

WP10 introduction: new monitoring technologies

**Felix Janssen, Antje Boetius
and MIDAS WP 10 members**

Introduction to WP10 (30 min)

- Objectives, partners, WP-interactions, tasks, timeline
(Felix Janssen, AWI)

Contractors' view of objectives of WP10 and beyond (15 min)

- Conceptual framework for impact assessment with implications for all WPs
(Ian Steward, Fugro)

D 10.1: Assessment of existing monitoring technologies (60 min)

- content & preparation
- 3 example technologies
 - Monitoring approaches in industry
(Richard Davies, Fugro)
 - Seafloor mapping and change detection with seafloor imagery
(Rafael Garcia, Coronis)
 - Rapid assessment of small benthic organisms
(Ann Vanreusel, UGent)

Midterm Deliverables: content and preparation (15 min)

- Integrative habitat mapping technologies (D10.2)
- Monitoring of ecosystem functions with modular systems (D10.3)
- Rapid biodiversity monitoring across size classes (D10.4)

Miscellaneous WP 10 issues

Open discussion led by Felix Janssen & Ingo Schewe

WP10 partners

Natural Environment Research Council (NERC-NOC, 1.8 PM)

Main expertise provided to WP10

- Seabed acoustic surveys and automated classification of habitats



**National
Oceanography Centre**
NATURAL ENVIRONMENT RESEARCH COUNCIL



**NATURAL
ENVIRONMENT
RESEARCH COUNCIL**

Helmholtz Centre for Ocean Research Kiel (GEOMAR, 6 PM)

Main expertise provided to WP10

- Monitoring of physicochemical seabed characteristics
- Hydroacoustic and visual mapping
- Bubble quantification
- Geochemical methods



Institut Français de recherche pour l'Exploitation de la Mer (Ifremer, 8.5 PM)

Main expertise provided to WP10

- Imaging and acoustic seafloor surveys
- Long term observation of seabed physical conditions
- Underwater instrumentation
- Ecosystem monitoring expertise in deep and shallow waters



University of Bergen (UiB, no PM)

Main expertise provided to WP10

- AUV-based hydroacoustic ,imaging‘ surveys (Synthetic Aperture Sonar)
- Sediment surface changes (repeated high resolution mapping)



Coronis Computing (CRN, 32 PM)

Main expertise provided to WP10

- High-resolution geo-referenced mosaicing and mapping of seafloor imagery (2D, 3D)
- Automated detection of seafloor changes



Norwegian Geotechnical Institute (NGI, 1.5 PM > transferred to WP1)

Main expertise provided to WP10

- Analysis of geophysical and geotechnical data from methane hydrate mining sites
- Sediment metagenomics to couple molecular characteristics to functions (Scientist in charge, Ann Gunn Rike, left NGI)



University of Bremen and MARUM (UNI-HB, 4 PM)

Main expertise provided to WP10

- Long term observation of seabed physical conditions (temperature and pore water pressure in boreholes): gas hydrate stability, seepage
- Imaging and acoustic seafloor surveys
- Ecosystem monitoring expertise in deep waters



Universitat de Barcelona (UB, 2 PM)

Main expertise provided to WP10

- Seafloor topography and sediment physical properties
- Characterization and time series of water column oceanographic properties (including fate of particles from mining plumes)



Universitat de Barcelona

Senckenberg Gesellschaft für Naturforschung (SGN, 5.5 PM)

Main expertise provided to WP10

- Biodiversity assessment
- Morphology-based as well as molecular methods
- Automated species recognition in images

SENCKENBERG
world of biodiversity

University of Gent (UGent, no PM)

Main expertise provided to WP10

- Meiofauna biodiversity
- Morphology-based as well as molecular methods



IHC Mining (IHC, 1.5 PM)

Main expertise provided to WP10

- State of the art mining technology
- Sediment dredging and dredging monitoring



Fugro Geos Ltd (Fugro, 15.7 PM)

Main expertise provided to WP10

- Industrial environmental monitoring technologies and strategies
- Data management, visualization, and web-based access



Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI, 41 PM)

Main expertise provided to WP10

- In situ instrument development and application
- Scientific data management (PANGAEA)
- Benthic microbial ecology
- Megafauna surveys and automated species recognition



WP10 objectives

WP10 in a nutshell

Identify appropriate monitoring targets and technologies to be recommended for routine application by industry

- Identify monitoring requirements
- Compile and assess available monitoring technology workflows from data acquisition to products incl. data management solutions
- Identify gaps in existing technologies and workflows
- Improve and demonstrate methodologies

Tasks and activities (1)

Identifying monitoring needs (task 10.1)

- Define monitoring targets in compliance with established guidelines (ISA, MSFD) and according to MIDAS findings
- Consider different ecosystems, minerals, mining technologies and monitoring stages (baseline, impact assessment, post-mining / recovery)

Collecting and assessing available monitoring methods (task 10.2)

- Collect technologies available in academia and industry
- Identify gaps in existing monitoring technologies and workflows
- Assess scientific soundness and potential for routine monitoring (readiness, efficiency, cost, time required for completion of workflow)

Tasks and activities (2)

Improving and demonstrating monitoring methods (task 10.3-10.6)

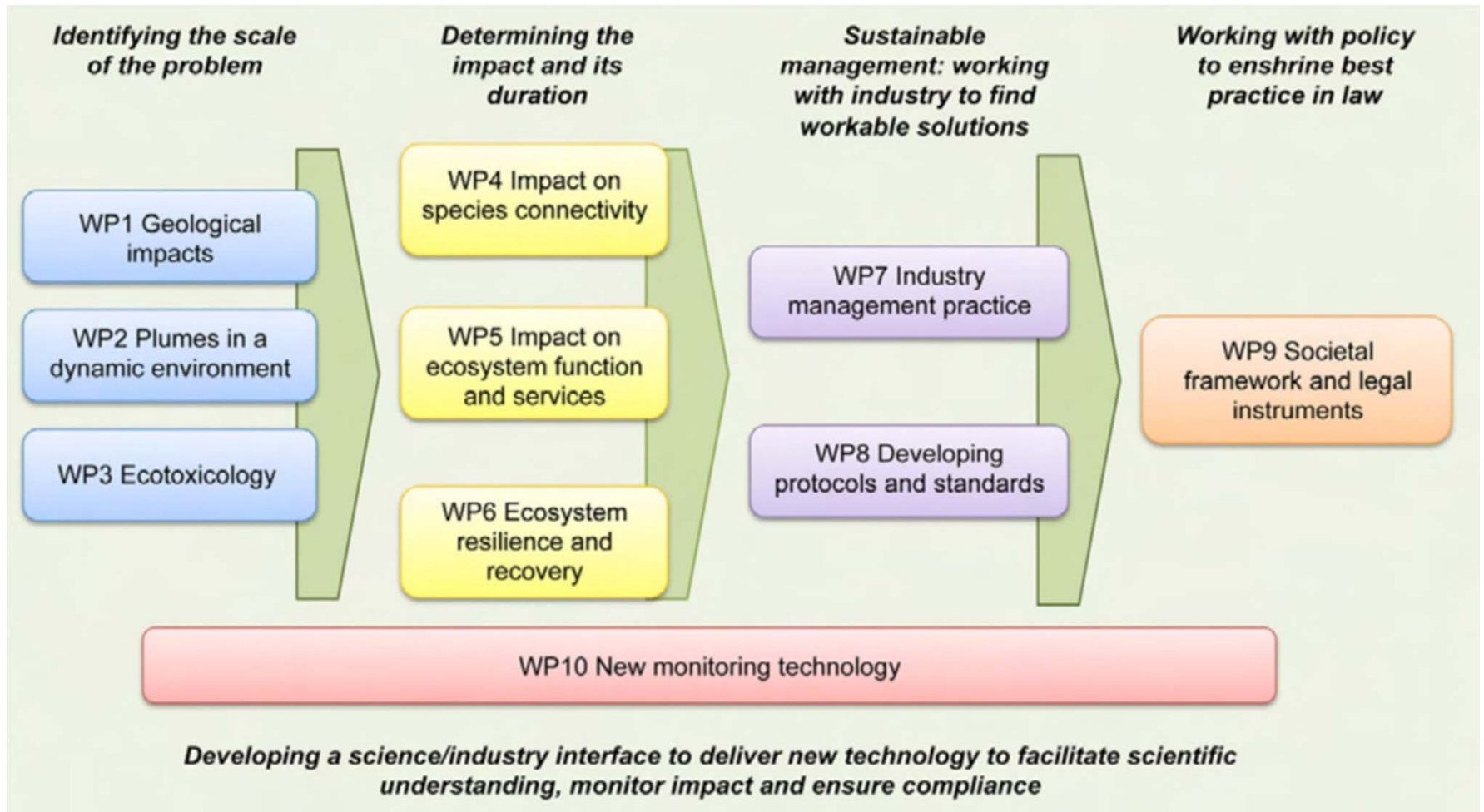
- Improve technologies (WP10 focus: image processing, Coronis)
→ *no development of new technologies planned*
- Planned focus areas:
habitat mapping (task 10.3), ecosystem functions (task 10.4), biodiversity (task 10.5), time series observations (task 10.6)
- Select appropriate technologies and opportunities for technology testing and demonstration (referring to other WPs and Industry partners)

Transfer of knowledge on mining monitoring

- Contribution to and review of monitoring guidelines, protocols, & standards
- Input to industry management practices

→ **Technology brokerage**: *bring together knowledge and technologies available in academia and industry across WPs and outside MIDAS, integrate for application by authorities, industry, and contractors*

Cross-linking with other WPs: input / output & benefit



WP1: Geological Impacts

Input to WP10

- Mining impacts on seabed physicochemical conditions and implications for plume generation and effects on geochemistry (incl. contaminant release)
- Identification of imminent hazard

Output in cooperation with WP1

- Monitoring targets and technologies to assess changes in seabed conditions and hazards, release of contaminants and methane

WP2: Plumes in a dynamic environment

Input to WP10

- Oceanographic and hydrodynamic conditions relevant for plume dispersal
- Hydrodynamic conditions at mining sites
- Monitoring results needed for plume modeling
- Prediction of spatial extent of secondary mining impacts

Output in cooperation with WP2

- Technologies to monitor hydrodynamic conditions and plume spreading and to allow for model validation

WP3: Ecotoxicology

Input to WP10

- Biochemical and molecular effects of mining related sub-lethal intoxication of deep sea fauna
- Typical behavioral effects of deep sea megafauna

Output in cooperation with WP3

- Target organisms / indicator species / responses to monitor intoxication, sampling methods, experimental approaches, analytical methods (e.g., marker gene expression)
- Technologies to assess aberrant behavior in situ?

WP4: Impact on species connectivity

Input to WP10

- Typical patterns of genetic diversity, gene flow, and geographical distribution of key taxa
- Molecular and morphological approaches to investigate distribution patterns

Output in cooperation with WP4

- Sampling schemes, coverage, and methods for monitoring of biodiversity and distribution to identify source populations and gene flow patterns

WP5: Impacts on ecosystem functioning and services

Input to WP10

- Key ecosystem functions and services of deep sea ecosystems and response to deep sea mining impact simulations and analogues

Output in cooperation with WP5

- Monitoring technologies to characterize and quantify baseline ecosystem functions and detect mining impacts

WP6: Ecosystem resilience and recovery

Input to WP10

- Acute and diffusive impacts on benthic communities by habitat modification (removal, restructuring, plume sedimentation)
- Typical recovery time scales

Output in cooperation with WP6

- Identify relevant monitoring targets (species, communities, habitat characteristics) and appropriate monitoring time scales

WP7: Industry management practices

Input to WP10

- Industry activities involved in extraction of the different resources and the impacts they are expected to cause
- Identification of industry environmental management approaches including plans for Environmental Impact Assessment

Output in cooperation with WP7

- Selection of monitoring strategies that match the foreseen mining activities and their expected impacts
- Revision of Environmental Impact Assessments and recommendations on management practices

WP8: Developing protocols and standards

Input to WP10

- Existing protocols and standards for mining and environmental monitoring (i.e., 'Best Available Technologies', BAT & 'Best Practicable Environmental Option', BPEO)

Output in cooperation with WP8

- Incorporation of scientifically sound state of the art monitoring technologies and qualifiers for good environmental status in guidelines and tools for mining and environmental monitoring industry
- Safeguard practicability of suggested monitoring strategies and technologies through strong linkage with industry

WP9: Societal framework and legal instruments

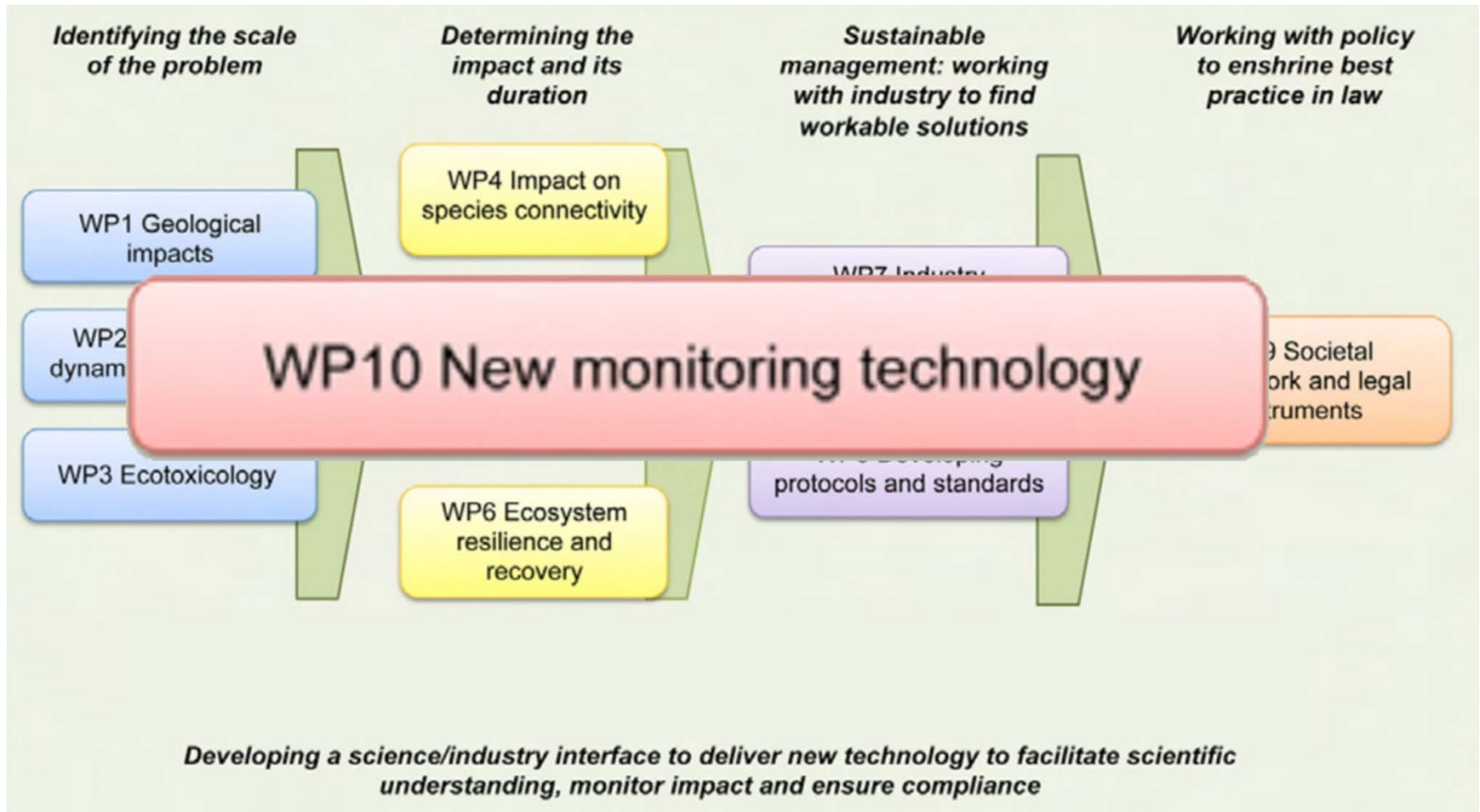
Input to WP10

- Contact to decision makers and stakeholders (incl. EC, ISA, UN-bodies, OSPAR) for consultations on monitoring technologies
- Socioeconomic view of key ecosystem services and risks that monitoring should take into account

Output in cooperation with WP9

- Incorporation of identified monitoring targets and appropriate technologies into suggested regulations

Cross-linking with other WPs: input / output & benefit



WP10 timeline and deliverables



D10.1

Compilation of existing deep-sea ecosystem monitoring technologies in European research and industry. Assessment of applicability, and identification of gaps in existing technologies.

M12, lead: AWI



D10.2

Integrative habitat mapping technologies for identification of different deep-sea habitats and their spatial coverage integrating physical, chemical, biological, and hydrographical characteristics. From data acquisition to spatial habitat information.

M18, Report, lead: Ifremer



D10.3

Integrated modular systems for monitoring of ecosystem functions in deep-sea habitats with relevance for mining. From in situ observations to quantitative descriptors.

M24, Report, lead: GEOMAR



D10.4

Rapid biodiversity monitoring across size classes. Timely identification of species assemblages and distribution patterns to be used for spatial planning, and the assessment of resilience, recovery, and the risk of biodiversity loss.

M30, Report, lead: UGent



D10.5

Testing of the protocols and standards developed in WP8 using a range of equipment and sensors on AUVs, ROVs and seabed landers to differentiate between natural variability and impact phenomena.

M36, report lead: Fugro

D10.1

Compilation of existing deep-sea ecosystem monitoring technologies in European research and industry. Assessment of applicability, and identification of gaps in existing technologies

**Report, month 12, all WP10 partners
lead: AWI**

Report content

Define monitoring needs

- Existing monitoring recommendations from mining and mining analogues (dredging, fisheries)
- Identifying expected impacts and scales (knowledge from other WPs)
- Consider different minerals / ecosystems and phases (baseline study, mining impact, recovery)
- Prerequisites for routine monitoring by industry / subcontractors

Compilation and assessment of existing monitoring methods

- Addressing the full workflow from sample / data acquisition to the generation of high-level and comprehensible / meaningful end products
- Include methods used by academia and industry
- Readiness: time- and cost-effectiveness, technological readiness
- Gaps: missing monitoring technologies and steps in monitoring workflow, identify innovation potential

D10.1 will guide selection of technologies for demonstrations

Habitat physicochemical characteristics

- **Acoustic habitat mapping**
Seabed topography, subseafloor structures
- **Visual habitat mapping**
Seabed topography and texture
- **Sediment physical properties**
Granulometry, stability, compaction
- **Subseafloor geophysical monitoring**
Stability & dynamics
- **Water column physical monitoring**
Sediment plume spreading, sedimentation
- **Water column chemical characterization**
Chemical plume, contamination
- **Deep Sea light and noise levels???**

Biogeochemical properties, biomass and biodiversity

- **Sediment biogeochemical properties**
Organics, pore water constituents
- **Biodiversity assessment with imaging surveys**
Megafauna
- **Biodiversity assessment with sampling-based methods**
Macrofauna, meiofauna, microbes
- **Biodiversity assessment with molecular methods**
Molecular taxonomy and gene flow
- **Bioacoustics???**
plankton- / nekton biomass / mammal presence
- **Trace metal burden???**

Ecosystem functions

- **In situ flux measurements**
Benthic matter cycling (including foodweb studies???)
- **Molecular and biochemical microbiology**
Microbial functions
- **Bioturbation monitoring???**

Crosscutting???

- **Multidisciplinary observations**
Combined sensors, time series
- **Data management concepts**
Archiving, dissemination, visualization
- **Modeling approaches**
extend and generalize monitoring results
- **Georeferencing**

Report preparation

Writing framework, compiling knowledge, report editing and compilation

- AWI in close cooperation with Fugro

Providing expertise and key literature, contact to experts, contributing and revising specific sections

- All WP10 partners, contact through theme leaders
- Theme leaders serve as contact points within (and maybe even without?) MIDAS

Issues to address now / soon

- Define general content
- Agree on core themes, appoint representatives (WP10 partners)

Suggested themes for D10.1...

HABITAT CHARACTERISTICS

Acoustic habitat mapping

Visual habitat mapping

Sediment physical properties

Subseafloor geophysical monitoring

Water column physical monitoring

Water column chemistry

Deep Sea light and noise levels???

BIOLOGY AND BIODIVERSITY

Sediment biogeochemical properties

Megafauna imaging surveys

Sampling-based biodiversity

Molecular taxonomy and gene flow

Bioacoustics

Trace metal burden ?

ECOSYSTEM FUNCTIONS

In situ flux measurements & foodweb

Molecular & biochemical microbiology

Bioturbation monitoring ?

CROSSCUTTING

Georeferencing

Multidisciplinary observations

Data management concepts

Modeling approaches

... and suggestions for theme leaders

HABITAT CHARACTERISTICS

Acoustic habitat mapping

GEOMAR (Jens Greinert?)

Visual habitat mapping

Coronis Computing (Rafael Garcia?)

Sediment physical properties

NGI (Carl Fredrik Forsberg?)

Subseafloor geophysical monitoring

MARUM (Achim Kopf?)

Water column physical monitoring

UB (Miquel Canals?)

Water column chemistry

Ifremer (Agathe Laes)

Deep Sea light and noise levels???

BIOLOGY AND BIODIVERSITY

Sediment biogeochemical properties

UB (Antonio Calafat?)

Megafauna imaging surveys

NERC (Veerle Huvenne?)

Sampling-based biodiversity

Ifremer (Lénaïck Menot?)

Molecular taxonomy and gene flow

Senckenberg (Pedro Martinez?)

Bioacoustics

Ifremer (Jean-Francois Rolin?)

Trace metal burden ?

SOC (Chris Hauton?)

ECOSYSTEM FUNCTIONS

In situ flux measurements & foodweb

GEOMAR (Peter Linke?)

Molecular & biochemical microbiology

AWI (Antje Boetius?)

Bioturbation monitoring ?

???

CROSSCUTTING

Georeferencing

???

Multidisciplinary observations

???

Data management concepts

???

Modeling approaches

???

First step: collection of methods available in MIDAS

- Collection started in the beginning of November within WP10
 - workflow, target ecosystem / minerals,
 - method maturity, developments needed for routine application
 - planned use / demonstration of method in MIDAS
 - dissemination of method information within WP10
google docs / dropbox > internal part of MIDAS web portal

- 15 technologies collected
 - water column phys. & chem. oceanography
 - habitat mapping
 - ecosystem function
 - megafauna survey
 - seafloor geophysical conditions
 - rapid biodiversity assessment

→ *Extend monitoring technology collection to all partners (slides or online questionnaire) and make information available within MIDAS*

Miscellaneous WP 10 issues

Workshop on conceptual framework to assess deep sea mining impacts: towards defining standards and recommendations
(relevant to all WPs)

Data management in MIDAS

Underrepresentation of small size class biodiversity work

- NGI: PM transfer
- UGent no PMs

Technology demonstration

- Candidate technologies
- Technology applications (cruises)
leading to the next session

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