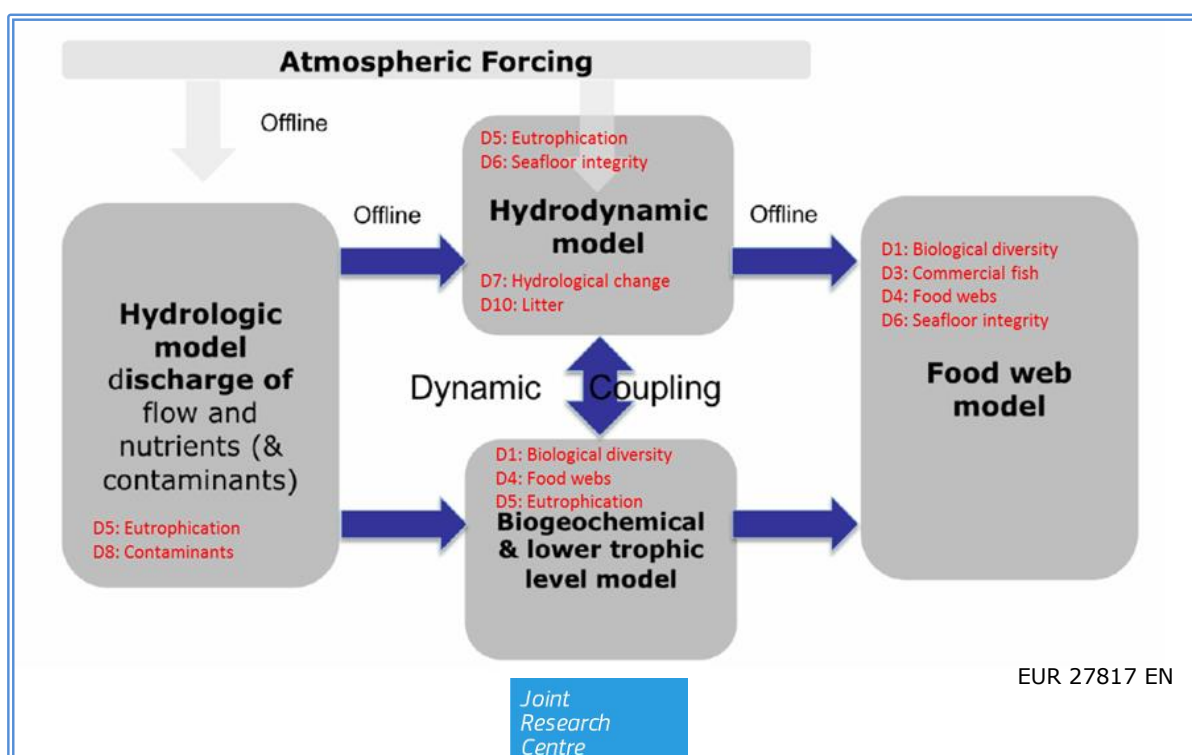European Commission

JRC TECHNICAL REPORTS

Report on the Kick-off workshop of the Network of Experts for ReDeveloping Models of the European Marine Environment

Eutrophication modelling and Descriptor 5 of the Marine Strategy Framework Directive

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Foreword

The 'Kick-off workshop of the Network of Experts for ReDeveloping Models of the European Marine Environment. Eutrophication modelling and Descriptor 5 of the Marine Strategy Framework Directive' was held on 20-21 January 2016 in Brussels, Belgium, jointly organized by DG Environment and DG JRC (IES –Water Resources Unit) within the framework of the Administrative Arrangement NoENV.C.2/2015/070201/705766 (Deliverable 2.2) and the Marine Strategy Framework Directive (MFSD). The aim of this workshop was to learn about existing modelling work and to draw lessons for the build-up of the European modelling effort. In this context, the workshop consisted of 18 presentations on the use of marine ecosystem models to address indicators within the Eutrophication descriptor (D5) of the MFSD in coastal zones and European regional seas, including assessment, indicator development and scenario building. Some other descriptors were also covered by the presentations and discussions. The presentations dealt with (1) South European regional seas (Black and Mediterranean Seas), (2) Atlantic shelf areas, (3) North Sea and Baltic Sea and (4) General lectures. The workshop also served as the inception meeting of the newly created informal network of experts on the Modelling of the European Marine Environment (MEME). The participants were invited to join the network DG Environment and DG JRC emphasizing the added value of a joint effort to further develop modelling capabilities with the objective of providing useful advice for policy makers. This was well received by the attendants. This report summarizes the workshop and provides further detail on the presentations, discussion and conclusions.

1. Introduction

While the implementation of the Marine Strategy Framework Directive (MFSD) is progressing in the Member States (MS), the European Commission is building up its own analytical capacity in order to improve the understanding of the marine environment from an EU perspective. The progress achieved during the last 30 years in marine modelling now allows a more realistic simulation of many aspects of the marine environment. As pointed out in the first presentation of the workshop by G. Hoermandinger from DG Environment (DG ENV) the use of marine modelling can support the assessment process of the marine environment as foreseen in the MFSD by defining baselines, addressing data gaps and allowing for scenario simulations. To fully exploit this potential the Commission has initiated the development of a modelling framework for the marine environment. This will be done in a transparent way, pursuing outside communication and consultation along two axes.

The first axis is vis-à-vis the Member States (MS) since it is vital to ensure consistency and mutual awareness between MS and the EU-level activities. This is true especially when assumptions and scenarios are being built up and when results are discussed. In order to achieve this, the Commission will ensure appropriate communication with the working groups under the Common Implementation Strategy of the MSFD.

The second axis is concerned with technical expertise. In this context the Commission is building up an informal advisory network of marine modelling experts to work on the Modelling of the European Marine Environment (MEME). The purpose of this network will be to ensure that the most pertinent and state-of-the-art technical knowledge is available in the development of the modelling framework. Participants in the network will be kept informed about progress in building up the modelling framework, and they will from time to time be asked for their opinions, advice or feedback. On occasion they may be invited to participate in workshops or other events.

The present workshop jointly organized by DG ENV and DG JRC within the framework of the Administrative Arrangement NoENV. C.2/2015/070201/705766 (Deliverable 2.2) has served as the initial, constituting meeting of the network. It was thematically focused on the application of marine ecosystem models to address indicators within the Eutrophication descriptor (D5) of the MSFD although some other descriptors were also covered by the presentations and discussion sessions (see below). Eutrophication was selected as initial environmental issue to be covered in this kick-off meeting since it has been and still is one of the major water quality problems in lakes, reservoirs, coastal zones and the marine environment in many parts of the world. Henceforth, participants were asked for contributions that addressed the modelling of eutrophication in coastal zones and European regional seas using ecosystem modelling for assessment, indicator development and scenario building. The aim was to learn about existing work and to draw lessons for the build-up of the European modelling effort. The participants were invited (but not required) to join the network and most responded with a considerable degree of enthusiasm. DG ENV and DG JRC emphasized the added value of a joint effort to further develop modelling capabilities with the objective of providing useful advice for policy makers. This was well received by the attendants. The workshop was organized mainly around geographic areas

covering the different European regional seas. There were presentations regarding the Black Sea, Mediterranean Sea, Atlantic Shelf, North Sea and Baltic Sea. Moreover, a number of talks dealt with more general concepts and were not concerned with a specific region (see detailed description below and abstracts in the Annex II. This report is, hence, structured around the different regions covered by the talks and it provides an overview of the presented works and take-home messages highlighted by the contributors. This report includes three Annexes with (I) the list of participants and the title of the corresponding presentations, (II) the Abstracts, and (III) the Workshop Agenda.

2. South European Regional Seas (Black & Mediterranean Sea)

A total of 7 presentations were made regarding the South European Regional Seas (SERS) by researchers from Spain (J. Ruiz), Belgium (M. Grégoire), Turkey (T. Oguz), Italy (P. Lazzari), Greece (K. Tsiaras), the Black Sea Commission (I. Makarenko) and the EU Commission (D. Macias).

One of the repeated topics were the connections between rivers and estuaries and ecosystem conditions in the nearby coastal areas. An exemplifier case study was the Guadalquivir estuary and the Gulf of Cadiz shelf region. J. Ruiz presented an integrated modelling approach that allowed his team to determine the ecological conditions in the estuary and assess the appropriateness of further dredging its navigation channel. With this modelling framework they were able also to link the estuary conditions to ecological status in the nearby continental shelf and to the stock levels of important fisheries in the region such as anchovy. In a final step, they have created a socio-economic model of that fishery that is dynamically coupled to the ecosystem models.

The same topic was covered in the lecture by M. Grégoire but for the case of the Danube and the North Western shelf of the Black Sea. In this case, the ecosystem model was focused in determining the frequency, extension and duration of hypoxia events in the benthic layer of the shelf, a clear eutrophication indicator. They have evaluated the importance for the eutrophication status in the region of the regulation measures taken in the Danube catchment since 1990's to reduce nitrate loads. In this case, and in contrast with reported measures, model simulation showed little recovery of the system with still frequent and large hypoxia events taking place. It seemed that monitoring data had been collected in sub-optimal ways (not appropriate timing and spatial distribution) so, this was a clear example on how ecosystem model could help direct monitoring efforts. Furthermore, by performing scenario runs, this group has been able to determine how much of the hypoxia problem could be attributed to nutrient loads and how much is associated with climate change. The representative of the Black Sea Commission in the workshop, I. Makarenko, showed strong interest in the approach and proposed future collaborations/applications of the tools in support of their action plans, presented in a separate talk at the end of the workshop.

Finally, land/ocean interaction was also the theme of the presentation by D. Macias, in this case studying how biological productivity has changed in the whole Mediterranean Sea for

the last 60 years. From a relatively long model hindcast run starting in 1960, they observed a clear evolution of the production levels in the Mediterranean basin from a relatively oligotrophic period up to ~1975, a sharp increase of primary and secondary production during a decade and a stabilization on a much more eutrophic state afterwards. The same pattern of temporal change is observed in independent fisheries statistics obtained from databases not connected with the model data, so it seems that a real trophic transition has occurred in the Mediterranean Sea both at low and high trophic levels. Nutrient levels (nitrate and phosphate) in the European rivers (from databases) and in the photic layer of the Mediterranean Sea (from model results) show a particular time evolution with phosphate peaking at early 1980's and nitrate showing maximum levels around year 2000. Both declines in nutrient levels seems to be related with EU regulation (ban of phosphorous in detergent, waste water treatment and agriculture policies) so this modelling study provides a link between policy implementation, chemical changes in freshwater quality, eutrophication levels and fish abundance.

The second topic covered for the SERS was the use of models to assess eutrophication status of the whole basin and regional applications. Two different modelling tools were presented by P. Lazzari for the whole Mediterranean and by K. Tsiaras for specific sub-basins showing a good representation of the more general production patterns in the basin but also with some evident problems to simulate local conditions in 'problematic' areas (such as the north Adriatic Sea). One principal way to overcome this problem was shown by K. Tsiaras as his team performs nested simulations with very high resolution (up to 50m) to address very localized and specific questions such as the impact of fish farming in Greek coastal regions. It was also shown by this same author that a change in the nutrients ratios (N/P) in freshwaters could induce a floristic change of phytoplankton communities, potentially allowing the proliferation of harmful species.

Finally, T. Oguz gave a presentation on some un-explored effects of jellyfish proliferations in degraded, eutrophic ecosystems. He showed, by applying an ad-hoc ecosystem model, how the blooming of certain jellyfish species could dramatically change the food web, carbon transfer efficiency and production levels of sensible ecosystems. He used the Marmara Sea as a showcase for his modelling applications. It must be said that the presence of invasive jellyfish (Mnemiopsis Leidyi) in the Aegean Sea was also a topic of K. Tsiaras' talk.

3. Atlantic shelf areas

X. Desmit gave a presentation on the results of the EMoSEM project, dealing with the assessment of the eutrophication problem in the NE Atlantic shelf regions. In this project, one hydrological model has been applied to rivers flowing towards Portuguese, Gulf of Biscay and English Channel coasts. Water flow and nutrient loads from this model were used to force three different hydrodynamic-biogeochemical models of the marine coastal ecosystems. They compare present production levels with a 'pristine' simulation in which the entire of EU was considered to be covered by forests (hence severely reducing the nutrient loads in rivers). By this comparison the areas more affected by human pollution could be identified and pre-industrial production levels were assessed. After this, they explored different policy scenarios including (i) a full implementation of waste water

management plans in the region, (ii) good agricultural practices and (iii) relocalized production + organic farming + demitarian diet. Scenarios (i) and (ii) did not show substantial improvement of eutrophication levels in coastal ecosystem. Scenario (iii) showed a generalized and large improvement of freshwater bodies' status but a more limited effect on marine ecosystems, most probably because of nutrient release from bottom sediment or because of an imbalance reduction of nitrate versus phosphorus. Finally, they used a 'tagging' technique to identify sources of the nutrients involved in the eutrophication processes. By marking the nutrients from individual rivers, a transboundary assessment of eutrophication sources could be done.

4. North Sea and Baltic Sea

Another 7 lectures were presented for these two basins by researchers from the UK (J. vd. Molen and A. Gallego), Germany (R. Friedland), Denmark (M. Maar and A. Erichsen), Sweden (B. Gustafsson) and Finland (V. Fleming).

The two contributions about the North Sea included impact assessment studies on the installation of renewable energy systems in different coastal regions of the UK. J. vd. Molen presented a study on the impact of tidal turbine installation on the northern tip of Great Britain and focused on the physical and biological conditions of the region. With the worst case (considering a very large amount of turbine deployed) the model simulation shows impacts in ecosystem dynamics along the eastern UK coast and reaching as far as East Anglia. In this same presentation, 3D hydrodynamic-biogeochemical models were used to assess the potential invasion of the North Sea by blooming jellyfish (such as *M. leidyi*). It was found that while this jellyfish could survive in the region and move between different estuaries, off-shore water temperature is too low to allow massive blooms in the area. The lecture finished with some examples of science-stake holders interactions and examples on 'how to make ecosystems models to count'.

On an additional presentation, A. Gallego showed a modelling study of the impacts associated with the installation of offshore wind-farms on the Scottish east coast. From preliminary analysis it seems that the physical environment will not be severely affected by those structures although their potential effects on the ecosystem status are not yet fully evaluated. Some concerns on the upwelling cells potentially created by the wind wake leeward of the turbines were raised during the discussion.

The 5 talks about the Baltic Sea were mostly devoted to the effect of allochthonous nutrient loads (mainly from rivers) on the ecological status and eutrophication levels of different regions of the basin. Two talks were centered in Danish waters and nearby straits. A. Erichsen showed how a combination of hydrological and marine mechanistic models could be used to assess the present-day sources of nutrients to the region, the associated percentage of eutrophication levels to the different sources (national rivers, North Sea and Baltic Sea boundaries) and to evaluate the effect of future scenarios (combining policy options and climate change). For the same region, M. Maar concentrated her talk on the importance of external and internal nutrient supply for the biomass and production of marine ecosystems in the Great Belt. They show the importance of using primary

production (*i.e.,* rates) instead of chlorophyll (*i.e.,* biomass) to determine the eutrophication status (something easily done with ecosystem models but not from data) and the need to look not only at surface conditions but also vertical distributions. In the final part of her presentation, M. Maar introduced a newly developed tool to implement ecosystem simulations called FLEXSEM. This tool allows to get inputs from a hydrodynamic model and implement them into a very flexible systems allowing to couple many different biogeochemical models and use diverse grid configurations.

In a [talk](#) by R. Friedland, the differences in targets for coastal and transition waters in the WFD and MSFD where presented for the German Baltic coast. He showed that 43 out of 44 inner water bodies in Germany are not in good environmental status (GES) and that the defined targets in the WFD are not achievable, most likely because of badly defined 'pristine conditions'. He proposed to use hydrological model results for the pre-industrial era (~1880) to define new reference values and use the differences between present day and this period to compute targets that are achievable and consistent for both Water Framework Directive (WFD) and MSFD.

Finally, the two last talk of this block dealt with ecosystem status and eutrophication levels in the whole Baltic basin and how ecosystem model could be useful. B. Gustafsson explicitly has [shown](#) that nutrients inputs from land sources are the main cause for the last decades eutrophication trend in the Baltic Sea. This lead to the Baltic Sea Action plan in which science has determined the maximum nutrient loads allowed to be basin in order to achieve a GES. However, the question remains on how to share the burden of the reduction between the different riparian countries. Numerical models could help to understand the effect of policy scenario implementation so they are using the 'Baltic Sea Long-term, Large-scale Eutrophication Model' to help answer some of these questions. This modelling approach has shown, for example, that the inertia of the system is so large (probably linked to nutrient releases from sediments) that there is a very long time between the implementation of measures (*i.e.,* nutrient loads reduction) and the achievement of the targets at sea (~100 years). This time-delay should be taken into account and made explicit when dealing with stakeholders and policymakers.

The [presentation](#) provided by V. Fleming also dealt with Baltic Sea basin-wide eutrophication assessment and how ecological model will play a role. She explained the basins of the Baltic Sea Action Plan, being this a multi-state agreement and not a legally-binding document and how the eutrophication assessment within is mostly based on the 'Common Monitoring Program' implemented since 1979. In spite of the long-tradition and huge resources investing in the monitoring program, there are multiple data-gaps both in the temporal and spatial domain. They are, thus, trying to fill in the gaps by running different ecosystem models in hindcast mode within the project 'TARGEV'. Model simulations results are currently being considered to stablish new targets for the GES in the different sub-regions within the Baltic Sea.

5. General lectures

Besides the region-specific presentations shown above, there were three additional talks on more general issues/applications concerning the topics of the workshop. In the first one, [J.](#)

Bruggeman spoke about the FABM (Framework for Aquatic Biogeochemical Models) system and its potentialities. FABM is an interface that allows the communication of several hydrodynamic models (e.g., ROMS, NEMO, GETM) with a suit of different biogeochemical models (e.g., ERGOM, ERSEM, etc.). Moreover, the latest FABM development has allowed to construct ad-hoc biogeochemical models using the 'bricks' (submodules) already incorporated in the system. With this new concept, a marine modeler could easily decide which biological process to include in his model setup in an easy and straightforward manner. This system is the one already being employed at JRC for its modelling implementations and was perceived as a suitable candidate to provide the basin for the 'modelling framework'.

In a subsequent talk, C. Piroddi explained a catalog recently developed within the EU FP7 project 'DEVOTES'. In there, more than 100 existing ecosystem models were assessed against their capability of contribute to the evaluation of MSFD indicators and descriptors. Most assessed indicators/descriptors as well as gaps have been identified in this contribution and this was perceived by the attendants as an initiative worth pursuing further as it could provide very useful information to modelers on potential applications related with MSFD.

Finally, A. Stips shown an example on how model-derived data could be used to compute eutrophication indexes, much in the way measurements have been used. He showed results from a Mediterranean Sea model implementation simulating hydrodynamics and biogeochemical conditions for the past several decades. Different eutrophication indexes were derived from model simulated variables and spatial patterns were shown. Also, the relevance of using primary production (rates) instead of chlorophyll (biomass) was evaluated, much in the line of M. Maar contribution explained above.

6. Discussion sessions and Conclusions

There were two main discussion sessions at the end of each day of the workshop. In the first session (Wednesday afternoon), the difficulty to translate model results into meaningful information to address MSFD indicators was mentioned. C. Piroddi corroborated the very different languages used in the modelling community and the legal jargon and the difficulties they found within DEVOTES to make the link. Henceforth, harmonization of terms is much desirable for future and better integration between modelling results and MSFD.

It was also mentioned that the general scientific community is also a 'stake-holder' of ecosystem models. L. Legendre insisted that a better integration between experimentalist and modelers is needed since the beginning of any project and that it has no sense to wait until the model is developed to ask for experimentalists' advice. To foster the usefulness of models a better blending is needed since the development and planning phases.

Another common comment from many attendants was the necessity of stablish long-term funding commitment from the different agencies if long-term scientific goals are to be achieved. Otherwise, researchers are forced to deal with shorter term objective associated to specifically funded projects without the possibility to work on the longer goals.

As a result of some of the presentations given during this first day, there was a general agreement on the necessity of model/data blending to get a more appropriate description of the status of the ecosystems. All accepted that models are idealistic representations of the real systems but, in similar terms, data alone cannot provide a comprehensive description of those systems. By combining both approaches, a more holistic and complete information on the status of marine ecosystems could be obtained.

The second general discussion session took place at the end of the workshop, on Thursday afternoon. The first topic commented was on the advantages of having a common place where all ecosystems models could be public and freely accessible. This will allow the scientific results to be reproducible and reusable as well as making our work more transparent/trustworthy. It was also mentioned that not only the model codes should be made accessible but all the parameters/data/forcings/meta information needed to repeat the simulations. Also, it was mentioned that making model simulations data accessible on a user-friendly interface will be also desirable. Having access to this type of data could, for example, empower the use of ENSEMBLE approaches to scenario simulations and be used as a test-bed for future endeavors (for example providing '*do*' and '*do not*' advices for the community at large). Finally, it was commented that maintaining such a 'database' will demand a lot of investment in economic terms and man-power, and it was suggested to try to integrate this with existing marine-related data repositories (such as Mar-Atlas and EMODnet). The EU Commission will consider the existing options to host such model repository site (termed by some as 'Modelling HUB') or using existing data-repositories such as Copernicus Marine Environmental Monitoring Service (CMEMS) as suggested by I. Lorkowski.

There was also some discussion on the usefulness of the catalog about model-indicators linkages developed within DEVOTES. Many of the attendants felt that such tool will help them to understand how their model results could be used in the context of the MSFD. Henceforth, maintaining and expanding this catalog was seen as desirable for the next future.

It was also mentioned that some of the MS with coastal areas were not represented in the meeting. The organizers of the workshop explained that some invitation were not answered in time and, in some cases, there was no expert in marine modeling identified for some MS. In this regard it was mentioned that the 'modelling framework' to be developed by the EU Commission could be very useful for those small countries without the necessary know-how to develop their own models. Also, some attendants made a remark on the necessity of incorporating local knowledge in the development phase of any modeling tool.

Finally, it was stated that for the MSFD revision due in 2018 model results are going to be very important given the limitations shown by monitoring programs alone. Henceforth the establishment of this network and the initiation of the modelling work within the Commission were understood as very timely and pertinent initiatives. As already mentioned in the Introduction, the participants were invited (but not required) to join the network and most responded with a considerable degree of enthusiasm. The message from DG ENV and

DG JRC on the added value of a join effort to further develop modelling capabilities with the objective of providing useful advice for policy makers was well received by the attendants.

Annex I: List of participants and title of presentations

Authors/Presenter	Contact	Title
J. Bruggeman	jbr@pml.ac.uk	Towards custom built models for water and sediment biogeochemistry based on reusable components
X. Desmit , Thieu V., Dulière V., Campuzano F., Garnier J., Gypens N., Pinto L., Lancelot C., Ramiro N., Menesguen A., Billen G. & Lacroix G.	xavier.desmit@naturalsciences.be	River-Ocean Models as Support to eutrophication management
A. Erichsen, H. Kaas, T. C. Larsen & F. Møhlenberg	aer@dhigroup.com	Setting WFD N reductions based on mechanistic models
V. Fleming	Vivi.Fleming-Lehtinen@helcom.fi	How could state of the art ecosystem modelling support the HELCOM eutrophication assessment?
R. Friedland	rene.friedland@io-warnemuende.de	Calculation of water quality targets in the south-western Baltic Sea on the edge of WFD and MSFD
A. Gallego	a.gallego@marlab.ac.uk	Regional scale modelling of windfarms in the Firth of Forth, Scottish east coast
E. Garcia-Gorriz	elisa.garcia-gorriz@jrc.ec.europa.eu	
G. Giorgi	giordano.giorgi@isprambiente.it	
M. Grégoire, A. Capet	mgregoire@ulg.ac.be	Disentangling the impact of eutrophication and climate change on the occurrence of hypoxia on the Black Sea's north-western shelf.
B. Gustaffson	bo.gustafsson@su.se	Modeling in support of the nutrient reduction scheme of the HELCOM Baltic Sea Action Plan
G. Hoermandinger	guenter.hoermandinger@ec.europa.eu	Building up the marine environment modelling framework: Motivation and background
P. Lazzari, Solidoro C., Salon S., Teruzzi A., Crise A	plazzari@ogs.trieste.it	Modelling the primary productivity of the Mediterranean Sea.

L. Legendre	legendre@obs-vlfr.fr	
H. Lenhart	hermann.lenhart@informatik.uni-hamburg.de	
T. Lovato	tomas.lovato@cmcc.it	
I. Lorkowski	Ina.Lorkowski@bsh.de	
M. Maar	mam@bios.au.dk	The importance of external versus local nutrient loads for Chla and primary production
D. Macias, A. Stips, E. Garcia-Gorriz	diego.macias-moy@jrc.ec.europa.eu	Ecosystem Modelling Framework applied to the Mediterranean Sea
I. Makarenko	iryna.makarenko79@gmail.com	Black Sea: Information policy, data products and modelling
T. Neumann	thomas.neumann@io-warnemuende.de	
T. Oguz	oguz@ims.metu.edu.tr	Assessing impacts of jellyfish and red tide blooms in functioning of eutrophic marine food webs
B. Planque	benjamin.planque@imr.no	
C. Piroddi	cpiroddi@hotmail.com	The use of ecosystem models to assess indicators in support of the EU Marine strategy framework directive
J. Ruiz Segura	javier.ruiz@csic.es	Modelling support to decision making where the land forces the sea: an example in the Guadalquivir estuary – Gulf of Cádiz shelf system
A. Stips, D. Macias, E. Garcia-Gorriz	adolf.stips@jrc.ec.europa.eu	Conceptual use of ecosystem modelling for Eutrophication assessment
L. Tedesco	letizia.tedesco@environment.fi	
K. Tsiaras, G. Petihakis, G. Triantafyllou	ktsiaras@hcmr.gr	Eutrophication modeling in the Mediterranean (N. Aegean)
J. van der Molen	johan.vandermolen@cefas.co.uk	Recent applications of GETM-ERSEM-BFM to the north-west European continental shelf

Annex II: Abstracts

(1) Modelling support to decision making where the land forces the sea: an example in the systems Guadalquivir estuary-Gulf of Cadiz shelf

Javier Ruiz, Department of Coastal Ecology and Management, ICMAN-CSIC, 11519 Puerto Real (Cádiz), SPAIN

The Guadalquivir estuary is a hot spot for environmental and human conflicts. The estuary and its immediate surroundings are presently home to 1.7 million people clustered in 90 population settlements. Aquaculture, navigation, agriculture, urbanization, tourism, salt production or fisheries are among the human activities stressing the estuarine environment. This environment includes very sensitive habitats such as Doñana National Park, a wetland considered a UNESCO-MAB Biosphere Reserve and World Heritage site. In this context, the recent decision by the Port Authority of Seville to extend the program of dredging so as to significantly increase the depth of the navigational section of the estuary triggered social alarm, and created the need for a comprehensive analysis of the estuary and the potential consequences of human actions on its physical and ecological dynamics. In the present communication we describe how a simple model based on previous formulations of the marine pelagic food web, but adapted to the special characteristics of the Guadalquivir estuary, assisted in providing this comprehensive, high quality baseline understanding, necessary to meet the demands of the stakeholders. The communication will also outline alternative approaches to probabilistically modelling the impact of estuarine and oceanographic processes on fishery resources at the Gulf of Cádiz shelf, including the economic impact on the sector.

(2) Disentangling the impact of eutrophication and climate change on the occurrence of hypoxia on the Black Sea's north-western shelf.

Marilaure Grégoire, Arthur Capet. MARE, B5a Sart-tilman, 4000 liege, Belgium.

We develop a three dimensional coupled circulation biogeochemical model of the Black Sea in order to assess the status, causes and mechanisms of hypoxia on the north-western shelf (BS-NWS) that was severely impacted by eutrophication in the 80's. Model simulations over the last 3 decades show evidences that hypoxia is still occurring seasonally on a non-negligible area of the bottom waters of the BS-NWS. This important finding (corroborated by the monitoring of local institutes) is in contradiction with the general idea that bottom hypoxia vanished with the reduction after 1992 of riverborne nutrient discharge. We found that the overestimation of recovering was due to the use of observations concentrated in areas and months not typically affected by hypoxia.

An index H which merges the aspects of the spatial and temporal extension of the hypoxic event is proposed to quantify, for each year, the intensity of hypoxia as an environmental stressor. In order to provide recommendations for the definition of policies aiming to avoid bottom hypoxia and to preserve the GES of the benthic habitat, a simplified statistical model has been derived to link the H index with the level of nutrients loads discharges by the Danube and specific climate drivers of hypoxia.

This approach allows establishing a cost of the local warming in terms of its impact on hypoxia. We find that the potential increase of water stratification in a global change context may promote the occurrence of seasonal hypoxia and this stresses that the definition of future management scheme of river discharges have to integrate the impact of climate change.

(3) Black Sea: Information policy, data products and modelling.

Iryna Makarenko, Pollution Monitoring and Assessment Officer, Permanent Secretariat of the Commission on the Protection of the Black Sea against Pollution

Ms. Iryna Makarenko presented the main activities relevant to Black Sea Commission's (BSC) information policy, data products and modelling. She emphasized that since the Bucharest Convention was elaborated more than 20 years ago, and the latest version of Black Sea Strategic Action Plan (BS SAP) is dated 2009, some new challenges as climate change, marine litter, marine noise, green economy, MSFD requirements etc. were not reflected and that the BSC has been working to incorporate these considerations in the documents of the Bucharest Convention (text of Convention, next version of BS SAP, monitoring program (BSIMAP), relevant chapters of Black Sea State of Environment Report (BS SoE) which will include socio-economic aspects and new challenges. She informed that BS SAP includes 4 Ecosystem Quality Objectives, one of them is to reduce nutrients originating from land-based sources, including atmospheric emissions. She also mentioned that there is no definition of GES and no targets to identify it in the Black Sea basin. She also stated that during the 31st BSC Regular meeting the BSC adopted the 6 tables reflecting the indicators for annual reporting to the Black Sea Commission, that the data also takes into account the new environmental challenges and legislation, as well as approaches introduced by relevant global and regional organizations (i.e. provisions of EU MSFD; GFCM; ACCOBAMS etc.). She presented the agreed pollution indicators, including the information on nutrients load, i.e. E-trix, BEAST indicators, as well as core set indicators grouped as causes - inorganic nitrogen, inorganic phosphorus (phosphates), direct effects - chlorophyll a , indirect effects - bottom oxygen (where available), Secchi. The values will be further defined by each country according to its reference values elaborated within Baltic2Black Project. She mentioned that the HELCOM tool HEAT, employed for the Baltic Sea to assess eutrophication status, was proposed for use in the Black Sea as well, being adjusted to the availability of Black Sea data. This is a step toward harmonization of assessments, however,she mentioned, the BSC still assesses the feasibility and relevance of usage of HEAT tool in the region. As another important deliverable of the HELCOM-BSC Baltic2Black Project she mentioned the research on the "APPLICABILITY OF USAGE OF SATELLITE CHLOROPYHLL DATA FOR EUTROPHICATION INDICATORS IN THE BLACK SEA". Summarizing the presentation she stated that (1) the new web tool "The Black Sea Information System Prototype" is being developed within the EMBLAS Project (http://www.blacksea-informationsystem.net/?pg=bsc_reporting) and could be used by the group; (2) BSC PS is wishing to collaborate on modelling component; (3) BSC PS invites experts to present the products, tools, models and guidelines developed so far for the consideration and testing by experts from Black Sea Region and BS scientific community (meetings of Advisory Group on PMA/LBS/CBD/FOMLR in spring 2016 other relevant meetings); (4) BSC PS invites the experts to share with Black Sea Commission' Permanent Secretariat the finalized products in order to sustain and to disseminate the

results of models and tools in the Black Sea region; (5) BSC PS invites the experts to contribute to the preparation of the Black Sea State of Environment Report (SoE Report).

(4) Ecosystem Modelling Framework applied to the Mediterranean Sea

D. Macias, A. Stips, E. Garcia-Gorriz. European Commission, Joint Research Centre, Institute for Environment and Sustainability, 21027, Ispra, ITALY

With this talk, we present the general structure being developed at JRC to build a 'modelling framework' of EU regional seas. The components of the framework and the different applications already made to regional basins are presented. Furthermore, an example for the evolution of biogeochemical conditions in the Mediterranean Sea during the last 50 years (1960-2010) is shown. The time evolutions of primary and secondary productions in the entire basin are assessed against available independent data on fisheries yields and catches per unit effort for the same time period. Concordant patterns are found in the time-series of all biological variables (from the model and from fisheries statistics), with low values at the beginning of the series, a later increase with maximum values reached at the end of the 1990's and a posterior stabilization or a small decline. Spectral analysis of the annual biological time-series reveals coincident low-frequency signals in all of them; the first, more energetic signal, peaks at 2000 while the second one (less energetic) presents maximum values at around 1982. Almost identical low-frequency signals are found in the nutrient loads of the main rivers of the basin and in the integrated (0-100 meters) mean nutrient concentrations in the marine ecosystem. Our analysis shows, hence, that the control of marine productivity (from plankton to fish) in the Mediterranean basin seem to be principally mediated through bottom-up processes that could be traced back to the characteristics of riverine discharges

(5) Modelling the primary productivity of the Mediterranean Sea.

Lazzari P., Solidoro C., Salon S., Teruzzi A., Crise A. Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, OGS, B.go Grotta Gigante-42/c, 34010 Sgonico, Trieste, Italy

Spatial and temporal variability at different scales of relevant biogeochemical properties are presented. The study is carried out by means of a 3D implementation of a numerical model (OGSTM-BFM). Several simulations are shown including hindcast and scenario simulations that reconstruct productivity and trophic regimes.

Simulations show that, on a basin scale, the Mediterranean Sea is characterised by a high degree of spatial and temporal variability in terms of primary production. On a spatial scale, important horizontal and vertical gradients have been observed. According to the simulations over a 6 yr period, the developed model correctly simulated the climatological features of deep chlorophyll maxima and chlorophyll west-east gradients, as well as the seasonal variability in the main off-shore regions that were studied. According to the model, the western Mediterranean, in particular the Alboran Sea, can be considered mesotrophic, whereas the eastern Mediterranean is oligotrophic. Results show that the effects of atmospheric and terrestrial nutrient loads on the total integrated net primary production

account for less than 5 % of the its annual value, whereas an increase of 30 % in the light extinction factor impacts primary production by approximately 10 %.

The impacts of climate change and environmental management policies on the Mediterranean Sea were analysed in multi-annual simulations of carbon cycling in a planktonic ecosystem model. The scenario simulations span the periods 1990–2000 and 2090–2100, assuming the IPCC SRES A1B scenario of climatic change at the end of the century.

All scenarios indicate that the increase in temperature fuels an increase in metabolic rates. The gross primary production increases approximately 5% over the present-day figures, but the changes in productivity rates are compensated by augmented community respiration rates, so the net community production is stable with respect to present-day figures. The 21st century simulations are characterized by a reduction in the system biomass and by an enhanced accumulation of semi-labile dissolved organic matter. The largest changes in organic carbon production occur close to rivers, at the coastal scale, where the influence of changes in future nutrient is higher and can potentially lead to eutrophication.

(6) Eutrophication modeling in the Mediterranean (N. Aegean)

K. Tsiaras, G.. Petihakis, G.. Triantafyllou, Hellenic Centre for Marine Research (HCMR), Greece

Within Operational Ecology (OPEC) project, coupled modeling systems were implemented in four European regional seas (North-East Atlantic, Baltic, Mediterranean and Black Seas) reconstructing the recent past and exploring the skill for future predictions, in support of an ecosystem-based management through MSFD descriptors. OPEC provided direct access to key environmental indicators, including those related to eutrophication, such as chlorophyll, nutrients and oxygen. Within OPEC, the Mediterranean coupled hydrodynamic/biogeochemical model (POM-ERSEM), currently operational within the POSEIDON forecast system (www.poseidon.hcmr.gr) was upgraded to assimilate satellite Chl-a. A new data assimilation algorithm was developed based on a Hybrid (Ensemble Kalman filter/ Optimal Interpolation) scheme that combines a flow-dependent ensemble error covariance with a static background covariance built from a set of empirical orthogonal functions (EOFs). The same coupled model has also been implemented on a regional scale (N. Aegean) within SESAME and MEECE EU-projects projects, to examine the impact of river nutrient load variability on the ecosystem functioning over the last decades. The increased phosphate river loads in the early 80's resulted in nitrogen and silicate deficiency in N. Aegean coastal, river-influenced regions, causing a relative decrease of diatoms and an increase of dinoflagellates. Such an increase was simulated in the late 90s in the Thermaikos Gulf, in agreement with the observed increased occurrence of Harmful Algal Blooms. Recently, within project SEAMAN, gelatinous ctenophore Mnemiopsis Leidyi that is also closely related to eutrophication was added in ERSEM functional groups in a simplified approach to study its effect on small pelagic fish.

(7) Assessing impacts of jellyfish and red tide blooms in functioning of eutrophic marine food webs

Temel Oguz. Middle East Technical University, Institute of Marine Sciences

The opportunistic red tide forming heteroptrophic dinoflagellate *Noctiluca scintillans* and the jellyfish (medusae and ctenophore) blooms are prominent features of the coastal and marginal sea ecosystems. Their distinguishing feature is too often act as their trophic dead ends, to introduce additional top-down controls and divert a part of energy flow from higher trophic level predators of the cretaceous food webs. In general, little is known about jellyfish and *Noctiluca*-mediated changes and their feedback mechanisms govern the general food web dynamics are poorly understood. The present modeling study indicates that their dissolved organic matter and inorganic nutrients release contribute to retaining nutrients effectively within the upper layer water column, sustaining the bacterial and algal productions, providing bottom-up resource supply for higher trophic levels throughout the year, and recovering a part of the energy diverted to the *Noctiluca* and jellyfish shunts. *Noctiluca* bloom events are found to be particularly pronounced if they coincide with the jellyfish blooms*.

(8) River-Ocean Models as Support to eutrophication management

Desmit X., Thieu V., Dulière V., Campuzano F., Garnier J., Gypens N., Pinto L., Lancelot C., Ramiro N., Menesguen A., Billen G. & Lacroix G.

Eutrophication is a considerable stressor of marine ecosystems at local and continental scales. In the North East Atlantic waters (NEA), most countries sustain systematic coastal eutrophication with toxic algae blooms and ecological nuisances. Marine eutrophication in the NEA directly relies on nutrient enrichment at the river outlets, which is linked to human activities and land use in the watersheds. Nitrogen emissions to Western Europe rivers are mainly stemming from agricultural practices. The sustainable governance of marine ecosystems and human societies requires to quantify these nutrient emissions and their impact at sea. The question rises of whether the human society can reduce its nutrient emissions by changing its land use without compromising its food security. To address this question, a new generic river model (pynuts/Riverstrahler) was designed to estimate the point and diffuse nutrient emissions (N,P) to the rivers. Nutrient emissions were computed according to land use in the watersheds across Western Europe (agro-food systems, urban structures, waste-water treatment plants). The river loads from the river model have been used as inputs to three marine ecological models (BioPComs, eco-mars3d, miro&co) covering together a large part of the NEA from the Portuguese shelf to the Southern North Sea and Celtic Sea [35°N-53°N, 13°W- 5°E]. Such a description of the land-ocean continuum allowed quantifying the impact of changes in land use across Western Europe on marine eutrophication in the NEA. A "pristine-like" scenario was tested to scale the current level of eutrophication with respect to an absolute "natural" level. Three "future" scenarios were also tested to appraise the impact of the actual EU recommendations (WFD, MSFD), and to propose a more radical but still "realistic" scenario. It is shown that a paradigmatic change in agricultural practices combined with a large-scale demitarian diet might sensibly reduce both riverine and marine eutrophication levels.

(9) Recent applications of GETM-ERSEM-BFM to the north-west European continental shelf

Johan van der Molen, Sonja van Leeuwen, Kieran Hyder

Model scenario studies with GETM-ERSEM-BFM can be used to improve understanding of effects of human actions on the planktonic and benthic ecosystems. As an example, results of a recent application to simulating potential effects of a marine renewable energy generation through large-scale tidal turbine deployment will be discussed (Van der Molen et al., 2015b).

The presentation will also touch on coupling a particle tracking model to simulate transport, survival and reproduction of the invasive comb jelly *Mnemiopsis leidyi* (Van der Molen et al., 2015a), and on coupling a size-based fish model to study future fisheries yield (Van Leeuwen et al, 2016). The presentation will continue with a comparison of simulated phytoplankton functional types with recent in-situ data from the North Sea which demonstrates an emerging capability to address biodiversity-related questions (Ford et al., in prep.).

These examples demonstrate the versatility and utility of GETM-ERSEM-BFM to address marine management questions. The presentation will finish with an overview of the results of the MASTS-MSCC workshop to increase the uptake of ecosystem model results in policy development and management (Hyder et al., 2015).

(10) Regional scale modelling of windfarms in the Firth of Forth, Scottish east coast

Alejandro Gallego. Marine Scotland Science.

Marine Scotland Science scientists are working on a project to investigate the potential effects of proposed wind farms on the circulation in the Firth of Forth and Tay area, off the Scottish east coast. The wind farms are projected to be sited in relatively shallow sand bank areas which are important habitats for sandeels, which is term sustain very important populations of seabirds and marine mammals. Significant changes to the circulation patterns may affect the physical characteristics of the sea bed and thus their suitability as sandeel habitats, while other hydrographic changes may affect primary productivity, with ensuing changes to the ecosystem structure and function. Rory O'Hara Murray (r.murray@marlab.ac.uk) has developed a FVCOM model of the area at very high maximum resolution (down to 10 m within the wind farms), representing turbine foundations as islands within the model. Simulations have shown small nearfield effects on current speeds but no noticeable effects further afield. The outputs of the FVCOM model are being used by a University of Aberdeen/Marine Scotland Science joint postdoc (Jacqui Tweddle; jftweddle@abdn.ac.uk) as forcing data for a 1-D primary productivity model to investigate the potential effects of any physical changes on primary productivity and higher trophic levels.

(11) Setting WFD N reductions based on mechanistic models.

Anders Chr., Erichsen, Hanne, Kaas, Trine Cecilie, Larsen & Flemming, Møhlenberg1. 1 DHI, Agern Allé 5, 2970 Hørsholm

In October 2014, the *Minister of Environment* announced that Denmark got its 1st generation *River Basin Management Plans* (RBMP) related to the *Water Framework Directive* (WFD). The plans were heavily delayed and the scientific rationale behind the plans have been subject to extensive criticism, why improvements were called for, for the 2nd generation of RBMPs.
Primo 2013 the work to improve and develop the tools for 2nd generation was initiated and on 22. of December, the new RBMPs were made public, the result of an interesting and professionally challenging project.

As part of the 2nd generation of RBMPs were the development of a marine modeling tool based on mechanistic models. These mechanistic models describe the causal link between the physical parameters (wind, currents, mixing etc.), and the chemical and biological parameters (nutrients, primary production, organic matter mm.), which are important for ecosystem functioning. Important inputs to the models are therefore both meteorological data and information on nutrient input from Denmark, as well as from our neighbors around the Baltic Sea.

Following the model build the results were used to develop relationships between nutrient loadings from Denmark and environmental status, and hence, providing the water authorities with an improved tool for setting differentiated actions and estimate nitrogen targit loads within each specific water body.

(12) The importance of external versus local nutrient loads for chl a and primary production

Marie Maar, Janus Larsen and Stiig Markager, Marine Ecological Modelling Centre, Aarhus Univ.

The Western Baltic Sea is affected by eutrophication and receives nutrients from local land-based sources, atmospheric deposition and by advection from the neighbouring North Sea and Baltic Sea. In the present study, we evaluated the importance of local (Danish) versus external (Baltic Sea-North Sea) nutrient loads for surface Chl *a-* concentrations, total areal primary production and the vertical distributions of primary production in the W. Baltic Sea using the 3D coupled HBM-ERGOM model. This was assessed by improving descriptions of nutrient loads and primary production in the model and by conducting scenarios of different nutrient loads according to i) the eutrophication level in 1990, ii) the new Danish Water Plan (DWP) and iii) DWP + the Baltic Sea Action Plan (BSAP2). The model results showed that local nutrient reductions have a profound effect on Chl *a* concentrations and primary production in the coastal areas of the Western Kattegat and the Belt Sea with the highest impact <10-25 km from the coast. However, on average for the study area, Danish reductions have a limited effect. The DWP complemented the BSAP2 reductions spatially, since they had the highest impact in different areas and both were important for improving

the ecological status of the ecosystem. The model suggested a significant change in the vertical distribution of primary production with less deep primary production in response to increased nutrient load. We recommend using this redistribution as an ecological indicator of eutrophication in seasonally stratified seas. The new description of primary production takes into account that carbon fixation continue, even when phytoplankton is severely nutrient limited. This model improvement increases primary production by a factor of 2.6 and brings the model estimates in agreement with measurements and the physiology of phytoplankton. We recommend that other dynamic ecosystem models using Liebig's law for primary production consider a similar approach.

(13) Calculation of water quality targets in the south-western Baltic Sea on the edge of WFD and MSFD

René Friedland, T. Neumann, G. Nausch, N. Wasmund, G. Schernewski (IOW & Klaipeda University)

A full re-calculation of Water Framework Directive reference and target concentrations for German coastal waters and the western Baltic Sea is presented. For this purpose a spatially coupled integrative modelling approach is used, which links a river basin flux model with three-dimensional ecosystem model of the Baltic Sea. The years around 1880 are considered as reference conditions reflecting a high ecological status and simulated with the model system. For all monitoring stations the present day water quality derived from observations was than transfered to the historical situation by multiplying it with the calculated changes from model simulations covering the present and the pre-industrial situation. This was used to derive the reference concentrations of all necessary eutrophication parameters and by adding 50% to it, the needed target concentrations were derived on the scale of the single water bodies. By taking into account the specifics of every water body, this approach overcomes the inconsistencies of earlier approaches. Our targets are well in agreement with the targets needed for the implementation of WFD and MSFD. To reach the averaged targets, German nitrogen inputs have to be reduced by 34 %, resulting in an average maximum allowable concentrations in German Baltic rivers of 2.6 mg TN/l. To our results, MAI according to the BSAP (as Baltic-wide implementation of MSFD) may be sufficient for the open sea, but are not sufficient to reach a good WFD status in German coastal waters.

(14) Modeling in support of the nutrient reduction scheme of the HELCOM Baltic Sea Action Plan

Bo Gustafsson

The HELCOM Baltic Sea Action Plan eutrophication segment includes a management cycle aiming for specified improved conditions in the sea and that is based on the best available scientific information gained from modeling and data analysis. On the basis of monitoring and assessment, ecological objectives are set and indicators developed. Quantitative targets that represent a good environmental status are established. In the following step, the relationships between pressure (i.e. nutrient loads for eutrophication) and target variables are established by means of physical-biogeochemical modeling using the BALTSEM model. The pressure-response relationships differ for the various regions within the Baltic Sea

because of differences in e.g. circulation, ecosystem and loads. The result of the modeling is the basin-wise Maximum Allowable Input (MAI) of nutrients that will result in a development towards reaching the targets. The basin-wise load reduction needed to meet MAI is divided between the countries according to polluter pays principles, and what is considered fair burden and is in agreement with the Helsinki Convention and by this Country Allocated Reduction Targets (CART) are established. HELCOM asked Baltic Nest Institute (BNI) calculate MAI and CART using the BNI Nest decision support system, in order to present results for decision by the environmental ministers of the HELCOM countries on October 3, 2013.

In this presentation, I will show how have found the optimal MAI by means of ecosystem modelling and the intricate construction and calculation of a set of CARTs that can be accepted by all countries. In addition, I will share our experiences of the challenges that we experienced in the long processes of making our scientific work so useful for and accepted by managers and stakeholders, that the results can be basis for concrete political decisions on load reductions.

(15) How could state of the art ecosystem modelling support the HELCOM eutrophication assessment?

Vivi Fleming (SYKE)

The eutrophication status of the Baltic Sea is assessed using a quantitative indicator-based assessment. No single parameter or indicator alone is sufficient to evaluate overall eutrophication, and a set of HELCOM CORE indicators with agreed boundaries for Good Environmental Status (GES) has been agreed upon by HELCOM. Present levels of these indicators may be updated using monitoring data reported by the coastal countries. However, evidence for estimating boundaries for GES is hard to find in a sea with a long history of widely spread pollution. In this presentation, I will explain the HELCOM eutrophication assessment approach and provide insight to problems and information gaps that could be filled by combining state of the art modelling with a management perspective. I will also show examples on how modelling has been already used to improve the eutrophication assessment of the Baltic Sea.

(16) Towards custom built models for water and sediment biogeochemistry based on reusable components

Jorn Bruggeman. Plymouth Marine Laboratory, Plymouth-UK.

Marine ecosystem models increasingly address challenges that involve many biogeochemical processes operating on multiple spatiotemporal scales. Eutrophication is a key example, with models needing to link nutrient loads to ultimate societal impact, while accounting for a plethora of biogeochemical transformations in water and sediment along the way. We propose that the complexity of this challenge necessitates a collaborative approach: the distributed development of process models, cherry picked and combined at will to build ecosystem models that address specific questions and constraints. The open-source Framework for Aquatic Biogeochemical Models (FABM, http://fabm.net) is designed

for this purpose: it enables the development of self-contained process models, combinable into ecosystem models of user-specific complexity, and usable from a wide range of hydrodynamic models (GOTM, GETM, NEMO, MOM, ROMS, FVCOM). The viability of this approach is demonstrated with the European Region Seas Ecosystem Model (ERSEM). Through its use of FABM, the modularized ERSEM seamlessly scales from a simple four-variable ecosystem to a comprehensive model featuring many types of plankton and benthic fauna, multiple chemical elements, and detailed descriptions of carbonate and redox chemistry.

(17) The use of ecosystem models to assess indicators in support of the EU Marine strategy framework directive

Chiara Piroddi. University of Barcelona, SPAIN.

The European Union's Marine Strategy Framework Directive (MSFD) seeks to achieve, for all European seas "Good Environmental Status" (GEnS, Borjia et al., 2011) by 2020; on the other hand ecological models are currently one of the strongest approaches used to predicting and understanding the consequences of anthropogenic and climate-driven changes in the natural environment. This presentation will highlight the results of a review conducted under an FP7 project called DEVOTES showing 1. current capabilities of the modelling community to inform on indicators outlined in the Marine Strategy Framework Directive (MSFD), with a special focus on the following three descriptors: biodiversity (D1), food webs (D4), non-indigenous species (D2) and seafloor integrity (D6); 2. which models are able to demonstrate the linkages between indicators and ecosystem structure/function and the impact of pressures on state and thus indicators; 3. gaps in model capability and needs for development.

In addition, in order to facilitate the implementation of management policies like the MSFD and explore future plausible scenarios, some preliminary results will be presented on spatial and temporal evolution of the Mediterranean marine ecosystem from 1950 to 2010 and structural and functional changes of the basin using specific model derived indicators.

(18) Conceptual use of ecosystem modelling for Eutrophication assessment

Adolf Stips, Diego Macias, Elisa Garcia-Gorriz, Svetla Miladinova. European Commission, Joint Research Centre, Institute for Environment and Sustainability, 21027, Ispra, ITALY

Eutrophication means the enrichment of water by nutrients causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned. Therefore eutrophication is generally characterized by following distinct features:

1) Causal factors: Nutrient levels (DIN, DIP)
2) Direct effects: Phytoplankton, Secchi Depth (Chla, Kd)
3) Indirect effects: Oxygen, disturbed higher trophic levels

The HELCOM Eutrophication Assessment Tool (HEAT) as well as other indicators used for assessing eutrophication (for example TRIX) are based on measured quantities of the above mentioned variables. However measured data often do have large gaps in space and time and therefore cannot provide a comprehensive picture of the ecosystem investigated. We propose to use model data from carefully validated ecosystem models to perform an additionally or complementary eutrophication assessment applying the same procedure as used with measured data. Because of the better temporal and spatial coverage this approach could help to identify sensitive regions and critical time periods. It could also support the identification of trends and to identify relevant data gaps in the monitoring program.

Preliminary examples of applying the HEAT and the TRIX tools to model data generated by the GETM/FABM/ERGOM modeling environment for the Mediterranean and Baltic Sea are provided. These examples demonstrate their potential by clearly detecting the strong eutrophication gradient that is increasing from the open sea to the coast and pointing to certain eutrophication hot spots, as well as giving quantitative temporal trends.

Annex III: Workshop Agenda

AGENDA

Session	Time	Presenter	Short Title	Comment
Day 1		**20.01.2016**		
	10:00	**M. Malgaj**	Opening	Welcome
	10:10	**ALL**	Introduction Round	
	10:30	**G. Hoermandinger**	Motivation&Background	
M-I	10:45	**D. Macias**	Mediterranean ESM	
	11:10	**G. Marilaure**	BlackSea-Eutro	
	11:35			Coffee
M-II	12:00	**T. Oguz**	Jellyfish&Foodweb	
	12:25	**P. Lazzari**	Modelling PPR	
	12:50			Lunch
M-III	14:00	**J.R. Segura**	Framework	
	14:25	**K. Tsiaras**	Eutrophication Aegean	
B-I	14:50	**J. Bruggeman**	Custom FABM	
	15:15	**J. v.d. Molen**	ERSEM - Shelf	
	15:40	**B. Gustafsson**	BSAP-modelling	
	16:05			Coffee
B-II	16:35	**R. Friedland**	WFD&MFSD	
	17:00	**M. Maar**	Nutrients	
	17:25	**All**	Discussion	
	18:00		Closure Day 1	
	19:30			Aperitif
	20:00			Dinner

Day 2		21.01.2016		
	09:00	**C. Piroddi**	Models&MFSD	
E-I	09:25	**X. Desmit**	Eutrophication	
	09:50	**A. Erichsen**	Eutrophication WFD	
	10:15	**V. Fleming**	Eutrophication HELCOM	
	10:40			Coffee
	11:10	**A. Stips**	Eutrophication ESM	
C-I	11:30	**ALL**	Recommendations	
	12:30	**G. Hoermandinger**	Next steps	
	13:00			**End of workshop**

References

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)

List of abbreviations and definitions

DG ENV: Directorate General Environment

DG JRC: Directorate General Joint Research Centre

FABM: Framework for Aquatic Biogeochemical Models

GES: Good Environmental Status

MS: Member State

MSFD: Marine Strategy Framework Directive

SERS: Southern European Regional Seas

WFD: Water Framework Directive

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