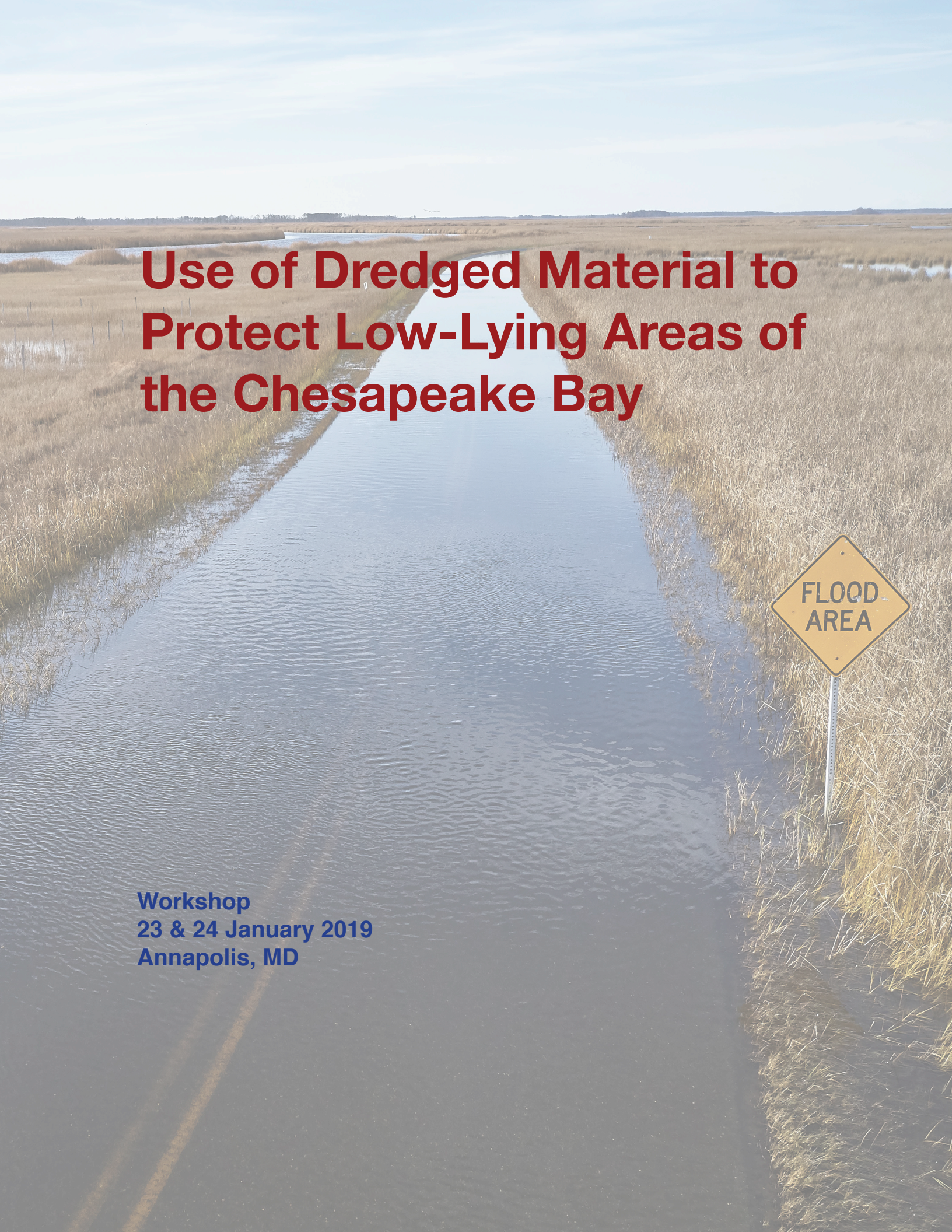
Use of Dredged Material to Protect Low-Lying Areas of the Chesapeake Bay



Workshop
23 & 24 January 2019
Annapolis, MD

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Use of Dredged Material to Protect Low-Lying Areas of the Chesapeake Bay

Westin Hotel, Annapolis, MD
23 & 24 January 2019

This workshop was organized and hosted by the Maritime Environmental Resource Center (MERC) at the University of Maryland Center for Environmental Science (UMCES) and sponsored by the Maryland Department of Transportation - Maryland Port Administration (MDOT--MPA)

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EXECUTIVE SUMMARY

This workshop was organized and hosted by Maritime Environmental Research Center at the University of Maryland Center for Environmental Science (MERC-UMCES), with support from the Maryland Department of Transportation – Maryland Port Administration (MDOT-MPA), to examine the potential use of dredged material to protect low lying areas of the Chesapeake Bay. Over 40 participants, representing diverse areas of expertise, multiple agencies and levels of government, and public and private interests, convened in Annapolis, Maryland on January 23rd and 24th, 2019 to gain a better understanding of the characteristics of sea level rise (SLR) projected in the Chesapeake Bay; the associated impacts to shorelines, people and infrastructure; and how existing and future technologies using dredged material might be used to address these impacts.

The participants displayed a shared interest to reach a common understanding of the scientific, engineering, economic and social aspects of rising sea levels and storm inundation on shorelines in the Chesapeake Bay as well as innovative approaches to address this critical issue. In addition, the participants were highly enthusiastic to share knowledge on this subject and to further guide and focus future discussion and decisions beyond the workshop itself.

The workshop explored the following topics in separate technical sessions:

Topic A: Understanding the problems and areas of vulnerability in the Chesapeake Bay;
Topic B: Current magnitude, type, and spatial extent of dredging activities and programs conducted in the Chesapeake Bay;
Topic C: Understanding the state of technology and potential applications of dredged material to protect low-lying areas;
Topic D: Understanding the potential benefits of, constraints on, and most promising opportunities for restoration and protection.

The technical sessions stimulated considerable discussion that helped to provide a common working knowledge among all participants regarding the current status of SLR and its associated impacts to the Chesapeake Bay, as well as the potential for dredged material to mitigate and manage these challenges. Facilitated breakout sessions created opportunities for exchange of ideas among all participants and afforded opportunities to explore those ideas in greater detail and help develop consensus on workshop recommendations. Table 1 of this document summarizes the ideas generated from the breakout sessions.

Several recurrent and over-arching themes emerged from the group dialogue that represented the overall group sentiment and helped mold the workshop recommendations. One salient and recurring theme and point of discussion was the recognition that sediment in the Chesapeake Bay needed to be considered as a valuable resource that is constructively managed and that efforts to strategically conserve and translocate sediment in the Bay as opposed to "disposing" of it warranted serious attention. It was further recognized that this viewpoint represented a significant departure and paradigm shift from many programs and policies that exist regarding Bay sediment management which are largely based on water quality standards. This shift will require substantial education, outreach, and policy changes

to successfully achieve a transformation in how sediment is regarded, regulated, and potentially used in the future.

Other important and recurrent themes evident throughout the workshop are summarized below:

- Use of dredged material, regardless of placement or application technique, represents one tool among many available that should be considered to address the issue of SLR, storm inundation and eroding shorelines;
- Design and implementation of future shoreline restoration and protection will require sustainable, resilient and adaptive solutions;
- Pilot projects are needed to help solve site-specific problems, demonstrate success, and pave the way for larger-scale regional solutions;

Shoreline restoration and protection from SLR is a Bay-wide issue. Movement and translocation of sediment in the Bay, regardless of jurisdictional boundaries, must be considered in developing future regional solutions. Future planning and implementation of solutions must take into full consideration the shorelines and sediment sources in both Virginia and Maryland waters.

- A regional approach to sediment management will be best able to address the scale and scope of problems that SLR will pose to vulnerable Chesapeake Bay shorelines in the future;
- Unconstrained problem-solving approaches that more accurately depict the "no action" future condition and that consider the full spectrum of economic, environmental and social benefits and uncertainty are needed to evaluate future investment and development decisions;
- Various shoreline vulnerability and mapping tools have been recently developed that can help determine the extent and severity of eroding shorelines. Existing tools should be further evaluated to determine which should be used (and further modified, if necessary) to identify and prioritize shoreline restoration and protection projects and concomitant resource allocation;

Workshop participants overwhelmingly agreed that additional attention and focused effort is needed to follow-up on many of the ideas generated over the course of the workshop which are reflected throughout this report and in the themes presented above. Four major recommendations are provided for follow-up to the workshop:

1. **Working Group:** A working group should be assembled to further consider the contents of this document and develop an Action Plan for implementation of the recommendations. The working group will also provide a continuing forum for dialog and catalyst for subsequent actions. Existing and related commissions, task forces and working groups should be explored as a vehicle for this group effort in addition to the potential of forming a new group.

2. **Web-Tool for Information Sharing:** A web-based public information repository and mechanism for information sharing should be established to support future collaboration and engagement of workshop participants and others interested. MERC/UMCES has offered to help develop this platform with the working group.

3. **Pilot Projects:** Identify and implement in the near-term (by 2021-2022) pilot projects to demonstrate replicable technologies and approaches to restore and protect shorelines vulnerable to SLR using dredged material. Projects with the potential for scaling up should be given greatest priority.

4. **Regional Strategy:** Concurrent to the development of pilot projects using dredged material, a regional strategy should be developed that integrates large-scale regional sediment management that focuses on conserving and managing sediment as a resource within the Chesapeake Bay.

WORKSHOP BACKGROUND, PURPOSE AND GOALS

Background

Global climate change drives SLR and storm severity, which leads directly to the increasing frequency and magnitude of coastal flooding. SLR can intensify the damage caused by storms as higher mean water levels result in greater wave energy forces at higher elevations on the shore profile, which accelerates coastal erosion. Over the next 15 to 30 years, many tidal and storm flooding events will shift from being minor inconveniences to more extensive disruptions, with increasing damage to coastal infrastructure, public and private property and posing a greater risk to public safety. Places such as Annapolis (MD), Dorchester County (MD) and Washington (DC) might experience more than 150 tidal floods per year (Spanger-Siegfried et al. 2014). Therefore, innovative approaches to prepare for, and minimize impacts of, SLR and storm inundation are a critical need.

Coastal wetlands help defend coastal communities from storm surge and SLR and mitigate coastline erosion. Coastal vegetation attempts to keep pace with SLR but relies on sediment accumulation and the availability of suitable uplands for its landward migration. From an ecological point of view, climate change, SLR and associated impacts will alter salinity distribution and stratification in the estuaries with a massive impact on the presence and productivity of estuarine environments and ecosystems.

The prospect of accelerated SLR and increased vulnerability of shorelines in the Chesapeake Bay emphasizes the urgent need for improving the scientific and engineering ability to predict its effects. This includes impacts on natural systems and human infrastructure. Advancing our understanding of the degree to which human assistance can effectively facilitate natural processes of sediment accretion, wetland migration, and other land use transitions will support cost-effective investments. In addition, new and innovative technologies must be refined and/or developed to protect and restore shoreline areas and to lessen the economic, social and environmental impacts of SLR in the future.

Over the past several decades, sediment generated from maintenance dredging activities of navigation channels have been beneficially used to nourish eroding shorelines, create wetland habitat, and restore and protect islands in the Chesapeake Bay. With few exceptions, these projects have been implemented in a limited fashion due to constraints in technology, spatial and temporal alignment of the restoration and dredging projects, site acceptability, cost and economy of scale, and due to environmental and regulatory concerns. As the issues of shoreline erosion and attendant impacts on the environment and infrastructure escalate with

projected increases in sea level, there is greater need to review current practices, technologies and opportunities to determine how sediment generated from dredging can be put to more practical use to address these problems.

Purpose

The Maryland Department of Transportation – Maryland Port Administration (MDOT-MPA) has long assumed a unique leadership role in developing innovative approaches to dredged material management as part of its dredging program for the Baltimore Harbor and Channel Project. These efforts have included large scale aquatic ecosystem restoration projects such as the Paul S. Sarbanes Environmental Restoration Project at Poplar Island. Other efforts have included upland containment facilities for dredged material from the Baltimore Harbor channels and the northern approach channels to the Chesapeake and Delaware Canal. Additionally, formation of a multi-stakeholder Innovative Reuse Committee to find new, innovative and acceptable methods for beneficially or innovatively reusing dredged material. Reuse of dredged material has received positive attention at the highest level within the State of Maryland government. Given this emphasis, and recognizing future risks associated with rising sea level in the Chesapeake Bay and impacts on the coastal environment and infrastructure, the MDOT-MPA initiated this workshop to explore if and how dredged material could be used to better address these risks in the future.

In 2017, Governor Hogan issued Executive Order 01.01.2017.13 that emphasizes waste reduction and resource recovery (State of Maryland, 2017). This Executive Order directed the Maryland Department of Environment to work with MDOT-MPA to develop technical screening criteria and guidance on the reuse of dredged materials which can be used in various applications by other state and local government and private agencies (Technical Screening Criteria and Guidance Document published August 2017 (MDE 2017)). These efforts lend support to the MDOT-MPA's ongoing efforts to find greater opportunities for the reuse of dredged material.

Given the expertise of MERC/UMCES, which conducts research and scientific inquiry of environmental components in the Chesapeake Bay and broadly on the global maritime industry, MDOT-MPA agreed to sponsor this workshop to explore the use of dredged material to protect low lying areas of the Chesapeake Bay. A workshop Steering Committee was organized to help plan and implement a workshop that would bring together the scientific community, all levels of government including resource agencies with a role in the Chesapeake's coastal areas and interested non-governmental organizations and other public and private stakeholders. In designing the workshop, it was acknowledged that other Federal and state agencies have already begun to address climate change, SLR, and coastal resiliency through a variety of programs. This workshop would provide a unique opportunity to build upon these efforts and provide for more targeted discussion regarding dredged material and Chesapeake Bay coastal erosion/SLR in a single, focused, forum. Recommendations from the workshop could be generated by its participants for further applied research, study, and implementation of programs and projects.

Goals

This one-and-a-half-day workshop in Annapolis, Maryland, on January 23rd, and 24th, 2019, brought together experts and stakeholders from the Chesapeake Bay region, United States and

the Netherlands, to address the following overall workshop goals:

(a) To gain a better understanding of the current state of science and technology in the use of dredged material to protect low-lying areas from SLR and storm surge;

(b) To better understand where sediment placement is occurring, volumes, characteristics of materials, and techniques for dredging;

(c) To develop a better understanding of impact trends and effectiveness of mitigation approaches in the coastal zone regarding erosion, habitat and living resources, commercial and recreational fisheries, navigation channels, water quality, flooding, and storm damage;

(d) To evaluate the variety of possible benefits and costs of using dredged materials to protect low lying areas facing SLR and increased storm frequency;

(e) To review ongoing efforts and programs that can be leveraged to locate and target, prioritize, and fund candidate sites for use of dredged material to protect these areas; and

(f) To recommend a strategy for future targeted research, development, and applied projects to improve the knowledge and application of current and new technologies.

ORGANIZATION AND STRUCTURE OF THE WORKSHOP

The workshop was structured to address four broad topical areas as follows:

- Topic A: Understanding the problems and areas of vulnerability in the Chesapeake Bay;
- Topic B: Current magnitude, type, and spatial extent of dredging activities and programs conducted in the Chesapeake Bay;
- Topic C: Exploring the state of technology and potential applications of dredged material to protect low-lying areas;
- Topic D: Understanding the range of benefits of, constraints on, and most promising opportunities for restoration and protection.

Each topical area was explored through eleven technical presentations delivered by experts in each area over the course of the workshop. A full listing of the presentations, including the name and affiliation of each presenter, can be found in Appendix A. Each presentation was followed by a short question and answer period. At the conclusion of the first day, the participants broke out into three facilitated groups to discuss and formulate responses to three charge questions relating to the day's topical sessions. On the final day, a facilitated recap and discussion of the proceeding day's results was followed by the final technical session. A final group discussion involving all of the participants concluded the workshop. A more detailed discussion of the technical sessions, group discussion, and final discussion is found in later sections of this report.

Dr. Mario Tamburri, UMCES Professor and Director of the MERC, kicked-off the workshop

by thanking attendees for their participation and broadly discussing the workshop goals and structure. Following self-introductions by all participants, Ms. Chris Correale, Director of Harbor Development at MDOT-MPA and Dr. Peter Goodwin, UMCES President, provided opening remarks.

Ms. Correale appealed to the participants to think creatively and share ideas throughout the workshop. She cited the importance of smart planning and coordinating across sectors facing coastal flooding, advanced erosion and increasingly severe storm events. She discussed MDOT-MPA's Dredged Material Management Plan (DMMP) comprised of many dredged material management solutions including projects that involve the beneficial use and innovative reuse of dredged material. She also reviewed the progress of the Port's Innovative Reuse Committee and its strategy for innovatively managing harbor sediments to enhance climate change resilience. Finally, she asked the participants to consider practical ways that sediment could be used as a resource, and be put to greater use to aid in the protection of low-lying areas of the Chesapeake Bay – providing benefits ranging from public health and safety, ecological restoration, habitat protection, and water quality while maintaining the safety and efficiency of the Port's navigation channels. She emphasized the need to better leverage resources to serve common interests in the future.

Dr. Peter Goodwin encouraged the multi-disciplinary participants of the conference to use their unique expertise and experience to work together during the workshop and focus on the workshop objectives. To provide further context for the workshop, he reviewed the physical and biological dynamics of tidal marsh and wetland evolution and the importance of restoring processes as opposed to specific places or locations. He also related the concept of "migration space" and the need to consider appropriate strategies on how to manage it. Finally, he cited the MDOT-MPA DMMP as a potential framework for innovation and called on the experience of Federal partners and others to help address the challenges associated with SLR and impacts to low-lying areas, noting the relatively long timelines required to not only develop projects, but to practically raise elevations in the Bay where needed.

Dr. Donald Boesch, UMCES Professor and former UMCES President, took the opportunity, due to his extensive knowledge and experience, to conduct the technical sessions with some over-arching remarks. Dr. Boesch emphasized the immediacy and urgency of SLR prompted by climate change and the need to avoid the unmanageable effects by focusing on zero global emissions. He cited the efforts of the Maryland Climate Change Commission and other state programs including the Coast Smart Program as providing opportunities to better position the region to address SLR issues. He acknowledged the need for decision-makers to be prepared to address significant SLR projections in the Chesapeake Bay including a 2-foot rise in sea level over the century that was likely in the absence of limiting global warming to 1.5 ^{0}C above pre-industrial levels per the recent Intergovernmental Panel on Climate Change (IPCC) assessment. He cited that traditional methods and the scale of solution sets that have been previously used to address coastal erosion issues must be substantially re-evaluated to address the dramatic and massive scale of the problem that the region will be facing in this century.

WORKSHOP SEGMENT SUMMARIES

TOPIC A: CURRENT UNDERSTANDING OF THE PROBLEMS AND AREAS OF VULNERABILITY IN THE CHESAPEAKE BAY

The primary objective of Topic A was to enhance the current understanding of the problems and areas of vulnerability in the Chesapeake Bay. Three presentations were delivered to introduce this topic:

- Coastline Management in Low-Lying Areas Affecting Tidal Range and Storm Surge Throughout the Chesapeake Bay, Ming Li (UMCES);
- Local Government Action on Climate Change in the Chesapeake Bay, Kristin Baja (Urban Sustainability Directors Network); and
- Areas of Vulnerability and Maryland Coast Resiliency Assessment, Jackie Specht (MD DNR).

Dr. Ming Li explored two coastal inundation scenarios which reflect two primary management techniques: softening shorelines using salt marshes and nourishment of beaches and hardening shorelines using seawalls, bulkheads and similar hard structures. Under the soft shoreline scenario, it was determined that storm tidal ranges decrease, with higher efficiency in energy dissipation and lower peak surges. Conversely, under the hard shoreline scenario, tidal ranges increase, there is slower dissipation of tidal energy due to greater depths, and storm surge height increases. Using a Regional Atmosphere Ocean Model which showed an intensification of storm under climate change, Dr. Li demonstrated these predictions at several Bay locations including Annapolis, Cambridge and Norfolk. He also concluded that using sediment to build shorelines in upstream low-lying areas would lessen storm surge by absorbing energy from tidal and storm surge currents. Several questions were posed by the participants regarding population and land use assumptions (the model was simplified), the impacts of slow-moving storms, and critical areas.

Ms. Kristin Baja's far ranging presentation focused on integrating climate change into resilience planning and a discussion of innovative techniques to better achieve resilience, particularly in urban settings. Ms. Baja defined resilience as: "The ability of our community to anticipate, accommodate, and positively adapt to or thrive amidst changing climate conditions or hazard events and enhance quality of life, reliable systems, economic vitality, and conservation of resources for present and future generations." She focused on innovative techniques emphasizing involvement of the community (citizen science), actions that serve multiple benefits, changes in regulatory codes (i.e., floodplain ordinances and green construction codes), changes in homeowner insurance plans and credit ranking, and integrating climate change features on buildings and streetscapes, among others. She cited dredged material as a resource with a variety of potential applications, including as fill material that can be used safely and in a manner that is protective of human health and the environment, and pointed out several issues and concerns of local government regarding the reuse of dredged material.

Ms. Jackie Specht reviewed the State of Maryland's Coastal Atlas including the Coastal Resiliency Assessment layer prepared by MD DNR to inform coastal conservation and restoration decisions. The Coastal Atlas provides a publicly available, on-line platform to

share spatial information. Features include a Natural Features Analysis, Community Flood Risk Analysis, Marsh Protection Potential Index, and identification of Priority Shoreline Areas for conservation and restoration actions. She further explained that this GIS-tool provides spatial information that can be used in the early stages of planning to identify where people and development are located along Maryland's shorelines, and where the hazards and risks zones exist. Shoreline priorities for natural solutions are identified. The Coastal Atlas is available at http://dnr.maryland.gov/ccs/coastalatlas/Pages/default.aspx.

Maryland's Coastal Resiliency Assessment is a landscape-level spatial analysis and modeling effort that identifies where natural habitats provide the greatest potential risk reduction for coastal communities. A beneficial use suitability model is incorporated to help locate beneficial use sites based on landform, distance from navigation channels, environmental impacts, and opportunities for enhancing coastal resilience. BUILD (Beneficial Use: Identifying Locations for Dredge), is an additional tool that will become publicly available as a layer on the Maryland Coastal Atlas. BUILD is populated with dredging and restoration projects and serves as an opportunity for spatially, temporally, and physically aligning the dredging and restoration projects. It includes information about the quality of sediment at the dredging location. Ms. Specht cautioned that BUILD was intended as a planning tool for use to screen potential locations and that additional site-specific analysis may be needed prior to selecting a location for a beneficial use project. Through further participant discussion, there was strong acknowledgement of the need to have more detailed information regarding sediment quality at both the placement location and from the source of dredged material.

TOPIC B: DREDGING AND PLACEMENT ACTIVITY IN THE CHESAPEAKE BAY

The intent of the presentations listed under Topic B was to provide workshop participants with an understanding of the scope of dredging and placement activities in the Chesapeake Bay. These activities are primarily conducted by the U.S. Army Corps of Engineers (USACE) and State of Maryland. In addition, these presentations provided examples of past and/or ongoing innovative placement activities to restore or protect shorelines. The presenters outlined the scope of dredging and material management solutions including annual volumes of material dredged, location of dredged channels, the nature of the dredged material, and dredged material placement practices. A spatial depiction of these activities was also provided. General observations were provided by the speakers on successes, hurdles, and/or barriers to using innovative placement practices. The following lists the presentation for this session:

- Baltimore Maintenance Dredging and Placement Program in Maryland, Danielle Szimanski (USACE, Baltimore District);
- Norfolk District Maintenance Dredging and Dredged Material Placement Program, Mike Anderson, (USACE, Norfolk District); and
- Waterways Improvement Fund, Isaac Wilding, (MD DNR).

Ms. Danielle Szimanski reviewed the Baltimore District dredging program. The Baltimore

District is responsible for performing channel maintenance dredging for about 87 miles of deep draft (50 ft.) channels and approximately 100 shallow draft projects. Of the latter, only a few projects are actually dredged based on budgeting priorities and navigation needs. Approximately 2 million cubic yards (mcy) per year of material is dredged from the Baltimore Harbor Approach Channels in the main Bay and placed at Poplar Island while approximately 1 mcy of material removed from the channel segments within the Baltimore Harbor is currently disposed of in upland dredged material containment facilities. Harbor channel maintenance material by law cannot be used in a beneficial use project outside of the Harbor (beyond the North Point – Rock Point line); however, a beneficial use project inside the Harbor utilizing Harbor channel material could be approved by MDE should the sediment quality meet appropriate screening criteria. Ms. Szimanski highlighted several beneficial use sites employed by the Baltimore District at Barren Island, Fishing Battery, Ocean City, Isle of Wight, Swan Island, among others. The Poplar Island Restoration site which accommodates the lion's share of the Port's dredged material (about 2 mcy/year on average) is used to create wetland and upland remote island habitat.

Mr. Mike Anderson reviewed the Norfolk District program which includes portions of the Baltimore Harbor and Channel Project in Virginia waters. Material from these segments are placed in open waters within the Bay and the Atlantic Ocean. Mr. Anderson reviewed the Norfolk District's plans to fund three hopper dredge projects and 11 cutters-head pipeline dredging projects in 2019. It was noted that many of these projects provide material to support coastal storm reduction projects, beach nourishment, and placement in upland sites. He indicated that the one of the primary challenges for the Norfolk District is to synchronize the dredging efforts of hopper dredging companies (few exist), while observing environmental dredging windows to ensure there is minimal risk to endangered species, and meeting commercial navigation needs. He cited pipeline projects at Lynnhaven Inlet, along the James River, Norfolk Harbor Channel and Rudee Inlet, among others. Mr. Anderson acknowledged that thin layer placement (TLP) had not been used at the Norfolk District. He also mentioned that a future study of the restoration at Tangier Island would evaluate a full range of methods for dredging and placement. Several technical questions were posed regarding dredging techniques.

Mr. Isaac Wilding reviewed the State of Maryland's shallow draft dredging efforts which are funded from the Waterway Improvement Fund that provides grants for dredging projects to Maryland counties and municipalities. These projects are managed by the recipient with oversight and review from the State of Maryland. Candidate projects are typically geared to meet residential boating needs and are therefore small in scope relative to Federal maintenance dredging projects. The program utilizes proximity to source and placement locations, material quality and quantity, and project timelines. The program priorities are mostly based upon reaction to public navigation issues (i.e., shoaling) and it is not always possible to identify viable beneficial use solutions given time constraints and need to resolve urgent navigation issues quickly. He acknowledged that a goal of the program was to become proactive so that more beneficial projects could be programmed in advance. At this time, projects have not included TLP however, MD-DNR is looking for these types of opportunities. Discussion points included the need to try to couple state vulnerable area identification with dredging projects (i.e., use of BUILD tool), the fact that these projects are adaptive and need to be looked at on a recurring basis (not "one and done"), the importance

of accepting risk with these projects insofar as willingness to "fail" and learn, and relatedness of similar efforts related to the Coastal Master Plan prepared in the Gulf states (https://thewaterinstitute.org/).

Also, of note in subsequent discussion was to use BUILD and other potential tools to find potential locations for shoreline restoration opportunities using dredged material, the need to find more applications to make better use of fine-grained material, as well as finding ways to make projects more constructible and cost-effective based on various sediment types. Lastly, there was general acknowledgement that while dredging is traditionally done to support navigation, it could also be conducted simply to serve sediment management needs, providing sediment as a resource and that restoration activities need to be integrated more broadly with sediment management plans. It was noted that construction (dredging activities) may be carbon intensive as it relates to air emissions and release of carbon from sediments.

TOPIC C: STATE OF TECHNOLOGY IN USE OF DREDGED MATERIAL TO PROTECT LOW-LYING AREAS

The objective of Topic C was to explore the state of technology in the use of dredged material to protect low-lying areas. To address this matter, four presentations were delivered from academic and private companies' perspectives. Use of dredged material from both coasts of the United States and a European practice from the Netherlands were presented.
The presentations for this session included:

- Wetland thin layer placement (TLP) as a tool for salt marsh maintenance and restoration: examples from across the US, Elizabeth Murray (USACE-ERDC);
- Ecological implications of habitat restoration with dredged material in Chesapeake Bay: Experiences from Poplar Island, Lorie Staver (UMCES);
- Lessons learned from dredging pilots in the Netherlands, Bram van Prooijen (TU-Delft, the Netherlands); and
- Challenges and successes using dredge sediment in the San Francisco Bay area, James Levine (Montezuma Wetlands).

Ms. Elizabeth Murray reviewed the recent technology on wetland TLP as a tool for salt marsh maintenance and restoration. She showed and discussed different examples from across the US from San Francisco Bay to the Gulf of Mexico. Salt marsh dynamics are not keeping up with SLR which implies disturbance of natural processes, altering morphology and functioning of salt marshes, compromising the ability of marshes to keep up with SLR. These issues drive the question "what can we do?" Actual interventions include allow the marsh to translocate, restore connections to sediments supply (if they've been interrupted), raise marsh platform elevation or expand marsh platforms. Marshes provide storm protection to communities, so there may not be enough space for translocation. Reconnecting natural sediment sources can disrupt important infrastructure, such as dams and levees, and isn't always possible. Elevating or expanding the marsh plain *in situ* requires sediment.

A new opportunity involves the TLP of dredged sediment, which provides an opportunity for purposeful placement of sediment in an environmentally acceptable manner to maintain or

restore ecological functions. There are still challenges for the practice such as perceptions and misperceptions in the regulatory community about TLP, e.g. the blanket of snow theory – the assumption that sediment deposition is homogenous in depth and grain size across the marsh plane. The presentation addressed multiple aspects of this new technique from the sediment characteristics to the amount of sediment to place on the marsh. Once the sediment is placed in the marsh, the monitoring has been comprehensive across physical, chemical and biological functions to learn about effectiveness and conduct adaptive management.

Another aspect presented by Ms. Murray was the need to better understand the volume of material that should be placed on the marsh and considerations for developing target elevations – upper intertidal range, goals for restoration, SLR rate, vegetation type, as well as the education process regarding the biology and physics about how it happens.

During the discussion, two main questions were raised by the audience: Once the TLP has been completed, how is sediment retained in place, and how is it monitored? The response given was that typically TLP areas will need sediment transport control measures during placement, which can be complicated in waters used for navigation. Other questions raised regarding marsh recovery: Will recovery time in east/west coast marshes be similar to Gulf Coast marshes? Are there unexpected impacts affecting recovery time? Ongoing monitoring at pilot projects should help fill some of these data gaps, especially regarding understanding the recovery of elevation, sediment dynamics, carbon sequestration, and flora and fauna. Successful outcomes depend on goals set and a risk analysis of the amount of material placed. Small placements may have shorter temporary impacts, but also do less to secure the long-term resilience of a marsh, whereas in some areas, larger placements may take longer to recover from, but do more to help the marsh long-term. There are costs both for acting, but also risks in being overly cautious or doing nothing.

Dr. Lorie Staver presented the ecological implications of habitat restoration with dredged material in Poplar Island, Maryland. Marshes have been restored for over 40 years using dredged material, but many of the strategies and expectations were developed using sandy substrate. Restoration success can depend on substrates used, and this needs to be considered when formulating methods and expectations. At Poplar Island and some other coastal and estuarine sites, fine-grained material which has higher nutrient availability is being used, and outcomes and timelines using this type of material are different compared to using coarser material.

The restoration project at Poplar Island uses Chesapeake Bay dredged material that contains high levels of pyrite which was originally a concern due to low pH. Ultimately, this was not a problem in the tidal marshes, but the initially high concentrations of ammonium (NH_4^+) had a major impact on plant growth and morphology, health and trophic dynamics. Marshes constructed with fine-grained dredged material can experience negative effects including low root-shoot ratio (RSR), increased rates of fungal infection and grazing pressure, and sudden vegetation dieback. These effects are expected to decline over time as nitrogen (N) becomes more limited due to plant uptake, denitrification and export. In the short term, these effects have potential implications for the marsh response to SLR. Marshes can respond to SLR via transgression (migration toward uplands through rhizome growth and/or seeding) or vertical accretion (inorganic deposition during flooding, organic deposition from plant production).

When transgression is limited, vertical accretion is the only means of adjusting to SLR. Dr. Staver discussed the design implications for using fine-grained dredged sediment with high nutrient availability. The substrate characteristics should be considered in the restoration design and management. In high nutrient systems where RSR is low, the system needs features to reduce exposure and retain biomass. Although higher RSR is usually considered better for marsh carbon sequestration, features at Poplar Island (e.g. dikes and inlet structures) which help retain plant biomass have resulted in marshes that are keeping up with SLR. In addition, these compact sediments require grading that promotes surface drainage to prevent ponding and vegetation losses.

Dr. Bram van Prooijen added an international point of view with examples of pilot projects in the Netherlands using dredged material. These included: the "Sand Motor" (often referred to as a sand engine), a large sand nourishment on a sandy beach; and the "Mud Motor", a strategic disposal of fines to feed mudflats and initialize saltmarshes. In general, a Sand Motor is one method to manage a dynamic coastline by placing material in one location, usually close to or adjacent to shoreline, and then allowing movement of the material along the coastline by wind and waves. This can reduce the potential for continual and repetitive replacement of material. The Sand Motor is considered a success as it is part of the coastal defense system, but also provides ecosystem services and recreational services. Furthermore, its vast dimensions and large number of involved and supportive parties made it "too big to fail".

The Mud Motor is based on the momentum created with the "Sand Motor", and consists of relocating mud to reduce harbor siltation, protect the foreshore, and turn bare mudflats into salt marshes by removing fine sediment from channel and placing it on the mudflat. To optimize the mud displacement, it is important to understand the interaction between tides, wind and waves on sediment transport. There are marshes in the area that provide propagules, however, the goals of the project were not yet met after a year:

- No significant reduction in dredging volume;
- No substantial increase in bed level on the mudflat; and
- No new salt marshes.

Most participants were however already satisfied, because:

- Port is creating nature instead of dumping in world heritage area;
- Vegetation started developing;
- More attention for safety with living shorelines;
- More insight into system dynamics; and
- Innovation in the region.

Both the Sand Motor and the Mud Motor rely on coastal processes (tides, waves, wind) to redistribute the sediment. Furthermore, they both aim to combine different functions.

- Sand motor: coastal safety, recreation, ecology
- Mud motor: dredging reduction, ecology, coastal safety

Mr. James Levine concluded the session by presenting challenges and successes of using dredged sediment in the San Francisco Bay area with a focus on the beneficial reuse of dredged material since mid-1990s, which has resulted in making dredging less controversial and more environmentally friendly.

The first project started with the Port of Oakland and US Army Corps of Engineers (USACE) deepening projects, followed by three major habitat projects: Montezuma wetlands, Hamilton airfield and Middle Harbor habitat enhancement. These projects gained environmental support, led to federal and state funding to support dredging activities, and streamlined the permitting process. Mr. Levine overcame technical, operational, regulatory and policy challenges and developed innovative dewatering systems. He summarized several projects:

- Sonoma Baylands and USACE demonstration project - characterized by shallow access, sensitive habitat needs proposed tidal connection. The project used 1.9 mcy to restore 320 acres of wetlands.
- Galbraith - used 1 mcy of dredged material to fill a municipal landfill and turn it into a golf course. Additionally, ponds were designed to achieve low total suspended solids in discharge.
- Hamilton Wetlands Project - a Federal and State of California project, which was initially costly, but efficiencies were realized over time through the reuse of dredged material. The project required filling low-lying areas with dredged sediment to protect from SLR and restore tidal habitats, but it was difficult and expensive to fill a site with no deep-water access. This project successfully capped residual contaminants from a previous military operation. The post-fill monitoring data is pending.
- Middle Harbor Project - involved a shallow in-bay fill with sediments of differing grain sizes and the first results are early habitat success with eelgrass, more habitat work is planned in the future.
- Montezuma Wetlands Project - is an initial multi-user upland sediment reuse site in San Francisco Bay area. The project will involve layering sediment which helps to isolate contaminants from the aquatic system through nitrogen transformation. This project is an alternative to ocean disposal of cover and non-cover sediment. Phase 1 of the Restoration is almost complete (600 acres) and it helped to develop a sediment regulatory criterion based on geochemistry and where the sediment is placed. The site infrastructure costs are being managed relative to disposal volumes, levees, and working on soft soil. Monitoring data has shown effective isolation of contaminants and habitat improvements.

The California experience can support Chesapeake Bay efforts through suggestions on permitting strategies, sediment regulatory criteria, long term management and financial assurance and integrating dredging project sequencing with reuse site management.

TOPIC D: UNDERSTANDING THE IMPACTS, CONSTRAINTS AND OPPORTUNITIES FOR RESTORATION AND PROTECTION OF LOW-LYING AREAS

This session explored techniques and considerations for evaluating the true costs and range of benefits that are possible for coastal risk reduction projects. The topic included implications of approaches to project justification and effects on public support and acceptance. As shoreline restoration projects using dredged material are proposed as a tool for coastal resiliency, the public and decision makers will want to understand their value and why investing in these projects are worthwhile from economic, social, and environmental

viewpoints. Furthermore, practitioners need to understand the regulatory complexities associated with project timelines and viability to promote sound project design and successful restoration. This session explored these issues through three interactive presentations:

- Dredging the Sand Commons – Costs and Benefits of Coastal Risk Reduction, Sathya Gopalakrishnan (OSU);
- Maryland Regulations and Guidance for Innovative Reuse and Beneficial Use of Dredged Material, Matt Rowe (MDE); and
- Economic Evaluation of Shoreline Protection Projects: Net Ecosystem Service Analysis, Scott McLaughlin and Mark Rockel (Northgate Environmental).

Dr. Sathya Gopalakrishnan explored what can be learned from evaluating environmental risks and benefits based on people's behaviors and how housing markets can provide useful feedback on changes in coastal environments. Using some case examples of areas impacted by Hurricane Sandy in the northeast United States, she discussed how residential homes on nourished beaches received a premium in market value (in one case 20%) for risk mitigation versus a drop-in housing values in storm-front regions without nourishment. She went on to explain how public policy responds to coastal risk and changes in markets, cited the interplay between market values and decisions regarding how often to rebuild, where to invest, how far out from shoreline to extend profiles and even, changes in investment decisions in adjacent communities subject to flood/erosion risk and adjacent to re-nourishment projects. She cited these spatial-dynamic interactions as being potentially important to the effectiveness of beach nourishment efforts along impacted shorelines. She discussed the importance of the need to regard sand as a capital resource and the need to think of innovative ways to pay for this resource. Finally, she cited climate change as an important factor in changing how markets are valuated.

Mr. Matt Rowe, in his role as Assistant Director, Water and Science Administration, Maryland Department of Environment (MDE), first reviewed the context for MDE's regulatory role with respect to water indicating that dredging and fill activities were regulated under the Section 404 of the Clean Water Act and the joint Federal/State permit process for Maryland waters. The focus of this presentation was on the dredged material guidance document and technical screening criteria published by MDE in August 2017, (https://mde.maryland.gov/programs/marylander/pages/dredging.aspx). MDE developed this guidance in close coordination with MDOT-MPA and many of its stakeholders related to the DMMP. The purpose of the effort was to address regulatory barriers regarding innovative use of dredged material which the guidance document helps to clarify and facilitate those seeking state permit approvals. The new guidance clarifies the MDE decision-making process for characterizing dredged material based on human health risk-based categories. The intent of the guidance is to provide more utility and flexibility and could be useful in the future for applicants seeking to reuse dredged material. Challenges include economies of scale for projects to be viable, identifying and prioritizing sites for innovative or beneficial use, cost of transporting material, and the need for more pilots, partners, education and outreach and incentives. He cited Maryland policy that living shorelines be considered the preferred practice for restoring damaged shoreline. He further indicated that lack of adequate mapping had been an impediment in granting living shoreline permits and getting these projects constructed and that if tools were available to do this, it would help streamline permitting and

enable permittees to develop better "purpose and need" statements in their permit applications. Mr. Rowe indicated that translocating sediments to an improved condition would not likely pose an obstacle to permitting with respect to Total Maximum Daily Load compliance.

Messrs. Scott McLaughlin and Mark Rockel presented a Net Ecosystem Service Analysis Framework that balances environmental, social, and economic issues. They defined ecosystem services as benefits people obtain from naturally functioning ecosystems and discussed using cost benefit analysis and assessment with quantifiable metrics to maximize the positive difference between benefits and costs. This approach, which is modeled after the Natural Resources Damage Assessment (NRDA), incorporates ecological services and human use (direct consumptive) and indirect passive or non-consumptive use. The presenters asserted that challenges of dredged sediment reuse projects (including local government support) could be more easily met by using this approach to show the wide range of potential positive and negative effects. They provided case studies for employing this technique in the Gulf of Mexico to support British Petroleum (BP) in which they compared costs and erosion reduction and other benefits of planting marsh habitat. They concluded that this approach improves measurement of environmental resource values, uses government accepted valuation methods, and accounts for difficult to measure monetary values in a consistent manner. It could even be used to quantify the effect of a "guided retreat" decision.

BREAKOUT GROUPS DISCUSSION

To stimulate group interaction and synergy of ideas from the workshop participants, breakout groups were organized during the afternoon session of the first day. Participants were asked to reflect on the technical sessions presented thus far and to answer the following three charge questions:

1) What should be the priorities for addressing SLR using dredged material along the Bay's shoreline and what areas can benefit the most from dredged material placement projects?

2) What type of dredged material reuse approaches show the most promise in the short-term (over the next 2 to 3 years) and in what circumstances can they be applied? What additional information and/or research is needed to implement these approaches?

3) How should we measure success and what criteria should be used to evaluate proposed projects?

The ideas generated by the breakout groups were reviewed, regrouped, summarized, and recast as presented in the list (Table 1) below. Mr. Robert Pace (EcoLogix Group) led a facilitated discussion of these ideas and solicited further input and discussion by the workshop participants.

Table 1. Summary of Results from Breakout Sessions

1. Existing screening tools should be used to help identify high priority restoration areas. The Maryland DNR's Coastal Resiliency Assessment was cited as one possible tool for screening although it was recommended that other tools be researched and identified. Regardless of the tool ultimately used, a case-by-case evaluation of existing site conditions using multiple criteria is needed prior to actual site restoration using dredged material.

2. **Multiple and diverse restoration, protection, and conservation strategies may be appropriate to meet different needs and site conditions** (one size does not fit all). While many of the workshop examples cited techniques such as TLP, wetlands restoration, and island restoration as potential techniques and applications for using dredged material, it was recognized that raising infrastructure and other forms of infrastructure protection may play an important role in protecting shorelines and shoreline development. The workshop attendees generally agreed that all strategies require consideration.

3. **Time frames:** A longer time horizon of more than 3-5 years will be required to demonstrate success. Given the time involved to identify potential projects, garner support, secure funding, implement, assess, and monitor performance, the consensus was that it would be difficult to implement projects and demonstrate results in less than a three-year time frame. The workshop participants did not offer shorter term alternatives, however, consideration of shorter-term solutions to demonstrate success should be taken up further by a working group.

4. **A common decision framework involving multiple criteria** is needed to help prioritize and ultimately select coastal restoration sites. The participants discussed that technical, economic, regulatory, environmental, social, and public acceptability factors are needed to determine which sites deserve attention and might have the highest chance of success. A decision framework for site selection should involve multiple criteria rather than using one that results in site selection based purely on technical, engineering merit, or other singular criteria.

5. **Benefits:** Multiple benefits including economic, ecosystem and social should be used to demonstrate value of restoring and choosing a particular site and the associated restoration/protection technique. The workshop participants recognized that to garner public support and funding for these projects, it is critical to demonstrate value. All benefits that derive from implementing restoration versus not acting should be considered, documented, and used to justify action.

6. **Short and long-term monitoring is essential.** Sharing their considerable institutional experience with environmental restoration and shore protection, many participants expressed concern regarding difficulty in securing funding to monitor the long-term performance of projects. Participants cited the importance of both short and long-term monitoring to measure project success and to enable effective adaptive management of projects during their project life. They indicated that long-term funding is often neglected or uncertain and stressed the importance of securing assurances for funding over time to conduct monitoring as an integral part of each project.

7. There was a need and interest regarding **sediment as a resource**, a need to get a better understanding of sediment transport, how to keep it in place, and **Regional Sediment Management tools or models** to better understand the systems and support decision-making.

8. Strong support for **pilot projects**. Carefully planned and implemented program needed.

9. **Public engagement and outreach needed** to better educate public of the value of these projects. Need high visibility projects and greater acceptance and visible endorsement by elected officials and leaders when projects are completed and successful.

10. **Risk management:** Participants recognized that implementation of new and emerging techniques to restore shorelines using dredged material entails risk. These risks manifest themselves as uncertain in whether the actions fully produce the results intended over the long-term, and if they produce unintended consequences. In some cases, it was acknowledged, failure is possible. It was further discussed that the risk of "no action" is generally not acceptable versus accepting some risk in taking an action that may have uncertain results. The consensus was that these risks need to be identified, communicated to the public, and managed so that over time they can be further minimized to assure higher success rates.

11. **Build partnerships:** Participants recognized that expertise and resources are potentially available through a variety of local, state, federal, non-profit and private entities. Over 30 different organization entities were represented at the workshop and scores of others that could potentially lend expertise and/or resources to shoreline protection and restoration projects are available. The workshop attendees stressed that leveraging capabilities, skills, knowledge, and resources will be essential for garnering support and maximizing success in addressing the issue of shoreline erosion and protection in the Chesapeake Bay.

The workshop attendees offered the following additional observations regarding the summary points and breakout sessions:

- Some members expressed the importance to resist "recreating the wheel" and urged that follow-up actions build upon prior experience. It was suggested that existing projects be first reviewed to evaluate their effectiveness and that an assessment of benefits was needed prior to undertaking new pilots or other projects.

- Beyond the technical aspects of shoreline restoration projects, it was generally agreed that a common and clear vision is needed that is broadly understood and that garners public support and investments for using dredged material for shoreline restoration and protection. It was further emphasized that it will be necessary for those in leadership and with public policy roles, as well as in government and capital project financing, to get strongly and publicly behind these projects if they are to be successful. It was emphasized that bold action will be needed to promote these projects, particularly if they are implemented on a large scale. Further, it was suggested that elected officials and leaders be visible to the public in promoting these projects and make strong public statements of support and endorse legislation that could provide funding. The cost of shoreline protection projects may increase over

time as regulatory requirements change, therefore regulatory streamlining was cited as important to facilitate and expedite project implementation.

- Dr. Boesch offered in-depth remarks and an appeal for more innovative and transformative approaches to plan for future coastal inundation and shoreline erosion in the Chesapeake Bay. He stated that future planning must be unconstrained from past models, traditional assumptions, conservative institutional thinking, and self-imposed limits. A fresh and unconstrained projection of the future "without" condition is needed so that all planners and decision-makers will have a more accurate forecast of what the future conditions in the absence of taking any action. For example, in 50 years will Blackwater Wildlife Refuge area have completely disappeared? Will certain infrastructure in our coastal areas including cities and communities be regularly impacted and/or overtaken by tidal waters? Dr. Boesch stressed that a fundamental paradigm shift in how planners and decision-makers view the future under SLR is urgently needed to successfully address the exceptional magnitude and severity of the problems that the Chesapeake region will face in the coming decades. He further suggested that this paradigm shift is needed to drive dynamic and innovative solutions of sufficient scope and scale to successfully address these unprecedented issues.

FINAL GROUP DISCUSSION

The final session of the workshop was a group discussion among all workshop participants. The session was led by Mario Tamburri (MERC-UMCES) and William Nardin (UMCES) and was initially designed to answer the following two charge questions identified in the workshop agenda:

1) What are the barriers and constraints (technology, legal, institutional, economic, etc.) for using dredged material to protect low lying areas of the Chesapeake Bay and how can they be overcome?

2) What ongoing efforts and programs that can be leveraged to locate and target, prioritize, and fund candidate sites for use of dredged material to protect these areas?

While these questions were considered a worthy initial charge, Chris Correale (MDOT-MPA) offered an alternate set of charge questions for consideration by the workshop attendees. These were formulated to better reflect the earlier workshop discussion and that of the breakout groups and to better direct future discussion and action items. The workshop attendees agreed that the workshop would be served better by addressing these more fundamental questions before deciding on a specific course of action and follow-up. The following new charge questions were posed and accepted by the participants as the basis for the group discussion for the remaining portion of the workshop:

- What is the outcome that we are we trying to achieve? Related to this, what does Maryland want?
- What methods do we need to achieve that outcome?

The group discussion that followed focused on the two questions posed. A detailed recording of ideas generated in this discussion is provided in Appendix B.

Over-Arching Workshop Themes

The ideas, suggestions, and recommendations made by participants throughout the workshop and further prompted by the charge questions during the concluding session were diverse and far-ranging, reflecting a high level of interest, enthusiasm, and sense of commitment to take further action. There was broad acknowledgment that the workshop provided solid foundational ideas and momentum to build a more detailed plan and potential implementation strategy. It was further recognized that not all issues could be addressed nor all questions answered over the course of the one-and-a-half-day workshop; various presentations and discussions, prompted a strong consensus that further dialogue, exchange and refinement of ideas, and development of follow-up actions that go beyond the foundational ideas generated from the workshop are needed.

The following over-arching themes discussed below further build upon and synthesize the ideas generated during the workshop question and answer sessions, group breakout sessions and the concluding group discussion:

- While the impetus for the workshop centered on use of dredged material to address shoreline erosion issues in the Bay, it was widely recognized that the **eroding shorelines from SLR must be addressed using multiple approaches that go beyond use of dredged material.** Given the immense scope and scale of the problem, there was general recognition that finding solutions to eroding and inundated Bay shorelines should not be constrained to those involving dredged material and should consider the full range of potential technical, social, and environmental solutions. Application of dredged material to restore and protect shorelines represents one tool among many that are collectively needed to address this issue.
- **Sustainable, resilient, and adaptive shorelines to SLR** should be sought after in design of future shoreline restoration and protection. This incorporates recognition that projects do not provide a static nor one-time solution but must be adaptive with flexibility for modification over time. Extensive monitoring is needed to measure performance and support adaptive management to changing conditions.
- **Sediment must be regarded as a valuable resource and carefully preserved in the Chesapeake Bay.** Increased effort is needed to conserve sediment in the Bay rather than employing methods to get rid of it (disposal) because diminution of sediment sources reduces the potential for shoreline protection and stabilization, and particularly, under SLR scenarios. Companion to this idea is the need to get a better understanding of bay-wide sediment transport, how to keep sediment in place, and need for a Regional Sediment Management framework to support decision-making. Examples of the Netherlands "Sand and Mud Motor" concepts which were presented at the workshop are relevant to this viewpoint. In many ways, the concept of

conserving sediment in the Bay runs counter to long-term efforts and programs to reduce Bay sediments to meet water quality standards (i.e., Total Maximum Daily Load).

- **Large-scale solutions are needed to tackle the immense problem that the region will face in the coming decades.** There was general consensus that present day models, frameworks, and solutions for dealing with shoreline loss from erosion will not be adequate to address the future magnitude of a problem that most have not adequately envisioned nor accepted (i.e., no more Blackwater National Wildlife Refuge, highways and other infrastructure inundated, areas regularly flooded, etc.). A review of ongoing restoration and protection efforts is needed to determine what efforts should be retained and/or abandoned under a new framework.
- **Advanced and unconstrained problem-solving is needed to address shoreline restoration and protection in the future.** This should include forecasting the "without" or "no action" condition so that the full range of future shoreline conditions can be predicted as accurately as possible. All planning should be done in a new and unconstrained framework to get to the right type, scale, and extent of solutions needed rather than by traditional and more constrained planning which will result in relatively small-scale fixes with little large-scale impact. More appropriate mechanisms for valuing a full range of benefits must be used to judge investments. While smaller-scale solutions and investments have their place in addressing present day site-specific problems, regional solutions should be concurrently considered to address looming large-scale problems.
- **Proof of success is needed to positively influence state and federal policies and secure buy-in** from high-level elected officials who can influence budgetary decision-making. Public engagement will be key to securing citizen, corporate, and government support. Smaller scale projects can help demonstrate success and garner support for future large-scale efforts.
- **Existing tools should be considered to map and evaluate vulnerable shorelines and help identify opportunities for restoration and protection.** All available tools should be evaluated for application and those appropriate chosen to map out/screen vulnerabilities and identify opportunities.
- Future planning and implementation need to be done in **close and strong coordination with efforts in the Virginia portion of the Bay.** Comprehensive solutions will require addressing sediment transport issues that transcend jurisdictional boundaries.

Recommendations

The preceding sections present a range of discussion points, observations, and over-arching themes developed during the workshop. These were a product of informative technical presentations, and energetic discussion and idea-sharing, which was further elevated by healthy challenges to current assumptions and knowledge regarding SLR and shoreline vulnerability in the Chesapeake Bay. These discussions also reflect the diverse viewpoints, perspective, experience, and roles of the various workshop attendees who represent an array of researchers, practitioners, and stakeholders from within and outside of the Chesapeake Bay

region. Not all questions raised by participants were thoroughly answered and most of the topics beg further dissection and discussion. Participants generally agreed however, that the workshop provided an excellent opportunity to initiate detailed discussion and development of a strategy on the potential use of dredged material to address the problem of shoreline erosion and inundation by rising seas in the Chesapeake Bay. In fact, the workshop facilitated a more expansive discussion of sediment management and its role in addressing this important regional issue.

The following four major recommendations are provided for follow-up to the workshop:

1. **Working Group:** A working group should be assembled to follow-up on implementing the recommendations of the workshop and to provide a mechanism for ongoing dialog and action on this subject. Existing groups should be explored as a vehicle for this group effort in addition to the potential of forming a new group.

2. **Web-Tool for Information Sharing:** A web-based public information repository and mechanism for information sharing should be established to support future collaboration and engagement of workshop participants and interested others. MERC/UMCES has offered to develop this platform.

3. **Pilot Projects:** Identify and implement in the near-term (2-3 years) pilot projects to demonstrate replicable technologies and approaches to restore and protect shorelines vulnerable to sea-level rise using dredged material. Projects with the potential for scaling up should be given greatest priority.

4. **Regional Strategy:** Concurrent to the development of pilot projects using dredged material, a regional strategy should be developed that integrates large-scale regional sediment management that focuses on conserving and managing sediment as a resource within the Chesapeake Bay.

Appendix A – Workshop Agenda

Use of Dredged Material to Protect Low-Lying Areas of the Chesapeake Bay

Day 1 - January 23, 2019
Annapolis Ballroom, Westin Hotel, Annapolis, MD

8:30 am Coffee and continental breakfast

Overview and background

9:00 am Workshop Outline and Objectives, Participant Introductions: Tamburri (UMCES)

9:15 am Welcome: Chris Correale (MPA)

9:25 am Opening Remarks: Peter Goodwin (UMCES)

Topic A: Current Understanding of the Problems and Areas of Vulnerability in the Chesapeake Bay - Facilitator, Don Boesch (UMCES)

9:40 am Presentation: Coastline management in low-lying areas affecting tidal range and storm surge throughout Chesapeake Bay - Ming Li (UMCES)

9:55 am Q&A

10:00 am Presentation: Local Government Action on Climate Change in the Chesapeake Bay - Kristin Baja (Urban Sustainability Directors Network)

10:15 am Q&A

10:20 am Presentation: Areas of Vulnerability and Maryland Coastal Resiliency Assessment - Jackie Specht (MD DNR)

10:35 am Q&A

10:40 am Break

Topic B: Dredging and Placement Activity in the Chesapeake Bay - Facilitator, Robert Pace (Ecologix)

11:00 am Presentation: Baltimore Maintenance Dredging and Placement Program (Maryland) - Danielle Szimanski (USACE)

11:15 am Q&A

11:20 am Presentation: Norfolk District Maintenance Dredging and Dredged Material Placement Program (Virginia) - Mike Anderson (USACE)

11:35 am	Q&A
10:40 am	Waterway Improvement Fund - Isaac Wilding (MD DNR)
11:55 am	Q&A
12:00 pm	Group Discussion: Chesapeake Bay areas of vulnerability and ongoing dredge placement efforts.
12:30 pm	Lunch

Topic C**: **State of Technology in Use of Dredged Material to Protect Low-lying Areas - Facilitator, William Nardin (UMCES)

1:30 pm	Presentation: Wetland thin layer placement (TLP) as a tool for salt marsh maintenance and restoration: Examples from across the U.S. - Elizabeth Murray (USACE-ERDC)
1:45 pm	Q&A
1:50 pm	Presentation: Restoration project in Chesapeake Bay: Poplar Island experience and monitoring - Lorie Staver (UMCES)
2:05 pm	Q&A
2:10 pm	Presentation: Lessons learned from dredging pilots in the Netherlands - Bram Van Prooijen (TU-Delft)
2:25 pm	Q&A
2:30 pm	Challenges and successes using dredge sediment in the SF Bay area - Jim Levine (Montezuma Wetlands)
2:45 pm	Q&A
2:50 pm	Three breakout groups to discuss and answer the following charge questions: 1) What should be the priorities for addressing sea rise using dredged material along the Bay's shoreline and what areas can benefit the most from dredged material placement projects? 2) What type of dredged material reuse approach(es) show the most promise in the short-term (over the next 3 to 5 years) and in what circumstances can they be applied? What additional information and/or research is needed to implement these approaches? 3) How should we measure success and what criteria should be used to evaluate proposed projects?
4:00 pm	Break

4:15 pm	Reports from Breakout Groups and Review of Day 1 - Facilitator, Mario Tamburri (UMCES)
5:00 pm	Adjourn

Informal group dinner for those interested (Rams Head Tavern www.ramsheadtavern.com)

Day 2 - January 24, 2019
Annapolis Ballroom, Westin Hotel, Annapolis, MD

8:30 am	Coffee and continental breakfast
9:00 am	Review of Day 1 and Goals of Day 2 - Facilitator, Robert Pace (Ecologix)

Topic D: Understanding the Impacts, Constraints and Opportunities for Restoration and Protection of Low-Lying Areas - Facilitator, Lisa Wainger (UMCES)

9:10 am	Presentation: Dredging the sand commons: costs and benefits of coastal risk reduction - Sathya Gopalakrishnan (Ohio State University)
9:25 am	Q&A
9:30 am	Presentation: Maryland's Regulations and Guidance for Innovative Re-use and Beneficial Use of Dredged Material - Matt Rowe (MDE)
9:45 am	Q&A
9:50 am	Presentation: Economic Evaluation of Shoreline Protection Projects: Net Ecosystem Service Analysis - Scott McLaughlin and Mark Rockel (Northgate)
10:05 am	Q&A
10:10 am	Break
10:25 am	Group discussions to answer the following charge questions: 1) What are the barriers and constraints (technology, legal, institutional, economic, etc.) for using dredged material to protect low lying areas of the Chesapeake Bay and how can they be overcome? 2) What ongoing efforts and programs that can be leveraged to locate and target, prioritize, and fund candidate sites for use of dredged material to protect these areas?
11:30 am	Consensus on conclusions, recommendations and next steps
12:00 p.m.	Lunch and Adjourn

Appendix B – List of Ideas Offered During Summary Discussion on Day 2

- Need to establish a clear vision of the future and future conditions.
- Need to implement real world projects that address the vision involving all stakeholders.
- Establish priorities using existing data and tools.
- Evaluate existing pilot projects and integrate the knowledge of these in moving forward.
- Influence state and federal policies by building strong support and buy-in by elected officials and decision-makers.
- Coastal vulnerabilities and opportunities need to be mapped out at a regional scale, considering existing tools, and determining if other tools are needed.
- Sediment should be regarded as a resource and protected. Increased focus and attention are needed to keep "clean" sediment in the system and to use these sediments (dredged material or other sediment part of the natural sediment transport processes) to enhance and protect Maryland shorelines.
- Connect and coordinate efforts in Virginia and leverage joint efforts. Chesapeake sediment issues are part of a system that transcends jurisdictional boundaries.
- Change paradigm in thinking of future needs. Consider enormous scale and challenges and unconstrained planning and action plans to address them.
- Solutions must be sustainable and adaptable.
- Need to consider assets and liabilities.
- Consider using Urban Sustainability Directors Network as a framework for establishing resilience.
- To meet continuing needs for information sharing and to provide a central repository for workshop-related information and ideas, MERC-UMCES volunteered to create a website as a platform for exchange of ideas and for further stakeholder collaboration.
- There is a need for follow-up from this workshop, to build upon and refine the ideas generated from it, and to develop courses of action. A working group should assemble to accomplish this. There was discussion regarding the need to consider existing groups as a vehicle rather than form a new group. The Chesapeake Bay Foundation offered to host the next meeting to help further define next steps and identify a future working group. As part of this effort, its consideration must be given on how to target and engage a diverse set of stakeholders.

Appendix C - Steering Committee and Participants

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REPORT COMMENTS

A draft of this workshop report was circulated among the steering committee and all participants, to solicit comments and edits. Comments were received from several participants. Many of the editorial, clarifying, and technical comments were addressed and incorporated in the Final Report. In addition, a few commenters chose to provide some broad and reflective comments in their transmittal correspondence. In order to preserve that record of this input for future use and reference, those comments are reproduced below.

Comment regarding pilot projects:
"Given the vast amount of international knowledge, pilot programs are less necessary. If a pilot program is deemed appropriate, those that can be scaled up quickly should take precedence."

Overall workshop and report comments:

- Evaluate and compare current pilot projects – potentially creating an overarching program
- Highlight current success stories and propose additional small and large steps needed to continue growth
- Develop an overarching program beginning with a new working group and website

"I was positively surprised by all ongoing projects, initiatives and innovations to re-use dredged sediment. I did not have this overview and I had the impression that many participants did not know about all initiatives either. Evaluating these pilot projects and comparing them with other pilots in other states (or even outside the US) would be very insightful. It provides the opportunity to make an overarching program, instead of stand-alone pilots. We can learn from the mistakes and roll out successful concepts."

"The workshop also made clear that there is a serious problem approaching. The drowning of marshes and the safety against flooding is at stake. Action is needed now. The re-use of sediment can be part of the solution, but it cannot be the only measure. As indicated in the report, a regional sediment management strategy is required. This should possibly not even be limited to the State of Maryland. It is advised to evaluate such strategies of other systems in the US and Europe and tailor it to the Chesapeake Bay system."

"In my opinion, the first three recommendations should not be seen as a goal in itself, but as the means to reach the most important recommendation, a Regional Sediment Strategy. The working group and website are useful platforms to evaluate and start new projects (going beyond the stage of pilot projects). Projects will be even more valuable if they are embedded in a large-scale program. In addition to a web-tool for sharing data, a digital platform could also be used to show the results to the public. Public awareness and participation are essential. The Regional Sediment Strategy, where the sediment is considered as a resource instead of a waste, should provide the framework for future decisions. Building and embedding such a strategy takes time and should start immediately."

LIST OF ACRONYMS

BP – British Petroleum

BUILD – Beneficial Use: Identifying Locations for Dredge

DMMP – Dredged Material Management Plan

ERDC – Engineer, Research and Development Center

IPCC – Inter-government Panel on Climate Change

mcy – million cubic yards

MDOT-MPA – Maryland Department of Transportation – Maryland Port Administration

MD-DNR – Maryland Department of Natural Resources

MDE – Maryland Department of the Environment

MERC-UMCES – Maritime Environmental Resource Center of the University of Maryland Center for Environmental Science

NRDA – Natural Resources Damage Assessment

RSR – Root Shoot Ratio

SLR – Sea Level Rise

TLP – Thin Layer Placement

USACE – United States Army Corps of Engineers

REFERENCES

Maryland Department of the Environment. 2017. Innovative reuse and beneficial use of dredged material guidance document. 94pp.

Spanger-Siegfried, E., Fitzpatrick, M., Dahl, K. 2014. Encroaching Tides: how sea level rise and tidal flooding threaten US East and Gulf Coast communities over the next 30 years. Cambridge, MA: Union of Concerned Scientists.

State of Maryland Executive Department. 2017. Executive Order No. 01.01.2017.13. Waste reduction and resource recovery plan for Maryland.