Marine Ecosystems Response in the Mediterranean Experiment

Implementation Plan 2017-2020

MERITE

Marine ecosystem response to the input of contaminants in the coastal zone

September 2017

CONTENT

1. EXECUTIVE SUMMARY

Impact of contaminants - The MERITE (Marine ecosystem response to the input of contaminants in the coastal zone) action aims at investigating the fate of chemical contaminants and their impacts on the benthic and pelagic habitats, in specific coastal ecosystems, such as urbanized bays and contaminated fishing grounds in the western and central Mediterranean. The integrative approach is mainly based on *in situ* observational data (existing databases and targeted new data collection), experimental work and modeling research. Numerical modeling allow the examination of physical, biogeochemical and anthropogenic drivers in the studied coastal ecosystem, at the relevant time scales. The achievement of the objectives is based on an integrated study of biotic and abiotic compartments conducted in coordinated way in different sites (mainly located in the Gulf of Lion, Provence area, and in the Sfax Bay and Gulf of Gabes).

2. MARINE ECOSYSTEM RESPONSE TO THE INPUT OF CONTAMINANTS IN THE COASTAL ZONE (MERITE)

COORDINATORS

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PERIOD

2016-2020

PARTICIPANTS

A total of ~85 participants from 17 French labs and 5 abroad.

French Participants: CEFREM (Perpignan), CEREGE (Aix-en-Provence), EPOC (Bordeaux), IFREMER-LERPAC/LBCM (La Seyne/mer), IFREMER-RBE/BE/EMH/LBCM (Nantes), IFREMER-DYNECO-DHYSED/REM-GM-LGM (Brest), IFREMER-RBE/MARBEC-LMH (Sète), IPREM-EEM (Pau), IRSN (La Seyne/mer, Cadarache), LA (Toulouse), LSCE (Saclay), MIO (Marseille), OSU OREME Montpellier (Géosciences Montpellier, Hydrosciences Montpellier and MARBEC), PROTEE (Toulon), OOB-LOMIC (Banyuls).

Foreign Participants: CBs (Sfax, Tunisia), University of Carthage/BFSA (Bizerte, Tunisia), HCMR-IO (Athens, Greece, *external collaborator*); NIMRD (Constanta, Romania, *external collaborator*); RBI (Zagreb, Croatia, *external collaborator*)

RATIONALES

The Mediterranean is a trans-regional and transboundary semi-enclosed sea that nowadays shares all marine ecosystems key challenges related to the growing anthropogenic pressures (biodiversity losses, climate change impacts, overfishing and pollution). The surrounding coastline is characterized by a high population density, especially increasing in the big coastal urban centers. The Mediterranean Sea is also an ultimate sink for a range of harmful chemical substances and plastic wastes which form a marine litter. The recent assessments of present status and trends show that pollution in the Mediterranean and Black Seas by the harmful substances continue to degrade mainly coastal areas but also their more remote settings (Azoury et al., 2013; Bordajandi et al., 2006; Castro-Jiménez et al., 2013; Carubelli et al., 2007; Gonzalez-Fernandez et al., 2014; Harmelin-Vivien et al., 2012; Martí-Cid et al., 2007, Thébault et al., 2008). The marine litter plastic has now become ubiquitous and may comprise up to 95% of debris accumulated on shorelines or sea floor and this figure can reach up to 100% on the sea surface (Galgani, 2015; Jambeck et al., 2015). The Mediterranean Sea is one of the most affected areas by marine litter in the world and the highest densities of marine litter stranded on the sea floor (Barnes et al., 2009).

This semi-enclosed sea is highly vulnerable to chemical pollution, because of long history of Europe's industrialization, high density of coastal populations and also because of its natural characteristics (such as large watersheds, high continental loads and long water residence times,…). The historical and present continuous inputs of persistent organic contaminants and trace elements entering the Mediterranean Sea are mainly related to the land watershed loads (rivers and groundwaters) and direct releases (from urban, industrial and transport activities), affecting mostly coastal areas (e.g. Dang et al., 2015; Guigue et al., 2011, 2014; Tedetti et al., 2010, 2012, 2013; Tessier et al., 2011), whereas atmospheric fallouts/depositions dominate contaminant inputs in more remote offshore areas of the open sea (Castro-Jiménez et al. 2012; Berrojalbiz et al., 2014; de Madron et al. 2011 and references therein). Once contaminants (such as metals, radionuclides and organic compounds) are released in the coastal areas, their environmental fates are mainly governed by interactions with particle dynamics, dissolved organic matter and marine biota which offer sites for sorption (e.g. Cindrić et al., 2015; Ferretto et al., 2014; Guigue et al., 2014; Oursel et al., 2013, 2014b), and processes at the sediment/water interface including bioturbation/biotransformation (ex. Dang et al., 2015a). In these shallow environments, the contaminants fate is mainly driven by chemical speciation, phototransformation, interactions with particles and primary trophic levels (autotrophs and heterotrophs) (Guigue et al., 2014; Tiano et al., 2014, Dufresne et al., 2014). Therefore, in the coastal areas the contaminants fates are very sensitive to intense events (storms, floods, stormwater and sewage discharges, plankton blooms…) which mobilize large quantities of particles capable of sorbing, transporting, releasing or burying contaminants in the continental shelf and slope. At the wider regional sub-basins scales their fates are mainly controlled: i) by atmospheric deposition, ii) exchanges at the air/sea interface and iii) by water column fluxes to the deep bottom sediments, all intertwined with biodegradation processes and with primary trophic levels dynamics, as well as with their transfer within marine food webs (up to the higher predators) (Benlamine et al., 2015; Cossa et al., 2012; Dachs et al., 2002; Dierking et al., 2009; Ensibi et al., 2015a, 2015b;

Fouin et al., 2013; Harmelin-Vivien et al., 2009, 2012; Lohmann et al., 2007; Ourgaud, 2015, Ourgaud et al., 2015; Salen-Picard et al., 2002; Sauret et al., 2015a; Strady et al., 2015; Tiano et al., 2014).

During the first phase of MERMEX, the attention was given to the identification of the source loads of carbon, nutrients and chemical contaminants and on their impacts at the different scales. The efforts were also seeking at an integrated approach combining observation, experimental work and modeling. Several aspects relative to the ecosystem response to these anthropogenic pressures in the coastal zone were thus explored: characterization of the status of coastal zones facing contrasted degrees of anthropization and inputs of materials; characterization of the behavior and fate of particles, nutrients, carbon and contaminants on the biogeochemistry and on plankton communities in the coastal zone; typology of community structures from heterotrophic prokaryotes to mesozooplankton and of trophic interactions zooplankton/small pelagic fish/tuna; identification of the mechanisms controlling the contaminants transfer from abiotic compartments to organisms, their accumulation throughout the trophic chain and their potential impact on community structures; characterization of the bio-degradation of contaminants and the relative role of degraders (ex. bacteria and fungi) on the eco-dynamics of the contaminants in pelagic and benthic environments.

The choice of the Gulf of Lion (GoL) and Provencal sub-basin area as experimental site for the first phase was mainly justified by the existence of a sound knowledge of basic processes and database in this area achieved during the last decades. This helped in the development of modeling. Furthermore, the GoL biogeochemical features provide also appropriate environmental context for these studies, with: i) the high riverine inputs of nutrients, carbon and contaminants from the Rhone River that influences the broad shelf as well as the presence of smaller rivers such as Têt, Hérault, Orb, Aude; ii) big cities such as Marseille and Toulon, where a number of case studies were developed and iii) the existence of some submarine groundwater discharges evidenced in the framework of MERMEX, especially along the karstic coast.

The results of the first phase of MERMEX were detailed in the syntheses report including WP1 – WP4 actions (Cobec, Copel, Rivers, Specimed, Poissons, IPP, C3A, Costas,...). Important gaps were identified concerning the availability of biogeochemical and chemical data at sufficient spatial and temporal resolution. Filling the gap is very important to enhance our ability to reproduce the biogeochemical functioning of ecosystems and the behavior of particles and contaminants in the coastal area. Information is still needed on the stocks of the different chemical compounds, including legacy and emerging contaminants in the different compartments (water, sediment, biotic compartment), and on the fluxes between them. A better understanding of the contaminants kinetics and transfer processes under various forcing is also required. In addition, the fate and impact of contaminants may also be strongly affected by biodegradation and/or biotransformation processes driven by microorganisms as well as phototransformation processes.

The MERITE action will operate interlinked with other components of MISTRALS and connected relevant studies. These connections are precisely identified below, under the description of the types of specific Mediterranean ecosystem which will be studied. This concern components and actions such as SICMED, BIODIVMEX and HYMEX of MISTRALS, and regional projects like SEDILION and LASERMED-OTMED, as well as the "Littoral and City" working group of MISTRALS. Furthermore the marine litter issue, while emerging as significant pressures in the Mediterranean Sea and potential vector of toxicants and pathogens will also be considered in the number of MERMEX related projects (ex. JPI Oceans PlasTox, …), including also a better evaluation of the rate of abiotic and biotic degradation of plastic items in the environment (ex OXOMAR project).[CG1]

OBJECTIVES

The general objective of MERITE focuses on a better understanding of exploited resources and ecosystems responses to contaminants. The emphasis is given to chemical contaminant transfer processes during their high loads related to intense events. The urban areas are zones of high inputs of multiple contaminants and fishing grounds are characterized by habitats which are diversely sensitive to contaminants. The understanding of contaminants impacts needs an integrative approach including studies of the ecosystems, their trophic interactions and contaminants transfer along the food webs. It also requires an increased knowledge of the related transport (of water and particles) mechanisms away from the sources. Recent studies highlighted this need for an integrative approach and a coupling of observations (ecological, biogeochemical, physical) and modeling activities (like in projects MerluMed, METROC, ANR/COSTAS, RETROMED…). The integrative approach will be improved in targeted habitats in the framework of MERITE. The studies will be conducted in selected types of specific Mediterranean coastal ecosystems, namely:

- Contaminated urbanized bays in the Western and Central Mediterranean selected pilot areas;
- Contaminated fishing grounds across the Western and Central Mediterranean areas.

The spatial implementation of the project in the Western Mediterranean refers more precisely to several relatively well-known strongly anthropized urban sites of Marseille and Toulon bays and to the pertinent scales of fishing areas in the Gulf of Lion. In the southern part of the Central Mediterranean, the efforts are undertaken to conduct and develop parallel mirror activities, in particular in the urban Sfax bay and on the fishing grounds of the Gulf of Gabes (Tunisia). The studied systems are characterized by different levels of anthropogenic pressures, distinct biogeochemical features and spatial extents (Figure 1).

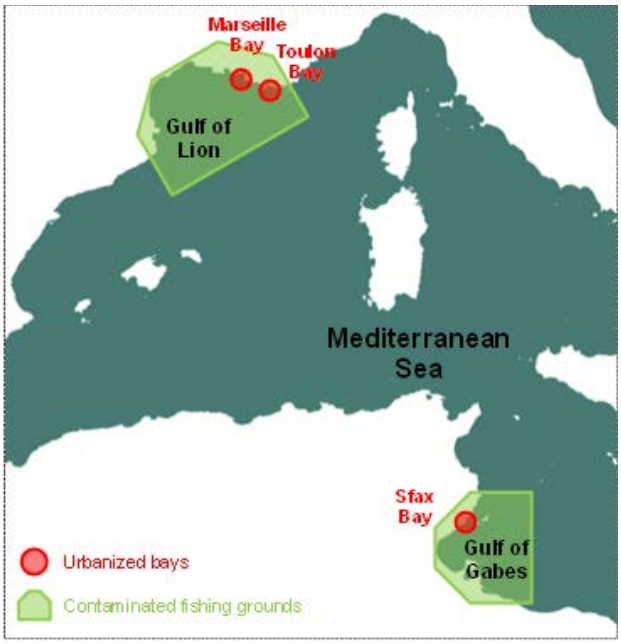


Figure 1. Map of the study sites

SCIENTIFIC STRATEGY

The proposed strategy merges different approaches that were previously used during the first phase of MERMEX in the northwestern Mediterranean Sea.

An integrated experiment combining observation, experimental work and modeling will take place in the coastal area. These studies rely on the following strategies:

- The simultaneous combination of a number of short-medium and long-term observational resources (such as fast deploying zodiac-type vessels, coastal vessels, moorings, gliders, profilers and satellite…) in order to investigate the key physical and biogeochemical, biological parameters and compartments impacting the contaminant transfers, especially during and after intense events (from a few days to weeks after an event).
- The development of experimental work and dedicated field sampling in order to assess processes, related kinetics and speciation of selected contaminants. This will notably include the study of contaminants transfer and exchanges through the different compartments (water/sediment/biota up to secondary trophic level small pelagic fish and targeted demersal/benthic species);
- The implementation, validation and improvement of physical, biogeochemical, chemical, sedimentary and ecological/ecosystem (including the associated contaminant transfers) coupled or connected/interfaced numerical models.
- Statistical and numerical modeling using physical, chemical and biological data will be interactively used to better characterize habitats, their abiotic and biotic components and related biological assemblages. The influence of contaminants on the distribution and abundance variation of species in these habitats will be assessed. The study of selected types of specific Mediterranean ecosystems across west-central transects will be undertaken, (i) on one hand, offering contrasted characteristics and processes, in terms of chemical multi-contamination (source/nature/amplitude…), ecosystems and hydrodynamic constraints, and (ii) on the other hand, benefiting from relatively wide existing knowledge and collaborative partnership and facilities.

CALENDAR AND IMPLEMENTION

Although the general objectives of MERMEX-MERITE will be fully maintained, a new integrative step will be implemented within the next three years (2018-2020), by adding a new task (Task 3). The tasks 1 (urbanized bays) and 2 (fishing grounds) (Figure Xa) are continued thanks to Regional, National and European fundings obtained as additive resources for MERITE. MERMEX-MERITE (in addition to the LMI CosysMed) will help to maintain the northern and southern communities working together. The new task 3, which will be the priority in term of support from MERMEX funding, will be implemented by a North South transMediterranean joint survey, conducted also with concerted field study and sampling activities and focusing on the uptake of contaminants by planktonic biota in various coastal zones and in offshore stations identified as references.

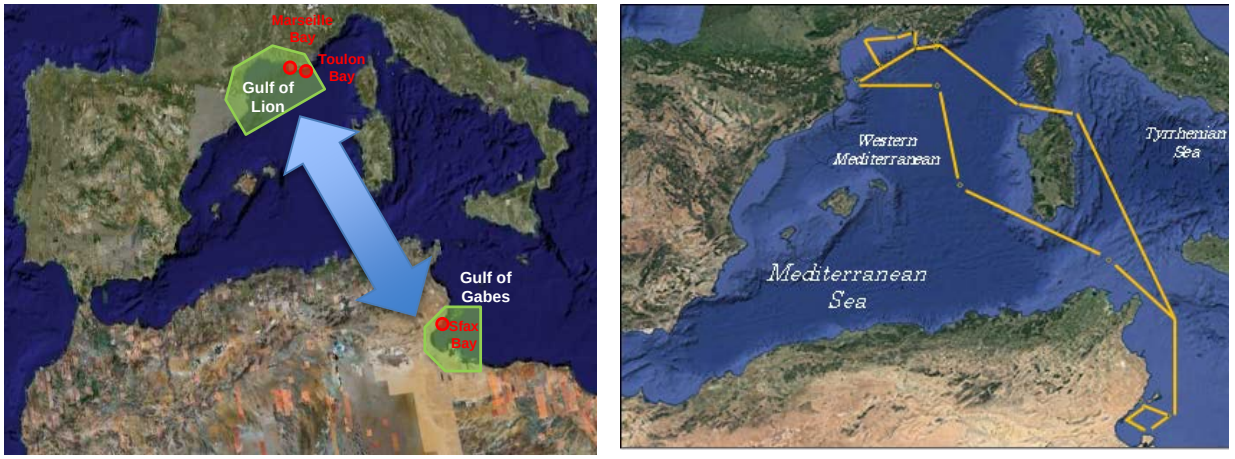
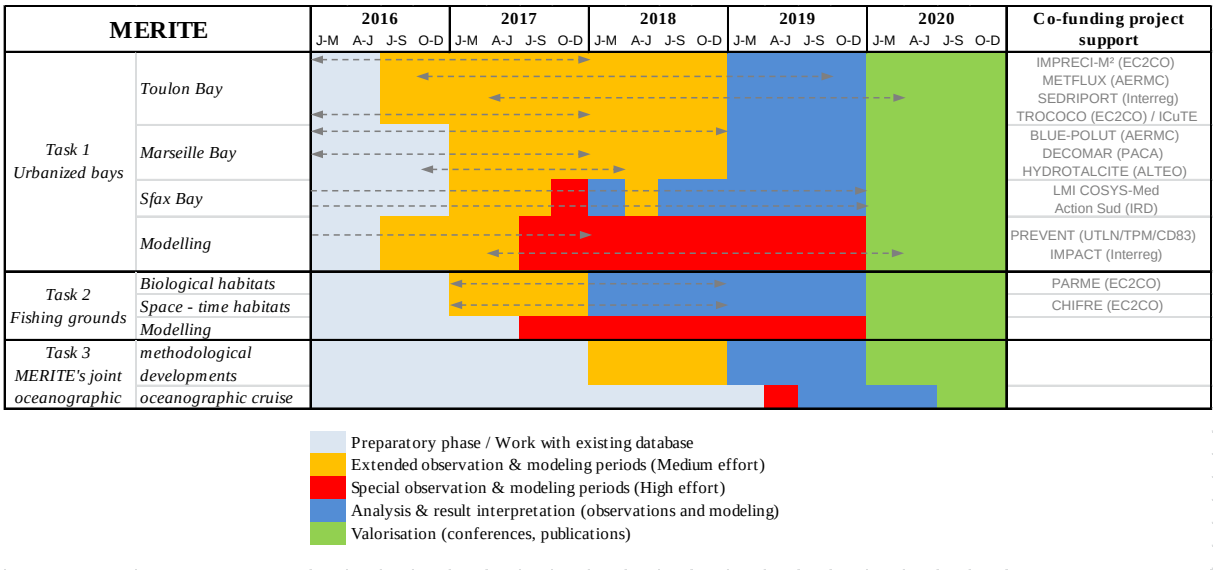


Figure 2: (left) studied areas in tasks 1 (urbanize bays) and 2 (contaminated fishing ground); (right) sampling location of the MERITE's 2019 oceanographic cruise in task3



The 3 scientific tasks of the MERITE project are described below.

Task 1. To study contamination processes in urbanized bays.

This task has the goal to study at high time resolution the kinetics of chemical contaminants transfer through the biotic and abiotic components after intense events. This is carried out by the ability to mobilize coordinated forces during these intense events.

These intense events are: (1) contaminated sediment resuspension, resulting either from natural (wind/storm) or human-driven action (e.g. dredging or large boat manoeuvre or trawling - Toulon and Sfax Bays), (2) urban agglomeration effluents discharge, either from natural rivers or sewerage network, draining the domestic and

industrial wastewater (Marseille: Huveaune and Aygalades Rivers, Cortiou / ALTEO Industry outfall in the Cassidaigne canyon; SIAPE Industry outfall and flash floods outfall in Sfax Bays).

The overall observation strategy consist in monitoring the response of similar abiotic and biotic compartments to contaminants in the different contrasted sites, using similar techniques and analytical methods, even if the followed contaminants are specific to the different coastal urban sites. The contaminants concentrations and chemical speciation are characterized in the water column and the sediment (including anoxic, anaerobic parts). For the biotic components planktonic food web up to their planktivorous predators and benthic communities are studied.

Similar protocols are used in all sites including water pumping in the water column, sediment core drilling, plankton nets, diving sampling. The choice of chemical compounds has beeb defined accordingly to (i) their occurrence in the area, (ii) the analytical/observation capacities of the involved partners, (iii) their relevance from both the geochemical and eco-toxicological point of view, and (iv) the available budget dedicated to the MERITE project.

These activities are particularly at interface with the "Littoral and City", a working group of the last MISTRALS prospective (2015), an interface again focused by the SIC prospective.

Pertinence for the choice of sites and main contaminants:

- Toulon Bay is a semi-enclosed bay (52 km^2) surrounded by a half-million inhabitants agglomeration, which presents a significant sediments contamination by metallic (e.g. Ag, Cd, Cu, Hg, Pb, Sn, Zn), organo-metallic (e.g. BTs) and organic (e.g. PAH and PCB) compounds, issued both from historical events (2^{nd} WW) and recent inputs (e.g. nautical activities). Processes inducing contaminated sediments resuspension could be a major threat for the surrounding ecosystem.
- Marseille Bay is directly impacted by the chemical contamination inflows resulting from (1) the urban agglomeration including discharges of the sewerage network, which drains the domestic and industrial wastewaters, and semi artificial water courses and untreated storm water drain outlets, (2) the Rhone River inflows and (3) the ALTEO industrial outfall in the Cassidaigne canyon. The different outfalls and urban rivers release both organic and metallic contaminants.
- Sfax Bay is the largest industrial and commercial city harbor of south Tunisia, situated in the north coast of the Gulf of Gabes, covering around 150 km^2 and near half million inhabitants. It is a major fishing harbor in Tunisia in terms of landings and employments. The main industrial activities are the artificial fertilizer production by SIAPE, the largest phosphate company. Organic and metallic contaminants are linked with phosphogypse outfalls.

Task 2. To study contaminated fishing grounds.
The general objective of this task will be a better understanding of exploited fish contamination in important selected commercial industrial fishing grounds in the Western and Central Mediterranean (i.e. Gulf of Lion shelf, Gabes Gulf shelf). This implies assessments of contaminants transport from their sources (large riverine discharges, urban and direct littoral release and atmospheric fallout) to the fishing grounds habitats and subsequent contaminants uptake by the primary trophic levels and their transfer along biota food webs.

Fundamental ecological questions are related with potential impacts of these anthropogenic pressures. This refers to the understanding of what and how natural and anthropic environmental forcing drives and affects fishing grounds habitats and their good ecological status in the Western and Central Mediterranean Sea. It is relevant for socio-economic issues regarding fisheries, biological resources and sanitary questions.

Biological habitats component

Specific objectives and approaches: The specific objectives of the biological habitats component consist in gaining a better understanding of functional dynamics of food web structures focused on targeted species (in both pelagic and benthic compartments) and their interactions with their physical and trophic habitats and a better identification of contaminant trophic pathways in short pelagic and benthic food webs. The spatial implementation of this part refers to the pertinent scales of fishing areas in the Gulf of Lion in the Western Mediterranean and in the Gulf of Gabes in the Central Mediterranean. The work is divided into two phases: in the first phase acquisition of additional new data obtained by targeted sampling cruise on the selected fishing ground habitats, and in the second phase workshops and historical existing database examination.

New data acquisition and targeted cruise: The focus is given on how plankton (including bacterioplankton) may interact with contaminants and how these biological loops may enhance the bioaccumulation of contaminants and enrich the base of food webs up to the planktivorous small pelagic fish. Characteristics of biological structures (e.g.: plankton and micronekton biomass size spectrum, stable isotope signatures $\delta^{15}N$ and $\delta^{13}C$, changes in elemental stoichiometric composition, pigments composition, flux cytometry and communities structures, fatty acid profiles…) are used to better constrain "diet" sources and to determine bioaccumulation pathways, trophic gradients and biogeochemical conditions in which contaminants are taken up by plankton and small pelagic fish.

The activities are implemented at two temporal scales: seasonal sampling conducted during two years survey mainly at two sites: Marseille bay and La Ciotat - national Calanques Parc, giving mainly emphasis on plankton-fish trophic interactions related to qualitative and quantitative seasonal changes of plankton communities (which are ongoing); second targeted surveys during short periods (2-3 weeks) before and during plankton blooms such as the two seasonal surveys done in 2017 in the Gabes Gulf;The new task 3 will propose a major survey including both targeted shelf areas.

Historical and new database analysis: Statistical and numerical modeling using physical, chemical and biological data will be interactively used to better characterize habitat of key fish populations. This work is based on the experienced gained from the recent study conducted in the PERSEUS project, uses a morphological traits-based approach to construct functional groups of fish species in the Mediterranean Sea and to study the relative changes in functional group biomasses over the last two decades across 12 Mediterranean areas. Using contaminants data from previous project and relationships with stable isotopes, we intend to address the spreading of contaminants within the different food webs. Such analyses will help identifying the main trophic pathways of contaminants in different parts of the gulf of Lion.

Space- time dynamics component: from sources to fishing grounds

Specific objective and approaches: The specific objective will be to improve our knowledge and our ability to model the transport and transformation of particulate matter, carbon, nutrients and associated contaminants from rivers to outlets of the coastal environment toward the open sea in the northwestern Mediterranean. Complementary to the habitat process studies, the temporal and spatial dynamics of both the particles associated with contaminants and the marine ecosystem from end to end is targeted at the scale of the Gulf of Lion.

The goal is to gather over an annual cycle the information necessary to calibrate the models in order to simulate the transport of matter and contaminants that have an affinity for particles, with an emphasis on intense events during which strong pelagic benthic exchanges occur, and the main functional groups of the first trophic levels from bacteria to mesozooplankton. The aim is to finally assess the transfer of selected contaminants along the trophic chain.

The activities are interlinked with other projects and at interface with MISTRALS components of continent/sea interface (mainly SICMED and HYMEX MISTRALS programs, and SEDILION project).

To study the seasonal cycle a one-year observation period started to be implemented on the SOMLIT-like monitoring that will be enhanced by biologic observations (microscopy, cytometry, HPLC, Zooscan) at the Bessète site (in front of Sète) and high frequency observations of T, S, O_2, fluorescence and turbidity operated at the Bessète, MesuRho (in front of the Rhône mouth) and POEM (in front of the Têt mouth) sites. The observations on the shelf and slope waters rely on autonomous platforms (especially gliders transects) equipped with T, S, O_2, fluorescence, turbidity sensors, and an ADCP (developed in the framework of the ANR MATUGLI), together with benthic stations equipped with ADCP and CTDs.

The new task 3 will dedicate stations to observe the organization of the ecosystem in relation with continuous hydrologic, sediment and biogeochemical measurements along a cross shelf transect and within the path of the Rhone freshwater.

A modeling part based on the coupling/interfacing of hydrodynamic, sediment, contaminants and biogeochemical models isis pursued in parallele to MERMEX ensuring the end to end integration of the project, and providing fluxes of matter to the deep environment, and hence bridging the gap between the coastal and deep environments should allow tracking the chemicals (C, N, P, some contaminants) throughout the Mediterranean basin.

Task 3. 2018-2020 MERITE implementation & funding – a joint oceanographic cruise from urbanized bays to fishing grounds.

New strategy for incentive well-coordinated scientific research

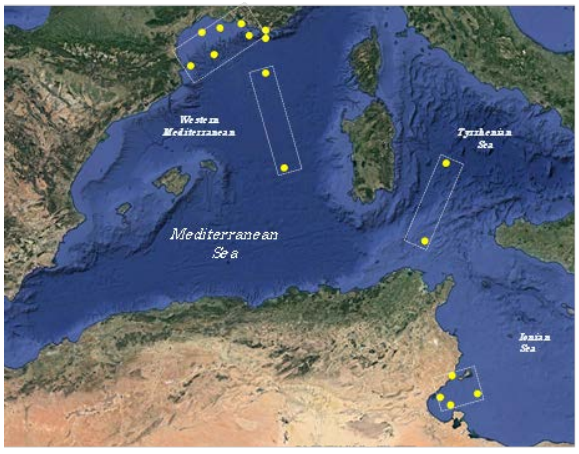
In order to further strengthen the coherence between the research actions of MERITE project, it is now proposed to evolve into single consistent working plan for task 3 of MERITE project for the 2018-2020 period. Whereas, conserving the initial thematic and scientific questions of the Mediterranean coastal ecosystem response to the inputs of chemical contaminant substances and elements, we propose to focus mainly on the key biogeochemical processes controlling the transfer of representative chemical pollutants from the water to the 1st levels of the trophic chain including microbial loop, phytoplankton and zooplankton components. The planktonic populations play a key role in the trophic food webs in marine ecosystems by mobilization and transfer of organic matter and energy towards higher trophic levels. However, the role of plankton in the transfer of contaminants is still not yet very well documented. Special attention will be indeed given to microbial loop component sampling – developing also new and approved techniques of isolation and characterization of this fraction of bacterioplancton, including experimental mesocosms set-ups.

The new knowledge will advance our capacity for environmental modelling of contaminants fates and impacts in the Mediterranean Sea. Furthermore, a sound scientific understanding of the factors influencing the chemical contaminants uptake by first planktonic trophic level in both southern and northern western Mediterranean will benefit environmental evaluations at basin to coastal scales. The coastal *versus* more off-shore contaminants accumulation will also provide new data for ecological status indicators. Whereas more largely, in the context of global change, plankton responses to the natural and anthropic pressures including global warming, ocean acidification, pollution, and toxic algal blooms become now key challenges in the field of marine ecology and biogeochemistry research. The Mediterranean Sea is recognized as particular system and “hot spot” for such studies.

Specific objectives and approches. The main objective will be thus to mount and carry out the joint oceanographic cruise in spring 2019 during post-planktonic bloom period in the Mediterranean. This joint oceanographic cruise will relate southern and northern selected study working areas of MERITE project that is urbanized bays of Toulon, Marseille and Sfax and fishing grounds in the western Mediterranean of the gulf of Lion and the southern Central Mediterranean of the gulf of Gabès. All components of the planktonic pelagic food web that can influence the transfer of contaminants and energy towards higher trophic levels (mainly plankton eating small pelagic fish) will be studied using an end-to-end sampling approach. Physical and chemical parameters of the water column and the size and biomass of planktonic components, ranging from pico- to mesoplankton, will be investigated to describe the structure of the plankton trophic relation and infer potential contaminants transfer pathways. Finally, the present proposal allow us to rely on relevant experience and data already obtained in 2017, to keep the competences of the partnership and to benefit from the others founded research projects related to MERITE /MERMEX study.

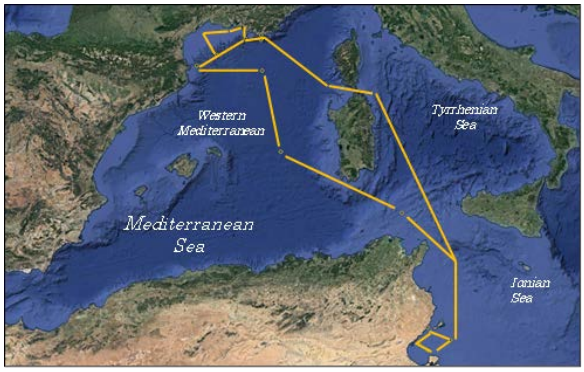
Task 3 implementaion working areas and program

Positions of sampling stations and working areas




N/O Antea

Provisional trajectories for the survey



Task 3 proposed working program and associated MERITE/MERMEX founding request is:

- **2018**: investigation tools breakthrough and study of biogeochemical processes in natural and controlled conditions.
Most of the activities will focus on the identification and development of ad-hoc methodologies for sampling of different plankton fractions, experimental set-ups and examination of existing data base on contaminants including statistical analysis, which actually make challenging:
(a) the evaluation of chemical contaminants speciation and dissolved/particulate fractionation;
(b) the assessment of chemical contaminants levels in the 1st trophic levels coupled with organisms diversity/abundance determination as well as stable isotopes use to evidence trophic pathways;
(c) the study of model chemical contaminants propagation in the trophic food webs;
(d) the study of these chemical contaminants impact onto these organisms.

To reach this goal:

- organization of a 1-day meeting (with visioconference), in February 2018, to gather the scientific community in order discuss the various approaches;
- development of the methodologies through the adaptation of existing sampling/sample treatment technics, analytical tools set-ups;
- evaluation of their efficiency from field experiments in the studied urbanized bays allowing to use smaller vessels and to easily scan strong gradient of chemical contaminants concentrations;
- performing lab experiments to investigate certain processes influencing contaminants distribution and impact onto the 1st trophic levels;
- examination of contaminants transfer on the basis of functional dynamics and structure of trophic webs in the gulf of Lion.

- **2019**: MERITE's oceanographic cruise - practices and planned approaches is given bellow

A 25-30 days sampling campaign will be organized in spring 2019 (i.e. during post planktonic bloom period) with sampling stations distributed in the 2 studied fishing ground areas (Gulf of Lion, Gulf of Gabes) and the 3 urbanized bays (Toulon, Marseille, Sfax). Such a strategy will allow to cover various conditions especially in terms of anthropogenic pressures and compare specificities of north vs. south of the Mediterranean Sea, highlighting the biogeochemical processes involved in the transfer and impact of chemical contaminants onto 1st levels of pelagic trophic food web. The different biogeochemical statuses of marine ecosystems study areas (e.g. oligotrophy vs. mesotrophy) will also be examined and compared. Finally biological tracers (δ15N, δ13C, CHN…) and plankton community's structures will be used to better constraint "diet" sources and to determined trophic gradients in planktonic food webs.

MERITE-MED will fully contribute to the following sub-tasks:
(1) Studies of the link between hot spots urbanized contaminated bays and contaminants uptake by plankton and pollutant dispersion;
(2) Assessment of contaminants impacts on plankton communities in biological habitats and fishing areas;
(3) Uptake, bioaccumulation and biomagnification of contaminants in planktonic food webs and higher trophic levels.

Competences and consortium

The proposal is that the joint oceanographic research cruise would be organized on the ANTEA French research vessel with research scientist gathering all needed competences under truly inter-institutional cooperation and fully fitted in the scope and well experienced. The scientific and administrative dossier will be submitted for evaluation in due time to CNFC (Commission Nationale de la Flotte Côtière).
Physical oceanography, marine ecologists, biologists, microbiologists and chemists will be shared from the French and Tunisian partner teams involved in the MERITE project.

- **2020**: Completion of sample analysis and scientific valorization of results by scientific publications and communications and data base archives.

Working areas and positions of planned stations and their water depth

Three working areas were provisionally selected as:
(1) golf of Lion with sampling stations in both bays Toulon and Marseille, stations under the influence of the Rhone plume and coastal imputs and a few stations along the transect which can be identified as closing limit of the golf system;
(2) reference off-shore stations in both western and central-southern basins of the Mediterranean and
(3) golf of Gabès with one station at Sfax bay and a few stations in the golf.

The selection of exact common sampling station locations will allow complementing and sharing observations and data which was already obtained and planned in both tasks "urbanized bays" and "fishing grounds". In particular this concerns "space- time dynamics component" and actually developed and planned study within CHIFRE project and related intended research actions.

On the other hand the working plan between 12 to maximum 24 hours at each station will allow conducting intensive full and maximized surveys and sampling including:
(A) deployment of a cluster of sensors for physical, biological and chemical measurements and water column sampling (CTD casts with ultraclean Niskin/Go-Flow rosette bottles for depth profils of chmical contaminants concentrations, nutrients and main physic-chemical parameters, and sampling for plankton biomass, abundance and community structure determinations …);
(B) intensive plankton sampling and in size class fractionations (such as *in situ* submersible pumps for bacterioplankton, cascade on line size class fractionation and “hydrobios” type horizontal repeated net tows deployments...) and;
(C) on-board mesocosms modern set-ups for targeted experimental investigations of plankton-chemical contaminants interactions: on coastal and off-shore plankton communities submitted either to a gradient of contaminants (to reach levels encountered in harbor areas or during polluted sediment resuspension events) or reversely to a reduced contaminants exposition (e.g. through the addition of chelates reducing the bioavailable fraction of trace metals and the use of accumulating membrane decreasing exposition to organic pollutants).

This work plan will be complemented by actions and developments in 2018.

The provisional cruise plan is given below including preliminary inventory of methodological procedures.

Stations description		Lat	Long	Depth (m)
Golf of Lion and Toulon, Marseille bays				
ST1	Toulon Bay	43° 3'49.17"N	5°59'4.80"E	34
ST2	Maures Escarpement C.	42°56'1.20"N	5°58'2.46"E	1864
ST3	Cassis canyon	42°58'51.01"N	5°24'2.33"E	1461
ST4	Marseille bay	43°17'21.45"N	5°13'46.19"E	33
ST5	Sete canyon	42°35'30.81"N	4°18'49.27"E	71
ST6	Rhone plume	43°10'54.48"N	4°30'6.12"E	96
ST7	Sète Agde	43° 9'6.80"N	3°54'55.46"E	1580
ST8	Cabo Creus canyon	42°19'52.73"N	3°32'48.37"E	809
Reference off-shore stations				
ST9	Western Ref1	42° 4'42.03"N	5°56'19.23"E	2533
ST10	Western Ref2	39°50'34.76"N	6°23'32.79"E	2855
ST11	Off –shore Tunis	37°53'18.18"N	10°21'32.05"E	433
ST16	Tyrrehnian	39°38'4.23"N	11°11'59.17"E	2985
Golf of Gabès and Sfax bay				
ST12	Gabès 1	34°15'29.41"N	11°31'33.59"E	58
ST13	Gabès 2 Sfax	34°42'12.73"N	10°47'49.07"E	6
ST14	Gabès 3	34°15'57.96"N	10°28'7.01"E	25
ST15	Gabès 4	34° 3'44.43"N	10°43'51.18"E	20

INTERNATIONAL COLLABORATIONS

MERITE provides a general framework and the opportunity for collaborative work to be developed in other pilot urbanized and fishing areas of middle/eastern Mediterranean and Black Sea. The inclusion of western, central and eastern pilot areas in the Mediterranean and Black Seas (Gulf of Lion, Gulf of Gabès, Adriatic, northern Aegean and Danube shelf) will on the short--term provide the needed dimension for federating international projects sharing same objectives.

The Sfax Bay/Gulf of Gabes region will allow setting up an action of international dimension by fostering collaboration with Tunisian partners (CBS, FSB,…), enabling the integration of competences, supports, and implementation means. Additionally, a Croatian partner (RBI, Zagreb) is developing similar approach in the Krka Estuary (Adriatic Sea), which will be interlinked with MERITE, as well as Italian colleagues (CNR, ISPRA, Genova and Cagliari universities) involved in Interreg Marittimo projects (started in 2017-2018) relating to coastal contamination (chemicals, microplastics) and impact onto more remote areas such as Marine Protected Areas. Fishing grounds habitats in the Athens/Saronikos Gulf and Constanta/Danube area in the Black Sea will be studied with MERITE similar approaches through collaborative work carried out with external partners (HCMR and NIMRD).

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3. FINANCIAL ALLOCATIONS, IN CASH OR IN KIND

PROVISIONAL YEARLY ALLOCATIONS OF MISTRALS FUNDING

YEAR	REQUESTED	ALLOCATED
2016		110 K€
2017		70 K€
2018	50 K€	
2019	100 K€	
2020	50 K€	

Details of 2018-2020 MERMEX funding request:
- 2018: 50K€
  5K€ travel costs for partners meeting
  25K€ for consumables/small equipments/anlaysis for methodological developments
  15K€ for complementary analysis of samples from 2017 campaign in Gabes/Sfax bay (to assess chemical contaminants levels and microorganisms abundance/diversity)
  5K€ for historic data collection of fishing grounds contamination

- 2019: 100K€
  20K€ travel costs for the oceanographic cruise
  25K€ for consumables/small equipments/products/… for on board sampling, sample treatment and analyse
  15K€ for consumables/small equipments/products/… for on board mesocosms experiments
  40K€ for biological and chemical analysis expenses

- 2020: 40K€
  35K€ for biological and chemical analysis expenses
  15K€ for the organisation of the final MERITE meeting

CO-FUNDINGS

MERITE		
Acquis		
ANR AMORAD	2013-2019	620 K€
ANR MATUGLI	2015-2017	150 K€
UTLN+TPM+CD83-PREVENT	2015-2017	93 K€
EC2CO-IMPRECI-M²	2016-2017	38 K€
EC2CO CHIFRE	2017-2018	18 K€
AERMC METFLUX	2016-2019	187 K€
AERMC BLUE-POLUT	2016-2019	70 K€
French-Tunisian actions		130 K€
INTERREG MARITTIMO SEDRIPORT	2017-2020	187 K€
INTERREG MARITTIMO IMPACT	2017-2020	217 K€
LABEX-OTMED MEDPOP	2015-2017	110 K€
JPI OCEAN-ANR PLASTOX	2016-2018	200 K€
ALTEO HYDROCALCITE	2016-2018	155 K€
ALTEO DYMERE	2016-2017	28 K€

ENVIMED COZOMED	2016	18 K€
IRD MICROGYPSE-1	2016	6 K€
PACA-PARTICULE / LEFE BATO	2016	12 K€
FFP GALION	2016-2019	
H2020 DISCARDLESS	2015-2019	
EC2CO DYNAMICA	2017-2018	37 K€
APOG PACA DECOMAR	2017	92 K€
INTERREG MARITTIMO GEREMIA	2018-2021	253 k€
INTERREG MARITTIMO SPLASH!	2018-2020	231 k€

Demandés

EC2CO SPECIPHYCO	2017-2018	39 K€
Parc National des Calanques	2017	10 K€
Mairie de marseille	2017	8 K€
LMI COSYS-Med	2017	15 K€
AO IRD	2017	5 K€
AO IRD	2017	6 K€
IRD MICROGYPSE-2	2017	5 K€
FEAMP SWORDFISH	2016-2017	
AMIDEX UECOCOT	2018-2020	398.4 k€