can be estimated and is estimated in a statistical sense. As noted, there is a likelihood of a fire once in every 10 years.

Preventive action can be taken regarding both the occurrence of fire and the damage caused by fire.

Educating the population about the possibility of a fire, how it most often occurs, how to identify it early and how much damage it can cause is of utmost importance.

In addition to the above, fire routes should be regularly maintained so that firefighters can efficiently put out a fire when it occurs. These routes can be used in tourism as bicycle paths with instructions for cyclists and paths for exploring the area under the guidance of tourist guides.

Finally, part of the prevention includes the maintenance of firefighting equipment and regular education and training of firefighters.

Action in case of accidental marine pollution

In case of a sudden fire and intense rain after that, the ashes from the burned area can be sent to the sea. This is less likely to occur than the fire.

In this case, accidental marine pollution cannot be prevented.

There is also no way to completely remediate marine pollution because the ash dissolves quickly in the water and affects the pH of the sea. The only thing that can be done then is to collect the macro-pollution from the sea surface of the Sali Bay and Sašćica Bay as soon as possible and dispose of it adequately.

3. FLOOD CONTINGENCY PLAN

Preventive action

Backwater

Bearing in mind that backwater causes flooding almost every year, it makes sense to take all possible preventive measures. First of all, the coastal fringe should be raised to a height that prevents water penetration into restaurants and other coastal infrastructure. However, raising the coastal fringe must be accompanied by the installation of one-way valves so that water can flow into the sea and not flood the coastal infrastructure in the event of torrents. Knowing that the sea level will rise due to global warming and melting ice caps, the height of the wall should be adjusted for safe defense in the next 50 years.

In addition to the above, the backwater will penetrate into sewers and infrastructure discharges along the coast, so all these points should have single-pass valves installed towards the sea and this infrastructure in terms of water drainage should not be used during the backwater, which is for a relatively short period.

Torrents

Retarders with gratings should be built at all possible points of penetration of torrents identified in this study in order to reduce the water velocity of the torrent, which will thus carry less material to the coast and into the sea.

It is also necessary to maintain the correctness of the equipment for collecting macro-pollution from the surface of the sea, as well as to perform regular drills of the SOC personnel and to participate in the ŽOC drills.

Action in case of accidental marine pollution

In case of accidental marine pollution, the spread should be limited by floating dams and macro pollution should be collected from the sea surface. Later, when backwater or torrents disappear, the demersal part of the bay should be inspected and macro-pollution should be collected from the bottom.

4. CONTINGENCY PLAN IN CASE OF SPILLAGE FROM WASTE OIL CONTAINERS OR SIMILAR STORAGE FACILITIES IN SMALL OVERHAUL SHIPYARDS OF SALI BAY AND SAŠĆICA BAY

Preventive action

When it comes to prevention of spillage of waste oil containers, there is an excellent measure that should be taken as soon as possible, which is the construction of a storage tank plant around the existing container in the Port of Sali.

Care should also be taken to ensure that paints, diluent, waste oils and other chemicals in overhaul shipyards are properly used and disposed of.

This will significantly reduce the risk of marine spills and pollution.

Action in case of accidental marine pollution

In case of accidental marine pollution with waste oil from the container on the pier in the port, a floating dam should be stretched as soon as possible to limit the spread of oil. Then the oil should be collected as soon as possible in accordance with the measures in the Contingency Plan for Accidental Marine Pollution in Zadar County.

The same procedure should be followed in the event of spills of paint and waste oils in shipyards.

5. CONTINGENCY PLAN IN CASE OF SPILLAGE FROM THE AMMONIA CONTAINER OF THE "MARDEŠIĆ" FACTORY

Preventive action

The two containers of ammonia present the only significant risk of accidental marine pollution from the Mardešić factory. Preventive action consists of periodic inspection of existing automatic devices for the prevention of ammonia emissions because adequate storage tank plants already exist.

Action in case of accidental marine pollution

In the event of a sudden spill of ammonia from the Mardešić factory tank, the ammonia will mainly leak into the atmosphere in the form of gas.

The soil to which the ammonia is bound should be adequately disposed of as soon as possible so that it does not leach into the sea.

6. CONTINGENCY PLAN IN THE EVENT OF AN ACCIDENT AT SUBMARINE OUTFALLS

Preventive action

Preventive action against the breakthrough of pollution from submarine outfalls consists of periodic inspection of outfalls and their proper operation.

In addition, a simple and quick inspection of the surface of the Sali Bay and Sašćica Bay should be performed every day in order to notice the difference in the color of the sea. This method is the fastest, though not the most accurate indication that a significant breakthrough of contamination has occurred before the outfall itself.

In addition to the above, it is necessary to take measures as soon as possible to adequately set the outfall of the Mardešić factory, currently at a depth of about 11 m above the thermocline, which is obviously not at a sufficient depth because grease occasionally comes to the surface. The outfall is inadequately positioned and instead of having the shape of a straight line from the shore to the open sea, it goes in a circle.

Action in case of accidental marine pollution

In the event of an accidental marine pollution that may be the result of an outfall rupture or a rush of torrents, the flow of fresh water will exceed the permeability of the outfall and carry with it an extremely large amount of pollution. Pollution that is lighter than sea water will float and should be collected and adequately disposed of as soon as possible.

Pollution that has mixed and dissolved in seawater will be carried out of the bay by sea currents.

Macro-pollution that is heavier than seawater will sink to the bottom. Therefore, after an accidental event, a diver should inspect the bottom and collect macro-contamination.

7. MARINE CASUALTY CONTINGENCY PLAN

Preventive action

Prevention includes regular waterway monitoring, signaling and informing seafarers of possible obstacles, sea conditions and vessel density. In addition, special attention should be paid in terms of the largest maritime traffic between Sali Bay and other destinations. In this sense, it is crucial to count the ships entering and leaving the Port of Sali.

It is also necessary to maintain the correctness of the equipment for collecting macro-pollution, petroleum and oil from the surface of the sea, as well as to perform regular drills of the SOC personnel and to participate in the ŽOC drills.

Action in case of accidental marine pollution

Action in case of an accident marine pollution should be carried out in accordance with the Contingency Plan for Accidental Marine Pollution in Zadar County, 2010.

In doing so, it would be useful to establish a Sali Operations Center (SOC) that could assist in early identification and emergency action before the arrival of manpower and equipment from the ŽOC, all in coordination with the ŽOC.

Conclusion

The fastest possible identification of accidental marine pollution is crucial in the sea remediation process, so it is proposed to establish a Sali Operations Center. Its purpose would not only be early detection but also working to limit the spread of marine pollution in accordance with the County Operations Center.

In the event of a most likely earthquake, no significant marine pollution is expected. In the event of a strong earthquake, a rupture of the water supply and sewage pipes, submarine outfall pipes and a possible shutdown of the pumping stations are expected. This will be causing marine pollution until the repair of the said infrastructure. Remediation comes down to collecting pollution from the sea surface.

In the event of a major open fire, ash is expected to enter the sea by soil leaching and torrents. Prevention includes the maintenance of fire roads that can also be used for sightseeing in the presence of tourist guides. Action in the event of a sudden fire comes down to limiting the spread of pollution, collecting and disposing of macro-pollution from the sea surface.

In the event of a backwater, the preventive action is to raise the coastal fringe and install valves on the outlets into the sea so that sea water does not penetrate into the sewer. Preventive action against the occurrence of torrents is reduced to the construction of stairs and gratings that slow down the flow of water and thus reduce the ratio of materials from the ground. Action after the onset of sudden pollution comes down to limiting the spread and collecting macro-pollution from the sea surface.

Regarding the waste oil container, the best preventive measure that will significantly reduce the risk of marine pollution is the construction of a storage tank plant. In the event of an oil spill, a quick reaction in limiting the spread is paramount.

Preventive actions regarding ammonia containers in the “Mardešić” factory include regular control of the correctness of automatic mechanisms for reporting and stopping spills.

In the event of an ammonia spill, the affected soil on the way to the sea should be collected and disposed of.

Preventive actions regarding submarine outfalls include regular control of the correctness of the pipes to the outfalls and the operation of the outfalls themselves. In addition, it is necessary to rehabilitate the outfall of the “Mardešić” factory, i.e. to enable its operation as scheduled. In the event of sudden marine pollution, macro-pollution that has started to drift should be collected and adequately disposed of as soon as possible.

Macro-pollution is heavier than sea water and it will sink to the bottom, so divers should inspect the bottom after a sudden event, collect any pollution and dispose of it.

In case of a maritime accident, the Contingency Plan for Accidental Marine Pollution in Zadar County (2010) should be followed. The establishment of the Sali Operations Center (SOC) would be useful because it would add to the speed of detection and action until the arrival of forces from the County Operations Center.

APPENDIX

Geographic informatics system

As part of the Contract, the Contractor performed the following:

- Establishment of GIS database
- Establishment of GIS data server (Geoserver)
- Establishment of a website with a GIS module for spatial data visualization

The following raster and vector data were provided throughout the project. In the last phase of the project, further optimization of the system is planned, as well as updating the GIS database with new collected data.

Table I-1. *Spatial data provided*

#	Layer type	Performance activity in the report	Layer description	Collection method	Scale (resolution)	Purpose/application
1	Vector	I A	The border of the wider area of the Sali settlement	DOF vectorization		Marking the boundary of the research area
2	Vector	I A	Bathymetric survey area	DOF vectorization		Marking the bathymetric survey area
3	Raster and vector	I A	Coastline	Aerophotogrammetry		Coastline length
4	Vector	I A	Dense point cloud	Bathymetry		Making a model of the depths of Sali Bay and Saščica Bay
5	Raster	I A	Bathymetric map of the Sali Bay and Saščica Bay	Bathymetry		Data on the depth, bottom hardness and the presence of Neptune grass
6	Raster	II A	DOF of the wider area of the Sali settlement - planimetrically correct aerial image, which by metric properties fully corresponds to the map of the same scale	Aerophotogrammetry	(0.292 m)	Detection of various anthropogenic and natural elements in the area of the Sali settlement (e.g. mapping and construction of a database of residential buildings, agricultural plots, roads, etc.)
7	Raster	II **B**	DSM of the wider area of the Sali settlement - relief and all natural and anthropogenic surfaces that are located on it	Aerophotogrammetry	(0.292 m)	Study of morphometric features of represented vegetation and anthropogenic objects
8	Raster	II D	DMR of the wider area of the Sali settlement - bare relief surface without anthropogenic and natural elements	Aerophotogrammetry	(0.292 m)	Performing hydrological and morphometric analyses, as part of modeling soil erosion and flood potential within the wider area of the Sali settlement

9	Raster	II **B**	Normalized digital surface model (nDSM) - display of heights of all aboveground anthropogenic and natural objects in area	Aerophotogrammetry	(0.292 m)	Classification of vegetation or anthropogenic structures according to their height (e.g. detection of residential buildings exceeding the legally prescribed height)
10	Raster	II C	Integral model of the Sali Bay and Sašćica Bay - digital depths model plus digital surface model of coastal areas	Bathymetry and aerophotogrammetry		Calculation of the volume of the Sali Bay and Sašćica Bay on the day of recording and generating predictive models of water level fluctuations in the bay
11	Vector	II A	Landmarks	GPS		Absolute orientation of the wider area model, examination of the accuracy of the model
12	Vector	II A	Dense point cloud	Aerophotogrammetry		Generating DOF and DMP with a spatial resolution of up to 5 cm
13	Raster	II A	DOF of the wider area of the Sali settlement - planimetrically correct aerial image, which by metric properties fully corresponds to the map of the same scale	Aerophotogrammetry	(5 cm)	Detection of various anthropogenic and natural elements in the area of the Sali settlement (e.g. mapping and construction of a database of residential buildings, agricultural plots, roads, etc.)
14	Raster	II **B**	DSM of the wider area of the Sali settlement - relief and all natural and anthropogenic surfaces that are located on it	Aerophotogrammetry	(5 cm)	Study of morphometric features of represented vegetation and anthropogenic objects
15	Vector	II **D**	Residential, auxiliary, commercial and other facilities	DOF vectorization	1:200 (5 cm)	Risk analysis of fire outbreaks, erosion and sea level rise, damage assessment

			within the wider area of the Sali settlement and bay			
16	Vector	II **D**	Roads within the wider area of the Sali settlement and bay	DOF vectorization	1:200 (5 cm)	Risk analysis of fire outbreaks, erosion and sea level rise, damage assessment
17	Vector	II **D**	False pits	Aerophotogrammetry	(0.292 m)	Performing accurate hydrological analyzes
18	Raster	II **D**	Flow direction for the wider area of the corrected DMR	Aerophotogrammetry	(0.292 m)	Determining the hydrological features of a particular area
19	Raster	II **D**	Water accumulation	Aerophotogrammetry	(0.292 m)	Determining on which network elements and to what extent water accumulation occurs
20	Raster and vector	II **D**	Drainage network	Aerophotogrammetry	(0.292 m)	Separation of occasional and constant flows
21	Raster	II **D**	Larger drainage basins	Aerophotogrammetry	(0.292 m)	Determining the topographic basin through the identification of surface watersheds delimiting the surrounding drainage basins for the purpose of determining the research area
22	Raster	II **D**	Drainage network hierarchy according to Stahler's method	Aerophotogrammetry	(0.292 m)	Defining the drainage network hierarchy
23	Raster	II **D**	Drainage network density model	Aerophotogrammetry	(0.292 m)	Defining the area of the highest density of drainage channels
24	Raster	II **D**	Defining the rate of precipitation runoff in a drainage basin	Aerophotogrammetry	(0.292 m)	Defining the rate of precipitation runoff in a drainage basin
25	Raster	II **D**	Flood estimation model - precipitation runoff rate in the	Aerophotogrammetry	(0.292 m)	Defining the rate of precipitation runoff in a drainage basin

			Sali and Polje drainage basin			
26	Raster	II **D**	Model of flood risk due to precipitation	Aerophotogrammetry	(0.292 m)	Defining the most vulnerable areas due to floods
27	Raster	III **B**	Thermal digital orthophoto model of the Sali settlement and bay	Aerophotogrammetry	(30 cm)	Determination of temperature changes
28	Raster	IV A	High-resolution (5 cm) multispectral image (DOF) of the Sali settlement and bay	Aerophotogrammetry	(5 cm)	Generating high resolution models
29	Raster	IV A	High-resolution (5 cm) digital surface model (DSM) of the Sali settlement and bay	Aerophotogrammetry	(5 cm)	Study of morphometric features of represented vegetation and anthropogenic objects
30	Vector	IV A	Landmarks	GPS		Absolute orientation of the wider area model, examination of the accuracy of the model
31	Raster	IV A	High-resolution (5 cm) multispectral image (DOF)	Aerophotogrammetry	(5 cm)	Sampling of test samples of specific vegetation types on the basis of which signature elements are added and validation of the final soil cover model is performed
32	Raster	IV C	Soil cover of the wider area of the Sali bay and settlement (model 2-version 2)	Aerophotogrammetry	(5 cm)	Detection of soil cover types in the wider area of the Sali bay and settlement
33	Raster		Spatial coverage of flooded parts of the coastal area in the model of sea level rise of 1 m (M1)	Aerophotogrammetry	(10 cm)	Detection of surveillance zones from sea level rise

34	Raster		Spatial coverage of flooded parts of the coastal area in the model of sea level rise of 3 m (M2)	Aerophotogrammetry	(10 cm)	Detection of surveillance zones from sea level rise
35	Raster		Spatial coverage of flooded parts of the coastal area in the model of sea level rise of 6 m (M3)	Aerophotogrammetry	(10 cm)	Detection of surveillance zones from sea level rise
36	Raster		Model of susceptibility to soil erosion of the wider area of the Sali settlement	Aerophotogrammetry		Detection of soil erosion surveillance zones
37	Raster		Extremely high fire risk model (Model 1 + Model 2)	Aerophotogrammetry		Detection of fire risk zones
38	Raster		Fire prevention model - visibility model	Aerophotogrammetry		Selection of locations for the installation of surveillance cameras

PROPOSAL FOR PROCUREMENT OF EQUIPMENT

Introduction

In enclosed seas, such as the Adriatic, risk assessments and the development of early pollution detection systems are key to preserving the environment. The rapid development of technology has made it possible to accurately detect various threats and pollution, such as petroleum or oil spills at sea. In addition to detecting pollution and discovering its source, data on the volume, thickness and deformation of oil spills, currents, waves, weather conditions (especially wind), the number of ships, and determining locations for protective floating dams are very important for remediation. Today's systems offer increased capabilities for early detection as well as the transfer of data needed for real-time response, allowing teams to respond and repair damage in a timely manner. The research group of the "SeaSky" consortium, based on the main objectives of the PEPSEA project and detailed analyses, proposes 2 systems for early detection of pollution and threats. The main objectives of using the proposed modern sensors and equipment are navigation safety, environmental protection, deceleration assessment, and determining locations for the installation of floating dams based on elaborate criteria.

Today's radar systems can accurately and reliably detect a specific glare created by oil pollution on the surface of the sea. Although a radar antenna with vertical polarization is recommended for such a function, a horizontal one can also be used, which is more affordable and more easily available on the market. The quality of detection is directly dependent on the type and quality of the radar antenna.

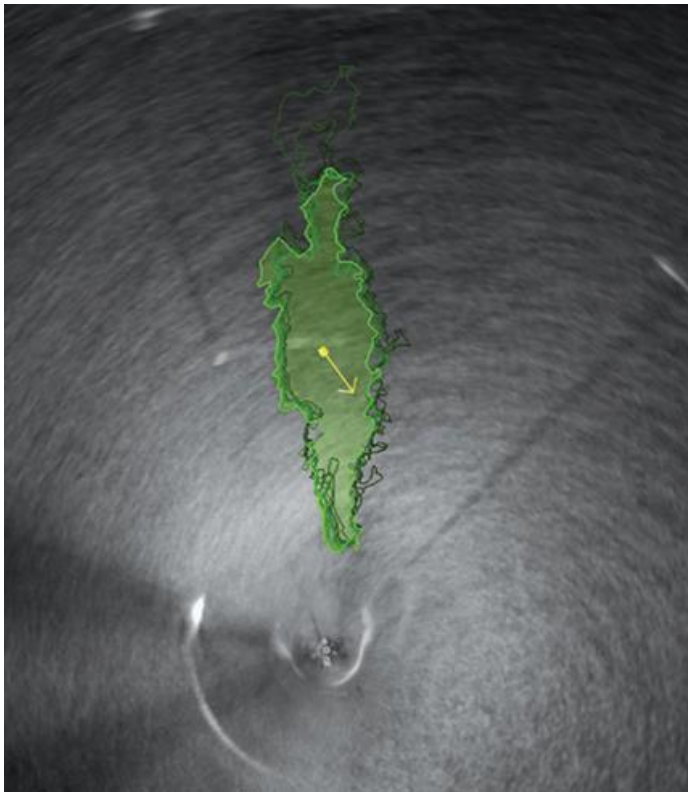


Figure I-1. *Detected pollution with shapes and position (radar trail).*

In addition to pollution detection, similar systems are very often used to monitor and manage maritime traffic. Given that pollution detection is most effective with a vertical polarization antenna while those with horizontal polarization are used to monitor traffic, it can be concluded that the system should optimally actually consist of a combination of both antennas. When processing a radar image, it is necessary to take into account the existence of an algorithm for automatic detection and marking pollution as well as methods for calculating its direction and speed. More advanced systems can also calculate the volume of pollution. Figure X-1. Displays the area of detected contamination along with the previous shape and position (radar trail). In addition, a motion vector (yellow) is shown.

Figure I-2. *Perspective view of detected pollution*

The role of AIS systems and cameras

AIS (*Automatic Identification System*) is a device that transmits static and dynamic ship data via VHF channels and is mandatory for most ships. The role of AIS is to identify the ship within range while the identification of ships not equipped with AIS is done by a camera. The camera can also be used to detect contamination, but with a very limited range.

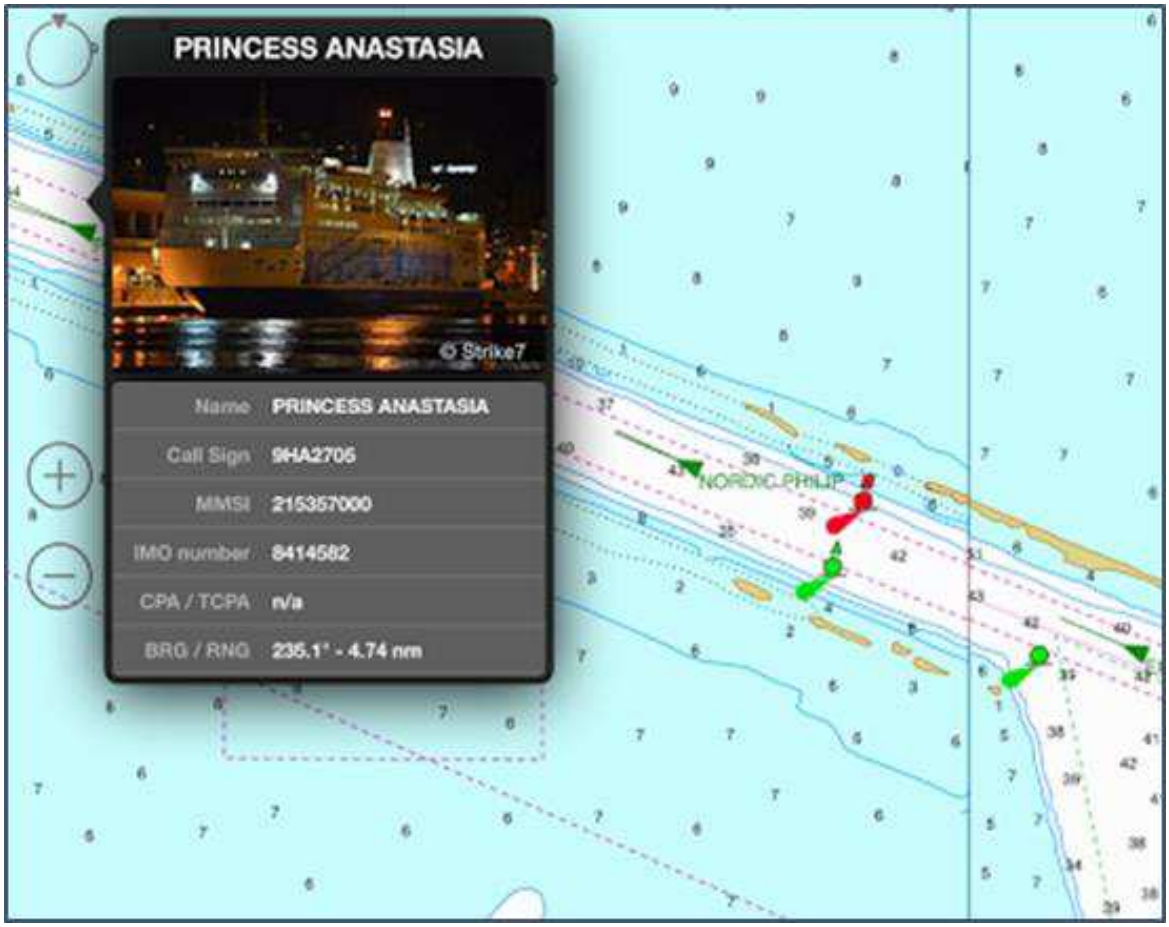


Figure I-3. *Example of AIS (Automatic Identification System)*

The role of the meteorological system

In addition to collecting general information on meteorological conditions, the meteorological system is also used to predict the movement of the resulting pollution, thus enabling better control and better response with available resources.

Interaction with the operator

The totality of available data is usually available within the VTS interface. Pollution caused by an oil spill is usually indicated by a polygon with an alarm.

The important role of the operator is to check and confirm the existence of pollution, and to alert the services responsible for repairing the damage. In addition, based on the collected data, the operator can provide quality instructions for the best response to the situation.

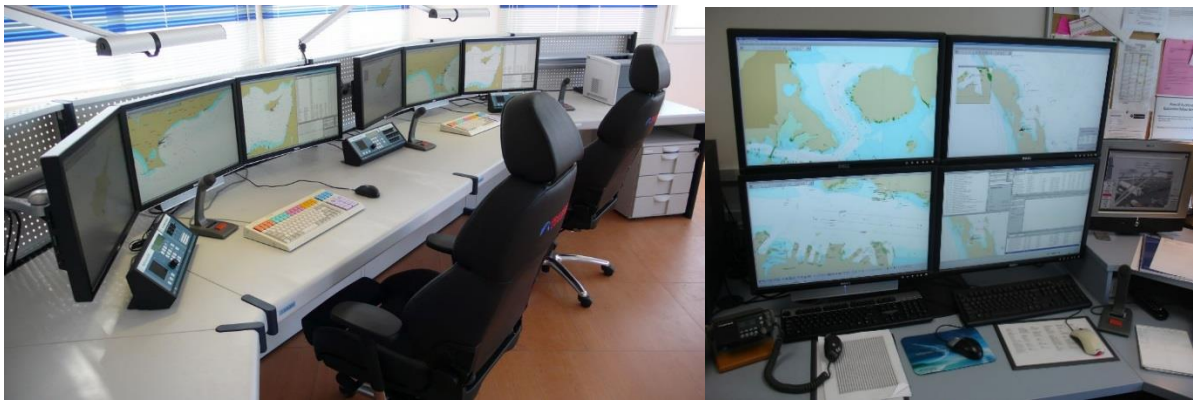


Figure I-4. *Example of an operations center*

Direct transfer of detected pollution to the ship's electronic chart (ECDIS) can be emphasized as an efficient transfer of pollution data to field units.

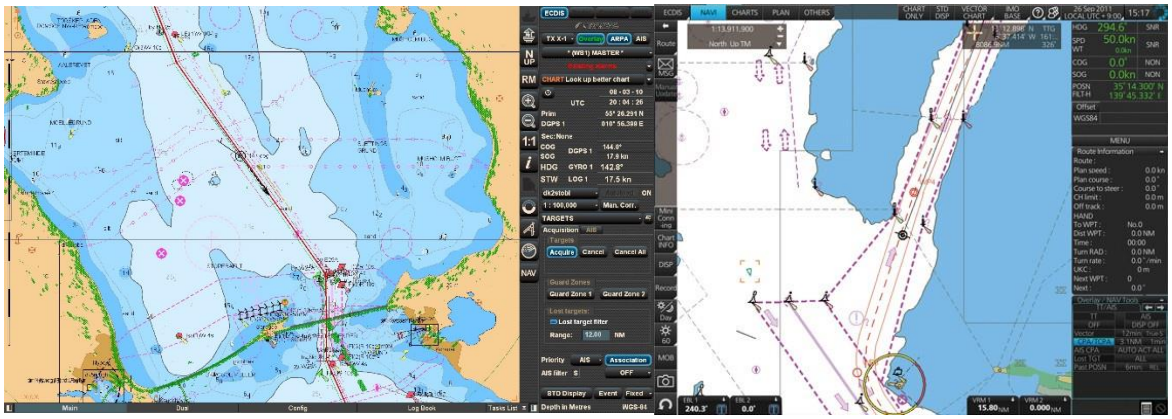
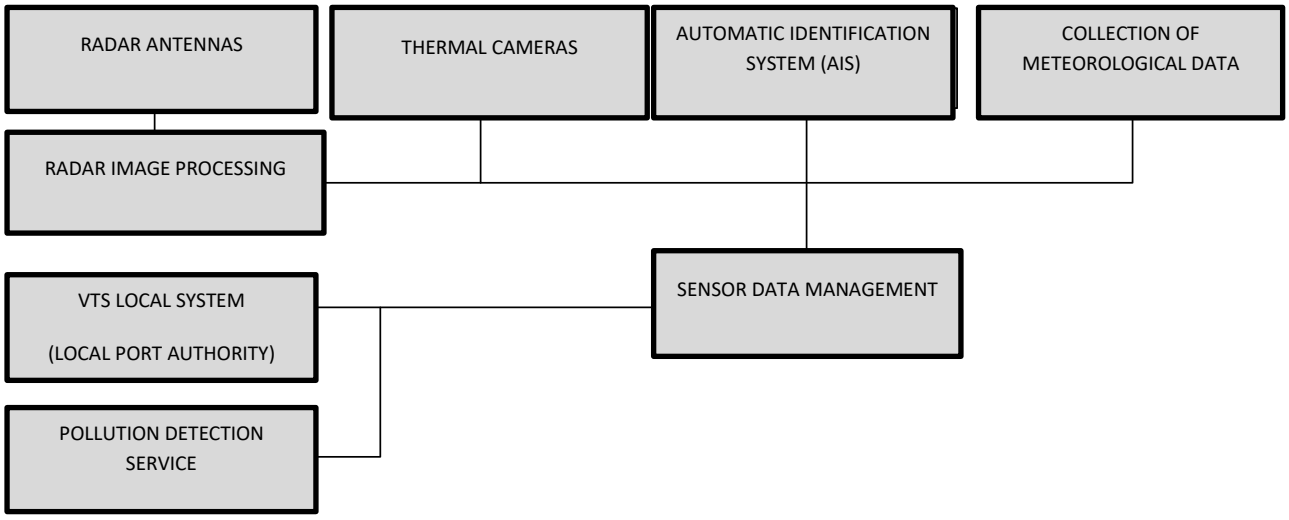
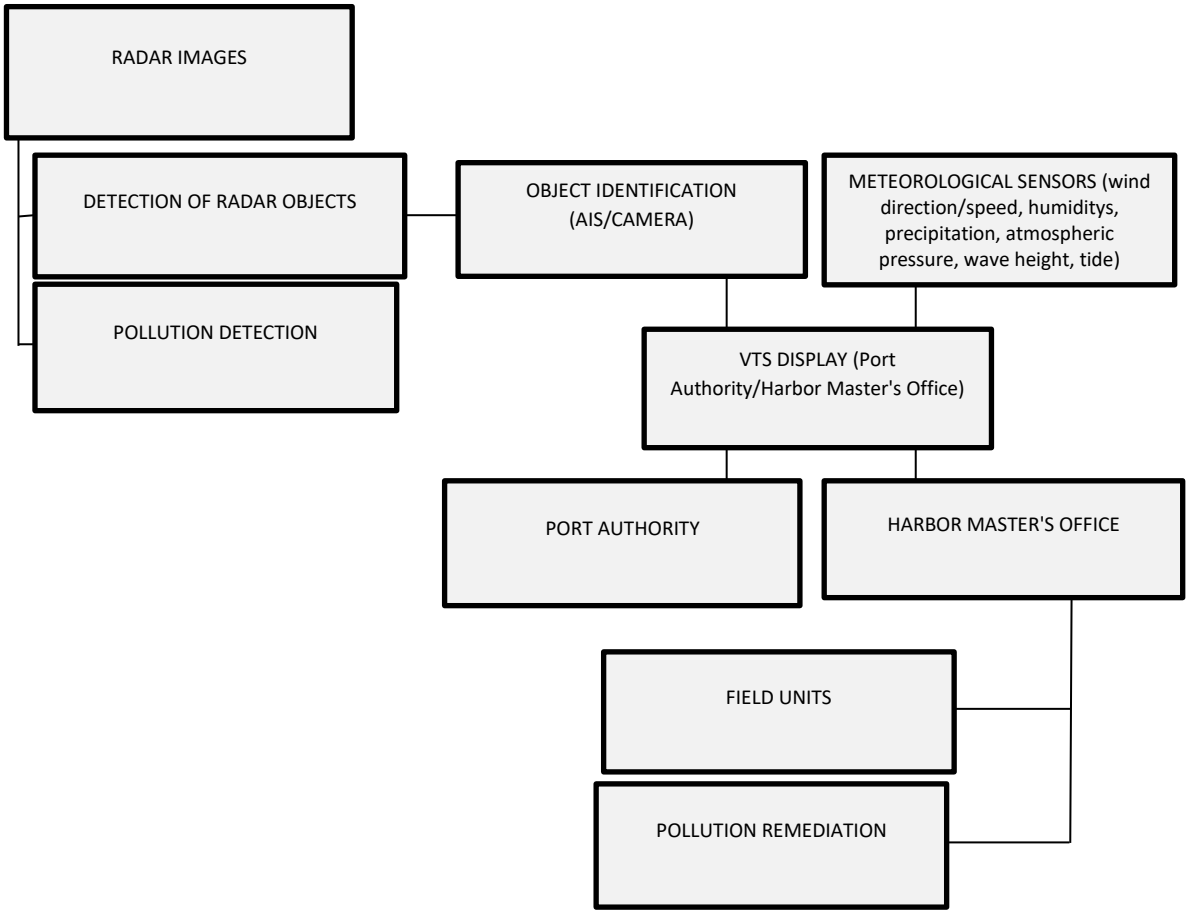


Figure I-5. *Ship's electronic chart (ECDIS).*

Functional diagram 1



Functional diagram 2



Flowchart

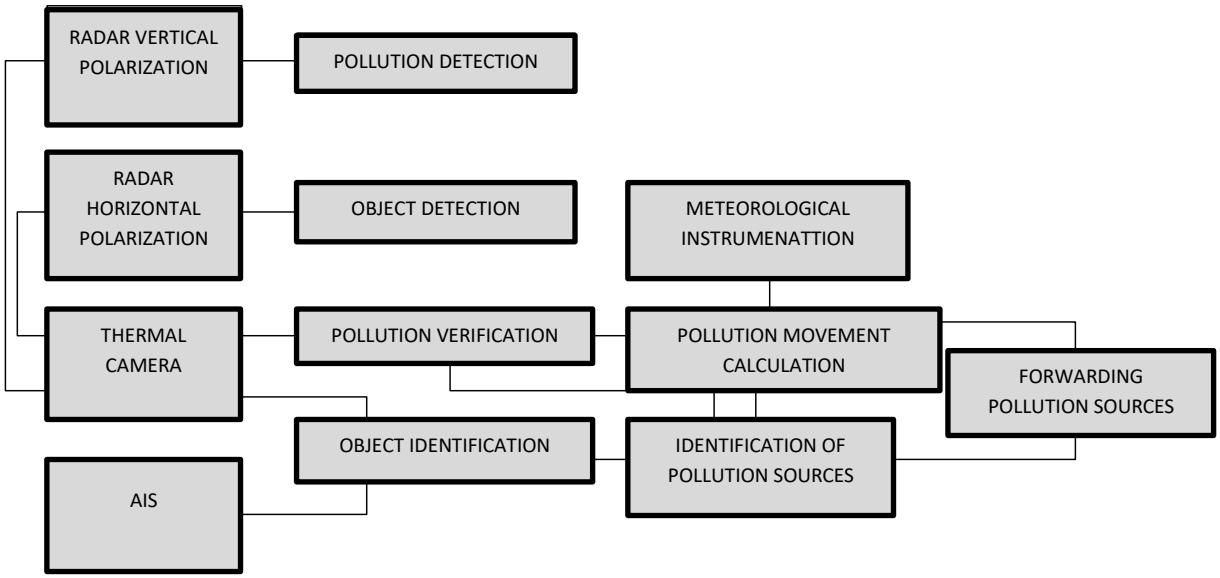

RADAR VERTICAL POLARIZATION
POLLUTION DETECTION
RADAR HORIZONTAL POLARIZATION
OBJECT DETECTION
METEOROLOGICAL INSTRUMENATTION
THERMAL CAMERA
POLLUTION VERIFICATION
POLLUTION MOVEMENT CALCULATION
FORWARDING POLLUTION SOURCES
OBJECT IDENTIFICATION
IDENTIFICATION OF POLLUTION SOURCES
AIS

Table I-2. *Necessary equipment*

No.	Item	Quantity	Description
1.	VP radar antenna	1 kit	Used to detect contamination
2.	HP radar antenna	1 kit	Used to control maritime traffic
3.	Thermal camera	2 kits	Used to confirm pollution and to identify vessels that are not equipped with AIS
4.	AIS base station	1 kit	Used for identification of vessels equipped with AIS and for communication
5.	Computer infrastructure	1 kit	The kit includes the entire computer infrastructure required to integrate the equipment into a functional unit with special emphasis on: 1) data collection to create a complete current picture of maritime traffic 2) radar image analytics with the aim of pollution detection 3) data presentation at the operator's workplace 4) sensor management from the operator's workplace 5) forwarding information to field units while processing and displaying information on board
6.	Software solution	1 kit	Software solution installed on the described computer infrastructure in order to perform the following tasks: 1) Radar image processing from VP radar antenna (Item 1) 2) Radar image processing from HP radar antenna (Item 2) 3) Collecting videos from thermal cameras and controlling the operation of cameras (Item 3) 4) Collecting meteorological data and AIS data 5) Integration of the data described under items 1 to 4 for the purpose of real-time display with data storage over a certain period of time

7.	Meteorological instrumentation	1 kit	Includes equipment for collecting data on: 1) Wind direction and speed 2) Movement and speed of sea currents 3) State of the tide 4) Measurement of wave properties 5) Humidity, temperature, atmospheric pressure
8.	Ship equipment	2 kits	Includes a type-approved ECDIS ship kit with the ability to receive radar objects marked at the operator's workplace.

Table I-3. *Minimum technical characteristics*

No.	Item	Description
1.	VP radar antenna	Radar antenna with the following features: • 6ft radar antenna • Transceiver power 25kW • Vertical polarization • Possibility to set blank sectors
2.	HP radar antenna	Radar antenna with the following features: • 12ft radar antenna • Transceiver power 25kW • Horizontal polarization • Possibility to set blank sectors
3.	Thermal camera	Camera with the following features: • Thermal camera + HD camera • Housing for external use • Continuous 360 degree camera rotation • Ability to work in fog and mist conditions • Image stabilization • Multiple color palette formats • Feedback on camera position • Detection (Johnson criterion): Person/Vehicle = 1800m/2300m • Identification (Johnson criterion): Person/Vehicle = 280m/350m
4.	AIS base station	AIS base station with the following feature: • 2 VHF receivers and 1 transmitter • Receiving/sending text messages
5.	Computer infrastructure	
5.1.	Server computer	Computer for collecting data from sensor equipment. In accordance with the requirements of the installed software.
5.2.	Server computer	Computer for collecting and storing data from cameras. In accordance with the requirements of the installed software.
5.3.	Server computer	Computer for communication (online access, communication with field units, data sharing with external systems, etc.) In accordance with the requirements of the installed software.
5.4.	Personal computer	Computer for processing radar image from VP radar antenna. In accordance with the requirements of the installed software.
5.5.	Personal computer	Computer for processing radar image from HP radar antenna. In accordance with the requirements of the installed software.
5.6.	Personal computer	Operator Workstation Computer # 1.

		In accordance with the requirements of the installed software. Must include at least two 26'' monitors.
5.7.	Personal computer	Operator Workstation Computer # 2. In accordance with the requirements of the installed software. Must include at least two 26'' monitors.
6.	Software solution	
7.	Meteorological instrumentation	Meteorological equipment should collect the following data: • Wind direction and speed • Movement and speed of sea currents • State of the tide • Measurement of wave properties • Humidity, temperature, atmospheric pressure
8.	Ship equipment	Includes a type-approved ECDIS marine kit consisting of the following components: • On-board computer with 24'' monitor and keyboard • UPS system for at least 30 min of autonomy • Ability to connect to all existing equipment compatible with the NMEA0183 standard • Possibility of secure communication via a type-approved device (must be part of the ECDIS type-approval system) • Possibility of receiving radar targets from the operator

The integration of the presented advanced system would be the optimal solution, considering the functionalities. However, the main disadvantage of the system is primarily the price, which can amount to over 1 million euros.

The optimal location, according to the scientific group of the SeaSky consortium, for setting up an advanced pollution detection system would be the settlement of Zadar.

Recommended early waste detection systems

Given the high cost of an advanced early pollution detection system, we suggest a combination of the following sensors that must have the ability to collect real-time data and connect to a geoportal.

Water and oil detection sensor on the water surface

The sensor works on the principle of UV fluorescence - the optical principle. It is installed above the water surface and has significant advantages (easy installation, minimal maintenance) compared to sensors that are immersed in water. The device allows real-time detection of a layer of petroleum or oil thicker than 1 micron.

Minimum technical characteristics of the sensor:

- Sensitivity: petroleum or oil layer thicker than 1 micron;
- Range: 0 - 10 meters above the water surface;
- Temperature range: -30 °C to +60 °C;
- Housing: IP68, stainless steel;
- Power consumption maximum 5 W;
- Maintenance period: 5 years (every 5 years the device must be sent to the manufacturer for recalibration).

Figure I-6. *Examples of petroleum or oil detection sensor installation*

Suggested locations for sensor placement are:

- Zrmanja River, Mala Proversa and Ždrelac.

Zrmanja

The Zrmanja River has been repeatedly polluted by fuel oil, most likely from the former alumina factory in Obrovac. A catastrophe happens every time it rains heavily.

Figure XI-7. *Example of fuel oil spill into the Zrmanja River (source: Dnevnik.hr)*

During the rehabilitation of the alumina plant itself, large fuel oil tanks were located in the immediate vicinity of the river. According to estimates, experts believe that there could be about 400 cubic meters in the karst cracks, which is not usable. Since the spill is currently impossible to prevent, the early warning system (fuel oil sensor) can reduce the consequences of its spill, i.e. localize the spill so that it does not go all the way to the Novigrad Sea and beyond. In combination with the flow measurement sensor, it is possible to precisely determine the spreading time of the fuel oil stain, and to determine the optimal locations for the installation of floating protective dams.

Mala Proversa and Ždrelac

Mali Ždrelac, is a small strait in the Adriatic Sea located between the islands of Ugljan and Pašman. It is the shortest waterway between the Middle Channel on the one hand, and the Pašman and Zadar Channels on the other. The width of the strait is 56 meters, which enables safer and faster navigation for an average of about two thousand vessels that pass through it daily. Approximately 200 m wide (6 m deep) entrance to the passage on the northern side and marked on both sides by lighthouses widens into a large bay on the western and eastern side. The depth in the middle is 4.5 m, whereas it is quite shallow towards the shores. On Ugljan is the church of Our Lady of the Snow with a new waterfront and pier. The depth along the waterfront is about 1 m, and along the pier on both sides about 2-3 m. Further towards the south and the exit, under the bridge 210 m long and 16.5 m high, the navigable canal is marked with 6 pillars of red and green color and lights. The width of the passage under the bridge is 20 m, and the depth is 4.3 m. The passage is well protected from all winds and the sea, but the waves of passing ships can be felt in it. The entrance to the passage is exposed to the winds, so entering during strong jugo wind can be uncomfortable and dangerous. Anchoring is prohibited in the middle of the passage. The current under the bridge is variable in direction and speed up to 5 knots, making it somewhat difficult to control the ship. Passage speed is limited to 8 knots.

Passenger and larger ships and those coming from the northeast have the advantage of passing, while smaller vessels (up to 15 GT) should allow larger ships to pass, which often announce their arrival on VHF channel 16.

Mala Proversa is located between Dugi otok and the Island of Katina. It is exposed to winds bora and jugo. A good anchorage is east or southeast from the Školjić cliff in the bay on the western side of the Island of Katina, and in the Ćuščica Bay (Dugi otok). The smallest depth in the middle of the passage is 4.6 m. The navigable channel is marked with light buoys. Given the specifics of the straits and the increased frequency of traffic, and thus the risk of maritime accidents, we propose the installation of sensors in both straits.

Non-contact water level meter (BMV)

Radar device that is mounted vertically above the watercourse (sea, river, lake), and measures the distance from the instrument to the water surface. During the installation, the height of the instrument is geodetically determined, and according to it, the measured distance is converted into absolute height coordinates. The advantages of this technology are very easy installation (no need to enter the water during installation), and minimal maintenance since the instrument is not in contact with water.

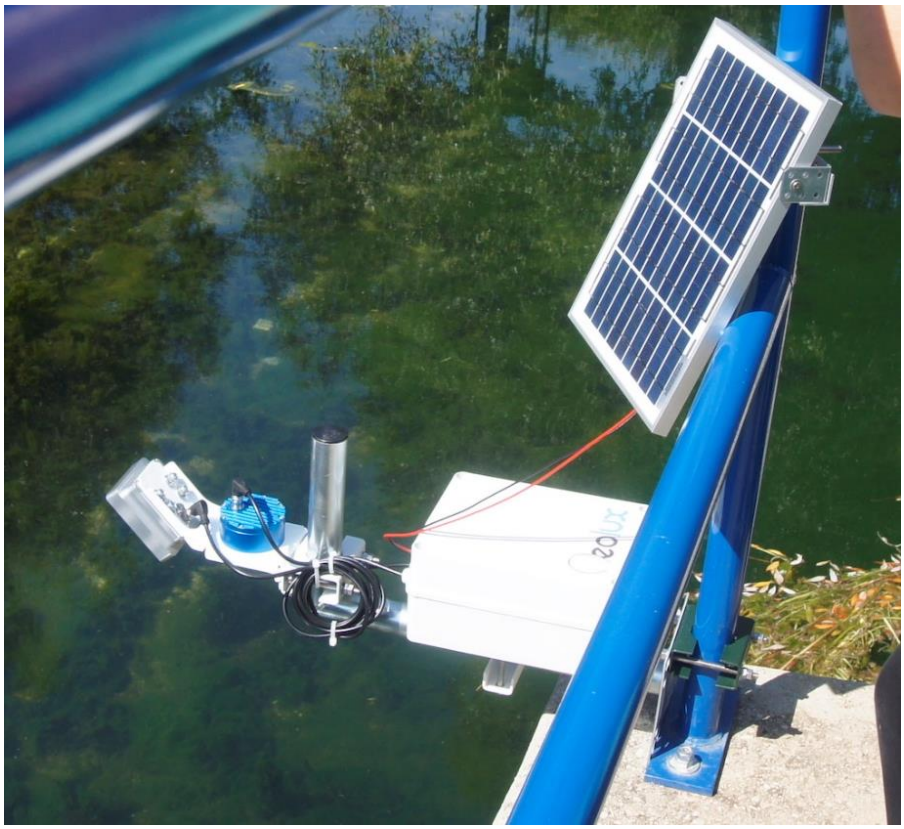


Figure I-8. *Example of BMV*

Thanks to advanced algorithms within the instrument itself, the waves do not interfere but are averaged by the instrument when calculating the water level. A special version of the instrument that reports 10 measurements per second is suitable for installations at sea, and this variant, in addition to the water level, also calculates the period and amplitude of the waves.

Minimum technical characteristics:

- Technology: FMCW radar in the W-band of the spectrum (77-81 GHz);
- Measuring range: 15 meters (there is also a version with up to 35 meters);
- Radar beam width, less than 12° on both axes;
- Internal resolution 0.5 mm;
- Accuracy +/- 3 mm;
- Housing protection IP68;
- Consumption: typically 1.8W, max 2.2W;
- Temperature range: -40 ° C to +85 ° C;

Sea level and tide data are required in a wide range of sea-related activities. The most important areas of application, which define the beneficiaries of the project products, are the following (HHI, 2020):

- Safety of navigation in the Adriatic (traffic of passenger and cargo ships, especially when entering and leaving ports, nautical tourism, fishing and mariculture, navigation of small ships and boats);
- Hydrographic and other research at sea and in the Adriatic submarine (measurements of bottom bathymetry, installation of various underwater installations - optical and electrical cables, pipelines and wastewater discharges, exploitation and research platforms);
- Impact on coastal infrastructure (analysis of extremely high sea levels episodes, assessment of flood possibilities, analysis of the impact on coastal infrastructure together with other oceanographic parameters, especially surface waves);
- Scientific and professional analyses of sea level fluctuations on time scales of several minutes and hours (free oscillations - seiche), 12 and 24 hours (tidal oscillations), several days (influence of atmospheric synoptic systems and planetary waves);
- Analyses of sea level fluctuations on a seasonal and multi-year time scale and sea level trends with special emphasis on the current problem of the global sea level rise;
- Legislation, in particular the Maritime Code, which defines certain terms using sea level data, e.g. the definition of the sea coast, maritime domain and territorial sea.

Suggested locations for sensor placement are:

- Sali, Ždrelac, Mala Proversa, Zadar (Jazine), Zrmanja, Rivanj-Ugljan passage.

Non-contact surface water speed meter

A Doppler radar device that measures the surface velocity of water flow. It is an extremely sensitive device that can detect a surface speed of as little as 2 cm/s, with a surface ripple of 1 mm.

With all the advantages of non-contact technology, the device also enables the calculation of flow on rivers or canals much more precisely than the flow estimation by the usual method using Q-h curves. Often the flow (Q) is implicitly calculated from the water level (h), based on calibration flow measurements for certain water levels. However, the effect of hysteresis is often observed on rivers or canals, where at the same water level the flow varies depending on whether the water level is rising or falling. In addition, upstream of large tributaries, sometimes the tributary downstream of the measuring location ”pushes” water upstream when the tributary has a very large rise in water level. In all these cases, the flow calculation is much more accurate based on two value measurements: water level and surface flow velocity. At Ždrelac and Mala Proversa, we recommend dual sensors, in order to monitor the input and output surface speed.

Minimum technical characteristics:

- Technology: Doppler radar in the K-band (24 GHz);
- Measuring range: up to 20 m above the water surface;
- Measuring range from 0.2 m/s to 15 m/s;
- Measurement resolution 1 mm/s;
- Accuracy 1%;
- Measurement accuracy confirmed by calibrations in the Swiss METAS Institute and the Croatian Naval Institute;
- Power Consumption 0.95 W;
- Housing protection IP68;
- Temperature range: -40 °C to +85 °C;

Suggested locations for sensor placement are:

- Ždrelac, Mala Proversa, Zrmanja.

GSM Smart Observer Datalogger with GSM communication

Datalogger for use in hydrometeorological measuring stations. Special emphasis is placed on minimizing electricity consumption, and on the maximum degree of integration of various components (the battery charger and GPRS modem are integrated in the datalogger).

Minimum technical characteristics:

- Support for RS-232, Modbus-RTU, SDI-12 and CAN digital communication interfaces by instruments;
- Support for analog voltage and analog 4-20mA current interface to instruments;
- Remote configuration through Geolux Hydroview software;
- Instrument power management via 2 channels;
- Wireless communication: 2G/3G/4G/NB-IoT;
- Integrated MPPT battery charger, supports various types of batteries (lead, gel-lead, Li+, LiFePO4, NiMH, NiCd);
- Operating power consumption <1.2 W, standby <0.1 W;
- Temperature range: -40 °C to +85 °C;

Suggested locations for sensor placement are:

- Sali, Ždrelac, Mala Proversa, Zadar (Jazine), Zrmanja, Rivanj-Ugljan passage, Maslenica.

HydroCam

A simple camera that periodically (e.g. once an hour) photographs the measurement location and sends the image to the system. Used for diagnostics; e.g. it can be seen on the camera when debris accumulates at the measuring location and spoils the measurement.

Suggested locations for sensor placement are:

- Sali, Ždrelac, Mala Proversa, Zadar (Jazine), Zrmanja, Rivanj-Ugljan passage, Maslenica.

Meteorological station

Integrated sensor for measuring meteorological parameters: air temperature, precipitation, atmospheric pressure, relative humidity, wind speed and direction by the ultrasonic principle, and it has a solar radiation sensor. In addition to water level sensors, meteorological stations can play a key role in estimating backwater and seiche.

Forced sea level oscillations take place without significant disturbance of the hydrostatic balance in the sea. Their behavior is non-periodic and is caused mainly by strong and prolonged winds and unusually high or low air pressure. At lower barometric pressure the sea level will rise, and at higher it will fall. The influence of wind on sea level fluctuations differs and depends on the relief of the area, direction, speed and duration of wind blowing. In the Adriatic, winds blowing from the southeast raise the sea level, especially in the northern Adriatic, where prolonged south winds and low atmospheric pressure can raise sea levels by up to 1 meter.

In the southern Adriatic, the influence of wind is weak, so the dominant influence on sea level is the influence of air pressure, which can change the sea level by up to thirty centimeters (HHI, 2020).

Free oscillations - seiches - occur generally as the sea's response to rapid change in meteorological parameters, especially wind, over a given area. If the wind, which develops to a greater intensity in a short period, blows towards the closed end of the basin, it raises the sea level and creates a difference in sea level at the entrance to the basin and at the closed end of the basin. The hydrostatic equilibrium is then disturbed, and if the wind abruptly changes direction or stops, the equilibrium is re-established by periodic sea level oscillations. The periods of these free oscillations depend on the dimensions and topography of the area, and the amplitudes also depend on the rate of change of wind intensity and direction (HHI, 2020).

Suggested locations for sensor placement are:

- Sali, Ždrelac, Mala Proversa, Zadar (Jazine), Biograd.

Vessel traffic monitoring system

The ship counting system should consist of two components: a location camera, and a PC device with software to receive and process images from the camera, detect vessels and count them.

It is important for the camera itself that it is a controllable PTZ (pan tilt zoom) camera, with an optical zoom of at least 30x. Due to the high energy consumption during continuous operation of the camera, it is necessary to provide a 220V power supply.

Minimum technical characteristics:

- 4 megapixel CMOS sensor;
- Wide dynamic range (WDR) 120dB;
- Signal-noise ratio (SNR) 55dB;
- 30x optical zoom (4.5mm - 135.0mm);
- Pan-tilt-zoom (PTZ) controllable camera;
- Day/night mode.

Vessel counting module

The camera should be accompanied by a specialized computer with software that will receive the image from the camera via a local Ethernet connection. Software, specially developed for this purpose, will be installed on this computer, which will detect and count the vessels in the image from the camera using convolutional neural network. The module will process images at a speed of at least 1 image per second, and will store the following data in the local database for each detected vessel:

- Vessel detection time;
- Direction of vessel movement;
- Estimation of vessel length;
- Estimation of vessel height.

Figure I-9. *Camera DAHUA SD-59230U-HNI used for monitoring in the PEPSEA project mounted on the wall of the Harbor Master's Office, and the direction in which the camera is facing (yellow arrow)*

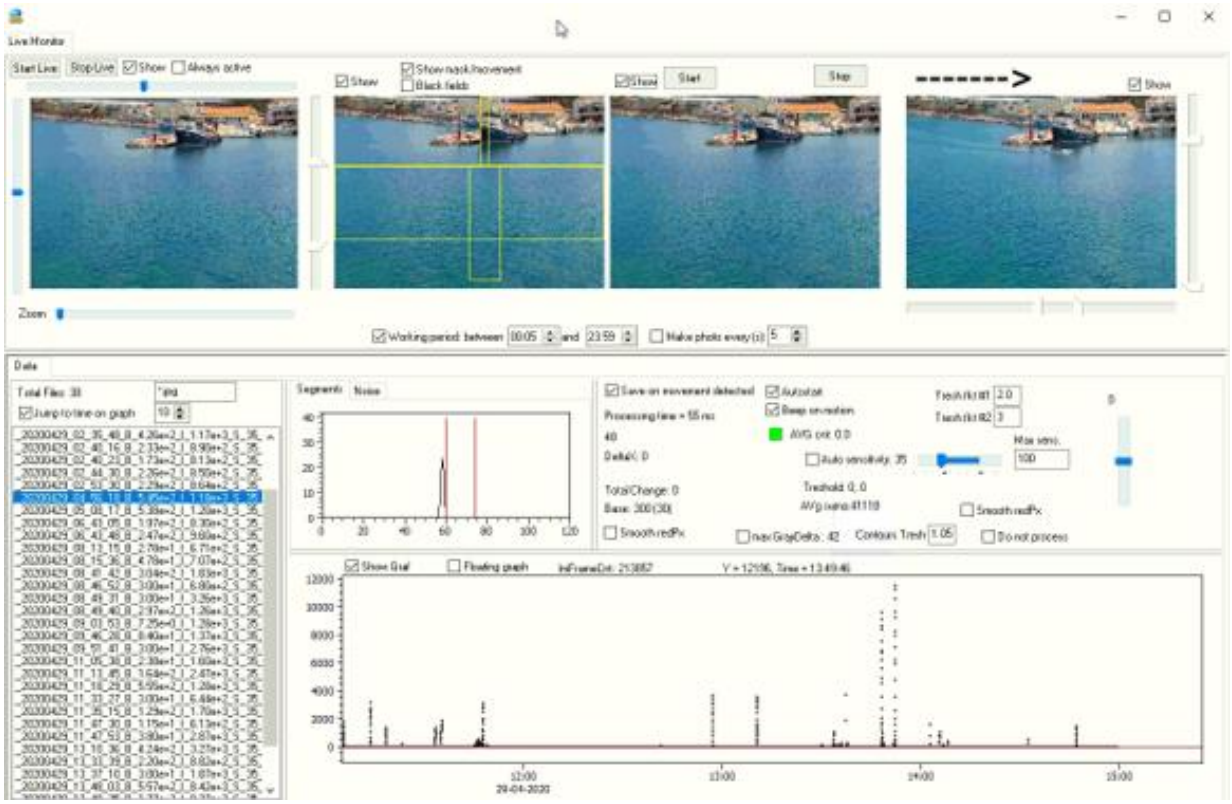


Figure I-10. *Example of Boat Monitoring Program*

<u>Suggested locations for sensor placement are:</u>

- Sali, Ždrelac, Mala Proversa, Zadar (Jazine), Rivanj-Ugljan passage, Maslenica, Biograd.

Drones

Unmanned Aerial Vehicles (UAVs) are, by definition, all controllable unmanned aerial vehicles (Bendea et al. 2007). Various UAV classification schemes have been proposed to help differentiate existing systems based on their operational characteristics and their capabilities (Dalamagkidis, 2015). The main division of drones depends on their working altitude and is divided into two basic groups:

1. Drones operating at an altitude of 3,000 m and above are able to collect data for a longer period of time with the minimum energy required to maintain the flight.

2. Drones with a maximum relative flight altitude of up to 300 m (micro and mini category of unmanned aerial vehicles) (Kolarek, 2010).

Table I-4. *Categorization of drones according to the UAVS - International standard (URL-1)*

Naziv kategorije (eng.)	Akronim	Težina letjelice [kg]	Doseg leta letjelice [km]	Max. visina leta [m]	Autonomija leta [sati]
Micro	Micro	< 5	< 10	250	1
Mini	Mini	25 - 150	< 10	150 - 300	< 2
Close Range	CR	25 - 150	10 - 30	3000	2 - 4
Short Range	SR	50 - 250	30 - 70	3000	3 - 6
Medium Range	MR	do 1250	70 - 200	5000	6 - 10
Medium Range Endurance	MRE	do 1250	> 500	8000	10 - 18
Low Altitude Deep Penetration	LADP	do 350	> 250	50 - 9000	0,5 - 1
Low Altitude Long Endurance	LALE	< 30	> 500	3000	> 24
Medium Altitude Long Endurance	MALE	do 1500	> 500	14000	24 - 48

Table I-5. *Categorization of unmanned aerial vehicles according to Dalamagkidis, 2015*

	Mass (kg)	Range (km)	Flight alt. (m)	Endurance (h)
Micro	<5	<10	250	1
Mini	<20/25/30/150[a]	<10	150/250/300	<2
Tactical				
Close range (CR)	25–150	10–30	3,000	2–4
Short range (SR)	50–250	30–70	3,000	3–6
Medium range (MR)	150–500	70–200	5,000	6–10
MR endurance (MRE)	500–1,500	>500	8,000	10–18
Low altitude deep penetration (LADP)	250–2,500	>250	50–9,000	0.5–1
Low altitude long endurance (LALE)	15–25	>500	3,000	>24
Medium altitude long endurance (MALE)	1,000–1,500	>500	3,000	24–48
Strategic				
High altitude long endurance (HALE)	2,500–5,000	>2,000	20,000	24–48
Stratospheric (Strato)	>2,500	>2,000	>20,000	>48
Exo-stratospheric (EXO)	TBD	TBD	>30,500	TBD
Special task				
Unmanned combat AV (UCAV)	>1,000	1,500	12,000	2
Lethal (LET)	TBD	300	4,000	3–4
Decoys (DEC)	150–250	0–500	50–5,000	<4

[a]Varies with national legal restrictions

With regard to categorization, legal regulations, user experience and drone prices on the market, the research group proposes the purchase of micro unmanned aerial vehicles (up to 5 kg) with the possibility of implementing various sensors (RGB cameras, multispectral, thermal cameras, etc.).

The primary purpose of unmanned aerial vehicles should be to monitor and map the damage (fire, flood, oil pollution) in order to document and create a database. Given that the process of data collection and model generation is demanding and requires extensive expertise, we suggest considering hiring an organization or company that will offer model recording and generation services depending on the purpose of the task.

Figure I-11. *An example of a drone with an integrated RGB and thermal camera*

Floating protective dam

In emergencies, such as petroleum or oil spills, an urgent and timely response that helps prevent environmental disasters is extremely important. Protective floating dams are important in such situations. Dams are water barriers whose main purpose is to collect petroleum and oil on the surface of the water and prevent it from spreading.

There are different types of floating protective dams: based on the materials used in production, purpose and filling. Based on the materials from which they are made, protective dams can be made of PVC, polyurethane or CSM rubberized fabric (Hypalon-Neoprene). Based on the purpose and place of use, open sea, bay and river dams are used. Based on the filling, dams can be inflatable or filled with polyethylene and Styrofoam.

Figure I-12. *An example of a protective floating oil dam*

Minimum technical characteristics

- Floating protective dam: -type of dam: curtain, dam filling: air, deflated dam height: minimum 90 cm, height of the underwater part of dam: minimum 40 cm, height of above-water part of dam: minimum 35 cm, dam height: maximum 3.3 kg/m, dam segment length: minimum 10 m - total length 150 meters;
- Dam transport and storage bags - number (quantity) depending on the total ordered length of the dam;
- Towing set - number (quantity) depending on the total ordered length of the dam and the number of segments;
- Dam blower - number (quantity) depending on the total ordered length of the dam and the number of segments.

Proposed locations for the installation of floating protective dams are:

- Sali, Obrovac (Zrmanja).

Dispersants

The purchase of dispersants is not recommended when purchasing equipment and/or consumables for the prevention or removal of oil and/or oil mixtures. Approved dispersants, procedures and geographical locations where their use is prohibited are defined in detail in the Contingency Plan for Accidental Marine Pollution (Official Gazette 92/2008, 80/2013) (Plan)

Dispersants are chemical agents for spraying and/or removing oil contaminants from the sea surface, which have a valid authorization for use. In accordance with the Plan, the decision on their use is made by the Headquarters for the Implementation of the Contingency Plan and the County Operations Center with the consent of the Headquarters. In the event that the Republic of Croatia submits a request for assistance of staff, technical/material resources and equipment within the Subregional Plan, the competent central state administration bodies are obliged, among other things, to allow temporary entry of equipment and products consumables including dispersants.

- The procedure for removing oil and/or oil mixture is performed by order of the Commander of the Headquarters or the ŽOC commander in the following order:
    - Removal of pollution sources,
    - Preventing the spread of oil and/or oil mixture,
    - Collecting the spilled oil and/or oil mixture,
    - Chemical treatment (use of dispersants) of the spilled oil and/or oil mixture as needed,
    - Removal of marine pollution,
    - Disposal of collected hazardous waste.

It is clear from the above that the use of dispersants, in accordance with the scheme of use of dispersants, is foreseen only if the contamination with oil and/or oil mixture cannot be removed mechanically. The scheme for the use of dispersants is given in Annex III of the Plan.

The use of dispersants according to the Plan is not allowed in the protected nature areas given in Annex V, item 1 of the Plan, which include the Telašćica Nature Park and the Kornati National Park, as well as in active mariculture farms in Annex VI of the Plan. In accordance with Annex VI of the Plan, there are 25 active mariculture farms in Zadar County, of which the closest one to the pilot location is Dumboka Bay, less than 0.4 cable lengths away.

Telašćica Nature Park is in the immediate vicinity of the pilot site and within the scope of Zadar County. Article 28 of the Ordinance on the Internal Order in Telašćica Nature Park prohibits “the discharge of liquids and the use of chemicals that may endanger the authenticity of flora and fauna.” Likewise, Article 33 of the Ordinance on the Internal Order in Kornati National Park, which is 5 NM away from the pilot site, prohibits any pollution of air, soil, water, sea, submarine or buildings, or diminution of their original

values by discharging liquids and using chemicals that may compromise the authenticity of flora and fauna.

Zadar County has a contract with the company Ciklon for action in emergency cases of marine pollution, which, among other equipment and consumables, has 400 l of dispersant located at the following coordinates ϕ=44°05,293'N λ=15°16,128'E (Gaženica port) along with other equipment. It also has an ECO 13/3 vessel with a speed of 24 knots for fast delivery of dispersant to the site of contamination after its use is approved by the Commander of the Headquarters or ŽOC.

From all the above, it is clear that the procurement of dispersants is not required, and in the case of obtaining a permit for the use of dispersants, smaller quantities are available at a known location, and the procedure for supplying new quantities is developed by the Plan.

Absorbents

Absorbents are insoluble materials or mixtures of materials used to collect (absorb) liquids through the mechanism of absorption, adsorption, or both. Absorbents are materials that collect and retain fluid distributed throughout its molecular structure, causing the absorbance of the absorbent to swell (50 percent or more). The absorbent must be at least 70 percent insoluble in excess liquid. In order to be useful in removing oil spills, absorbents must be both oleophilic (attract oil) and hydrophobic (water-repellent). Although they can be used as the only cleaning method in small oil spills, absorbents are most commonly used to remove final traces of oil or in areas that skimmers cannot reach. Collected materials used for oil collection must be disposed of in accordance with the approved collector for this type of waste. Any oil squeezed from the absorbent must also be properly disposed of or recycled.

Absorbents can be divided into three basic categories: natural organic, natural inorganic, and synthetic.

Natural organic absorbents include peat moss, straw, hay, sawdust, ground corn cobs, feathers and other readily available carbon-based products. Organic absorbents can absorb oil between three to fifteen times their weight. The main disadvantages of some organic absorbents are the possibility of adsorption of water and oil, which is why these absorbents have a tendency to sink. Many organic absorbents are loose particles like sawdust and are difficult to collect once they have spread across water. These problems can be offset by adding floating devices, such as empty drums attached to absorbent bales of hay, to overcome the issue of sinking or wrapping loose particles in a net to aid collection.

Natural inorganic absorbents consist of clay, perlite, vermiculite, glass wool, sand or volcanic ash. They can absorb oil between four to twenty times their weight. Inorganic absorbents, like organic absorbents,

are cheap and readily available in large quantities. These types of absorbents are not used on the water surface, but exclusively to collect oil residues on land.

Synthetic absorbents include plastic-like artificial materials, such as polyurethane, polyethylene, and polypropylene, and are designed to absorb liquids on their surfaces. Other synthetic absorbents include crosslinked polymers and rubber materials, which absorb liquids into their solid structure, causing the absorbent material to swell. Most synthetic absorbents can absorb oil between 70 times their weight.

When selecting absorbents for cleaning oil stains, the characteristics of both absorbents and types of oil must be taken into account:

Absorption rate - Oil absorption is faster with lighter petroleum products. Once absorbed, the oil can no longer be drained. It is effective with light hydrocarbons (e.g. Gasoline, diesel, benzene).

Adsorption rate - Thick oils adhere more efficiently to the absorbent surface.

Oil retention - The weight of the used oil can cause the structure of the absorbent to sag and deform, and when lifted out of the water, it can release the oil trapped in the pores. Lighter, less viscous oil is lost through the pores more easily than heavier, so more viscous oils can cause secondary contamination during absorbent collection.

Easy to apply - absorbents can be applied to oil stains manually or mechanically, using a blower or fan. Many natural organic absorbents that exist as loose materials, such as clay and vermiculite, are dusty, difficult to apply in windy conditions, and can be dangerous if inhaled.

The following table shows the advantages and disadvantages of the available absorbent types:

	Material	Advantages	Disadvantages
bulk	• Organic - bark, sawdust, paper pulp, cork, chicken feathers, wool, human hair • Inorganic - vermiculite and pumice • Synthetic - primarily polypropylene	• Often naturally abundant or widely available as a waste or by-product of industrial production • Can have a low price • It can be used to protect flora and fauna	• Difficult to control application, can be carried by the wind • Difficult collection • A mixture of oil and absorbent can be problematic for pumping • Disposing of the absorbent-oil mixture is more difficult than the oil itself • Voluminous for storage
packed	• All the above materials can be packed in nets	• Easier to apply and collect • A closed dam has a higher surface area than a continuous one	• Structural strength limited to that of mesh or packaging • Organic dams can quickly saturate and sink • Oil retention is limited
continuous	• Synthetic - primarily polypropylene	• Long-term storage • Relatively easy to apply and collect • High degree of oil collection especially if used at full capacity	• Limited efficiency for viscous and more volatile oils • Not prone to dissolution and limited disposal options
fiber	• Synthetic - primarily polypropylene	• Effective on volatile and more viscous oils	Less effective on lighter and medium heavy oils


The pictures show the absorbing dam and pads.

Organic absorbents are commonly used in Croatia. The company Ciklon d.d., with which the Zadar County has a contract for action in case of marine pollution in the warehouse in the port of Gaženica, has the following quantities and types of absorbents.

Material	qty.	Warehouse	Ownership	price	transport cost
dam absorbent	300 m	44°05,293'N 15°16,128'E	Ciklon d.o.o.	HRK 187/l	HRK 3.50/km
absorbent absorbers	500 pieces	44°05,293'N 15°16,128'E	Ciklon d.o.o.	HRK 6.25/piece	HRK 3.50/km
powdered absorbent	1700 l	44°05,293'N 15°16,128'E	Ciklon d.o.o.	40 HRK/l	HRK 3.50/km

Awareness campaigns

The local population of Sali and its surroundings will benefit from the presentation of the research results at the pilot site. It is recommended that the presentation of the results be done by external experts so that the population is aware of the risks and consequences of various activities.

Research has shown that there is a significant risk of marine pollution from land through human activities of agriculture and industry. The local population would benefit most from education related to the proper disposal of waste and the use of pollutants in agricultural activities.

It would be useful for local stakeholders to become familiar with contingency plans in cases of sudden marine pollution by disseminating materials (publications and intervention plans) and discussing through a public event.

It is recommended to work on the younger population through workshops in order to contribute to raising awareness as soon as possible and thus increase the effect of protecting the sea from pollution through careful use of the sea.

The environmental remediation system can be learned through livinglab using biomimicry. Livinglabs are virtual laboratories that can be established in any type of environment. In livinglabs, participants from different disciplines and backgrounds immerse themselves, in this case, in the island environment, exposed to nature and learning about environmental problems and related sustainable solutions. Biomimicry is an emerging discipline that uses biological models to develop sustainable solutions to environmental, technology, engineering, and design challenges. It is an innovation tool that has a unique capacity to accelerate the holistic processes necessary for a successful sustainable project that addresses local issues.

Appendix 1 Key legal and natural persons to operate in the DCP with a list of available equipment

Appendix 2 - Activation scheme of the Headquarters and ŽOCs & Notification flow scheme according to the Contingency and Action Plan for Oil and/or Oil Mixture Contamination.

B. PROJECT PARTNER 3 – SPLIT-DALMATIA COUNTY

Abstract

An earthquake intervention plan has been developed and preventive action has been proposed. Contingency plans have also been made for sudden marine pollution.

A plan of interventions in case of fire has been developed, and preventive actions against open fires and preventive actions against fire in industrial facilities have been proposed.

A plan of action in case of sudden sea pollution in case of fire in industrial plants has also been made.

A flood intervention plan has been developed and actions in case of sudden sea pollution have been proposed.

An intervention plan has been developed in the case of waste oil from open storage facilities and separators, and preventive actions have been proposed, as well as actions in the event of sudden sea pollution.

An intervention plan has been developed in the event of an accident at submarine outfalls, which includes preventive actions, and actions in the event of sudden sea pollution.

An intervention plan in the event of a maritime accident has also been developed, and preventive actions as well as actions in the event of sudden marine pollution have been proposed.

A proposal was made for the procurement of equipment for monitoring sudden marine pollution, as well as cleaning the marine environment if pollution occurs.

CONTINGENCY PLANS FOR ACCIDENTAL MARINE POLLUTION

INTRODUCTION

Contingency plans for accidental marine pollution (hereinafter referred to as: „Plans“) are documents which propose procedures and prevention measures, preparedness for intervention in case of accidental marine pollution and unusual marine phenomenon within pilot location.

Plans result from risk assessment model and are compliant with Contingency plan for accidental marine pollution in Split-Dalmatia County (2010) and with National Contingency plan for accidental marine pollution of the Republic of Croatia (OG 92/08), and are based on measurements and assessments deriving from data obtained in this Project, and from literature references.

PURPOSE

The purpose of the plans is to provide efficient appropriate and timely preventive and intervention measures in case of accidental marine pollution or threat from pollution, aimed at reducing damage in the sea and on coastal area, and at reducing harmful impact of accidental pollution to economy and protection of life, health and quality of life in north-east part of Kaštela Bay, taking into account the existing Contingency plans for accidental marine pollution adopted by the Government of the Republic of Croatia and Split-Dalmatia County. Plans are result of multidimensional analysis of pilot location, intended to increase the efficiency of already existing and adopted plans.

The responsibility for the implementation of the Plans is assigned to County Operational Centre (COC).

1. CONTINGENCY PLAN IN CASE OF EARTHQUAKE

Preventive actions

As it is well known, earthquake cannot be predicted, and it presents the emergency phenomenon.

However, probability of earthquake incident can be assessed, and it is assessed in statistical sense.

As stated, 95 years incidence of the earthquake with magnitude VI MKS is probable just like the 475 years incidence of the earthquake with the magnitude VIII MKS. Total probability of major earthquake is one incident in 100 years.

Possible damages to the infrastructure in the City of Kaštela should be discussed with ALFA-ATEST, 2019 and for the issue of total risk, see the chapter dealing with risk in this report, which has taken in consideration the overall area of the north-east part of Kaštela Bay.

As prevention, the infrastructure facilities can be constructed in such a way that they can easily stand the magnitude VI of the earthquake, and not to suffer significant damages which are dangerous for people at the magnitude VIII of the earthquake. Croatia has adopted building practices and construction protocols, which are available and have to be fulfilled.

Preventive activities for accidental marine pollution imply periodical verification of proper operational condition of water supply and sewage system, all the facilities of the existing industrial companies, in particular their handling surfaces, preparedness of equipment in case of accident and organisation of regular practical training exercises for the staff under the jurisdiction of COC.

Intervention in case of accidental marine pollution

As previously stated, significant earthquake can induce the rupture of water supply system, sewage, facilities constructed on handling surfaces of industrial plants and pollution separators.

Rupture of water supply system results in drinking water spilling into soil and on the surface, whereby both by their run-off lead to marine pollution. Drinking water which leaks into the soil collects pollution, and thus being saturated, runs-off into the sea. The sea at the very point of outflow and around it shall develop yellow or grey colour, and could be easily detected by surveillance cameras. In case that oil slick does not appear on the surface, little can be done to reduce marine pollution, save for urgent repair of water supply system, sewage or pollution separator. Should the oil slick appear, which is less probable,

the slick surface must be assessed and immediately enclosed by barrier, and thereupon collect oil or fuel by absorbents or skimmer. The recovery intervention should be coordinated by COC.

Sewage system rupture can lead to run-off of wastewater and significant microbiological pollution of coastal sea within entire period until the sewage repair. It can also result in the oil slick appearance along the shore. Since the repair of sewage system is usually not ranked as the priority after the earthquake, microbiological pollution of coastal sea can last for months and threaten marine economic activities. All until the repair of sewage system, marine recovery is not possible; however in case of appearance of oil slick, it must be enclosed by dam and oil must be collected by absorbents or skimmer. COC is in charge of marine recovery coordination.

Industrial facilities impairments, dispersion or spillage of dangerous substances from handling surfaces and ***run-off from pollution separator***. Impairments of industrial plants can also result in leakage of fuel and oil into the sea, regardless of the fact that all the plants have the protection, aimed at preventing the leakage into the environment, namely they have secondary containment tanks (bunds). Therefore the probability of marine pollution is significantly reduced.

In case of marine pollution, due to the use of surveillance cameras which must be installed in such a way that they cover entire coast of the north-east part of Kaštela Bay, it will be possible to notice the slick on the surface, differing in colour and reflection. In such case, the surface and volume of the slick must be assessed, in order to activate the procurement of the dam providing sufficient length, and to procure sufficient equipment to collect the oil generating the slick. The intervention of the recovery of the sea surface shall be coordinated by COC.

In addition, the sea quality along the relevant section of the shore of pilot location should be immediately examined, and in compliance with obtained results, assess the need for further interventions and further monitoring of marine condition.

Should the monitoring reveal the occurrence of significant microbiological or other marine pollution, the source of pollution must be urgently identified, and as necessary, repair the sewage system, water supply system or stop the run-off from the source, collect and adequately manage the pollution.

In case of constant visual pollution of sea surface, the pollution must be permanently entrapped, and oil must be collected until the repair of water supply system, sewage system, industrial plant, pollution separator or submarine outfalls, and dispose it adequately.

2. CONTINGENCY PLAN IN CASE OF FIRE

Preventive actions against open fires

As already known, it is impossible to predict the open fire, instead it is ranked as the emergency phenomenon. However the incidence of fire can be predicted, and it is predicted in statistical sense. As already stated, the probability of significant fire is once in 12 years.

Preventive actions are possible, addressed to occurrence of fire and to fire incurred damage.

The major importance is given to education and periodic communications to population about the possibility of fire incidence, information on the most frequent causes of fire, its early identification, level of damages it might incur and on efficient damage mitigation response.

In addition, the fire evacuation routes must be regularly maintained, enabling firemen to extinguish the fire efficiently when it occurs. These routes in tourist offer can be used as bicycle routes with fire-fighting instructions to cyclers, and routes to discover the territory assisted by tourist guides.

Preventive actions against fire in industrial facilities

Each major industrial facility has its Study on fire and explosion safety. However the Study itself is not enough. The officials in charge in industrial facilities must conduct periodical control of operation of possible processes, which unintentionally can lead to explosion or fire, and inspectors must periodically verify how these controls are performed. The major importance is periodical testing of occurrence and persistence of static electricity, since in most of the cases it is the cause of emerging accident, and we must not neglect that it is always present in major or smaller extent in almost all industrial processes.

Besides the above, key factor in preventive actions are periodic training exercises for the staff, working in the facility and their timely and efficient alert and testing of the arrival of help from the nearest Fire Fighting Brigade in case of real accident.

Finally, the part of prevention is also the maintenance of fire-fighting equipment, regular education and training of firemen.

Intervention in case of accidental marine pollution

In case of sudden fire and intensive rain after it, the ashes from the fire-affected area can be washed into the sea. Probability for such event significantly diminishes after the fire incidence. Similar applies for the fire in industrial facilities. Logically, depending on location of industrial facility, the probability for marine pollution is higher, when the facilities along the sea are affected.

In such a case, the accidental marine pollution cannot be prevented.

As well, there is no way to recover fully the marine pollution, because the ashes melt fast in water and affect pH value of the sea. The only thing that can be done in such a situation is to collect macro pollution from the sea surface and dispose it adequately.

In case of oil, grease or fuel spill from coastal industrial facilities, which can be induced by fire, it will be detected by surveillance cameras. In such an emergency, the priority action is to assess the surface and extent of the slick on sea surface, in order to engage sufficient quantity of equipment: dams and material for recovery of oil from the surface. In all the other issues must be followed the instructions of Contingency plan for accidental marine pollution in Split-Dalmatia County, 2010 , that is the instructions of COC.

Prevention of marine pollution in case of fire in industrial facilities

Within pilot area there are several locations with tanks of oil and petroleum products and with other flammable substances. Locations / capacities / existing intervention procedures in incidents affecting tenants using the premises, are addressed in chapters VIII and IX of this document. Procedures of tenants of the premises determine the procedures of notifications and participants in fire extinguishing activity.

In case of fire on the land, sea pollution can occur during the fire extinguishing intervention, whereby the polluting substance together with fire extinguishing water leaks into the sea, or the polluting substance itself flows into the sea over the shoreline. In such a situation, the substances like crude oil and petroleum products (oils) can catch fire on sea surface. In the text below are provided the recommendations for such a situation, taken from the book „In-Situ Burning for Oil Spill Countermeasures“ (Fingas, 2018).

Flammable element in oil fire is the result of its evaporation. Oil evaporation must be sufficient to reach stable burning state, that is the state at which the quantity of evaporation is approximately equal to the one consumed by fire. For most oils, to reach the burning phase, the oil slick must be ca. 0,5-2 mm thick. Once when the burning process has started on sea surface, it must last until the thickness of oil slick

does not get thinner, and reaches 0,5 mm. The beginning of the in-situ burning , besides the oil slick thickness, is also affected by type of oil and environmental conditions, like wind.

If the evaporation of fuel is faster than its combustion, it will generate more soot as result of partial combustion, and fuel drops will be released downwind, or, more typically, cause small explosions or fire balls. The said phenomenon is often seen in case of gasoline or light oil fire. Diesel fuel has demonstrated combustion pattern different from other fuels, with tendency of atomisation, rather than evaporation. It results in difficulties in creation of soot. Most of the other fuels evaporate under the impact of heat and do not create drops, like diesel, kerosene or jet - fuel. Most of the oils burn at a rate of ca. 1–4 mm/min, meaning that the thickness of oil decreases for corresponding value of millimetres in a minute.

The speed of flame spreading, doesn't differ much depending on the type of fuel, however it differs significantly depending on the wind and wind direction, and ranges from 0,01 to 0,02 m / s (0,02-0,04 knots). The speed of downwind flame spread ranges from 0,02 to 0,04 m / s (0,04–0,08 knots) and up to 0,16 m / s (0,3 knots) at strong wind. Flame spreading through vapour clouds can reach the speed up to 100 km/h, which can occur at leakage of gasoline or similar volatile fuels.

The flame height depends on fire radius. The assessment of the flame height for the fire within dam with radius of ca. 10–20 m is ca. 1,5 times higher than the diameter, or 15–30 m.

Table 1 describes the inflammability features of various fuels, notwithstanding whether the oil is on the land or on the sea.

Regardless the fact that oil burning will significantly reduce sea pollution, it will also cause thick black smoke, generating fear of toxic emissions among the population; however it can also cause fire spread to other facilities, which risk must be particularly considered having in mind the intended use and population density of coastal area.

Basic emissions from burning oil and petroleum products are: Carbon dioxide (CO_2), H_2O and side products: particulate matter, organic compounds and gases. The residues remain on sea surface.

Concentration of particulate matter in the emissions generated by burning of diesel are approximately four times higher than the concentration of crude oil of the similar size, at same distance from the fire. The particles are exponentially distributed downwind, away from the fire. Concentrations on the level of the ground (1 m) can be above normal levels of health concern (35 µg/m^3), even up to 500 m downwind, in case of crude oil small fire. The major concern are minute particles or those that can be breathed. Fraction PM-10 or the particles smaller than 10 µm usually make ca. 0,7 share of total number of particles' concentration of all the measured particles (1). Tiny particles PM-2,5 are currently in major focus of interest due to health problems they cause.

Table XI-1: *Characteristics of flammability of various fuels (Fingas, 2018)*

Fuel	Flammability	Ignition	Flame spread	Burning speed (mm/min)	Combustion efficiency
Gasoline	Very high	Very easy	Very fast, through vapour	3,5 - 4	95 – 99
Diesel	High	Easy	Moderate	3–4.0	90–98
Light crude oil	High	Easy	Moderate	3–3.7	85–98
Medium crude oil	Moderate	Easy	Moderate	3–3.7	80–95
Heavy crude oil	Moderate	Moderate	Moderate	3–3.5	75–90
Light oil	High	Moderate	Moderate	2.5–3	80–90
Weather affected crude oil	Low	Difficult, adding incineration agent	Slowly	2.8–3.5	50–90
Heavy oil	Very low	Difficult, adding incineration agent	Slowly	2.5–2.8	40–70
Used oil	Very low	Difficult, adding incineration agent	Slowly	2–2.5	15–50
Oil emulsion	Low	Difficult, adding incineration agent, high heat	Slowly	1–2	40–80

Oil combustion generates organic compounds, among which are the following ones: Polycyclic aromatic hydrocarbons (PAH), carbonyls, dioxin, polychlorinated dibenzofuran, benzene, toulene, ethylbenzene, xylene.

Polycyclic Aromatic Hydrocarbons - PAH are considered as being harmful for people and environment, and one of their sources is combustion. Crude oil contains PAH; however, oil spill by itself does not contribute to significant impact of PAH on the environment, meanwhile, oil combustion can present significant PAH intake in the environment. It is particularly emphasised that two sources which generate the most significant PAH intake in the environment are diesel engines and home heating by fuel oil,

similar to diesel fuel. It is generally considered that the sources with low temperature, like diesel engines, cause higher PAH intake in the environment than the sources with high temperature, like fires.

Carbonyls in the emissions generated by crude oil fire have very low concentrations and are significantly below the level which is considered as dangerous for health, even close to the fire. Carbonyls generated by diesel fuels fire are somewhat higher, however still remain below the health dangerous level. Combustion of fuels which contain alcohol results in increase of released carbonyls.

Dioxin and Polychlorinated Dibenzofuran are highly toxic substances, however the testing of the oil fires up to now have shown that the emissions of these gases are negligible.

Benzene, Toluene, Ethylbenzene and Xylenes - BTEX are frequently released by oil spill. Analysis of emissions of several types of oil has shown that the concentration of BTEX during the combustion is lower than in case of evaporation of oil slick.

The gases released by fire of oil and petroleum products are classified in the groups: Volatile Organic Compounds - VOC, carbon dioxide, carbon monoxide, sulphur dioxide and other gases.

VOC concentrations are relatively small at combustion or similar to those referred to in the comparison with evaporation. Concentrations are below the level considered as human health risk, even if very close to the fire. Concentrations are highest at the ground (1 m) and are exponentially dispersed downwind from the fire source. Regardless the presence of VOC, they do not present high danger for people or environment.

Carbon Dioxide is final result of combustion and is recorded in increased concentrations around the fire. Usual atmospheric level is ca. 300 ppm, and the level close to the fire can reach ca. 500 ppm, which does not present the risk for people. Measured three-dimensional dispersion of carbon dioxide around the fire record the highest carbon dioxide concentrations at the height of 1 m, falling to negligible level at 4 m height.

Carbon Monoxide levels are usually on or below the lowest level of detection by instruments and therefore do not present any danger for people. Gas is measured only when it seems that the burning is non-efficient, e.g. when water is being sprinkled into the fire. It seems that carbon monoxide is dispersed in the same way as carbone dioxide.

Sulphur Dioxide, by itself, is usually not revealed at significant levels, and sometimes even not on measurable levels in the oil fire area. Sulphur acid or sulphur dioxide which has reacted with water, is revealed in fires, and it seems that levels, although it is not alarming, correspond to the content of sulphur in the oil.

The Figure XI-1 provides the illustration of behaviour of emissions. (a) particulate matter together with absorbed organic substances, e.g. with PAH, are released and precipitate downwind; (b) water vapour and light gases rise into the air, and are further widespread and dispersed; (c) carbon dioxide and other heavy gases rise up, and afterwards slowly fall down and can circle through the fire; (d) organic gases like volatile organic compounds (VOC) and carbonyls are transported far away and dispersed.

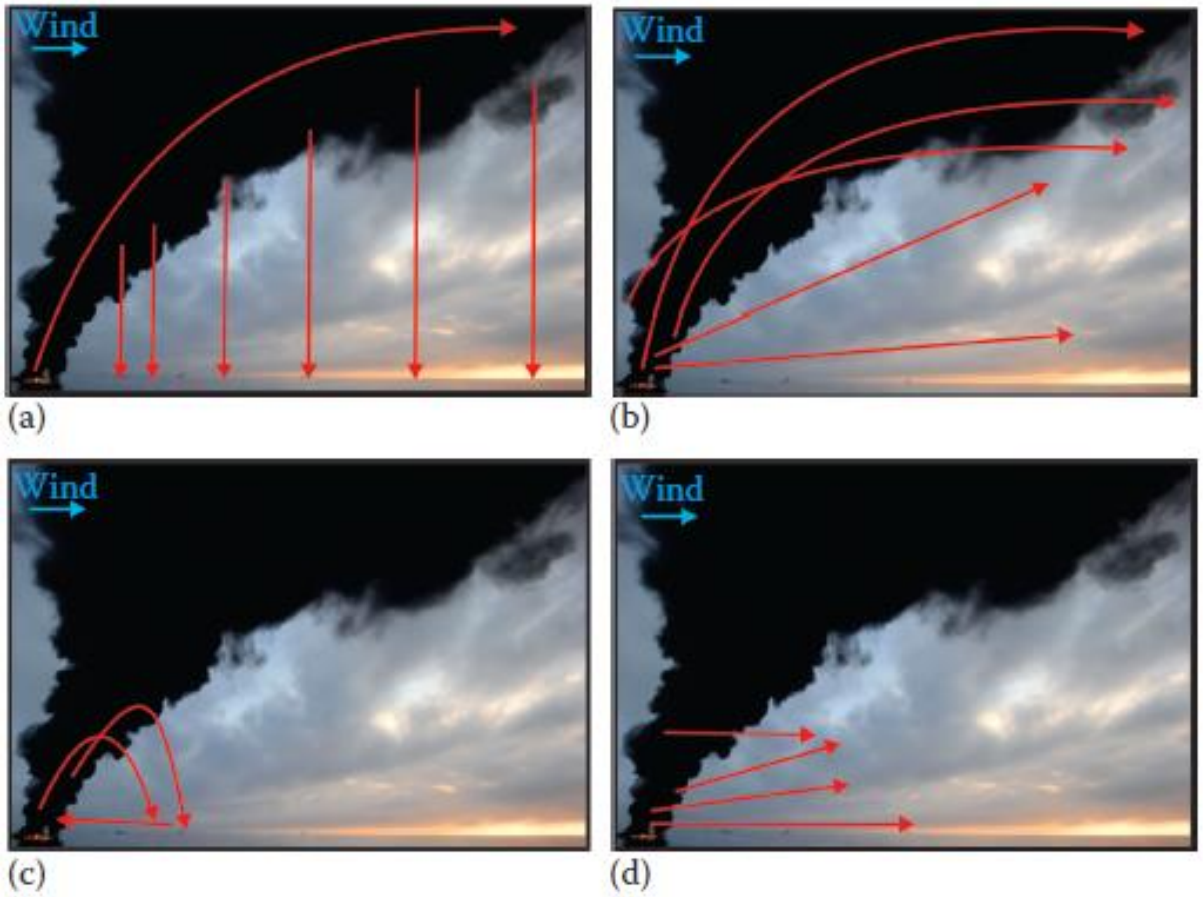


Figure XI-1. *Emission of gases and particles during fire*

The above described behaviour pattern of the oil and petroleum products' fire on sea surface, leads to conclusion that tiny particles PM-2,5 present the highest risk for human health, since they prevail in the particulate matter emissions.

The residues of oil combustion are mostly unburned oil, with removed lighter or more volatile products. When the fire ceases, remains unburned oil which is simply too thin to keep going the combustion

process. Besides unburned oil, it is recorded the presence of the oil, which is subject to high heat, and thereby affected by time and changed. Highly efficient combustion of some types of heavy crude oil may result with residues of oil which after cooling sink in sea water and can affect the marine fauna. Testing of adhesiveness of original oil (crude and mid fuel oil) and their combustion residues shows that their adhesiveness for feathers is similar, although the combustion residues are somewhat more sticky.

Table XI-2 *Calculation of safe distance based on concentration PM-2,5 (Fingas, 2018)*

Type and surface	Fire affected area (in ha)	Safe distance (km)
Crude oil fire		
Small area, 250m^2	0,25	0,09
PP dam 500 m^2	0,5	0,3
Large PP dam, 750 m^2	0,75	3,2
Diesel fire		
Small area, 250 m^2	0,25	0,8
PP dam 500 m^2	0,5	2

Further to above described effects of sea pollution caused by oil fire which has spread to sea surface, the following conclusions can be reached:

- oil fire on sea surface must be localised applying fire-resistant floating dams,
- regardless positive environmental effects generated by the burning of oil and petrol products, in sense of prevention of further sea pollution, having in mind the vicinity of settlements and presence of industrial plants, it is necessary to prevent the spread of fire of spilled oil on the surface,
- before final adoption of measures on prevention of pollution caused by oil or petrol products spill to the sea surface, the expert teams of the owner of the plant should be consulted, in order to provide the exact specification of polluting substances.

There are only few commercially available fire-resistant dams, because the market is small, and production costs are high, and these dams cost much more than conventional ones. Besides to fire-

resistant features, they are also tested to hardness, integrity and ability to contain the oil during the towage. Various types of fire-resistant dams include water cooled dams, stainless steel dams, heat resistant dams and ceramic dams. Fire-resistant dams, and particularly stainless steel dams, considering their size and weight, require special handling. Heat resistant dams are similar in their appearance and operate just like conventional dams, however they are built of numerous layers of fire-resistant material. Different types of fire-resistant dams are presented in the Figure XI-2.

Standard dams usually cannot be used to contain the burning oil, since the materials they are made of, either burn off or melt in very short time, threatening the ability of the dam to contain the oil. However, often is much faster to provide the conventional dam at spill site, because conventional dams are much cheaper and usually available at storages, which have on stock quite a few fire-resistant dams. Conventional dams may be used solely to stop the spreading of oil slick and contain it until the fire-resistant dam is put in place. Timber clogs or other floating material can sometimes be used as a temporary barrier.

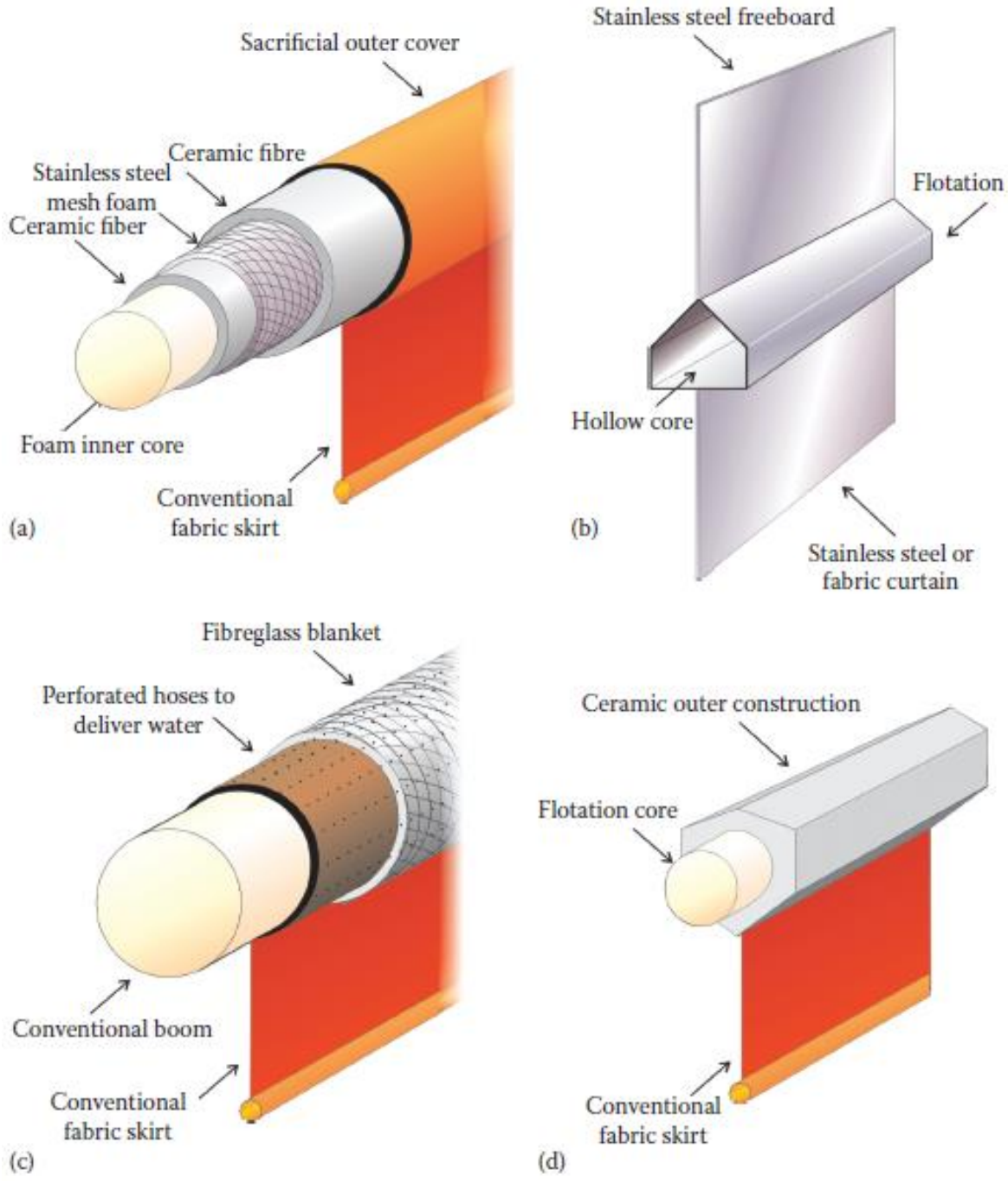


Figure XI-2. *Types of fire-resistant dams: (a) Heat resistant dam - fabric based; (b) dam made of stainless steel; (c) water cooled dam; (d) ceramic dam (Fingas, 2018)*

3. CONTINGENCY PLAN FOR FLOOD INCIDENTS

Preventive actions

Backwater

Having in mind that almost each year the flood develops from the backwater, it is wise to undertake all possible prevention measures. Priority should be to raise the shoreline up to the height which prevents the penetration of water in restaurants and in other coastal infrastructure facilities. However, raising of shoreline must be complemented with the installation of one-way valves, so that in case of torrents, the water can run-off into the sea, without causing flood of coastal infrastructure. Knowing that the sea level is going to rise due to global warming and melting of ice caps, the height of the wall must be designed to provide safe defence in the following 50 years, which means for 50 cm.

Besides the above, the backwater shall penetrate in sewage outlets and infrastructure outfalls along the coast, therefore at all these spots must be installed single permeable valves towards the sea, and this infrastructure should not be used for water drainage as long as the backwater is on, which is relatively short period.

Torrent flows

At possible points of the penetration of torrents which are identified in this study, should be built the backwater grids in order to reduce the speed of the water of torrent flow, and thus carry away less material to the coastal area and to the sea.

As well the equipment for recovery of macro-pollution from sea surface must be kept in proper condition, along with regular training for civil protection forces, and participation in the training exercises organised by COC.

Acting in case of accidental sea pollution

In case of accidental sea pollution, the priority should be to limit the spreading of pollution by floating dams and recover macro-pollution from sea surface, and later, when backwater or torrent flows disappear, the bottom part of the bay must be examined and macro-pollution must be recovered from the bottom.

In case of occurrence of oil slick, which is going to be detected by surveillance cameras, the priority should be to assess the surface and extent of the slick, in order to prepare adequate equipment, specifically dams and material for recovery of oil from the surface. The recovery must be coordinated by COC.

4. CONTINGENCY PLAN FOR WASTE OIL SPILL FROM OPEN TANKS AND SEPARATORS

Preventive acting

Special attention must be dedicated to ensure that paint, diluters, waste oils and other chemical agents in shipyards and marinas are properly used and after the use, adequately managed. All the grease & polluters' separators must be properly secured from backwater and torrents. Thereby will be significantly reduced the risk from leakage and sea pollution.

It is recommended to protect the separators by preventing the inflow of the sea or the inflow of backwater and torrents above certain level, by building-in appropriate sensors for closing the separators in the circumstances when the inflow of water into the separators exceeds their operational capacities. Such a solution would prevent further inflow of water and discharge of oil from the separator into the sea, however the possible pollutions from the open working surfaces would enter the sea without filtering treatment. In order to reduce the consequences of such pollution, it is essential that all the working surfaces, which might be affected by backwater or torrents, are always kept clean and any leakage of oil on such surfaces must be immediately picked up by absorbents or by environmentally friendly detergents.

When dealing with tanks, it is recommended to install them in closed secondary containment (so called bunds), which would contain leaked oil and grease.

Acting in case of accidental marine pollution

Should the marine pollution by waste oil or grease nevertheless occur, in such the event will apply Contingency plan for accidental marine pollution in Split-Dalmatia County (SDC Plan) („Official gazette of Split-Dalmatia County", number 11/09), since in the area encompassed by pilot location, there's not a single tank for collection of waste oil or other waste harmful or dangerous liquids, with capacity exceeding 2.000 m3. Namely, Contingency plan for accidental marine pollution in Split-Dalmatia County, inter alia, prescribes the application of national Contingency plan for accidental marine pollution (Official Gazette 92/2008, 80/2013) when the quantity of spilled oil exceeds 2.000 m3.

In such incidents, SDC Plan prescribes that each person who has caused or has noticed the marine pollution or the accident likely to cause marine pollution, must immediately, without any delay, notify Harbourmaster's Office Split, the Branches of Harbourmaster's Office Split or County centre 112 about

such event. The official receiving the notice on marine pollution or on the event which may cause marine pollution, must proceed the received information to the Commander of COC of Split-Dalmatia County and to National Maritime Rescue Coordination Centre (MRCC) in Rijeka, that is , proceed according to the scheme on alerting and procedure in case of marine pollution, provided for by SDC Plan.

Working organisations operating in the area encompassed by pilot project, whose operating procedures or operating equipment may cause marine pollution, prescribe in their rules described in the chapter IX, procedures and legal entities which have to be alerted in case of accidents. In this territory, in the prevention of marine pollution are involved the following entities: Voluntary Fire Brigade Kaštel Gomilica d.o.o. for ecological marine protection and company CIAN d.o.o.

The Appendix 2 of this Plan contains legal persons and their equipment, available for recovery of pollution within or close to the east part of Kaštela Bay.

The Commander of COC Headquarters, who by his title is the Harbour master of Harbourmaster's Office Split, upon receiving the notice on pollution or possible pollution, shall proceed with providing necessary data required in order to establish type, scope, location, threat of pollution for people and environment, all for the purpose of passing decision on the need to activate the Plan. For collection of data and exploration, the COC Commander may use vessels or aircrafts and other private and legal persons who can contribute to quality of decision on the activation of the Plan. In addition, until the moment of decision on the Plan activation, he will undertake necessary actions and activate resources aimed at limiting damage, or in case of the minor scope pollution, organise definite recovery of damage without convocation of COC.

In case of the Plan activation, all decisions on intervention at sea and on the coast, aimed at pollution recovery, shall be passed by COC Commander, in line with operative procedures provided for in the Plan, and as necessary in cooperation with the owner / manager of the pollution source.

5. CONTINGENCY PLAN FOR SUBMARINE OUTLETS ACCIDENT

Preventive acting

Preventive acting against penetration of pollution into the sea from submarine outlets consists in periodical examination of the outlet pipes and its proper operation.

Besides the above, every day must be made simple and fast inspection of sea surface of the bay, aimed at noticing difference in sea colour. It will be possible through installation of cameras' surveillance. The subject method is the fastest indication, showing the occurrence of the penetration of the pollution between the land and submarine outlet.

Acting in case of accidental marine pollution

In case of accidental marine pollution which can be consequence of the rupture of the outlet or the gust of torrent flows, the fresh water flow will exceed the breakthrough capacity of the outlet and bring with it exceptionally huge quantity of pollution. Pollution which is lighter than sea water shall start floating, and has to be promptly recovered and adequately managed.

The pollution which has mixed with and dissolved in sea water will be brought away from the coast by sea currents. Macro-pollution which is heavier than sea water shall sink to the sea bottom. Therefore, after the accident, the divers must scan the bottom and recover macro-pollution.

Logically, the outlet pipe should be repaired promptly.

In case of leakage of oil or fuel, it will start floating on sea surface very soon, and thereby will be detected by surveillance cameras. After revealing the leakage, the same procedure should be applied, as the above described, in case of oil slick along the coast.

6. CONTINGENCY PLAN FOR MARINE DISASTER

Preventive acting

Prevention includes regular control of navigation route, signalisation and alerting seafarers on possible obstacles, sea state and density of traffic. Besides, special attention should be addressed in the time of peak maritime traffic at pilot location. Accordingly, the essential activities are numbering of ships at both entries into Kaštela Bay, along with monitoring by surveillance cameras.

As well, the equipment for recovery of macro-pollution, fuel and oil from sea surface, must always be kept in proper condition and stand by, provide for regular training of the local civil protection staff, and participate in the training organised by COC.

Acting in case of accidental marine pollution

In case of marine disaster, the commander of the vessel either directly or through his agent, or other person who has noticed the marine disaster, must notify the Harbourmaster's Office Split or emergency service 112 about the type of marine disaster, its extent, location, meteorological-oceanographic data on the spot of the accident, threat for people, environment and properties. The official who has received the notice must alert the Harbour Master of the Harbourmaster's Office Split, who is also the Commander of COC, and National Maritime Rescue Coordination Centre /MRCC Rijeka about the accident.

The official in the Harbourmaster's Office Split, branch of Harbourmaster's Office or County 112 centre, upon receiving the report on marine pollution or about the event which may cause marine pollution, must request from the person responsible for maritime craft which has or is likely to cause the pollution, the following data:

- exact time of accident,
- type of accident,
- type, size (capacity) and name of maritime craft,
- number of persons on the craft,
- owner/user of the craft,
- craft's shipping agent in the Republic of Croatia,
- exact position,
- route of direction and speed of sea craft, and its distance from other maritime crafts,
- risk level for human life, data on wounded and possibilities to provide help to the injured,

- type and quantity of cargo and containers, and information on threat of the cargo for marine environment,
- size of craft's damage,
- undertaken activities in removing the cause, threats and consequences of the pollution.

According to Marpol 73/78 Convention (International Convention for the Prevention of Pollution from Ships) each oil tanker of 150 GT or more and each vessel which is not oil tanker, of 400 GT and more, must have on board the approved Shipboard Oil Pollution Emergency Plan (SOPEP). The Plan contains:

- procedure to be applied by ship commander or other persons commanding the vessel to report on pollution accident,
- specification of authorities or persons that have to be contacted in case of oil pollution accident,
- detailed description of actions to be immediately undertaken by persons on board to monitor and reduce the oil spill after the accident,
- procedures and positions for establishment of connection on board, in order to adjust the measures with national and local authorities aimed at prevention of pollution.

Besides SOPEP Plan, on board there's also the limited quantity of equipment required for intervention in case of oil spill, which the ship will use according to the actions prescribed in the SOPEP Plan, and in coordination with COC Commander. The use of dispersants is not allowed without approval granted by COC or Headquarters, as applicable.

COC Commander, based on collected data on type of pollution, quantity of spilled oil and location, shall activate the Contingency plan for accidental marine pollution in Split-Dalmatia County. In situations when the pollution has occurred in ZERP (Ecological and Fisheries Protection Zone) , or the affected area is located within jurisdiction of several County operational centres , or the quantity of spilled oil exceeds 2.000 m3, or the pollution exceeds the response capacities of COC of Split-Dalmatia County, COC Commander shall submit written request to the Headquarters' Commander on activation of response measures according to the national Contingency plan for accidental marine pollution (Official Gazette no. 92/2008, 80/2013). Until the activation of the Plan, he will implement the operative procedures of Contingency plan for accidental marine pollution in Split-Dalmatia County. COC Commander shall implement the procedures in coordination with representatives of the shipper and shipper's underwriter, and in coordination with the competent state authorities.

In case of going ahead with national Contingency plan for accidental marine pollution, COC Commander shall notify the Headquarters in written on all the response actions undertaken until that moment.

Thereby it is useful to carry on periodical training of local civil protection forces, which can help in early identification and emergency response prior to arrival of COC human and equipment resources , all in coordination with COC.

Further on we shall consider the marine pollution by oils, which present the highest pollution threat, however, as a whole or in certain segments, the subject procedure is applicable for all pollutions by floating agents on sea surface, notwithstanding the sources they are generated from.

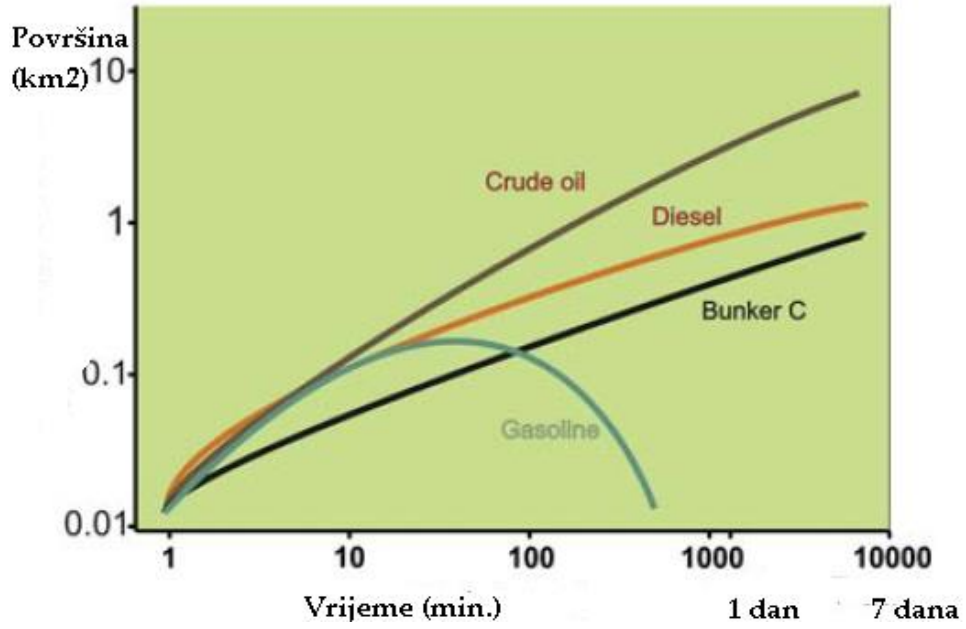
After the leakage of oil on sea surface, the oil shows tendency of spreading into the slick on the surface. This refers in particular to lighter oil products, like gasoline, Jet A-1, diesel fuels and light crude oils, which create very thin slicks. The heavier crude oil and bunker C at the beginning spread into several millimetres thick slicks. Heavy oils can also create small balls or surfaces of thicker layer of tar.

The oil spreads horizontally across sea surface by diffusion, even in the absence of residual, tidal and wind induced current. Generally, the oil slick on the water shall spread relatively fast immediately after the leakage (Figure XI-3). External borders of typical slick in this phase are usually thinner than the internal side.

Winds and currents also spread the oil slick and accelerate the procedure of its spreading. Oil slicks shall stretch in direction of wind and currents, and as the spreading process develops, they will get the shape affected by steering forces of spreading. Iridescence (shine) of the oil on the sea surface often precedes to major or more dense oil concentrations, and if the winds are stronger (above 20 km/h), shiny iridescence may detach from thicker slicks and move down the wind.

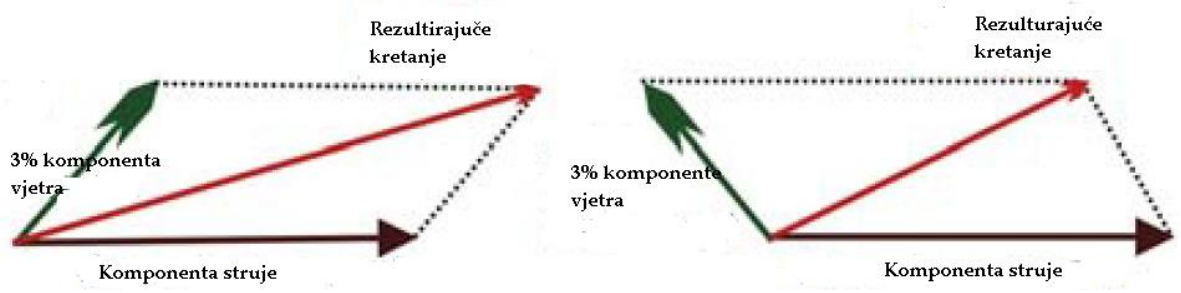
Due to oil's natural tendency to spreading, the oil slicks on the water move along the water surface, primarily by wind induced surface currents. If the oil slick is close to the land, and the wind speed is below 10 km/h, the slick mostly moves at speed of the surface current and approximately 3% of the wind speed, and in this case, the wind generally does not have any major role.

However, if the wind speed exceeds ca. 20 km/h, and the slick is at the open sea, the wind shall prevail in affecting the slick movement. In most of the situations, must be taken in account the wind and surface tidal current. When trying to identify the movement of oil slick, the key factor is to establish exact speed of wind and current in the moment of leakage, and their forecasts.



(Vertical line: **Surface (km2)** / Horizontal line: **Time (min)** **1 day** **7 days**)

Figure XI-3. *Calculation of spreading of several types of oil on sea surface (quantity 10 t of each) reduced for evaporated quantity. The Figure shows one week period. Gasoline at the beginning spreads fast, followed by decreasing of affected area due to fast evaporation*.



(Vertical line: **3% wind component** / Horisontal line: **Sea current component**
Upper horizontal line: **Resulting movement**)

Figure XI-4. *Effect of wind and current direction to resulting movement of oil slick*

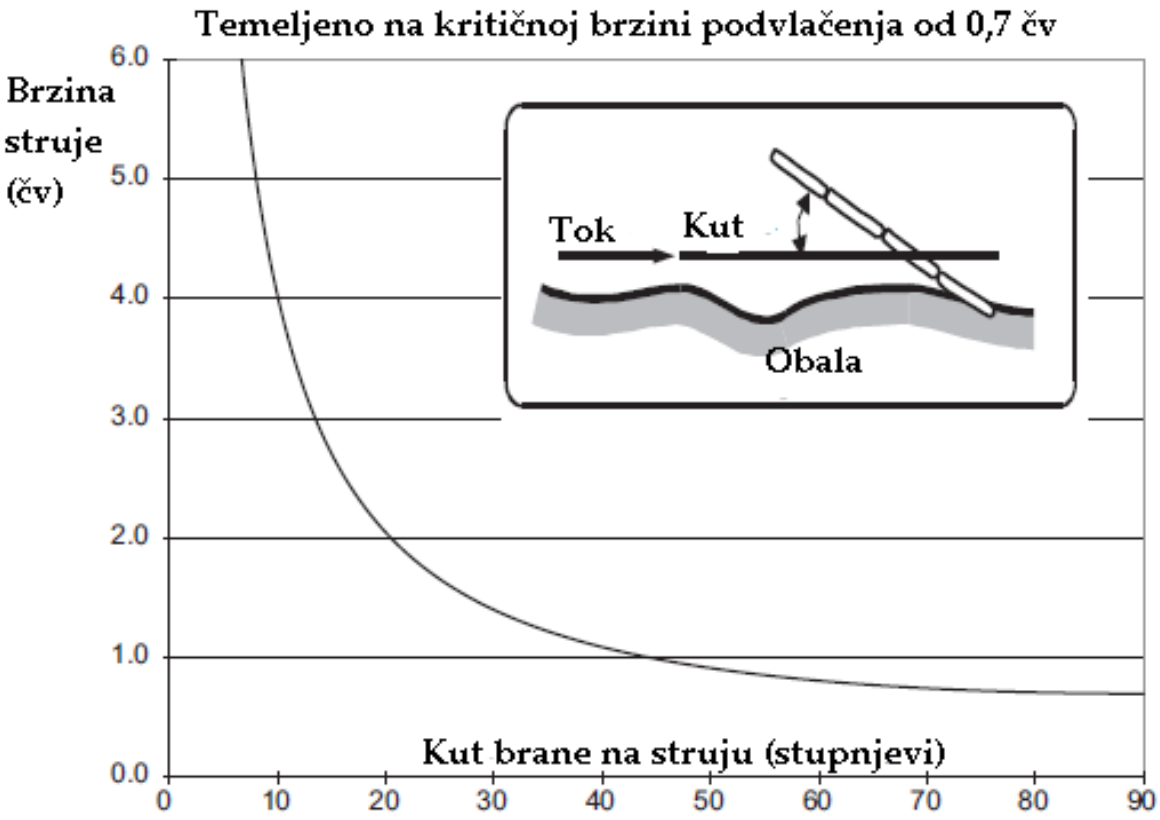
In line with the above stated, and taking in consideration the surface of pilot location and entire Kaštela Bay, shape, morphology of the coast, meteorological and oceanographic features, it is of crucial importance to prevent immediately the spreading of oil slick by dam, and upon doing so, start with recovery. For light oils, likely to evaporate fast, it is recommended to choose the method of oil evaporation and mechanical recovery of residual matters, rather than use of dispersants. In case of intention to use dispersants, the procedure shall be applied as described in the Annex III - Flow chart on use of dispersants, and Annex IV - List of dispersants approved for use in Republic of Croatia and EU Member States, all from the national Contingency plan on accidental marine pollution (OG no. 92/2008).

In Kaštela Bay, considering meteorological and oceanographic circumstances, it is very important to install, at critical positions subject to increased pollution risk, the equipment, if possible with remote reading of records, measuring wind speed and speed of sea surface current, so that the expected spreading of oil slick might be defined at the very beginning.

The pilot location encompasses several cliffs and smaller islets, which should be protected from oil slicks, if their spreading is not suspended on the spot of the spill itself. This shall also apply for the coasts of the ports in marinas and oil slick should be removed from such structures. Jetties, wave breakers or breakwaters covered by rubble mound or concrete shapes aimed at preventing erosion are very hard to clean and therefore it is essential to prevent any contact with oil slick. The most efficient method to obtain it is to anchor the dam in front of such coast.

In case of pollution of fast flows like river Jadro, or strong surface currents, it must be taken into account that the oil slick shall flow below the dam, notwithstanding the depth of the dam curtain, if placed vertically to the current direction in case that current speed exceeds ca. 0,75 knots. Loadings which create wind generated currents can also affect the performance of the equipment, therefore the wind impact should also be included. Determination of the angle of placing the dam in regard to current direction is described in Figure 5.

In case of pollution of narrow bays or at the mouth of river Jadro in width reaching ca. 40 m and lacking the emergency response dam, it is possible to place the vessel or barge in order to route the oil slick in desired direction or to contain it in the place of origin. In such a situation the vessel must be placed taking in consideration direction of the current, just the same as if were the dam.



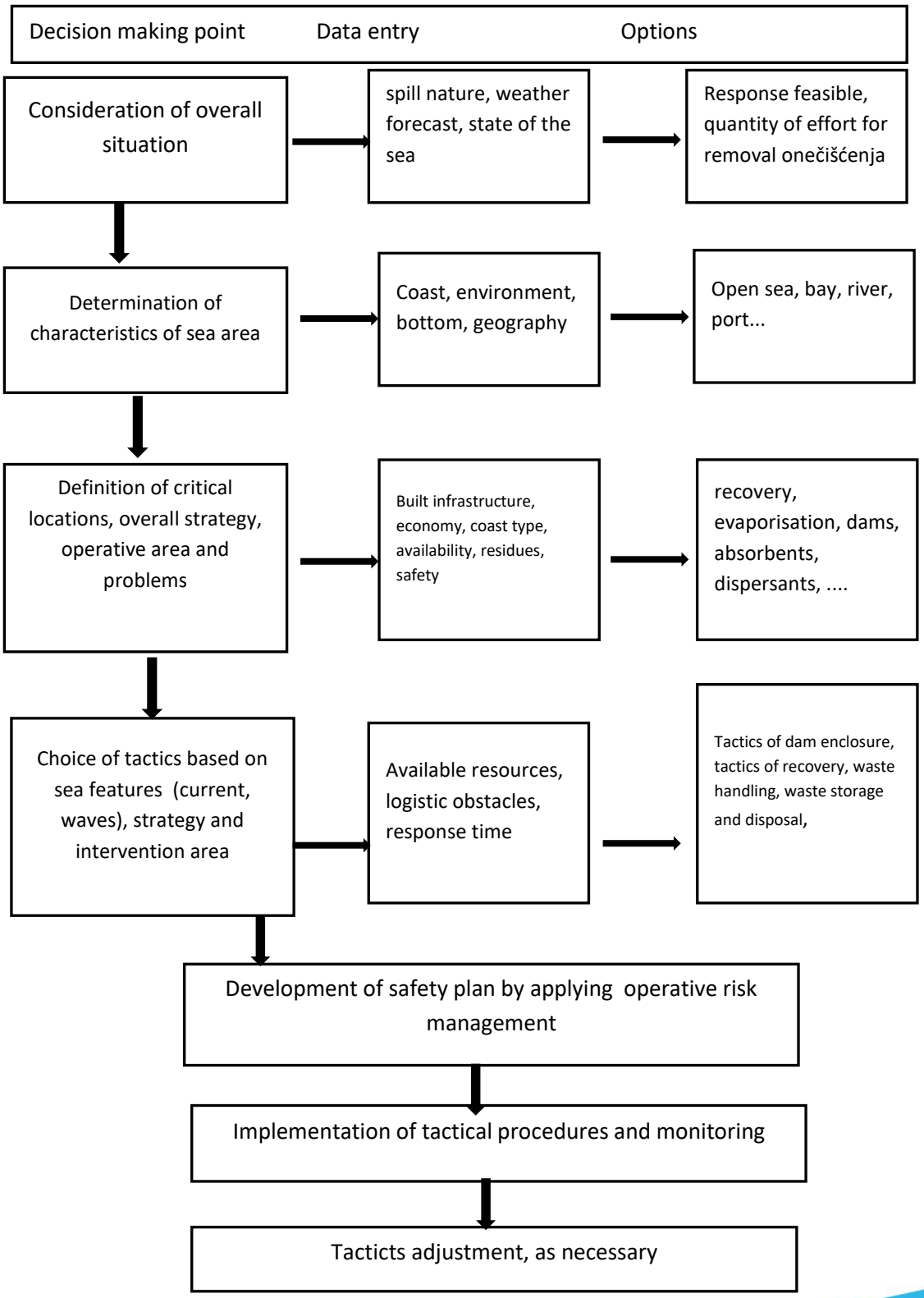
(Vertical line: **Current speed** / Horisontal line: **Angle of dam positioned to the current (degrees)**
Upper horisontal line: **Based on critical speed of slipping**)
(Wording in the frame: Tok = **Flow** / Kut = **Angle** / Obala = **Shore**)

Figure XI-5. *Max. required angle in placing the dam for prevention of oil penetration.*

Participation in activities of prevention of marine oil pollution is dangerous situation, where all the stakeholders are exposed to different types of threats, presented jointly with prevention acting in Table XI-3.

Table XI- 3. *Resume of risks in preventing oil pollution*

Resume of risks in the activities of preventing oil pollutions		
Risk	**Possible injuries**	**Prevention**
Slips and falls	Fractures and dislocations	Risk awareness, protective clothes, safe rope
Ergonomics	Back injuries, hernia, ankle injuries	Proper lifting method, lifting equipment
Inflammability – fire and explosion	Death, serious burns, fractures, sight loss	Risk awareness, proper ventilation, situation monitoring
Oil toxicity	Eyes/skin irritation, nausea, dizziness, long lasting effects	Air quality monitoring, breathing system protection, gloves, overalls
Risk of rupture of moorings	Death, loss of limbs and eyes, broken limbs	Appropriate strength of moorings, safety observer, knife availability
Risk of heavy equipment	Eyes damage, hearing loss, inhalation of exhaust gases, cuts and scratches	Eyes and ears protection, provision of loose clothing, standing away from risk places / exhausts
Water (drowning)	Critical – death The following should be considered: use hands and feet to remove obstacles; do not tie a rope to a swimmer or rescuer.	Benefits: life jackets, safety belt, lifebuoys, hooks, lifeboats for rescue/picking up, avoid baggy clothes, avoid slipping on fire hoses


Decision making point
Data entry
Options
Consideration of overall situation
spill nature, weather forecast, state of the sea
Response feasible, quantity of effort for removal onečišćenja
Determination of characteristics of sea area
Coast, environment, bottom, geography
Open sea, bay, river, port...
Definition of critical locations, overall strategy, operative area and problems
Built infrastructure, economy, coast type, availability, residues, safety
recovery, evaporisation, dams, absorbents, dispersants, ...
Choice of tactics based on sea features (current, waves), strategy and intervention area
Available resources, logistic obstacles, response time
Tactics of dam enclosure, tactics of recovery, waste handling, waste storage and disposal,
Development of safety plan by applying operative risk management
Implementation of tactical procedures and monitoring
Tacticts adjustment, as necessary

However, if the coast pollution occurs anyway, during the recovery intervention, due to practical or safety reasons, and if pollution threatens coastal zone, defensive strategy should be applied in order to reduce to minimum the size of polluted area and prevent the pollution to reach sensitive coastal zones.

Before final decision on coast recovery method, the input information necessary for decision , must be obtained. Information are usually collected:

- by air screening aimed at identifying the major concentrations of pollution;
- thorough inspection of affected area in order to establish the scope and character of the pollution, on the surface and below it;
- joint work of cleaning and inspection teams, in order to establish the best cleaning-up practice;
- final inspection by multi-disciplinary team, in order to establish final result.

Planning of coast recovery development includes decisions and recommendations regarding strategies and tactics of the treatment of pollution and definition of final criteria or final spots of the treatment of polluted shore. Elaboration and planning of these activities at the beginning includes knowledge of the following factors:

- exact locations of the pollution on the coast, river Jadro, bays, marinas;
- type of polluted coast;
- type and quantity of oil at each polluted location;
- location of oil (considering sea tides, surface pollution, penetrated into the base layer or dug under the sediments);
- possibilities for renewed release of oil pollution from the base;
- expected persistence of pollution;
- character of the coastal hinterland, providing access during the cleaning process, and place where the logistics support is going to be located;

The decision on the method of cleaning the pollution shall be based on the collected data. Comparative strategies and tactics with their respective effects are presented in the Table XI-4.

Table XI-4. *Comparison of strategies and tactics of pollution treatment.*

Strategy		Tactics	Logistic support	Relative response speed	Waste quantity / waste type
Natural recovery		Monitoring	Minimal – monitoring team	n/a	none
Physical removal	Washing and recovery	- Rinsing - Washing - Recovery	Very demanding: - pumps, pipes, diluters, dams, skimmers, storage; - intensive work	Slow	High - liquid
	Removal	- Manual or mechanic excavation, cutting, sieving, absorbents; - Vacuum recovering	Portable-very high: - shovels, rakes, absorbents, and vacuum cleaners	Manual, absorbents, vacuum: slow	Manual: moderate - Solid or liquid
			Mechanical – low - excavators or agricultural equipment - Vacuum cleaners	Mechanical: fast	Mechanical: large - Excavation: solid -Vacuum: liquid
	Treatment at location	- Dry mixture; - Wet mixture; - Sediment relocation ; - Ignition.	Very low: - mechanical support, excavators or agricultural equipment	Fast	Very small: - some solid logistic waste, possible burning residues
Biological	Bio-remediation	- Nutritive components with possible mixing	Low: possible mechanic. support in mixing	Fast	Very small: - some solid logistic waste
Chemical	Agent for superficial washing	Detersive	Very demanding: - pumps, pipes, absorbents, dams, skimmer, storage; - intensive work	Slow	Large : - liquid
		Dispersant	Low - Usually used for small localised areas	Fast	Very small: some solid logistic waste

One of the factors in selection of strategies and tactics for coastal cleaning is the type of shore affected by pollution. Table XI-5. shows the strategies and tactics applicable for specific types of coast.

Table XI-5. *Cumulative strategies and tactics applicable for coast cleaning, depending on the type of coast*

Strategy		**Tactics**	**Type of coast for primary application**
Natural recovery		Monitoring	All types of coast
Physical removal	Washing and recovery	- washing and rinsing - recovery	- Rocky - Built coast - Rough sediment beaches - Protective stone barriers - Wetlands
	Removal	- manual excavation, cutting, sieving, absorbents	- All types of coast
		- Mechanical excavation, sieving	- Beaches
		- Vacuum induced recovery	- All types of coast
	Treatment at location	- dry mixture; - wet mixture; - sediment relocation ; - ignition	- Beaches
Biological	Bio-remediation	- Insertion of nutritive components with possibility of mixing	- All types of coast
Chemical	Superficial washing agent	- Detersive - Dispersant	- Rocky coasts - Built coasts - Rough sediment beaches - Protective stone barriers

Fire on vessel in the port

Fire on vessel in the port (boat, yacht, ship) may indirectly cause the marine pollution due to:

1. fire extinguishing by liquid which in contact with oils / dangerous cargo on board or in holds / engine room, thereby polluted flows from the vessel into the sea,
2. pumping of polluted waters from ship into the sea in order to prevent the flooding of the area, i.e. while pumping the bilge water from ship holds during fire of cargo or bilge waters from engine room during fire in engine room,
3. ship sinking due to burning of the part of the ship's hull and loss of buoyancy (timber and plastic ships) or due to loss of stability caused by flooded spaces and acting of free surfaces,
4. pollution by cargo, which has ended in the sea, as a consequence of fire extinguishing or other incident.

General procedures

If the fire affected vessel directly threatens or is likely to threat other nearby vessels or the facilities of port substructure / superstructure or equipment (environment), if possible, it should be at the earliest towed with the tugboat, away from the site where it threatens the safety of environment and to the place of lower risk for fire spreading, taking in consideration the safety of crew of the fire affected ship and of the tugboat.

If the conditions allow, all probes, filler necks and draught diverters for fuel tanks / cargo / lubricating oil, must be closed, in order to prevent uncontrolled flow of fuel / cargo/ lubricating oil, in case of shipwreck.

At the fire extinguishing site, the vessel shall be enclosed by dams, in order to contain the pollution at restrained and controlled surface. It is recommended to use fire-resistant dams.

Should the fire occur on the vessel which is subject to the International Convention for the Safety of Life at Sea, (SOLAS 1974), International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) , the vessel crew (hereinafter: „ship crew“) has already elaborated and trained procedures for accidents, also including the fire and marine pollution. At each incident, notwithstanding external participants in the activities of rehabilitation of the incident, final responsibility on board is always assigned to ship commander. If the situation is such that it has threatened human lives, priority in the activities shall be given to the rescuing of human lives. It should be followed by the prevention of pollution, and finally rehabilitation of the sea from pollution.

In the area of Port of Split, at locations defined by Port Authority Split, the specific types of dangerous cargo is being handled (Chapter IX). In case of accident involving dangerous cargoes, which are likely to result in marine pollution, Chapter 7.8. *International Maritime Dangerous Goods Code* provides basic instructions for response in case of incident with dangerous goods. Detailed instructions for response in accidents involving dangerous goods, which include the displaying of cargo, are provided in Carriage Of Dangerous Goods: International Maritime Dangerous Goods (IMDG) Code - Revised Emergency Response Procedures For Ships Carrying Dangerous Goods (Ems Guide) MSC.1/Circ.1588, of 11 June 2018, which should be consulted. Procedures from the Code are included in the Safety Management System on Ships (SMS).

The use of specific types of equipment for removal of the oil pollution and other pollutions from water surface, are described in this Chapter.

Tools for treatment of oil pollutions

Dams

Dams are usually used to enclose the pollution on the sea and to re-route the pollution away from sensitive resources or to the place of recovery. Their main features are the capacity of containment or re-routing the pollution. Their usual features are as follows:

- surface part for prevention or decrease of pollution overflow;
- submarine curtain for prevention or reduction of pollution passing below the dam;
- buoyancy in form of air, foam or other floating material;
- longitudinal fastener for consolidation (steel, hawser or chain) to withstand the wind, waves or currents' force;
- ballast to keep the dam in vertical position.

Dams are mostly divided in two categories:

- curtain dams – fitted with submarine curtain, usually hung on floating cylinder chambers , filled with air or foam;
- enclosure dams – usually having flat cross-section, floating vertically in the water, supported by integrated inner or external floats, ballast and fixing supports;

During the use, the dam sections are connected by special couplings into the unique entity. In fastening process, the attention shall be drawn, not to place the couplings at the spots with the highest concentration of pollution.

Table XI-6. *Characteristics of conventional dams*

Dam type	Buoyancy method	Storing	Wave performance	Mooring or towing	Cleaning ease	Relative price	Preferred use
Curtain dams	Blowing	Compact when free of air	Good	Both	Simple	High	Littoral and open sea
	Firm foam	Bulky	Solid	Mooring	Easy/ simple	Medium to low	Protected coastal waters, ports
Enclosure dams	External floats made of foam	Bulky	Poor	Mooring	Hard/medium: pollution is stuck behind external floats or chamber joints	Low	Protected waters, marinas, ports
Shore protection dams	Upper chamber is inflated, lower are filled with water	Compact when free of air and water	Good	Mooring	Medium: pollution can be stuck in slots between chambers	High	Along protected tidal shores, free of wave breaks

The forces developing on the dams must be calculated in order to provide for their towing or mooring. The forces are calculated applying the equation:

Forces developing from sea current:
$F = L\ (m) \times A\ (m) \times V^2\ (m/s)$

whereby:

L – dam length expressed in meters

A = dam length (m) x curtain height (m)

V – speed of current, expressed in (m/s) – if dam is towed

value V equals the speed of dam through the water

Forces developing from the wind:

F = L (*m*) x B (*m*) x (v(*m/s*) /40)^2

whereby:

L – dam length expressed in meters

B – dam length (m) x height of the dam section above the surface (m)

v – wind speed expressed in m/s

Dams use

Dams can be used by towing or by mooring. The towing principle (usually with two tugboats) is to encircle the pollution with a dam, and once enclosed, it will be recovered by skimmer. Thereby, the attention must be drawn to ensure that the dam, during the towage, retains „U“ shape, what is obtained by fastening the dam to tugboats with the guide of towing rope. Besides the above, the towing speed must be adjusted, so that the pollution would not pass below the curtain. Depending on manoeuvring abilities of the tugboat, weather conditions and ship course, dam can be fastened to the stern or to the bow, which decision shall best be made after the attempts at the very site of recovery.

Dams should be moored in situations when it is desired to contain the pollution close to its place of origin. In such a case we have to take into account the depth to which we shall anchor the dam, since major accumulations of oil close to a incident situation may create fire risk. Therefore dam mooring is mostly used as defence of the sensitive parts of the shore, taking into account the efficiency of enclosure and priorities of sensitivity of the area. Proper mooring and anchoring of a dam is of substantial importance for complete fulfilment of its purpose , whereby the attention has to be drawn to the proper angle, concerning direction of the current. If practically feasible, may be used even several anchors. Anchor type should be chosen depending on the bottom where anchoring shall be made, taking in consideration that anchors with wider blades will stick better on sandy or muddy bottom, while the anchors with longer arms shall stick better on stone bottom.

For selection of proper tactics in dam application, the training exercises should be carried on potential pollution sites, in different weather conditions, thus enabling fast and proper response in real emergency situation.

Dispersants

Main purpose of the application of dispersants is „breaking“ of oil slick in numerous smaller drops , which are going to dissolve fast in sea column and as a consequence degrade in natural process generated by micro-organisms. As indicated in the Contingency plan for accidental marine pollution, the use of dispersants is recommended when other methods of removal of pollution have not been effective.

Dispersants are made in order to improve natural process of dispersion of oil pollutions, by decreasing surface tension between oil and water. Dispersants are mixture of surface active agent/surfactant and diluter, which has double role, to reduce viscosity of surfactant, in order to enable the spraying on the surface and to facilitate penetration of active agent in oil slick. Their application should be considered before usage, since nowadays usual and allowed dispersants are applied in mixture with the sea.

However, dispersants in application have certain restrictions, the most significant being state of the sea and oil characteristics. The experience has shown that application of dispersants is most efficient at wind speed of 4 – 12 m/s (8 – 25 knots or 3 – 6 Bf). In case of calm sea (so called *"bonaca"*) dispersed oil drops will float up again and create slick, while at stronger wind and waves, the waves can melt the oil slick and prevent direct contact of oil and dispersant, which is going to reduce dispersant efficiency. Dispersants are formulated to operate in sea water with salinity range of 30 – 35 ppt; decrease of salinity will reduce efficiency of dispersant, so that in fresh water its effect might be reduced to minimum.

Two features of the oil affect the efficiency of dispersant, namely oil viscosity and dropping point or so called pour point. Efficiency of dispersant declines with increase of viscosity.

As a general rule it can be said that dispersants shall be inefficient for application with oil whose viscosity exceeds 5.000 – 10.000 centistokes (cSt – unit for kinematic viscosity: centimetre-gram-second 1/100 of substance) in the moment of leakage. Viscosity of oil slick increases with time, due to effect of exposure to weather conditions, mostly to evaporation and emulsification, what can cause that the oil, after being previously subject to dispersant, after some time, does not act any more.

Regarding the dropping point or pour point, general rule which applies is that oils whose dropping point is close to or higher than the temperature of sea surface, shall not disperse when subject to dispersant.

Light products, like diesel, gasoline or kerosene do not create readily emulsion, they rather spread in very thin film or shine across sea surface, so that they finally evaporate or disperse fast, without using dispersants. Additionally, application of dispersants on light petroleum products or on shiny traces of crude oil is not recommended, because it will be harder for dispersant particles to penetrate the thin

film in water column beneath and create oil accumulations. Dispersants designed for application on mineral oils will not affect other oils, like palm or rapeseed oils.

Dispersants are applied by spraying from the ship or airplane. The application by spraying method requires the size of drops to be optimally ca. 600 – 800 µm, since tinier drops are going to be blown by the wind, and bigger ones will rather penetrate through oil slick than remain on the junction of oil and water.

Use of dispersants requires high quality logistic support and monitoring of dispersant performance efficiency; for this purpose, the best is to use ultra – violet fluorometer, which is being pulled by vessel to take samples beneath the slick, at depth higher than one meter, in order to measure the variations of oil concentration. Dispersion is recorded in significant increase of oil concentration, revealed by sensor, compared to oil concentration , measured before the use of dispersant.

Use of dispersants may have adverse impact on marine flora and fauna, therefore always before its application should be consulted multi-disciplinary team, which is going to consider its application from all the aspects, taking care not to introduce into the environment the substance which is even more harmful than the pollution itself.

Skimmers

Among numerous alternatives for elimination of oil slicks, primary method is their mechanical removal, which is usually obtained by use of dams for concentration of oil slicks and various tools and machinery, with common name skimmers (lifter). Table XI-7 shows key characteristics of skimmers.

Table XI-7. *Skimmer's characteristics.*

Skimmer		Removal rate	Oils	State of the sea	Waste	Attachments
Oleophilic	Disc	Depending on number and size of discs	Most efficient at medium viscous oils	At small waves and currents can be highly selective with small water intake. At heavy sea it can be overflowed	Waste can block it	Separate supply section, hydraulic and pumping pipes, pump and suitable storage place
	Rope skimmer	Depending on number and speed of	Most efficient at medium oils although can be efficient at	Very little or no water intake. Can	Can tolerate larger pieces of waste	Small unit with built-in drive. Larger units need

		rope. Generally poor performance	heavy oils.	operate on heavy sea		separate attachments
	Drum	Depending on size and number of drums	Most efficient at medium oils.	At small waves and currents can be highly selective with small intake of water. At heavy sea it can be overflowed	Waste can block it	Separate supply section, hydraulic and pumping pipes, pump and suitable storage place
	Brush	Depending on size and number of brushes. Generally medium.	Different brush sizes for heavy, medium and light oils.	Collects relatively little free or contained water. Some designs can operate on heavy sea, and some will be overflowed	Effective for smaller waste pieces, however bigger ones can block it	Separate supply section, hydraulic and pumping pipes, pump and suitable storage place
	Belt	Poor to medium	Most efficient on medium and heavy oils	Can be highly selective with small intake of water. Can operate on heavy sea	Effective for smaller waste pieces, however bigger ones can block it	Can pump oil directly in the tank from the top of the belt. Attachments should be unloaded from ship to the shore
Non-oleophilic	Vacuum /suction	Depending on vacuum pump. Generally low to medium	Less efficient for light and medium oils	Used for calm sea. Small waves will result in huge intake of water. Usually designed with basket	Can be congested by waste	Vacuum vehicle and trailer usually have their necessary power source, pump and storage
	Basket	Depending on pump	Efficient from light to heavy oils. Very heavy	Can be highly selective at	Can be occluded by	Separate supply section, hydraulic

		capacity, oil type.., can be significant	oils maybe cannot flow through basket.	calm sea. Can be easily overflowed and increase water intake.	waste, although some pumps can treat smaller waste	and pumping pipes. Some skimmers have built-in pumps
	Belt	Low to medium	Most efficient for heavy oils	Can be highly selective with small intake of water. Can operate on heavy sea	Effective for small waste pieces. Occlusion when treating larger ones	Can pump oil directly in the tank from the top of the belt. Attachments should be unloaded from ship to the shore
	Drum	Moderate	Efficient for heavy oils	At small waves and currents can be highly selective with small intake of water. At heavy sea it can be overflowed	As for skimmer with basket	As for skimmer with basket

Skimmer recovery system applies the method of separation or skimming of oil from sea surface and its transfer to the storage. Mechanical appliances which collect the oil from sea surface involve oleophylic system which transposes oil by adhesion principle from the surface, suction system, basket system based on gravitation and system which physically lifts the oil with mechanic scoops, belts or grippers.

Just like at other systems, limiting factors are adverse weather conditions, oil viscosity and effect of waves & currents. Further limiting factors may be spreading and fragmentation of oil slick, storage capacities for waste oil, pumping capacities, distance from place of waste oil storage.

Efficient and appropriate response to accidental pollution requires regular training exercises of oil recovery in different situations, along with applying various tools.

Absorbents

In describing absorbents and their use, we have relied on the recommendations of ITOF edition: *Use of sorbent materials in oil spill response* (Impact PR & Design Limited, 2012). Oil absorbents are wide spectrum of organic, inorganic and synthetic products designed in such a way that they recover oils rather than water. Although used often at oil spill incidents, it is essential to use them purposely , in order to prevent their excessive usage, which can pose major logistic problem, in compliance with secondary pollution, recovery, storage and disposal, thus contributing to the increase of cleaning intervention prices. This has to be taken in particular consideration when using synthetic absorbents, trying to use up their full potential.

In practice, the use of absorbents is most efficient during final activities of coast cleaning and for cleaning of small oil pools, which cannot be cleaned-up by applying other techniques.

Table XI-8. *Benefits and weaknesses of available types of absorbent material (Impact PR & Design Limited, 2012)*

Type	Material	Benefits	Weaknesses
Bulk	• organic like: bark, peat, sawdust, pulp, cork, feathers, straw, wool and human hair • inorganic like: mineral vermiculite and pumice stone (pumicite / porous rock), • synthetic – primary polypropylene	• Often widely available as residues of industrial process • low price • can be used in relocating fauna to new habitats	• Difficult to control and wind can blow it away • Hard to collect • Difficulties in extraction of oil and absorbent mixture • Disposal of oily absorbent is more restricted than disposal of oil itself
Packed / closed	• all above listed bulk material can be packed in nets or netting	• easier to apply and collect than bulk material • closed dam has larger absorbing surface than continuous	• Structural strength limited by hardness of net or netting • Organic dams can saturate fast and sink. Oil absorption is limited.
Continuous	• synthetic – primary polypropylene	• long term storage • relatively easy to apply and collect • high level of oil absorption if used up to full capacity	• limited efficiency for oils affected by time, and thereby changed or for higher viscosity oils • not easily degradable and limited possibilities of disposal
Fibres	• synthetic – primary polypropylene	• efficient during oil exchange or for higher viscosity oils	• less efficient for fresh light and medium oils

In selecting the absorbent, the following criteria should be taken in consideration: buoyancy, saturation, oil containment, hardness and durability, fermentation, price, availability, storage and transport. Absorbent's buoyancy is important , since it prevents absorbent to soak fast by water and sink. In some cases, good buoyancy of absorbent may have negative impact , since it can float on the surface of heavy viscose oil, thus reducing soaking surface. In such situations, absorbents should be mixed manually with oils, thus stimulating the soaking.

In some cases, absorbent can promptly become soaked, oil saturated , and can overflow the dam and pollute the area which we are going to protect. Once when absorbent is saturated with oil, it must be removed fast, in order to prevent its leakage. It is recommended to use a smaller diameter dam with absorbents, to avoid the risk of dam being soaked in its outer part, while the inner one remains unused.

Oil containment is important feature of the absorbents, which prevents the soaked oil to leak again during handling process or due to impact of waves, current and wind. Absorbents with tiny pores, like mineral vermiculite and some types of foam show good results in oil containment. Negative side of these materials is their poor recovery of viscose oils, what is going to cause their leakage immediately after collecting absorbent. The leakage rate is directly linked to oil viscosity - whereby lighter, less viscous oils leak faster.

Firmness and durability of absorbent is particularly shown when absorbent must be left on the spot for longer period of time, exposed to wind and waves, in particular if the area concerned is rocky one. The firmness of absorbent in dams is directly related to the firmness of the net in which is placed the absorbent.

Fermentation is also one of the features that has to be considered if the absorbent is left for longer time on the spot, and it can change characteristics of material intended for oil absorption, and later on cause problems in collecting and disposal. Some organic absorbents have the tendency of fermentation.

The price of the absorbent is generally lower for organic and inorganic material, however it is higher for synthetic products, but always must be considered alternatively totally needed quantities, absorption power, oil characteristics, costs of disposal, availability, etc.

Availability, storage and transport are closely connected with other described characteristics, and likewise with oil features. Organic and inorganic absorbents are usually more available than synthetic ones, however they are less efficient. Absorbents provided for longer storage must be protected from UV radiation, in particular synthetic ones, and organic against humidity and insects. Transport is a significant logistic problem, even more if the pollution occurs in areas with poor traffic infrastructure.

Use of absorbents on the shore or close to the shore should be limited to minimally necessary quantities, due to problem of subsequent recovery and disposal; it is therefore recommended

mechanical cleaning wherever it is applicable, like at sandy beaches. Absorbent dams are highly useful for recovery of oil/pollution which leaks from the source at the shore, or while washing the shore after the pollution incident. This way of use is applicable along the shore, whenever are used sea tides for shore rinsing and prevention of oil spread to open sea.

Usage of absorbents as primary agent to remove oil slicks from the sea, generally is not recommended due to a series of problems it causes. The very operation of applying the absorbent is problematic, although in some cases can be used a fan blower, it can float on oil slick without any special absorption effect, it can generate problems in using skimmers, wind and currents deposit it beyond control. Should currents, wind and waves bring it to the shore, it will pollute the shore and cause the problem of its collection. For more efficient use at minor pollutions in nautical ports and marinas, it is recommended to apply absorbents in the shape of dam, which after use, have to be managed in a proper way. The absorbent recovery must be given due attention, preventing the oil soaked absorbent to become bigger pollution problem, than the oil itself.

Used absorbent should be kept and transported to final approved storage place and destroyed in impermeable containers, in order to prevent secondary pollution.

Communication with public

Contemporary technology and communication enables the public to get the information about the pollution, before the prescribed regional or national authorities, which creates additional pressure for the operative centre and team acting in emergency situations. Therefore, operative centre must address meaningfully the requests of media and public information , thus preventing speculative and non-realistic statements, which can lead to panic among population. For this purpose can be held the meetings with public, however in a way which shall not disturb planned activities of pollution removal teams.

In case that media wish to visit the pollution site, the measures must be provided for their safety and smooth carrying of activities of marine rehabilitation. In the same way should be addressed the politicians or other distinguished persons who want to visit the accident venue, assigning them appropriate coordination and guides.

If it is considered as useful, the interest of public may be directed towards volunteering in rehabilitation of pollution or to donating necessary equipment. Considering that the public is going to show huge interest for this, one or more persons should be appointed in call centre, who will be collecting information, filter and re-direct them.

PUBLIC AWARENESS CAMPAIGNS

The local population around the eastern part of the Kastela Bay as well as part the population with work or recreation related to that part will use presentations research results at the pilot site. It is recommended that they present the results external experts to make the population aware of the risks and consequences of different activities.

Research has shown that there is a significant risk of marine pollution from land through human activities of agriculture and industry. The local population would benefit most from education related to the proper disposal of waste and the use of pollutants in agricultural activities.

It would be useful for local stakeholders to become familiar with case intervention plans sudden marine pollution by disseminating materials (publications and intervention plans) and discussing through a public event.

It is recommended to act on the younger population through workshops in order to as soon as possible contributed to raising awareness and thus increased the impact of protecting the sea from pollution careful use of the sea.

The environmental remediation system can be learned through livinglab using biomimicry. Livinglab are virtual laboratories that can be established in any type of environment. In livinglabs participants from different disciplines and backgrounds are immersed, in this case, in island environment, exposed to nature and learning about environmental problems and related sustainable solutions.
Biomimicry is an emerging discipline that uses biological models to develop sustainable solutions to environmental, technology, engineering, and design challenges. It is an innovation tool that has a unique capacity to accelerate the holistic processes necessary for a successful sustainable project that addresses local issues.

CONCLUSION

The fastest possible identification of accidental marine pollution is crucial in the process of marine rehabilitation and therefore installation and maintenance of surveillance cameras are of substantial importance. Besides early identification, local civil protection forces also have to deal with restraining the spreading of marine pollution, all in coordination with COC.

In case of the most probable earthquake, it is not expected any significant marine pollution. In case of stronger, but significantly less probable earthquake, it is expected the rupture of the pipes of water supply, sewage, rupture of pipes of submarine outlets, power failure and possible failure of pumping stations operation. It will cause marine pollution, all until repair of the said infrastructure.

Rehabilitation implies recovery of pollution from sea surface and monitoring which is going to establish when the micro-biological pollution has disappeared.

In case of occurrence of major open fire, it is expected the inflow of ashes into the sea, caused by soil sieving and torrent flows. Prevention includes maintenance of fire-fighting routes which can be used for tourist sightseeing, in the presence of tour guides. Response in case of accidental fire is reduced to limitation of spreading of pollution ; followed by recovery and disposal of macro-pollution from sea surface.

In case of fire on coastal industrial facilities or vessels in pilot area, it is expected possible marine pollution caused by spill of oil and fuel. Prompt identification and assessment of polluted area is crucial in activation of sufficient resources for marine recovery. The polluted area shall be enclosed by stretching the dams , and oil or fuels shall be recovered by absorbents and skimmers.

Preventive action in case of flood by backwater is limited to increase of shoreline and insertion of valves on outlets into the sea, thus preventing sea water to enter the sewage system. Prevention against occurrence of torrents (torrent flows) means construction of stairs and grids which slow down the water flow, thereby reducing the erosion of material from the soil. The intervention upon the occurrence of accidental pollution means the enclosure of spreading and recovery of macro-pollutions from sea surface.

In case of spill of oil or grease from industrial plants, the fast response in limiting the spreading is of substantial importance, and therefore the identification of the slick on sea surface by surveillance cameras is of critical importance. Rehabilitation is analysed in this chapter, and it involves dams, absorbents, skimmers and dispersants.

Preventive actions addressing possible disasters on submarine outlets include regular control of accuracy of pipes up to the outlet and operation of the outlets. In case of accidental marine pollution, macro-pollution which has started to float should be soon recovered and adequately managed.

Since macro pollution which is heavier than sea water, shall sink to the bottom, the bottom after the emergency event or after the repair of the outlet, must be checked by divers and the pollution must be recovered and managed.

Response in case of marine disaster and in all above possible accidents, requires strict adherence to the Contingency plan for accidental marine pollution in Split-Dalmatia County, 2010. Periodical training exercises organised for local civil protection forces, facilitate the speed of detection and response until the arrival of COC forces. Since the speed of detection of the consequences of the accident to marine pollution is key factor of rehabilitation, implementation and maintenance of proposed equipment will significantly contribute to the assessment of the resources which are needed for the rehabilitation, and increase the speed and efficiency of response in each single case.

C. PROJECT PARTNER 4 – ŠIBENIK-KNIN COUNTY

Abstract

The action plan for the case of sudden pollution in the St. Anthony's Channel contains the basic assumptions and legal sources on which it is based, the principles of action, and the application of the results of risk analysis and environmental threats.

Based on these analyses, measures for the prevention, collection and disposal of pollution have been developed, and in particular the procedure to be applied by the relevant institutions and other participants.

Finally, the Plan also sets out the principles and procedures for trainings and practices. Attached to the Plan is a representation of the increased hazard area, coastal edge classification (ESI), checklist forms and work logs.

CONTINGENCY PLAN FOR ACCIDENTAL MARINE POLLUTION IN SV. ANTE CHANNEL AREA

1. INTRODUCTION

(1) The Contingency Plan for Accidental Marine Pollution in the Sveti Ante Channel area (hereinafter: Plan) was developed within the project Protecting the Enclosed Parts of the Sea in Adriatic from Pollution - PEPSEA. The project aims to increase the degree of protection of the sea and coast from pollution from ships, platforms, and land pollutions and protect the way of life of the population along the coastal area of the Adriatic Sea and preserve the biodiversity of the Adriatic region.

(2) The Contingency Plan was developed as a part of the procurement procedure for the purchase of pilot site test services and the development of risk models and contingency planning – as a part of the PEPSEA project, log number 49/20.

(3) Project partners include the Zadar County Development Agency ZADAR NOVA as a leading partner, Adriatic Training and Research Centre – ATRAC and Splitsko-dalmatinksa and Šibensko-kninska Counties from Croatia, and Italian partners are Consorzio Futuro in Ricerca, Agenzia regionale per la Protezione dell'Ambiente del Friuli Venezia Giulia, Ente Parco Regionale Veneto del Delta del Po and Camera di Commercio di Bari. The PEPSEA project, with a total value of EUR 2.9 million, is co-financed by the Interreg V-A Italy-Croatia 2014-2020 programme.

(4) The Plan deals with the area of the Sv. Ante Channel, between the line connecting Jadrija and Braničevo points on the west and a line connecting Burnji Turan and Južnji Turan point, on the east part (hereinafter: the designated area).

Figure 2. *Scope area (marked with white lines)*

(5) The Plan deals with emergencies involving sudden pollution of the sea and the coastal region, caused by reasonably probable events, regardless of whether they occurred in the channel area or its immediate vicinity if it is certain to cause pollution in the designated area.

(6) The Plan deals with pollution of the sea and the coastal areas with liquids and solids. This Plan also applies appropriately in cases of biological pollution.

(7) This Plan is a subsidiary document, as stated, concerning:

- *Contingency Plan for Accidental Marine Pollution*[1]
- *Contingency Plan for Accidental Marine Pollution in Šibensko-kninska County, 2010*

(8) This Plan fully follows the organisational structure, management and communication system or competencies set out in the Contingency Plan for Accidental Marine Pollution in the Šibensko-kninska County.

[1] Narodne novine 92/2008.

(9) This Plan follows all the determinants set out in the Contingency Plan for Marine Pollution (Oil spill) – GUIDELINES,[2] which are reasonably probable and applicable to the designated area.

(10) In particular, this Plan takes into account the provisions of the following regulations:

- *Maritime Code,*[3]
- *Law on the Transport of Dangerous Goods,*[4]
- *Regulation on the requirements to be met by ports,*[5]
- *Ordinance on the conditions and manner of maintaining order in ports and other parts of inland sea waters and territorial seas of the Republic of Croatia,*[6]
- *Ordinance on the handling of dangerous substances, the conditions and manner of transport in maritime transport, the embarkation and disembarkation of hazardous goods, bulk and other cargo in ports, and how to prevent the spread of expired oils in ports,*[7]
- *Ordinance on the mode of transport of dangerous goods in maritime transport,*[8]
- *Ordinance on places of refuge.*[9]

(11) This Plan follows the provisions and recommendations of international treaties binding the Republic of Croatia and associated guideline on the protection of the sea from pollution, in particular:

- *International Convention on the Prevention of Pollution from Ships, 1973 (London, 2 November 1973), (MARPOL Convention), (Official Register of the SFRY: International Treaties 2/85),*
- *1978 Protocol relating to the International Convention on the Prevention of Pollution from Ships, 1973 (London, 17 February 1978), (Official Newspaper SFRY: International Treaties 2/85),*
- *International Convention on Oil Pollution Preparedness, Response and Cooperation, 1990 (OPRC Convention), (Official Gazette 2/97),*
- *Protocol of 1992 to amend the International Convention on Civil Liability for Oil Pollution Damage 1969 (CLC Convention), (NN-MU 2/97),*
- *Protocol of 2003 to the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1992 (NN-MU 2/97),*

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2 Document developed under PEPSEA project, and listed in procurement documents EV 49/20.
3 Narodne novine 181/04, 76/07, 146/08, 61/11 i 56/13.
4 Narodne novine 79/07.
5 Narodne novine 110/04.
6 Narodne novine 90/05, 10/08, 155/08, 127/10 i 80/12.
7 Narodne novine 51/05, 127/10, 34/13 i 88/13.
8 Narodne novine (NN 79/96, 76/02, 51/05,127/10, 34/13 i 88/13.
9 Narodne novine 3/08.

- *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London, 29 December 1972), (Official Newspaper SFRY: International Treaties 13/77),*
- *International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001 (London, 5 October 2001), (AFS Convention), (NN-MU 10/06),*
- *International Convention on Civil Liability for Bunker Oil Pollution Damage (BUNKER) 2001 (Official Gazette 9/06),*
- *Agreement on the Subregional Plan of Interventions for the Prevention of, Readiness for and Response to Sudden Pollution of the Adriatic Sea on a Larger Scale (Subregional Intervention Plan), (Portorož, 9 November 2005), (NN-MU 7/08),*
- *Protection of the Mediterranean Sea from Pollution (Barcelona, 16 February 1976), (Official Newspaper of the SFRY, International Treaties and Other Agreements 12/77),*
- *Protocol on the Prevention of Pollution of the Mediterranean Sea due to the sinking of waste and other substances from ships and aircraft (Barcelona, 16 February 1976), (Official Newspaper SFRY, International Treaties and Other Agreements 12/77),*
- *The Protocol for the Prevention of Pollution in the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea. (NN-MU 17/98)*
- *Protocol Concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency (Barcelona, 16 February 1976) (Emergency Protocol), (Official List of the SFRY, International Treaties and Other Agreements 12/77),*
- *Protocol for the protection of the Mediterranean Sea against pollution from land-based sources (Athens, 17 May 1980), (LBS Protocol), (Official Newspaper SFR). J, International Treaties 1/90),*

(12) This Plan also takes into account the guidelines or recommendations of international and national official and unofficial organisations with expertise in the field of marine environmental protection, in particular:

- *International Maritime Organisation - IMO,*
- *European Maritime Safety Agency - EMSA,*
- *US National Oceanic and Atmospheric Administration - NOAA,*
- *International Tanker Owners Pollution Federation – ITOPF,*
- *International Petroleum Industry Environmental Conservation Association– IPIECA.*

(13) This Plan does not apply to:

- *air pollution, unless caused by an event that primarily endangers the marine environment,*
- *consequences of ballast water discharges,*
- *damage compensation procedures.*

(14) This Plan shall be taken into account by the responsible persons of the County Operations Centre (ŽOC) or the national Headquarters (hereinafter: responsible persons) when pollution occurred in the designated area.

(15) This Plan will be amended by the competent authorities of Šibensko-kninska County and implemented as such:

- *in the case of a significant change in the transport load in the designated area, in terms of the number of ships, their size, properties and cargo,*
- *in the case of construction of new facilities near the designated area that may cause marine pollution in the designated area or nearby areas,*
- *in the case of the construction or upgrade of port facilities in the Bay of Šibenik area, if those port facilities handle light or heavy fuel oils, mineral, vegetable or animal oils or hazardous, noxious or harmful cargoes,*
- *in the case of amendments to the Contingency Plan for Accidental Marine Pollution or Contingency Plan for Accidental Marine Pollution in the Šibensko-kninska County,*
- *at least once every five years.*

(16) Finally, all considerations presented in this Plan should be understood in light of the research activities, and conclusions set out in the PEPSEA project.

2. GUIDANCE AND PRINCIPLES OF ACTION

(1) During containment, recovery and disposal of marine pollution in the designated area, the responsible person and other participants are expected to comply with the guidance and principles of action set out in this Chapter.

(2) Pollution containment includes all activities that minimise the amount of pollution that will reach the sea or prevent the spread of pollution in the marine environment.

(3) Pollution recovery includes all activities by which pollution that has reached the sea is collected for extraction from the sea and subsequent disposal.

(4) Pollution disposal includes all activities aiming to safely store the collected pollution and contaminated substances or objects for further cleaning or permanent storage so that they cannot pollute the marine or terrestrial environment.

Proportionality

(5) The extent of the containment, recovery and disposal measures should be proportionate to the damage or threats to human health or threats to the marine environment.

(6) Containment, recovery and disposal measures will not be implemented, or their implementation will cease when it is certain that:

- *the measures carried out successfully address reasonable risks to human health and the marine environment;*
- *the cost of future safeguards to be taken to achieve an initial status or similar level is disproportionate to the environmental benefits that should be achieved.*

Effectiveness

(7) In the event of sudden pollution, while deciding on containment, recovery and disposal measures to be implemented, priority will be given to measures and procedures that have a minimal long-term impact on the marine environment.

(8) If it is not possible to assess with certainty the extent of adverse impacts of a particular measure aiming to contain, recover and dispose of marine pollution, that measure should be averted.

(9) When selecting the containment, recovery, and disposal measures, due considerations will be given to their effects on the entire sea area and the Šibensko-kninska County's coastline.

Compliance

(10) When implementing containment, recovery, and disposal measures, the account will be taken to inform or involve other entities that may have an economic or other interest in implementing the measures, provide additional assistance or professional support, or assume responsibility for the implementation, including part of it.

(11) All available resources and workforce will be involved in the implementation of containment, recovery and disposal measures in such a way as to achieve the best possible overall result, regardless of ownership or affiliation or management responsibilities.

(12) In particular, in the event of required professional or other support, the responsible persons will seek professional or other support whenever they doubt the possible outcomes or limitations of a particular containment, recovery or disposal measure.

Economic efficiency

(13) When implementing measures to contain, recovery and dispose of pollution, the costs of their implementation will also be taken into account, in such a way that where two or more measures can achieve the same long-term effects, priority should be given to the one that incurs lower costs, regardless of who will ultimately bear the costs in question.

Public participation

(14) Information on the state of the environment and the containment, recovery and disposal measures taken will be regularly provided to public media representatives.

3. THREATS TO THE ENVIRONMENT

(1) Threats to the environment are emergency circumstances or conditions that can lead to significant pollution in the designated area and adjacent navigable areas.

(2) In particular, threats to the environment are those emergencies and circumstances that are identified as such in:

- *Contingency Plan for Accidental Marine Pollution*
- *Contingency Plan for Accidental Marine Pollution in the Šibensko-kninska County, 2010*

(3) Threats to the environment caused by maritime accidents with a reasonable probability to occur in the designated area are:

- *grounding of ships and yachts,*[10]
- *collision and allision of ships and yachts,*
- *fire and explosion on ships and yachts,*
- *the sinking of a ship or yacht.*

(4) Marine pollution caused by other maritime accidents are considered as not having reasonable probability and will not be considered in particular below.

(5) Threats to the environment are threats involving at least one vessel or yacht, greater than 50 GT, in a maritime accident in the designated area.[11]

(6) Threats to the environment that occur outside the designated area shall also be regarded as exceptional circumstances or conditions, if consequent pollution, its quantities or properties, may cause significant adverse consequences for marine life or economic activity in the designated area, in particular:

- *pollution of the sea by liquid or solid harmful or noxious substances caused by the sinking of the ship in adjacent areas,*
- *pollution of the sea by the solid waste of unknown origin.*

(7) In particular, reasonably probable threats to the environment in the designated area are those events causing sudden marine pollutions and involving:

- *light oils,*
- *heavy fuel oils,*
- *liquid cargoes, in particular mineral oils, vegetable oils and animal fats,*

[10] The term „yacht“ includes yachts larger than 50 GT.

[11] It is assumed that ships and yachts of less than 50 GT do not pose danger to the marine environment to the extent that would require the activation of the Plan.

- *harmful and noxious liquid and solid cargoes,*
- *solid waste.*

Grounding

(8) The grounding is the ship's contact with the sea bottom, with or without damage to the ship's hull, machinery, or equipment. In general, the ship may be grounded due to the deck officer's fault, under the influence of inclement weather, as a result of a machine failure or other events, or could be caused intentionally to save the ship from some other greater danger that threatens it. As a rule, the grounding consequences are proportionate to the ship's kinetic energy at the moment of contact and may include the puncture of tanks and cargo holdings.

(9) The grounding shall be deemed a maritime accident with a modest probability of environmental pollution and the most likely maritime accident in the designated area, with the maximal possible environmental pollution.

(10) In principle, the remedial action in case of pollution caused by the grounding of the ship in the designated area, depending on the circumstances, includes all or some of the following procedures:

- *enclosing a grounded ship with protective booms,*
- *containing the pollution (for example, by deploying the second row of protective booms or completely closing the entrance(s) to the designated area),*
- *unloading substances that may pollute the sea in case of uncontrolled discharge,*
- *recovery and disposal of pollution waste.*

Collision and allision

(11) A collision is a ship's contact with another ship in navigation, at an anchorage or alongside, while allision is a contact with a floating object other than the ship. As a rule, the collision and allision are the results of the misconduct of the deck officers. The allision rarely causes significant pollution and therefore is omitted hereinafter. Collisions' consequences depend on ships' kinetic energy and the contact angle and can cause fuel or cargo tanks and holds to be breached.

(12) Collision of ships in the designated area shall be assessed as a maritime accident with a modest probability of environmental pollution (simultaneous navigation of several ships with significant quantities of fuel or cargo that may pollute the environment in the designated area is prohibited[12]).

[12] Naredba o plovidbi u prolazu u šibensku luku, u Paš-manskom tjesnacu, u prolazu Mali ždrelac i Vela vrata, rijekama Neretvom i Zrmanjom, te o zabrani plovidbe Pelješkim, Koločepskim, Unijskim kanalom i kanalom Krušija, te dijelovima Srednjega kanala, Murterskoga mora i Žirjanskoga kanala, Narodne novine 09/07, 104/16 i 53/19.

(13) In principle, the procedure for the threat of pollution caused by a collision of ships in the designated area, depending on the circumstances, includes all or some of the following procedures:

- *anchoring or otherwise restricting the movement of ships involved in a collision,*
- *enclosing damaged ship(s) with protective booms,*
- *preventing the spread of pollution (for example, by deploying protective booms to close the entrance(s) to the designated area),*
- *unloading substances that may pollute the sea by uncontrolled discharge,*
- *recovery and disposal of pollution waste.*

Fire and explosion on board

(14) A fire onboard is an uncontrolled burning of the entire ship or parts thereof. The explosion is considered the immediate combustion of part of the cargo, i.e. flammable gases and vapours of liquid cargo or ship's fuel. Often the explosion precedes the fire. Fire and explosion may occur due to human error, technical failure or may be caused by other marine accidents.

(15) A fire on board ships in the designated area shall be assessed as an accident having an extremely low probability of environmental pollution.

(16) In principle, the procedure for the clean-up of the pollution caused by a fire on board in the designated area, depending on the circumstances, includes all or some of the following procedures:

- *towing a ship outside the designated area,*
- *anchoring or otherwise restricting the movement of the ship,*
- *supporting firefighters,*
- *enclosing a ship with protective booms,*
- *preventing the spread of pollution by deploying additional protective booms,*
- *unloading substances that may pollute the sea from the ship,*
- *recovery and disposal of pollution waste.*

Ship's sinking

(17) The sinking of a ship is a maritime accident that may be caused by one or more causes, namely the loss of buoyancy of the ship (uncontrolled flooding of the hull interior), loss of hull strength (cracking of hull construction) or loss of ship stability (compromised weight distribution on board).

(18) A ship's sinking in the designated area shall be assessed as a maritime accident with an extremely low environmental pollution probability. The sinking of a ship in areas directly next to

the designated area, especially in part towards the open sea, is assessed as a maritime accident with very little probability of environmental pollution.

(19) In principle, the procedure for the threat of pollution caused by the sinking of a ship in the designated area or adjacent areas, depending on the circumstances, includes all or some of the following procedures:

- *encircling the area where pollution may surface with protective booms,*
- *protecting valuable coastal areas in the immediate vicinity, to the extent possible and reasonable (for example, by deploying protective booms or absorbents to protect valuable beaches),*
- *unloading substances that may pollute the sea by uncontrolled discharge or lifting of a ship,*
- *recovery and disposal of pollution waste.*

Light fuel oils

(20) Light fuel oils (notably Petrol and Diesel fuel, MDO) are light, refined petroleum product with a relatively narrow range of boiling temperatures. The specific weight of diesel fuel is 0.82-0.88, while the specific weight of gasoline is 0.71-0.77. Unlike gasoline, diesel fuels have a much wider application as ship's fuel due to a slightly less propensity to ignite.

(21) Light fuel oils contain significant amounts of highly toxic compounds (notably benzene, toluene, ethylbenzene and xylene) and many aromatic compounds, which is the main reason they should be considered environmentally harmful substances.

(22) Due to low viscosity, there is a very rapid dispersion of light fuel oils over the water's surface after leakage. Due to the high proportion of easily volatile compounds, their evaporation is extremely fast. In case of discharge of small quantities, complete evaporation occurs already in a few hours, while in larger quantities, it can take up to a day or two. Although they quickly penetrate the coastal rocks' pores, they also break down quickly, especially under waves of medium or higher energy.

(23) Microorganisms may easily and completely decompose diesel oil within 1-2 months when there is enough oxygen. Adding nutrients can speed up this process in case of soil contamination.

(24) Light fuel oils are petroleum products highly toxic to marine life. Fish and invertebrates who come directly into contact with naturally dispersed and trapped diesel oil in the water column can be wiped out. However, smaller spills into open waters dilute so quickly that they do not result in such an outcome as a rule. In case of larger quantities or concentrations, shellfish in shallow, coastal areas may also be exposed to harmful effects. These organisms bioaccumulate the oil and excrete it, usually during the few weeks after the exposure.

(25) Light fuel oils may, in some circumstances, affect the seabirds exposed to them. Mortality can be caused by ingestion or hypothermia due to glued feathers. However, such circumstances are possible only in case of spills of larger quantities, while in case of small spills (up to several tons), seabirds are generally not affected due to the extremely short time of oil retention on the surface of the water.

(26) According to its behaviour after leakage, biodiesel[13] or kerosene may be considered as light fuel oils. Biodiesel, especially concentrated, oxidises significantly faster in the sea and can also cause a noticeable decrease in dissolved oxygen levels. In reality, biodiesel's behaviour depends to a significant extent on the composition or method of production.

(27) Pollution of smaller quantities of light fuel oils (up to 1,000 litres) in the designated area shall be estimated as pollution of medium probability.

(28) Pollution of larger quantities of light fuel oils (more than 1,000 litres) in the designated area shall be estimated as pollution of very low probability.

(29) In the designated area, no measures are foreseen to be taken to contain, recover and dispose of light fuel oil spills, except in the case of contamination by larger quantities of light fuel oils that take place over a longer period (gradual pollution).

Heavy fuel oils

(30) Heavy fuel oils (HFO) are dense, viscous oils. They are produced by mixing heavy residual oils with lighter oil to meet viscosity conditions and melting temperature. The specific weight ranges from 0.95 to more than 1.03, which can cause it to float, suspend itself in a water column or sink. Small changes in water density can determine whether the oil sinks or floats.

(31) When spilt, heavy fuel oil spreads like a thick dark liquid. High viscous oils will often disintegrate into separate stains and clusters of tar.

(32) Heavy fuel oil is a persistent oil. It is expected that only 5-10% will evaporate in the first hours after the spill, so winds and currents can carry the rest. Sometimes they can create an emulsion, but only after a few days.

(33) The harmful effects of heavy fuel oil occur by soiling wildlife habitats on the aquatic surface, suffocating coastline organisms and prolonged sediment pollution. Mortality rates can be high for seabirds, aquatic birds and sea mammals. Although the toxicity of water-soluble ingredients is less than that of light fuel oils, it can often be higher due to significantly longer exposure

[13] Biodiesel as fuel is most often a mixture of diesel and biodiesel in a ratio of up to 7% biodiesel.

times, which generally depend on environmental factors that affect water column mixing and weather conditions.

(34) Pollution of smaller quantities of heavy fuel oils (up to 1,000 litres) in the designated area shall be estimated as having an extremely low probability of occurrence.

(35) Pollution of larger quantities of light fuel oils (more than 1,000 litres) in the designated area shall be estimated as having a very low probability of occurrence.

(36) The recovering of heavy fuel oils from the sea's surface is effectively carried out using skimmers and vacuum pumps, especially immediately after pouring.

(37) Clean up of the coastline can be effective if it is started and carried out before volatile components evaporate completely.

(38) In the designated area, all appropriate measures shall be taken to contain, recover and dispose of heavy fuel oils.

Liquid cargoes

(39) Liquid cargoes may be very diverse. Mineral oils, vegetable oils and animal fats are the most frequents cargoes in maritime transport.

(40) Mineral oils[14] include oil in any form, including crude oil, fuel oil, sludge, oil waste, and refined products (other than petrochemical products subject to the MARPOL Convention - Annex II) and include substances listed in the MARPOL Convention - Annex I.

(41) Due to numerous reasons, particularly if spilt, persistent oils are considered as requiring particular attention.[15]

(42) The recovering of mineral oils depends substantially on their properties and may include all known recovering and disposal methods.

(43) Vegetable oils (soybean oil, palm oil, rapeseed oil, sunflower oil, etc.) are liquids (some need to be heated) with a specific density of 0.90-0.97. Upon spilling out, they float and create stains. They can subsequently harden, sink or continue to float, depending on the type, volume, wave energy, temperature, presence of floating debris, clusters of suspended particles or sediments,

[14] See MARPOL Convention.

[15] Persistent oil is all persistent hydro-carbon mineral oils other than those falling within the definition of non-persistent oil. Non-persistent oil is oil which consists of hydro-carbon fractions at least 50% of which, by volume, distils at a temperature of 340 degrees C, and at least 95% of which distils at a temperature of 370 degrees C when tested by the ASTM Method D 86/78 or any subsequent revision thereof.

and more. Evaporation is modest. Immediately after a spill, these oils can partially penetrate porous rocks or sediments.

(44) The recovering and removal of vegetable oils by skimmer or vacuum equipment is approximately as effective as it is a case with light oils

(45) In liquid form, vegetable oils may cover plants and animal species and lead to hypothermia, dehydration, hunger or suffocation. They often cause a decrease in oxygen levels. Toxicity is modest and occurs subsequently by biochemical processes in the sea. They degrade relatively quickly (if they do not change the structure).

(46) Animal fats (e.g. bovine fat) are transported in significantly smaller quantities. They can have very different properties, but as a rule, they are similar in properties and influence on marine life with vegetable oils of greater viscosity.

(47) Mineral oil pollution in the designated area is estimated to have a negligible low probability of occurrence.

(48) Vegetable oils pollution in the designated area is estimated to have an extremely low probability of occurrence.

(49) Pollution of animal oils in the designated area is estimated as having a negligible low probability of occurrence.

(50) In the area under consideration, all appropriate measures are foreseen to be taken to contain, recover and dispose of liquid cargo spills, except in the case of liquid cargo spills labelled as OS substances, in accordance with the MARPOL Convention - Annex II.

Harmful and noxious cargoes

(51) Hazardous and harmful substances (HNS) include all substances other than oil, which, if introduced into the marine environment, are likely to create a danger to human health, harm living resources and marine life, damage properties, or interfere with other legitimate uses of the sea.[16] The term includes gases, liquids, and solids transported in packaged form or bulk.

(52) In respect of the impact on the marine environment, hazardous and noxious substances may be:

- *radioactive,*
- *corrosive,*
- *carcinogens,*
- *toxic to marine organisms,*
- *bio-accumulative,*

[16] See OPRC-HNS Protocol (2000).

- *persistent.*

(53) Hazardous and noxious substances can affect people, human health and the marine environment. Therefore, it is significantly difficult to predict a harmful substance's behaviour after it has reached the marine environment.

(54) Pollution involving hazardous and noxious substances in the designated area is estimated to have an extremely low probability of occurrence.

(55) The most probable procedure to recover hazardous and noxious substances depends on several factors, the most important of which are:

- *the state of matter of the substance (solid, liquid or gaseous),*
- *the amount of substance,*
- *location on board,*
- *the behaviour of substance(s) in water.*

(56) The procedure for recovering hazardous and noxious substances shall be established in each case and shall, in principle, consist of:

- *risk assessments based on the properties and quantity of hazardous or noxious cargo spilt out,*
- *estimated consequences of releasing the maximum possible amount of hazardous or noxious cargo,*
- *decisions on the application of a specific measure of containment, recovery and disposal,*
- *identifying personal protective measures for persons carrying out the containment, recovery and disposal of hazardous or noxious cargo,*
- *decisions on the monitoring procedure following the containment, recovery and disposal measures are completed.*

Solid waste

(57) Solid waste includes durable, manufactured or processed solids and substances other than those of natural origin which reached the sea by dumping from land or ships and yachts, rivers, drainage, municipal systems, wind or otherwise. Waste in the sea includes floating waste, waste dispersed in a column of water, waste found on the seabed or the coastline. For the most part, it originates from the mainland.

(58) Solid waste may be of diverse origin, composition, size, shape and durability. It is commonly classified as food residues, household and industrial waste (metal, glass, rubber, processed wood and paper), plastics, solids (cargo residues from ships), ash, cooking oil, fishing tackle and

animal carcasses. Different types of waste have different decomposition time and may adversely affect marine organisms' survivability, human health, economy, and seawater quality.

(59) Plastic materials may have a particularly adverse impact.

(60) Pollution by the solid waste in the designated area is estimated to have an extremely low probability of occurrence.

(61) Waste recovering under this Plan shall be carried out in the case of waste quantities exceeding amounts that the responsible public services can collect.

(62) Waste recovering under this Plan shall be carried out in cases involving large quantities of plastic waste at sea. The main goal is to prevent its decomposition under the influence of various chemical, biochemical and physical processes up to the level of microplastics.[17]

(63) The recovering of solid waste shall be carried out by mechanical means, manual collection, or protective booms.

Pollutant	Negligible probability of pollution	An extremely small probability of pollution	A very small probability of pollution	Medium probability of pollution
Light fuel oils (up to 1000 litres)				X
Light fuel oils (more than 1000 litres)			X	
Heavy fuel oils (up to 1.000 litres)		X		
Heavy fuel oils (more than 1.000 litres)			X	
Crude oils	X			
Vegetable oils		X		
Animal oils	X			
Hazardous and noxious substances		X		
Solid waste		X		

[17] Microplastics are considered to be all plastic items with a maximum dimension of less than 5.0 mm, regardless of whether they have reached the sea or are formed from larger objects during decomposition in the sea.

4. MEASURES TO CONTAIN, RECOVER AND DISPOSE OF SPILLS

(1) In the event of pollution of the sea or coastal area within the Sv Ante Channel area or in close vicinity, responsible persons shall consider all available means of action, considering the necessity to implement the initial measures as quickly as possible.

(2) When measures to contain, recover and dispose of the pollution may affect human rescue or procedures mitigating health threats, the priority should be given to rescue measures or measures to reduce the threat to human health.

(3) The initial action shall include measures aiming to restrict the spread of pollution and reduce future damage to the environment, economy or other legitimate uses of the sea and the coastal area.

(4) Once initial action has been established, the responsible persons should consider and choose measures to recover the pollution and dispose of pollution waste with the ultimate aim of bringing the coastline to the initial state to the extent reasonably possible and appropriate to the circumstances.

(5) In the case of pollution in the designated area, the following measures or procedures should be considered to contain, recover and dispose of pollution waste.

Natural recovery

(6) Natural recovery is a process by which natural (physical, chemical and biochemical) processes in the sea are left to break down pollutant over time. Accordingly, no action shall be taken in the event of pollution to eliminate it and reduce the adverse environmental impact.

(7) Natural recovery is particularly appropriate where natural degradation is rapid (e.g. in the case of liquids that evaporate rapidly), when the amount of pollutant is limited, when access to the contaminated area is difficult to reach, or when the use of other means of eliminating pollution would do more harm than natural recovery.

(8) In the designated area, natural recovery is appropriate in case of pollution:

- *highly-volatile liquids (e.g. petrol),*
- *low viscosity liquids,*
- *smaller quantities of food or biodegradable solids.*

(9) If natural recovery is selected as a fundamental measure, monitoring the movement of pollutants, decomposition dynamics, and assessment of the potential impact on the marine life in the area is necessary. In the event of adverse developments, other measures should be taken.

The monitoring shall be carried out as long as there is noticeable pollution of the sea, in or outside the designated area.

(10) In the designated area, natural recovery is not appropriate in case of pollution:
- *involving significant amounts of biodegradable solid waste,*
- *with substances requiring a long time for decomposition (plastics and similar materials),*
- *with substances and objects that can pollute the marine environment for a long time (e.g. decomposition products),*
- *involving persistent oils and similar liquids,*
- *with other substances, if they may cause significant and long-lasting effects on the marine environment or economy.*

Containing the pollution

(11) Pollution containment is a process that aims to keep pollution in the area of discharge (as a rule, close to the vessel, boat, yacht, or coast object that is a source of pollution).

(12) The containment of pollution shall, as a rule, be carried out using protective booms.

(13) The protective booms are also suitable to prevent the spread of pollution into the highly valuable areas (economically or biologically) or the spread of pollution outside the recovery area (to be carried out using other means).

(14) The efficiency of protective booms is limited in the case of:
- *strong sea currents (speeds of more than 0.7 knots) or high waves, especially in the case of stronger winds, which may cause pollution to be carried above or below the boom,*
- *delayed deployment,*
- *extremely large amounts of spills, with adverse weather conditions (due to a high load on the boom).*

(15) In the designated area, deployment of the protective booms to limit the spread of pollution is very effective (there are several sections where it is possible to connect opposite sides of the Channel with booms up to 300 m long, without using dedicated anchoring systems).

(16) Adequate protective booms should be considered those with a height of at least 600 mm with a break strength of more than 20 kN.

(17) The appropriate amount of protective booms should include at least two times of 400 m booms intended for:
- *containing the pollution within the designated area (in cases the source of pollution is within the area),*

- *preventing pollution from penetrating the designated area (in cases when the source of pollution is outside the area).*

(18) The protective booms intended to be used within the area must be equipped with:
- *connecting mechanisms (ensuring effective prevention of leakage between individual sections),*
- *mechanisms to connect booms with coast-side ensuring effective prevention of leakages between the end of the boom and the coast.*

(19) In addition to the protective booms intended to close the entrance to the designated area, at least 400 m of additional protective booms should be provided to recovery areas (to be used to prevent the spread of pollution outside the area).

(20) The appropriate timing of deployment of protective booms intended to close the entry of the spill into the Channel should be less than 2 hours from the time of reporting the spill or the notification of a threat of contamination until the entrance into the Channel is effectively closed.

(21) In case of deployment of protective booms around the vessel or yacht, it is necessary to have a certain number of anchors. In this regard, it is assumed that there is at least one concrete anchor (low profile) for every 200 m of the boom with appropriate mooring equipment (approximately 150 m of rope of appropriate break strength per anchor). It is not necessary to recover anchors out of the sea after use. Besides, it is possible to involve smaller vessels, primarily fishing ones, to maintain booms if necessary until their anchoring is ensured.

Mechanical collection and recovery

(22) Mechanical collection and recovery is the process by which a pollutant on the surface of the sea (liquid spill or solid waste) is concentrated and towed towards sites where it can be recovered by other means.

(23) The mechanical collection is generally carried out by booms, stationary or towed, and less frequently by water jets. It is appropriate to prevent coastal pollution in case of pollution outside the designated area (for example, on the high seas).

(24) If the pollutant is mineral oil or an oil derivative, the emulsion may occur while collecting the oil. If contact with soil sediment occurs, significant amounts of oily material may be produced. Such circumstances should be avoided by collecting oil away from the coastline.

(25) The mechanical collection has limited effectiveness in the case of stronger wind or waves.

(26) Within the designated area, the disposal of pollution recovered by mechanical collection is not assumed.

(27) Mechanical collection and recovery within the designated area are an acceptable method to reduce pollution, considering that there are significant restrictions on the application due to the Channel's little distance between opposing coasts.

Absorbents

(28) The absorbents[18] are primarily intended to absorb oils or similar liquid substances from the surface for easier recovery and subsequent disposal.

(29) The method involves using oleophilic textile or similar materials that run through a thick layer of polluting spill or is otherwise put into contact with the pollutant. Efficiency, therefore, selection of the absorbing materials, depends on absorption capacity, properties, in particular viscosity, target pollutants[19] and energy needed for the subsequent extraction of the pollutant.

(30) Further information on the properties, advantages and disadvantages of individual derivatives of absorbent substances may be found in the instructions specified in ITOPF – TIP 8 Use of Sorbent Materials in Oil Spill Response.[20]

(31) The advantage of the method is that it can be used in almost any conditions, especially in particularly vulnerable areas, as well as in hard-to-access areas. It is often used as a secondary way of recovering smaller quantities after larger quantities have been collected by other means.

(32) Unnecessarily large amounts of waste may occur in case of overuse. Also, in case of a too-long stay in the water, there is a possibility of rupture and, thereby, additional environmental pollution. The absorbent means should be considered as waste, although they may be recycled in most cases.

(33) The use of absorbents should be considered the primary method of liquid pollution recovery in the designated area and should be used wherever possible.

[18] Adsorption is the appearance of adhesion of atoms, ions or molecules from gas, liquid or dissolved solids to the surface of an object. Adsorption differs from absorption, in which the liquid dissolves or permeases with liquid or solid. Adsorption is a surface phenomenon, while absorption involves the entire volume.

[19] For example, for heavy oils, used substances absorb only with their surface part, while for lighter oils the oil penetrates and absorbs with entire volume of the substance used.

[20] https://www.itopf.org/knowledge-resources/documents-guides/document/tip-08-use-of-sorbent-materials-in-oil-spill-response/

Dispersants

(34) The use of dispersants aims primarily to minimise the harmful impact of oil on marine organisms or organisms whose sea surface is a natural habitat (e.g. birds), in particular in cases where the harmful effect of oil on the surface of the sea is greater than the harmful effects of dispersed oil on the seabed or in the water column.

(35) Dispersants are agents that reduce the adhesion forces of oil and water, causing oil to be dispersed into small droplets, mixed with water and then sink. Dispersants are applied by spraying on the sea's surface in the amount of 1-5% of the oil volume to which they are applied. Dispersants may be used undiluted or diluted with water, and sometimes it is necessary to stir the surface on which they are applied for better efficiency. They should not be used in shallow waters as they adversely affect sea organisms up to a depth of 10 metres. Their fundamental advantage is that they do not produce waste that needs to be disposed of later.

(36) The use of dispersants in the designated area is not acceptable. Exceptionally, in the case of minor pollution quantities and with the responsible person's prior approval, it is acceptable to use dispersants in very limited quantities when other recovering methods are not sufficiently effective.

Manual removal (cleaning)

(37) Manual cleaning consists of cleaning up stranded oil residues and contaminated sediment with hand tools and storage in barrels or similar containers of appropriate capacity allowing relatively easy delivery and dispatch, even from not easily accessible places. This method also includes cleaning subsurface areas by divers with handy tools.

(38) This cleaning method is applicable all over the designated area, provided that pollution has been deposited or it created significant sediment concentrations. A large amount of waste may be expected in the latter case, requiring noteworthy disposal and processing efforts. The same applies to workers' hand tools and clothing, which should also be considered waste that needs to be properly disposed of and processed.

Mechanical cleaning

(39) Mechanical cleaning shall be carried out when a pollutant, separately or in a mixture with other substances from the immediate surroundings, form sufficient volume that may be removed using mechanical means, particularly construction machinery (bulldozers, excavators, backhoes, and similar, as may be appropriate).

(40) In the designated area, mechanical cleaning has limited usability (except in certain parts) due to limited accessibility to the coastline. The use of heavy machinery is limited, especially within the soft soil areas, porous rocks, and areas of archaeological sites or similar places.

(41) Particular attention should be paid in cases when mechanical cleaning may remove a layer of the soil. In such cases, it is necessary to limit the amount of waste produced and its undesirable impact on the coastline's living world. Therefore, the procedure should be allowed only to the depth of the penetration of pollution. Simultaneously, such an approach will minimise the amount of waste (weight and volume).

Mechanical tools

(42) Mechanical tools should be used for collecting pollution in cases when pollution already reached the coast by natural movement or by mechanical collection procedures. It is done using vacuum pumps and skimmers.

(43) Vacuum collection is a recovery method using dedicated devices that collect oil and similar pollutants by creating low pressure (vacuum). The device consists of a flexible tube and pump and may vary in size from smaller portable units to large devices mounted on vehicles or ships.

(44) Spill recovery using skimmers is a way of collecting pollution by using dedicated devices that collect oil and similar pollutants by overflowing the surface layer or otherwise. The device consists of a flexible pipe, overflow part and storage tank and can vary in size from smaller portable units to large devices installed on vehicles or ships.

(45) Recovery using mechanical tools is effective, particularly if the spilt substance has not absorbed too much seawater. Therefore, the area where recovery is carried out must be enclosed by protective booms to maintain a sufficient pollutant density permanently.

(46) The use of these devices in the designated area is justified in cases where the bulk of the spill still float on the surface and, as a rule, does not have a detrimental impact on the environment.

(47) Particular attention should be paid to prevent receptacles used to store the recovered pollution and other equipment to pollute other parts of the coast or cause mechanical damage to the environment (for example, while using heavy equipment close to the beach to transport recovered quantities).

Removal of vegetation

(48) The removal of vegetation shall be carried out in the event of contamination of vegetation near the coastline to eliminate the risk of re-contamination. Removal of contaminated vegetation should be used to prevent damage to the roots and prevent pollution from penetrating deeper into the soil.

(49) When removing vegetation, further soil erosion should be prevented by all means.

Flushing

(50) Flushing with water aims to eliminate liquid pollution from the coast when it is easier to recover the spill from the sea surface than from the coast. It is carried out using manual nozzles or deploying a perforated pipe with water at ambient temperature on the coast, parallel to the coastline. The water flow washes out spilt substances to the sea, where it is then recovered (most often by using absorbents or mechanical tools).

(51) Flushing is effective in cases involving high contamination by oils, particularly persistent oils, where oil is mixed with gravel (to reduce contamination levels) and is often used as a supplementary cleaning method.

(52) Protective booms must be used to enclose the area where pollution is recovered using flushing.

Rinsing with high-pressure water

(53) Rinsing with high-pressure water is a way of eliminating liquid and finer solid material that is easier to recover from the sea than from the coast. It is carried out using high-pressure pumps. Efficiency largely depends on the viscosity of the pollutant.

(54) Rinsing with high-pressure water effectively washes away liquid pollution that clings more firmly to the substrate or pollution accumulated on coastal artificial structures and rocky or gravel coasts characterised by higher granulation.

(55) Rinsing with high-pressure water is not effective when spill reached sandy or gravel coasts of fine granulation.

(56) Protective booms must be used to enclose the area where pollution is recovered.

Rinsing with warm water

(57) Hot water rinsing is used in spills of very viscous liquids. The procedure consists of rinsing the coastline with hot water with a temperature of up to 80°C. It is most commonly used to avoid re-adhesion of contamination to the substrate.

(58) Hot water rinsing is suitable on rocky, sandy or pebbly coast and artificial structures when the area is contaminated with thick oil deposits.

(59) In case of contamination by liquids containing a significant proportion of highly volatile components, the procedure is very effective if used immediately after the contamination occurs (while highly volatile components have not yet evaporated).

(60) The procedure may harm marine organisms, especially if water is too hot or tools produce too high jet pressures.

(61) Hot water rinsing in the designated area is acceptable only for cleaning the artificial structures, where there are no distinct intertidal communities.

(62) Protective booms must be used to enclose the area where pollution is recovered.

Bio-stimulants

(63) Bio-stimulants are agents that accelerate oil degradation by supporting biological processes (adding nutrients). They are applied by spraying the areas of lower concentration with microorganisms with substances that promote their growth. The method is mostly carried out after the coastal zone has been cleaned up to a certain level to clean up the remaining oil traces. The greatest effect is achieved by applying it to thinner deposits of crude oil.

(64) The use of bio-stimulants in the designated area is not acceptable except exceptionally.

Other methods to eliminate pollution

(65) Other methods of addressing pollution, not listed in this section, are considered as methods which, given the characteristics of the area, may cause more damage to the living world in the event of application than is achieved by applying the above methods.

(66) Unacceptable methods in the designated area are:

- *sandblasting,*
- *washing with water with additives,*
- *steam rinsing,*
- *rinsing with high-pressure hot water (except in the case of artificial structures),*

- *mechanical treatment of beaches (except adding beach material as may be needed is provided),*
- *use of additives for solidification, increasing compactness or emulsification,*
- *in situ burning.*

(67) Therefore, the recovery methods and clean-up not specified in this section are not considered to be used in the designated area.[21]

[21] For further details one should consult *Characteristics of Response Strategies: A Guide for Spill Response Planning in Marine Environments, U.S. DEPARTMENT OF COMMERCE, National Oceanic and Atmospheric Administration, 2013.* Vidi: https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/characteristics-response-strategies.html

5. PROCEDURE IN CASE OF SUDDEN POLLUTION

(1) According to this Plan, the clean-up procedure is initiated:
- *after receiving a notification on marine pollution in the designated area by the competent services,*[22]
- *after receiving a notification of a marine accident likely to cause marine pollution.*

(2) According to this Plan, the clean-up procedure shall begin regardless of how the initial notification is delivered/received.

(3) The clean-up procedure in case of sudden pollution of the sea consists of the following actions:
- *gathering information on the threat to the environment,*
- *assessment of circumstances and choice of protective measures,*
- *preventing further spread of pollution through selected protective measures,*
- *collecting the polluting substance from the coastline, sea surface, or bottom of the sea, as appropriate,*
- *recovery of polluting substance from the coast,*
- *disposal of collected substance and other waste.*

Gathering information and assessing circumstances

(4) The collection of information on the threat to the environment includes at least information on:
- *source of pollution,*
- *the location or place of contamination,*
- *the type and properties of the pollutant,*
- *the amount of pollutant released and the amount that may be released,*
- *the weather's state and outlook (wind direction and power, cloudiness, air and humidity temperature, and others) and the sea (sea and tides, sea temperature, currents, waves, and more).*

(5) In the case of oil pollution (other than vegetable and animal oils) or fuels, the assessment of the amount of pollution may be carried out by estimating the surface area and thickness of the pollution, with the thickness of the pollutant layer determined according to the following table:

[22] The competent service is considered to be the competent Harbour Master's Office, Center 112, and the responsible departments of the Šibensko-kninska County.

Visible occurrence	Layer thickness
silvery	<0.0001 mm
rainbow colour	0.0001mm - 0.003 mm
light brown to black	0.003mm - 0.1mm
dark brown to black	>0.1 mm

(6) Further information on cargo properties or appropriate procedures in case of discharge into the sea can be found:

- *in case of contamination of hazardous and noxious substances (HNS) in MIDSIS - TROCS 4.0 - Maritime Integrated Decision Support Information System on Transport of Chemical Substances, [23] i.e. on CAMEO Chemicals,[24]*
- *in case of contamination of hazardous and noxious substances (HNS) in Marine HNS response manual, Bonn Agreement, HELCOM, REMPEC, 2020[25]*
- *in case of contamination by fuel oils and crude oil, using the ADIOS2 programme (data on a particular liquid's behaviour, in particular evaporation and dispersion).[26]*

(7) If the source of contamination is a ship, yacht or floating object, the necessary information shall include at least:

- *the name of the ship and the IMO number, the flag, the number of crew members, the nationality of the master and crew, the name and IMO number of the company,*
- *tonnage, length, width, draught, deadweight, quantities and characteristics of cargo,*
- *the condition of the ship's hull, machinery and equipment,*
- *data on insurance and financial warranties,*
- *name and means of contact with the company's Designated Person Acoast (DPA), name and address of the insurer, name and address of the P&I representative.*

(8) The assessment of circumstances should include as a minimum:

- *expected drift of pollutants,*
- *the degree of danger to human lives and health,*
- *degree of fire/explosion hazard,*
- *the expected extent of the impact (in particular, the length of the contaminated coastline),*
- *the expected impact on the living world in the area of pollution.*

23 https://midsis.rempec.org/en/documents/chemicals.pdf
24 https://response.restoration.noaa.gov/cameochemicals
25 https://midsis.rempec.org/en/documents/hns-manual.pdf
26 https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/response-tools/adios.html

(9) The assessment of circumstances is the basis for the selection of protection measures and, as a result, it should indicate a need for required vessels, workforce and equipment, in particular:

- *requirements on standby tugs or vessels with appropriate towing force and other equipment to assist vessel(s) at sea,*
- *requirements on dedicated ships, equipment and pollution response personnel on standby,*
- *requirements in respect of civil protection units to be alerted,*
- *requirements in respect of standby emergency services (firefighters, paramedics, HGSS),*
- *requirements in respect of involving the Red Cross to accommodate crews of ships and other persons,*
- *considerations in respect of other measures appropriate to the identified risk of pollution.*

(10) In the case of pollution outside the designated area, particularly in the open sea areas, information on the pollution drift should be obtained by reconnaissance of pollution on the sea surface by aircraft or vessel.

Choice of protective measures

(11) The designated area is outlined mostly with the characteristic rocky structures sheltered from the high wave impact. Such rocky coasts can vary significantly in permeability.

(12) In the designated area, coastal vegetation extends to the coastline (which is a common characteristic for the areas where no large wave energies are present).

(13) In the designated area, in addition to sheltered rocks, there is also a short pebble beach (along the southwest Channel coast) and a segment that remains dry at low tide (tidal wave area) or is characterised with shallow water (the part near the fortress of St. Nicholas).

(14) The artificial coastline structures are relatively short and low and, as a rule, intended for mooring local inhabitants' boats. The 75 m long pier is located in the southwestern part of the Channel (former military facilities).

(15) Due to the coastline's characteristics (porosity, very low wave energy), long-term retention (glueing) of liquid pollution for the substrate is expected. It is especially emphasised in the case of viscous liquids (oils) in the coast segment with dry, rough, rocky surfaces, especially in the tidal wave area.

(16) In general, the coastline of the designated area is expected to experience:

- *significant oil penetration into the rough rocky surface, especially in the tidal wave area, forming a noticeable oil belt,*
- *significant retention, especially in pores and cracks where oil is expected to 'age',*

- *less retention in the lower part of the tidal wave, especially in parts occupied by algae and similar organisms, which limit the adhesion of oil to the surface of the rock,*
- *penetration of pollutants into cracks developed by collapsing structures, with possible long-term contamination of the sediments,*
- *adverse impact on marine organisms even after short exposure to light fuel oils (high acute toxicity).*

(17) When selecting remedial actions, the following should be taken into account as crucial:

- *the potential environmental harm of the measure(s) selected,*
- *the effectiveness or quantity of pollution and waste that is eliminated by a certain way in total as per unit of effort,*
- *availability and appropriateness of a particular measure, especially given the cost of the necessary resources and workforce;*
- *availability and competencies of staff,*
- *the possibility of transporting people, equipment and means to the place of work,*
- *the need to limit pollution incurred in the designated area (closing the Sv. Ante Channel),*
- *the possibility and restrictions in respect of the disposal of the waste produced.*

(18) When choosing how to clean up pollution, it is also necessary to consider:

- *possible costs of preventing and eliminating pollution,*
- *short- and long-term impact on economic activities in the immediate vicinity.*

(19) In principle, measures marked with A and B in the following table are considered appropriate for implementation within the designated area.[27]

[27] In case of need for additional information, in particular in case of pollution in areas outside the designated area, it is adviced to use *Characteristic Coastal Habitats - Choosing Spill Response Alternatives, U.S. DEPARTMENT OF COMMERCE, National Oceanic and Atmospheric Administration, 2017*. See: https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/characteristic-coastal-habitats.html

Environmental impact	I	II	III	IV	V
Natural recovery	A	A	B	B	B
Manual recovery and cleaning	–	C	B	C	C
Adsorbents	A	A	B	C	C
Mechanical tools	–	B	B	B	C
Mechanical cleaning	–	A	A	A	A
Removal of vegetation	–	–	D	D	D
Flushing	–	A	A	B	C
High-pressure rinsing	–	C	B	B	C
Hot water rinsing	–	–	D	D	D
Bio-stimulants	–	A	B	C	C

Polluting substance

I Petrol and similar highly volatile liquids
II Diesel fuel, low-density crude oil and similar liquids
III Medium density crude oil and similar derivatives
IV Heavy oil and residues
V Heavy residual oils

Environmental impact

A - small to a negligible adverse effect on the environment
B - a medium detrimental effect on the environment
C - significant environmental impact
D - highly detrimental effect on the environment
- not appropriate

(20) Based on the previous, within the designated area, depending on the estimated environmental sensitivity index (ESI), the following clean-up methods are preferred:[28]

[28] *ESI – Environmental Sensitive Index*. For details see: https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/shoreline-sensitivity-rankings-list

Coast type	Recovery methods
Sheltered Rocky Shores ESI 8A	- natural recovering - flushing, high-pressure rinsing (if needed) - mechanical cleaning
Mixed Sand And Gravel Beaches ESI 5	- flushing - natural recovery - manual cleaning - mechanical cleaning - mechanical tools - soil top-of[29]
Sheltered solid structures ESI 8B	- high-pressure rinsing - hot water rinsing - mechanical cleaning

(21) In general, the most effective way to eliminate pollution is to flush rocky coasts with low water pressure as early as possible until a significant dispersion of liquid into the water column occurs.

(22) In the case of contamination by heavy oils, mineral and vegetable and similar oils, machine collection takes precedence over other collection methods.

(23) On the beach and in the part of the low-level coast (in particular, near the fortress of St. Nicholas), accumulated pollution is recommended to be cleaned by manual collection, with abundant rinsing.

(24) Removal of contaminated marine plants and algae is not recommended.

(25) Extensively contaminated vegetation should be removed. Removal of less contaminated vegetation should be avoided as far as possible.

(26) The use of heavy equipment directly along the coastline should be avoided (except for part of the artificial coastline).

(27) In a particular case, as a rule, exceptionally, the choice of protection measures may also be affected by characteristics not mentioned above. In such cases, it is necessary to indicate the reasons or justification for such a choice.

[29] The soil top-up involves the removing gravel material of appropriate granulation where it is necessary to remove part of the beach and replace it with new material of similar properties. It can be considered a limited application of mechanical processing.

(28) Exceptionally, the responsible person may also decide on the application of environmental protection measures having a significant direct impact on the environment or whose impact on the marine environment is unknown, where it is reasonable to expect that this will result in less damage to the marine environment in the long term than would be the case if such clean-up measures were avoided.

(29) The responsible person shall pay special attention and request professional assistance if fuel or cargo or substances in the sea cause the formation of:

- *toxic or explosive gas clouds, in particular high-irritation gases or highly unpleasant odours,*
- *a build-up of flammable liquids on the surface of the sea, in particular highly volatile liquids,*
- *highly persistent spots on the water surface,*
- *toxic or carcinogenic clusters in the water column,*
- *a thick layer of pollution on the sea bottom.*

Selection of areas intended for recovery

(30) The recovery area is an area where a pollutant is collected and loaded on the vehicles for transport to temporary or permanent disposal.

(31) In case of pollution located in the open sea (outside the designated area), recovery shall be carried out as much as possible on the high seas and transferred to vessels to minimise the amount of pollution reaching the coastline.

(32) In the case of a recovery area located ashore (pollution has reached the coastline or has been released close to the coastline), the preferred area should be:

- *artificial piers,*
- *those with good access from the mainland, providing easy delivery of the necessary equipment and resources or transfer the allocated waste.*

(33) An appropriate recovery area in case of pollution that has a source in the designated area is an artificial pier near Rt pod Škajom, where good protection of the nearby pebble beach from major pollution is required.

Work Plan

(34) A Work Plan is a document developed based on the information collected and the assessment of the circumstances for each case of pollution in the designated area so that all persons involved in the clean-up operations are aware of the essential decisions and how they will be implemented.

(35) The Work Plan should be based on a checklist (see Annex). It should present the intended procedures, means, and workforce unambiguously to clean up pollution and present the expected workflow.

(36) The Work Plan should contain all the information and data required by the checklist and appropriate to the individual case. Data or information inadequate or not affecting containment, recovery, and disposal shall be excluded from the Work Plan.

(37) The Work Plan shall be drawn up by the responsible person or person authorised by him or her.

(38) All ŽOC members and managers of services involved in the clean-up operation must be aware of the Work Plan's content.

(39) If the need for a substantial amendment to the Work Plan is required, the responsible person should amend the existing one or draw up a new Plan and familiarise the members of the ŽOC and the managers of services involved in the clean-up operation with its contents.

Logbook

(40) A Logbook should record all actions, relevant decisions, or other relevant circumstances that have been accepted or occurred during the Work Plan implementation. Minor amendments to the Plan should also be entered in the Logbook.

(41) As a rule, the following information should be entered in the Logbook:
- *information on the protection measures taken (time, place, person in charge),*
- *information on the equipment and means used (name and characteristics, owner, user, duration),*
- *information on authorised participants and other persons involved (person in charge, start and end time of assignment, purpose),*
- *information on any other events, actions or circumstances that may affect the marine environment or other participants during the recovery and disposal of pollution.*

(42) The Logbook shall be kept by the responsible person or person authorised by him or her.

Securing the field of work

(43) The responsible person must ensure regular photographing with a photographic apparatus of all polluted areas, both before and during recovery and disposal. Photos must have recorded recording time.

(44) If necessary, the responsible person may, where appropriate, apply measures to ensure the area of work, in particular:
- *order sampling of seawater, and if necessary, air quality monitoring,*

- *prohibit access and operation in contaminated areas to all unauthorised persons,*
- *prohibit fishing and other seafood-related activities in a contaminated area,*
- *ban the economic activities,*
- *prohibit navigation in a contaminated area.*

(45) Pollution samples should be taken with clean containers, as early as possible, in the amount of at least 3.0 litres per sample, and at least three places close to the area with the maximum concentration of pollution.

(46) In the event of the implementation of work safety measures, the responsible person should:
- *define the area in which the measures are mandatory,*
- *the time limit for which the measures are declared,*
- *inform the competent persons of the Šibensko-kninska County about the application of the measures.*

(47) Securing the areas (at sea and on the coast) where pollution occurred, the prohibition of fishing and the prohibition of movement and action of unauthorised persons is generally carried out by the competent police department on the responsible person's proposal.

(48) In case of need, the prohibition of navigation by ships, yachts or boats shall be determined by the responsible persons and enforced by the competent port authority service. The prohibition of navigation should be limited only to the critical area and the necessary time, to the extent necessary to ensure the efficient recovery and disposal of pollution.

Workforce, equipment and means

(49) Personnel participating in the recovery and disposal of pollution shall be divided into groups.

(50) Each group shall be assigned an identification code (number), and the group leader shall be appointed.

(51) As a rule, groups should combine from five to 10 persons who carry out the recovery and disposal of pollution. Exceptionally, a group may have more or fewer people, as required (for example, crew members on a vessel or personnel serving a particular machine or equipment).

(52) As a rule, groups perform recovery and disposal operations for no more than eight hours a day.

(53) While carrying out tasks aiming to recover and dispose of the pollution waste, all persons must be provided with:
- *personal protective means, for all persons participating, regardless of the legal basis on which they participate,*

- *a place (logistics centre) on the coast where means, equipment and workforce carrying out the tasks of recovering and disposing of pollution will be shipped or received;*
- *accommodation, food, means of personal hygiene and replacement of protective means.*

(54) The responsible person must ensure the availability of backup groups that may be sent quickly to assist or replace groups recovering and disposing of the pollution waste.

(55) The responsible person may transfer the assignment of tasks to individual groups to the managers of services involved in the clean-up operations (for example, heads of legal entities which have undertaken a contractual obligation for clean-up operations in an area or under certain circumstances).

(56) The inclusion of volunteers, their equipment and resources, in addition to civil protection units, is appropriate where their participation is necessary in order to reduce and eliminate the risk in cases when damage to the environment would be greater if those equipment, resources and workforce were not involved.

Pollution disposal

(57) Immediately after the start of the recovery operations, the responsible person should:

- *ensure the disposal of collected hazardous waste from the coastline in accordance with environmental regulations and those regulating the handling of hazardous waste,*
- *choose a temporary and permanent location for disposal of collected waste, in accordance with local environmental regulations,*
- *provide an appropriate place/way of cleaning vehicles, vessels and other equipment used during pollution cleaning.*

(58) The site chosen for temporary disposal may be in the coastal area, but it must be distant from the coastline as required to ensure that pollution cannot reach the sea again, even in case of severe weather conditions. The site must be protected so that pollution cannot penetrate the soil and, even in the worst case, up to a depth of 0.10 m.

(59) Cleaning of vehicles, vessels and other equipment is generally not carried out in the designated area unless necessary and implementable in an appropriate manner.

(60) Permanent disposal of pollution waste is carried out in accordance with the Contingency Plan for Accidental Marine Pollution in the Šibensko-kninska County.

Live animals

(61) Live animals exposed to pollution, such as birds, may be registered within a period of up to one week of the contamination. In case of the live animals exposed to pollution, it is necessary as soon as possible to:

- *inform the experts responsible for nature protection,*
- *select recovery procedures,*
- *start recording data.*

(62) In the case of birds exposed to pollution, the first specimens should be sent to the competent veterinary station to assess the degree of contamination and consequences and modify or amend the further procedures accordingly.

(63) In the case of exposed birds, particularly large ones, particular attention should be paid to preventing injury.

Pollution caused by an extraordinary natural event

(64) The clean-up operations to be carried out in case of an extraordinary natural event at sea follows, in principle, the same procedure as in the case of oil spills and oil mixtures.

(65) The clean-up operations to be carried out in case of an extraordinary natural event shall be carried out under collaborative scientific institutions' supervision.

(66) The sequence of clean-up operations and areas where the consequences of a natural event should be eliminated shall be determined by the responsible person, depending on the extent and impact of the pollution in particular and in accordance with the recommendations of the collaborative scientific institution.

Reporting

(67) The participants' reporting on the state and course of the recovery and disposal of pollution and essential decisions shall be carried out using a public mobile and fixed public network.

(68) Ship reporting is carried out using VHF channel 16 or 09.

(69) Other forms of communication may also be used depending on the circumstances.

(70) The responsible person or the person authorised by him or her shall inform the public of:

- *the time, location and quantity of the spill*
- *measures taken to prevent, limit and eliminate pollution,*
- *areas where access, exploitation of the sea or any other measure is temporally prohibited for which public information is necessary.*

(71) The report on measures taken to contain, recover and dispose of pollution shall be released to the general public at regular intervals, usually every 6 hours or less if circumstances require so.

End of intervention

(72) The responsible person shall decide to terminate operations under this Plan.

(73) The termination of operations under this Plan may be permanent or temporary.

(74) The decision on the temporary termination of operations shall be taken if:

- *weather or other conditions put at risk persons working to recover and dispose of pollution or are in danger of exceptional damage that cannot be prevented within a reasonable time;*
- *it is not clear how pollution should be addressed due to a lack of knowledge of the essential facts.*

(75) The decision to proceed under this Plan shall be taken when the circumstances causing the provisional termination are solved.

(76) The decision on the permanent termination of operations under this Plan shall be taken:

- *when marine pollution has been eliminated, and the collected waste is disposed of,*
- *when the threat that started action ceased;*
- *if continued cleaning by available means and equipment would be more harmful to the marine environment than natural recovery.*

(77) Marine pollution is considered to be eliminated when the water is of satisfactory quality, and it is visually verified that there is no contamination with tar residues, glass, plastics, rubber or other waste[30] (there are no visible residues of contamination on the surface of the water).

(78) The decision on the temporary or permanent termination or interruption made by the responsible person should be submitted as soon as possible to all persons participating in the recovering and disposing operations.

(79) Upon a decision to terminate operations under this Plan, the equipment used must be cleaned, inspected and brought to its initial state. Equipment that cannot be restored to its initial state shall be inspected, recorded and reported to the responsible person and the equipment owner.

[30] See Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC.

Monitoring

(80) Upon termination of operations, the responsible person must establish a procedure for monitoring the designated area.

(81) The procedure aims to establish, in a systemic manner, the temporal and spatial scope and content of the monitoring, in particular in respect of:

- *monitoring the residual pollution,*
- *sea quality measurements in the designated area,*
- *the criteria for reactivation of the Plan,*
- *obligation to report on environmental changes,*
- *other circumstance-appropriate measures.*

(82) As a rule, the monitoring process should take six months from the day of contamination. In some circumstances, the duration may be longer or shorter, but not less than three months.

(83) A full or adapted monitoring program should follow the monitoring procedure set out in the IPIECA - Oil spill monitoring and sampling instructions.[31]

[31] See https://www.ipieca.org/resources/good-practice/oil-spill-monitoring-and-sampling/.

6. TRAINING AND EXERCISES

(1) Training programmes and regular exercises shall ensure the effectiveness of the application of this Plan.

Training programs

(2) Training programmes aim to improve a particular activity, get personnel acquainted with the properties of technical means, or acquire certain skills necessary for carrying out certain tasks within this Plan's scope.

(3) An appropriate training programme for effective implementation of this Plan shall be considered to be programmes that are at least equivalent to the programmes set out by the International Maritime Organisation (IMO).[32]

(4) In order to ensure the effective implementation of this Plan, the Basic Training Programme (IMO Tier I) should attend at least:
- *collaborative service managers (e.g. Red Cross, HGSS, and others),*
- *group leaders working on the collection and disposal of pollution,*
- *crew members on ships participating in the recovery collection and disposal of pollution,*
- *employees of companies authorised to recover and dispose of minor pollutions under the contractual relationship independently,*
- *managers of legal entities in charge of the temporary or permanent disposal of pollution or waste.*

(5) In order to ensure the effective implementation of this Plan, the Basic Training Programme (IMO Tier II) should attend at least:
- *all members of the ŽOC,*
- *employees of the Harbour Master's Office who assume or may assume the supervisory role,*
- *public service managers (police, firefighters, paramedics, and others),*
- *all other persons who may assume decision-making duties during the recovery and disposal of pollution.*

[32] See *IMO OPRC Model Curses and IMO HNS Model Courses* (https://www.imo.org/en/OurWork/Environment/Pages/IMO-OPRC-Model-Courses.aspx).

Exercise

(6) Exercises are organised practical work programmes carried out to rehearse activities in case of a pre-selected template (scenario), which take place on the coastline or at sea.

(7) The objectives of the exercises are:
- *to improve the cooperation and coordination of staff, in particular authorised participants,*
- *to verify the command structure,*
- *to verify and improve the communication system, notably between responsible persons and authorised participants,*
- *to check staff preparedness,*
- *to check the availability, appropriateness and preparedness of equipment and means,*
- *to gain experience in handling equipment, products and other means.*

(8) Exercises can be:
- *table-top exercises,*
- *active exercises.*

(9) Each table-top exercise aims to determine the responsible person and associates' organisational readiness to act in case of pollution.

(10) The table-top exercise shall be based on a dynamic template developed by a person who has no specific responsibilities in case of pollution. The template must contain at least:
- *detailed characteristics of the cause of pollution (e.g. type of ship, type and characteristics of pollution, description of the current accident and its development, if appropriate),*
- *location and rate of pollution release,*
- *weather conditions at the time of pollution,*
- *available communication systems,*
- *availability of equipment and means.*

(11) Each active exercise shall aim to establish the readiness of the workforce and equipment to act in case of pollution and shall consist of at least:
- *preparations of the marine pollution template (scenario), including the cause of contamination, type of released substance, location and rate of release,*
- *verification of the communication system,*
- *verification of availability and delivery of equipment and resources,*
- *real-time actions including at least two groups at different sites, carrying out recovery operations by implementing selected prevention, recovery and disposal measures appropriate to the chosen pollution template within a given time.*

(12) After the exercise, the responsible person is obliged to:
- *assess the overall readiness to act,*
- *assess the performance of individual procedures and, in particular, identify procedures that did not meet expectations.*

(13) After active exercises, the responsible person is also obliged to assess (in writing) individual groups' readiness to implement the work.

(14) At least once a year, exercises shall be carried out without prior announcement.

Conclusion

The area of the St. Anthony's Canal is an area of exceptional beauty and preservation. But it is also an area where significant traffic of ships, boats, and yachts occurs. As a result, it is exposed to possible serious pollution, primarily caused by maritime accidents in the Canal itself and in navigation areas directly adjacent to the entrances to the Canal.

Significant quantities of ships' fuel, particularly on larger passenger and cargo ships, pose the greatest threat, sufficient to cause serious damage to the environment, the wildlife of the sea and land.

For this reason, it is necessary to ensure a coordinated and effective action in case of pollution, aiming to prevent pollution widespread, and to ensure effective collection and disposal of polluted material, if it occurs.

Maritime accidents that can cause significant pollution of the marine environment are primarily stranding, collision and allision, fire and explosion or sinking of a vessel or yacht in the area of the St. Anthony's Canal.

Pollution can be caused by various substances, particularly light and heavy marine fuels, liquid cargoes, hazardous and harmful solids and waste, both from ships and land.

The drafted contingency Plan in case of pollution in the area of the St. Anthony's Canal sets out primarily the principles of action and the relationship to plans and documents of a higher order of importance. In particular, the Plan identified the characteristics of maritime accidents and pollutants and analysed possible measures and procedures that achieve an optimal level of environmental protection while limiting efforts and costs to a necessary, reasonably acceptable level. In addition, for the circumstances identified as those with the highest impact, an assessment of the risk probabilities under the current conditions has been made.

In particular, parts of the coastline, particularly at risk of pollution, are identified, including prevention, collection and disposal measures. For each of the measures envisaged, the conditions and adequacy of the application, precautionary measures and restrictions are laid down. Also, measures to be avoided have been identified. Given the value of the area under consideration, priority is given to measures that minimally impact the current state of the environment, particularly natural recovery and mechanical collection. Also, other factors were taken into account (for example, the availability of means, equipment, and manpower).

The Plan also sets out general procedures to be followed in case of pollution, in particular information gathering, assessing the circumstances and choice of protection measures, prevention of further pollution spread, collection of polluted material from the coast, sea surface or seafloor, and measures to remove pollution material from the area and dispose of it.

In addition, the Plan elaborated the necessary documentation (checklists, action logbook and work register), reporting procedures and monitoring measures.

Finally, the Plan also sets out other measures for effective action in the case of pollution in the area of the St. Anthony's Canal, particularly the provision regarding work areas, workforce organisations, equipment and means, methods of disposing of pollution waste and living creatures, exercises and training programmes for persons in charge of implementing the Plan.

7. Annexes

7.1. Areas of increased risk of collision and grounding

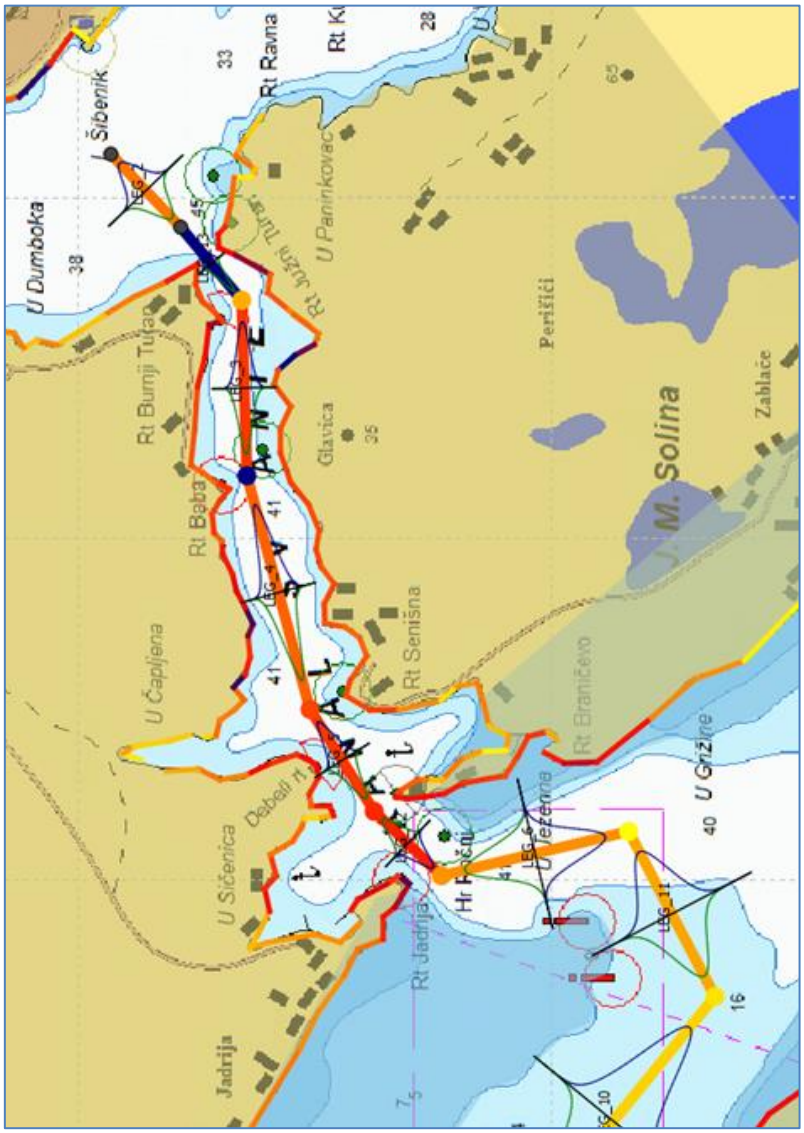


Figure 1 *Areas of increased collision hazard (areas with higher probability are indicated by darker navigational colour) and grounding (a darker colour of the coastline indicates areas with higher probability)*[33]

[33] Prometno - plovidbena studija za plovna područja Primorsko-goranske, Ličko-senjske, Zadarske i Šibensko-kninske županije, Pomorski fakultet Sveučilišta u Rijeci, 2015.

7.2. Coastline classification

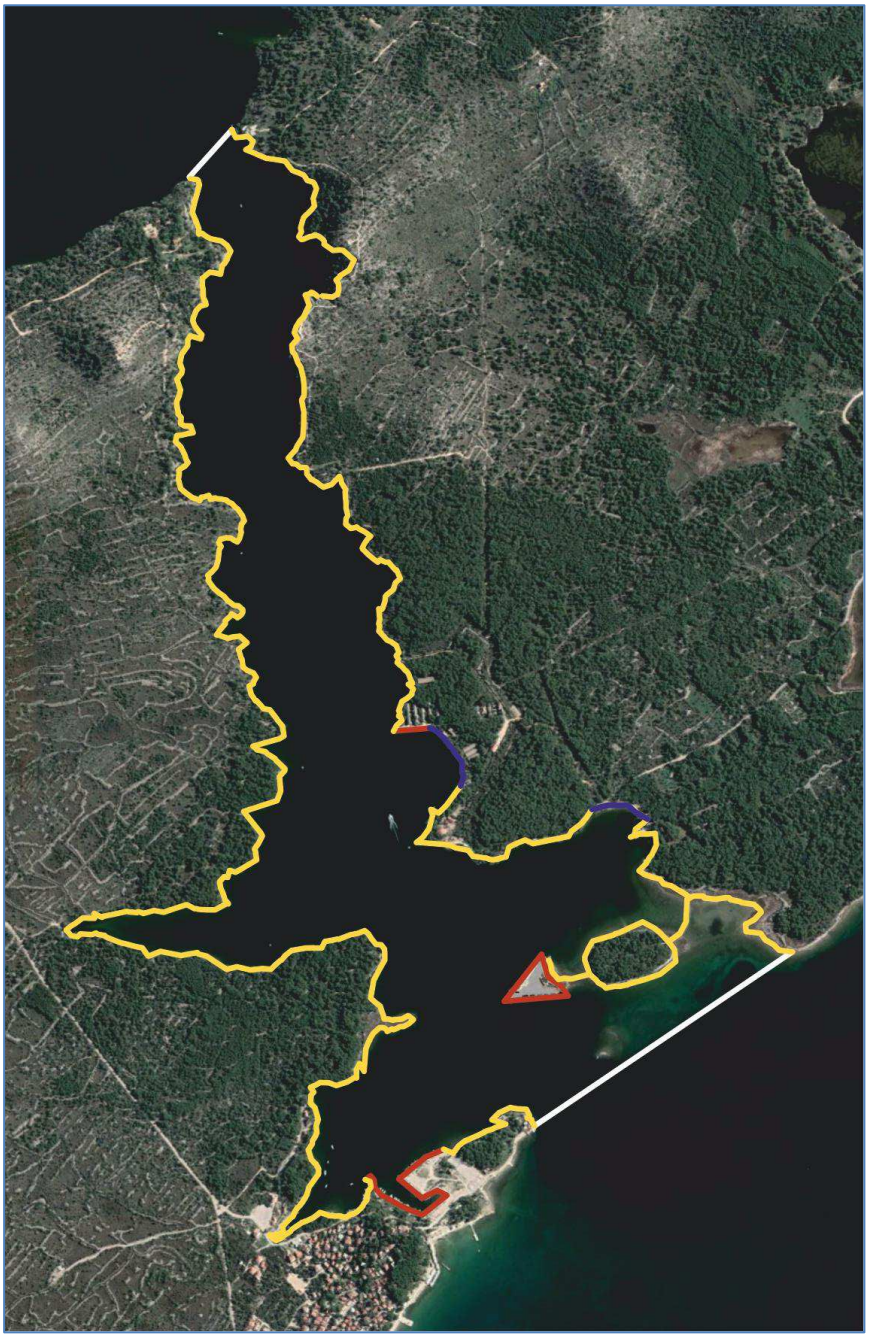


Figure 2. *Classification of the designated area coastline yellow - protected rocky coast (ESI 8A) red – artificial coastline (ESI 8B) blue – pebble-sand beach (ESI 5)*

7.3. Checklist

Ships/yacht name		Position	φ=
Flag			λ=
IMO number		Type	
Number of crew members		Length	m
Port of departure		Breadth	m
Port of destination		GT	

The first notification received at .....

Notification sent by .....

Notification received by .....

Primary communication mode with the ship .....

The person responsible for constant connection to the ship .....

A backup method of maintaining a connection to the ship .....

Designated Person Ashore (DPA) .....

Insurer name and address .....

P&I representative name and address.....

Is it known:

- The current state of the winds and waves at the site of the accident? .....[ ]
- Weather forecast and prevailing wind directions for the next 48 hours? .....[ ]
- Direction and speed of sea currents? .....[ ]
- Temperature, humidity and density of the sea? .....[ ]
- Visibility? .....[ ]

Is it known:

- The type and origin of a pollutant? .....[ ]
- Quantity of spilt and residual substances? .....[ ]
- Chemical and physical properties of the spilt substance? .....[ ]
- The spilt substance's behaviour in the current circumstances (sea temperature, waves, ocean currents, and others)? .....[ ]
- Toxicity of the spilt substance:
  - in the sea (for marine organisms) .....[ ]
  - on land (for humans and terrestrial organisms) .....[ ]

Has the natural recovery assessment been carried out, including the impact of oceanological and meteorological conditions (Weathering)? .....[ ]

Pollution monitoring ensured, especially aerial monitoring by a trained watcher? .....[ ]

Time for pollution to reach the shore is estimated (if appropriate)? .....[ ]

Is there a need to report to the HQ and request coordination of actions by the MRCC? .....[ ]

The length of the contaminated coastline is estimated:

- for the worst case? .....[ ]
- for the most favourable case? .....[ ]
- for the given circumstances? .....[ ]

The segmentation of the pollution area (contaminated coastline) has been carried out? .....[ ]

The order of protection (cleaning) of individual segments is selected? .....[ ]

For each segment of the contaminated coastline:

- The initial measures are selected? .....[ ]
- Are complementary measures selected? .....[ ]
- Method and place of disposal of waste are determined? .....[ ]

Has the following been established for each segment:

- Availability of means for recovery and disposal? ..... [ ]
- The time and method of delivery of means? ..... [ ]
- The type and quantity of expected waste and the recovery site? ..... [ ]
- Possibility of obtaining supplementary quantities of cleaning products and equipment? ..... [ ]

A system of monitoring endangered areas has been established? ..... [ ]

A decision has been taken to call on people to participate in pollution clean-up (e.g. Civil Protection, firefighters, volunteers), in addition to those who are obliged to do so? ..... [ ]

Has the following been decided:

- The number of people to call? ..... [ ]
- The number of groups (from 5 to 10 people) to be formed immediately? ..... [ ]
- The number of groups (from 5 to 10 people) to be formed later (as needed)? ..... [ ]
- Tasks (place and works) for each group? ..... [ ]
- Standby time (gatherings)? ..... [ ]
- Mode of transport to the site of contamination? ..... [ ]
- Duration of operation and replacement time? ..... [ ]
- Food, water, work clothes and equipment supply? ..... [ ]
- Means ensuring personal hygiene? ..... [ ]
- Obtaining and use of heavy vehicles and machinery along the coast? ..... [ ]
- How to deliver fuel and tools? ..... [ ]
- Who will provide health care? ..... [ ]

Support (workforce and equipment) from neighbouring counties and expert advice has been considered? .....[ ]

The place and equipment for cleaning vessels and their equipment, road vehicles, machinery and other equipment been has established? .....[ ]

Had a place been established where food, water and other supplies would be delivered for people employed in clean-up operations? .....[ ]

Is a person responsible for public relations appointed and known? .....[ ]

Is a person responsible for keeping notes on the course of action regarding assistance and clean-up operation appointed? .....[ ]

Has the health care service been notified? .....[ ]

Have the relevant ministries been notified? .....[ ]

7.4. Logbook

LOGBOOK

Date: _____

Time and place	Event

Responsible person:

_____

Geographic informatics system

Within the Project *INTERREG PEPSEA Italy-Croatia* one of the activities was development of the GIS database. The GIS database included vector and raster layers. Raster layers were created in different formats in which the GeoTIFF format predominate. The spatial resolution of the raster data was determined by the type of sensor used in the data collection process. Vector data is provided in shapefile (.shp) and geodatabase (FileGDB) format and was displayed by line, point and polygon.

7.5. PROPOSAL FOR EQUIPMENT PROCUREMENT

a) Equipment for detecting and limiting pollution spreading

In closed seas, such as the Adriatic, risk assessments and the development of early pollution detection systems are key to preserving the environment. The rapid development of technology has enabled the precise detection of various threats and contaminants, e.g. oil or oil spills at sea. In addition to detecting pollution and discovering its source, data on the volume, thickness and deformation of oil spills, currents, waves, weather conditions (especially wind), number of ships, and determining locations for protective floating dams are very important for remediation.

Today's systems offer increased opportunities for early detection as well as the transfer of data needed for real-time response, allowing teams to respond and repair damage in a timely manner. The research group of the SeaSky consortium, based on the main objectives of the PEPSEA project and detailed analyses, proposes the following systems.

1. **Sensor for detection oil on the water surface**

The sensor works on the principle of UV fluorescence. It is installed above the water surface and has significant advantages (easy installation, minimal maintenance) compared to sensors that are immersed in water. The device allows real-time detection of a layer of oil or oil thicker than 1 micron.

Minimum technical characteristics of the sensor:

- Sensitivity: a layer of oil or oil thicker than 1 micron;
- Temperature range: -30°C do + 60°C;
- Max consuption 5 W;
- Maintenance period: 5 years (every 5 years the device must be sent to the manufacturer for recalibration).

The suggested locations for this system are:
1. Atlagića bridge in city of Knin for monitoring the inflow of old oil from Knin wetlands (Figure 1)
2. Krka bridge for monitoring inflows from the town of Skradin and ACI marina (Figure 2)

The appearance of the hydrocarbon detector on the surface is shown in Figure 3.

Figure 1 *Atlagića bridge, Knin*

Figure 2. *Krka bridge, Skradin*

Figure 3. *Examples of oil detection sensor installation*

2. Non-contact water level meter

Radar device (Figure 4) that is mounted vertically above the watercourse (sea, river, lake) and measures the distance from the instrument to the water surface. During the installation, the height of the instrument is geodetically determined, and according to it, the measured distance is converted into absolute height coordinates. The advantages of this technology are very easy installation (no need to enter the water during installation), and minimal maintenance since the instrument is not in contact with water.

Thanks to advanced algorithms within the instrument itself, the waves do not interfere. A special version of the instrument that reports 10 measurements per second is suitable for installations at sea, and this variant, in addition to the water level (water level), also calculates the period and amplitude of the waves.

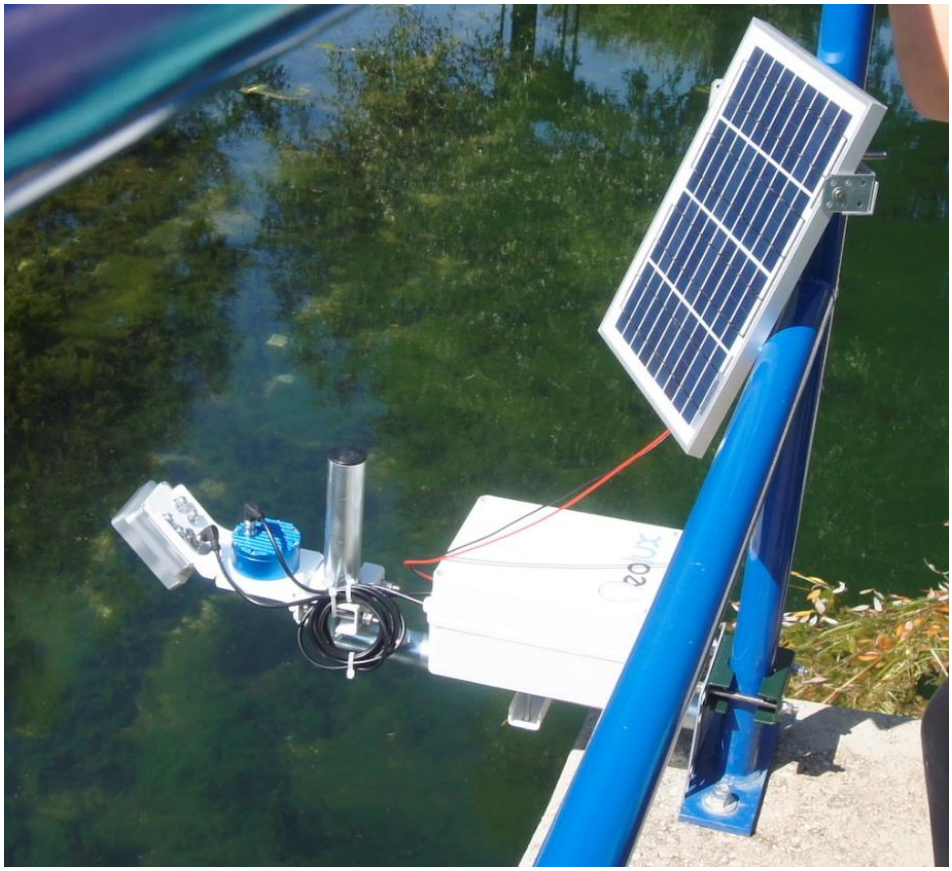


Figure 4. *Non-contact water level meter*

Minimum technical characteristics:

- Technology: FMCW radar in the W-band of the spectrum (77-81 GHz);
- Measuring range: 15 meters (there is also a version up to 35 meters);
- Radar beam width, less than 12 ° on both axes;
- Internal resolution 0.5 mm;
- Accuracy +/- 3 mm;
- Housing protection IP68;
- Consumption: typically, 1.8W, max 2.2W;
- Temperature range: -40 °C to +85 °C;

The suggested locations for this system are:

1. 1. Atlagića bridge in city of Knin (Figure 1)
2. Lighthouse in front of Minerska for monitoring tides and wave height (Figure 5)

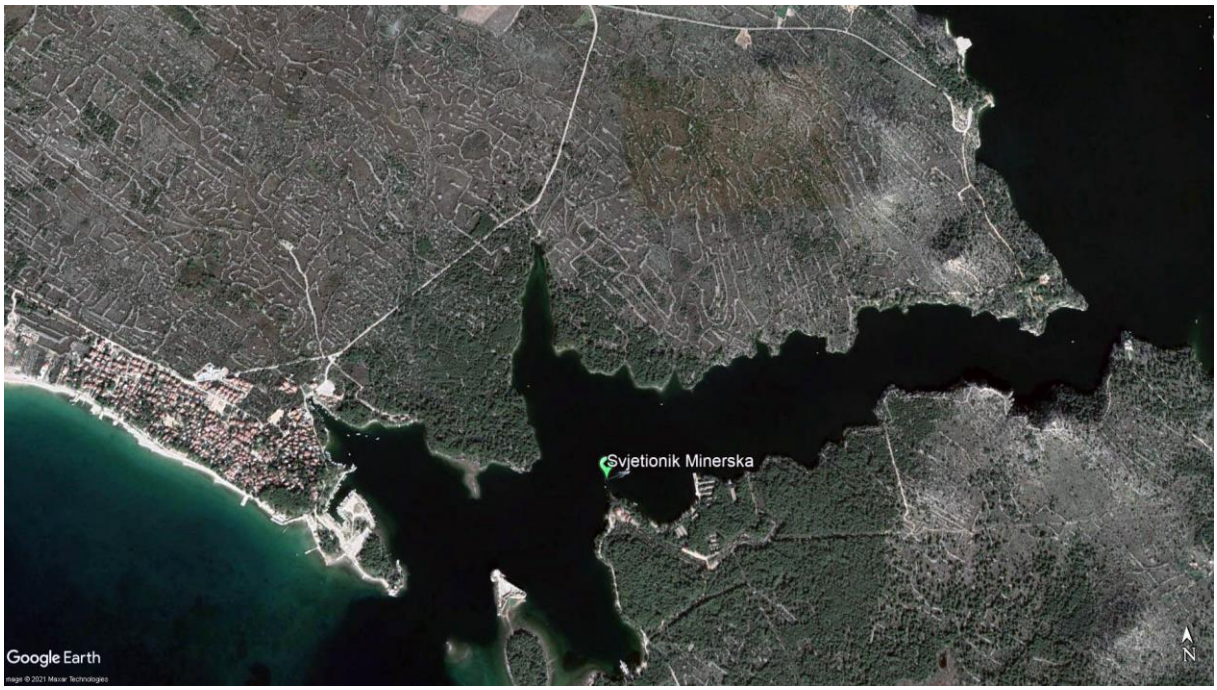


Figure 5. *Lighthouse in front of Minerska*

3. Contactless surface water speed meter

Non-contact surface water velocity meter A Doppler radar device that measures the surface velocity of water flow. It is an extremely sensitive device that can detect a surface speed of as little as 2 cm / s, with a surface ripple of 1 mm.

With all the advantages of contactless technology, the device also enables the calculation of flow on rivers or canals much more precisely than the estimation of flow by the usual method using Q-h curves. Namely, often the flow (Q) is implicitly calculated from the water level (h), based on calibration flow measurements for certain water levels. However, the effect of hysteresis is often observed on rivers or canals, where at the same water level the flow varies depending on whether the water level is rising or falling. In addition, upstream of large tributaries, effects are observed where the tributary downstream of the measuring location "pushes" upstream water when the tributary has a very large rise in water level. In all these cases, the flow calculation is much more accurate based on two value measurements: water level and surface flow velocity.

Minimum technical characteristics:
• Technology: K-band Doppler radar (24 GHz);
• Measuring range: up to 20 m above the water surface;
• Measuring range from 0.2 m/s to 15 m/s;
• Measurement resolution 1 mm/s;
• Accuracy 1%;
• Power consumption 0.95 W;
• Housing protection IP68;
• Temperature range: -40 °C to +85 °C.
The suggested locations:

- Atlagića bridge in city of Knin (Figure 1)
- Lighthouse in front of Minerska bay (Figure 5)

4. GSM Smart Observer Datalogger with GSM communication

Datalogger for use in hydro-meteorological measuring stations. Special emphasis is placed on minimizing electricity consumption. energy, and the maximum degree of integration of various components (in the datalogger are integrated and the battery charger and GPRS modem).

Minimum technical characteristics:

- Support for RS-232, Modbus-RTU, SDI-12 and CAN digital communication interfaces by instruments;
- Support for analog voltage and analog 4-20mA current interface according to instruments;
- Instrument power management via 2 channels;
- Wireless communication: 2G / 3G / 4G / NB-IoT;
- Integrated MPPT battery charger, supports various types of batteries (lead, gel-lead, Li +, LiFePO4, NiMH, NiCd);
- Power consumption in operation <1.2 W, in standby <0.1 W;
- Temperature range: -40 ° C to +85 ° C.

The suggested locations:

- Atlagića Bridge in the city of Knin (Figure 1).
- Krka Bridga (Figure 2).
- Lighthouse in front Minerska bay (Figure 5).

5. HydroCam camera

A simple camera that periodically (eg once an hour) photographs the measurement location and sends the image to the system. Used for diagnostics; e.g. using a camera it can be seen when debris accumulates at the measuring location and spoils the measurement.

The suggested locations:

- Atlagića Bridge in the city of Knin (Figure 1).
- Krka Bridga (Figure 2).
- Lighthouse in front Minerska bay (Figure 5).

6. Video system for monitoring vessel traffic

The ship counting system should consist of two main components: a camera, and a PC device with software to receive and process images from the camera, and a server station with the possibility of archiving the last 30 days of traffic should be connected.

The camera system would consist of one or more stationary cameras that would be used to continuously record traffic and analyse it. This could be achieved with a single camera on the hill Kamenar although then the canal would not be completely covered, or a system of cameras could be used in suitable locations along the Sv. Ante. It is important for this system that, in addition to the cameras, thermal channels are monitored to monitor the channels during the night.

In addition, one camera would be set up, which is important for a controllable PTZ (pan tilt zoom) camera, with an optical zoom of at least 30x. so that the operator can check the details. Due to the high energy consumption during continuous operation of the camera, it is necessary to provide 220V power supply.

Minimum technical characteristics:
- 4 megapixel CMOS sensor;
- Wide dynamic range (WDR) 120 dB;
- Signal-noise ratio (SNR) 55 dB;
- 30x optical zoom (4.5mm - 135.0mm);
- Pan-tilt-zoom (PTZ) controllable camera;
- Day / night mode.

Vessel counting module

In addition to the camera, it would be useful to use a specialized computer with software that will receive the image from the camera via a local Ethernet connection. Software, specially developed for this purpose, will be installed on this computer, which will detect and count the vessels in the image from the camera using convolutional neural networks. The module will process images at a speed of at least 1 image per second, and will store the following data in the local database for each detected vessel:

- Vessel detection time;
- Direction of vessel movement;
- Estimation of vessel length;
- Estimation of vessel height.

Ground Surveillance Radar

Video surveillance would be most practical to pair with surveillance radar, as this would achieve the best monitoring of passing vessels.

Minimum technical characteristics:

- Detects vessel up to 500 meters
- Simultaneous tracking of up 25 objects
- Distance, relative angle and relative speed reported for each detected object
- Range precision ± 1m
- Speed precision ± 1km/h
- Angle precision ± 1°
- Easy pole, wall or enclosure mounting
- Supports wide variety of communication interfaces
- (Ethernet, RS232, RS485, CAN)
- PoE or 9VDC to 27VDC power supply
- IP66-rated enclosure (for outdoor applications and harsh environments)
- Operation in license free K-band
- Configurable areas of interest and exclusion areas

General:

<u>Radar Type</u>

K-band 24.05 to 24.245 GHz
FMCW modulation, 20 dBm EIRP
Beam Angle
90° Azimuth, 22° Elevation
Detection Distance
150 m humans (0,75 m2 RCS)
500 m vehicles (10 m2 RCS)
Speed Range
0,5 km/h to 336 km/h
Tracker
5 Hz refresh rate, up to 32 targets

The suggested locations

- Jadrija lighthouse (Figure 6)

Figure 6. *Jadrija lighthouse*

7. Unmanned Aerial Vehicles – UAV

Unmanned Aerial Vehicles (UAVs) are, by definition, all unmanned aerial vehicles that can be piloted (Bendea et al. 2007). Various UAV classification schemes have been proposed to help differentiate existing systems based on their operational characteristics and their capabilities (Dalamagkidis, 2015). The main division of unmanned aerial vehicles depends on their working altitude and is divided into two basic groups:

1. Aircraft operating at an altitude of 3,000 m and above are able to collect data for a longer period of time with the minimum energy required to maintain the flight.

2. Aircraft with a maximum relative flight altitude of up to 300 m (micro and mini category of unmanned aerial vehicles) (Kolarek, 2010)

With regard to categorization, legal regulations, user experience and aircraft prices on the market, the research group proposes the purchase of micro unmanned aerial vehicles (up to 5 kg) with the possibility of implementing various sensors (RGB cameras, multispectral, thermal cameras, etc.).

The primary purpose of unmanned aerial vehicles should be to monitor and map the damage (fire, flood, oil pollution) in order to document and create a database. Given that the process of data collection and model generation is demanding and requires extensive expertise, we suggest considering hiring an organization or company that will offer model recording and generation services depending on the purpose of the task.

Figure 7. *An example of a drone with an integrated RGB and thermal camera*

8. AIS Class A ship station

Usually installed on large ships BT <300, but also suitable for small ships of higher speed due to its response speed (3s vs 30 s for B class) and priority display on transponders and ECDIS system in areas of heavy traffic.

Manufacturers: JRC, Furuno, Samyung ENC, ComNAV.

9. ECDIS ship kit - 24 "monitor

IMO approved navigation system, designed for use on SOLAS ships. Easy to use with integrated 24-inch flat screen (Figure 8) and standard Windows PC interface with integrated map management and ordering, universal radar coverage.

Manufacturers: Simrad, Sperry Marine, Raytheon Anschütz GmbH.

Figure 8. *24“ monitor*

b) Equipment for cleaning and disposal

10. Skimmers

Among the many alternatives for removing oil stains, the primary method is their mechanical removal, which is usually achieved by using dams for concentrating oil stains and various tools and devices of the common name skimmer (stripper).

We recommend purchasing a Disk skimmer (Figure 9) with the possibility of using discs and brushes and an external power supply and a floating transfer pump with a capacity of up to 20 m^3/hour.

Example like: Vikoma Mosquito Midi 2. Manufacturers: Singreat Industry Technology, Vikoma, Haomei.

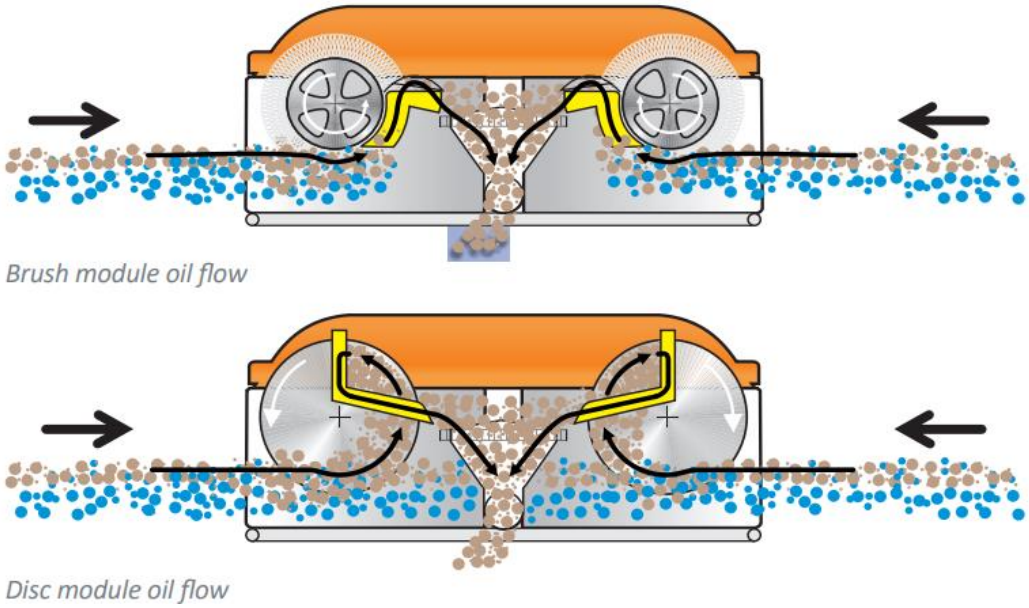


Figure 9. *Disk skimmer*

11. Floating protective dam

In emergencies, such as oil or oil spills, an urgent and timely response that helps prevent environmental disasters is extremely important. One of the important products in such situations are protective floating dams. Dams are water barriers whose main purpose is to collect oil and oil on the surface of the water and prevent it from spreading. There are different types of floating protective dams: according to the materials used in production, purpose and filling. Based on the materials from which they are made, protective dams can be made of PVC, polyurethane or rubberized cloth CSM (Hypalon-Neoprene). Based on the purpose and place of use, dams for the open sea, bay and river are used. According to the filling, the dams can be inflatable or filled with polyethylene and styrofoam.

Dams are commonly used to fence off pollution at sea and to direct the movement of pollution from sensitive resources or towards the place of collection. Their main characteristics are the ability to retain or direct pollution

We recommend the purchase of an inflatable floating protective dam (Fig. 10) made of polyurethane with a steel front at the top for pulling and a ballast chain. Each set is equipped with two valves, couplings and a storage bag. Set length 10 - 15 m. Height of dam overhangs up to 350 mm and curtains up to 500 mm. Required quantity: 500 to 1,000 meters.
Dam inflator pump pcs. 1

Figure 10. *Inflatable floating protective dam*

12. Absorbents

Absorbent material is most used to absorb residual contaminants or minor contaminants. The material can be in various forms such as absorbent dams (Figure 11), rags (Figure 12), rolls of absorbent materials or in bulk. When using absorbent materials, care should be taken in their wear so as not to create a logistical problem of disposing of used and oily materials.

Recommendation for procurement:

absorbing dams 12.5 x 400 cm pieces of 100 or more

absorbent cloths 40 x 50 cm pieces 400 or more

absorbent rags in rolls of 1 x 50 m pieces of 2 or more

Figure 11. *Absorbent dams*

Figure 12. *Absorbent rags*

c) Pollution remediation and quality monitoring equipment

13. Protective clothing

To act in the event of marine pollution, special attention should be paid to working in a safe manner on staff involved in the removal of oil pollution to provide sufficient disposable personal protective kits.

- We suggest purchasing at least 50 sets of disposable protective clothing, and possibly more.
- In addition, we suggest buying at least 50 storage bags with laces, and possibly more.

14. Miniwash

As the coast in the channel Sv. Ante is mostly rocky,s the most suitable means of cleaning from pollutants are high-pressure washer. There are washers on the market from various manufacturers, and washers with a power of 3 kW and more with the possibility of heating water are recommended. In order to supply the washer with electricity, one power generator should be paired with each washer. There are two-stroke and four-stroke engines on the market, which can use gasoline or diesel fuel. It is necessary that the unit has a higher power than a high-pressure washer.

- We suggest purchasing 3 to 5 or more high pressure washers.
- We suggest the purchase 3 to 5 or more generators for the production of electricity.

15. Dispersants

Dispersants are chemical agents for spraying and / or removing oil contaminants from the sea surface and have a valid authorization for use. In accordance with the Plan, the decision on their use is made by the Headquarters for the implementation of the Intervention Plan and the County Operations Center with the consent of the Headquarters. In the event that the Republic of Croatia submits a request for assistance of staff, technical / material means and equipment within the Subregional, the competent central state administration bodies are obliged, among other things, to allow temporary entry of equipment and products consumables including dispersants.

- The procedure for removing oil and / or oil mixture is performed by order of the Commander of the Headquarters or the Commander of ŽOC in the following order:

- removal of pollution sources,
- preventing the spread of oil and / or oil mixture,
- collection of spilled oil and / or oil mixture,
- chemical treatment (use of dispersants) of the poured oil and / or oil mixture as required,
- removal of sea pollution from coast,
- disposal of collected hazardous waste.

It is evident from the above that the use of a dispersant. and in accordance with the dispersant use scheme, provided only if the oil and / or oil mixture contamination cannot be removed mechanically.

According to the Plan, the use of dispersants is not allowed in protected areas of nature, and it is not recommended to procure them for operation in the Sv. Ante.

Recommendation for raising awareness

1. Local population connected with St. Chanel will be informed about results of the risk assessment through presentations and workshops done by external experts. A specific attention will be given to the involvement of local population and tourists in specific innovative awareness activities, to gain practical experience in sea water quality monitoring and water pollution prevention through sustainable management.

2. Next, local stakeholders will become familiar with plans of interventions for cases of sudden sea pollution. Moreover, they will have opportunity to improve plans through regular civil defense practices and workshops done by experts.

3. The system of environment remediation will be set through LivingLab using biomimicry. LivingLab are mainly virtual labs that can be established in any type of environmental settings. At LivingLabs participants from different disciplines and backgrounds get immersed, in this case, in channel setting, exposed to nature and learning about environmental issues and related sustainable solutions. Biomimicry is an emerging discipline that utilizes biological models to evolve sustainable solutions to environmental, technological, engineering and design challenges. It is a tool for innovation that has a unique capacity to expedite holistic processes necessary for a successful sustainable project addressing local issues.

D. PROJECT PARTNER 6 – PO DELTA VENETO REGIONAL PARK

List of abbreviations and terms

EPS: Enclosed Parts of the Sea

ESI: Environmental Sensitivity index

Executive Summary

The Pilot areas of Po Veneto Delta Park fall into rank 10, specifically in the category “10A Salt and brackish water marshes” equal to the maximum sensitivity of the ESI scale. The maximum sensitivity of these type of EPS depends on the high biodiversity and high value of use, as well as the difficulty of cleaning and the potential for long-term impacts on many valuable organisms.

The two Pilot areas interest a population of about 70,000 inhabitants connected to economic activities of primary importance directly connected to the EPS. As a matter of fact the geographic Po river delta leads clam production with about 80% of the Italian production.

Partial monitoring is implemented, the available data shows fluctuation out of range of some parameters typical of this brackish water EPS, therefore specific equipment must be acquired.

INTRODUCTION

This contingency plan is drawn up according to the design guidelines produced during WP 3.1, "Contingency Plan for Marine Pollution (Oil spill) GUIDELINES Release 0.2 December 2019 Polytechnic University of Bari - DICATECH".

The general structure of the plan follows the aforementioned guidelines of WP3.1 but with the appropriate declinations to the territorial specificity of the Po delta.

For this purpose, two in-depth analyzes were carried out relating to the North and South areas, with a lagoon for each area. For design purposes, the delta has been divided into two areas as in Figure 1. The two areas are connected with the existing northern and southern districts of the Civil Protection.

The physical, hydro-morphological and environmental characteristics are detailed in the following paragraphs.

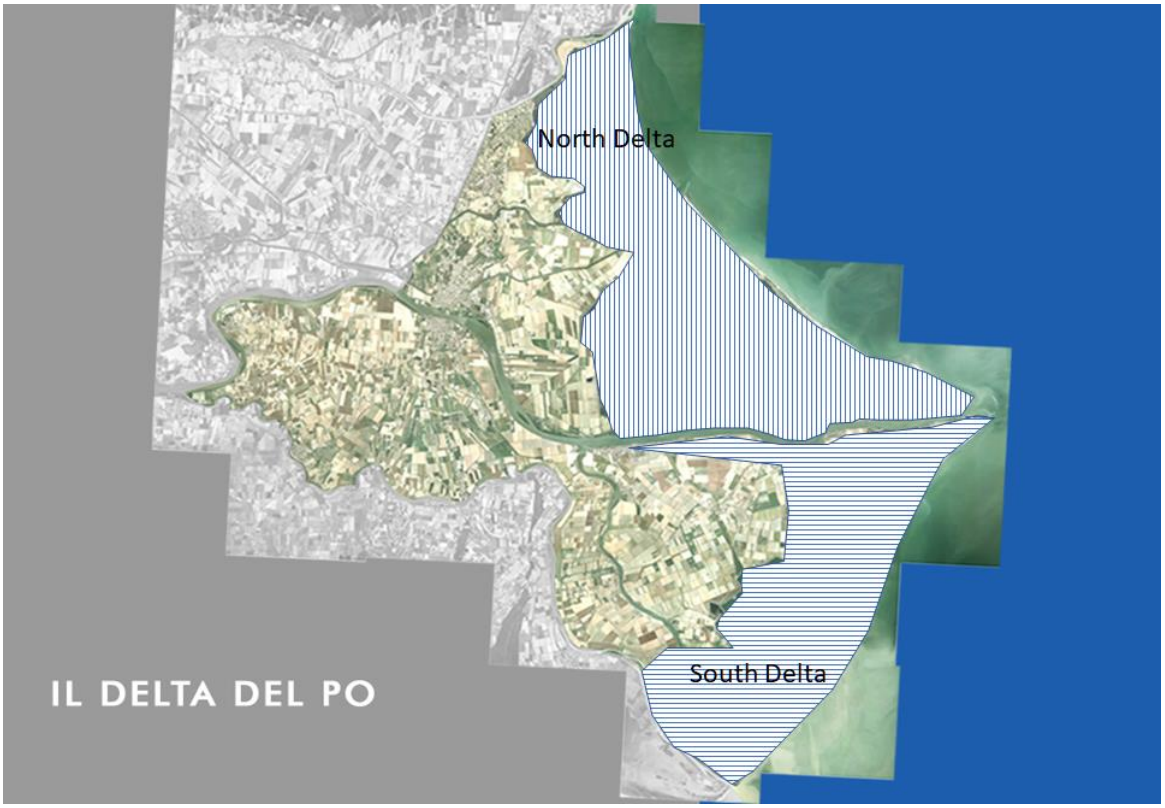


Figure 3: *PEPSEA project areas of interest.*

RISK ASSESSMENT

Preliminary analysis

The Regional Park of Po delta Veneto insists over a surface of about 12,500 ha and over 9 Municipalities: Adria; Ariano nel Polesine; Corbola; Loreo; Papozze; Porto Tolle; Porto Viro; Rosolina; Taglio di Po, Figure 4.

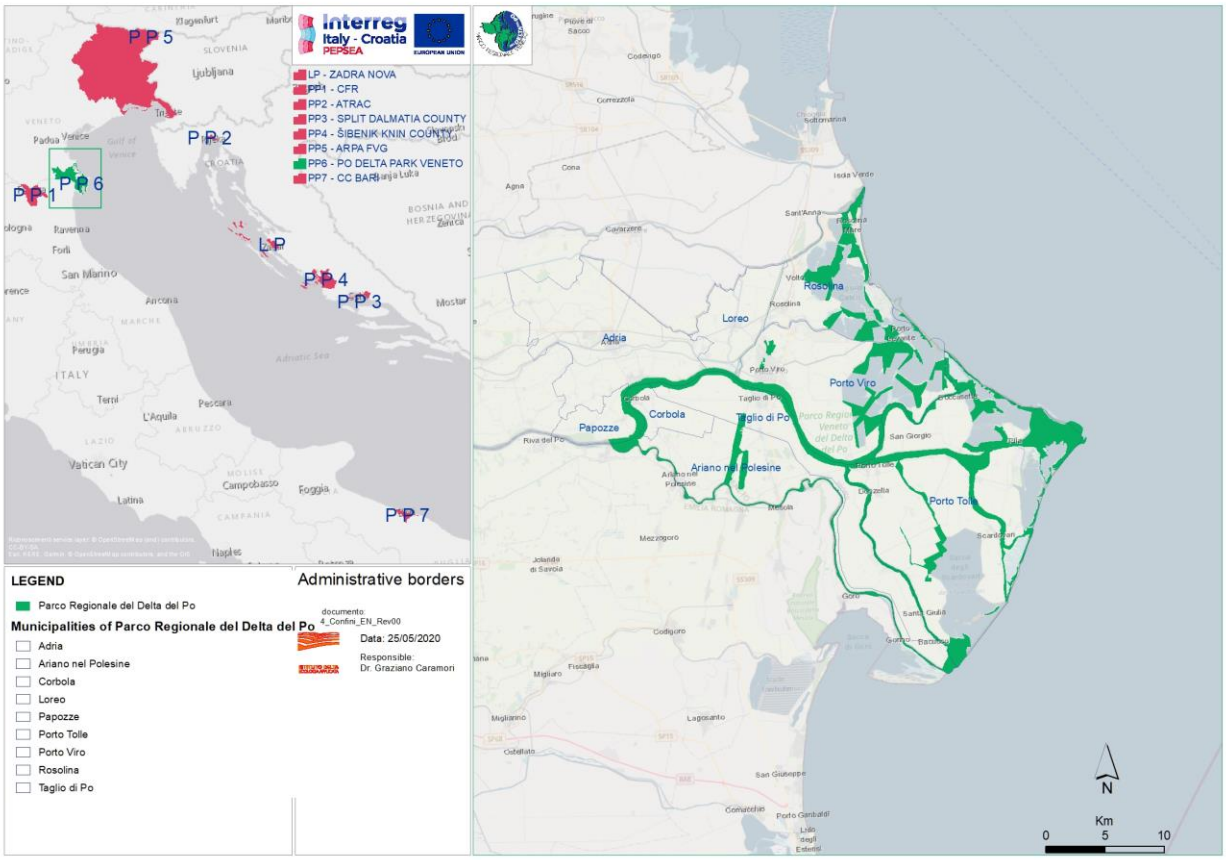


Figure 4: P*roject's area and partner Parco Regionale Veneto Delta del Po.*

From the hydro-morphological point of view, the Po river delta falls within three main hydrographic basins, named Adige, Canal Bianco and Po, see Figure 5.

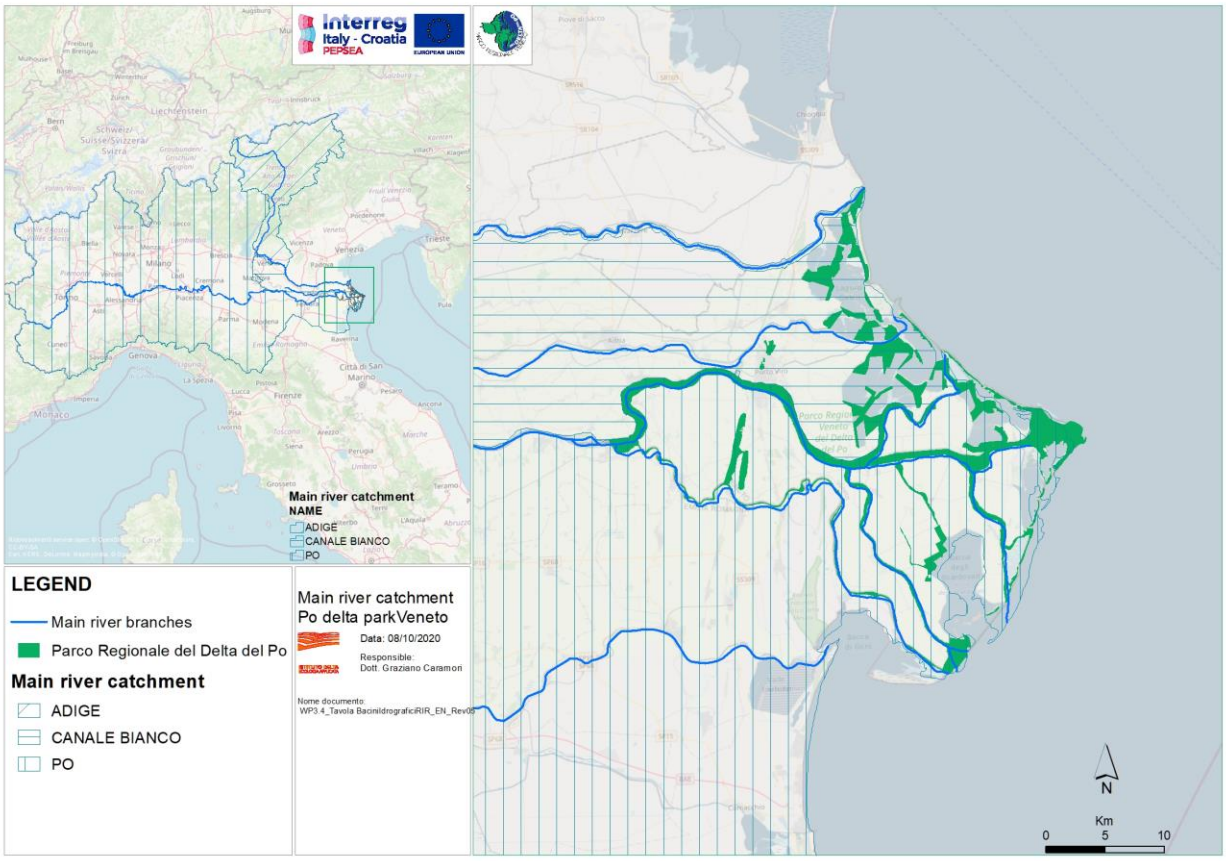


Figure 5: *main river catchment areas of the Po delta.*

Vulnerability analysis

As highlighted in the guidelines In the event of an oil spill the elements at risk to be considered are:

- Type of coast and its environment
- Ecosystems, habitats, species and key natural resources
- Socio-economic characteristics (including cultural heritage)

Considering the Po river delta it is also necessary to build two reference scenarios for hydrocarbon pollution:

1) source of pollution upstream, in the main catchment areas of the delta mapped in Figure 5;

2) **source of pollution at sea**.

Considering the first scenario, it is necessary to highlight the oil spill accident in the Lambro river occurred in February 2010. At the delta by chance the oil spill did not cause serious consequences, the oil spilled in Lombardy Region was blocked at the Isola Serafini dam on the Po river. However other potential pollution sources are also downstream of the aforementioned Isola Serafini dam, which consequently pose a greater risk due to the shorter times of reaching the Po delta. A survey of the data available for the Veneto Region was carried out. thanks to ARPAV, in the catchment areas there are three companies at significant risk (RIR) pursuant to Legislative Decree 105/2015, of the petrochemical or hydrocarbon type, see Figure 6.

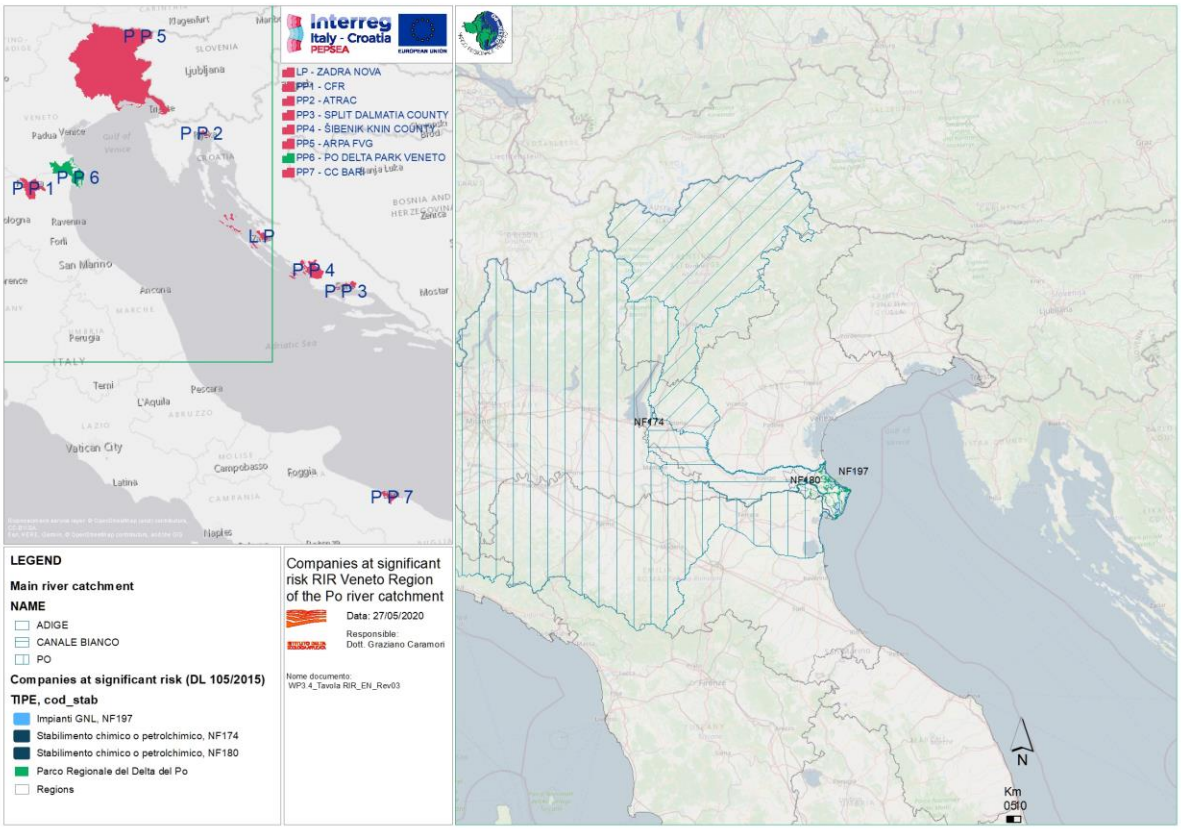


Figure 6: *Companies at significant risk (RIR) of Veneto Region, ARPAV data updated to 2019.*

Type of coast and its environment

In accordance with the guidelines according to the ESI (Environmental Sensitivity index), the types of coast are divided into 10 main categories depending on the environmental characteristics. The scale from 1 to 10 corresponds to a minimum sensitivity value (1) up to very high sensitivity (10), Figure 7. The degree of sensitivity has been associated with a chromatic scale for the elaboration of sensitivity maps. In comparison to rocky shores sandy beaches are the most difficult areas to clean up following an oil pollution event. The EPS considered are all inside the maximum sensibility category: 10, specifically 10 A marine areas and brackish wetlands.

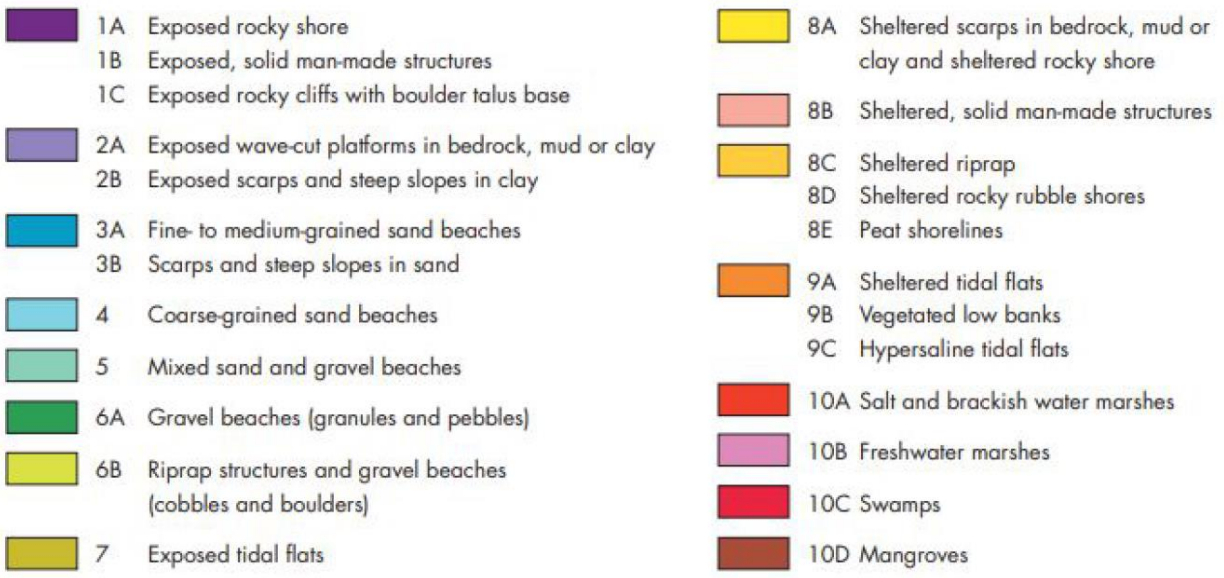


Figure 7: *Environmental Sensitivity index color code.*

The risk maps for the Pilot areas have been elaborate considering an EPS for the North area, the Caleri lagoon, and an EPS for the South area, the Canarin lagoon. The resulting maps are reported in the Pilot areas-risk maps paragraph.

Key ecosystems, habitats, species and natural resources

The Park is characterized by wetlands, among them the widest areas are brackish lagoons, which represent the EPS (Enclosed Parts of the Sea) for the purposes of the PEPSEA project. The lagoons, although within the limits of delta dynamism, are mapped in Figure 8.

Besides lagoons the main ecosystems present in the delta are river branches influenced by the tide, river mouths, sandy and muddy wetlands; brackish wetlands, pastures and brackish steppes; sandbanks; internal water bodies of stagnant and running waters.

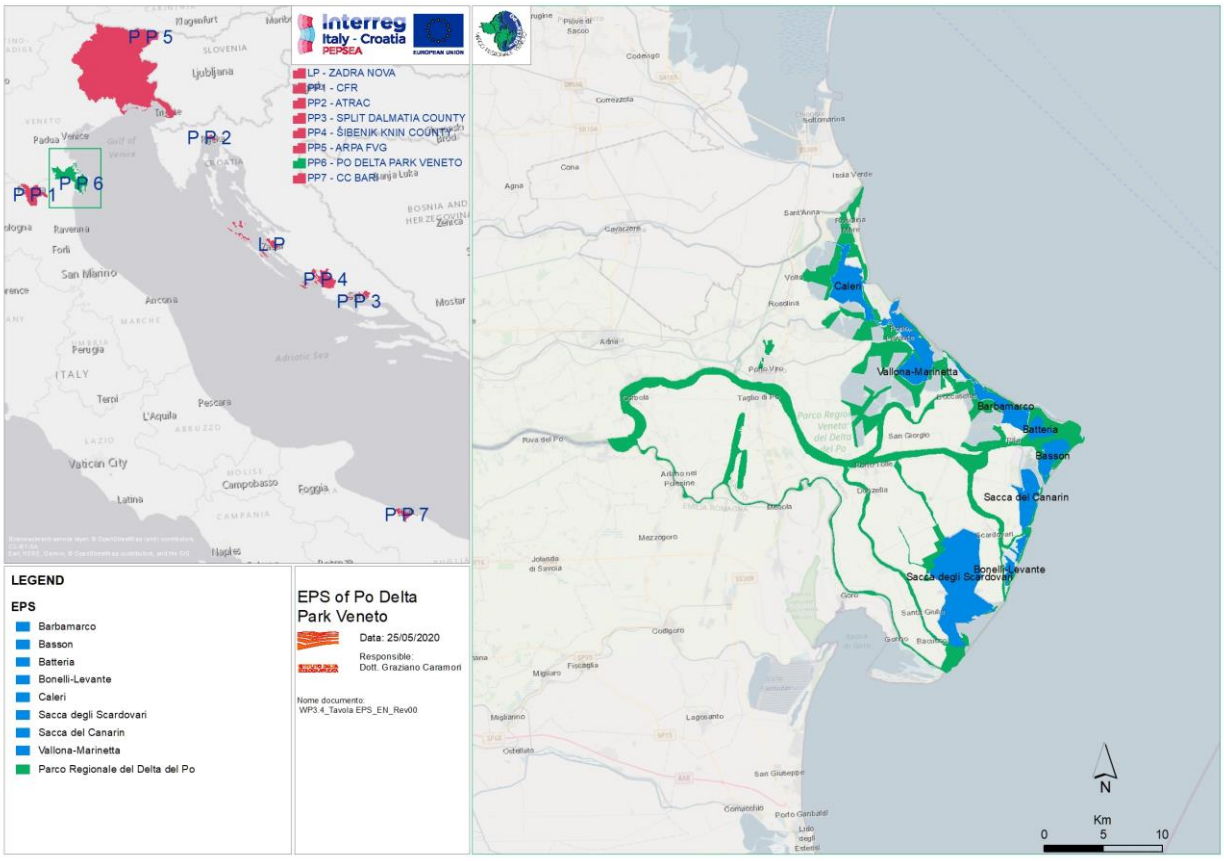


Figure 8: *EPS of Pilot areas in Po Delta Park Veneto.*

Socio-economic characteristics

The Park insists over 9 Municipalities for a total of 69,122 inhabitants at January 2019, the inhabitants resident in each Municipality are reported in the table below.

Municipality	male	female	total
Adria	9.345	10.002	19.347
Ariano nel Polesine	2.023	2.179	4.202
Corbola	1.112	1.229	2.341
Loreo	1.704	1.754	3.458
Papozze	695	738	1.433
Porto Tolle	4.694	4.852	9.546
Porto Viro	6.897	7.320	14.217
Rosolina	3.192	3.191	6.383
Taglio di Po	4.055	4.140	8.195
Total	33.717	35.405	**69.122**

The distribution into the territory is better represented in Figure 9, in which the number of residents is represented with a graduated color from the lightest gradation for the minimum number of residents (1,433 Papozze), up to the darkest gradation corresponding to the maximum number of residents (19,347 Adria).

In the Po delta pilot area the EPS are declined the brackish lagoons, consequently the economic activities of EPS are shellfish farming, traditional fishing, tourism and hunting. Shellfish farming is practiced inside the lagoons and it is the most significative economic activities, it involves two species, the clam *Ruditapes philippinarum*, and the mussel *Mytilus galloprovincialis*. Mussel farming is practiced both inside the lagoons and at sea, thanks to the ecological characteristics of this species. On the contrary, clam aquaculture of *R. philippinarum* is practiced only and exclusively within the EPS. The ecological characteristics of this species confine it to a narrow salinity range, the species can tolerate marine salinities for short periods, but they cannot survive for long. In addition to these two species, a small-scale oyster farming activity has begun with very low quantities but with high quality productions. Clam farming, in the last 10 years, inside the lagoons of the geographic Po river delta are leading the Italian production, as a matter of fact about 80% of the national production is produced here, with a significative economic return.

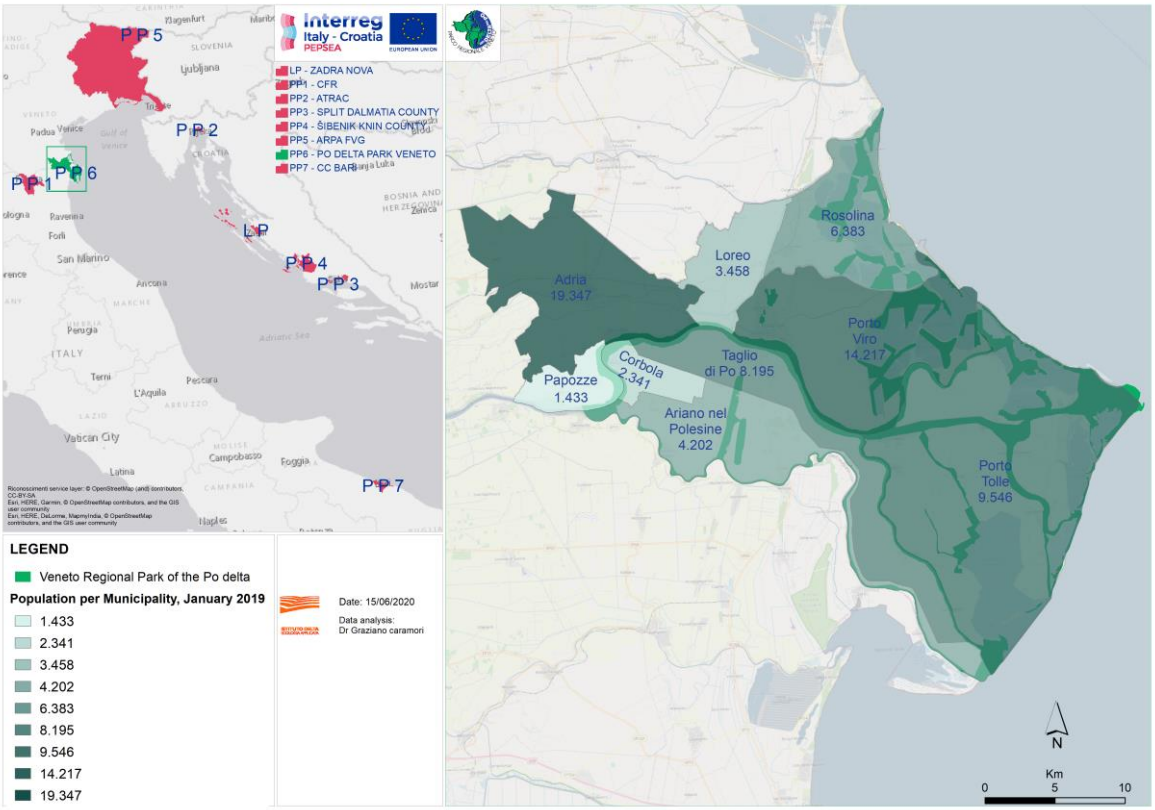


Figure 9: R*esident population on January 2019, ISTAT data, elaboration by Istituto Delta.*

RISK MAPS OF PILOT AREAS

The risk maps of the Pilot areas have been realized accordingly the guidelines and the codes of the ESI index scale, reported in Figure 7.

Both pilot areas fall into rank 10, specifically in the category “10A Salt and brackish water marshes” equal to the maximum sensitivity of the ESI scale. The maximum sensitivity of these type of wetlands depends on the high biodiversity and high value of use, as well as the difficulty of cleaning and the potential for long-term impacts on many valuable organisms. Risk maps for pilot EPS are shown below in Figure 10 and Figure 11.

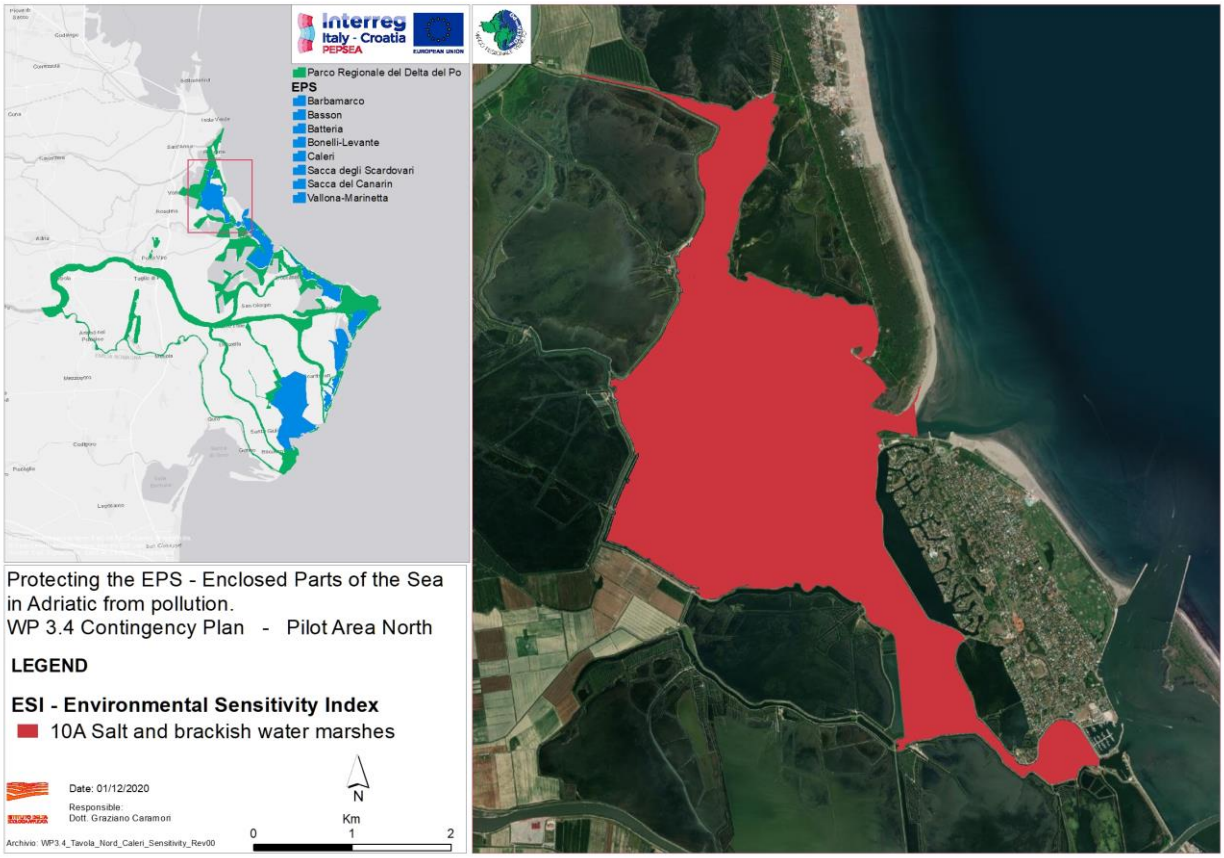


Figure 10: *Risk map of North area accordingly ESI index.*

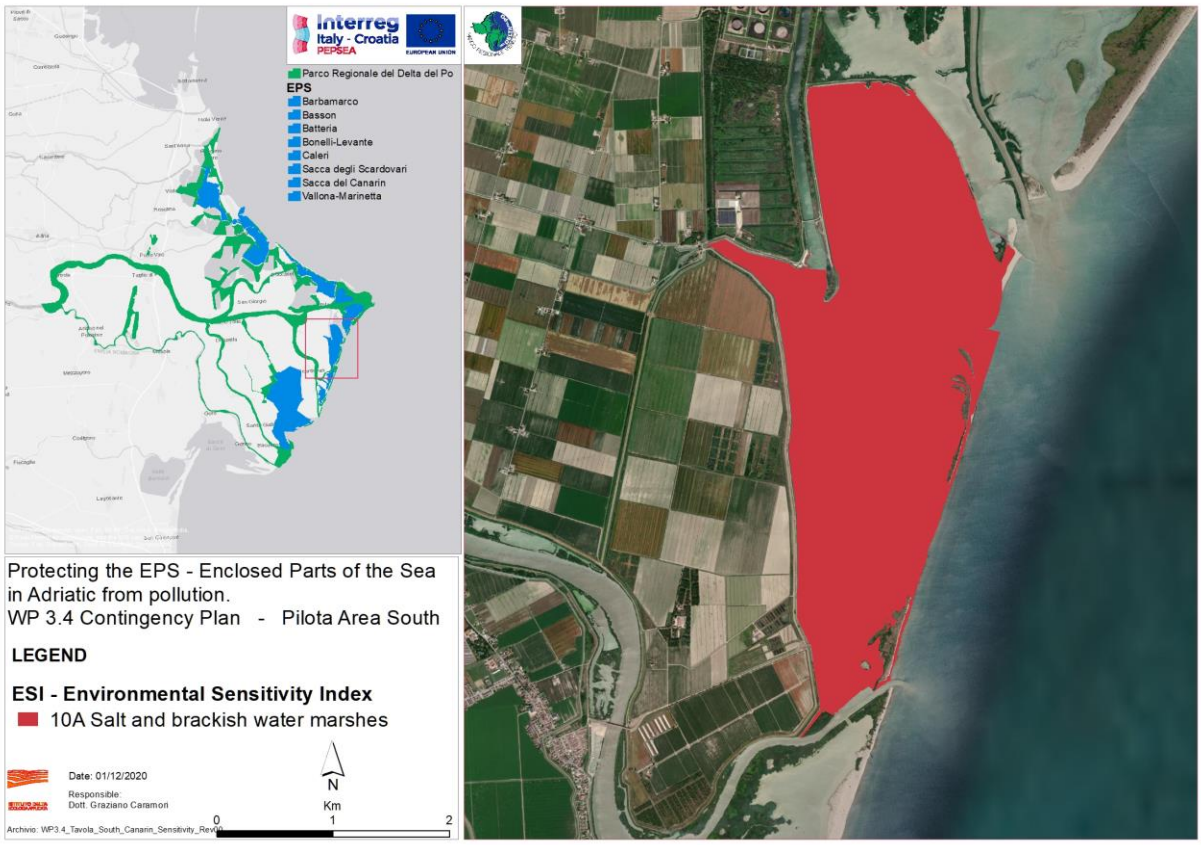


Figure 11: R*isk map of South area accordingly ESI index.*

OPERATING PROCEDURES

Considering the environmental and socioeconomic characteristics of the Pilot areas and the reference scenarios for hydrocarbon pollution with possible sources both upstream and at sea, an Inter-municipal Operations Center is proposed for the 9 Municipalities of the Park: Adria; Ariano nel Polesine; Corbola; Loreo; Papozze; Porto Tolle; Porto Viro; Rosolina; Taglio di Po.

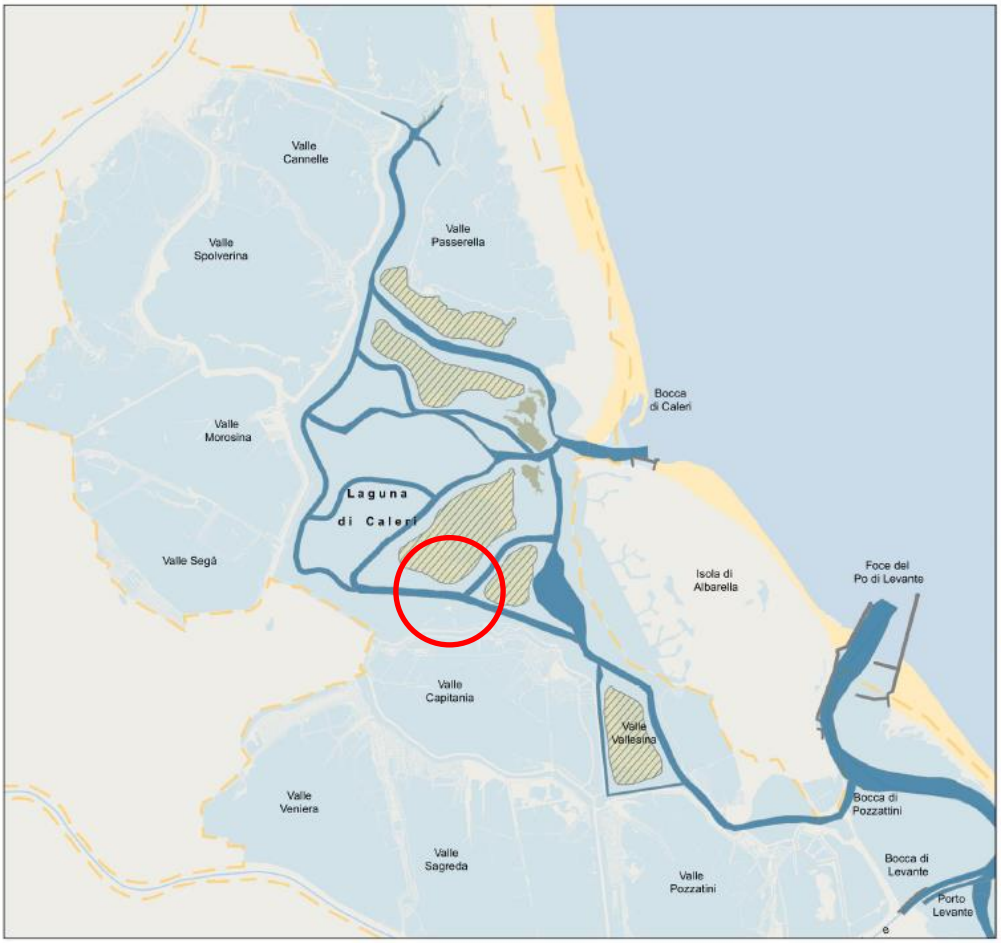
In consideration of the existing plans, the operating procedures will be linked with the existing framework of the procedures of the Civil Protection. Hydrocarbon pollution concerns the intervention model for Chemical-Environmental event. The operating procedure sheets follow an existing intervention model by event, and are not the subject of this report.

ANNEXES

First assessments on the pilot areas

Considering the characteristics of the pilot areas, some preliminary considerations are reported based on data available for the northern pilot area, Caleri and the southern pilot area, Canarin.

As regards the Caleri lagoon, Nort Pilot area, the reference document is "Guidelines for the implementation of maintenance and accommodation works to be carried out in the areas of the coastal strip of the Po delta. The guidelines" approved by D.G.R n. 442 of 9 April 2019.



Considering the conservation of EPS as wetlands the guiding principle and, in broader terms, sustainable development, it is necessary to take into account the dynamism of these environments. The underwater canals are one of the elements necessary for these environments. However, the canals to improve water circulation must be commensurate with the each specific lagoons, as there is no single model valid for all wetlands.

In the guidelines relating to the Caleri lagoon at project level, the area identified with a red circle should be re-evaluated and quantified for the effects of water circulation and consequence on parameters such as salinity. Since this is an area defined as a sub-lagoon channel, a quantification would be necessary for the purposes of hydrodynamics, with the aim of achieving the best result in terms of: hydrodynamics; cost of works; volumes of sediments moved; maintenance of the maximum possible water surface; cost of work.

Last but not least into Caleri lagoon It is therefore necessary to extend the monitoring network with specific equipment in order to evaluate over time the maintenance in balance of the main parameters within the lagoon.

For the South pilot area, in particular Canarin lagoon, in addition were considered the water monitoring data made available by ARPAV as Open Data for the period 2010-2018, the data were obtained from the monitoring probes. The data for the year 2019 at the date of drafting the current plan were not yet published on the ARPAV Open Data portal.

The available parameters are:

- Temperature
- pH
- Specific conductivity at 25 ° C
- Salinity
- Dissolved oxygen mg / L

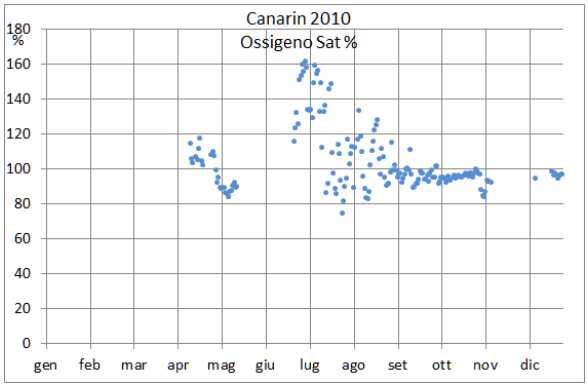
The ARPAV data were recorded continuously at constant intervals of 30 minutes, and constitute a database of 118,831 records for each of the 5 parameters mentioned which for the 6 years correspond in total to over half a million point measurement data.

To make the information readable, the data were analyzed on an annual basis, corresponding to at least one reproductive cycle of the aforementioned bivalve species of economic importance.

Taking into consideration the production models, specifically clam farming, among the available parameters, Salinity and oxygen are of particular interest, as they are among the five relevant parameters for clam farming.

The table below shows the trend graphs for each year using the daily averages.

Processed Open data ARPAV portal https://www.arpa.veneto.it/dati-ambientali/open-data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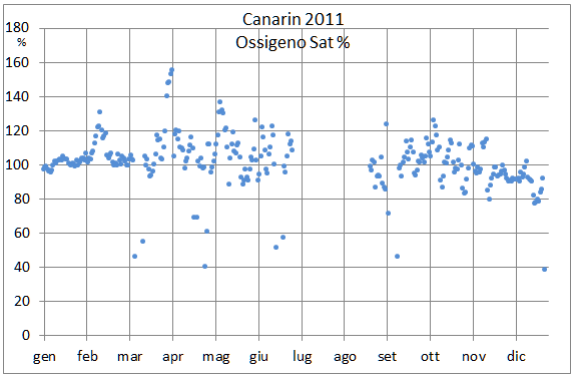
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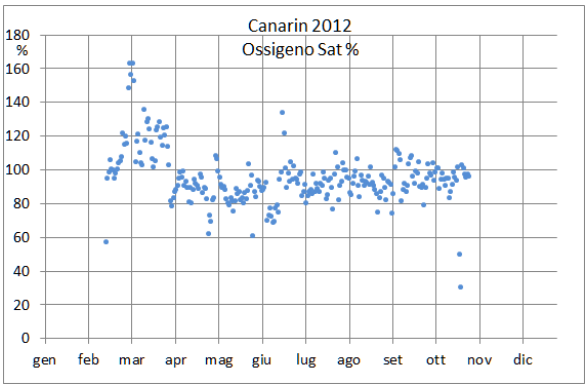
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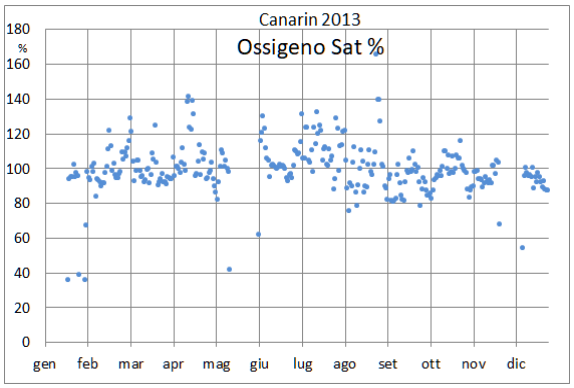
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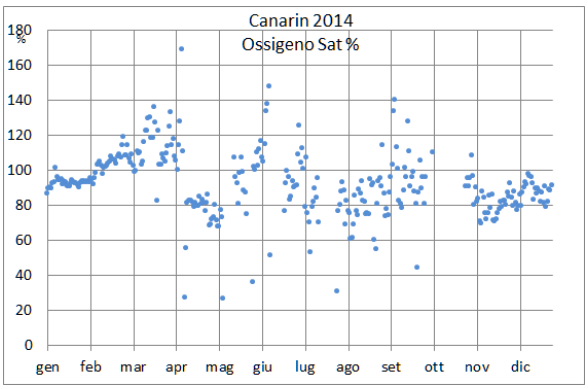
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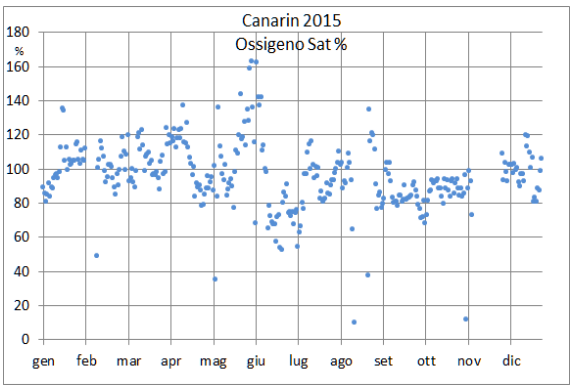
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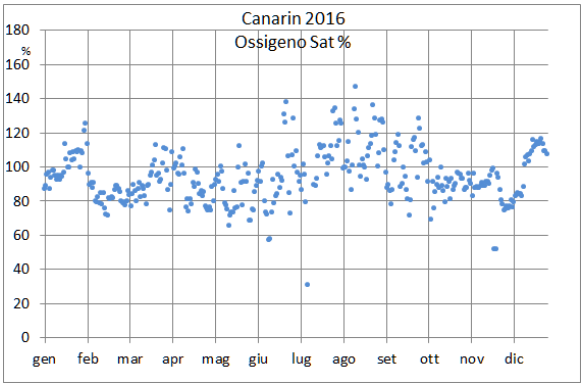
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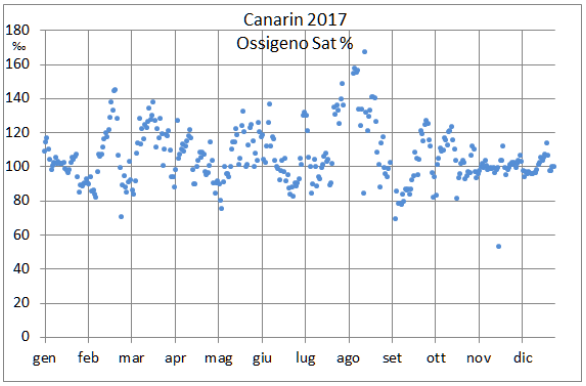
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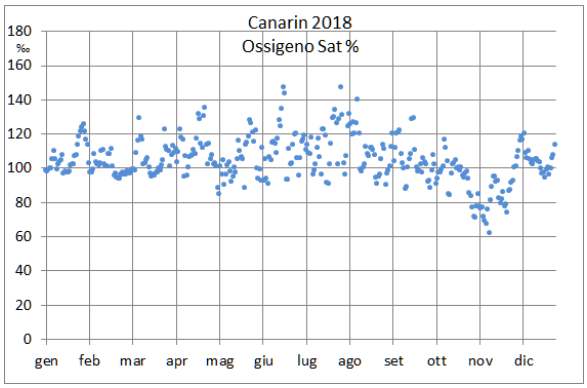
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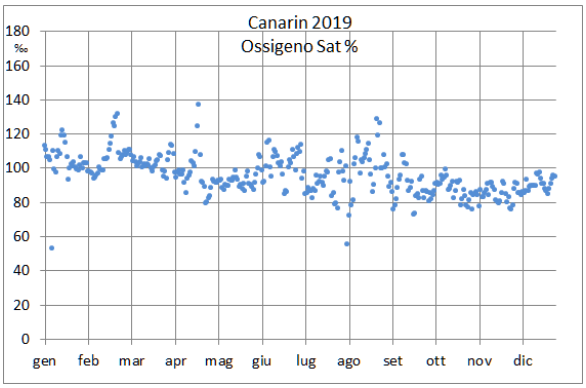
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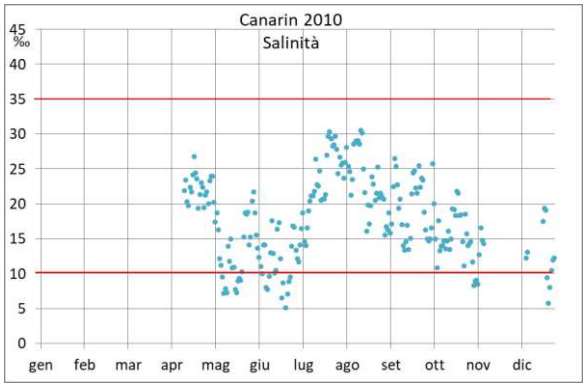
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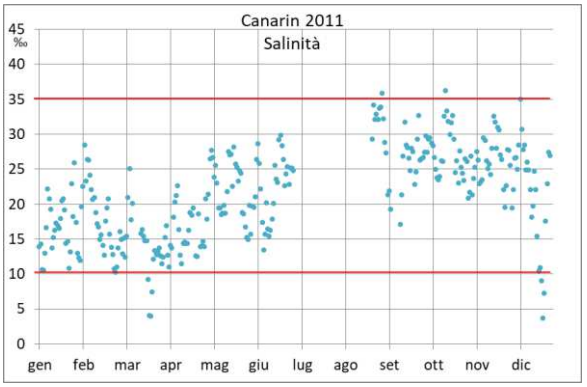
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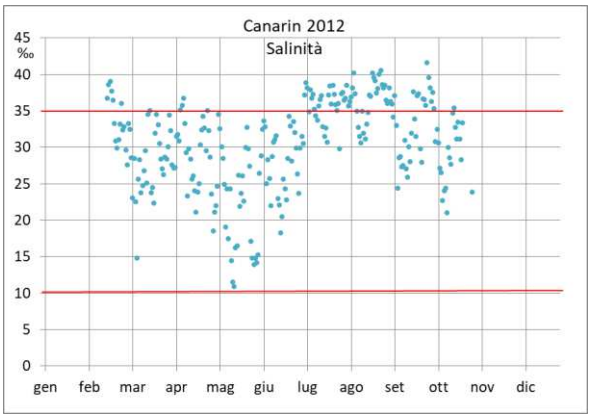
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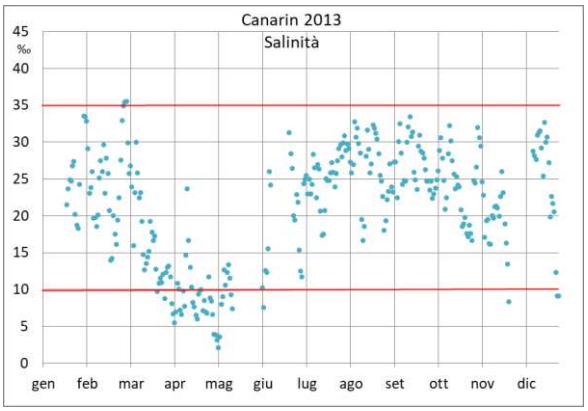
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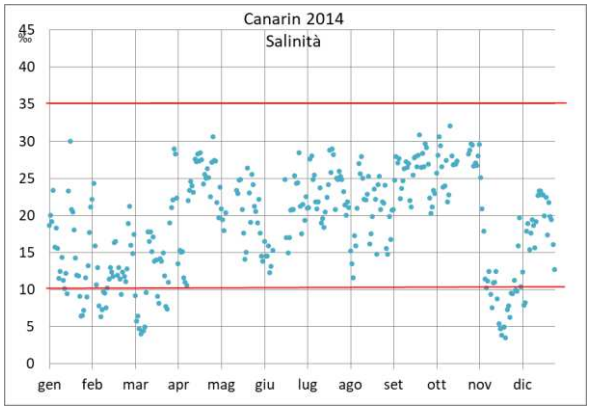
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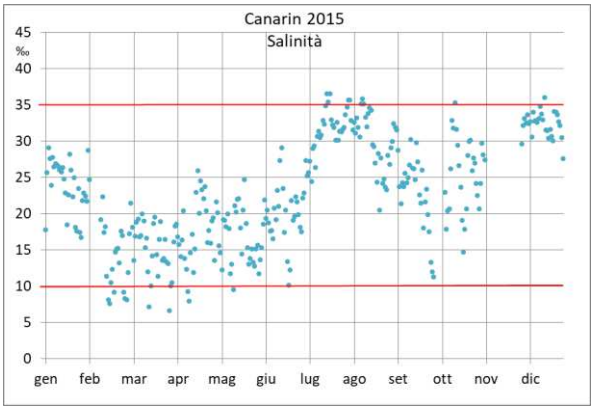
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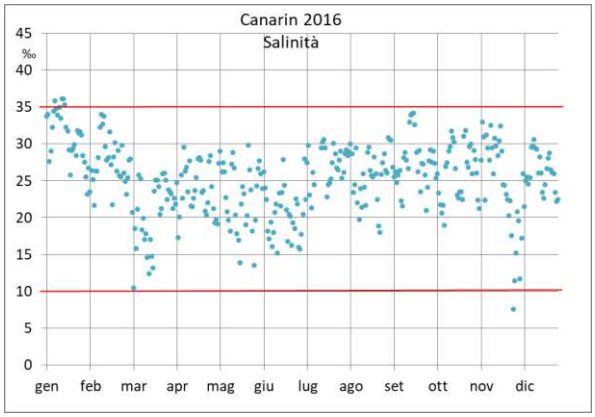

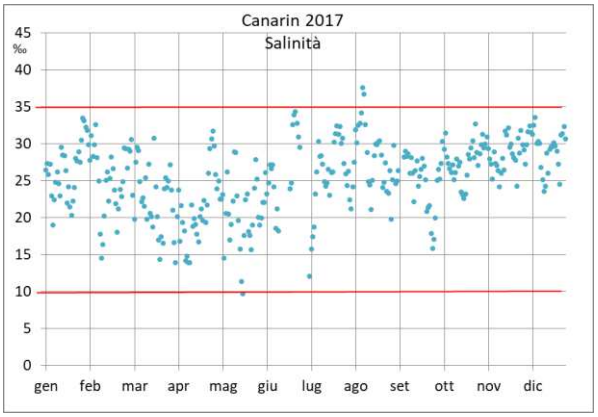

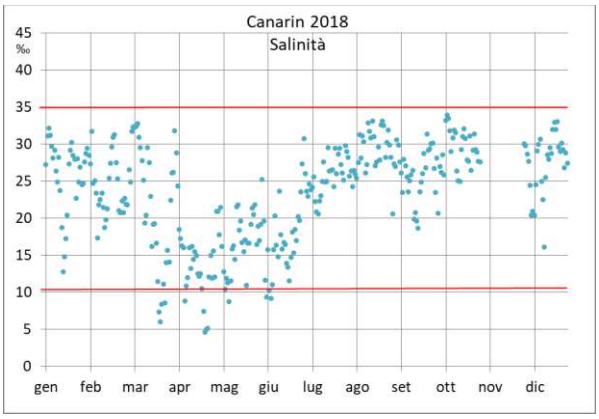

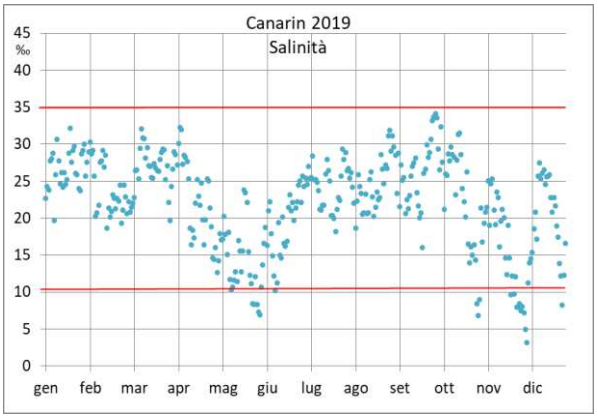

Salinity ‰	2010 N° days	2011 N° days	2012 N° days	2013 N° days	2014 N° days	2015 N° days	2016 N° days	2017 N° days	2018 N° days	2019 N° days
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>=35	0	**3**	**69**	**2**	0	**10**	**4**	**2**	0	0
<=10	**26**	**7**	0	**37**	**44**	**11**	**1**	**1**	**12**	**19**
<=5	0	**3**	0	**5**	**10**	0	0	0	**2**	**2**

WP4 Improvement of response center equipment

It is evident that the EPS during the years suffered of long lasting period out of the tipical range for this brackish lagoon. Monitoring appears to be essential both for oil spil early warning as well as for management of the EPS and specific equipment must be acquired.

For an effective response to pollution events it is necessary to improve the existing detection equipment. In consideration of the reference area the lagoons, or EPS, and the type of environment concerned, a purchase of equipment for fixed stations in number from 2 to 5 is suggested, in addition to an aquatic drone, the latter can be used moving it to specific areas according to the emergency needs.

In particular, the Caleri lagoon, North area, needs a long-term monitoring system similar to the South area, Canarin pilot lagoon. The continuous and long-term monitoring data allow the identification of annual trends and any variations beyond the limits of the balance of the main factors that influence these EPS that are framed within the transitional waters. In this case, the fundamental element is the balance within a range of variations of the main parameters.