Chesapeake Modeling Symposium 2012

Interfacing between modeling, management, and the public: TMDLs, politics, litigation and conflicting stakeholder interests.

Synopsis: *Over two days in May 2012, environmental modelers, experimentalists, managers, and local government representatives met for a symposium to discuss and present on the state of environmental modeling in the Chesapeake region and how model output ,integrated with observations of physical and biogeochemical processes in the Bay system, can inform management decisions.*

On day 1, the symposium featured a keynote talk by Jeff Corbin, Senior Advisor to the EPA Administrator for Chesapeake Bay and Anacostia River. This was followed by a plenary talk from Denise Reed (University of New Orleans) and Gerard Learmonth (University of Virginia). The day continued with several special sessions discussing a range of topics, from addressing general process and modeling issues for Chesapeake Bay and similar systems, to integrating model output with field and space-based observations in coastal margin ecosystems, to building model decision support tools for the 2017 Assessment and beyond.

Day 2 started with a panel discussion featuring Chesapeake scientists, managers, and stakeholder group representatives and moderated by Jonathon Kramer of the National Socio-Environmental Synthesis Center (SESYNC). The discussion was lively and primarily focused on the perception of environmental models by the various stakeholder communities in the Chesapeake Region. The afternoon of day 2 featured additional special sessions with similar scope and topic as the Day 1 sessions.

Introduction

The Chesapeake Community Modeling Program (CCMP) held it's third biennial Chesapeake Modeling Symposium (CheMS12) May 21-22, 2012 in Annapolis, MD. The goal of the CCMP is to foster the development and use of open source watershed and estuary models specific to the Chesapeake Bay region. Every two years they host a symposium focused on this topic revolving around a particular theme.

For 2012, the CCMP focused the symposium on the complex interplay of modeling and environmental management and stakeholder and public perceptions and understanding of this interplay. This topic is timely given that the Chesapeake Bay Program (an office of the EPA charged with coordinating the Chesapeake restoration effort) is in the process of developing Total Maximum Daily Loads to regulate the quantities of Nitrogen, Phosphorus, and Sediment that enter the Bay. These loads will be allocated across all of the municipalities within the 64,000 square mile watershed of Chesapeake Bay and the allocations are being developed using the Chesapeake Bay Program's (CBP) modeling suite. Given that the municipalities will be responsible with making potentially expensive nutrient and sediment reductions as dictated by the allocations, the validity of the CBP modeling suite has, and will continue to, come under increased scrutiny.

Using focused plenary talks and panel discussions, the CCMP's goal for the symposium was to foster a dialogue about the use of models in environmental management and the potential impacts to the various stakeholder communities in the Chesapeake region. Stakeholders include the general public, watermen, farmers, local government officials and even the managers and model developers.

Key Note and Plenaries

CCMP Program Coordinator Raleigh Hood kicked off CheMS12 by welcoming all those in attendance and then briefly reviewing the format of the symposium and covering a few logistical details. He then introduced the keynote speaker Jeff Corbin, Senior Advisor to the EPA Administrator for Chesapeake Bay and Anacostia River.

Jeff Corbin – ***World Class Modeling in Chesapeake Bay – May No Good Deed Go Unpunished***. Jeff began his presentation by describing the current status of TMDL development. He made a point of the fact that the world is actually watching how things develop in the Chesapeake. The Chesapeake Bay Program (CBP) has had inquiries from Japan, China, Philippines, Korea, and Canada as well as management agencies from Long Island Sound, Puget Sound, and Albemarle-Pamlico Sound. Jeff indicated that complaints about the TMDL for Chesapeake Bay are for the most part the same complaints that any environmental regulation encounters. These complaints range from the political where people feel the government is over-reaching, to the financial where there are questions about who is going to foot the bill, to the logistical where people are questioning the science behind the process. Jeff then spent some time reviewing the evolution of the CBP model since the 1980s, discussing vast improvements to both model resolution and the questions it can inform. His presentation then turned to how the model technical review process at the Bay Program has also evolved over time and, using the CBP Agricultural Workgroup as and example, Jeff illustrated how in addition to federal, state, and academic representation, the workgroup now included representatives from industry groups, conservation districts and NGOs. The CBP is also forming expert review panels to investigate proposed best

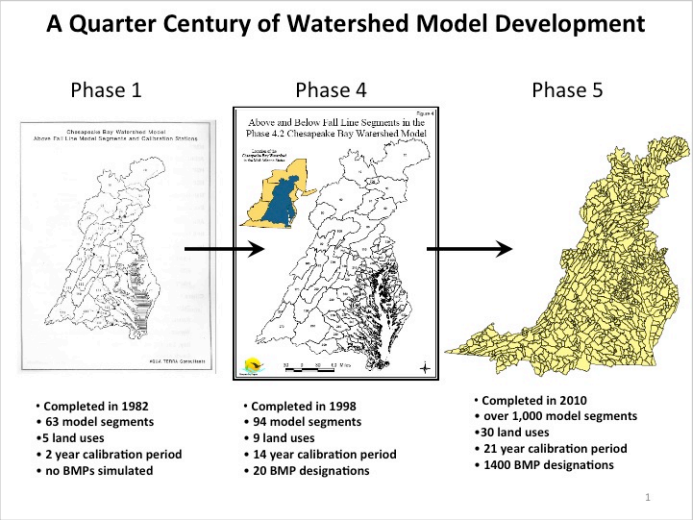

Figure 1 - An image from Jeff Corbin's key-note speech showing the evolution of the Chesapeake Bay Program watershed model.

management practices (BMPs) that will help municipalities meet their TMDLs. There will be expert panels for agriculture, urban, and forestry BMPs.

Jeff then turned his presentation to some of the lessons learned during the TMDL process and how model developers could help moving forward. He shared that a State Representative once told him that he wanted to be able to explain models to his stakeholders and be certain that they understood. Jeff asked the modelers to be better communicators and that better communication needed to be part of the model refinement process. He made it clear that the public relations world would be where the battle for bay restoration would be won or lost.

Denise Reed - **Using Models to Inform Restoration Decision Making.**
Denise's presentation focused on two real world examples where models were used to inform management and restoration decisions. The first example described using conceptual models in ecosystem restoration planning in the Sacramento-San Joaquin Delta. The second example described how more complex analytical models were used to develop a Louisiana Coastal Master Plan.

For the San Joaquin Delta example, Denise described the role of conceptual models in the Adaptive Management process. Denise described adaptive management as a process where managers set goals and objectives for restoration. Conceptual models are then used to estimate all of the possible positive and negative outcomes that could occur if management/restoration actions are undertaken to achieve those goals and objectives. These positives and negatives are then weighed to determine what the overall benefit or risk of the proposed actions are. If risk is high relative to benefits, it may be decided that additional research is need or that a different restoration/management approach should be considered. As the ratio of benefit to risk increases, managers may choose to proceed with pilot scale or even full-scale restoration. As this process unfolds, information gathered informs revision of objectives, conceptual models, and restoration actions. Denise indicated that using conceptual models in the decision making process is ideal because they are transparent (based on peer reviewed research), based on current scientific understanding, and they identify trade-offs among multiple consequences of actions.

In developing the Louisiana Coastal Master Plan, managers needed to consider the utility of 210 restoration projects and 200 environmental protection projects. An important part deciding which projects to include in the plan was considering how they would fair over a fifty year time span. To do this, two of

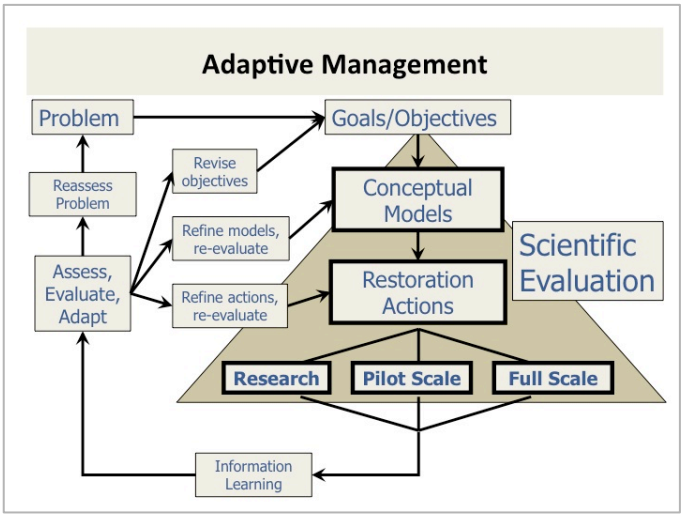

Figure 2 – The role of conceptual models in the adaptive management process.

scenarios were developed to describe conditions along the Louisiana coast in fifty years. In the moderate scenario, impacts due to climate change were set at the lower end of what is predicted by climate forecast models with a 0.3 meters of sea level rise, a 10% increase in storm intensity but no change in storm frequency, precipitation, and river discharge and a 12% decrease in river nutrient concentrations. In the less optimistic scenario, sea level was set to rise 0.5 meters, storm intensity increases by 20%, storm frequency increases by 3%, precipitation and river discharge decrease and river nutrient concentrations remain unchanged from current levels.

To determine how the Louisiana coast would change under the two scenarios several different models were developed to simulate the various parts of the coastal ecosystem. These included models for eco-hydrology, wetland morphology, barrier shoreline morphology, vegetation, ecosystem services, storm surge/waves, and risk assessment. These models were developed to interact with each other, for instance, the storm surge/waves model receives output from the wetland and barrier shoreline morphology models. Using the model output from each of the scenarios, the cost effectiveness of each of the proposed projects was determined and used to develop the final 2012 Coastal Master Plan which identifies 109 projects totaling $50 billion dollars over 50 years. On May 22, 2012, the Louisiana Legislature unanimously approved the 2012 Coastal Master Plan. It will serve as the blueprint for all future coastal protection and restoration efforts in Louisiana.

Gerard Learmonth - **The University of Virginia Bay Game.**
The University of Virginia has developed a large-scale participatory simulation that is based in the Chesapeake Bay watershed (http://www.virginia.edu/baygame/). Players can take the role of farmers, developers, watermen, and local policy makers. In these roles they make decisions about their livelihood or environmental regulations. They then get real-time feedback on the impacts of their decisions on their own personal wealth, the local economy, and the health of the Bay watershed. The model behind the game is based on statistical relationships between land use, river flow, and Chesapeake Bay water quality. Gerard

Figure 3 - Gerard Learmonth gives a status update to symposium attendees playing the UVA Bay Game.

gave a brief introduction to the UVA Bay Game and some of the science behind it before he and his associates from UVA guided the approximately 140 people in attendance in playing a few rounds.

Each of the tables in the conference room was assigned to one of the major Chesapeake rivers (Susquehanna, Potomac, James, York, etc.) with symposium attendees being assigned roles (waterman, developer, environmental manager, etc) based on cards placed on the table beforehand. Attendees then proceeded to play using their laptops and iPads connected through the web to UVA's server. Players proceeded through several "years", making financial and environmental decisions based on their respective roles. After each year of play, the team from UVA would review how the players decisions for that year and Mother Nature impacted the health of the Chesapeake. An entertaining aspect of the game is that players can post messages to the entire group on a live discussion board while they are playing.

Reaction to the Bay Game by the symposium attendees was very positive. Because the game is based on how Chesapeake stakeholder decisions impact Bay health, it was right in line with the theme of the Symposium and helped to set the tone for the next two days.

Special Sessions: *Day 1*

Session: General Processes and Modeling Aspects of the Chesapeake Bay and Estuaries with Similar Settings (Day 1)

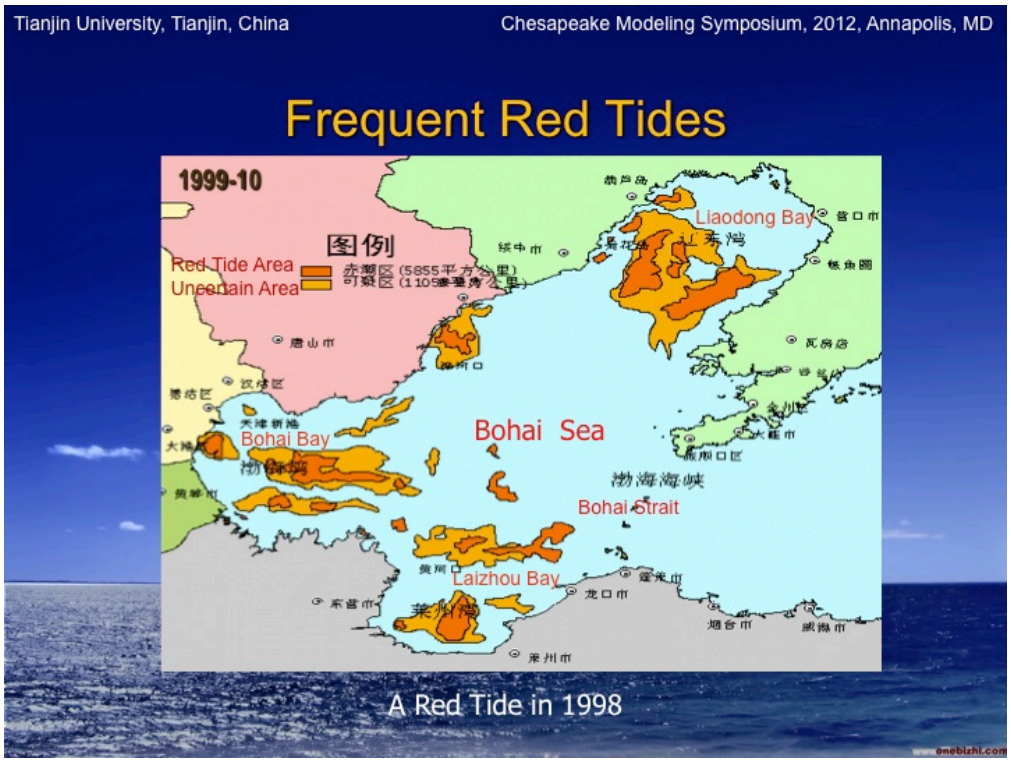

Figure 4 - A figure from invited speaker Jiabhua Tao's presentation on environmental conditions in Bohai Bay, China.

Sessions Leads: *William Boicourt, Wen Long, Courtney Harris, Howard Townsend, Namsoo Suk, Xinsheng Zhang, Christopher Sherwood*

This session addressed process and modeling issues for Chesapeake Bay and similar systems, including the estuary and its watershed, airshed, and aquifiers, in a general and synergistic way. It was a general modeling session that brought together a diverse and interdisciplinary set of researchers who are addressing issues within Chesapeake Bay and similar estuarine systems. The session showcased a range of modeling issues and approaches for aspects of these estuaries, and generated exchange of ideas, and discussion

This session was so large that it was distributed over two afternoons. On the first afternoon, there were eight presentations including a presentation from invited speaker Jianhua Tao from Tianjin University who's presentation was titled "Study on eco-environmental characteristics of Bohai Bay, China". Many of the other talks on Day 1 were focused on sediment modeling in Chesapeake Bay. Other topics included unstructured grid modeling, submerged aquatic vegetation habitat, sediment processes, model coupling, the Chesapeake and Delaware (CnD) Canal and its impact on the two-bay system, hurricane flood hazards, data assimilation, spatial interpolation methods, and marsh sedimentation and morphology.

Session: Building Blocks for the 2017 Assessment

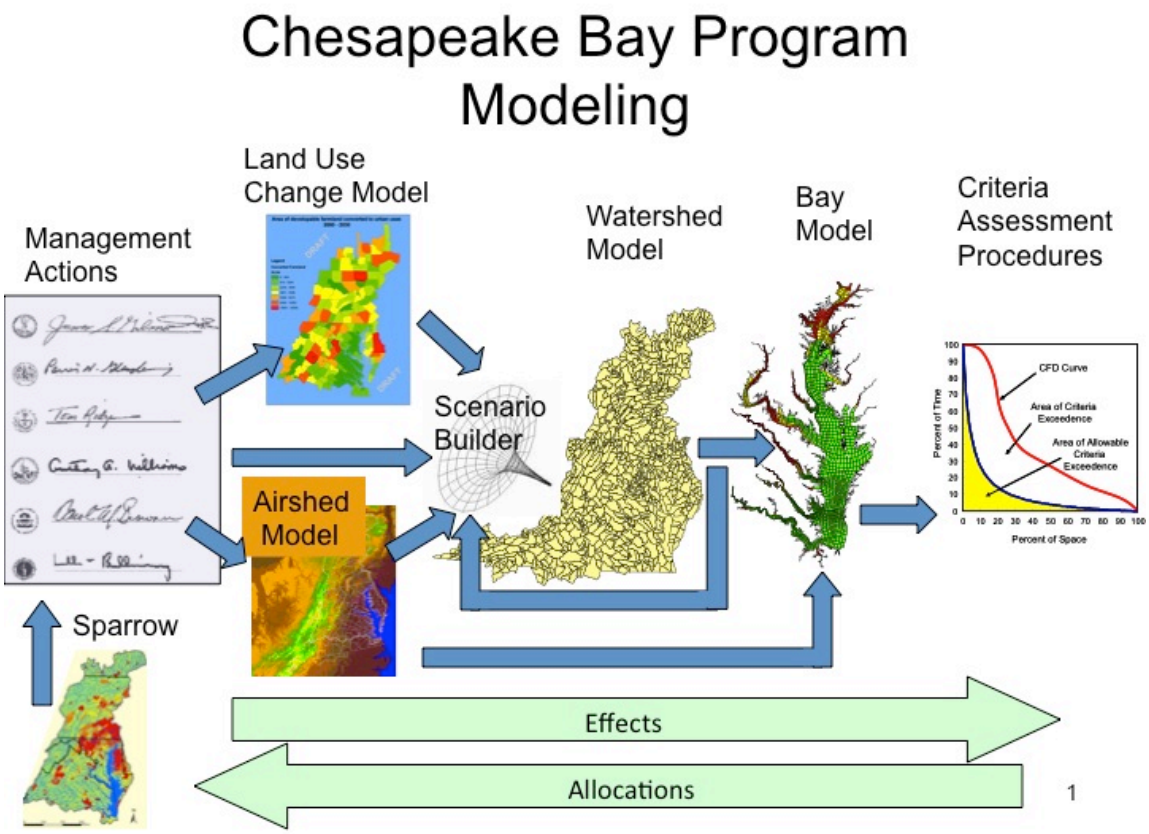

Figure 5 - A slide from session lead Lewis Linker's presentation on the challenges of the 2017 Assessment.

Session Leads: *Lewis Linker, Jian Shen, Gary Shenk Carl Cerco, Dominic Di Toro and Rich Batiuk*

In 2017, the Chesapeake Bay Program will assess the progress of the Chesapeake TMDL and make plans for the implementation of the last phase of nutrient and sediment reductions prior to the 2025 TMDL deadline. To get to the 2017 Assessment, many of the modeling and assessment building blocks we have available today will be expanded and refined in order to provide a range of best available model decision support tools for the 2017 Assessment and beyond. This session exploresd extensions and applications of the current CBP modeling toolkit with an eye toward how that toolkit can be applied to future Chesapeake Bay Program environmental management challenges. This was a very popular and full session with 13 presentations ranging from tools to help stakeholders use model output to new and ongoing modeling efforts in the Chesapeake basin.

Session: Observations and Physical-Biogeochemical Modeling at the Fringes – Land Water and Air-Water Interactions

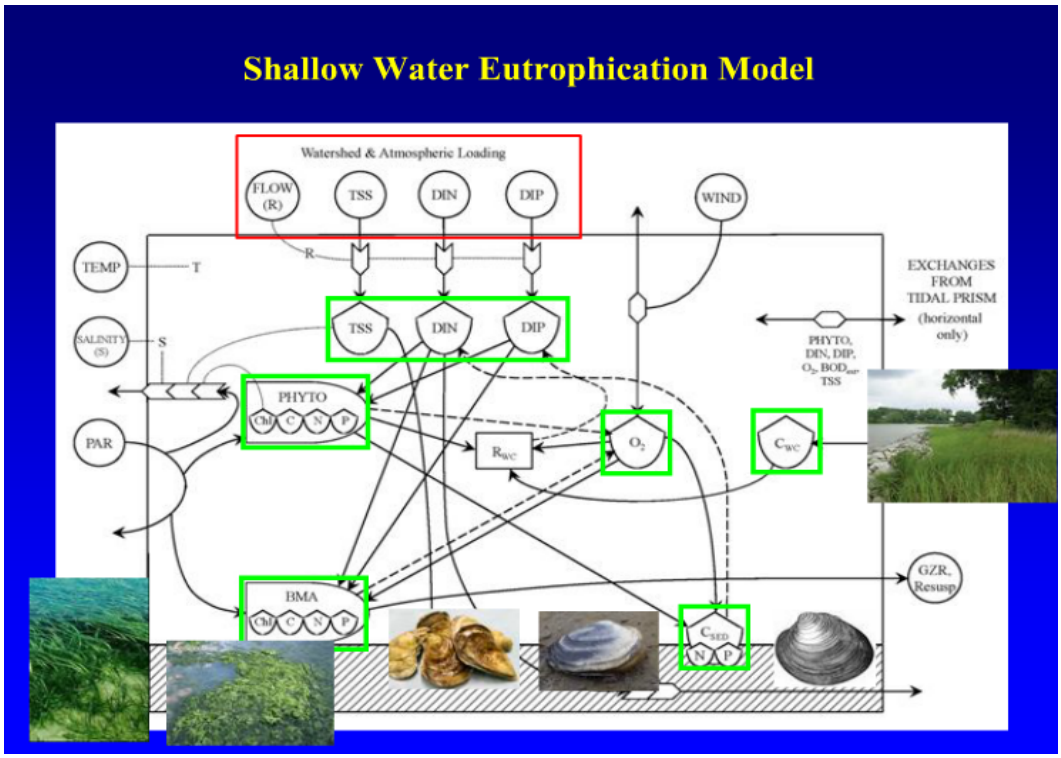

Figure 6 - A figure from Mark Brush's presentation, showing the complex biogeochemical processes and atmosphere-land-water exchanges in shallow waters and at the land-estuarine interface.

Session Leads: *Maria Tzortziou, Carl Cerco, Larry Sanford, Raleigh R. Hood , Patrick J. Neale and Kevin Rose*

Among our biologically and economically most valuable natural resources, estuaries are hot-spots of biogeochemical exchanges. Due to their location, estuarine systems are also particularly vulnerable to climate variability, coastal urban development, land-use changes and other anthropogenic disturbances. Despite recent advances in modeling biogeochemical cycles in coastal and open ocean waters, a large gap still exists in our ability to accurately model and predict changes in the sources, quality and fate of carbon, nutrients and pollutants in estuarine margin ecosystems. Improved understanding and predictive modeling of biogeochemical processes and exchanges in shallow waters and at the land-estuarine interface is imperative for effective management of estuarine resources and decision-making support. It is also crucial for gaining insights into how future changes will affect estuarine biogeochemical cycles, metabolism and ecosystem functioning, and subsequently the role of wetlands and estuaries in regional and global carbon cycling and atmospheric CO2 control.

Development of complex, deterministic models of fringing habitat interactions with the water column is a formidable task, in view of the complexity of associated processes

and the variety of these habitats in the bay system. We think that modules of moderate complexity are optimal, incorporating reasonable empiricism as well as mechanistic processes. These modules should be designed, to the greatest extent possible, to interact with a variety of eutrophication models and to be true community models. The point of this session was to bring together experimentalists, modelers, managers and stakeholders to exchange information and understanding on current state-of-the-art, missing components, and future directions in integrated observations and modeling of biogeochemical cycles in Chesapeake Bay estuarine margin ecosystems.

It was another popular and full session with 12 presentations dealing with many different aspects of modeling and monitoring the shallow water areas of Chesapeake Bay. This has become and increasingly important topic over the last few years as Bay scientists and managers have come to recognize the importance of quantifying the dynamics of the shallow water environment.

Day 2 – *Panel Discussion "TMDLs, politics, litigation, and conflicting stakeholder interests"*

On the morning of the second day of the Symposium, a panel discussion was held on the topic "TMDLs, politics, litigation, and conflicting stakeholder interests". Jon Kramer (National Socio-Environmental Synthesis Center) moderated the panel whose members included Anne Swanson (Chesapeake Bay Commission), Beth McGee (Chesapeake Bay Foundation), Rich Batiuk (EPA – Chesapeake Bay Program), Kim Burgess (Baltimore Department of Public Works), Arthur Butt (Virginia Department of Environmental Quality), Ken Staver (University of Maryland), Jason Keppler (Maryland Department of Agriculture), Lee Curry (Maryland Department of Environment), and Michael Paolisso (University of Maryland). Kramer led off the discussion by asking each panelist to take five minutes to introduce themselves and explain which constituency or stake holders they felt they represented.

All of the panelists seemed to support the idea that the TMDL was a necessary step in protecting the Chesapeake. And there was general consensus that the TMDL process is a incredibly complex and ground-breaking effort. While they all agreed that the TMDL would have a positive impact on Bay health, they each had a unique perspective on what the impacts of new regulations would be on various stakeholders. And, while everyone agreed that models play a pivotal role in the process, they each had their own opinions, born of experience, about how models are perceived by various Chesapeake stakeholders.

Figure 7 - Panel members answer questions during the panel discussion on day 2 of the symposium.

Jon Kramer posed some specific questions to the panelists to help foster discussion about TMDLs, models, and Chesapeake Bay management. These questions and a synopsis of the responses are detailed below.

Question 1 – What can we do at the local level to ensure the success of the TMDL?
Answers **–**

- We need to keep in mind that we've moved on from improvements that can be observed (i.e. erosion) to improvements that are best described as trust based (i.e. dissolved nutrients).
- People want to see monitoring data that proves what the model is saying.
- People want to know EVERYONE is going to contribute to the effort.
- Set short term goals, mark progress, and make sure we know how we got there.
- If we miss the 2025 goal, it's "game over". We need to communicate this sense of urgency.
- Farmers want to be stewards and we need to capitalize on this by helping farmers understand their role in the global environment.
- Tools such as MAST and VAST are very important in showing people their impacts. (*MAST and VAST stand for Maryland Assessment and Scenario Tool*

and Virginia Assessment and Scenario Tool. These online tools allow managers to take existing land use data and develop nutrient management scenarios.)

- More interactive tools need to be developed.

Question 2 – How do we ensure that the model is credible so it is defensible?
Answers –

- It is helpful to point out the number of times that the model has been peer reviewed.
- We need better communication about scenarios and progress runs.

Question 3 – How do we talk to stakeholders about model uncertainty?
Answer –

- Lead with what you know before discussing what you don't know.

Questions from the audience

How do we represent ourselves in court about being 95% certain (about model calculated nutrient reductions from the TMDL)?
Answers –

- It is important that we support all statements with "lots of documentation".
- It is important to remember that uncertainty does not mean hit or miss, but slightly less right or slightly more right. What is certain is the trend – worsening conditions but better with TMDL implementation.

A county representative from Virginia indicated that the BMP numbers used in the model are off by a factor of nine for some sectors and they cannot move forward with planning because of this.
Answers –

- The tools need to be refined to address these kinds of issues.
- Bring these issues forward to be addressed in the 2017 review.
- The local data needs to be fine tuned to fix these issues. Local governments (in Virginia) should work directly with the Virginia Department of Conservation and Recreation.

Special Sessions: *Day 2*

Session: General Processes and Modeling Aspects of the Chesapeake Bay and Estuaries with Similar Settings (Day 2)

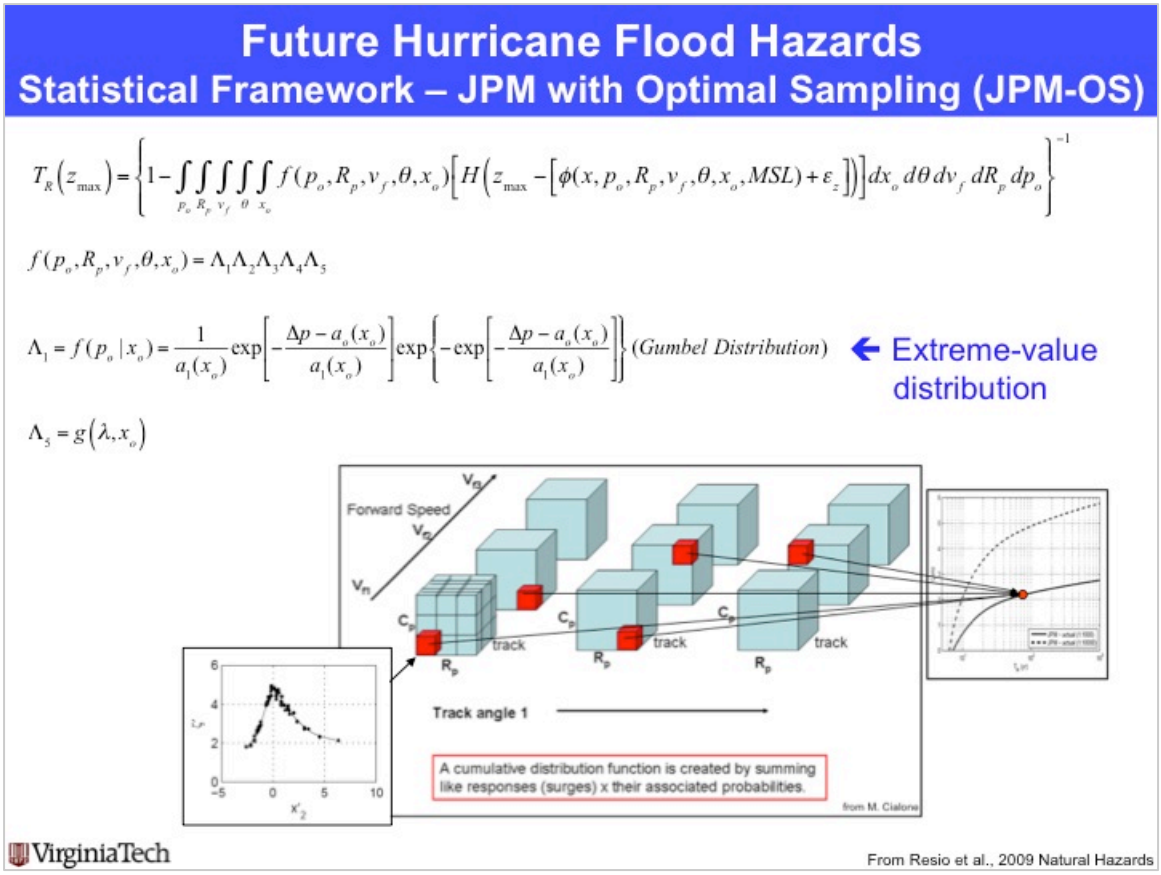

Figure 8 - A slide from Jennifer Irish's presentation on estimating hurricane flood hazards.

Sessions Leads: *William Boicourt, Wen Long, Courtney Harris, Howard Townsend, Namsoo Suk, Xinsheng Zhang, Christopher Sherwood*

This was a continuation of the same session from Day 1. Day 2 featured eight presentations on topics ranging from the FVCOM model and it's implementation in Chesapeake Bay and the modeling of SAV (submersed aquatic vegetation) and its habitat in Chesapeake Bay.

Session: Interfacing between modeling, management and the public: TMDLs, politics, litigation and conflicting stakeholder interests

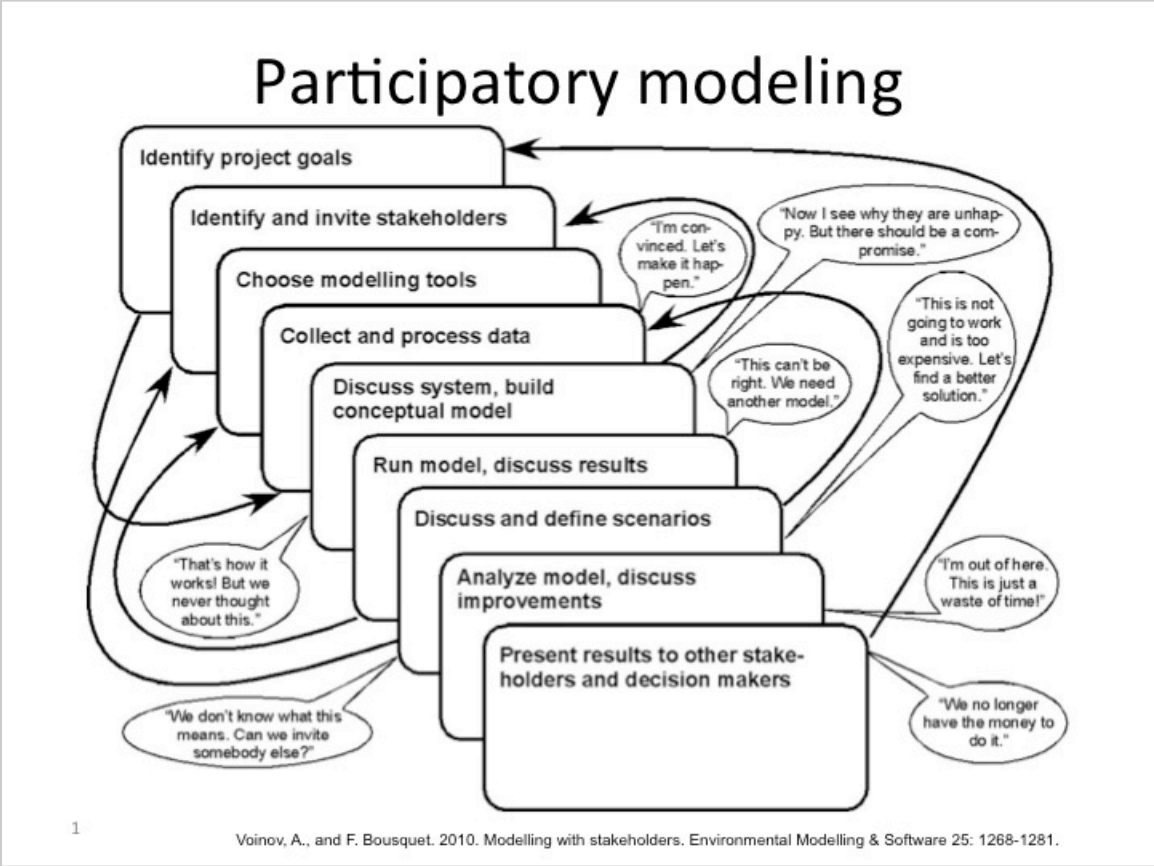

Figure 9 - A slide from Alexey Voinov's presentation showing the process of participatory modeling.

Sessions Leads: *Raleigh Hood, Michael Paolisso, David Jasinski and Kevin Sellner*

Environmental models are increasingly taking on higher profile roles in the management process. In Chesapeake Bay, the Chesapeake Bay Program Watershed and Water Quality models are now being used to support regulatory decisions such as TMDLs, rather than voluntary decisions. One of the effects of this changing role is that it is bringing to light concerns and conflicting interests within different stakeholder communities affected by the regulatory process. Another effect is that the models are increasingly under scrutiny with respect to their scientific validity and skill. It is anticipated that the thresholds set for TMDLs by these models will face numerous scientific and legal challenges in the coming months and years. This session attempted to shed light on these emerging concerns and conflicts as they relate to regulatory thresholds and the environmental models that are used to set them, focusing on topics such as understanding, communication, and credibility. By bringing together modelers, managers, scientists, and stakeholders for a series of broadly assessable presentations and discussions brought to light the unique issues

and concerns of each of these groups and provided a venue for open dialogue with the goal of identifying and planning for the development of vetted, useful and accepted models and modeling tools for routine application by the management and non-modeling community. It was a half afternoon session and was developed to follow on the themes of the panel discussion immediately prior to it. Presentations focused on the interaction between models and management and how to communicate scientific information to the public.

Session: Big Science and Chesapeake Bay - Embracing the NAS recommendations: options for a modeling laboratory

Sessions Leads: *Kevin McIlhany, Gary Shenk, and Michael Kemp*

The long history of modeling of the Chesapeake Bay has produced many research groups and several competing models. The question arises: Is the Chesapeake modeling effort ready to coalesce into a Big Science model, where many smaller groups band together and form a large collaboration, spanning several universities and state institutions? Models for how big science is working in other communities were presented as well as the pitfalls of creating such large collaborations. In moving forward with the Big Science model, many questions will need to be addressed such as: what should the structure of a large collaboration be, how can the group include new members, what funding opportunities could be opened up as a result of a larger collaboration and how desirable is the idea of many smaller groups merging their various modeling efforts?

The National Academy of Sciences recently released a report "*Achieving Nutrient and Sediment Reduction Goals in the Chesapeake Bay: An Evaluation of Program Strategies and Implementation"* in which they made several recommendations about environmental management of Chesapeake Bay. One of these suggestions was the creation of a modeling laboratory focused on the development of Chesapeake Bay ecosystem models. The two presentations and discussion in the session were focused on this recommendation and what such a laboratory might look like.

Discussion: Modeling approaches to water resource/water supply issues

Sessions Leads: *Cherie Schultz and Heidi Moltz*

A number of models, including the Chesapeake Bay Program's Phase 5 Watershed model, provide scientists and water managers in the Chesapeake Bay watershed with tools to support investigations and management decisions concerning water quantity. This session provided an opportunity for presenters to report on hydrologic modeling applications to water resource and water supply management problems. In regions that depend on stream flow for water supply, flow forecasts are needed to assess whether or not future demand can be met by future resources under the impact of projected changes in climate and land use. Stream flow

predictions are also needed in environmental flow studies, currently underway or planned in a number of states in the Chesapeake Bay watershed. These efforts benefit from efficient simulation of multiple flow scenarios at ungaged locations to understand how flow alteration affects biota. Finally, since many urban streams are devastated by the high flows that occur during storm events, some states may be considering the possibility of "flow" TMDLs to address biological impairments in streams. This half afternoon session featured for presentations focused modeling water management and use issues.

Session: Modeling Alternative Future Land-Cover and Land-Use Scenarios to Inform Chesapeake Bay Restoration Efforts

Sessions Leads: *Peter R. Claggett, David I. Donato and Renee Thompson*

Intended for both modelers and the managers who make use of model results in decision making, this session covered current and future work in land-change modeling (LCM) in the Chesapeake Bay Watershed. The session emphasized the role of LCM in understanding the potential drivers of land change in the Bay watershed and the role of loosely coupling LCM and watershed models for quantifying the impacts of land-use planning on nutrient and sediment loads to the Bay**.** The session also introduced the USGS National Land Change Modeling Framework consisting of a set of open-source software tools and standards for building customized regional LCMs. This was half afternoon session and featured five presentations.

Conclusion

Overall response to the Chesapeake Modeling Symposium 2012 has been very positive. The biennial symposium is a unique opportunity for the regional Chesapeake modeling community to assemble to discuss issues unique to modeling in this area. The Chesapeake Community Modeling Program recognizes the importance of this and will continue to pursue this and other opportunities for open dialogue about models. Most of the presentations from CheMS12 can be viewed on the symposium website - http://communitymodeling.org/chesapeakemeetings/CheMS2012/