New Directions in the Environmental Hydraulics Technical Committee

Vincent Neary (1), Panos Diplas (2), Dennis Lynn (3)

(1) Asst. Prof., Department of Civil and Environmental Engineering, Tennessee Tech, Cookeville, TN, PH (931) 372-1954; FAX (931) 372-6352; email: vneary@tntech.edu
(2) Prof., Department of Civil and Environmental Engineering,Virginia Tech, Blacksburg, VA, 24061, PH (541) 231-6069; FAX (540) 231-7532; email: pdiplas@vt.edu
(3) Prof., Department of Civil and Environmental Engineering, Purdue University, West Lafayette, IN, 47907, PH (765) 494-9615; email: dlyn@ecn.purdue.edu

Abstract

Last year the Technical Committee on Environmental Hydraulics was re-authorized within the recently formed EWRI. This paper is intended to introduce the committee to the hydraulic engineering community by means of a statement of the aims and scope of the Committee, to generate discussion on this subject, to summarize the committee's recent activities, and to invite participation in its activities. It is a revised version of the forum article that appeared in ASCE's *J. of Hydraulic Engineering* (May 2000, Vol. 126, No. 5, pp. 320-321).

Introduction

The general concern about impact of humans on the environment and the search for more environmentally friendly engineering solutions has necessarily been reflected in civil engineering in general and hydraulic engineering in particular. What began as the ASCE Hydraulics Division now finds a home in the Environmental and Water Resources Institute (EWRI). The former Hydraulics Division convened a Research Advocacy Task Committee, which was entrusted with proposing a vision of hydraulic engineering for the next 20 years. The result was a paper, to be referred to below as EH, entitled "*Environmental Hydraulics*: New Research Directions for the 21st century" (ASCE Task Committee, 1996).

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What is Environmental Hydraulics?

Although the use of the term environmental hydraulics probably began recently, this field draws on a long history of practice and research whether one looks at it as a subset of environmental engineering or as a subset of hydraulics. Examples of technologies for removing wastewater date back to the sanitary sewer systems built by the Romans. Recommendations for purifying water by boiling and filtering date back still further to 2000 B.C. (Nazaroff & Cohen 2001). The first research in

environmental hydraulics would probably include Leonardo DaVinci's flow visualization of turbulence, or his mixing experiments with wine and water to determine rates of dilution (See Fig. 1) (Macagno 1988).

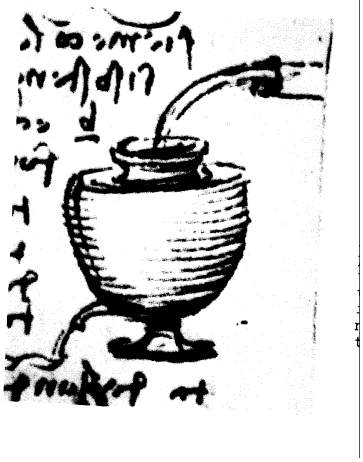

Fig. 1. DaVinci's Sketch of Dilution Experiment (Macagno 1988).

It is worthwhile considering the meaning of the term environmental hydraulics more recently. Fischer et al. (1979) do not give a formal definition of environmental hydraulics in their classic text, "Mixing in Inland and Coastal Waters," but their opening remarks suggest their understanding that it is the sub-discipline of hydraulics that deals with the hydrodynamic aspects of *water quality* management in *natural* water bodies.

"In recent years hydraulic engineers have frequently been asked to analyze and predict mixing in natural bodies of water. It is no longer sufficient to deal only with water quantities because of the growing concern over water quality."

EH suggested that environmental hydraulics emphasize the fluid mechanics of *natural* systems. Some of us would argue that these definitions of environmental hydraulics are too narrow, and that this field has to move in new directions to meet future environmental challenges. Environmental hydraulics should not be restricted to completely *natural* systems, nor should it deal strictly with *water quality*. Fischer et al.'s text treats what most of us today think of as classical environmental hydraulics topics: mixing in rivers, reservoirs and estuaries, turbulent jets and plumes, and the design of diffusers. One example of such a problem is illustrated in Fig. 2.

Fig. 2. Sediment Plume in Tidal Estuary

Literally speaking, environmental hydraulics is a composite term that describes the role of moving water in shaping and changing the environment, in terms of both its geomorphic and biotic aspects. These processes may be dictated by water alone, in which case water quantity and speed are important (e.g., floods); by pollutants transported by water, in which case water quality becomes important; or both. More specifically, environmental hydraulics emphasizes the study of the linkages between physical (hydrodynamic, sediment transport and morphology), chemical (conservative and non-conservative mass transport, reaction kinetics and water quality) and biotic (ecological) components of a system. The ultimate objective is to predict the response of the environment to a natural or human activity or to improve our ability to restore components of the environment. These linkages are illustrated in Fig. 3. The environment is a subject area that is claimed by biologists, ecologists, geomorphologists, physical limnologists, and oceanographers. There may be significant overlap between topics studied by these workers and those of interest to hydraulic engineers, and EH has argued forcefully that the hydraulic engineers need to engage in more dialog and closer collaboration with earth scientists.

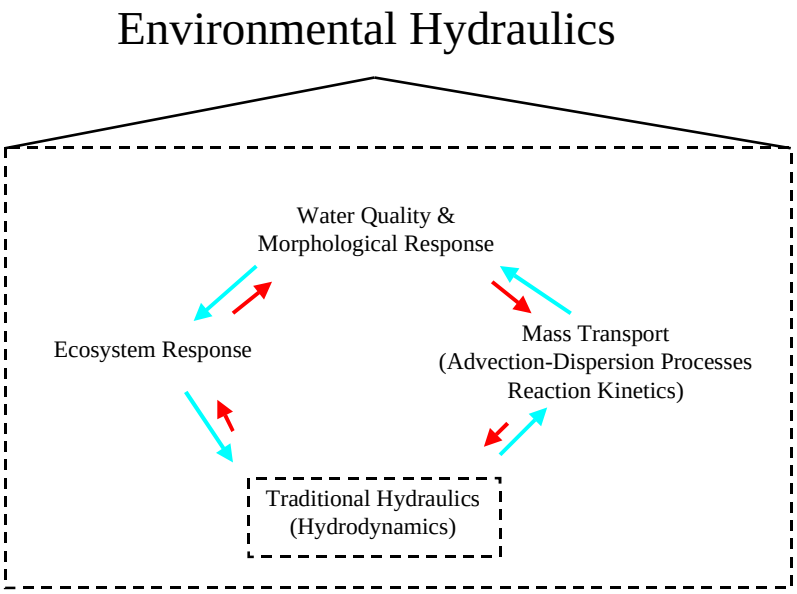

Figure 3. Elements of Environmental Hydraulics

From this perspective, environmental hydraulics is both narrower and broader in scope than traditional hydraulics It is narrower in that there are undoubtedly many hydraulics problems, such as scour around bridge piers, in which the environmental aspect is of minimal interest. At the same time, it can be considered as broader in that it may venture beyond the bounds of hydraulics itself to include topics more traditionally dealt with by other disciplines, such as mass transfer, hydrodynamics-mediated reactions, and identifying stream flow patterns that are of ecological significance.

The focus on natural systems has also resulted in a blind spot, which has obscured an entire topical area that could fit ‘naturally’ within the scope of environmental hydraulics, namely the fluid mechanics of water treatment processes. The treatment plant is evidently a wholly artificial and ‘unnatural’ system, yet its efficient operation may depend strongly on transport processes very familiar to hydraulic engineers and may have significant consequences for downstream water quality. One might also point out that historically, natural systems such as rivers, wetlands and lakes, not to mention aquifers, played the role of treatment systems, and the treatment plants of today might therefore be seen as descendants evolved from natural systems. The hydrodynamics of water treatment processes, which has in the past been largely neglected by hydraulic researchers and left to environmental engineers, could potentially be a very fruitful field lying beyond the pale of traditional hydraulics.

The foregoing thoughts attempt to clarify the meaning and scope of the term environmental hydraulics, but it would be unwise to draw hard impermeable boundaries around the term. Just as results in ecology and/or limnology may be found useful in engineering studies, fundamental research in traditional hydraulics, such as the turbulent flow over bedforms in alluvial channels, may have important implications for projects examining mass and heat transfer across the sediment-water interface.

Objectives

The objectives of the Environmental Hydraulics Committee in the Environmental and Water Resources Institute are threefold:

1. To promote the study of the fluid mechanics of natural and engineered systems, with the aim of improving our understanding of such systems, and hence of our ability to predict reliably and ameliorate the impact of human intervention on the environment.

2. To encourage the transfer and application of understanding of fundamental transport processes and the consequent advancement of engineering practice and technology in the solution of problems with environmental consequences.

3. To enhance communication and collaboration between practitioners in relevant technical fields -- notably, hydraulicians, geologists, environmental chemists, and biologists, and the various professional societies, as well as the broader community, including regulators and society at large. Technical know-how is needed to best manage wetlands, and small streams, such as that illustrated in Fig. 4.

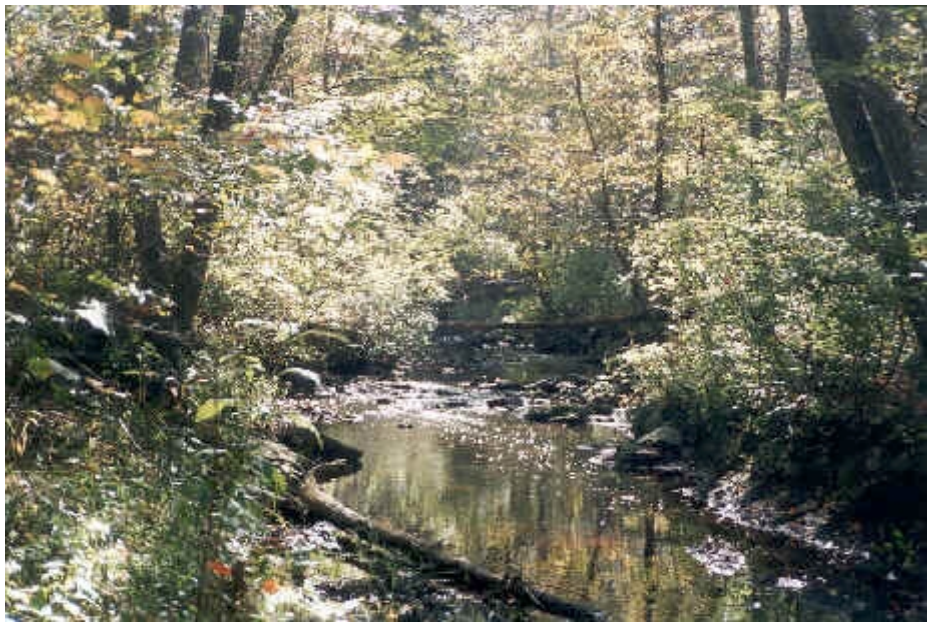

Figure 4. The Study of Movement of Water, Sediment, and Pollutants through a Stream Surrounded by Wetlands (Reedy Creek, Caroline County, VA) Constitutes an Important Component of Environmental Hydraulics.

Recent Activities

Committee Meeting. The Environmental Hydraulics Committee met in Minneapolis on July 30, 2000 to plan future activities, including initial efforts organizing task committees. Among the agenda items discussed was the forum article that appeared in the May 2000 issue of the Journal of Hydraulic

Engineering (JHE) (*Vol. 126, No. 5, pp 320-321*). The forum article was written to generate interest and discussion among researchers and practitioners within ASCE and the Environmental and Water Resources Institute (EWRI) about the future direction of the Committee.

Meeting participants emphasized the importance of communication and collaboration with other professional societies and scientists working on water environment problems. Several federal agencies have adopted this thinking by suggesting the use of holistic approaches for the solution of environmental problems. In particular, the Committee would like to attract non-engineering professionals (e.g. biologists, ecologists, chemists, etc.) and to organize joint activities with other professional societies. These goals fit in nicely with EWRI's commitment to diverse membership and collaborative partnerships. Just recently, for example, EWRI drafted a cooperative agreement with the International Association of Hydraulic Research (IAHR). The agreement allows for direct and more streamlined interaction with IAHR technical sections, such as Ecohydraulics. Also, it encourages collaboration in organizing conferences and symposiums, publishing, and financial and technical activities.

Participants proposed the following task committee topics for consideration:

- Exchange at the sediment-water interface
- Ecological impacts of dam removal
- Scale issues in environmental hydraulics
- Water treatment through wetlands
- Fish friendly hydraulic structures
- Determination of Total Maximum Daily Loads
- Vegetation effects in aquatic and riparian ecosystems
- Interaction/Exchange between surface and groundwater
- Integration of watershed and aquatic ecosystems
- Microstructure measurements in the aquatic environment
- Evaluation of modeling tools
- Estuarine water quality modeling

These topics reflect both the interests of the meeting participants and the pressing problems that the research and consulting community will be tackling in upcoming years. Some topics overlap with those being considered by other task committees. For example, the impact of dam removal is a topic of interest for the sedimentation technical committee as well.

Committee Web Site. A new web site (http://gemini.tntech.edu/~vneary/ehtc.html) was posted to help facilitate exchange of information between current committee participants, to generate interest and to recruit new members. The web site includes a mission statement, membership list, task committees, upcoming events, a posting of the committee's J. of Hydraulic Engineering forum article, meeting minutes and links to related organizations. A pdf version of the forum article can be downloaded, and viewers are encouraged to provide input.

New Task Committee. A new task committee on advanced environmental-hydraulics modeling was organized under the direction of Fotis Sotiropoulos, of Georgia Institute of Technology, and C.Y. Wei, of Harza Engineering Co.. This task committee will evaluate and report the potential uses of computational fluid dynamics to assist in the design of various hydraulic structures, especially to assess

the impacts on the environment in which they operate. A forum article introducing the task committee and inviting participation appeared recently in ASCE's *J. of Hydraulic Engineering* (Jan. 2001, Vol. 127, No. 1, pp. 3-4). A pdf version of this forum article can also be downloaded from the EH web site.

Invitation

The Environmental Hydraulics Committee is off to a new beginning. It is evident that its objectives are broader and more interdisciplinary in nature than before. EWRI, which allows membership of nonengineers, provides an excellent environment for such a committee to grow and flourish. Therefore, the Committee extends an invitation to those of you who are willing to contribute to this effort to contact one of us and express your interest in joining this committee. A balanced committee should consist of engineers and other professionals dealing with various aspects of the environment who are working for the private sector, for local, state, and federal agencies, and in academics. The Committee is looking for new ideas about potential task committees that would organize sessions in conferences, prepare monographs and state-of-the-art articles on topics of importance to our profession, establish collaborative ventures with other societies with similar interests and carry out other activities.

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