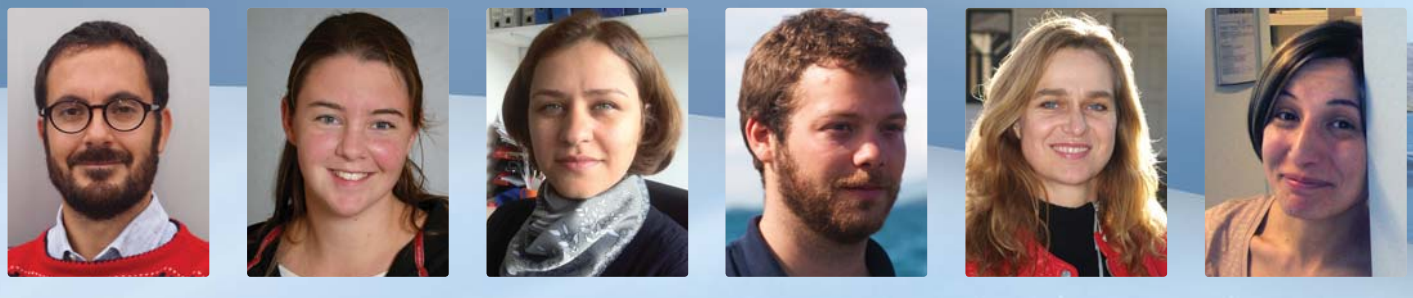


From left to right: Dr Paolo Simonelli, Dr Elin Lindehoff, Dr Jamileh Javidpour, Dr Romain Pete, Dr Stella Berger and Dr Tatiana Tsagaraki.

Expert web

By placing a component of the marine environment under controlled conditions, mesocosms provide important links between field studies and laboratory experiments. Project Leader **Dr Paolo Simonelli** and scientific site coordinators **Drs Elin Lindehoff**, **Jamileh Javidpour**, **Romain Pete**, **Stella Berger** and **Tatiana Tsagaraki** explain how they are opening up access to these unique resources for European scientists

To begin, could you briefly outline the present state of research into aquatic ecosystems?

RP: Aquatic ecosystems are vast and understanding them is a slow process. We now face challenges in many fields. One is regarding the use of aquatic resources, such as fishing, aquaculture and the shellfish industry, as well as recreational use. Prioritising research in the field of aquatic ecosystems would address these concerns. Mesocosms are the tool of choice, as manipulation of large volumes allows significant representation of the ecosystem under study.

EL: Our mesocosm facility aids ongoing investigation of human impacts on the Baltic Sea – an ecosystem already heavily strained by eutrophication, intensive fishing and pollution. New challenges are arising from increased temperatures due to climate change. Increased river inputs are expected, and thus increased dissolved organic matter, nutrients and pollutants. These factors could change the base of the Baltic food web with repercussions up the web chains, thus affecting fish populations. Understanding these processes has great ecological and socioeconomic value.

SB: Interactions of organisms within pelagic food webs and/or coupling to benthic food webs and transfer to higher tropic levels are important ecosystem functions that need to be studied outside lab monocultures. With the support of MESOAQUA, several mesocosm experiments manipulated factors such as CO2, eutrophication, temperature and changes in light availability or food web compositions to assess the impact on planktonic food webs in different oceanic environments.

TT: We were able to answer lots of questions which – as is often the case in science – raised even more new ones. We aim to study the effects of acidification and temperature change in our marine community though an experiment planned for 2013. We also plan to work on the interactions induced by Saharan Dust on ecosystems and to improve and expand our modelling tools.

How has MESOAQUA progressed since we last featured the project?

RP: The MESOAQUA project has two main objectives. The first is to give transnational access (TA) to mesocosm facilities to aquatic researchers addressing original scientific questions. The MESOAQUA consortium has met the planned access target, offering over 4,000 days of access to around 20 projects and 150 scientists spread over the seven facilities in the project. This clearly demonstrates the need and interest of the scientific community in such an aquatic research tool.

The second objective of MESOAQUA is to develop mesocosms as a way of investigating different ecosystems in contrasting regions of the world. The Kiel Off-Shore Mesocosms for future Ocean Simulations (KOSMOS) and the new Lagrangian Mesocosms Platform (LAMP) were implemented and tested during the course of the project. They are now both up and running and will surely be the next generation of mesocosm facilities for aquatic research.

PS: This final test of LAMP, constructed at CNRS - Ecosym Montpellier/ Medimeer Sète, was performed in September 2011 in Crete and consisted of a joint experiment which involved all MESOAQUA partners.

Further to this, at the beginning of September 2011, MESOAQUA organised a workshop in Kiel, attracting graduate and postgraduate students from 17 countries, on the challenges and potential of using mesocosms in aquatic ecology.

Through TA, MESOAQUA has supported a number of experiments ranging from the effects of CO2-induced seawater acidification on plankton communities to the impact that Saharan dust deposition has on the biogeochemistry of the Eastern Mediterranean Sea.

EL: One of the greatest achievements of MESOAQUA is a significant growing network through TA activities and joint projects. Introducing and making mesocosm facilities available to international researches and graduate students is a top priority.

SB: This year, two mesocosm experiments were performed in Bergen and one in each of the other facilities, in Crete, Montpellier, Umeå and Kiel. Another important goal met is the Virtual Transnational Pelagic Mesocosm Centre (VTPMC), our information hub providing TA information and web-based TA applications.

PHYTOSTRESS EXPERIMENT AT THE NORWEGIAN NATIONAL MESOCOSM CENTRE, UNIVERSITY OF BERGEN, NORWAY © STELLA BERGER

The VTPMC (www.mesoaqua.eu) provides information about and contacts for mesocosm facilities, a bibliography of mesocosm publications, a picture gallery of people working at the different mesocosm structures and locations and news about all other activities such as workshops, meetings and symposia within and outside the MESOAQUA network.

How has the MESOAQUA network grown since its inception?

SB: The MESOAQUA mailing list contains about 800 members and is still increasing. Presentations of mesocosm experiments supported by MESOAQUA at international conferences contribute to increase the network. Through blogs during experiments we also get more people wanting to join the MESOAQUA network. Our personal contacts with scientists all over the world make the network a fruitful tool for future mesocosmic science.

Have you set any new priorities for the network as a whole?

PS: The impact that human activities and climate change have on aquatic food webs and the role that oceans play in the functioning of our planet are most urgent issues if we want to ensure the future of our species. Unfortunately, this is the last year of MESOAQUA, but the consortium of facilities and scientists will continue to exist and run new experiments to answer these questions.

Our next priority is to organise and publish the knowledge of mesocosm-based science acquired during these last four years in scientific journals and through other fora such as open workshops.

RP: The MESOAQUA steering body will seek to perpetuate the consortium and enlarge the network. The web portals (http://mesoaqua.eu and http://mesocosm.eu) will continue to be run and updated with information and literature on research and news, projects and calls in this area.

The network covers research into aquatic ecosystems from the Arctic to the Mediterranean. What are the challenges in studying and communicating research findings across such a wide geographical area?

PS: For what concerns science, the wide geographical area covered by our consortium is rather an advantage. Thus it provides a unique opportunity for scientist to test their hypothesis under completely different ecosystems and to compare them. Moreover the need to collectively plan a mesocosm experiment, to provide high-quality data within given dead lines, to collectively publish the result, and not least the social pleasure of doing this as a member of a multi/disciplinary team, tends to smooth any kind of cultural differences creating networks and working relationships that last far beyond the period of any single project.

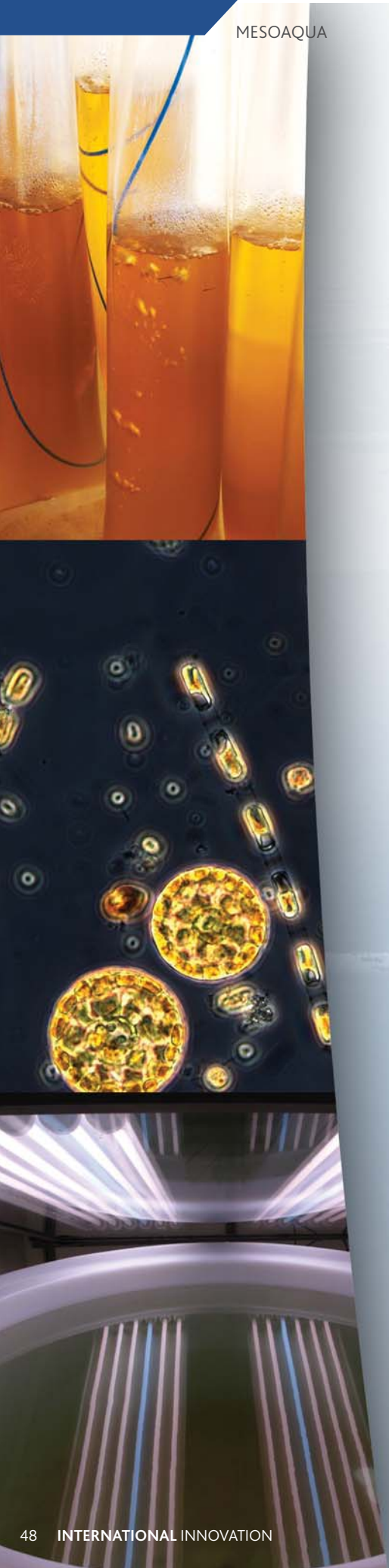
RP: Often, these regions are considered delimited, one being warm, dry and sunny, the other very cold, icy, and receiving light half of the year. Indeed, the regions represent a continuum of ecosystems throughout the latitudinal gradient. Since the tools used in experiments are similar, the main challenge is the way relationships and comparisons can be set between contrasting ecosystems.

SB: Although climate change and eutrophication occurs worldwide the oceanic environment is very different at distinct geographical locations and so is the composition of the plankton organisms. This can lead to completely different responses and that is what makes our work so interesting. For example, an increase in temperature might have a more pronounced or a completely different effect on cold-adapted Arctic plankton organisms than on temperate or warm adapted Mediterranean species.

Finally, can you highlight some of the ways in which you plan to continue the work of this exemplary network in the future?

TT: This coming October, the Hellenic Centre for Marine Research will be hosting an international symposium in Crete. It will be the first symposium dedicated to mesocosm research, drawing together scientists funded by MESOAQUA and others working in the field from all backgrounds. It will be an excellent opportunity to share knowledge with other experts in the field and to start future collaborations.

PS: Although the project will conclude by the end of 2012, the consortium of scientists and of infrastructures will continue to exist. Mesocosms are precious tools which can uniquely answer important scientific questions. The success of MESOAQUA demonstrates that there is a real need for access to mesocosm facilities within the European aquatic ecologist community.



Sustainable mesocosmic cooperation

MESOAQUA has united more than the European marine mesocosm facilities; scientists from across Europe now work collaboratively to evaluate and compare the effects of climate change and ecological challenges on aquatic environments using mesocosms as main research tool

INCREASING ACIDIFICATION AND temperature in the oceans is a concern not only for the viability of coral reefs and other marine ecosystems, but also for the food security of many millions of people. Thus, these changes may negatively affect the microbial food web from which depend all the other higher trophic compartments up to commercial importance. It is therefore fundamental to understand the functioning of the microbial food web and its response to pollution and climate change effects

This cannot be achieved only inside the laboratory but scientists need tools allowing experimental approach to near-natural pelagic systems. This is the premise of a coordination effort in MESOAQUA, a European Union Seventh Framework (FP7) project, which started in 2009 and is due to conclude later this year.

MESOAQUA has established a network of mesocosms facilities to provide European and non-European scientists with experimentation access for the study of future aquatic ecosystems from the Arctic to the Mediterranean. Moreover, MESOAQUA facilitates the exchange of mesocosms technical innovations and promotes interdisciplinary collaboration and training for young scientists.

Mesocosms are reservoirs that enclose a volume of water which can be manipulated to modify its biological physical and chemical characteristics. They allow therefore to study the effects that increased temperature, increased acidity, pollutants and invasive species, exerts on the aquatic microorganisms. Some are designed to be portable and deployable in different waters. "The mesocosm-based research field is relatively young and unknown. The usefulness of this experimental approach and the possibilities the network offers in terms of access to facilities and training for young scientists deserve wide attention," asserts Dr Paolo Simonelli from the Department of Biology of the University of Bergen, the present coordinator of MESOAQUA.

THE EUROPEAN MESOCOSMS

There are seven mesocosms facilities throughout Europe that represent very different marine environments: the CRETACOSMOS mesocosms at the Hellenic Centre for Marine Research near Heraklion, Greece; the MEDIMEER mesocosms platforms of the University of Montpellier sited on the Mediterranean coast on the Thau lagoon near Sète, France; an indoor facility at the Helmholtz Centre for Ocean Research at Kiel (GEOMAR) in Germany from which depends also the mobile mesocosm called Kiel Off-ShoreMesocosms for future Ocean Simulation (KOSMOS) that have been deployed in the Arctic in a Norwegian fjord and recently in the Baltic Sea; the Norwegian National Mesocosm Centre mesocosm of the University of Bergen (UiB), near Bergen, Norway; the Umeå Marine Sciences Centre mesocosm of Umeå University, Sweden; and the mesocosms at the Kings Bay Marine Laboratory, the northernmost marine laboratory in the world, at Ny-Ålesund in Norway.

Each mesocosm supports whole ecosystem studies to provide further insights into the complexity of aquatic ecosystems. All the European mesocosms are augmented with sophisticated environment monitoring, water sampling and analysis technologies, and during MESOAQUA, a number of technological improvements and upgrades to components and systems have been conducted: "Mesocosms are research tools under continuous development. All the partners are continually testing and developing increasingly optimal, state-of-the-art solutions. This allows exchange of good practice and technologies for the benefit of both local users and visiting scientists," states Simonelli.

STRENGTH IN BREADTH

MESOAQUA has provided 4,200 days of access to the European mesocosms facilities. These were taken up by a many European and non-European scientists who staged or participated in experiments and Joint Research Activities, some while completing doctorate degrees, obtaining samples and data for a variety of studies, as Dr Stella Berger, the Scientific Coordinator for the Norwegian National Mesocosm Centre at Espegrend, highlights: "MESOAQUA has supported cooperation between many scientists from research institutes all over the world from various fields of expertise, enabling them to gather information on several levels in large-scale experiments and very effectively expand their scienctific network strongly benefiting the development of global future marine science".

A good example of the novel work the network supports is that of the Montpellier University/Sète team, who developed the second mobile mesocosm platform called Lagrangian Aquatic Mesocosm Platform (LAMP). LAMP is equipped with several sensors monitoring automatically physiochemical and biological parameters of the experimented natural water masses in the mesocosms, and transmits the data at real time. LAMP has been

SCUBA DIVER DEPLOYING LAMP MESOCOSMS
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transported to Crete for a study of the effects of the limitation of phosphorus on the food chain in the Cretan Sea: "It was exciting to build an off-shore mesocosm platform from scratch, deploy it for a 10 day experiment and then repack it. Every day there was a new problem to solve, a new challenge," reflects Dr Romain Pete, the Scientific Coordinator for MEDIMEER. KOSMOS is another next-generation large scale free floating mesocosm that was deployed after transportation to the Baltic Sea.

Four research projects this year alone addressed the effects of seawater acidification on plankton in different ecosystems. Other projects have used mesocosms to investigate such subjects as the effects of eutrophication, trace metal depletion on microalgae composition and the effects of increasing UV light, due to climate change on aquatic species, food chain and ecosystems dynamic. "Mesocosm studies are important for understanding how processes such as climate change and eutrophication affect different marine environments and the effects of any countermeasures, which is key to restoration of marine habitats and protecting the production of marine resources, from fisheries to aquaculture," explains Dr Elin Lindehoff, the scientific site coordinator for the Umeå Marine Sciences Centre mesocosm.

In addition, the importance of sharing knowledge and educating early stage researchers has been reflected in the coordination of a number of workshops and symposia. This year, Dr Jamileh Javid staged a workshop at the Helmholtz Centre for Ocean Research at Kiel (GEOMAR) that focused on jellyfish as the model organism and attracted 26 students from 24 universities in 15 countries and 13 guest speakers. She is keen to highlight how successful the workshop proved: "We provided a series of lectures given by experienced scientists like Jennifer Purcell, Mark Martindale and Kylie Pitt from different fields of jellyfish-related aquatic science to discuss the advantages and limitations of mesocosms in current research on gelatinous zooplankton. We also presented current ocean acidification, stress ecology and trophic ecology mesocosm studies".

AN EVOLVING LEGACY

The funding for MESOAQUA ends this year, but the scientists involved already envision future collaborative studies: "The final symposium will be in October: it will summarise the project and also trigger the next steps for mesocosm research in aquatic science," declares Simonelli.

The consortium plan to release sets of guidelines for mesocosm based research which will include the many lessons learned in mescocosm design, setup and deployment during MESOAQUA. The team are delighted that the MESOAQUA web portals will be maintained, providing updated links and information on new literature, meetings, funding opportunities and press releases related to mesocosm-based aquatic ecosystem science in Europe and worldwide. They anticipate also extending to freshwater mesocosms in future.

To Simonelli, the greatest legacy of the project is the rapid exchange of knowledge and nurturing of a network of young scientists that it has fostered and enabled: "The MESOAQUA young scientists form a natural cooperative group, building transnational scientific cooperation that will persist, expand and spark new projects long after the termination of MESOAQUA".

The team will continue to collaborate to build a future project to include more mesocosm facilities in marine and freshwater ecosystems. The perpetuation of the VTPMC (www.mesoaqua.eu and www.mesocosm.eu) after the end of the project reflects this vision.

MESOAQUA

OBJECTIVES

To offer European researchers access to a range of mesocosm facilities; develop and test new technologies; improve the services of the facilities by exchange of technology and experience; facilitate cross-disciplinary fertilisation and better coordination and; promote the training of young scientists in the use of experimental ecosystem research.

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ELIN LINDEHOFF is the scientific site coordinator for the Umeå facility. Her research is aimed at metabolic strategies of phytoplankton and interactions within the microbial community.

JAMILEH JAVIDPOUR is a researcher at the Helmholtz Centre for Ocean Research (GEOMAR), Kiel. Her focus lies in trophic ecology and invasion ecology of jellyfish.

ROMAIN PETE is a postdoctoral researcher and scientific site coordinator of Medimeer at the University of Montpellier 2. His research is focused on marine trophic food web dynamics and composition under climate changes.

STELLA BERGER is a researcher and scientific site coordinator of the Bergen facility. She uses mesocosms to study environmental effects on planktonic food webs in freshwater and marine ecosystems.

TANYA TSAGARAKI is the scientific site coordinator at the Cretacosmos facility in Crete, Greece. She is interested in microzooplankton trophic interactions and water column stoichimetry.