ANR 2014 - Défi Gestion Sobre des ressources et adaptation au changement climatique

SunRISE
Sediment fluxes, tUrbidity aNd seafloor Integrity for the MaRIne StratEgy

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1 Summary

The dynamics of sediment fluxes in the fluvial and marine environments are still poorly known, particularly at a regional scale. Measurement techniques as well as numerical models still require research in order to assess these fluxes from their continental source to the shelf edge; this research would also benefit from improved and shared monitoring networks.

SunRISE gathers a large community of French and European research laboratories, consulting companies and governing agencies in order to address i) climate change related issues, particularly in the current context of coastal vulnerability, ii) European Directives issues, for which pertinent state indicators and monitoring strategies have to be developed.

SunRISE is organized around 5 workpackages (WP) aiming at identifying which are the priority research topics to address in order to tackle the following issues: “sediment fluxes at a regional scale in a changing climate”, and “definition of state indicators for the physical parameters describing the marine environment”. WP1 will define the priority processes to account for, WP2 will define the necessary innovations in terms of observation, WP3 will investigate the various modelling approaches, WP4 will work on the research needed in order to improve state indicators. The last WP is transversal and will help define the main orientations of projects to be designed to answer 2016 ANR and/or H2020 calls for proposals. The financial support sought from the ANR will contribute to fund workshops aiming at writing these projects.

The originality of this network lies in the fact that it will bring together French and European teams working at defining integrative descriptors of the physical regional and coastal environment. Such a structure is essential in order to lead coordinated action at the European level, in particular in the framework of the Marine Strategy Framework Directive (MSFD). The strong participation of European partners (who accepted to lead three of the five WPs) illustrates this initiative relevance.

2 Partners

Parner	Name	First name	Position	Implication per partner (months)	Partner expertise and role in the project
Ifremer	Cayocca	Florence	Researcher	2,5	Project oordinator WP leader S2, S6, T1, T3, M1, M2
	Le Hir	Pierre	Researcher		
	Verney	Romaric	Researcher		
	Gohin	Francis	Researcher		
	Grasso	Florence	Researcher		
Université de Lille 1 (LOG) CNRS UMR 8217	Trentesaux	Alain	Researcher	1,2	Partner coordinator S2,S4,S7,T1,T2,T5
	Hequette	Arnaud	Researcher		
	Verpoorter	Charles	Researcher		
	Reynaud	Jean-Yves	Researcher		
	Graveleau	Fabien	Researcher		
Université de Caen et de Rouen (M2C) CNRS DR19	Le Bot	Sophie	Lecturer	1,2	Partner coordinator S2, S3, S4, S6, T1, T5
	Deloffre	Julien	Lecturer		
	Laffite	Robert	Professor		
	Bennis	Anne-Claire	Lecturer		
Université de Caen (LUSAC)	Guillou	Sylvain	Researcher	1,5	Partner coordinator S2, S3
	Thiébot	Jérôme	Researcher		
Université de Nantes (IUML) CNRS FR 3473	**Gernez**	**Pierre**	**Researcher**	**1,2**	**Partner coordinator S6, T2**

Université d'Angers (LPG-BIAF) UMR 6112	Maillet	Grégoire	Researcher	1,5	Partner coordinator S1, S6, S7
	Howa	Helène	Researcher		
Université de La Rochelle (LIENSs) UMR 7266	Chaumillon	Eric	Researcher	2	Partner coordinator S1, S2, S3, S4, T3, T5
	Bertin	Xavier	Researcher		
	Brenon	Isabelle	Researcher		
Université de Bordeaux (EPOC) UMR 5805	Sottolicchio	Aldo	Researcher	1,5	Partner coordinator S1, S2, S3, S5, S6, S7, T1, T3
	Castelle	Bruno	Researcher		
	Marieu	Vincent	Engineer		
	Schmidt	Sabine	Researcher		
Université de Toulouse (LA) UMR 5560	Estournel	Claude	Researcher	1,5	Partner coordinator S3, T3
	Ulsès	Caroline	Researcher		
Université de Perpignan (CEFREM) UMR 5110	Bourrin	François	Researcher	2	Partner coordinator S2, S3, S7, T1
	Durrieu de Madron	Xavier	Researcher		
	Certain	Raphaël	Researcher		
	Robin	Nicolas	Researcher		
Université d'Aix-Marseille (CEREGE – MIO) UMR 7330 – UMR 7294	Sabatier	François	Researcher	2	Partner coordinator S1, S2, S3, S6, S7, T1
	Anthony	Edouard	Researcher		
	Meulé	Samuel	Researcher		
	Rey	Vincent	Researcher		
Université Pierre et Marie Curie (LOV) CNRS	Doxaran	David	Researcher	1	Partner coordinator S1, S2
Université de Grenoble (LEGI) UMR 5519	Larroudé	Philippe	Researcher	1	Partner coordinator S3, S7, T3
BRGM	Vinchon	Charlotte	Engineer	2,7	Partner coordinator WP leader S2, S3, T3, T5, M1, M2
	Idier	Déborah	Researcher		
	Desmazes	Franck	Engineer		
	Müller	Héloïse	Researcher		
IRSN	Bailly du Bois	Pascal	Researcher	2	Partner coordinator S5, T1
	Charmasson	Sabine	Researcher		
	Duffa	Céline	Researcher		
	Laguionie	Philippe	Researcher		
	Aranud	Mireille	Researcher		

SHOM	Jourdin	Frédéric	Researcher	2	Partner coordinator WP leader S4, T4, T5, M1
	Garlan	Thierry	Researcher		
	Blanpain	Olivier	Researcher		
	Marchès	Elodie	Researcher		
	Tew Kaï	Emilie	Researcher		
CEREMA	Guillou	Nicolas	Researcher	1	
	Chapalain	Georges	Researcher		

Private Companies

CREOCEAN	Walker	Patrice	Engineer	1	Partner coordinator S2,S3,T5
	Devilliers	Caroline	Engineer		
ARTELIA	Walther	Régis	Engineer	0,6	Partner coordinator S1,S2,S6,T3
	Sauvaget	Patrick	Engineer		
DHI	Tessier	Caroline	Engineer	0,25	Partner coordinator
	Vested	Hans Jacob	Engineer		

Foreign partners

CNR ISMAR- Italy	Ferrarin	Christian	Researcher	2	Partner coordinator WP leader S3, T3
	Umgiesser	Georg	Researcher		
RBINS - Belgium	Fettweiss	Michael	Researcher	2	Partner coordinator WP leader S1, S2, S3, S4, S6, T1, T2, T3, T5, M1, M2
	Van Lancker	Vera	Researcher		
	Legrand	Sébastien	Engineer		
	Van den Eynde	Dries	Engineer		
CSIC - Spain	Palanques	Alberto	Researcher	2	Partner coordinator WP leader S2, S3, S5, S6, S7, T1
	Guillén	Jorge	Researcher		
	Pere Puig	Enrique Isla	Researcher		
	Simarro	Gonzalo	Researcher		
	Durán	Ruth	Researcher		
UB - Spain	Canals	Miquel	Researcher	1	Partner coordinator S1, S2, S3, S4, T1, T5, M1, M2
	Calafat	Antoni	Researcher		
	Lastras	Galderic	Researcher		
	Sànchez-Vidal	Anna	Researcher		
	Amblàs	David	Researcher		
Technical University of Delft, Netherlands	Van Prooijen	Bram	Researcher	0,5	Partner coordinator S2, S5, T2, T3
NERC - UK	Souza	Alejandro	Researcher	0,5	Partner coordinator S1,S3, S6 T1, T3

Governing Agencies with no funding

AAMP	Beauvais	Sophie	Engineer	0,25	Associate member M2
	Paillet	Jérôme	Engineer		
Joint Nature Conservation Committee, DEFRA, UK	Herbon	Cristina			Associate member M2
Federal Environment Agency, Federal Environment Ministry, Germany	Leujak	Wera			Associate member M2
Water Institute, Republic ov Slovenia	Peterlin	Monika			Associate member M2

Scientific skills	Technical skills	Management
• River discharges quantification and fate (S1) • Shoreline dynamics and sand fluxes from the shore to the innershelf (S2) • Coastal and shelf oceanography and morphodynamics (S3) • Coastal and shelf geomorphology and high resolution stratigraphy (S4) • Bed reworking quantification at the regional scale (S5) • Estuarine sediment dynamics (S6) • Beach processes (S7)	• Instrumentation / *in situ* observations (T1) • Satellite remote sensing: algorithm improvement / validation (T2) • Sediment fluxes numerical modelling (T3) • Statistical modelling (T4) • Cartography (T5)	• Data management (M1) • Application of European policy and reporting (M2)

Changes in the Consortium since the pre-proposal:

- one scientific partner has been added (LUSAC, Caen University)
- the non-French governing agencies that were mentioned in the pre-proposal (DEFRA, United Kingdom; Federal Environment Agency, Germany; Water Institute, Slovenia) have confirmed their interest in the network. Since they are not research institutions, they are mostly interested in being informed about the network outputs, without investing time into it. They will be invited to attend SunRISE's last meeting. They were not requested to fill the "fiches partenaires" on line.
- the 50 k€ amount mentioned in the ANR action plan for networks was initially understood as a maximum value. Given the number of partners and the update of the maximum possible funding amount, the request for funding has been increased to 82 k€. This amount will also contribute to fund travel expenses for non-French partners (as specified by mail by the ANR : the call for proposal was not very explicit about that possibility).

Even though the coordinator will be the only partner receiving funding, all scientific partners were requested to sign a "fiche partenaire" so as to testify their commitment in the network. However, the pages relative to administrative information for all partners but the coordinator were removed (the information is online) so as to keep the document size acceptable, therefore the page numbering in the corresponding file is wrong.

3 Context and objectives

3.1 State of the art

Despite being the support of numerous resources and potential uses for humanity and a biodiversity reservoir, the marine environment appears to be an insufficiently known world. The awareness of that situation has raised numerous research projects in the past decades, as well as regulatory policies at the international, European and national levels. However, despite the importance of the hydrodynamic and morphodynamic processes in controlling the biota distribution and quality, these projects have mainly investigated the living compartments of the marine environment, while the physical environment has been poorly addressed. In particular, little attention has been paid to the regional investigation of sediment flux dynamics in the marine environment. Past investigations were indeed often restricted to fairly local areas, and lacked integrative "source to sink" type approaches. These limitations partly result from the overall sediment dynamics complexity: the rigorous assessment of these fluxes requires understanding transport processes of mineral particles in the water column as well as their behaviour in the seabed, oftentimes under the influence of biota (impacting flocculation processes, resuspension capacities and consolidation within the sediment). Investigating sediment fluxes from their continental source to the shelf still requires advanced research dedicated to the improvement of measurement techniques (particularly for sand transport, but also to qualify optic and acoustic devices for instance) as well as the improvement of modelling approaches. The

overall assessment of turbidity and sediment fluxes also needs to rely on the use of existing monitoring networks and the construction of new ones in coastal environments.

Sediment fluxes assessment is a key point in order to investigate coastal morphological evolutions and/or habitat changes. Morphodynamics in urbanized areas has become a particularly sensitive topic since conditions of sediment remobilisation and transport may change under increased climate change stress (sea-level rise, wave climate change, modification in the drainage basins hydraulic regime due to modified rainfall), but also under the stress of increased human impact (river management and damming, dredging, marine aggregate extraction, aquaculture, fishing, offshore renewable energy farms), which may change sediment inputs from the continent and the conditions of sediment remobilisation and transport in the coastal zone. Moreover, fine sediments resuspension cannot be disconnected from the induced turbidity, hence from the primary production in coastal environments. In this document, the term “sediment fluxes” will thus be understood in the sense of *i)* long-shore or cross-shore sediment fluxes, from the continent to the shelf, *ii)* the related evolutions in bottom sedimentary coverage (links with the seafloor integrity), turbidity (links with the euphotic depth and primary production), and morphology (links with bathymetric and/or hydrodynamic changes, *cf.* coastal erosion issues).

In the late 1990s and early 2000s, the ONR-funded North-American STRATAFORM project, followed by the joint EU-ONR-funded EuroSTRATFORM project were pioneers in gathering scientists from the whole sediment dynamics community (geologists, stratigraphers, sedimentologists, sediment dynamics researchers, instrumental and numerical developers, *etc.*) , in order to understand sedimentary systems from source to sink. While these projects came to an end, the success of the experience led James Syvitski (University of Colorado at Boulder) to initiate the NSF-founded CSDMS (Community Surface Dynamics Modeling System) network. Even though this network focused on modelling issues (which is not SunRISE’s purpose), it was born from the successful mixing of disciplines usually mostly foreign to each other. Ten years after its foundation, it is still very much alive and still fosters successful pluridisciplinary interactions in the field of sediment dynamics approaches at all space and time scales. It is the success of this approach that SunRISE aims at reproducing in a national and European environment, yet with a wider disciplinary scope (not restricted to modelling) and more restricted space and time scales (restrained to the whole continental shelf and modern processes).

The challenges set by the ANR Action Plan and by the European context also require the adoption of an “overall” view of the environment. In the marine environment, several European framework directives (WFD ; MSFD, Natura 2000), Regional sea conventions (RSC), as well as national policies such as the road map for “marine biodiversity, seas and oceans” drawn after the French environmental conference (2013) aim all toward a common objective of improving or maintaining a good “environmental” or “ecological” status for the sea. While they apply to different scales and perimeters, all stress the need for an ecosystemic approach where the water column and the sea bed physical characteristics are the support (substrate) for biological activity. These directives are based on a DPSIR approach (Driving Forces, Pressures, States, Impacts, Responses) for which knowing the seabed and water column physical status is a key to understand how various sources of pressure can impact the status of its living component.

Within the MSFD, the physical characteristics of the sea floor and water column are dealt with through two “descriptors” (D6 = “sea floor integrity”, and D7 =” no permanent change in hydrography”). One of the directive’s goals is ensure little to no disturbance due to human activities regarding natural sedimentation, bathymetry, turbidity, hydrodynamics, so as to ensure in turn little to no disturbance to the living environment. Both descriptors are therefore closely linked to pelagic and benthic habitats, even if little is still known regarding the accurate assessment of the space and time impact of human activities on the biota (apart for some activities which have been thoroughly investigated, such as marine aggregate extraction). A monitoring program is being set up within the MSFD so as to monitor the evolution of seafloor and water column physical parameters, determine state indicators, and possibly assess the efficiency of management measures.

Numerous scientific gaps and the absence of a dedicated framework for the sediment dynamics research community to propose coordinated action have led the teams in charge of implementing MSFD for D6 and

D7 to provide partial answers to the MSFD requirements. This resulted in little coherence between European Member States. SunRISE has the ambition to propose synergetic projects so as to promote a sound strategy based on scientific expertise. The enthusiasm shown by the European partners involved in MSFD issues to join this network illustrates their longing for such structure.

To our knowledge, no other country has taken the lead to coordinate projects dedicated to address the MSFD for Descriptors 6 and 7. European scientists, particularly in disciplinary fields that have not yet been somewhat structured within European conventions, also miss such scientific coordination. SunRISE is a starting point, and will involve European teams willing to participate in enlightening future Horizon2020 projects.

While climate change as such is not addressed within the MSFD, it cannot be disregarded when trying to assess anthropic *vs.* natural variability. As far as sediment fluxes are concerned, this purely "sedimentological" aspect of the sediment fluxes at the regional scale may disregard links to biology, while being required to investigate past variability as well as climate change issues. The proposed network therefore also sets a sound platform in order to gather a wide range of different experts likely to build future projects addressing climate change issues (*e.g.* long-term coastal or estuarine morphological evolutions, long-term sediment coverage trends, coastal erosion issues as required by the National Strategy for Integrated Coastal Management [SNGITC] *etc.*).

3.2 Scientific and technological issues

Several technological and scientific barriers still impair proper evaluation of sediment fluxes (optical *vs.* acoustic techniques, particular issues related to sand flux evaluation, *etc.*); while river solid discharges are now starting to be more accurately measured or estimated, their fate is still unknown because of difficulties in tracking them in the coastal environment and validating numerical models; sediment exchanges between the shore and the inner shelf are still incompletely understood, partly because of the complexity of wave-current interactions to be accounted for. The fate of sediments eroded during storms is for instance mostly unknown.

The network will help prioritize relevant issues in order to improve our capability to predict overall sediment fluxes across the shelf, and much can be expected from the collaboration between field researchers, experts in data acquisition and processing, physical oceanographers and numerical modellers.

Furthermore, the definition of pertinent indicators qualifying a “good environmental/ecological status” is still a challenge. Different European countries have come up with various propositions that deserve more attention, particularly because quantifying the natural variability at the regional scale has not yet been done for sediment-related parameters, because the overall impact of superimposed human activities on different parameters (turbidity, morphology, sediment distribution) is not yet known either, because choosing relevant state indicators should also be done taking into account the ecosystem’s sensitivity to various parameters.

3.3 Expected results

The goal of this project is to gather the national and international experts to be solicited to fully address the issues regarding sediment fluxes at a regional scale. It will create a missing link between the different scientific communities working from the continental or coastal sediment source to the continental shelf, from the “observation” world to the “modelling” world as well as the “technical” world. It will also complement existing marine sciences networks (such as related to ICES or Regional Seas Conventions) by addressing marine issues from the physical standpoint.

Shared projects and objectives are the best way to motivate true collaborations between specialties that may seem, from afar, to fall under the same disciplinary field ("sediment dynamics"), but that actually exhibit a vast diversity of approaches and expertise depending on the investigated time scale or space scales. The SunRISE network will build a scientific environment where researchers will share advances on measurement devices and techniques, sedimentary processes, integrative numerical models, and monitoring approaches.

The results will therefore consist in:

- a proposed perennial European structuration so as to promote improved coordination regarding how Descriptors 6 and 7 will be addressed within the Marine Strategy Framework Directive, even beyond the lifespan of the SunRISE network;
- the definition of several research actions to be included within one or several projects to be proposed to 2016 ANR or H2020 calls for proposals.

3.4 Outcomes with regards to society, economy, regulations, environment

The introduction of the #1 societal challenge "sober resources management and adaptation to climate change" in the call is enlightening: human impacts on the environment (whether "direct" impacts or climate change-related) are now perceived from the local to the global scales, ecosystems are affected while the need for natural resources is continuously increasing. At the national level, this understanding led to the second road map issued from the 2013 Environmental Conference for an Ecological Transition. This roadmap identified research priorities regarding marine biodiversity, seas and oceans. It particularly mentioned the need to define the conditions for the sustainable exploitation of resources from the marine environment and for « the development of maritime activities such as marine renewable energy exploitation and maritime traffic ». Such activities may indeed affect the marine biodiversity, either directly or indirectly. As a translation into regulatory commitments, the roadmap also sets up the need to define scientific and operational priorities in support of European public policies such as the Marine Strategy Framework Directive (Directive cadre stratégie pour le milieu marin), the Flora and Fauna Habitat Directive (Directive habitat faune flore), Natura 2000 and the strategy to create protected marine areas.

One of our society's challenges is to understand the intricate processes governing natural and human-impacted systems, and to imagine remediation strategies. Sediment fluxes are one of these processes, likely to be modified by climate change (because of changing continental erosion impacting inputs to the ocean, modified wave climate or sea level transforming sediment dynamics in coastal seas, *etc.*), and being modified by human impacts (river damming, dredging, sand extraction, offshore installation of large structures, aquaculture, trawling, *etc.*). Climate change and broad scale activities (such as fishing or large infrastructures construction) are already disturbing the overall sediment flux dynamics in rivers and coastal seas though various processes: *i)* reducing coarse sediment inputs to the sea, *ii)* creating sometimes undesirable large sediment traps (for fine sediments, sand or pebbles) requiring further management, impairing in places natural sand transfers to the beaches, *iii)* modifying benthic habitats through mechanical bed reworking, changes in bed composition or increased turbidity, *iv)* modifying pelagic habitats through increased turbidity, which may in turn affect phytoplankton growth or the location of fish nourishing grounds. These changes are all motivated by the need for resources: energy resources (damming, marine renewable energy), mineral resources (river or marine sediment extraction), food resources (aquaculture and fishing). The intensity of these needs is likely to increase, which will require alternative strategies to limit their negative impact on an environment under continuous exploitation.

Whether related to the ecosystem or not, all these issues are more or less related to sediment transfers, whether under direct human action, or under natural forcing (*e.g.* sediment transfers between the shelf and the shoreface). Apart from the ecosystemic point of view clearly identified within the MSFD or other international directives, particularly in a rising sea level context, it becomes of utmost interest to know the present and future sources and sinks of sediments, in order to better anticipate future trends in coastal areas morphological evolutions. These « morphodynamic » issues have been identified as priorities within the national HED^2 research association (GIS Hydraulique pour l'Environnement et le Développement Durable – Hydraulics for the Environmental and Sustainable Development) led by the CEREMA (Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement) , as well as within the National

Strategy for the Coastline Integrated Management (Stratégie Nationale pour la Gestion Intégrée du Trait de Côte) led by the French Ministry of Ecology.

3.5 National / international position

At the national level, this network re-activates past collaborative actions such as the Transversal Action ART7 from the Programme National Environnement Côtier, while enlarging it to the shelf scale (and an international partnership). It encompasses research issues that were identified by the 2010 Ocean Atmosphere INSU Prospective (in particular regarding sediment transfers from the continent to the inner shelf). It also constitutes a concrete continuation of the SHELFLUX initiative (EC2CO 2008) aiming at assessing sediment fluxes at the regional scale. That theme has since been identified as a main research axis by the national HED^2 association research program.

From the MSFD standpoint, the network reinforces the so far informal links between the French institutes in charge of coordinating the Directive's work plan for Descriptor 6 and Descriptor 7 (respectively BRGM and SHOM) and research teams possibly involved in designing or operating improved indicators and/or monitoring strategies.

From a scientific point of view, most universities and research organizations that investigate sediment dynamics along French coasts are involved in the network. Investigation sites cover the English Channel, the Bay of Biscay and the Mediterranean Sea. The choice of allowing such a wide consortium was made so as to foster productive brainstorming related to the a large range of different topics that need to be addressed in order to tackle ambitious objectives, and so as to collect experience from teams working in different types of environments. European teams are also included for their interest in the regional scale and/or for their expertise in certain processes, for the benefit of their experience in non-French waters (e.g. North Sea, Adriatic Sea) and for their implication within the Marine Strategy in their own country.

4 Scientific and technical programme, project organization

4.1. 1 WP1 Priority process-oriented research topics to be addressed in order to assess sediment fluxes over the shelf - WP leader: CSIC, Spain

The continent-ocean transfer of matter and energy involves a number of processes operating and interacting at different time and space scales, having a direct effect on "seafloor integrity" and "hydrography" (descriptors D6 and D7). Human disturbances on watershed, coastal and offshore systems, and disturbances resulting from global change, superimpose on natural processes and must be fully addressed.

Anthropogenic transformations have altered all physiographic compartments participating in sediment transfers from the continent to the shelf edge:

- the river watershed (damming, channelling of river beds, water and gravel extraction)
- the coastline, which has been heavily remodelled by infrastructures (harbours and marinas, breakwaters and groins, sewage pipes, storm sewers) or beach nourishment,
- the coastal area, sometimes expanding to the shelf, undergoing activities such as dredging, sand extraction and trawling.

These human activities have dramatically altered the natural sediment fluxes and hydrography in many regions of the world, including Europe. Superimposed to these direct impacts, climate change modifies forcing conditions, hence contributing to indirect changes in sediment transfers and water turbidity.

These changes induce impacts on the ecosystems, which in turn alter sediment fluxes and hydrography. The main objective of this WP is to investigate how to account for the complex interaction of all these factors in order to evaluate the MSFD D6 and D7 descriptors.

One task will analyse the role of watershed inputs, coastal systems and human activities. Another task will study the main marine processes controlling hydrography and sediment dynamics and a third task will specifically investigate the impact of extreme events.

Task 1: Improved integrated assessment of sediment discharges into the ocean including the effects of human activities.

- Sediment inputs from rivers and coastal erosion and resulting sediment fluxes.
- Role of coastal lagoons and estuaries on coast-shelf sediment exchange and trapping
- Role of harbours, infrastructures, and dredging activities in modifying coastal sediment fluxes, water masses and currents
- Role of bottom trawling on altering continental margin sediment fluxes and morphology

Task 2: Main processes driving sediment dynamics and hydrography onshore, offshore and off-shelf

- Role of wind induced currents, high-frequency wave oscillatory currents and low frequency waves on sediment transport in tidally and non-tidally influenced shelves.
- Role of biological and physicochemical processes on particle flocculation and cohesion, and in stabilising/destabilising the seabed
- Role of internal waves on shelf sediment fluxes and bottom morphology
- Shelf edge sediment exchange processes and slope transfer through submarine canyons
- Processes controlling nepheloid layers dynamics

Task 3: Impact of extreme events on sediment fluxes

- Sediment fluxes and dynamics during major storms, floods, dense shelf water cascading events and benthic storms
- Fluid muds, and storm and flood layers.
- Biological and physical reworking of bottom sediment after extreme sediment transport events

Large data sets are required to observe and detect changes in the environmental status as it results from processes working at different time scales. Data are mainly provided by in situ measurements and satellite observation, and are complemented by model outputs. In order to assess seafloor integrity and hydrography, locations where sediment fluxes, physical processes and organisms have been monitored and labelled as locations in “good environmental status” will be compared to locations exhibiting different levels of natural and human-induced pressure. This approach will help assess the relevance of various indicators associated with sediment fluxes and hydrography in order to assess the environmental status.

Index of success of WP1

The state of the art as issued from the confrontation of all partners’ expertise will set the bases to prioritize research themes aiming at improving our understanding of the shelf-scale sediment dynamics. Main gaps in knowledge will be identified according to their impact on the correct determination of sediment fluxes at the regional scale.

Risk of failure and contingency plan

The list of issues to be addressed is long. Finding criteria to favour some “priority” topics to be included in future projects may be challenging. Confrontation with the outputs from other WPs (including WP4) and additional state of the art reviews may be required so as to sort out a reduced number of priorities.

Regarding MSFD final objectives, the different characteristics of each site must be well understood in order to properly discriminate different values for D6/D7 indicators: some of these could be different for different sites (e.g. for the Atlantic and for the Mediterranean Sea). A challenge will be to use these differences in order to better capture the definition of a “good” environmental status.

Chronogram

- Kick off meeting: organisation of participants and identification of key areas for analysis of processes, human activities and environmental status
- End of year 1 meeting: Identification of relationships between processes and good environmental status. Structuration of a report focused on proposal elaboration
- End-year 2: Integration of the results for writing of drafts proposal

4.1. 2 WP2 : Improvement of critical observation techniques and strategies - WP leader:RBINS, Belgium

The focus of this WPs lies on *i)* the evaluation and intercomparison of established monitoring techniques and strategies for descriptors D6 and D7 describing the marine ecosystems physical background (seafloor integrity and hydrography) and *ii)* on the proposition and assessment of new methods. The main parameters to be monitored are bottom shear stress, turbidity (suspended particulate matter – SPM concentration), particle settling and bed load transport. An important aim is to assess the state of our understanding and to evaluate the uncertainties involved in the measurement of these parameters. Knowledge of the uncertainty will become an important issue, as they will be used as tools to evaluate ecosystem changes and the good environmental status of the marine ecosystem.

Task 1: Evaluation and intercomparison of existing monitoring techniques for

1) Suspended sediment dynamics in the water column. This includes in situ optic and acoustic methods to measure suspended sediment concentration and its characteristics.
2) Bottom boundary layer dynamics. This includes measurements of bed shear stress, critical erosion shear stress and bedload sediment transport.
3) Assessing geographical turbidity variability using remote sensing techniques.

Task 2: Uncertainty of the monitoring techniques

1) Repeatability and spatial representativity of the measurements.
2) Calibration and intercalibration of optic and acoustic sensors for measuring sediment dynamics in order to assess the uncertainty of the sensors.

Task 3: Improvements of monitoring methods

1) Combination of optic and (multi-frequent) acoustic sensors for measuring sediment dynamics
2) Assessment of the interest for systematic mineralogical composition, organic matter and biomass characteristics of the seabed and the suspended matter in the water column
3) Assessment of methods (fixed stations, random sampling in space and time, vertical profiling, combination of different sensors) for long-term monitoring strategies of the seabed (morphology) and the sediment dynamics in the near-bed and the water column
4) Investigating the complementarity of using fixed stations (moorings, buoys, tripods...) and mobile platforms such as gliders or profiling floats all equipped with same sensors (optics and acoustics at multiple wavelengths).

Some of these technical issues are likely to be of interest for developers of monitoring devices. Once some key technical issues will have been identified, specific needs and/or solutions will be submitted to private companies that may be interested in future cooperation within H2020 projects.

Index of success of WP2

Help fill gaps in the exploitation of in situ measurements, and improve implementation methods in order to achieve a robust technical and scientific understanding of the primary data types required for the monitoring of D6/D7 indicators.

Risk of failure and contingency plan

Technical and scientific questions arising from this WP depend on existing and new technologies. They are related to the physical processes, their variability and the effect of biological activity. Time-scales from seconds to years will have to be addressed. Common measuring strategies will have to be defined in order to guarantee intercomparison between datasets from geographically distant areas with different environmental settings. Concerning the ability to detect long-term variations, e.g. due to human impact or climate change, answers can only be found through research programmes including long term monitoring networks.

4.1. 3 WP3: Assessing modelling techniques and strategies - WP leader: CNR ISMAR, Italy

Integrated numerical models are important support tools for the management of coastal water environments as well as for research. This WP aims to bring together different initiatives in the field of integrated modelling system development in order to create a European wide community and discussion forum. The scope of this WP is the definition of a modelling framework that could help define best modelling practices in order to characterize MSFD indicators for descriptors D6 and D7.

Many European research institutions, both private and public, are involved in developing numerical modelling systems in order to investigate coastal dynamics for research and management issues. The basic idea of the network is to gather the efforts of already existing scientific groups from France and other European countries, in order to establish a common understanding of sediment transport modelling techniques and strategies. The network activity would also provide new insight useful for coastal management decision throughout Europe.

The principal parameters to be modelled are the same as assessed in WP2, *i.e.* bottom shear stress, turbidity (in terms of suspended sediment concentration), and bedload sediment transport.

Task 1: Sediment transport modelling techniques

This task aims at creating interactions and synergies between the different French and European modelling groups in order to critically evaluate the existing modelling strategies used to assess sediment fluxes and define:

- the role of coupling hydrodynamic, wave and sediment transport models;
- which « boundary conditions » need to be known, at which space and time resolution (seabed composition, quantified river inputs, hydrodynamic/weather forcing) at the regional scale;
- which resolutions are required;
- what is the role of coastal processes in the regional dynamics;
- how to account for the role of biological processes on sediment flux.

Task 2: Long term morphodynamic modelling and climate change

This task will investigate how long term modelling techniques could be used in defining descriptor D6 (sea floor integrity), especially under a climate change perspective. Long term morphological modelling is highly time consuming and a proper simulation set-up has to be defined in order to reproduce the main processes responsible for sediment transport. This task will evaluate existing strategies for long term morphological modelling and propose guidelines for a proper application of numerical models to investigate the effects of a changing climate.

Task 3: Model uncertainty and data assimilation

Numerical modelling results need to be accompanied by the estimation of their uncertainty. This is especially true for sediment transport modelling where high uncertainty characterize the numerical results. The aim of this task is to review the calibration and validation procedures used by the modelling groups involved in the SunRISE consortium in order to understand the limits and reliability of numerical models for describing the dynamics of sediment fluxes in the fluvial and marine environments. The use of data assimilation in sediment transport modelling will be also considered and evaluated.

Index of success of WP1

Be able to identify several scientific questions regarding numerical modelling. Create a network of researchers following a common strategy for sediment flux modelling. Help defining the role of numerical model in describing indicators D6 and D7.

Risk of failure and contingency plan

Scientific questions arising from this WP might find an answer, if all partners of the SunRISE consortium participate in defining common “good modelling practices”.

4.1. 4 WP4: Identify and activate baseline research in support of GES indicators on the physical components of the European seas - WP leader: BRGM-SHOM, France

For a couple of decades, several international, European and national strategies have aimed at defining a “good ecological (or environmental) status” (GES) for marine waters, and at launching procedures so as to reach this target. The implementation of the MSFD sets methods so as to achieve pertinent diagnoses, monitoring strategies, development of indicators and reference values for several descriptors of the environment. Increasing the level of coherence of measures/indicators throughout European waters requires strong cooperation within each defined Marine Region and between the different Marine Regions.

The GES of the European seas, to be achieved in 2020, is described through 11 descriptors. Descriptors D6 and D7 describe the marine ecosystems physical status, and are critical to understand how human activities impact the living component addressed by other indicators. Background information and current activities in support of D6 and D7 suffer from (1) insufficient dedicated research, and (2) lack of European working groups on marine hydrodynamics, morphology and sedimentology. The tight agenda for the implementation of the MSFD is split into 6-year cycles during which predefined indicators have to be assessed according to a stable monitoring strategy. For the first cycle (2010-2016), since knowledge of some environmental parameters at regional scale was missing, approximate indicators were sometimes derived from existing data (e.g. in order to confront the intensity of human activities agains the status of benthic habitats). This

strategy has many weak points and it urgently requires to be improved. The MSFD cycles approach should lead to more robust and sound future assessments of the GES mostly based on the implementation of dedicated research and the development of a refined conceptual frame.

The aim of WP4 is to:

- Review the different GES definitions throughout Europe for descriptors 6 and 7 (bibliographic research)
- Bring a critical analysis
    - of the existing indicators proposed for D6 and D7 within the MSFD. Give guidelines to improve their definition (status assessment, threshold or trends with regard to the "good" status), and define a strategy to move toward a coherent approach throughout Europe
    - of the MSFD first cycle monitoring program tentatively defined within each Member State in order to assess the values of D6 and D7 indicators.
- Identify, along with WP1, which are the main scientific issues to assess in order to better define pertinent descriptors for D6 and D6, and/or to quantify the need for data aiming at quantifying natural vs. human induced variability.

This work will take into account previous results from the FP7 STAGES project (Science and Technology Advancing Governance of Good Environmental Status; *e.g.* report on "Quality-assured science policy briefings on the needs for further research").

Task1: 1) Critical analysis of the physical GES descriptors D6 and D7 as defined in relation to the MSFD 2) Critical analysis of the national reports provided by EU member states in relation to GES descriptors D6 and D7, and 3) Set up of the basis for a European-wide monitoring program

On the basis of the state of art of progresses and deliverables of the implementation of MSFD (initial assessment, preliminary definition of GES, monitoring program), this task will review the European knowledge/indicators regarding descriptors 6 and 7 and make a critical analysis of the work done, so as to improve the cycle 2 approach of the GES and base it on a sound and shared scientific approach: it will in particular try to assess the pertinence of existing indicators throughout Europe, and define how European countries can improve common indicators definition, thresholds and/or trends for D6 and D7 descriptors.

Within the SunRISE network, an international workgroup gathering scientists in charge of D6 and D7 implementation in their own country will synthetize the information provided by all Member States for the initial assessment and for the initial definition of the good environment status (step 1). This synthesis will then be presented to the whole network so as to initiate a brainstorming procedure aiming at proposing improved indicators definitions, and associated monitoring programs (step 2).

Step 1 will be prepared within each Member State, following a chart proposed by WP leaders. A workshop (mid-year 1) will be organized to synthesize the outputs (day 1) present them to the enlarged working group and initiate a first brainstorming session (day 2). A second workshop (end of year 1) will be organized to give the feedback of the critical analysis and launch task 3.

Task2: Improving the links with other marine European directives

This task aims at creating interactions and synergies between the different European directives dedicated to the marine ecological status improvement: the Marine Strategy Framework Directive (MSFD), the Water Framework Directive (WFD), as well as the regional seas conventions (OSPAR, HELCOM, Barcelona), the "action plans for the sea" and the French road map for "marine biodiversity, sea and ocean". A greater coordination between those directives or conventions would bring better coherence and would optimize the efforts dedicated to developing indicators of the marine physical status.

The network will make a first attempt at compiling and analysing the documents produced by Europe and Member States (MS) to implement those plans or directives. The aim of the analysis is to point out common objectives, following the approach of OSPAR and Barcelona sea conventions. These conventions are indeed also developing similar indicators as defined within the MSFD for descriptors D6 and D7.

Task3: Making research propositions to improve the scientific bases of D6 and D7 indicators and the associated monitoring program

Tasks 1 and 2 will identify possible strategies for improving a unified GES assessment throughout Europe with respect to D6 and D7. They will also point out needs for dedicated research aiming at assessing the "physical" environment status at the regional scale. Task 3 will try to deliver guidelines in order to:

- improve the methodology and scientific background for indicators elaboration (taking into account relationships between the physical environment and the pelagic and benthic habitats);
- define methods leading to the definition of thresholds for a "good" environmental status,
- improve the monitoring program related to D6 and D7, aiming at homogenizing the monitoring strategies for the Marine Strategy and Water Framework Directives.

This task will lead to a set of guidelines as a deliverable of task 1 and 2. These guidelines will point out shortcomings in the MSFD first cycle and possible improvements for the next cycle, regarding 1) the Good status definition for D6 and D7 and 2) the optimization of the associated monitoring program, as required by the EU before starting a new MSFD cycle in 2017. Outputs from other WPs will be merged to these guidelines.

Propositions to improve MSFD implementation will be disseminated to all member states, so to be taken in account for the MSFD second cycle.

Index of success of WP4

Be able to identify one or several scientific questions. Help fill gaps in knowledge that imped a sound scientific background to the implementation of D6/D7 indicators. Put forward the key of understanding environmental status that is physical processes and characteristic knowledge.

Risk of failure and contingency plan

Scientific questions arising from this WP might find an answer, if developed in research projects and funded, within several years after 2016. It will not fit with the MSFD second cycle starting in 2017, and asking for an improved definition of good environmental status in 2017. That is why besides finding guidelines of research, it is also important to make methodological propositions or improvement of the MSFD approach to be applicable in 2017.

Chronogram

- Kick off meeting: organisation of task 1 and 2 working group
- Desk studies (reviews od MSFD documents)-Task 2)
- Mid-year 1 meeting: synthesis of first step of task 1
- Desk studies (critical analysis Task 1, compilation and analysis of other policies
- End of year 1: 2 days workshop –Feedback of task 1 and 2, identification of scientific questions, launching of task 3

- Redaction of the report
- Mid-year 2: End of task. Report delivery

4.1. 5 WP5: future project design: come up with several options, and analyze their respective benefits/drawbacks - Proposed WP leader: IFREMER, France

All partner will be involved in this WP that will merge the conclusions of all WPs to think about which project(s) to propose together. This task will be prepared by the WP leader before the mid-year 2 meeting. Preparation will consist in compiling the outputs of workpackages 1 to 4, and providing an analysis of the 2016 Horizon2020 and ANR call. The mid-year 2 meeting will be dedicated to the construction of several possible scenarios for the writing of proposals. Governing agencies will be invited to participate in that meeting so as to express their needs and/or give recommendations regarding the relevance of future projects. Several non-exclusive options may already be imagined, among which:

- creation of a perennial European network dedicated to the assessment of “physical parameters” within European directives (linked to ecosystem-oriented networks)
- proposal for one large European MSFD oriented D6/D7 project including research / applications for various areas
- one project strictly « indicator oriented », with partners representative of other MSFD descriptors related to ecological issues
- one « technical » project focusing on best practice for monitoring the physical environment (in situ / satellite / model), including specific tasks in each field
- one project focusing on sediment transfers from the continent to the shelf edge, at various time scales

Index of success of WP5

Document providing the synthesis of proposed tasks to be inserted within future calls (production from WP1, WP2 and WP3)

Analysis of the national and European calls

Production of advanced drafts for proposal(s)

Risk of failure and contingency plan

The network will be trying to design proposals answering calls that will come out in 2016. The main risk would be for a “thematic” project not to fit these calls as a whole, in which case the network would be “split” in order to join pluridisciplinary consortiums.

Chronogram

- After the end-year 1 meeting: Preparation of the mid-year 2 meeting: synthesis of the outputs of WP1 to WP3. Analysis of the Horizon2020 and ANR calls
- mid-year 2 meeting: structuration of one or several proposals
- end-year 2 workshop (not plenary): writing of the advanced drafts for proposals

4.2 Project organization

The financial support offered for “start-up” activities consists in allowing workshops to be organized so as to prepare collaborative research programmes, at the national or international level. Several work groups will be identified within the network, according to the proposed workpackages, hence *i)* specific needs related to the MSFD requirements (in terms of research, but also international structuration), *ii)* “upstream” research topics related to processes (WP2), observation (WP3) and numerical modelling (WP4).

Given the large number of partners, the number of meetings will have to be fairly limited, and all the better prepared. The first meeting (kick-off) will include a plenary session and WP meetings for which WP leaders will have defined clear and contained objectives for each group, keeping in mind the two global themes supported by the network. This first meeting will have to comfort a set of research orientations within each WP, but will also have to propose a set of ideas so as to bring together different approaches. Brainstorming will be encouraged through the organization of several “transversal” working sessions.

Each workgroup will plan one or dedicated meetings in order to more precisely address the key issues relevant to its theme. Given the transversal links in between WP1, WP2 and WP3, these meetings will be tentatively organized at the same time and place (mid-year 1 and/or end-year 1). The possibility of focusing the research on shared sites will be explored. At that stage, the pertinence of inviting partners outside the network into possible consortiums will be assessed (particularly for H2020 proposals). Particularly regarding MSFD issues, the network will assess the opportunity of inviting representatives of national governing agencies and of the European Commission to attend the last meeting. The idea would be to inform governing agencies of the network’s initiative, and give them the opportunity to express their opinion and/or recommendations regarding European structuration.

A second plenary session (mid-year 2) will help compile the ideas emerging from all WPs. This meeting will help structure common objectives to be included into future proposals (WP5). If the option of inviting governing agencies is agreed upon by the network, the construction of these proposals may benefit from their inputs.

Ifremer	4 400,00 €	CEREGE	3 250,00 €
LOG	2 200,00 €	LPG	1 000,00 €
M2C	3 250,00 €	ARTELIA	1 000,00 €
MMS Nantes	1 000,00 €	CREOCEAN	2 200,00 €
LIENSs	3 250,00 €	NERC	1 800,00 €
LEGI	1 000,00 €	CEFREM	3 250,00 €
BRGM	4 400,00 €	EPOC	3 250,00 €
IRSN	3 250,00 €	LUSAC	2 200,00 €
SHOM	4 400,00 €	LOV	1 000,00 €
CNR ISMAR	2 900,00 €	CEREMA	1 000,00 €
RBINS	4 000,00 €	Montpellier	1 000,00 €
ICM	2 900,00 €		
UB	2 900,00 €	LA	2 200,00 €
TU Delft	1 800,00 €	DHI	2 200,00 €
		Meetings	15 000,00 €
		TOTAL	**82 000,00 €**

A last meeting (end-year 2) restricted to the main writers will help finalize the actual proposal(s) to be submitted.

Funding will be dedicated to the organization of the meetings (conference room, catering) and the travelling expenses for all partners. Since the project coordinator has to manage the overall amount dedicated to the network, the following table is an attempt to share the funding among partners. During the course of the project, travelling expenses will be reimbursed upon request (bills to be provided to Ifremer)

These are rough estimates according to the number of scientists involved. Actual reimbursements will be done according to the actual participation in meetings. If a partner, for any reason, cannot contribute actively to the network anymore, this partner will not participate in the next meetings and its overall funding may be reduced.

5 Project promotion, global impact

5.1 communication (conferences, publications)

The network activities will be communicated to governing agencies (for themes related to European directives). Projects drafts are not to be published.

5.2 links with private companies

Most professional human activities at sea have an impact on sediment dynamics (at different space scales). Consulting companies are therefore often solicited by professionals or public managers in order to carry out impact studies; several of these companies are regularly involved in research and development activities, and remain close to academic research laboratories with which they share their expertise. Three consulting companies are involved in the network so as to promote this necessary transfer from the academic sphere to the industrial sphere.

Because of the challenges that still exist regarding observation techniques, the network may identify some technical innovations to be encouraged in order to access some sediment-related parameters (in situ and remote observations). Such technical developments may involve industrial developers, which may therefore be invited to join a future consortium.

5.3 impacts for governing agencies

The network integrates the French agencies in charge of interacting with the French Ministry of Ecology regarding the application of European Directives (Agence des Aires Marines Protégées AAMP– Ifremer). The national leaders in charge of Descriptors 6 and 7 (BRGM and SHOM) are also members of the network, as well as active laboratories in charge of these same descriptors in Spain (University of Barcelona) and in Belgium (RBINS). The national governing agencies in charge of the application of European Directives will therefore directly benefit from the work carried out within this network. Agencies from several European Member States expressed their interest in this network (UK, Germany, Slovenia), even though they did not have time to formally participate.

6 References

ALEMAN N., ROBIN N., CERTAIN R., BARUSSEAU J.-P., GERVAIS M., 2013. Net Offshore bar Migration variability at a regional scale: Inter-site comparison (Languedoc-Roussillon, France). In: Conley, D.C., Masselink, G., Russell, P.E. and O'Hare, T.J. (eds.), Proceedings 12th International Coastal Symposium (Plymouth, England), Journal of Coastal Research, Special Issue No. 65, pp. 1715-1720, ISSN 0749-0208.

Amos C.L., Umgiesser G., Ferrarin C., Thompson C.E.L., Whitehouse R.J.S., Sutherland T.F., Bergamasco A., 2010. The erosion rates of cohesive sediments in Venice lagoon, Italy. Continental Shelf Research, Vol. 30 (8), 859-870, doi:10.1016/j.csr.2009.12.001.

Bailly du Bois, P., et al. (Submitted). "System for high-frequency simultaneous sampling at several depths during sailing." Ocean Engineering.

Bellec V., Van Lancker V., Degrendele K., Le Bot S. (2010). Geo-environmental characterization of the Kwinte Bank. Journal of Coastal Research, Special Issue N°51, 63-76.

Bertin, X., Bruneau, N., Breilh, J.F., Fortunato, A.B. and Karpytchev, M., 2012. Importance of wave age and resonance in storm surges: the case Xynthia, Bay of Biscay. Ocean Modelling 42 (4), 16-30.

Billy, J., Chaumillon, E., Féniès, H. and Poirier, C., 2012. Tidal and fluvial controls on the morphological evolution of a lobate estuarine tidal bar: the Plassac Tidal Bar in the Gironde Estuary (France). Geomorphology, 169–170, 86–97.

Blanpain O., Bailly du Bois P., Cugier P., Lafite R., Lunven M., Dupont J., Le Gall E., Legrand J., and Pichavant P. (2009) Dynamic sediment profile imagery (DySPI): a new field device for the study of dynamic processes at the sediment-water interface. Limnology and Oceanography: methods, 7, 8-20

Blanpain, O., et al. (2009). "Dynamic sediment profile imaging (DySPI): a new field method for the study of dynamic processes at the sediment-water interface." Limnology and oceanography: Methods: 7:8-20.

BONA, P., B. PRUD'HOMME LACROIX , S. LEDOUX, L.THIEBOT , R. WALTHER, L.HAMM ,2012: RESTORATION OF THE LOIRE ESTUARY: THE RESULTS OF 20 YEARS OF STUDIES, AIPCN 2012

Bourrin, F., Durrieu de Madron, X., Heussner, S. and Estournel, C. (2008). Impact of winter dense water formation on shelf sediment erosion (evidence from the Gulf of Lions, NW Mediterranean). Continental Shelf Research, 28(15): 1984-1999.

Brito, A. C., I. Benyoucef, B. Jesus, V. Brotas, P. Gernez, C. R. Mendes, P. Launeau, M. P. Dias, and L. Barillé (2013) Seasonality of microphytobenthos revealed by remote-sensing in a South European estuary, Continental Shelf Research 66: 83-91, doi.org/10.1016/j.csr.2013.07.004

BRUNEL C., CERTAIN R., SABATIER F., ROBIN N., BARUSSEAU J.P., ALEMAN N., RAYNAL O. (accepted in Geomorphology). Secular sediment budget and seismic stratigraphy of the Languedoc-Roussillon shoreface (Western Gulf of Lions, France).

Canals, M., Puig, P., Heussner, S., Durrieu de Madron, X., Palanques, A. and Fabres, J., 2006. Flushing submarine canyons; *Nature*, 444: 354-357.

Cartier, A. et Héquette, A., 2013. The influence of intertidal bar-trough morphology on sediment transport on macrotidal beaches, Northern France. *Zeitschrift für Geomorphologie*, 57, p. 325-347.

Cartier, A., Larroudé, P., Héquette, A., 2012. Comparison of sediment transport models with in-situ sand flux measurements and beach morphodynamic evolution. Proceeding of ICCE 2012

Cartier,Adrien, Philippe Larroudé and Arnaud Héquette, Longshore sediment transport measurements on sandy macrotidal beaches compared with sediment transport formulae, chapter in the book "Sediment Transport", ISBN 980-953-307-557-5. 2013.

Castelle, B., Coco, G. (2013). Surf zone flushing on embayed beaches, Geophysical Research Letters, 40, 1-5, doi:10.1002/grl.50485.

Castelle, B., Marieu, V., Bujan, S., Ferreira, S., Parisot, J.-P., Capo, S., Sénéchal, N., Chouzenoux, T. (en révision). Equilibrium shoreline modelling of a high-energy meso-macrotidal multiple-barred beach. Marine Geology.

Castelle, B., Marieu, V., G. Coco, Bonneton, P., Ruessink, B.G. (2012). On the impact of an offshore bathymetric anomaly on surfzone rip channels. Journal of Geophysical Research - Earth Surface, 117, F01038, doi:10.1029/2011JF002141.

Consequences of hydrological events on the delivery of suspended sediment and associated radionuclides from the Rhône River to the Mediterranean Sea, J Soils Sediments, DOI 10.1007/s11368-012-0575-0, 12:1479–1495.

Deloffre, J., Lafite, R., Lesueur, P., Verney, R., Lesourd, S., Cuvilliez, A. and Taylor, J., 2006. Controlling factors of rhythmic sedimentation processes on an intertidal estuarine mudflat – Role of the turbidity maximum in the macrotidal Seine estuary, France. Marine Geology, 235, p. 151-164.

Desprez, M., Pearce, B., and Le Bot, S. (2010). The biological impact of overflowing sands around a marine aggregate extraction site: Dieppe (eastern English Channel). ICES Journal of Marine Science, 67 (2), 270-277.

Dodet, G., Bertin, X., and Taborda, R., 2010. Wave climate variability in the North-East Atlantic Ocean over the last six decades. Ocean Modelling 31, 120-131.

Doxaran D., J.M. Froidefond, P. Castaing and M. Babin, 2009. Dynamics of the turbidity maximum zone in a macrotidal estuary (the Gironde, France): Observations from field and MODIS satellite data. Estuarine, Coastal and Shelf Science 81, 321–332.

Duclos P-A, Lafite R, Le Bot S.,Rivoalen E., Cuvilliez A., in press Dynamics of Turbid Plumes Generated by Marine Aggregate Dredging: An Example of a Macrotidal Environment (the Bay of Seine, France), Journal of Coastal Research.

Etcheber H., Schmidt S., Sottolichio A., Maneux E., Chabaud G., Escalier J.-M., Wennekes H., Derriennic H., Schmeltz M., Quéméner L., Repecaud M., Woerther P. & Castaing P. (2011). Monitoring water quality in estuarine environments: lessons from the MAGEST monitoring program in the Gironde fluvial-estuarine system. Hydrology and Earth System Sciences 15, 831-840, doi:10.5194/hess-15-831-2011.

EYROLLE F., RADAKOVITCH O., RAIMBAULT P., CHARMASSON S., ANTONELLI C., FERRAND E., AUBERT D., RACCASI G., JACQUET S., GURRIARAN G., 2012:

Ferrarin C., Cucco A., Umgiesser G., Bellafiore D., Amos C., 2010. Modelling fluxes of water and sediment between the Venice Lagoon and the sea, Continental Shelf Research, Vol. 30 (8), 904-914, doi:10.1016/j.csr.2009.08.014.

Ferrarin, C., G. Umgiesser, A. Cucco, T.-W. Hsu, A. Roland and C. L. Amos, 2008. Development and validation of a finite element morphological model for shallow water basins. Coastal Engineering, Vol. 55, 716-731, doi:10.1016/j.coastaleng.2008.02.016.

Ferret Y., Le Bot S., Tessier B., Garlan T. & Lafite R. 2010. Internal architecture of marine dunes in the English Channel over 14 and 56 year intrevals: the influence of tides and decennial storms. Earth Surf. Process. Landforms 35, 1480–1493 (2010)

Ferret, Y., Le Bot, S., Tessier, B., Garlan, T., Lafite, R. (2010). Migration and internal architecture of marine dunes in the eastern English Channel over 14 and 56 year intervals: the influence of tides and decennial storms. Earth Surf. Process. Landforms, 35 (12), 1480-1493.

Fettweis M, Francken F, Van den Eynde D, Verwaest T, Janssens J, Van Lancker V. 2010. Storm influence on SPM concentrations in a coastal turbidity maximum area (southern North Sea) with high anthropogenic impact. Continental Shelf Research 30, 1417-1427. doi:10.1016/j.csr.2010.05.001.

Fettweis M, Monbaliu J, Nechad B, Baeye M, Van den Eynde D. 2012. Weather and climate related spatial variability of high turbidity areas in the North Sea and the English Channel. Methods in Oceanography 3-4, 25-29. doi:10.1016/j.mio.2012.11.001

Forest A., M. Babin, L. Stemmann, M. Picheral, M. Sampei, L. Fortier, Y. Gratton, S. Bélanger, E. Devred, J. Sahlin, D. Doxaran, F. Joux, E. Ortega-Retuerta, W.H. Jeffrey, J. Martín, B. Gasser, J.C. Miquel, Ecosystem function and particle flux dynamics across the Mackenzie Shelf (Beaufort Sea, Arctic Ocean): an integrative analysis of spatial variability and biophysical forcings. Biogeosciences, 10, 2833-2866

Doxaran, D., Ehn, J., Bélanger, S., Matsuoka, A., Hooker, S., and M. Babin (2012): Optical characterisation of suspended particles in the Mackenzie River plume (Canadian Arctic Ocean) and implications for ocean colour remote sensing, Biogeosciences, 9, 3213-3229, doi:10.5194/bg-9-3213-2012

Garlan T., 2004. Apports de la modélisation dans l'étude de la sédimentation marine récente. Mémoire d'HDR, Université des Sciences et Techniques de Lille: 155 p.

Garlan, T., A. Cartier, M. Franzetti, P. Le Roy, J. Duarte, J. Pombo, M.Peix, P. Guyomard, Y. Le Faou, I. Gabelotaud and E. Marchès. Complexmorphology and organisation of dunes in a giant dunes field. Marine and River Dune Dynamics – MARID IV, V VanLancker et T Garlan Ed. 15-16 April2013, Bruges, Belgium: 113-118.

Gernez P., D. Antoine, and Y. Huot (2011), Diel cycles of the particulate beam attenuation coefficient under varying trophic conditions in the NW Mediterranean Sea: observations and modeling, Limnology & Oceanography 56:17-36

Gernez, P., D. Stramski, and M. Darecki (2011), Vertical changes in the probability distribution of downward irradiance within the near-surface ocean under sunny conditions, Journal Geophysical Research 116, C00H07, doi:10.1029/2011JC007156

GRASSO, F., MICHALLET, H., BARTHÉLEMY, E. AND CERTAIN, R., 2009. Physical modeling of intermediate cross-shore beach morphology: Transients and equilibrium states, Journal of Geophysical Research C: Oceans 114 (9), art. no. C09001

Grunnet, N., Drønen, N., Deigaard, R., Kristensen, S., Tessier, C. and Forain, N., 2012. Evaluation of nourishment schemes based on long-term morphological modelling. Accepted for publication in proceedings for 33rd Int. Conf. on Coastal Engineering.

Guillèn, J., Bourrin, F., Palanques, A., Durrieu de Madron, X., Puig, P. and Buscail, R. (2006). Sediment dynamics during wet and dry storm events on the Tet inner shelf (SW Gulf of Lions). Marine Geology, 234(1-4): 129-142.

Guillou, N., Chapalain, G. et Thais L. (2009). Three-dimensional modeling of tide-induced suspended transport of seabed multicomponent sediments in the eastern English Channel. *Journal of Geophysical Research*, 114, C07025, doi: 10.1029/2008JC004791

Guillou, N. et Chapalain, G. (2010b). Numerical simulation of tide-induced transport of heterogeneous sediments in the English Channel. Continental Shelf Research, 30, Issue 7, 806-819, doi:10.1016/j.csr.2010.01.018

Guillou, N. et Chapalain, G. (2011). Modelling impact of northerly wind-generated waves on sediments resuspensions in the Dover Strait and adjacent waters. Continental Shelf Research, 31, Issue 18, 1894-1903, doi: 10.1016/j.csr.2011.08.011

Héquette, A. et Aernouts, D., 2010. The influence of nearshore sand bank dynamics on shoreline evolution in a macrotidal coastal environment, Calais, Northern France. *Continental Shelf Research*, 30, p. 1349-1361.

Héquette, A., Hemdane, Y. et Anthony, E.J., 2008. Sediment transport under wave and current combined flows on a tide-dominated shoreface, northern coast of France. *Marine Geology*, 249, p. 226-242.

Idier D., Romieu E., Pedreros R. and Oliveros C. (2010) A simple method to analyse non-cohesive sediment mobility in a macro-tidal environment, Continental Shelf Research, doi:10.1016/j.csr.2009.12.006.

Idier, D., Castelle, B., Charles, E. and Mallet, C. (2013) Longshore sediment hindcast: spatio-temporal variability along the SW Atlantic coast of France ! In: Conley, D.C., Masselink, G., Russell, P.E. and O'Hare, T.J. (eds.), Proceedings 12th International Coastal Symposium (Plymouth, England), Journal of Coastal Research, Special Issue No. 65, pp. 1785-1790, ISSN 0749-0208. [action conjointe RIS24-RIS25]

Jourdin, C. Tessier, P. Le Hir, R. Verney, M. Lunven, S. Loyer, A. Lusven, JF Filipot, J. Lepesqueur, Sporadic biofouling, waves bubbles, turbidity and mean particle size observed with a dual-frequency couple of sea bottom deployed ADCPs, Geo-Marine Letters, Special issues of Particles in Europe (PiE) 2012 Conference, Submitted Septembre 2013

Laignel, B., Costa, S., Lequien, A., Massei, N., Durand, A., Dupont, J.P., Le Bot, S. (2008). Current inputs of continental sediment to the English Channel and its beaches: A case study of the cliffs and littoral rivers of the Western Paris Basin. Zeitschrift Für Geomorphologie, 52, 21-39.

LANSARD B., CHARMASSON S., GASCO C., ANTON M.-P., GRENZ C. ET ARNAUD M., 2007: Spatial and temporal variations of plutonium isotopes (238Pu and 239,240Pu) in sediments off the Rhone River mouth (NW Mediterranean). Science of the Total Environment, 376 , 215–227

Le Bot S., Lafite R., Fournier M., Baltzer A. & Desprez M., 2010. Morphological and sedimentary impacts and recovery on a mixed sandy to pebbly seabed exposed to marine aggregate extraction (eastern English Channel, F). Estuarine, Coastal and Shelf Science, 89: 221-233.

Le Bot S., Lafite, R., Fournier, M., Baltzer, A., Desprez, M. (2010). Morphological and sedimentary impacts and recovery on a mixed sandy to pebbly seabed exposed to marine aggregate extraction (Eastern English Channel, France). Estuarine, Coastal and Shelf Science, 89 (3), 221-233.

Le Hir P., Cayocca F. and Waeles B., 2011. Dynamics of sand and mud mixtures: a multiprocess- modelling of a mixed sand/mud coastal environment: the Seine estuary, France. Proceedings in Marine Science. Vol 9: 477-498

MAILLET G.M., VELLA C., SABATIER F., POIZOT, E. & MEAR Y., 2011. Sediment transport pattern in a microtidal river mouth using geostatistical sediment trend analysis (GSTA). The case of the Grand Rhone River, France.. Journal of Sedimentary Research, 81, 138-152.

MARION, C., MAILLET G. M., ARNAUD, M. & EYROLLE, F., 2010. Estimations of the Rhône solid fluxes near the river mouth: inputs of the Durance during the extreme flood of May 2008. La Houille Blanche, 5, 72-80

Martín, J., X. Durrieu de Madron, P. Puig, F. Bourrin, A. Palanques, L. Houpert, M. Higueras, A. Sanchez-Vidal, A. M. Calafat, M. Canals and S. Heussner. Sediment transport along the Cap de Creus Canyon flank during a mild, wet Winter. Biogeosciences Discussions, 9, 18211-18252, 2012. doi: 10.5194/bgd-9-18211-2012

Michaud H., Marsaleix P., Leredde Y., **Estournel C.,** Bourrin F., Lyard F., Mayet C., Ardhuin F., 2012. Three-dimensional modelling of wave-induced current from the surf zone to the inner shelf. *Ocean Science,* 8, 657-681, http://dx.doi.org/10.5194/os-8-657-2012

Mulder, S. Zaragosi, T. Garlan, J. Mavel, M. Cremer, A. Sottolichio, N. Sénéchal & S. Schmidt. 2012. Present deep-submarine canyons activity in the Bay of Biscay (NE Atlantic). Marine Geology, v295-298: 113 – 127

PAIRAUD I., REPECAUD M., LACHAISE J., RAVEL C., ARNAUD M., RABOUILLE C., TOUSSAINT F., GARCIA F., RAIMBAULT P., VERNEY R., MEULÉ S., GAUFRÈS P. AND CADIOU J. F., 2013. The Mesurho multi-parameter moored observatory for monitoring of river: Inputs and extreme events at the Rhone river mouth. CIESM, Marseille.

Palanques, A., J. Guillén and P. Puig. Impact of bottom trawling on water turbidity and muddy sediment of an unfished continental shelf. Limnology and Oceanography, 46(5): 1100-1110, 2001.

Palanques, A., P. Masqué, P. Puig, J. A. Sanchez-Cabeza, M. Frignani, F. Alvisi. Anthropogenic trace metals in the sedimentary record of the Llobregat continental shelf and adjacent Foix submarine canyon (northwestern Mediterranean).Marine Geology, 248: 213-217. 2008.

Palanques, A., P. Puig,, J. Guillén, J. Jiménez, V. Gracia, A. Sánchez Arcilla, and O. Madsen**.** Near-bottom suspended sediment fluxes on the microtidal low-energy Ebro continental shelf (NW Mediterranean). Continental ShelfResearch, 22: 285-303, 2002.

Poirier, C., Chaumillon, E., Arnaud, F., 2011. Siltation of river-influenced coastal environments: respective impact of late Holocene land use and high-frequency climate changes. Marine Geology, 290, 51-62.

Puig, P., Canals, M., Company, J.B., Martín, J., Amblas D., Lastras, G., Palanques, A. and Calafat, A.M., 2012. The ploughing of the deep seafloor; *Nature*, 489: 286-290 + SI, doi:10.1038/nature11410.

Rivier, A., Gohin, F., Bryère, P., Petus, C., Guillou, N. et Chapalain, G. (2012c). Observed vs. predicted variability in non-algal suspended particulate matter concentration in the English Channel in relation to tides and waves. Geo-Marine Letters - Special Issue, Volume 32, Number 2, 139-151, doi: 10.1007/s00367-011-0271-x

SABATIER F., MAILLET G.M., FLEURY J., ANTONELLI C., SUANEZ S., PROVANSAL M. & VELLA C. 2006. Long term relationships between river sediment input and littoral bathymetric change in a microtidal deltaic system (Rhone delta shoreline, Mediterranean sea, SE France). Marine Geology, 234, 143-157, doi:10.1016/j.margeo.2006.09.022.

Sanchez-Vidal, A., Canals, M., Calafat, A.M., Lastras, G., Pedrosa-Pàmies, R., Menéndez, M., Medina, R., Company, J.B., Hereu, B., Romero, J. y Alcoverro, T., 2012. Impacts on the deep-sea ecosystem by a severe coastal storm; PLoS ONE, 7 (1): 1-7, e30395.

Schmidt S., Howa H., Diallo A., Martín J., Cremer M., Duros P., Fontanier Ch., Deflandre B., Metzger E., Mulder Th. Recent sediment transport and deposition in the Cap-Ferret Canyon, South-East margin of Bay of Biscay. Deep Sea Research II http://dx.doi.org/10.1016/j.dsr2.2013.06.004.

Schmidt S., Howa H., Mouret A., Lombard F., Anschutz P. & Labeyrie L. (2009). Particle fluxes and recent sediment accumulation on the Aquitanian margin of Bay of Biscay. Continental Shelf Research 29, 1044-1052.

Sottolichio, A., P. Castaing, H. Etcheber, E. Maneux, M. Schmeltz, S. Schmidt, (2011) Observations of suspended sediment dynamics in a highly turbid macrotidal estuary, derived from continuous monitoring. Journal of Coastal Research, Sp. Issue 64, vol 2, 1579-1583

Sottolichio, A., P. Le Hir, P. Castaing (2001) Modeling mechanisms for the turbidity maximum stability in the Gironde estuary, France, in: W.H. McAnally, A.J. Mehta (Eds.), Coastal and Estuarine Fine Sediment Processes, Proceedings in Marine Sciences, Elsevier, Amsterdam, 373-386

Tessier, P. Le Hir, F. Dumas, F. Jourdin, Modélisation des turbidités en Bretagne Sud et validation par des mesures in-situ, European Journal of Environmental and Civil Engineering, Vol 12, n°1-2, p 179-190, 2008.

Ulses, C.**, C. Estournel**, P. Puig, X. Durrieu de Madron, and P. Marsaleix**, 2008**, Dense shelf water cascading in the northwestern Mediterranean during the cold winter 2005. Quantification of the export through the Gulf of Lion and the Catalan margin *Geophysical. Research. Letters* 35, L07610

Ulses, C., **Estournel C.** , Durrieu de Madron X. and A. Palanques, **2008**, Suspended sediment transport in the Gulf of Lions (NW Mediterranean): Impact of extreme storms and floods. *Continental shelf research*, 28, 2048-2070

Van Lancker V, Baeye M, Du Four I, Degraer S, Fettweis M, Francken F, Houziaux J-S, Luyten P, Van den Eynde D, Devolder M, De Cauwer K, Monbaliu J, Toorman E, Portilla J, Ullman A, Liste Muñoz M, Fernandez L, Komijani H, Verwaest T, Delgado R, De Schutter J, Janssens J, Levy Y, Vanlede J, Vincx M, Rabaut M, Vandenberghe N, Zeelmaekers E, Goffin A. 2012. QUantification of Erosion/Sedimentation patterns to Trace the natural versus anthropogenic sediment dynamics (QUEST4D). Final Report, Science for Sustainable Development. Belgian Science Policy, 93 pp.

Vested, C. Tessier, B.B. Christensen, E. Goubert, Numerical Modelling of Morphodynamics – Vilaine Estuary, Ocean Dynamics, vol 63, p. 423-446, 2013.

Waeles B.,2013. Extension du port de Calais, Expertise hydrosédimentaire et Assistance à Maîtrise d'Ouvrage sur la dynamique sédimentaire, Conseil Régional du Nord- Pas De Calais.

Walker, 2013.Sediment dynamics and coastal zone management, Workshop "Climate change and sea level rise Coastal vulnerability and societal impacts"Collège de France, Paris

Walther, Régis , Julien Schaguene, Luc Hamm, Eric David, 2012: COUPLED 3D MODELING OF TURBIDITY MAXIMUM DYNAMICS IN THE LOIRE ESTUARY, FRANCE, ICCE 2012 Santander