

MARI

Mitigation & Adaptation Research Institute

*Learning to Live with
Changing Climate and
Rising Sea Levels*



MITIGATION AND ADAPTATION RESEARCH INSTITUTE

Executive Summary

The Institute

Vision and Mission

MARI's **vision** is that of thriving coastal communities. In pursuit of this vision, MARI's **mission** is engaged in mitigation and adaptation research to provide the practice-relevant knowledge needed by coastal communities to handle the challenges, and utilize the opportunities, of climate change and sea level rise.

The **Mitigation and Adaptation Research Institute** (MARI) at [Old Dominion University](#) engages in research that produces the practice-relevant knowledge needed to cope with the impacts of climate change and sea level rise on the coastal zone and the urban coast in particular. In doing so, MARI responds to the knowledge needs of a wide range of community stakeholders, including government, military, private sector, and citizens. The high rate of local sea level rise, the exposure to extreme weather events, and the complex socio-economic structure makes Hampton Roads a natural laboratory for climate change and sea level rise. MARI utilizes this laboratory and works with stakeholders within and outside the region to generate the knowledge that can enable them not only to reduce the negative impacts but also to utilize the opportunities in the changes to come. To ensure that the stakeholders get the knowledge they can apply, MARI works closely with them to ensure a co-creation of practice-relevant knowledge and to support them in the use of this knowledge.

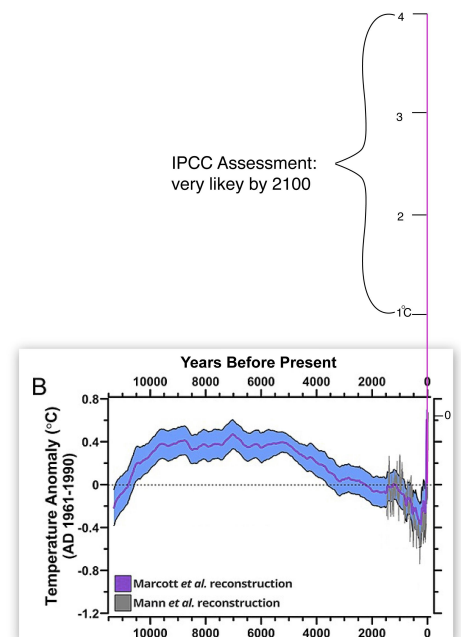
Leaving the Holocene: The Challenge of Climate Change

There is Urgency

Climate change is impacting the daily life of people already now. The time for mitigating climate change and its impacts and adapting to the changes is running out. There is an urgent need to develop adaptation science and to produce the practice-relevant knowledge that address all these issues.

Climate change and sea-level rise pose unprecedented threats to communities across the world, especially the heavily-populated urban coasts. The changes experienced during the last century are unprecedented during the Holocene, that is, the relatively stable 10,000 years in which civilization could develop. There is increasing evidence that the changes anticipated for the 21st Century will push the climate outside the range known to civilization and into a phase of much greater variability. This challenges decision-making in all societal sectors, and it requires a new level of preparedness to mitigate the impacts and adapt to the changes.

Likely changes in 21st Century global temperature compared to changes during the last 11,000 years. The anticipated changes in global temperatures (as well as many other climate-relevant variables) during the 21st Century will by far exceed changes documented in paleo data both in magnitude and the pace of changes. This will put the planet in a state unknown to civilization and the ecosystems of today. Modified by Plag (2014) from Marcott et al. (2013).



Sea Level Rise: A Threat to an Increasingly Urban and Coastal Civilization

Preparing for a Range of Possible Futures

Understanding the probabilities of LSL rise, coastal communities need to prepare for rising sea levels and develop concepts for living where it is safe and working where it is needed.

Human population has moved from rural areas in urban, and most of the rapidly growing urban areas are in the coastal zone. During the 1933 flood in Hampton Roads only 35,000 people were living in Virginia Beach and Norfolk; today 1 Million people are exposed in the same area to the risk of extreme weather events. Both on a global scale and in the U.S., an increasing fraction of the population and the most productive infrastructure are in the coastal zone. They are at increasing risk from accelerating sea level rise (SLR), and a rapid SLR already in the near future cannot be excluded. The likely SLR will increase the risk of disasters caused by storms and storm surges, and the frequency and severity of storms is expected to increase and further exacerbate this risk. Because of the dependence of humanity on the coastal zone, these disasters threaten food and water security, supply chains, public health, and crucial parts of Earth's life-support system. The coastal zone thus is a frontline for humanity's sustainability. The high economic productivity and importance of the coastal zone rules out a simple retreat to safer areas, and new solutions for living in the coastal zone with a variable sea level need to be found. To achieve this, we need to improve our understanding of the vulnerabilities, increase our foresights, have more insight into the societal decision making processes, develop the institutional framework for mitigation and adaptation, provide a wide range of options, and identify the barriers and obstacles that hamper mitigation and adaptation.



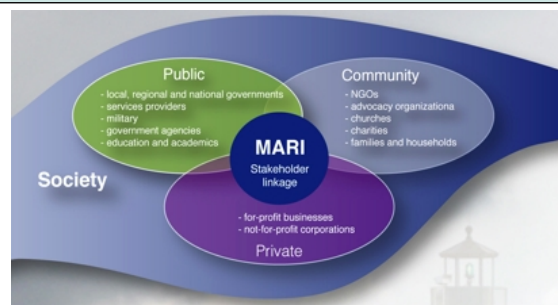
“Nuisance flooding” is increasingly common in Hampton Roads. Many low-lying areas are exposed to increasingly more frequent flooding as a result of the recent rise in Local Sea Level (LSL), which is low compared to what might happen over the next decades. In some areas, roads and buildings are by now exposed to flooding for up to 200 hours per year and this might rapidly increase to 500 or more hours per year in the near future.

MARI and its stakeholders

A Stakeholder-Driven Institute

Continuous input from stakeholders in climate change mitigation and adaptation enables MARI to create the practice-relevant knowledge society needs to find sustainable solutions to the challenge of climate change and sea level rise, which cannot be found without a solid foundation in solution-focused research.

MARI's vision and mission imply a strong linkage between the institute and a wide range of societal stakeholders in climate change mitigation and adaptation. MARI proactively and continuously seeks input from stakeholders to gain a thorough understanding of their knowledge needs. The institute works with them to design and co-create the knowledge and seeks with them the most appropriate solutions, be they, for example, engineering or technological approaches intended to mitigate against the impact of severe storms and flooding or adaptive approaches intended to live and prosper within new environmental constraints.



MARI serves a wide range of stakeholders. Climate change mitigation and adaptation is cross-sectoral and stakeholders relevant to MARI reside in all societal sectors. MARI will develop infrastructure, organizational frameworks, and procedures that ensure a strong and continuous linkage between them and the institute.

MARI's Research Focus

Defining Mitigation and Adaptation

1. Mitigation of Climate Change and SLR: actions that limit and reduce changes in the Earth's system that are known to force climate change or increase SLR.
2. Mitigation of climate change and SLR impacts: actions that aim to protect against certain levels of impacts of climate change and/or SLR.
3. Adaptation to climate change and SLR: actions that increase our preparedness for a wide range of probable climate change and SLR and allow us to adapt to the changes if and when they happen.

MARI focusses on problem-motivated basic and applied research on all aspects of mitigation of climate change and its impacts as well as adaptation to the changes that cannot be prevented with a view on sustainable development. Implementation of mitigation and adaptation measures require societal decision making, and MARI researches the opportunities and obstacles in decision and policy making and the institutional framework for mitigation and adaptation. The institute aims to develop a wide range of options for mitigation and adaptation. Doing so in an effective manner requires an understanding of the ranges and probabilities of the hazards and the identification of vulnerabilities, and MARI researches the effect of climate change on sea-level and weather-related hazards and the vulnerability of coastal communities to these hazards and provide risk assessments. The research covers the robustness of the built environment in the urban coast, the robustness and resilience of crucial services such as food, water, communication, transportation, power, and public health, and the resilience of the social fabric in its socio-economic and socio-ecological settings. MARI compares urban coasts in different cultural, social, economic and environmental settings to gain an understanding of the key factors that can support or limit the adaptive capabilities of coastal communities.

MARI facilitates and engages in collaborative, transdisciplinary research that is motivated by real-world problems and focused on the finding of solutions. In its research project, MARI ensures a balance between the traditional academic disciplines and ensure that basic research on transdisciplinary methodology is inherently integrated in the research. MARI works with societal stakeholders to develop options to mitigate and adapt to climate change and sea level rise, and in doing so, MARI also researches methodology for sustained co-design, co-creation, and co-usage of practice-relevant knowledge.

MARI's Contribution to Education

A Need for Transdisciplinary Education

To support, maintain and guide sustainable coastal communities, a work force and societal leadership is needed that can communicate across traditional disciplines and societal sectors, and to achieve this, a strong transdisciplinary element in education is needed.

MARI engages in the development of transdisciplinary approaches to education related to scientific and societal challenges of climate change, sea level rise, and sustainability in general. The institute's role is mainly in the development of transdisciplinary, problem-motivated courses, certificates, and degrees, and MARI provides the teaching and education by taking maximum advantage of existing resources and faculty, always in an interdisciplinary fashion. The institute begins by offering courses, which will be followed by certificates and, eventually, degrees. Certificates and degrees are hosted in appropriate colleges and MARI members engage in the required teaching.

The complexity of the coastal zone as well as the nexus linking energy, food, water, and public health require a work forces and societal leadership that has an understanding of the coastal environment, including the urban coast, and its life-support systems as well as the impacts climate change, sea level rise, and environmental changes can have on this sensitive socio-ecological and socio-economic environment. MARI develops a footprint on the workforce and leadership in Hampton Roads and beyond that will support the development of adaptive capabilities.

MARI and Student Engagement

An Uncertain Future Needs Engaged Citizens

Students are important for the future of our society and engaging them in addressing climate change is crucial for future generations of engaged citizens and a sustainable development.

MARI engages students in many different ways in its activities. Linking students to the societal environment is a cornerstone in engaging students. Bringing students in contact with the issues both in academic programs and activities that link them to societal problems is necessary to help students understand the challenge they will face over the decades to come. MARI works with existing student engagement programs at ODU to achieve this. Of particular importance is collaborative leadership development. While MARI develops certificates open to leaders in society, there is also a need to engage students in the effort of developing the leadership capabilities that are needed in mitigation and adaptation. Coupling the need and advantages of civic engagement in the deliberation of mitigation and adaptation strategies for the development and public acceptance of resilience-related policies, MARI encourages [Service Learning](#) projects and courses that emphasize leadership development, critical thinking, and personal reflection while encouraging community, civic engagement, and personal responsibility. Student engagement and leadership development are vital for the linkage between ODU and its societal environment.

MARI and its Outreach

Bringing Knowledge to Where it is Needed

Creating knowledge is just the first step; in order to affect real change, managing that knowledge effectively and efficiently is crucial, with proactive outreach as the front and end stage of MARI's Knowledge Management process.

The outreach activities of MARI are embedded in the general outreach concept of ODU. They have the goal to link MARI to its stakeholders and by that to ensure that knowledge created responds to stakeholder needs and is available to those who can put it to work. The institute conducts outreach, in both face-to-face and online settings, in particular by standing up and maintaining a comprehensive web presence. A focus is on multi-faceted dissemination of knowledge enabling mitigation and adaptation to climate change and SLR. Knowledge Management is at the heart of this strategy. Maintaining and cultivating collaborative relationships with stakeholders in, and beyond, Hampton Roads is key to the success of MARI and to the understanding of the needs and requirements of those stakeholders with respect to mitigation and adaptation. The comprehensive outreach program ensures that stakeholders are involved in the co-creation of the knowledge they need and that they have the capabilities to make use of this knowledge.

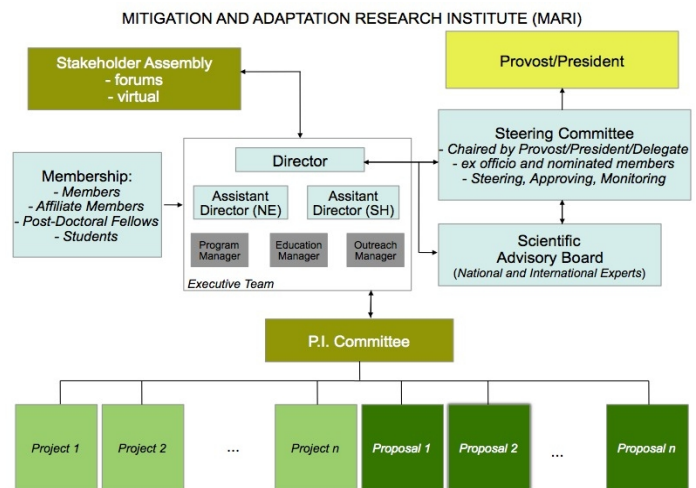
MARI within ODU

Facilitating Transdisciplinary Research and Education

The discipline-based organization in higher education requires new elements outside this traditional environment that can built transdisciplinary education and research programs linking colleges and departments across boundaries.

MARI is based on the recognition that comprehensive knowledge is the basis for solutions, and that this knowledge can only be derived through interdisciplinary and cross-sectoral collaboration. The institute is designed in a way that ensures a transdisciplinary approach, with a governance structure that facilitates the inclusion of all academic disciplines. The governance structure as well as the monitoring and evaluation procedures are designed to foster direct input from stakeholders.

The governance structure takes into account that transdisciplinary entities need to be linked to the highest decision level at ODU and at the same time have a strong foundation in the existing colleges. This governance structure also seeks to set in place a dynamic collaborative decision-making process that will leverage appropriately the need for “top-down”, “bottom-up” and horizontal decision-making, collaboration and information flow.



A transdisciplinary institute in a disciplinary environment. MARI is governed by a Steering Committee with representation of relevant ODU bodies, which endorses the research and business plans of MARI, monitors its work and finances, and appropriates resources for MARI. Important advice comes from a Scientific Advisory Board, which consists of national and international experts and ensures the connection of MARI with relevant research programs. The Executive Team takes care of the day-to-day business and the programmatic development of the institute.



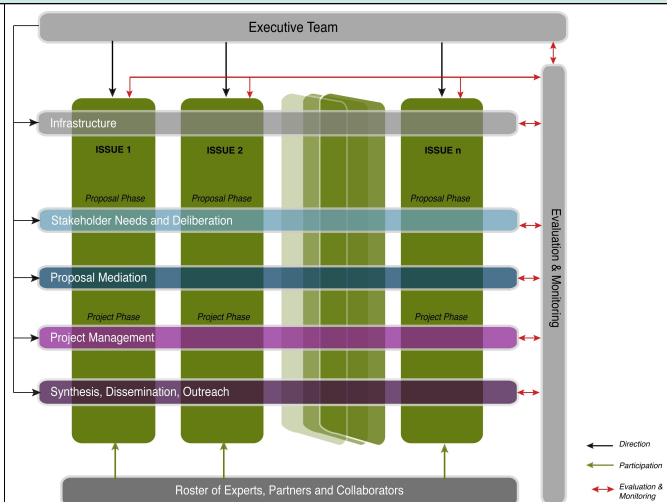
The Anatomy of MARI

Supporting the Construction of Solutions

To facilitate solutions, MARI provides the functions that support problem-motivated projects based on common infrastructure, databases and knowledge bases, and enable to construction of comprehensive and innovative solutions from multi-project outcomes.

Being driven by the knowledge needs of a wide range of stakeholders and conducting problem-motivated and solution-focused research requires a novel approach to the internal structure of the institute. The expertise needed at any given time depends on the problems addressed, and MARI has to draw on ODU's expertise, as well as outside expertise, depending on the nature of a problem. The internal structure of MARI is designed to leverage to the greatest feasible extent existing ODU technological and human capabilities. MARI also has an agile internal organization that can rapidly respond to emerging knowledge needs.

MARI takes a constructionist approach, which requires a framework bringing together different experts, a wide range of tools, comprehensive databases, and project findings and results for a solution-focused outcome that is practice-relevant. The internal structure of MARI is designed to provide all those functions required to transition from the traditional de-constructionist nature of science providing information to a constructionist approach providing solutions.



A design facilitating a constructionist, solution-oriented approach to societal problems. MARI will provide several “horizontal” functions, which will facilitate and support transdisciplinary projects addressing issues related to the impacts of climate change and SLR on (mainly) urban coasts. The project participants come from a roster of experts in the faculties at ODU, other regional universities and research institutes, and international collaborators. Evaluation and monitoring of projects as well as MARI as a whole provide essential feedback on the success, stakeholder acceptance, and impacts of MARI.

Measuring the Impacts of MARI

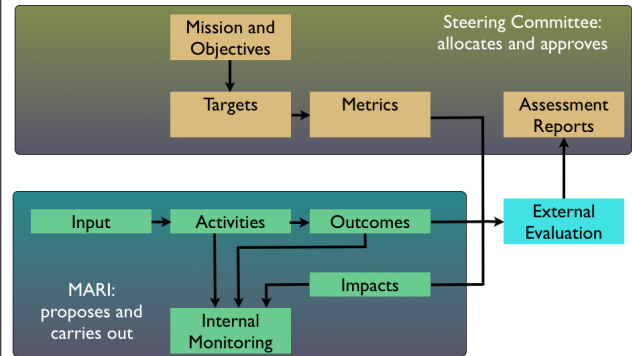
The Societal Benefits of MARI

The societal, environmental and economic costs of climate change and sea level rise are expected to grow rapidly. MARI contributes to enable a wide range of stakeholders to reduce the costs through mitigation where possible and timely adaptation where needed.

Importantly, the institute aims to be a source of new business opportunities and, in cooperation with the business world, help to generate jobs in the area of mitigation and adaptation.

MARI is a novel approach to an emerging science field that focuses on practice-relevant knowledge and at the same time has to engage in basic research and develop the foundation for the science of adaptation. Adaptation research can only be of societal relevance if the research is strongly linked to the stakeholders making use of the knowledge created, and MARI has to develop a conceptual and practical framework for the co-design and co-creation of knowledge. Marching into unknown terrain in several dimensions, MARI faces a number of challenges related to the academic and research organization at ODU, the science foundation, and the working with stakeholders. Most of these challenges will surface as surprises.

For the success of MARI, it is important to closely monitor the progress and to evaluate the approaches taken. Evaluation needs to cover all dimensions, including the research carried out and the usefulness of knowledge created, the academic contribution, the economic basis, the linkages to societal stakeholders, and the societal benefits of MARI, including the impact on local businesses and jobs created.



Monitoring and evaluation of MARI. The Steering Committee determines mission and objectives of MARI and approves outcome-related targets and metrics proposed by MARI. MARI uses resources allocated by the Steering Committee and solicited from external sources to carry out the activities and generate outcomes. MARI also monitors activities, outcomes and impacts. The result of the monitoring is made available to the Steering Committee on a regular basis. On request from the Steering Committee, the external evaluation compares outcomes and impacts to the metrics and targets approved by the Steering Committee and prepares an assessment report.