Marine-Hydrokinetic Energy and the Environment: Observations, Modeling, and Basic Processes

Research at the Interface of Marine Hydrokinetic Energy and the Environment: A Workshop; Minneapolis, Minnesota, 5–7 October 2011

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Marine and hydrokinetic (MHK) energy harvesting technologies convert the kinetic energy of waves and water currents into power to generate electricity. Although these technologies are in early stages of development compared to other renewable technologies, such as solar and wind energy, they offer electricity consumers situated near coastlines or inland rivers an alternative energy technology that can help meet renewable portfolio standards. However, the potential environmental impacts of MHK energy are far from well understood, both in general principles and in site-specific cases. As pressure for new MHK energy licenses builds, accelerated research in providing the scientific understanding of harnessing the natural power of water for renewable energy at a competitive cost and without harming the environment becomes a priority.

A U.S. National Science Foundation (NSF) workshop at the University of Minnesota brought together researchers from academia, industry, and national laboratories to discuss research gaps, opportunities, and priorities related to the development of MHK energy technologies (from the device perspective) and the effect of these technologies on the physical and biological processes of the coastal or fluvial environment. Potential effects associated with the deployment of arrays of MHK devices pertain to changes of the local hydrodynamics, wave and turbulence properties, sediment transport and biological activity (e.g., fish habitats and benthic organisms), and acoustic and electromagnetic field intensities affecting behavioral features and migrating patterns of fish. These changes might be local or nonlocal (extending over a large area around the device location) and short or long term.

The following priority research areas were identified at the workshop: (1) development of a better understanding of the natural variability and dynamics of the physical/biological environment against which changes due to MHK energy devices can be assessed; (2) definition of multidimensional metrics for quantifying environmental change and for differentiating MHK effects from background natural variability; (3) development of predictive multiscale, multiphysics models of varying degrees of complexity and resolution to guide device deployment scenarios and assess short- and long-term consequences of those scenarios; and (4) incorporation of uncertainty into decision making.

An overarching topic of discussion by all workshop participants was the need to establish mechanisms, formal and informal, for integrating basic and applied research and strategically coordinating NSF and Department of Energy initiatives for accelerated progress in this pressing topic that lies at the intersection of energy, environment, and society. Participants expressed the need for establishing a MHK energy research center, where modeling research would be seamlessly integrated with benchmark data sets, including field- and laboratory-scale measurements, and would facilitate data and model dissemination to the broader community for enhanced collaborative efforts. Given the global importance of this problem, developing mechanisms for fostering international collaboration and data exchange was also seen as a priority.

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