IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

EXTREMA

Episodes météo-climatiques extrêmes et redistribution des masses sédimentaires et des polluants associés au sein d'un système côtier

Dossier déposé en réponse à l'Appel à Projet émis le 9 juin 2006
par l'ANR sur son programme :
VULNERABILITE - MILIEUX ET CLIMAT 2006

En collaboration avec :

DIRECTION DE L'ENVIRONNEMENT
ET DE L'INTERVENTION
SERVICE D'ÉTUDE ET DE SURVEILLANCE DE LA RADIOACTIVITÉ DANS L'ENVIRONNEMENT

IRSN
INSTITUT
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**DIRECTION DE L'ENVIRONNEMENT
ET DE L'INTERVENTION**

Service d'Études et de Surveillance de la Radioactivité dans l'Environnement - BP 35 - 78116 Le Vésinet Cedex

EXTREMA

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ANR

Laboratoire d'Étude Radioécologique du milieu Continental et Marin

Rapport DEI/SESURE n° 2007 - 40

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Dates	13/04/2007	25/07/2007	27/7/07	30/07/07	
Signatures					

PARTICIPANTS A CETTE ETUDE

Nom		Organisme
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Dominique Aubert		CEFREM
Xavier Durieu de Madron		CEFREM
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SOMMAIRE

INTRODUCTION

Le 9 juin 2006, l'Agence Nationale de la Recherche a émis un Appel à Projet (AAP) sur le programme « 'Vulnérabilité – Climat et milieux' », ciblé sur la vulnérabilité des milieux au changements globaux, qu'ils soient d'origine climatique ou anthropique.

En fonction des thèmes et des orientations de recherches, des recommandations et des critères d'élligibilité des projets énoncés dans l'AAP (Annexe 1), le laboratoire SESURE/LERCM a répondu en partenariat avec le CEntre de Formation et de Recherche sur l'Environnement Marin (CEFREM, Université de Perpignan CNRS UMR 5110), le Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement (CEREGE, Université Paul Cézanne Aix-Marseille III CNRS UMR 6635), l'IFREMER et le Laboratoire d'Aérologie du Pôle d'Océanographie Côtière de l'Observatoire Midi-Pyrénées (LA, Toulouse CNRS UMR 5560).

Le projet déposé, EXTREMA, a été retenu pour financement par l'ANR en novembre 2006 et a été labellisé par les pôles de compétitivité 'Mer PACA' à vocation mondiale et 'Gestion des Risques et Vulnérabilité des Territoires' à vocation nationale.

EXTREMA reprend les objectifs du projet EXTREME, consultable sur le site scientifique de l'institut, en élargissant toutefois son champs d'investigations d'une part aux contaminants métalliques stables (Cu, Pb, Cd et Hg) et aux Polluants Organiques Persistants (POPS) et d'autre part à la têt et au Golfe du Lion jusqu'au canyons sous marins en marge du plateau continental. EXTREMA inclut enfin une forte composante modélisation qui permettra d'élaborer de manière prédictive les conséquences du changement global sur la répartition des stocks de contaminants à l'échelle de l'ensemble du Golfe du Lion pour les 20 à 30 prochaines années. Ces travaux seront développés sur la base des modèles hydro-sédimentaires du LA de Toulouse et du modèle ARPEGE de météo France, sur la base du scénario de changement climatique A2 de l'IPPC.

Ce rapport présente le dossier tel qu'il a été déposé à l'ANR le 23 août 2006.

PROGRAMME VULNERABILITE : MILIEUX ET CLIMAT 2006

APPEL A PROJETS DE RECHERCHE

I - FICHE D'IDENTITE DU PROJET

Titre du projet *(maximum 120 caractères)*

Episodes météo-climatiques extrêmes et redistribution des masses sédimentaires et des polluants associés au sein d'un système côtier

Acronyme ou titre court *(12 caractères)*
EXTREMA

TYPE DE PROJET :	Recherche fondamentale ☒ Recherche industrielle ☐ Développement. pré-concurrentiel ☐

Mots-clés (cinq maximum)
Evènements climatiques extrêmes, polluants, flux, vulnérabilité, milieux

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Résumé du projet *(maximum 5000 caractères)*

1- Contexte scientifique et objectifs du projet

L'environnement est soumis à des perturbations d'origine anthropique ou naturelle s'exerçant sur des échelles de temps et d'espace très variables et pouvant conduire à des déséquilibres ou des évolutions majeures. La connaissance de ces aléas passe par la nécessité de capter les phénomènes extrêmes et de détecter les non stationnarités. Plusieurs programmes de recherche se sont récemment intéressés aux phénomènes exceptionnels (crues, tempêtes, mélange vertical hivernal, etc.) qui "pèsent" fortement sur les bilans (ORME ; EUROSTRATAFORM ; PNEC ; CARMA). Cette thématique s'inscrit dans les conséquences du changement climatique, dont l'une des principales observations concerne l'amplification de la saisonnalité et l'augmentation de la fréquence des épisodes météo-climatiques extrêmes (WCRP, GEWEX ; PIGB ; GICC; IMFREX, ….). Ces derniers peuvent être de nature très diverse : fortes précipitations pour les transferts atmosphère-sol ou sol-rivière, épisodes évènementiels de dépôt de particules d'origine éolienne, crues pour les flux des rivières vers le milieu marin ou le compartiment terrestre en cas d'inondation, crues également pour le transfert du milieu marin côtier vers le domaine marin profond, tempêtes pour la remise en suspension des sédiments en zone côtière, épisodes de plongée d'eau froide (cascading) des marges vers le milieu marin profond. Ils génèrent, sur des temps très courts, des transferts de masse exceptionnels et une intense redistribution, au sein de la géosphère, des contaminants associés à la phase particulaire. Les flux impliqués, largement supérieurs à ceux résultant des processus de transfert moyen, sont souvent équivalents aux flux cumulés sur plusieurs mois, voire plusieurs années. La vulnérabilité des milieux soumis à ces redistributions massives de polluants n'est pas établie.

EXTREMA propose d'étudier, à court et moyen terme, les processus naturels générateurs de flux évènementiels de matière et leur impact sur la redistribution de polluants au sein des différents compartiments de la géosphère : atmosphère, sols, rivières et fleuves, milieu marin côtier, milieu marin profond. Ce travail repose principalement sur la quantification et la modélisation des flux de matière solide et liquide, vecteurs de polluants.

Les enjeux de cette recherche s'inscrivent dans un contexte de changement global et d'amplification avérée des évènements météo-climatiques de grande ampleur générateurs de transferts de masses importants. Ils nécessitent de préciser la variabilité des flux et des concentrations de polluants, une étape indispensable dans l'évaluation de la vulnérabilité de l'environnement soumis aux aléas climatiques au cours des 20 à 30 prochaines années destinée à répondre aux questions suivantes :

Quelles sont les conséquences des redistributions massives des masses sédimentaires sur le transfert des polluants au sein d'un continuum continent-milieu marin côtier-mileu profond?

Ces redistributions conduisent-elles à une dispersion/dilution des polluants dans l'environnement ou au contraire à une accumulation focalisée/concentration dans certains milieux récepteurs ?

La vulnérabilité des milieux impactés est-elle modifiée ? Sur quelle échelle de temps ?

Quels sont phénomènes de seuil susceptibles d'induire à moyen terme des changements abrupts dans la répartition des polluants anthropiques dans l'environnement ?

2- Description du projet, méthodologie

EXTREMA développe une démarche intégrée atmosphère/continent/milieu marin sur le **système côtier du Golfe du Lion**, une zone expérimentale choisie en raison :

- de sa vulnérabilité à la fois aux épisodes extrêmes d'origine météo-climatiques et aux sources de pollution,
- des connaissances acquises et des compétences développées au sein des différents compartiments de ce système,
- des chroniques disponibles et des dispositifs expérimentaux déjà en place (valorisation des réseaux d'observation et instrumentation).

Sur ces critères, le Rhône aval et le bassin versant de la Têt, leurs embouchures et deltas et le Golfe du Lion jusqu'au milieu marin profond (pied de la pente continentale) constituent les zones ateliers du projet. EXTREMA cible ses travaux sur deux grandes familles de contaminants : les radionucléides artificiels (^{137}Cs et transuraniens) et les métaux traces (notamment Pb, Zn, Cd et Cu). La vulnérabilité des milieux aux conséquences des aléas climatiques pour les prochaines décennies est abordée par la modélisation des transferts de masses en réponse à différents scénarii de changement climatique.

3- Résultats attendus

Par l'analyse combinée des données historiques et de celles générées dans le cadre du projet au sein des zones ateliers ainsi que par la mise en synergie des compétences des différentes équipes partenaires (physique de l'atmosphère, chimie, géochimie, morphologie, sédimentologie, océanographie, modélisation), EXTREMA permettra d'apporter des connaissances sur :

- L'évolution de la **fréquence des épisodes météo climatiques extrêmes** sur la zone côtière du Golfe du Lion en s'appuyant sur les chroniques historiques du siècle dernier (précipitation, poussières atmosphériques, crues, inondations, tempêtes, cascading).
- La quantification des **flux évènementiels générés** par les épisodes météo-climatiques intenses par rapport aux flux moyens annuels (flux liquides/flux solides – radionucléides artificiels et métaux traces associés)**.**
- La **nature/typologie des flux extrêmes** en identifiant les **vecteurs préférentiels** de transfert (suspension/charriage, dispersion/translocation, chenaux, …).
- Les **relations empiriques forçage/flux** au sein des différentes zones ateliers (grand bassin versant/bassin de taille restreinte) utiles à la fois aux extrapolations et aux approches prédictives.
- L'**intensité de la redistribution des contaminants** au sein des différents compartiments de la géosphère.
- L'identification des **points de concentration/focalisation** et des compartiments **puits.**
- La **durée des déséquilibres** engendrés par les aléas (réversibilité/irréversibilité**, phénomènes de seuil** et **changements abrupts**).
- La **vulnérabilité** des environnements côtiers **au changement global** pour les 20 à 30 prochaines années**.**

Coordinateur du projet[1] (Partenaire 1)

Civilité	Nom	Prénom	Laboratoire (nom complet)	Type (établissement public, fondation, association, entreprise)
Melle	Eyrolle	Frédérique	**Institut de Radioprotection et de Sûreté Nucléaire** Laboratoire d'Etude Radioécologique en milieu Continental et Marin **IRSN**/DEI/SESURE/LERCM	EPIC

Nom des responsables scientifiques des autres partenaires

	Civilité	Nom	Prénom	Laboratoire (nom complet)	Type (établissement public, fondation, association, entreprise)
Partenaire 2	Mr	Aubert	Dominique	**CEntre de Formation et de Recherche sur l'Environnement Marin** **CEFREM**	CNRS UMR 5110
Partenaire 3	Mme	Provansal	Mireille	**Centre Européen de Recherches et d'Enseignement des Géosciences de l'Environnement** **CEREGE**	CNRS UMR 6635
Partenaire 4	Mr	Cadiou	Jean François	**Institut Français de Recherche pour l'Exploitation de la MER** Laboratoire Environnement Ressources Provence Azur Corse **IFREMER/**LER/PAC	EPIC
Partenaire 5	Mme	Estournel	Claude	**Laboratoire d'Aérologie**, Observatoire Midi-Pyrénées, Toulouse	CNRS UMR 5560

[1] Rappel : le coordinateur du projet doit consacrer au moins 30% de son temps de recherche au projet

Nombre de personnes impliquées dans ce projet (en équivalent temps plein : ETP)[2]: 303,8
Durée du projet (max. 48 mois) : 48 mois

IRSN
Chercheurs et enseignants-chercheurs permanents _1,05_
Post-doctorant(s) déjà recruté(s)_0_ Doctorant(s) __0_____ Ingénieurs et techniciens _0,25_
Personnes à recruter _1,0_

CEFREM
Chercheurs et enseignants-chercheurs permanents _1,15_
Post-doctorant(s) déjà recruté(s)_0_ Doctorant(s) ___1,0____Ingénieurs et techniciens _0,35_
Personnes à recruter _1,0_

CEREGE
Chercheurs et enseignants-chercheurs permanents _0,45 _
Post-doctorant(s) déjà recruté(s)___ Doctorant(s) ___0,15__ Ingénieurs et techniciens _0_
Personnes à recruter _0_

IFREMER
Chercheurs et enseignants-chercheurs permanents _0,40_
Post-doctorant(s) déjà recruté(s)_0_ Doctorant(s) ___0___ Ingénieurs et techniciens _0,35_
Personnes à recruter _0,5 _

LA Toulouse
Chercheurs et enseignants-chercheurs permanents _0,45_
Post-doctorant(s) déjà recruté(s)_0,25_ Doctorant(s) _0,2_ Ingénieurs et techniciens _0_
Personnes à recruter _0,5_

Dimensionnement total du projet

Coût complet du projet : 3130343 € Reporter le total indiqué au tableau (a) du récapitulatif global (section D du document)
Aide financière demandée : 669671 € Reporter le total indiqué au tableau (b) du récapitulatif global (section D du document)
Effort en personnel demandé : 303,8 homme. mois Reporter le total indiqué au tableau (c) du récapitulatif global (section D du document)

[2] Quelque soit la catégorie de personnel, il s'agit ici, pour chaque personne impliquée dans le projet, de multiplier son temps de recherche par le pourcentage de temps qu'il consacrera à ce projet.

Programme Vulnérabilité : milieux et climat 2006

APPEL A PROJETS DE RECHERCHE

II - PRESENTATION DETAILLEE DU PROJET

A - Identification du coordinateur et des autres partenaires du projet

Acronyme ou titre court du projet : EXTREMA

A-1 : Partenaire 1 = Coordinateur du Projet

Un coordinateur, responsable scientifique du projet, doit être désigné par les partenaires.

** champ obligatoire*

*Civilité **	*Nom **	*Prénom **	
Melle	EYROLLE	Frédérique	
Grade *	D^{r}	**Employeur ***	IRSN
Mail *	**Frederique.eyrolle@irsn.fr**		
Tél *	+33 (0)4 42 19 95 12	**Fax** +33 (0)4 42 91 42	

Laboratoire ou Entreprise *(nom complet)* *	
Laboratoire d'Etudes Radioécologiques en milieu Continental et Marin (DEI/SESURE/LERCM) **(IRSN)**	
N° Unité *(s'il existe)*	
Adresse complète du laboratoire ou entreprise *	
IRSN/DEI/SESURE/LERCM Centre de Cadarache BP3	
Code postal * 13106	**Ville** * St Paul Lez Durance
Etablissements de tutelle *(indiquer le ou les établissements et organismes de rattachement, souligner l'établissement susceptible d'assurer la gestion du projet)* **:** Institut de Radioprotection et de Sûreté Nucléaire	

Principales publications :

Liste des principales publications ou brevets (max. 5) de l'équipe partenaire 1 (définie tableau ci-dessous) au cours des cinq dernières années, relevant du domaine de recherche couvert par la présente demande dans l'ordre suivant : Auteurs (en soulignant les auteurs faisant effectivement partie de la demande), Année, Titre, Revue, N°Vol, Pages. N'indiquez pas les publications soumises.

Charmasson S., 2003, ^{137}Cs inventory in sediment near the Rhône mouth : Evaluation of the role played by different ^{137}Cs sources in this area, Oceanologica Acta, 26, 4, 435-441

Eyrolle F., Charmasson S. and Louvat D., 2004, Plutonium isotopes in the lower reaches of the river Rhône over the period 1945-2000: Fluxes towards the Mediterranean Sea and sedimentary inventories, Journal of Environmental Radioactivity, Special issue, 74, 127-138.

Lansard B., Grenz C., Charmasson S., Schaff E. et Pinazo C., 2006, Potential plutonium remobilisation linked to marine sediment re-suspension : First estimates based on flume experiments.• Journal of Sea Research, 55, 1, 74-85.

Eyrolle F., Duffa C., Rolland B., Antonelli C. and Leprieur F., 2006, Radiological consequences of the extreme flooding of the Rhône valley area (South east France, December 2003), The Science of the Total Environment, 366, 427-438.

Antonelli C., Eyrolle F., Rolland B., Provansal M. and Sabatier F., 2006, Suspended sediment and artificial radionuclide fluxes during exceptional floods. Case study; The Rhône River (SE France) in December 2003. Geomorphology, accepted.

Partenaire 1 = Coordinateur du Projet

	Nom	Prénom	Emploi actuel	Discipline (à renseigner uniquement pour SHS)	% de temps de recherche consacré au projet	Rôle/Responsabilité dans le projet 4 lignes max
Coordinateur	Eyrolle	Frédérique	Chercheur IRSN		30%	Coordination scientifique - Impact des crues du Rhône sur les processus de Dépôt/Erosion au sein des berges du Rhône aval/ Accumulation/reprise des contaminants
Membres de l'équipe	Arnaud	Mireille	Chercheur IRSN		25%	Dépôts/Erosion prodelta du Rhône – Masses sédimentaires et contaminants associés
	Charmasson	Sabine	Expert IRSN		10%	Dépôts/Erosion plateau continental- Masses sédimentaires et contaminants associés
	Antonelli	Christelle	Chercheur IRSN		20%	Flux solides du Rhône (OPERA Arles) et contaminants associés
	Masson	Olivier	Expert IRSN		20%	Flux atmosphériques (précipitation/charge solide de l'atmosphère/dépôts éoliens) et contaminants associés (OPERA atmosphérique)
	Boullier	Vincent	Technicien IRSN		11%	Responsable des échantillons du réseau OPERA fluvial
	Saey	Lionel	Technicien IRSN		7%	Responsable des échantillons du réseau OPERA atmosphérique
	Champelovier	Alain	Technicien IRSN		7%	Responsable des prélèvements des sédiments continentaux

Pour chacun des membres de l'équipe dont l'implication dans le projet est supérieure à 25%, fournir une biographie **d'une page maximum** qui comportera :

A/ Nom, prénom, âge, cursus, situation actuelle
B/ Autres expériences professionnelles
C/ Liste des 5 publications (ou brevets) les plus significatives des cinq dernières années
D/ Prix, distinctions

INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

Acronyme ou titre court du projet : EXTREMA

A-2 : Autres partenaires du projet (remplir une fiche par partenaire)

Un responsable scientifique de l'équipe partenaire doit être désigné

Partenaire 2

*Civilité **	*Nom **	*Prénom **	
M.	AUBERT	Dominique	
Grade*	MCF 2e classe	**Employeur ***	U. Perpignan Via Domitia
Mail *	dominique.aubert@univ-perp.fr		
Tél *	+33 (0)4 68 66 22 90	**Fax**	+33 (0)4 68 66 20 96

Laboratoire ou Entreprise * *(nom complet)*	
CEntre de Formation et de Recherche sur l'Environnement Marin **(CEFREM)**	
N° Unité *(s'il existe)*	UMR 5110 CNRS-UPVD
Adresse complète du laboratoire ou entreprise *	
CEFREM Université de Perpignan Via Domitia 52, avenue Paul Alduy	
Code postal * 66860	**Ville *** Perpignan Cedex
Etablissements de tutelle *(indiquer le ou les établissements et organismes de rattachement, souligner l'établissement susceptible d'assurer la gestion du projet)* **:** <u>Centre National de la Recherche Scientifique, Délégation Languedoc-Roussillon</u> Université de Perpignan Via Domitia	

Principales publications :

Liste des principales publications ou brevets (max. 5) de l'équipe partenaire 2 (définie tableau ci-dessous) au cours des cinq dernières années, relevant du domaine de recherche couvert par la présente demande dans l'ordre suivant : Auteurs (en <u>soulignant</u> les auteurs faisant effectivement partie de la demande), Année, Titre, Revue, N°Vol, Pages. N'indiquez pas les publications soumises.

<u>Aubert D.</u>, Stille P., Probst A., Gauthier Lafaye F., Pourcelot L., Del Nero M., 2002, Characterization and migration of atmospheric REE in soils and surface waters, Geochim. Cosmochim. Acta, 66, 19, 3339-3350.

Ferré B., Guizien K., <u>Durrieu de Madron X.</u>, Palanques A., Guillén J. and Grémare A., 2005, Fine-grained sediment dynamics during a strong storm event in the inner-shelf of the Gulf of Lion (NW Mediterranean), Cont. Shelf Res., 25, 19-20, 2410-2427.

<u>Heussner S.</u>, <u>Durrieu de Madron X.</u>, Calafat A., Canals M., <u>Carbonne J.</u>, Delsaut N. and Saragoni G., in press, Spatial and temporal variability of downward particle fluxes on a continental slope: lessons from an 8-yr experiment in the Gulf of Lions (NW Mediterranean), Mar. Geol.

Ludwig, W., Serrat, P., Cesmat, L., and Garcia-Esteves, J., 2004, Evaluating the impact of the recent temperature increase on the hydrology of the Têt River (Southern France), J. Hydrol., 289, 204-221.

Palanques A., <u>Durrieu de Madron X.</u>, Puig P., Fabres J., Guillén J., Calafat A., Canals M., <u>Heussner S.</u> and Bonnin J., in press, Suspended sediment fluxes and transport processes in the Gulf of Lions submarine canyons. The role of storms and dense water cascading, Mar. Geol.

Le Roux G., <u>Aubert D.</u>, Stille P., Krachler M., Kober B., Cheburkin A., Bonani G. and Shotyk W., 2005, Recent atmospheric Pb deposition at a rural site in southern Germany assessed using a peat core and snowpack, and comparison with other archives, Atmos. Envir., 36, 6790-6801.

PARTENAIRE 2

	Nom	Prénom	Emploi actuel	Discipline (à renseigner uniquement pour SHS)	% de temps de recherche consacré au projet	Rôle/Responsabilité dans le projet 4 lignes max
Responsable	Aubert	Dominique	MCF2		60%	Coordination des actions CEFREM - Distribution des contaminants métalliques et des traceurs de phase dans les différents compartiments (dépôts atmosphériques, fleuve, particules, eau de mer, sédiments).
Membres de l'équipe	Durrieu de Madron	Xavier	CR1		15%	Hydrodynamique, hydrologie et transferts particulaires côte-large (transport horizontal; néphélométrie). Etude du cascading dans les canyons.
	Heussner	Serge	DR2		15%	Transferts particulaires côte-large (transport vertical; pièges à particules). Analyse des données historiques.
	Ludwig	Wolfgang	MCF1		25%	Analyse des séries temporelles (acquises et nouvelles). Modélisation retrospective et prospective des apports liquides et solides de la Têt au milieu côtier.
	Jeanty	Gérard	IE EN		20%	Analyse des métaux et du carbone organique et inorganique.
	Carbonne	Jacques	AI EN		15%	Responsable des prélèvements de terrain (fleuve, prodelta et pente continentale) et des mouillages instrumentés; entretien de la plateforme POEM.

Pour chacun des membres de l'équipe dont l'implication dans le projet est supérieure à 25%, fournir une biographie **d'une page maximum** qui comportera :

A/ Nom, prénom, âge, cursus, situation actuelle
B/ Autres expériences professionnelles
C/ Liste des 5 publications (ou brevets) les plus significatives des cinq dernières années
D/ Prix, distinctions

Acronyme ou titre court du projet : EXTREMA

A-3 : Autres partenaires du projet (remplir une fiche par partenaire)

Un responsable scientifique de l'équipe partenaire doit être désigné

Partenaire 3

*Civilité **	*Nom **	*Prénom **	
Mme	PROVANSAL	Mireille	
Grade*	Professeur	**Employeur ***	Université de Provence
Mail *	provansal@cerege.fr		
Tél *	+33 (0)4 42 97 15 63	**Fax** +33 (0)4 42 97 15 59	

Laboratoire ou Entreprise * *(nom complet)*	
Centre Européen de Recherche et d'enseignement des géosciences de l'environnement **(CEREGE)**	
N° Unité *(s'il existe)*	UMR 6635
Adresse complète du laboratoire ou entreprise *	
CEREGE Europole de l'Arbois BP80	
Code postal * 13545	**Ville *** Aix en Provence cedex 04
Etablissements de tutelle *(indiquer le ou les établissements et organismes de rattachement, souligner l'établissement susceptible d'assurer la gestion du projet)* **:** CNRS Délégation régionale PACA Université Paul Cézanne Aix-Marseille III	

Principales publications :

Liste des principales publications ou brevets (max. 5) de l'équipe partenaire 3 (définie tableau ci-dessous) au cours des cinq dernières années, relevant du domaine de recherche couvert par la présente demande dans l'ordre suivant : Auteurs (en soulignant les auteurs faisant effectivement partie de la demande), Année, Titre, Revue, N°Vol, Pages. N'indiquez pas les publications soumises.

Antonelli C., Provansal M. and Vella C., 2004, Recent morphological channel changes in a deltaïc environment.The case of the Rhône River, France, Gemorphology, 57, 345-402.
Maillet G., Vella C., Berné S., Friend P. L., Amos C. L., Fleury T. J. and Normand A., 2006, Morphological changes and sedimentary processes induced by December 2003 flood event at the present mouth of the Grand Rhône river (southern France), Marine geology, accepted.
Provansal M., Sabatier F., Vella C., Antonelli C. and Maillet G., 2005, Impacts of the fluvial sediments imputs and channel morphology in the mobility of the Rhône delta coast during the Holocene and recent period, LOICZ Newsletter, March 2005, 34, 4-6.

Provansal M., Vella C. and Sabatier F., 2003, Apports solides et mobilité holocène des littoraux delatïques, Océanis, vol. 29,1-2, 209-240.
Radakovitch O., Roussiez V., Ollivier P., Ludwig. W, Grenz C. and Probst J.L., 2006, Particulate heavy metals input from rivers and associated sedimentary deposits on the Gulf of Lion continental shelf. Estuarine, Coastal and Shelf Science, in press.

PARTENAIRE 3

	Nom	Prénom	Emploi actuel	Discipline (à renseigner uniquement pour SHS)	% de temps de recherche consacré au projet	Rôle/Responsabilité dans le projet 4 lignes max
Responsable	Provansal	Mireille	Professeur	géographie	10%	Coordination des actions CEREGE - Crues : Reprise des berges et flancs du chenal/ Transit de Fond (Rhône aval)
Membres de l'équipe	Vella	Claude	Maître de conférence	géographie	5%	Crues : évaluation du charriage de fond (Grand Rhône et embouchures)
Membres de l'équipe	Sabatier	François	Maître de conférence	géographie	5%	Crues : évaluation du charriage de fond (Grand Rhône et embouchures)
Membres de l'équipe	Vassas	Carolyne	Doctorante	géographie	15%	Crues : évaluation du charriage de fond (Grand Rhône et embouchures)
Membres de l'équipe	Radakovitch	Olivier	Maître de conférence		15%	Analyse de métaux traces particulaires, étude de resuspension, prélèvements
Membres de l'équipe	Noack	Yves	Directeur de recherche		10%	Prélèvements et analyses des poussières atmosphériques (métaux, minéralogie)

Pour chacun des membres de l'équipe dont l'implication dans le projet est supérieure à 25%, fournir une biographie **d'une page maximum** qui comportera :

A/ Nom, prénom, âge, cursus, situation actuelle
B/ Autres expériences professionnelles
C/ Liste des 5 publications (ou brevets) les plus significatives des cinq dernières années
D/ Prix, distinctions

IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

Acronyme ou titre court du projet : EXTREMA

A-4 : Autres partenaires du projet (remplir une fiche par partenaire)

Un responsable scientifique de l'équipe partenaire doit être désigné

Partenaire 4

*Civilité **	*Nom **	*Prénom **	
Mr	CADIOU	Jean-François	
Grade*	Ingénieur II	**Employeur ***	IFREMER
Mail *	jfcadiou@ifremer		
Tél *	+33 (0)4 94 30 49 75	**Fax** +33 (0)4 94 30 44 17	

Laboratoire ou Entreprise * *(nom complet)*	
Laboratoire Environnement Ressources Provence Azur Corse (LER/PAC) **(IFREMER)**	
N° Unité *(s'il existe)*	
Adresse complète du laboratoire ou entreprise *	
Zone Portuaire de Brégaillon – BP 330	
Code postal * 83507	**Ville *** La SEYNE sur MER
Etablissements de tutelle *(indiquer le ou les établissements et organismes de rattachement, souligner l'établissement susceptible d'assurer la gestion du projet)* **:** IFREMER (Institut Français de Recherche sur l'Exploitation de la Mer), 155 rue Jean-Jacques Rousseau, 92138 ISSY-LES-MOULINEAUX	

Principales publications :

Liste des principales publications ou brevets (max. 5) de l'équipe partenaire 4 (définie tableau ci-dessous) au cours des cinq dernières années, relevant du domaine de recherche couvert par la présente demande dans l'ordre suivant : Auteurs (en soulignant les auteurs faisant effectivement partie de la demande), Année, Titre, Revue, N°Vol, Pages. N'indiquez pas les publications soumises.

Berné, S., Rabineau, M., Flores, J.A. and Sierro, F.J., 2004, The impact of Quaternary Global Changes on Strata Formation. Exploration of the shelf edge in the Northwest Mediterranean Sea. Oceanography, 17, 4, 92-103.

Gaudin, M., Berné, S., Jouanneau, J.M., Palanques, A., Puig, P., Mulder, T., Cirac, P., Rabineau, M. and Imbert, P., in press, Massive sand beds attributed to deposition by dense water cascades in the Bourcart canyon head, Gulf of Lions (northwestern Mediterranean Sea), Marine Geology.

Sarradin P.-M ; Sarrazin J, and Cadiou J.F, 2004, Extreme ecosystem studies in the deep Ocean: Technological Developments - EXOCET/D project – ISOPE conference 2004 proceedings , I ,738.

Gonzalez J.L ., 1992, Comportement du cadmium et du mercure lors de la diagenèse précoce et flux à l'interface eau-sédiment en zone littorale. Thèse de Doctorat de l'Université de Bordeaux I, n° 773, 247 p.

Cossa D and Coquery M., 2005, The Mediterranean Mercury Anomaly, a Geological or a Biological issue – Springer. The Handbook of Environmental Chemistry, Vol 5 (The Mediterranean Sea) Part K, 177-208.

Khripounoff A, Vangriesheim A, Babonneau N, Crassous P, Dennielou B and Savoye B., 2003, Direct observation of intense turbidity current activity in the Zaire submarine valley at 4000m water depth. Marine Geology, 194, 151-158.

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DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

PARTENAIRE 4

	Nom	Prénom	Emploi actuel	Discipline (à renseigner uniquement pour SHS)	% de temps de recherche consacré au projet	Rôle/Responsabilité dans le projet 4 lignes max
Responsable	Cadiou	Jean-François	Ingénieur 2		10%	Coordination des actions IFREMER – Expertise en instrumentation marine
Membres de l'équipe	Khripounoff	Alexis	CR 2		15%	CascadingMesures des flux solides côte-large, radionucléides et métaux traces associés en relation avec le CEFREM
	Berne	Serge	CR2		10%	Enregistrements sédimentaires, prélévements, analyses
	Cossa	Daniel	CR3		5%	Analyses et synthèse mercure
	Gonzalez	Jean-Louis	CR2		10%	Analyse contaminants métalliques, échantillonneurs passifs
	Sauzade	Didier	Ingénieur 3		5%	Contamination de la zone de Marseille
	Levêque	Jean-Pierre	Ingénieur 3		10%	Instrumentation station FRAME
	A déterminer		Ingénieur 1		10%	Instrumentation, échantillonneurs passifs

Pour chacun des membres de l'équipe dont l'implication dans le projet est supérieure à 25%, fournir une biographie **d'une page maximum** qui comportera :

A/ Nom, prénom, âge, cursus, situation actuelle
B/ Autres expériences professionnelles
C/ Liste des 5 publications (ou brevets) les plus significatives des cinq dernières années
D/ Prix, distinctions

Acronyme ou titre court du projet : EXTREMA

A-5 : Autres partenaires du projet (remplir une fiche par partenaire)

Un responsable scientifique de l'équipe partenaire doit être désigné

Partenaire 5

Civilité *	Nom *	Prénom *	
	ESTOURNEL	Claude	
Grade*	DR2	**Employeur ***	CNRS
Mail *	Claude.Estournel@aero.obs-mip.fr		
Tél *	+33 (0)5 61 33 27 77	**Fax** +33 (0)5 61 33 27 90	

Laboratoire ou Entreprise * *(nom complet)*	
Pôle d'Océanographie Côtière de l'Observatoire Midi-Pyrénées. Laboratoire d'Aérologie **(LA)**	
N° Unité *(s'il existe)*	UMR 5560
Adresse complète du laboratoire ou entreprise *	
14 Avenue Edouard Belin	
Code postal * 31400	**Ville *** Toulouse
Etablissements de tutelle *(indiquer le ou les établissements et organismes de rattachement, souligner l'établissement susceptible d'assurer la gestion du projet)* **:** Université Paul Sabatier, CNRS	

Principales publications :

Liste des principales publications ou brevets (max. 5) de l'équipe partenaire 5 (définie tableau ci-dessous) au cours des cinq dernières années, relevant du domaine de recherche couvert par la présente demande dans l'ordre suivant : Auteurs (en soulignant les auteurs faisant effectivement partie de la demande), Année, Titre, Revue, N°Vol, Pages. N'indiquez pas les publications soumises.

Dufau-Julliand C., Marsaleix P., Petrenko A. and Dekeyser I., 2004, Three-dimensional modeling of the Gulf of Lion's hydrodynamics (northwestern Mediterranean) during January 1999 (MOOGLI3 Experiment) and late winter 1999 : Western Mediterranean intermediate water's (WIW's) formation and its cascading over the shelf break. Journal of Geophysical Research,109, C11002.

Estournel C., Zervakis V., Marsaleix P., Papadopoulos A., Auclair F., Perivoliotis L. and Tragou E., 2005, Dense water formation and cascading in the Gulf of Thermaikos (North Aegean) from observations and modelling, Continental Shelf Research, 25, 2366-2386.

Estournel C., Durrieu de Madron X., Marsaleix P., Auclair F.,Julliand C. and R. Vehil, 2003, Observation and modelisation of the winter coastal oceanic circulation in the Gulf of Lions under wind conditions influenced by the continental orography (FETCH experiment), Journal of Geophysical Res., 108, C3, 8059.

Ulses C., Grenz Ch., Marsaleix P., Schaaf E., Estournel C., Meulé S. and Pinazo C., 2005, Water circulation in a semi-enclosed bay submitted to strong continental supplies (Gulf of Fos), Journal of Marine Systems, 56, 113-132.

Partenaire 5

	Nom	Prénom	Emploi actuel	Discipline (à renseigner uniquement pour SHS)	% de temps de recherche consacré au projet	Rôle/Responsabilité dans le projet 4 lignes max
Responsable	ESTOURNEL	Claude	DR2		30%	Coordination des actions LA – Responsable de la modélisation couplée physique, sédiment dans le projet. Spécialité : Modélisation physique et transport sédimentaire
Membres de l'équipe	MARSALEIX	Patrick	CR1		15%	Modélisation physique. Soutien sur les aspects numériques.
	HERRMANN	Marine	Doctorante		20% (année 2007)	Fourniture des forçages pour le modèle côtier d'après sa thèse sur l'impact du changement climatique sur la circulation et les écosystèmes en Méditerranée Nord occidentale
	ULSES	Caroline	Post-Doc		25%	Modélisation du transport sédimentaire. Développement du module contaminants. Participation aux simulations

Pour chacun des membres de l'équipe dont l'implication dans le projet est supérieure à 25%, fournir une biographie **d'une page maximum** qui comportera :

A/ Nom, prénom, âge, cursus, situation actuelle
B/ Autres expériences professionnelles
C/ Liste des 5 publications (ou brevets) les plus significatives des cinq dernières années
D/ Prix, distinctions

Ce projet fait-il partie des projets labellisés (ou en cours de labellisation) par un pôle de compétitivité (ou par plusieurs, en cas de projet interpôle) ? **OUI**

Demande de labellisation aux pôles :

1- Mer, Sécuriré et Surêté
(Provence – Alpes – Côte d'Azur)

2- Gestion des Risques et Vulnérabilité des Territoires
(Provence-Alpes-Côte d'Azur, Languedoc-Roussillon)

Demande d'agrément au pôle :

1- Aéronautique et espace
(Aquitaine, Midi-Pyrénées**)**

Programme Vulnérabilité : milieux et climat 2006

B - Description du projet

Acronyme ou titre court du projet : EXTREMA

B-1 - General context and objectives

The environment is impacted by natural and anthropogenic perturbations that occur at very different spatial and temporal scales and lead to major changes and even disequilibria when exceeding the ecosystem resilience. Describing the quantitative modifications (physical, chemical, biological) environment undergoes, their recurrence and their controls are nowadays subject to an increasing socioeconomic demand, especially for those perturbations considered as hazards (which includes the notion of danger to or deleterious effects on the environment). However, identifying and forecasting hazards face several cognitive difficulties since they require the understanding of internal transformations and possible critical thresholds: spatial dimension of the physical aspects, rates of modification and scale changes.

In the coastal environment (sensu lato, i.e. the coastal land fringe, the rivers and their watersheds and the coastal sea down to the foot of the continental margin), such an exercise is perhaps even more complex due to the difficulty of observing hazards as they occur. Understanding its vulnerability, and especially to those processes related to climate change, is still in its infancy. Assessing potential hazards there first necessitates characterizing extreme events such as storms, floods and other dynamical processes that are part of the "natural" functioning of the environment. Second, it needs to understand the consequences climate change could have in modifying the occurrence and intensity of these events, as univocally underlined by major research programs (WCRP, GEWEX, IGBP, GICC, IMFREX). The French program IMFREX for example concluded to an increase of severe winter precipitations in the northern half of France, a general increase of floods during winter and spring, and drought during summer and autumn in the southern half.

Within this general context, several regional, national and international programs (e.g., ORME, PNEC, CARMA, EUROSTRATAFORM) recently addressed, among other topics, the fate of riverine sediment supply to the coastal environment, including depositional patterns on the continental shelf as well as subsequent erosion and transport of cohesive sediments and suspended particles from the shelf to the deep. These studies put a particular emphasis on very energetic atmospheric and oceanic events that strongly constrain source-to-sink sedimentary budgets: floods, storms and shelf-to-slope cascading of dense water (the submarine equivalent of exceptional river floods for what concerns the masses transferred). In promoting a considerable transfer of fine particles on which radioactive and metallic pollutants are preferentially adsorbed, these extreme events redistribute anthropogenic pollutants at almost unknown levels and rates within the marine system. Moreover, the fate of sedimentary particles – and thus of pollutants - during the ultimate move from shelf to slope waters is far from being elucidated.

During the last decade, environmental directives entrained a significant decrease of the primary input of pollutants to the aquatic environment (e.g., lead reduction in petrol). Nevertheless, stocks of riverine or marine sediments, in particular those formed during the last 50 years, are still present and nowadays constitute significant pollution reservoirs. During severe meteorological events, the release of pollutants as these secondary sources become eroded is believed, according to preliminary estimates, to exceed primary sources (Vives i Battle, 1993; Williamson et al., 1996; Cook et al., 1997; Witt and Siegel, 2000).

These studies suggest that extreme events are likely to move considerable quantities of sediment and associated radioactive and metallic elements between the various coastal compartments over very short periods of time, probably equivalent to average fluxes cumulated over several months or even several years. However, if any, the vulnerability of the environment to such intense redistributions of pollutants has not yet been established, essentially because of the lack of data on the quantities displaced during the events.

Within the framework of the program « Vulnérabilité : milieux et climat », the EXTREMA project aims at studying, on the short and medium terms, the impact of extreme atmospheric and oceanic processes on the redistribution (translocation) of anthropogenic (radionuclides and metals) pollutants within the coastal zone continuum of the Gulf of Lion (NW Mediterranean). Taking advantage of the well-documented existing knowledge, this study will basically built on the quantification of water and fine sediment fluxes, vectors of pollutants, between the various compartments of the coastal environment continuum: atmosphere, continent, rivers, continental shelf, and deep sea (Fig. 1).

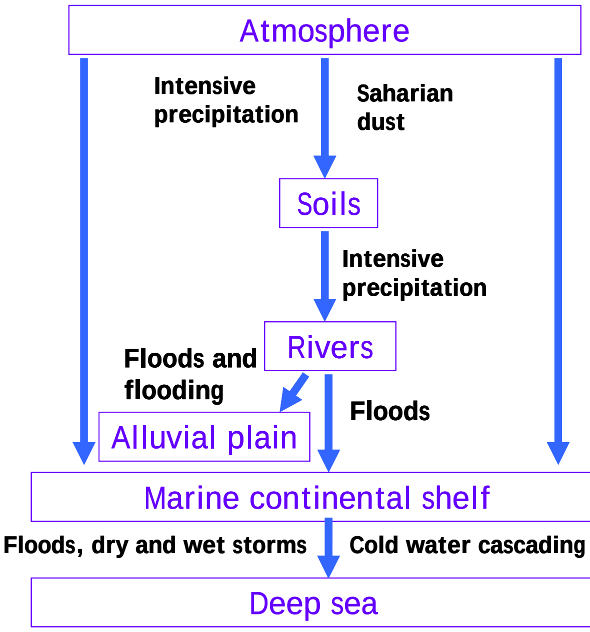

Figure 1. The various compartments of the coastal environment and the meteo-climatic extreme events considered by the EXTREMA project.

The specific objectives of EXTREMA are:

- to quantify the present day magnitude and frequency of water and suspended sediment fluxes associated to flood, storm, and cascading events and to compare them with previous estimates,
- to assess the intensity of pollutant fluxes during these extreme events with respect to average values obtained from long-term chronicles,

- to determine and model the importance of pollutant translocation within the entire coastal environment,
- to examine the potential effects of a changing climate on pollutant translocation.

The proposed research represents a first step towards a sound assessment of the vulnerability of the coastal environment. Within the climate change context and the expected amplification of severe climatic events, the stakes are to evaluate the evolution of pollutant stocks within the different compartments of the Gulf of Lion during the coming 2-3 decades. We are convinced that the new data and ideas generated by EXTREMA will provide substantial answers to the following general questions:

- What are the consequences of the intense transfer of sedimentary stocks during extreme events on the translocation of pollutants?
- Do extreme events lead to a dispersion/dilution of the pollutants in the coastal environment or, on the contrary, to a preferential accumulation (focusing) in specific compartments?
- Is the vulnerability of the impacted compartments modified, and if so, on what time scale?
- Can we already identify threshold processes able to induce, in the medium term, abrupt changes in the distribution of anthropogenic pollutants within the environment?

B-2 - Project description and expected results

1. Current knowledge of sediment and pollutant transfer in the Gulf of Lion coastal environment

The coastal environment of the Gulf of Lion is particularly interesting for studying the transfer of energy and materials from the land to the open ocean system. With an area of about 12 000 km^2 (water depth <100 m), its shelf is one of the largest in the Mediterranean Sea. It is characterized by large amounts of terrestrial material inputs and high rates of biological productivity. It is also one of the few places in the Mediterranean where deepwater formation occurs. Sediment inputs to this environment are dominated by those from the Rhône River, which is now, after the damming of the Nile River, the most important river of the Mediterranean in terms of freshwater discharge (Ludwig et al., 2003). At least 80% of the riverine inputs of total suspended sediments (TSS) into the Gulf of Lion come from this river (Durrieu de Madron et al., 2000). The remaining part is delivered by the small coastal rivers, mainly in the form of intermittent pulses triggered by flash floods. Atmospheric deposits of particulate matter mostly derive from crust-rich Saharan aerosols, but anthropogenic-rich European aerosols are also introduced into the study area (Avila et al., 1998; Caquineau et al., 1998; Blandin et al., 2002; Dulac et al., 2004; Pham et al., 2004). First order estimates indicate that these particulate inputs are at least an order of magnitude lower than the riverine inputs, although they can be important for the introduction of some of the associated pollutants such as Pb and Zn for example (Roussiez et al., in press).

Recent studies by the different partners of EXTREMA considerably improved the knowledge on the transfer of particles and organic carbon (Durrieu de Madron et al., 2000; Heussner et al., in press), of radiogenic trace elements (Thomas, 1996; Charmasson 1998; Arnaud et al., 2003; Charmasson, 2003, Eyrolle et al., 2004a; Duffa and Renaud, 2004; Antonelli et al., 2006), and of heavy metals and other pollutants (Roussiez et al., 2005a, b, in press; Radakovitch et al., in press) in the Gulf of Lion. All these investigations clearly evidenced the fundamental role of extreme meteorological events, such as heavy rainfall, floods and storms, on the mobilization of the investigated compounds. For example, Masson et al. (2005) demonstrated that the brief (a few hours) atmospheric deposition that occurred in SE France in February 2004 yielded a radioactivity input comparable to the annual mean deposit. It has also been shown that the large flood of the Rhône River in December 2003 delivered in 5 days more than 75% of the annual discharge of TSS and associated radioactivity (Rolland, 2006; Antonelli et al., 2006). Interestingly, half of the ^{238}Pu mobilized during that flood came from erosion of the riverbanks that were previously contaminated by radioactive releases of the Marcoule reprocessing centre (Eyrolle et al., 2004a; Rolland, 2006). The translocation of sediments and associated pollutants from the river prodelta, and hence the offshore transport of these pollutants to the open ocean system, might therefore be strongly controlled by extreme meteorological events, but quantification of these processes is still difficult on the basis of the present knowledge.

Most model scenarios on future climate change converge in the prediction of increasing drought in the Mediterranean region (Houghton et al., 2001). Rising temperatures, as recorded during the last 30 years in particular in the western part of the Mediterranean basin (Mitchell and Jones, 2005), might influence the frequency and intensity of meteo-climatic events in this region, which were frequently observed during the last decades. Moreover, recent research of the EXTREMA partners evidenced the strong potential impact of climate changes on the formation and cascading of dense cold coastal waters in the Gulf of Lion. Cascading is a recurrent process, which plays an important role in the transport of sediments to the open ocean. The largest events can disturb the entire shelf sediments and flush up to 2/3 of the volume of shelf water (Béthoux et al., 2002; Dufau-Jullian et al., 2004; Canals et al., submitted; Ulses et al, submitted). Climate change might therefore considerably alter the inputs, translocation and storage of sediment-bound pollutants in the Gulf of Lion in the future, even if the pollutant release by anthropogenic activities remains unchanged.

2. The selected key environments and their vulnerability to meteo-climatic events

Research in the EXTREMA project will focus in particular on the Rhône and Têt river systems, as well as on the distribution and mobility of fine-grained sediments on the entire Gulf of Lion continental margin. The river systems comprise both the freshwater and saltwater compartments, hence including the sediment and pollutant delivery from upstream and their deposition in the prodelta sediments off the river mouths. To a large extent, these studies will rely on fieldwork in connection with the experimental platforms that have been/ will be implemented by the partners. The study on the marine component of the Gulf of Lion sedimentary system, on the other hand, has a strong modelling component. It will be supported by numerous field data on the material inputs as well as on the hydrodynamic forcing parameters from all compartments (atmosphere, rivers, prodeltas, shelf, and continental slope).

The Rhône watershed extends over one hundred thousands km^2, i.e. 1/5 of the metropolitan French territory. Despite extensive damming, its discharge is still subject to important short-term variations, often the result of localized storms of Mediterranean origin. While the mean annual flow rate of the Rhône is rather constant since the beginning of the 20th century, flood frequency is largely varying: the 1960-1990 period presented only a few exceptional events in comparison with the 1990-2003 period that was characterized by six major floods with >50-y return periods (Antonelli, 2002). Important industrial and agricultural activities in the river basin result in strong nutrient and pollutant fluxes to the Rhône, an anthropogenic impact that also affects the marine system, since the Rhône inputs play a leading role in the functioning of the whole Gulf of Lion. Almost twenty nuclear reactors are located along the Rhône valley, representing Europe's biggest concentration of nuclear power plants. Until its closure in 1997, the Marcoule reprocessing plant of spent nuclear fuel released most of the liquid radioactive wastes (Charmasson, 1998) to the river. Radioactive isotopes observed in the Rhône also originate from the weathering of the catchment basin contaminated by the global atmospheric fallout from the past nuclear tests carried out between 1945 and 1980 and the atmospheric fallout from the Chernobyl accident in 1986 (Cigna et al., 1987; Thomas, 1996; Calmet et al., 1998; Renaud et al., 1999). These primary radioactive inputs are today several orders of magnitude lower than those observed at the beginning of the 90s. Recent work underlined the significant contribution of floods and flooding on the reuptake/translocation of contaminated sediment accumulated over the past 40 years of nuclear production/reprocessing (Rolland, 2004a, b, 2006; Eyrolle et al., 2006). The Rhône also represents a significant particle source to the continental shelf leading to the formation of a prodelta area around a water depth of 30 m, mainly resulting from physico-chemical processes such as flocculation. This prodelta area is characterized by high accumulation of river-driven pollutants, and sedimentation rates up to 30-50 cm y^{-1} have been determined close to the river mouth (Calmet and Fernandez, 1990; Charmasson et al., 1998). The amount of ^{137}Cs trapped in the sediment on a 480 km^2 area near the Rhône mouth was estimated at 19.6 TBq in 1990 (Charmasson, 2003) and at 13.2 TBq in 2001 (Arnaud et al., 2003) due to a decrease in the releases from the Marcoule reprocessing plant. In the same area Lansard (2005) estimated the amount of plutonium being trapped in 2001 at 92 GBq for ^{238}Pu and 522 GBq for $^{239+240}Pu$. However, these areas cannot be considered as permanent repositories for particle-reactive pollutants since they are subjected to reworking processes. During flood and storm events, particle resuspension due to current and wave action on the seabed can lead to translocation of pollutants.

The Têt River is a typical small Mediterranean river that drains the eastern part of the French Pyrenees to the Mediterranean Sea. Its basin area is about 1400 km^2 and the river length is about 120 km. As for many other Mediterranean rivers, the water flow of the Têt River is highly variable and strongly dominated by the occurrence of short and violent flash floods. The average water discharge of the river is about 10 m^3 s^{-1}, but it can increase by more than two orders of magnitude during major floods. As a consequence, the sediment discharge is also characterized by a very high inter-annual and seasonal variability. Serrat et al. (2001) estimated the mean sediment discharge at 53,000 ±16,000 tons y^{-1} for the reference period of 1980-1999, whereas during some years, about 2-3 times this amount was discharged within only three days (e.g. in 1996). As climate and the occurrence of flash floods are the major drivers for the particulate material transport by the Têt River, special emphasis has been given on the evaluation of the potential impact of climate change on this particular river. A first study on the effect of the rising temperatures during recent decades on the hydroclimatic functioning of the Têt River (Ludwig et al., 2004) showed a possible increase of flood frequency in the near future, which should also affect the sediment transport. Consequently, the basic scientific approach of this study has been enlarged in the framework of a PhD study on the other coastal rivers west of the Rhône (Lespinas et al., in preparation), and now also includes the development of future scenarios in conjunction with GCM climate model predictions. First evaluations of the trace metal loads in the Têt have been undertaken through clean sampling of suspended matter during several flood events in 2003-2004 (Roussiez et al., submitted; Radakovitch et al., in press). These data show that the current trace metal contents in the river sediments is rather constant during floods, indicating hence that the metal fluxes could be predicted with rather good precision on the basis of the data and models for the river sediment loads. Trace metal contents were also regularly measured in the Têt prodelta surface sediments off the river mouth to follow their introduction in the marine realm. The results clearly show that the deltaic sedimentation and subsequent burial of these materials is highly dynamic and includes the combination of several processes, such as the sediment delivery by floods, their temporary storage in the estuary, their remobilization during storms and their deposition in proximate and distal sedimentation zones (Roussiez et al., submitted). All these processes are highly dependent on the prevailing hydrodynamic conditions in the drainage basin and coastal area, making them very sensitive to climate change. Moreover, as sedimentation rates are very low compared to the prodelta of the Rhône River, the mobility of riverborn particles and associated contaminants may be very different in the prodelta systems of the small coastal rivers, giving them probably a particular role in the introduction of terrestrial contaminants into the marine system.

The sedimentological setting of the Gulf of Lion was first described in details in different publications and maps (e.g., Aloisi et al., 1977), based on large numbers of samples (around 1200 stations collected over the entire continental shelf). It was subsequently actualized during numerous campaigns (for a more recent map, see Roussiez et al., 2005a). These data revealed an offshore granulometric gradient that consists in a sandy band in the inner shelf, followed by a typical middle shelf mud bank, and finally by a mixing of relict sands and modern fine-grained sediments in the outer shelf. The muddy deposits are particularly interesting since most of the particulate pollutants, such as heavy metals, show high degrees of association with the fine-grained sediments (Roussiez et al., 2005b). Their thickness generally decreases in the Gulf of Lion in a NE-SW direction, which underlines the important role of the Rhône River as major sediment source. However, at the same time, the average current velocities during major storms increase in an opposite direction (Ulses, 2005), indicating that the hydrodynamic conditions may also exert a strong control on the distribution of fine-grained sediments and associated pollutants on the shelf. Very recent results have shown that high waves and strong currents associated to storms are able to produce erosion of very large amounts of matter (Guillèn et al., in press). During the February 2004 storm, models associated to observations allowed to estimate a reworking of at least 10×10^6 tons of sedimentary mass at the scale of the entire Gulf of Lion, i.e., around twice the solid load delivered by the Rhône flood in December 2003. During such events, most of the transport of shelf water and fine sediments converges to the southwestern end of the Gulf of Lion, next to the Cap de Creus promontory, where a large part of the off-shelf export takes place (Palanques et al., in press; Ulses et al., submitted). While exportation associated to autumnal storms is confined to subsurface waters, the dense shelf water overflowing the shelf break and cascading down the continental slope represents a unique and massive way to rapidly and directly export pollutants from the shallow shelf water to the intermediate (200-1500 m) and deep (>1500 m) levels of the basin. However, nothing is known regarding the fate of these contaminants, either focusing in specific slope depocenters or dispersion by the general along-slope circulation.

3. Experimental field work

3.1. Monitoring and sampling through multi-instrumented platforms

EXTREMA relies, to a large extent, on several existing experimental platforms implemented by the partners in various compartments of the Gulf of Lion coastal system (Fig. 2). Some are running for several years now, others are more recent. Specially adapted to extreme events, they are designed to monitor liquid and/or solid fluxes and associated pollutant. They automatically provide samples for chemical analysis at preset intervals, which is the only way to access sampling during harsh weather conditions.

The *OPERA platform* (Observatoire PErmanent de la RAdioactivité de l'Environnement) run by IRSN will be dedicated to (1) sampling of both atmospheric wet and dry depositions, and (2) sampling of the Rhône River solid load. Regarding the atmospheric compartment, deposition sampling uses two collector types: (1) one for global atmospheric deposition (dry/wet) over weekly or monthly integrated periods (for dust events, this period will be reduced to the duration of the event), and (2) one dedicated to rain events (wet only opening collector). These atmospheric stations are located between the Toulon University in collaboration with the LEPI (Laboratoire d'Etude des Particules aux Interfaces) and the IFREMER Centre based in La Seyne sur mer. Around 5 major dust events per year are expected. Since 2004, the OPERA Rhône observatory station at Arles measures the fluxes of artificial radiogenic trace elements at a water depth of 0.5 m through integrated large volume water sampling during low-water conditions. When discharge exceeds 3000 $m^3 s^{-1}$, discrete flood samples are taken at an increased rate (1 per 8 hours). OPERA samples will be distributed to partners for trace metal analyses.

The *POEM-LR2* (Plateforme d'Observation de l'Environnement Méditerranéen - Littoral du Languedoc-Roussillon) observation and sampling platform has been installed by CEFREM in 2003-2004 on the coupled freshwater/saltwater system of the Têt River. Its purpose is to allow, in the long term, a quantitative and qualitative tracking of the land-derived particles into the coastal system. The platform consists of (1) an automated monitoring and sampling station on the main river course (3 km upstream the river mouth), and (2) a buoy in the Têt prodelta (25m water depth) that bears a weather station and two multi-parametric marine probes. The river station measures hydrological properties (CTD, pH, O_2, fluorescence, turbidity) and provides high resolution (hourly) TSS sampling during floods that will help to determine the impact of hydrology on the contaminant imprint during flash-type floods. The buoy measures and transmits (GSM) to the laboratory in near real-time meteorological parameters (wind, pressure, temperature, humidity) and the same hydrological properties as for river waters. It further allows the periodic deployment, protected from trawling, of diverse bottom-mounted instruments, to monitor the dynamical (ADCP) and sedimentological (altimeters) conditions of the coastal area (e.g., field truth for modelling). Numerous representative prodelta sediment samples collected during previous experiments will be made available for the project for contaminant analysis. New samples will be further acquired through the deployment of a sediment trap coupled to the POEM buoy to determine the contamination level of sediment resuspended after severe storms and/or floods. A terrestrial aerosol sampler in the hinterlands (Cap Bear) and a sediment trap/current meter mooring in the Lacaze-Duthiers Canyon off-shore the Têt River (1000 m water depth) complete the monitoring strategy (both collect samples in monthly time intervals).

The *FRAME instrumentation* (Station sous-marine de Fond, Régional, Autonome, de Mesure et d'Echantillonnage), which was initially developed by IFREMER in the frame of the MEDICIS/METROC project, is a small autonomous benthic station with two working modes: (1) a periodic measurement mode (continuous measurements of currents, wave, CTD, turbidity) at a rate sufficient to get useful time series of physical parameters for coastal modelling and also to detect extreme events that trigger the passive sampling module (DGT); (2) a passive sampler module for pollutant measurements. On event detection, passive samplers become active for a few hours, corresponding to the duration of most extreme meteo-climatic events. FRAME will be first implemented in the Gulf of Marseilles for 2-3 months. A large amount of data has been gathered in this area highly contaminated by industrial, harbour or urban activities (RNO, 1998). It will then be deployed for similar durations close to the Rhône prodelta to acquire data and samples during storms and/or floods. DGT will be analyzed in the laboratory for metallic contaminants upon system recovery.

3.2. Additional sampling and analyses of existing samples

Besides the work performed by and around the platforms, additional sampling and instruments will be necessary in some key compartments of the system. This concerns first the bottom solid load transferred by the Rhône River, which may account for at least 10% of the total solid fluxes to the marine environment. Large uncertainties exist on its precise contribution to the translocation and transfer of sediments and associated contaminants especially during extreme floods (Antonelli, 2002; Antonelli et al., 2006). Such fluxes are not quantified by the OPERA monitoring station. The bed load will be investigated within a 500 m long experimental area at the Rhône mouth through (1) high resolution bathymetric measurements (5x5 m) every 3 months during a complete year and (2) direct flux measurements using a Helly-Smith trap supported by a Delft bottle. The latter instrumentation will be deployed during several field cruises depending on the flow rate of the river. The long term evolution of the bed load transferred by the Rhône will be investigated based on existing records (1959 to now). Samples will be analyzed for contaminants as only scarce studies focused on the role of this solid load on the exportation of contaminants towards the marine environment (Antonelli et al., 2006).

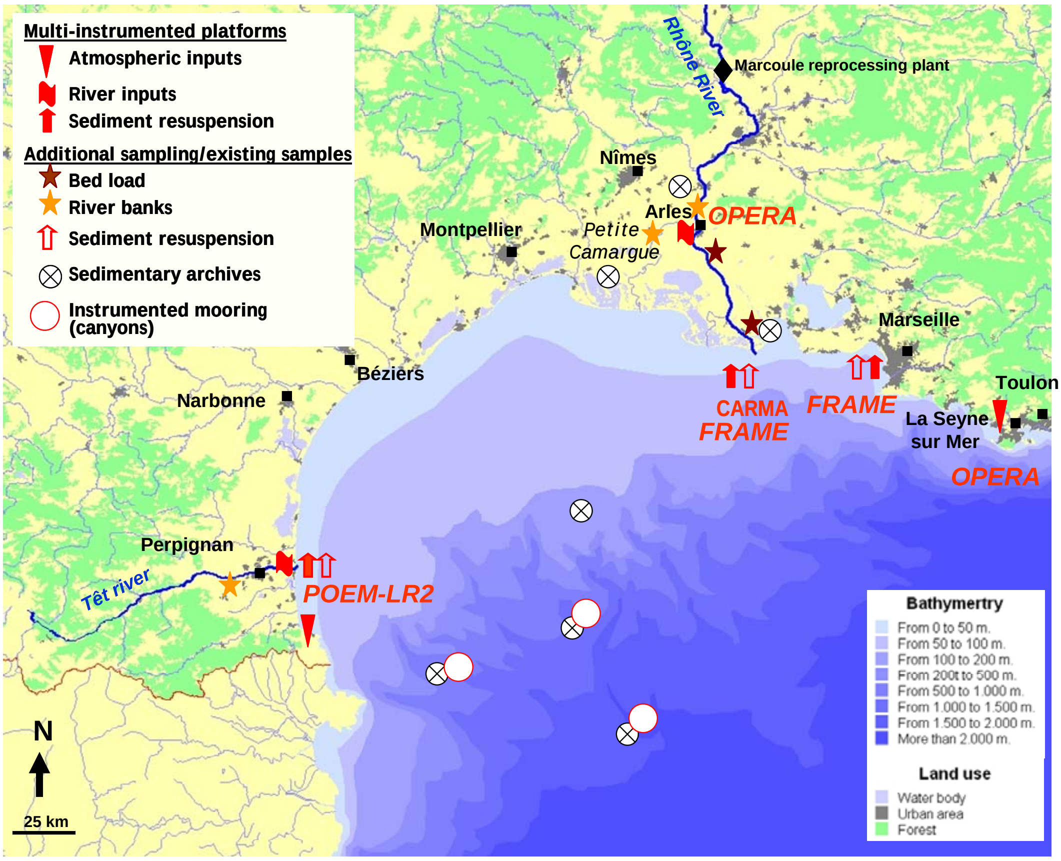

Figure 2. Bathymetry map of the coastal system of the Gulf of Lion and location of the main sampling areas of the EXTREMA project.

Riverbanks are known to be important reservoirs for the temporary storage of riverine pollutants (Maillet, 2006; Rolland, 2006). The morphology of the lower Rhône River indeed favours the retention of river sediments and pollutants during low-water conditions, where they can be easily remobilized during floods. The contribution of the riverbanks to the overall pollutant flux by the river will be determined at previously occupied experimental sites. These sites will also serve as sediment archives to reconstruct the recent history of heavy metal concentrations in the Rhône sediments, as the sediments can be roughly dated through their levels of artificial radiogenic trace elements. Similar investigations will be conducted within the Têt River.

At the Rhône mouth, data acquisition will also rely on instrumentation deployed by the CARMA project. Continuous measurements of currents, frequency/direction of waves, temperature, pressure, salinity, turbidity are performed at two benthic stations moored for four 6-month periods in the plume of the Rhône River. Altimetric bottom measurements at six coastal stations at various depths from 10 to 30 m were also initiated in the frame of CARMA to evaluate the real impact of Rhône river sediment transport on the coastal area. In the frame of EXTREMA, sediment samples taken before and after flood or storm events coupled with the data acquired by the CARMA instrumentation will be made available for radionuclides and trace metal contaminants.

The transfer of suspended particles and associated elements from the coastal waters to the open marine system mainly passes through the submarine canyons into the Gulf of Lion shelf. Periods of cold dense water cascading play a crucial role in this transport. Several canyons have been equipped with sediment traps and current meters during previous research projects by the EXTREMA partners. A 13-yr long time series of trap samples from the Planier (NE entrance of the Gulf of Lion with respect to the general along-slope circulation) and Lacaze-Duthiers (SW exit) canyons, encompassing at least 3 severe cascading periods (winters of 1999, 2004 and 2005) will be made available to the project for contaminant analyses. Measurements and sampling will be continued for at least 2 years in the Lacaze-Duthiers Canyon (trap/current meter pairs at 500 and 1000 m depth on a 1000 m deep station) and deep stations (1000 – 2000 m) in the Sète Canyon will be newly equipped.

Sedimentary archives from the Sète Canyon will be examined for sedimentological and geochemical properties using an existing sediment core that covers the entire Holocene period. This epoch (the last 6000 years) can be regarded as representative of the current period (except for the effect of anthropogenic activities). Results obtained by the EUROSTRATAFORM project show that recent sandy deposits (<5000 years) cover the area located at the outlet of the Sète Canyon, which collects sediments from all other canyons in the western part of the Gulf of Lion. Dense water cascading could be the reason of these deposits, a hypothesis that will be further examined for it could provide a historical perspective for cascading in that area. Dating of the core will be performed through ^{210}Pb and ^{14}C techniques and the samples will be available for contaminant analysis.

3.3. Laboratory experiments

A particular attention will be paid to the influence of sediment resuspension on pollutant dispersion on the shelf. Very few experiments have been conducted so far on this subject (Lansard et al, 2005; Radakovitch et al., in press). They show that higher concentrations of metals or radionuclides are observed on resuspended particles. However, relations between concentrations and size or nature of the particles resuspended are still to be investigated. One goal of EXTREMA will be to analyse metals in resuspended particles to propose relations that could be useful for the modelling performed by the project. Sediment cores will be collected in specific areas of the shelf for resuspension experiments (prodeltas, areas subject to resuspension by storms, FRAME deployment areas, shelf-water cascading areas). Resuspension will be performed in a recirculating flume at the COM laboratory (Centre Océanologique de Marseille). Trace metals will be analyzed in both core and resuspended particles together with grain size and organic matter content.

4. Modelling the present day pollutant transfer and its potential evolution in the coming decades

4.1. Model adaptation, development and validation

Modelling of the material fluxes through the entire system is an important step towards answering the question whether climate change might affect the inputs, translocation and/or storage of pollutants in the Gulf of Lion. The objective of the modelling in EXTREMA is to assess the present and future risks of contamination of the marine environment linked to extreme events. The purpose is not to develop a new model but to rely on a tool that has proved to be efficient in simulating both coastal circulation and particulate/sediment transport under conditions such as floods, storms and dense water cascading (Ulses, 2005). We propose to address the focal point of EXTREMA by implementing a specific module dealing with the transport of heavy metals and radionuclides from sources (rivers, prodeltas) to the water column and sedimentation areas (continental shelf, canyons, deep basin). The model will be validated and used in a first step on well-documented periods (from winter 2003-2004 till the last field work of the program) to study in detail the dynamics and the pathways of contaminants from sources to sinks. The evolution of contamination for the next decades in relation with the climate change will then be evaluated.

The existing model is based on three coupled modules: a hydrodynamic model, a wave model and a sediment transport model. The SYMPHONIE hydrodynamic model was developed at Laboratoire d'Aérologie and used for more than 10 years to study the Gulf of Lion (Rhône plume, wind curl induced circulation, dense water cascading, intrusions of LPC current, small-scales circulation - for refs see http://poc.obs-mip.fr/pages/publications/publi_symphonie.htm, Estournel et al., 2001; Estournel et al., 2003). The WAVEWATCH3 wave model will take benefit from very recent developments (Ardhuin et al., 2006). The sediment transport model, developed following Harris and Wiberg (2001), considers cohesive and non-cohesive resuspension by currents, waves and their interactions, and the grain size interactions. The coupled model was used to simulate the 2003-2004 winter, a period rich in extreme events (flood and storms). Time-series of suspended matter concentration were correctly simulated and allowed building a realistic mass budget over 8 months.

Regarding model developments within the scope of EXTREMA, we will implement, on the sediment transport model, a new module allowing the determination of pollutant (metals, radionuclides) concentration and translocation during extreme events. This module will take into account the well-known propensity of pollutants to associate with fine particles. The three fine particle classes between 2 and 63 microns will be subdivided in pollutant concentration classes. The initial state of the sediment will be given by the compilation of available sediment core analyses in the Gulf of Lion. Concentration in the different rivers will be determined from measurements and modelling. The parameterization of resuspension will be adjusted using the flume measurements of metal concentrations in resuspended matter. The atmospheric aerosol will be also taken into account using deposition maps generated from measurements at several stations of southern France. The contaminant contents will be fixed from analyses performed during the project. The settling velocities will be determined from granulometric analyses. After the successful validation on exceptional storms and moderate dense water cascading of winter 03-04, validation will go (1) on winter 04-05 marked by intense dense water formation and cascading and then (2) on extreme events that will be documented during the project. It will be based on measurements (temperature, current, suspended matter and pollutant concentrations) on prodeltas (POEM platform and CARMA instrumentation, FRAME and recirculating flume experiments data) and at the canyons moorings. The aim of the model is to calculate not only particulate matter concentrations and fluxes but also the pollutant concentrations in the coastal zone during extreme events and the fluxes through the different interfaces between continent, shelf sediment and deep basin. A cartography of sediment and pollutant translocation will be established showing the erosion and deposition areas for marine, riverine and atmospheric particles at the end of the events. The hypotheses of the model and its results will be analysed and regularly discussed by the project partners to allow modifying some parameterizations/initial conditions on the basis of new results.

4.2. Assessing potential changes in pollutant transfer in the coming decades

Finally, all the data (historical and newly-acquired, simulations) will feed hint- and forecasting modelling. Reconstruction of TSS riverine inputs into the Gulf of Lion will be produced for the last 30 years on the basis of the daily discharge records and TSS-Q rating curves that have been established within ongoing monitoring activities (e.g., for the Têt, Hérault and Rhône rivers via the ORME network). Fluxes of heavy metal and radiogenic trace elements will be linked to these inputs. In a first approach, constant trace element concentrations will be assumed, as such a tendency has been revealed by the first measurements of heavy metals in the river solids during floods (Radakovitch et al., in press). Then, in a more sophisticated approach, the algorithms for trace element dynamics in the rivers will be refined on the basis of the new data acquired by the project, both on river TSS and riverbank sediments. The latter are especially important for the decadal reconstruction of the radiogenic trace element levels in the Rhône, which were highly variable during time. The average heavy metal concentrations may also have changed over the last 30 years and will be tentatively reconstructed through the riverbank and other sedimentary records. The overall data will be further used to examine the role of storm and flood events in the mobilization of contaminants to the river mouths and, further offshore, towards the shelf break.

For the future climate conditions, the project partners will rely on the climate scenarios produced by different General Circulation Models (GCM), in particular on the ARPEGE-Climate model of Météo-France. Previous studies already examined the impact of climate change on the Rhône River catchment hydrology (e.g., Etchevers et al., 2002) and a similar study has been started on the coastal rivers west of the Rhône (Lespinas et al., in preparation). The latter study clearly evidences the strong coupling of the catchment hydrologies with the atmospheric circulation patterns at larger scales (NAO index, Hadley circulation), which, according to almost all model predictions, will evolve towards much warmer and dryer climate conditions in this area of the Mediterranean. Little is known, however, on the potential impact of these climate conditions on flood frequency and intensity. Downscaling of both the present-day and future climate conditions to daily time step resolutions will therefore be produced by EXTREMA to examine statistically whether the climatic constellations that favour flash floods and storms may be more or less frequent in the future, with direct consequences on the sediment and pollutant transfer by rivers.

Regarding future trends in pollutant translocation in the marine compartment, our high resolution coastal simulation will be forced by the outputs of the regional ocean (OPA) and atmosphere (ARPEGE) climate models that provided a simulation over the 1960-2099 period under the A2 scenario of IPCC (Somot et al., 2006). We will focus on coastal processes responsible for resuspension and transport of contaminants. The occurrence and strength of onshore storms associated to powerful swell and flood will be examined carefully for potential changes. Dense water cascading, which is the main transfer vector of matter towards the deep sea, will be probably modified in its occurrence frequency but also in its intensity, which controls the exportation depth. The trend of these characteristics is difficult to forecast as they are dependent on meteorological conditions, freshwater discharge, which lightens coastal water, and thermohaline properties of the offshore water, which governs the cascading depth. Only the use of a coastal model can allow answering this question. In the extreme case cascading would be reduced or stopped in our simulations, we will study the progressive redistribution of contaminants over the shelf.

5. The selected contaminants

Among all the trace elements that can be measured in the solid phase using the ICP-MS technique, EXTREMA will focus on 4 elements (Pb, Zn, Cd and Cu) that have a recognized major anthropogenic origin and a serious environmental impact and toxicity on ecosystems. Pb (mainly through automotive traffic) and Zn (industry) are widely dispersed in the atmosphere since many decades and thus the long range transport of these elements has impacted large areas. Cd is very toxic and very often associated to Zn in carbonate and sulphur. Since Cu is widely used as fungicide in agriculture (vineyards and fruit trees) in the large area boarding the Gulf of Lion, it is of great interest in the general context of this study, as it could serve as a tracer of agriculture intensity. Recent results from the Têt River system (Roussiez et al., submitted) show that both suspended matter transported by the river and the prodelta sediments are slightly enriched in Pb, Cu and Zn. Sample preparation prior to chemical analysis will be performed by CEFREM and CEREGE using clean state-of-the-art techniques. All the analyses will be performed by ICP-MS in the Laboratoire des Mécanismes de Transfert en Géologie in Toulouse.

There has been a significant reduction in anthropogenic radioactivity inflows and fallout over the last decades. The last atmospheric nuclear weapons tests took place in 1980, and the Chernobyl accident was in 1986. Likewise, for most radionuclides, there has been a significant reduction in activity released from nuclear facilities, under statutory monitoring, over the last 15 years, due to changing activities, technical improvements and the implementation of strict directives regarding environmental protection (Charmasson, 1998; Eyrolle et al., 2004a, b; Review Control, 2000). Although artificial radionuclides such as ^{137}Cs and transuranic nuclides are observed at ultratrace levels (10^{-15} ppm) within the present day environment, they represent a historical concern with respect to human health protection. These pollutants are particularly involved by the reworking of sedimentary reservoirs mainly since primary sources from nuclear industries declined. All radionuclide analyses will be performed at the Laboratoire de Mesure de la Radioactivité de l'Environnement (IRSN/DEI/STEME/LMRE) in Orsay.

6. Work scheduled and role of the participants

Extreme events	Work scheduled	Partners
A Precipitation Atmospheric solid load and Saharan dust	**A1** Atmospheric solid fluxes and associated contaminants: Use of high volume aerosol sampling device from the existing OPERA network **A2** Saharan dust fluxes and associated contaminants: Monitoring of dust events based on dust forecast from the web site of the Athens University and sampling of the major ones (about 5/year) either under dry or wet forms. Use of large surface collector. **A3** Precipitations: Use of a rainfall radar for the determination of the rain along the vertical and the variation of the associated parameters during the event. Rain type characterization based on intensity, duration, cumulated amount during the event. Wet-only deposition sampling with an automated rain gauge and a large(>3m^2) opening collector (to be acquired). Comparison with a bulk collector to determine the dry deposition over monthly averaged periods. For A1, A2 and A3 sampling sites are located between Toulon and Cadarache.	**1,2,3** **1,2,3** **1,2,3**
B Floods and flooding	**B1** Quantification of liquid and solid fluxes and associated contaminants of the Rhône and Têt rivers: Monitoring by the OPERA and POEM platforms. **B2** Contribution of bed load to solid fluxes and associated contaminants: Direct flux and bathymetric measurements at the Rhône mouth. **B3** Contribution of bank erosion to the solid fluxes and associated contaminants: 2 sites on the lower Rhône: casier Saxy/Pillet bank; Petite Argence. **B4** Assessment of past contamination levels in the Rhône and Têt rivers: Analysis of selected sediment depositories (banks, locks, …). **B5** Flooding: In case of no flooding events during the project, samples collected during the December 2003 flood around Arles and in the "Petite Camargue" area will be used.	**1,2,3** **1,2,3** **1,2,3** **1,2,3** **1,2,3**
C Storms	Quantification of sediment mass reworking and associated contaminant remobilization within the continental shelf based on: **C1** CARMA project instrumentation moored at the Rhône mouth. **C2** FRAME instrumentation (trace metal fluxes only) deployed in the Gulf of Marseille and close to the Rhône prodelta. **C3** POEM-L2R platform dedicated to solid fluxes and associated trace metals investigations within the Têt prodelta. **C4** Recirculating flume experiments (COM, Marseille) to acquire key data for modelling.	**1,2,3** **2,4** **2,4** **1,2,3,4**
D Dense water cascading	**D1** Quantification of sediment and associated contaminant fluxes induced by cascading: 3 instrumented moorings deployed between 1000 and 2500 m depth in the Planier, Sète and Lacaze-Duthiers canyons. Each mooring, deployed for 6-m periods, are equipped with 2 trap/current meter pairs at 30 and 500 m above the bottom. Analysis of selected samples from the long term (>13 y) time series in the LD and Planier canyons to detect potential inter-annual trends in the level of contaminants. Analysis of superficial sediment cores (upper 5 mm). **D2** Occurrence of extreme events during the Holocene on the continental slope and the deep basin: Analysis of data from existing sediment cores from the outlet of the canyon of Sète (additional datings (^{210}Pb, ^{14}C)). **D3** Assessment of the past contamination levels: Interface cores from the Sète Canyon of will be used for contaminant analysis.	**1,2,4** **1,4** **4**
E Modelling	**E1** Model development: Implementation on the sediment transport model (SYMPHONIE) of a module allowing to determine the pollutants (metals, radionuclides) concentration and translocation during extreme events. **E2** Validation: It will go on first on winter 2004-2005 marked by intense dense water formation and cascading events and then on extreme events which will be documented during the project, based on observations collected on prodeltas and at the canyons moorings (FRAME, OPERA, POEM platforms/instrumentions and recirculating flume experiments. **E3** Simulation analysis: A cartography of sediment and pollutants translocation will be established showing the erosion and deposition areas at the end of the events (continent, shelf sediment and deep basin). **E4** Evolution of extreme event-related transfer of pollutants in the coming decades: Use as forcings of the high resolution coastal simulation the outputs of the regional ocean (OPA) and atmosphere (ARPEGE) climate models from Météo-France that provided a simulation over the 1960-2099 period using the A2 scenario of IPCC.	**5** **1,2,3,4,5** **1,2,3,4,5** **2,5**

7. Planning of actions

Themes	Actions	Partner implied	Duration (months)																
			0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
A	A1	1,2,3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
	A2	1,2,3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
	A3	1,2,3			x	x	x	x	x	x	x	x	x	x	x	x	x		
B	B1	1,2,3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
	B2	1,2,3			x	x	x	x											
	B3	1,2,3			x		x		x		x		x						
	B4	1,2,3			x		x		x		x		x						
	B5	1,2,3													x				
C	C1	1,2,3	x	x	x	x	x	x	x		x								
	C2	2,4					x	x											
	C3	2,4			x	x	x	x	x	x	x	x							
	C4	1,2,3,4			x		x		x		x		x						
D	D1	1,2,4			x	x		x	x		x	x		x	x				
	D2	1,4		x	x	x	x	x											
	D3	4		x	x	x	x	x											
E	E1	5	x	x	x	x													
	E2	1,2,3,4,5					x	x	x	x									
	E3	1,2,3,4,5									x	x	x	x					
	E4	2,5													x	x	x	x	x
Partner's meeting			x		x		x		x		x		x		x		x		x
Délivrables					xx		xx		xx		xx		xx		xx		xx		xxx

xx Intermediate report
xxx Final report

x Scheduled
x Achieved
x Delayed

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IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

B-3 - Justification scientifique des moyens demandés pour chaque équipe partenaire impliquée dans le projet.

Partenaire 1 (IRSN)

Salaries : Our needs rely on a Post Doctoral recruitment on the field of River bank research specially in terms of field collection based on geomorphology/sedimentology investigations.

Costs :	12-month full time Post Doctoral level:	51108
	Requested: 6 month full time	**25555**

Equipment: Regarding the atmospheric compartment, EXTREMA needs the implementation of an open collector for precipitation and dust sampling during extreme events. Regarding the Rhone river mouth, the work within EXTREMA will be performed by the same team that initiated the CARMA project. This work includes deployments of an array of sediment/current meter moorings (Acoustic Doppler Current Profiler, acoustic altimeter), part of which already exists in the CARMA instrumentation. This equipment will be deployed over a 1 year period during the EXTREMA project. The new equipment will complete and facilitate mooring in this area subjected to frequent trawling. It includes a trawl-resistant bottom mount which is specially designed for our RD Instruments ADCP and acoustic release for shallow water. The second ADCP current meter will be also equipped with a multiparametric probe. We will use the RDI ADCP current meters, ALTUS acoustic altimeters, OCEANO acoustic release, multiparemetric probe existing in the laboratory to complete all the mooring stations.

Costs:	1 Open collector	30000
	1 FLOTEC trawl-resistant bottom mount	11084
	1 mutiparametric probe	14050
	1 mounting assembly for non-standard acoustic release	450
	1 OCEANO 500 acoustic release	3325
	1 DESK SET OCEANO TT701	5150
	TOTAL:	64059
Requested:		**40000**

Consumables: Analytical costs for about 50 atmospheric samples, 100 Rhone water samples (solid load) and 100 sediment samples (gamma spectrometry and ICP-MS). These costs also include filters, cartridges and mooring consumables (lost anchors, batteries for 2 ADCP, 6 altimeters and acoustic releases).

Costs:	gamma spectrometry	79500
	ICP-MS for Pu isotopes	40100
	Cartridges and Filters	29700
	Moored equipment consumables	1504
	TOTAL:	150804
Requested:		**50000**

***Travel*:** Travel funds for meetings including field work preparation and discussion on results. The costs are calculated for 2 yearly meetings and 3 persons either in Cadarache, Marseille or Perpignan. Travel funds for 5 field work periods on river and 3 cruises at sea.

Costs:	Travel funds for 2 meetings/yr x 3 p x 4 yr	4800
	Field trips (globally estimated)	5400
	Total :	**10200**

External services: The atmospheric and Rhone observatory stations need technical assistance sub- contracted to private companies (The Rhone observatory station still receives a subvention of 50% from the Agence de l'Eau Rhône Méditerranée Corse). Besides, the 1-year survey of various parameters on the Rhône prodelta requires monthly visits to the 8 mooring stations to collect data and change batteries and technical assistance on mooring campaigns. This work will be also sub-contracted to a private company.

Costs (global estimate requested):	Atmospheric station	10000
	Rhone Observatory station	18000
	Moorings	28810
Total :		**56810**

Partenaire 2 (CEFREM)

Salaries **:** Our needs in terms of field collection (river sampling and oceanographic cruises) and analytical manpower (trace metals) have to be partly covered by a fully dedicated person at the doctoral level (40% of the total manpower implication of CEFREM). This participation to EXTREMA represents an excellent opportunity for a young researcher to be trained in a multidisciplinary and integrated approach of the environment, in the use of various state-of-the-art sampling techniques on land and at sea (sediment traps, current meters, altimeters, automated river sampling etc.), and in high quality analyses of trace metals (ICP-MS). The salary costs are those used by CNRS at the pre-doc level.

Costs : 36-month (Yr 1-3) full time PhD student : **78804**

Equipment **:** The work that will be performed by the team includes the deployment of an array of sediment/current meter moorings that is part of the existing POEM platform. The new equipment required by the EXTREMA project will be repeatedly deployed for a 2-yr period under the POEM meteoceanic buoy in the Tet prodelta. It includes an automated sediment trap (PPS3 Technicap with 12 receiving cups) intended to collect settling particles resuspended from prodelta sediments and an AQUADOP current meter to measure current speed and direction. We will use equipment existing in the laboratory (glass floats, SONARDYNE acoustic release) to complete the line.

Costs :	1 Technicap PPS 3/12 cups automated time series sediment trap :	15242
	1 AQUADOP current meter :	15828
	TOTAL :	31070
	Requested :	**25209**
	Complementary funds from CNRS recurrent support to CEFREM	5861

Consumables **:** This budget line includes all necessary expenses to treat and analyze the samples (trace metals, organic and inorganic carbon) collected for the purpose of our participation in the project. Analytical costs are based on a tentative (minimum) total number of 1000 samples (rivers, traps, sediments) of suspended and trap particles as well as of sediments. These real costs are based on our own recent expenditures and special rates for ICP-MS at the LMTG in Toulouse. Consumables further include the costs of running various moored equipment (lost anchors, batteries for 5 traps and 5 current meters, 1 ADCP, 3 altimeters) as well as a contribution (50%) to the maintenance of the POEM platform (regular visits by professional divers for the buoy moored in the Tet prodelta and consumables, in particular for sensors of the buoy and the Tet River station).

Costs :	1000 ICP-MS runs at 5 euros (Before Tax) each :	5863
	1000 organic and 1000 inorganic C at 2 euros (BT) each :	4690
	150 sediment trap samples (filters, chemicals) at 20 euros (BT) each :	3517
	Moored equipment consumables :	7035
	Contribution to the maintenance and running of POEM :	14070
	TOTAL :	**35175**

Travel **:** This project needs travel funds for meetings (field work preparation, exchange and discussion of results between the partners). The expenses are based on 2 yearly meetings for 2 persons either in Perpignan, Marseille, Toulouse or Cadarache. Travel funds are also needed for field work (on rivers and at sea) during a 2-yr period. Each field trip includes 2 (rivers) or 3 (work at sea) people at least. Finally we expect 4 1-week travels for 2 people to perform the ICP-MS analyses in Toulouse.

Costs :	Travel funds for 2 meetings/yr x 2 people x 4 years (at 200 euros each)	3200
	Field trips (global estimate)	4180
	Travels for ICP-Ms analyses in Toulouse (at 500 euros each)	2000
	TOTAL :	**9380**

External services **:** The 2-yr field survey of solid river discharge from the Rhone and the Tet rivers necessitates a monthly visit to OPERA, the field station run by IRSN in Arles to collect between 50 and 100 l of water and suspended sediment samples. To bring these samples back to the lab in Perpignan we use a small rental truck for around 100 euros per round trip.

Costs : 24 roundtrips at 100 euros (BT) **2814**

Partenaire 3 (CEREGE)

Salaries : The post-doctoral position will be dedicated to the bedload experiment on the Rhone mouth. He (she) will participate to acquisition of bathymetric profiles on the Rhone mouth, realisation of bathymetric map and compilation of the various MNT acquired in this area. He (she) will be in charge of bedload sampling with sand traps and delft bottle in the Rhone and adjacent prodelta and treatment of samples. The position will start from October to March, covering thus the fall and winter floods.

Cost :	6-month full time post-doc	**19716**

Equipment : The equipment corresponds to small apparatus required for various topics proposed by the CEREGE. Our present apparatus for the acquisition of high precision bathymetric profiles must be implemented. A computer is required for the treatment of airplane photographies. The recirculating flume that will be used for the analyses of metal resuspension must be adapted. Particles issued from the seawater used for the flume must be filtered prior their introduction into the flume in order to avoid any metal contamination. A peristaltic pump equipped with a specific system for filtration of water with high concentration of SPM will be used to separate the resuspended particles after the experiment.
This material will be entirely purchased with funds from EXTREMA.

Implementation for bathymetric profiles :	6000
Specific Field Computer	3000
Recirculating flume adaptation	3000
Total equipment	**12000**

Consumables :
This line includes expenses covering the various analyses proposed by the laboratory : grain-size, geochemistry (metals (atmospheric particles, river particles, sediment and resuspended particles) and organic matter on resuspended particles) and mineralogy (atmospheric particles).

Analyses :	9000
Recirculating flume experiments	3000
Total consumables	**12000**

Location :
The location of an additional ADCP is required for the experiment on bedload transport in the Rhone river.

ADCP location for bedload experiment	**2000**

Travel :
We need travels funds for internal meetings (field work preparation, discussion of results), field works and participation to an international conference.

Internal meetings : (2 meetings/2 people/4 year)	3200
Participation to international meeting	1000
Field works	14 000

This line is very expensive because we include expenses related to the use of the laboratory boats and because the bathymetric maps will be done by 4 to 5 persons at the same time using two boats. It also includes expenses related to : river sampling ; transport of equipment (including multicorer) and participation to two oceanographic cruises for the collection of sediment cores required for resuspension experiment. The calculation is based on : (- 12 days * 500 € = 6000 euros ; 12 days*400 = 4800 euros ; 6 days * 200 euros = 1200 euros, Two oceanographic cruises : 2000 euros)

Total travels	**18200**

Partenaire 4 (IFREMER)

Three Ifremer laboratories will be involved in the EXTREMA project :

- LEP : Laboratoire Environment Profond (Deep environment), Department of Deep Ecosystems, Centre of Brest, for the study of the temporal variations of the particulate contributions at the outlet of the canyon of the Var
- LES : Laboratoire Environnement Sédimentaire (Sedimentary Environment), Department of Marine Geosciences, Centre of Brest, for the study of the transfer system functioning of the Rhône sediments towards the deep basin
- LER/PAC: Laboratoire Environnement Ressources Provence Azur Corse, Department Environment Resources, Centre of the Mediterranean Sea, for the study of the levels of contaminants salted out by coastal sediment during strong meteorological events.

Salaries:

Two year post docs, one in support of LER/PAC and the other in support of LEP and LES, are required to complete the envisaged work. **72000**

Equipment:

Field work in the frame of the project largely relies on the equipment pool already acquired by the laboratories.

- LER/CAP: spares for the system FRAME (Bottom Station for Automated Measurement and Sampling) for 40k€. For information, a complete FRAME unit, including a high frequency measurement unit (CTD, turbidity sensor, altimeter, current profiler) and an automated sampling unit for passive samplers costs between 120 and 150 k€.

Total requested : **70 000**

Small equipment, consumable, operation:

- LEP: 30k€ for mooring replacement, submarine instrumentation reconditioning, replacements for the laboratory park of instrumented particles traps. For information, an instrumented particles traps unit with automatic realise costs approximately 45 to 50k€.
- LES: 5k€ for consumables for imagery and seismic
- LER/PAC: 15k€ for: equipment transport, passive samplers consumables; submarine instrumentation reconditioning.

Total requested**:** **60 000**

Travel:

- LEP : 10k€ for missions Brest Provence
- LES : 15k€ for missions Brest Provence
- LER/PAC 5k€ for local missions

Total requested: **30 000**

Partenaire 5 (LA)

Salaries **:** We need a person at the post-doc level to prepare and perform the simulations concerning the transport of pollutants. These simulations are very time consuming as they necessitate putting together a large amount of data for the atmospheric and oceanic forcing. This post doc will work in close connection with the permanent researchers of the program who will implement the pollutants in the sediment transport model. The post-doc will be associated to the simulations analysis and for this objective will strongly collaborate with the other partners. The salary costs are those used by CNRS at the post-doc level.

Costs : 24-month full time post doc :	**78874**

Equipment **:** The equipment corresponds to an Opteron quadri-processor server with 32 Go RAM. This server implemented in Toulouse will be used for the coupled hydrodynamic sediment pollutants model. The development and debugging of this coupling associated to the large number of state variables of this model requires such a powerful computer.

Costs :	16500
Participation of SESAME (EU program)	4500
Requested to ANR	**12000**

Consumables **:** This budget line includes small expenses mostly for the storage of simulation forcing and results and the expenses for one publication.

USB external disks and DAT cartridges	3000
Expenses for one publication	**1500**

Travel **:** This project needs travel funds for meetings (field work preparation, exchange and discussion of results between the partners). The expenses are based on 2 yearly meetings for 2 persons either in Perpignan, Marseille, Toulouse or Cadarache. We also ask for a participation to an international conference for two persons.

Costs :	Travel funds for 2 meetings/yr x 2 people x 4 years (at 200 euros each)	3200
	Conference	1000
	TOTAL :	**4200**

Propositions d'experts et confidentialité

Les membres du comité d'évaluation et du comité de pilotage sont astreints à la confidentialité.

- Possibilité de fournir une liste de 3 à 5 noms d'experts français ou étrangers (avec coordonnées complètes : adresse postale et adresse électronique) susceptibles d'évaluer le projet avec lesquels les équipes participant au projet n'ont ni conflit d'intérêt, ni collaborations en cours.

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- Possibilité éventuelle de fournir une liste de 5 noms max. d'experts auxquels les participants au projet ne souhaitent pas que le projet soit envoyé s'il y a risque de conflits d'intérêts.

Programme Vulnérabilité : milieux et climat 2006

C - Moyens financiers et humains demandés par chaque équipe partenaire du projet

Chaque équipe partenaire remplira une fiche de demande d'aide selon les modèles proposés ci-dessous (laboratoire public ou fondation ; entreprise ou association) en fonction de son appartenance.

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Programme Vulnérabilité : milieux et climat 2006

Fiche de demande d'aide – Laboratoire public / Fondation

Acronyme ou titre court du projet : EXTREMA

Partenaire 1 : IRSN - Coordinateur (nom, prénom) : **Eyrolle Frédérique**

Calcul de l'aide demandée à l'ANR et estimation du coût complet du projet pour le laboratoire du partenaire

Avant de remplir ce tableau il vous faut décider quel sera votre établissement gestionnaire (cf notes 5 et 6 en bas de page)

				Euros HT	Taux spécifiques à chaque établissement	
	Nbre Homme .mois	*Coût Homme.mois (salaire chargé)*	*Nombre de personnes impliquées*			
Dépenses de personnel [1] catégorie 1 : ingénieur - chercheur catégorie 2 : technicien	50 12	6 745 3 547	5 2	379 814	1.988	755 070
Dépenses de personnel non permanent à recruter[2] catégorie 1 : post-doc	12	4 259	1	51 108	1.988	101 602
Equipements (>4000 €) détail § B-3				64 059	-	64 059
Petits matériels, consommables, fonctionnement, etc				150 804	-	150 804
Frais de missions si montant > 5% de la somme demandée, justification § B-3				10 200	-	10 200
Prestations de service externes, sous-contractant [3]				56 810	-	56 810
Total des dépenses de fonctionnement				217 814		217 814
Frais généraux (assistance, encadrement, coût de structure) (max 4 % du coût total des dépenses)						13 319
Assiette de l'aide [4]						346300
Aide demandée **≤ Z** [5]						**182565**
Coût complet du projet [6]				**1 151 864**		

Programme Vulnérabilité : milieux et climat 2006

Fiche de demande d'aide – Laboratoire public / Fondation

Acronyme ou titre court du projet : EXTREMA

Partenaire 2: CEFREM UMR 5110 CNRS-UPVD Coordinateur (nom, prénom) : **Aubert Dominique**

Calcul de l'aide demandée à l'ANR et estimation du coût complet du projet pour le laboratoire du partenaire

Avant de remplir ce tableau il vous faut décider quel sera votre établissement gestionnaire (cf notes 5 et 6 en bas de page)

				Euros HT	Taux spécifiques à chaque établissement	
	Nbre Homme .mois	*Coût Homme.mois (salaire chargé)*	*Nombre de personnes impliquées*			
Dépenses de personnel [1] catégorie 1 : enseignant chercheurs catégorie 2 : chercheurs catégorie 3 : ingénieurs	20 14 17	4660 5810 4200	2 2 2	245940	1.8	442692
Dépenses de personnel non permanent à recruter[2] catégorie 1 : pré-doc catégorie 2 etc…	36	2189	1	78804	1.8	141847
Equipements (>4000 €) détail § B-3				21500	0.1725	25209
Petits matériels, consommables, fonctionnement, etc				30000	0.1725	35175
Frais de missions si montant > 5% de la somme demandée, justification § B-3				8000	0.1725	9380
Prestations de service externes, sous-contractant [3]				2400	0.1725	2814
Total des dépenses de fonctionnement				(X1)= 40400		47369
Frais généraux (assistance, encadrement, coût de structure) (max 4 % du coût total des dépenses)						6055
Assiette de l'aide [4]						157437
Aide demandée **≤ Z** [5]						**157437**
Coût complet du projet [6]				**663172**		

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Programme Vulnérabilité : milieux et climat 2006

Fiche de demande d'aide – Laboratoire public / Fondation

Acronyme ou titre court du projet : EXTREMA

Partenaire 3 : CEREGE - UMR 6635 CNRS - Coordinateur (nom, prénom) : **Provansal Mireille**

Calcul de l'aide demandée à l'ANR et estimation du coût complet du projet pour le laboratoire du partenaire

Avant de remplir ce tableau il vous faut décider quel sera votre établissement gestionnaire (cf notes 5 et 6 en bas de page)

				Euros HT	Taux spécifiques à chaque établissement	
	Nbre Homme .mois	*Coût Homme.mois (salaire chargé)*	*Nombre de personnes impliquées*			
Dépenses de personnel [1] catégorie 1 : chercheur catégorie 2 : enseignant-chercheur etc…	4.8 16.8	6528 4660	1 4	109622	1,8	197320
Dépenses de personnel non permanent à recruter[2] catégorie 1	6	2965	1	17790	8%	19213
Equipements (>4000 €) détail § B-3				12000	17.25%	14070
Petits matériels, consommables, fonctionnement, etc				12000	17.25%	14070
Frais de missions si montant > 5% de la somme demandée, justification § B-3				18200	17.25%	21339
Prestations de service externes, sous-contractant [3]				2000	17.25%	2345
Total des dépenses de fonctionnement				32200	17.25%	37754
Frais généraux (assistance, encadrement, coût de structure) (max 4 % du coût total des dépenses)						2784
Assiette de l'aide [4]						72398
Aide demandée ≤ **Z** [5]						**72398**
Coût complet du projet [6]				**271141**		

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Programme Vulnérabilité : milieux et climat 2006

Fiche de demande d'aide – Laboratoire public / Fondation

Acronyme ou titre court du projet : EXTREMA

Partenaire 4 : IFREMER - Coordinateur (nom, prénom) : **Cadiou Jean-François**

Calcul de l'aide demandée à l'ANR et estimation du coût complet du projet pour le laboratoire du partenaire

Avant de remplir ce tableau il vous faut décider quel sera votre établissement gestionnaire (cf notes 5 et 6 en bas de page)

				Euros HT	Taux spécifiques à chaque établissement	
	Nbre Homme .mois	*Coût Homme.mois (salaire chargé)*	*Nombre de personnes impliquées*			
Dépenses de personnel [1] Cadre 1 Cadre 2 etc…	12 12	6167 8222	2 5	172668	61%	277995
Dépenses de personnel non permanent à recruter[2] Post-doc catégorie 2 etc…	24	3000	2	72000	61%	115920
Equipements (>4000 €) détail § B-3				70000	-	70000
Petits matériels, consommables, fonctionnement, etc **Analyses + consommables**				60000	-.	60000
Frais de missions si montant > 5% de la somme demandée, justification § B-3				30000	-	30000
Prestations de service externes, sous-contractant [3]				-	Taux TVA non réc.	0
Total des dépenses de fonctionnement				90000		90000
Frais généraux (assistance, encadrement, coût de structure) (max 4 % du coût total des dépenses)						11037
Assiette de l'aide [4]						243037
Aide demandée ≤ **Z** [5]						**150 000**
Coût complet du projet [6]				**564952**		

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Programme Vulnérabilité : milieux et climat 2006

Fiche de demande d'aide – Laboratoire public / Fondation

Acronyme ou titre court du projet : EXTREMA

Partenaire 5 : Laboratoire d'Aérologie UMR5560 CNRS/Université Paul Sabatier Coordinateur (nom, prénom) : **Estournel Claude**

Calcul de l'aide demandée à l'ANR et estimation du coût complet du projet pour le laboratoire du partenaire

Avant de remplir ce tableau il vous faut décider quel sera votre établissement gestionnaire (cf notes 5 et 6 en bas de page)

				Euros HT	Taux spécifiques à chaque établissement	
	Nbre Homme .mois	*Coût Homme.mois (salaire chargé)*	*Nombre de personnes impliquées*			
Dépenses de personnel (1) catégorie : chercheurs catégorie : CDD	21.6 21.6	6350 1825	2 2	176580	1.8	317844
Dépenses de personnel non permanent à recruter(2) catégorie 1 : post-doc catégorie 2 etc…	24	3286.4	1	78874	1.8	132973
Equipements (>4000 €) détail § B-3				12000	0.1725	14070
Petits matériels, consommables, fonctionnement, etc				4500	0.1725	5276
Frais de missions si montant > 5% de la somme demandée, justification § B-3				4200	0.1725	4925
Prestations de service externes, sous-contractant (3)				0	0.1725	0
Total des dépenses de fonctionnement				(X1)= 8700		10201
Frais généraux (assistance, encadrement, coût de structure) (max 4 % du coût total des dépenses)						4126
Assiette de l'aide (4)						107271
Aide demandée ≤ **Z** (5)						**107271**
Coût complet du projet (6)				**479214**		

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Programme Vulnérabilité : milieux et climat 2006

D - Récapitulatif global de la demande financière pour le projet

Acronyme ou titre court du projet : EXTREMA

a-Estimation du coût complet de cette demande

(reporter les valeurs (CC) des fiches des différents partenaires)

	Coût complet
Coordinateur (Partenaire 1) (IRSN)	1151864
Partenaire 2 (CEFREM)	663172
Partenaire 3 (CEREGE)	271141
Partenaire 4 (IFREMER)	564952
Partenaire 5 (LA Toulouse)	479214
Total	3130343

b-Total de l'aide demandée

(reporter les valeurs (Aide demandée) des fiches des différents partenaires)

	Aide demandée
Coordinateur (Partenaire 1) (IRSN)	182565
Partenaire 2 (CEFREM)	157437
Partenaire 3 (CEREGE)	72398
Partenaire 4 (IFREMER)	150000
Partenaire 5 (LA Toulouse)	107271
Total	669671

c- Effort en personnel demandé

(reporter les valeurs des fiches des différents partenaires)

	en homme. mois
Coordinateur (Partenaire 1) (IRSN)	74
Partenaire 2 (CEFREM)	87
Partenaire 3 (CEREGE)	27,6
Partenaire 4 (IFREMER)	48
Partenaire 5 (LA Toulouse)	67,2
Total	303,8

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CONTRATS PUBLICS ET PRIVES SUR LES TROIS DERNIERES ANNEES (EFFECTUES ET EN COURS) (P 1/4)

Nom du membre participant à cette demande	% d'implication	Intitulé de l'appel à projet Source de financement Montant attribué	Titre du projet	Nom du coordinateur	Date début - Date fin
Partenaire 1					
Arnaud Mireille	20 20 10	5e PCRDT UE, 61587 euros Midi Pyrénées-PACA, 326000 euros Zone Atelier PEVS, CNRS,	EUROSTRATAFORM CARMA ORME	Weaver P.P.E. Charmasson S. Ludwig W.	11/2002-10/2005 2005-2006 2001-2006
Charmasson Sabine	10 20 30 10	5e PCRDT UE, 107000 euros 5e PCRDT UE, 61587 euros Midi Pyrénées-PACA, 326000 euros ANR, 24000 euros	REMOTRANS EUROSTRATAFORM CARMA ECCO	Holm E. Weaver P.P.E. Charmasson S. Melon C.	1999-2001 11/2002-10/2005 2005-2006 01/2006-12/2008
Eyrolle Frédérique	20 20 5	5e PCRDT UE, 61587 euros Zone Atelier PEVS, CNRS, ORE ministère, 65 kE	EUROSTRATAFORM ORME RESYST : Réponses d'un système deltaique aux forcages actuels	Weaver P.P.E. Ludwig W. Radakovitch O.	11/2002-10/2005 2001-2006 07/2003-07/2006
Partenaire 2					
Durrieu de Madron Xavier	20 25 25	5e PCRDT UE, 225000 euros 5e PCRDT UE, 284000 euros 6e PCRDT UE, 352000 euros	INTERPOL EUROSTRATAFORM HERMES	Lykousis V. Weaver P.P.E. Weaver P.P.E.	01/2001-12/2003 11/2002-10/2005 04/2005-03/2009
Heussner Serge	30 20 20	5e PCRDT UE, 225000 euros 5e PCRDT UE, 284000 euros 6e PCRDT UE, 352000 euros	ADIOS EUROSTRATAFORM HERMES	Heussner S. Weaver P.P.E. Weaver P.P.E.	01/2001-12/2003 11/2002-10/2005 04/2005-03/2009
Ludwig Wolfgang	20	Zone Atelier PEVS, CNRS,	ORME	Ludwig W.	2001-2006

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CONTRATS PUBLICS ET PRIVES SUR LES TROIS DERNIERES ANNEES (EFFECTUES ET EN COURS) (P 2/4)

Nom du membre participant à cette demande	% d'implication	Intitulé de l'appel à projet Source de financement Montant attribué	Titre du projet	Nom du coordinateur	Date début - Date fin
Partenaire 3					
Noack Yves	15 20	ADEME, 9000 euros ADEME, 16000 euros	impact sanitaire des émissions atmosphériques de métaux lourds d'un complexe sidérurgique spéciation des métaux lourds à l'émission de sources fixes industrielles		
Provansal Mireille	15 5 5	ZA-PNVS, 40000 euros LITEAU, 23000 euros ORE ministère, 65000 euros	ORME GIZCAM : gestion intégrée de la zone cotière de Camargue RESYST : Réponses d'un système deltaique aux forcages actuels	Ludwig W. Chauvelon P. Radakovitch O.	2001-2006 07/2003- 07/2006
Radakovitch Olivier	30 15 20 10	5ème PCRD UE, 63000 euros ANR blanc, 35000 euros PNEC, 100000 euros ZA-PNVS, 40000 euros	EUROSTRATAFORM AMANDES (Amazon-Andes) PNEC – Chantier Nord Méditerranée ORME	Weaver P.P.E. Jeandel C. Raimbault P. Ludwig W.	2002-2005 2006-2008 2002-2006 2001-2006
Sabatier François	10 5 20 5	Région Midi Pyr.-PACA 326000 euros LITEAU, 23000 euros GICC, 106000 euros ORE ministère, 65000 euros	CARMA GIZCAM : gestion intégrée de la zone cotière de Camargue IMPLIT RESYST : Réponses d'un système deltaique aux forcages actuels	Charmasson S. Chauvelon P. Moron V. Radakovitch O.	2005-2006 07/2003- 07/2006
Vella Claude	25 10	Région Midi Pyr.-PACA 326000 euros GICC, 106000 euros	CARMA IMPLIT	Charmasson S. Moron V.	2005-2006

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CONTRATS PUBLICS ET PRIVES SUR LES TROIS DERNIERES ANNEES (EFFECTUES ET EN COURS) (P 3/4)

Nom du membre participant à cette demande	% d'implication	Intitulé de l'appel à projet Source de financement Montant attribué	Titre du projet	Nom du coordinateur	Date début - Date fin
Partenaire 4					
Berné Serge	20 25 55	5ème PCRD UE, 63000 euros 5ème PCRD UE, 450000 euros ANR, Blanc CSD6, 360000 euros	EUROSTRATAFORM PROMESS SESAME (Seismic and Sedimentary Attributes in the Mediterranean)	Weaver P.P.E. Berné S. Berné S.	2002-2005 2002-2006 2006-2008
Cadiou J. François	30 10 5	6ème PCRD 552000 euros Appel à projets Recherche région PACA 2005, 86400 k€ Appel à projets Recherche région PACA 2003 76200 euros	EXOCET/D - EXtreme ecosystem studies in the deep OCEan: Technological Developments (STREP) Station sous-marine de Fond, Régionale, Autonome, de Mesure et d'Echantillonnage (FRAME) PRISME	Sarradin P.M. Cadiou J.F. Sauzade D.	2004-2006 2006-2008 2002-2006
Dennielou B.	25 25 20	6ème PCRD 1000000 euros 5ème PCRD UE, 63000 euros 5ème PCRD UE, 450000 euros	HERMES IP EUROSTRATAFORM PROMESS	Weaver Ph. Weaver P.P.E. Berné S.	2005-2009 2002-2005 2002-2006
Gonzalez J. Louis	10	Appel à projets Recherche région PACA 2005, 86400 k€	Station sous-marine de Fond, Régionale, Autonome, de Mesure et d'Echantillonnage (FRAME)	Cadiou J.F.	2006-2008
Khripounoff Alexis.	10 10	6ème PCRD 552000 euros 6ème PCRD 1000000 euros	Station sous-marine de Fond, Régionale, Autonome, de Mesure et d'Echantillonnage (FRAME) HERMES IP	Sarradin P.M. Weaver Ph.	2004-2006 2005-2009
Leveque JP	30	Appel à projets Recherche région PACA 2005, 86400 k€		Cadiou J.F.	2006-2008

CONTRATS PUBLICS ET PRIVES SUR LES TROIS DERNIERES ANNEES (EFFECTUES ET EN COURS) (P 4/4)

Nom du membre participant à cette demande	% d'implication	Intitulé de l'appel à projet Source de financement Montant attribué	Titre du projet	Nom du coordinateur	Date début - Date fin
Sauzade Didier	10 10	Appel à projets Recherche région PACA 2005, 86400 k€ Appel à projets Recherche région PACA 2003 76200 euros	Station sous-marine de Fond, Régionale, Autonome, de Mesure et d'Echantillonnage (FRAME) PRISME Plateforme Régionale d'Imagerie Sous-Marine pour l'Environnement	Cadiou J.F. Sauzade D.	2006-2008 2002-2006
Partenaire 5					
Estournel Claude	10 10 10 17	5eme PCRD 150000 euros Midi Pyrénées-PACA, 326000 euros 5eme PCRD 47000 euros 6eme PCRD	Mediterreanean Forecasting System. Toward Environmental Processes CARMA EUROSTRATAFORM SESAME Southern European Seas: Assessing and Modelling Ecosystem changes	Pinardi N. Charmasson S. Weaver P.P.E. Papathanassiou E.	2003-2006 2005-2006 2002-2005 2007-2010
Marsaleix P.	20	6eme PCRD	INSEA	Neves R.	2006-2008

DEMANDES DE CONTRATS EN COURS D'EVALUATION [3]

Nom du membre participant à cette demande	% d'implication	Intitulé de l'appel à projet Source de financement Montant attribué	Titre du projet	Nom du coordinateur	Date début - Date fin
Ludwig Wolfgang	20	6e PCRDT UE, 165000 euros	SESAME	Papathanassiou V.	
Heussner Serge	15	6e PCRDT UE, 165000 euros	SESAME	Papathanassiou V.	
Durrieu de Madron Xavier	10	6e PCRDT UE, 165000 euros	SESAME	Papathanassiou V.	
Radakovitch Olivier Provansal Mireiile Estournel Claude	25 10 30	ANR Blanc	RIOMAR-Fr	Rabouille C.	
Provansal Mireiile Radakovitch Olivier Sabatier François	20 5 5	EC2CO, 23 kE	PIBAL	Provansal M.	

[3] *Mentionner ici les projets en cours d'évaluation soit au sein de programmes de l'ANR, soit auprès d'organisme, de fondations, à l'union européenne, etc. que ce soit comme coordinateur ou comme partenaire. Pour chacun donnez le nom de l'appel à projets, le titre du projet et le nom du coordinateur.*