
Integrated Water Resources Management Curriculum in the United States: Results of a Recent Survey

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This paper summarizes the progress of the Corps of Engineers' Advanced Degree Program in Integrated Water Resources Management (IWRM) and the results of a survey that was conducted in the summer of 2006 to solicit feedback on training needs related to IWRM. The survey, which was jointly sponsored by the Universities Council on Water Resources (UCOWR) and the American Water Resources Association (AWRA), was conducted to capture the views of water resource specialists related to the emerging field of IWRM. Over 600 people responded to the survey, representing a fairly balanced blend of academicians, government officials and consultants. The results suggest that there are often opposing views of what comprises IWRM and the means by which it should be implemented in the U.S.

As the survey results suggest, the conduct of IWRM in the U.S. is extremely complex owed in large part to the breadth of issues it faces and the decentralized manner in which practices are governed. The definition of IWRM is problematic in the U.S. due to the wide practices that it encompasses – from scientific monitoring of streams to the dredging of navigable waterways to flood risk reduction measures. Perhaps it is best viewed as a process that strives to balance regional economic growth while achieving wise environmental stewardship. In that sense, water resources management and development is a participatory process involving previously competing interests.

In spite of the increased recognition of IWRM, students interested in pursuing a related degree are, for the most part, faced with choosing between the more narrowly defined fields of civil engineering,

physical hydrology, economics or environmental science. There are few educational options available that provide an integrative curriculum that touches upon the various types of water resources management objectives in a practical and balanced way. The Advanced Degree Program in IWRM, which has been under development by the Corps of Engineers (www.waterresourceseducation.us), began as a means to educate the Corps' planning community. It was designed to promote inter-departmental degrees at the graduate level that were specifically geared towards water resource practitioners. The program has been operational for the past four years, but is not proving to be self-sustaining due to its somewhat narrow focus combined with training cutbacks the Corps has experienced within recent years. An expansion of the designed curriculum to address the full range of IWRM objectives could attract a wider range of federal, state, and regional interests beyond the Corps of Engineers.

The survey was conducted in order to gauge broad interest on IWRM-related training and to solicit input on what might comprise such a curriculum. The results suggest that there is wide interest in IWRM across all water resource sectors, and that further discourse is warranted to determine how its principles relate to the U.S. experience and how they should be governed.

An Early Attempt to Devise an Interdisciplinary Curriculum

The impetus for the Corps of Engineers' Advanced Degree Program began in 2001 as an attempt to strengthen its planning capabilities. Based on the recommendations of the Civil

Works Planner Capability Task Force Report, Corps Headquarters tasked its Institute for Water Resources (IWR), in collaboration with UCOWR, to develop an educational training program to meet the needs of future leaders in the Corps. The challenge at the time was twofold:

1. Expectations of a loss of 35 percent of the Corps' planning leadership expected due to retirements or promotions produced an immediate need to educate existing employees.
2. The new water resources challenges faced by the Corps required leaders to have a strong multi-disciplinary educational foundation.

A joint committee of Corps personnel and representatives from UCOWR developed a multi-disciplinary graduate curriculum to meet the task force objectives. The curriculum included requirements in hydrology, ecology, social sciences (specifically, public policy, political and social decision-making and resource economics), engineering, history and law. The program was fully endorsed by a joint Corps-UCOWR focus group in Dallas, Texas, in 2001 and at the UCOWR annual conference.

Five universities¹ were subsequently identified to participate in the program and each one has invested substantial time and effort over the past four years to devise a flexible approach that is practical and addresses the training needs of the planning community. Unfortunately, training funds within the Corps have been dramatically curtailed resulting in a minimal number of students participating in the program. Additional steps, therefore, had to be identified to bolster broader interest in multi-disciplinary training, including:

- An expansion of the program to focus on the broad principles that define IWRM;
- The involvement of more universities that are well suited to address both regional and national issues, as well as multi-disciplinary training tracts;
- The establishment of a partnered program that involves other federal and state agencies and related professional organizations; and
- The advancement of distance learning options that are tailored to meet the needs of water resources practitioners.

The Corps of Engineers was interested in

providing its employees with the opportunity to obtain a graduate-level degree in water resources planning as part of a program of incentives to encourage the hiring and retention of a top-quality workforce. The multi-objective nature of water resource projects, combined with the need to promote public participation in the planning process, further contribute to the need for more cross-trained individuals. A practical degree program that builds on the principles of IWRM would help to address this void among the profession, and specifically the loss to the Corps of Engineers.

At the request of the Corps of Engineers, the Universities Council on Water Resources (UCOWR) polled its member organizations regarding the availability of water resources degree programs, and the interest of these institutions in participating in a targeted graduate degree program. Based on a significant positive response, the Corps requested that UCOWR form an academic advisory group to help evaluate what a water resources planning curriculum should contain, as well as how it might best be delivered.

The focus for what would become the Masters Degree Program in Water Resources Planning and Management was to better equip planners to be able to respond to 21st century water resources challenges. The UCOWR committee concluded that in order to respond effectively, a directed program should be configured to produce generalist planners, as opposed to those who are more narrowly specialized in one topic area. The course requirements would need to be more analogous to a Masters of Business Administration degree rather than a Masters of Civil Engineering. The program, therefore, needed to be interdisciplinary in nature. Key assumptions about the future water resources planning environment that were integrated into the course designs included:

- a reduced emphasis on large-scale projects;
- more changes (rehabilitations/redesign) of existing projects to meet new needs;
- deauthorization/dismantling of existing projects;
- more planning to manage/optimize system performance;
- watersheds as a planning focal point;
- more issue/program focus versus individual

- project focus;
- more interagency/collaboration and planning; greater reliance on institutional approaches to dealing with water resources issues;
- more technical review and management of private sector work; and
- how policy is made and implemented, what is needed to defend your work in that broader context.

A UCOWR committee was commissioned by the Corps of Engineers in 2001 to develop a curriculum for what would become the Masters Degree Program in Water Resources Planning and Management. The committee was tasked with identifying standardized courses and course content that universities would be required to adopt if they wished to participate in the program. Eight “cornerstone” core courses were subsequently identified, which the committee determined provided the needed grounding in key components of water resources planning. In addition to independent study and a “capstone course,” the following eight “core” courses comprised the Master’s Program:

- Philosophy of Planning (3 semester hours)
- Institutional Considerations in Water Resources Planning (3 semester hours)
- Social Decision-Making (3 semester hours)
- Ecology for Water Resources Planning (3 semester hours)
- Engineering for Water Resources Planning (3 semester hours)
- Economics for Water Resources Planning (3 semester hours)
- Hydrology/Hydraulics/Climatology (3 semester hours)
- Quantitative Methods for Water Resources Planning (3 semester hours)

In addition to curriculum development, the committee had to take into account some practical considerations. The Corps of Engineers, for instance, is a geographically diverse organization, operating out of 37 field offices (districts) and eight regional offices (divisions) that are spread across the country. It was simply infeasible to identify a network of co-located universities. It was also assumed that most of the employees pursuing a Master’s Degree would also be working full time with as little time away from the office as possible. A number of flexible options for delivering the

program therefore had to be taken into account, such as:

- Maximized distance learning options
- Intensive short-courses: instruction provided over a week or two-week period,
- Resident program: students are resident at university for a semester or during the summer for intensive course work, and
- Blended delivery: combinations of distance learning and one or more of the other options.

Once the training needs were identified, a request for a proposal to implement the multi-disciplinary graduate program was sent to more than 90 member universities of UCOWR, plus a select group of other potential candidate universities. Over 20 qualified universities expressed a strong interest but were unable to participate due to internal constraints, such as one year residency requirements, limits on the acceptance of transfer credits, and the absence of any interdisciplinary degree program.

A number of factors that were addressed in the development of the Corps’ Masters Degree Program, therefore, have direct relevance for the implementation of an expanded, multi-university program that encompasses the principles of IWRM. Since the inception of the Corps’ program, other universities, such as Texas A&M and the University of Wisconsin, have started to develop inter-disciplinary degree programs related to water resource management on their own. The survey was prepared in an attempt to gauge the adequacy of what is presently being offered on a national scale or whether further steps are warranted to advance training and education related to IWRM.

Survey Questions and Results

AWRA has a large database of water resources specialists throughout the world. An online survey was prepared by a small group of senior AWRA and UCOWR representatives and emailed to those individuals on AWRA’s omnibus list. That list, which has been compiled over the years, is not restricted to a particular sector (academia or government) or water resource discipline (engineering or economics). Such a broad representation arguably allowed for feedback from the entire spectrum of interests that IWRM comprises. SurveyMonkey software was used to conduct the online survey,

with over 600 people responding. In addition to the short number questions, many of the respondents took the time to answer the separate discussion questions that were included in the survey, thus yielding substantial results. At the outset of the survey, the respondents were asked whether or not they would be representing their own personal views or those of their respective organizations through the course of the survey; 91 percent of those responding stated that they were voicing their own personal views.

Importance of IWRM

The respondents were asked, on a scale of 1 (low) to 5 (high) how important the integration of multi-disciplinary education and application in water resources management was to accomplishing their organization's mission. Nearly everyone responded to this question, with 85 percent of them feeling that it was very important. Less than 5 percent viewed it as unimportant to their mission, while 10 percent gave it the mid-rating of 3.

IWRM Responsibilities

For the next question, those surveyed were asked to define their area of responsibility on the

same scale of 1 to 5 from an assigned list of 20 specialty areas. The purpose of this question was to determine what capacity of IWRM they felt they best represent. The ranges for this question were not substantial, with the rather nebulous entry of *water resources management* receiving the highest response average of 4.31. In a field of 20 sub-specialty areas associated with IWRM no one particular area of responsibility stood out from this particular field of respondents³. At the same time, no field was discounted, suggesting how rich and varied the field is in practice.

Training Disciplines of Importance

It was very important to glean from the respondents which educational areas should be primarily targeted for the purposes of deriving an IWRM curriculum. For this question, 14 separate disciplines⁴ were provided for the respondents to choose from. They were asked to identify which of these areas of training would help their organization accomplish their mission. The leading response was *watershed hydrology and modeling* with 86 percent of the survey respondents. The specialty area of *geographic information systems (geography)* came in second at 75 percent (Figure 1).

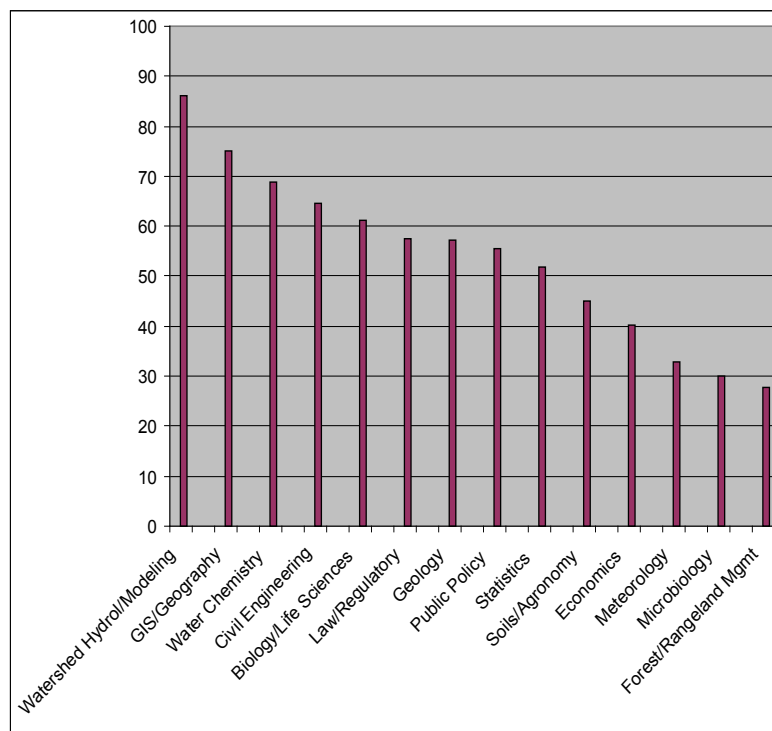


Figure 1. Breakdown of disciplinary education/training areas of interest.

Importance of IWRM Training and Education

The respondents were then asked, on a scale of 1 (low) to 5 (high), how important it was for them and their staff to have education and/or training in IWRM. Of those who answered this question, 82 percent felt it was very important, while less than 5 percent felt it was of little importance. The question did not differentiate between on-site certification classes versus those sponsored by universities and colleges.

Training Needs Being Met

The next question was whether or not they felt that their training needs were being met by available university curriculum; 57 percent felt that they were not while 43 percent felt that they were. A total of 377 individuals followed up with written responses, with several individuals making the following points:

- The curriculum that is available is too theoretical and not well suited to the practical world.
- Individuals with good inter-disciplinary skills are unavailable.
- There are far too many generalists that are emerging who lack sound scientific skills and experience.
- The problem-solving skills are deteriorating in the workforce resulting in a cadre of “number-crunchers”.
- The universities are producing far too many advocates and not enough analysts who can think in an objective manner.
- The stovepipe (single disciplinary) approach within academia continues to prevail.
- There is no substitute for on-the-job-training, as it provides the most practical individual training.
- IWRM as it applies to the U.S. still needs to be defined (one respondent admitted to never having heard the term).
- Students are having to fend for themselves when it comes to developing a degree plan related to water resources management.

It starts to become evident that many of the

points made by one group are cancelled out by an equal number in an opposing camp, as evidenced by the generalist versus specialist sentiments. Other worthy sentiments of note included the following:

- Attempts at producing integrative approaches at the university level have largely failed within the U.S.
- IWRM should begin at the undergraduate level, and five-year degree plans at the bachelor’s level should be developed and promoted.
- One individual advocated that the environmental science field by its very nature comprises IWRM, while several other individuals were critical of the cadre of professionals who had those types of degrees.
- The pre-requisites for so many graduate and undergraduate courses preclude the student’s ability to develop an inter-disciplinary degree plan, i.e., they are being forced to stay within a single discipline.
- The engineering field should not be the critical driver when it comes to IWRM curriculum. Economics, political science, and environmental science should play a much more pivotal role.

One rather reflective respondent offered the following observation: “University curricula emphasize an objectivist, means-end approach to water resources management. Our research with community groups requires a constructivist approach which is profoundly difficult to those who have been trained in the objectivist paradigm. There is a need for both strands of teaching, and a need for a reflective understanding of both.”

The Federal Role

Respondents were then asked if they felt that the federal agencies have a role to play in terms of advancing IWRM education on a national level (e.g., degree requirements for positions, better hiring opportunities, staff training or education incentives). Of these, 79 percent felt there was a federal role to play in the process, while 21 percent responded in the negative. A wide range of suggestions were provided, with a few individuals adamant that there was no role for the

government's intrusion in the educational process. The vast majority, however, offered several constructive suggestions. Several emphasized that the public and private sectors should develop closer relationships with universities. Suggestions along these lines included:

- There is a need for more adjunct professors who can offer practical perspectives within a classroom setting
- Government representatives should help advise college deans and department heads on curriculum development
- Cooperative research and academic programs should be developed between the government and private sectors with the universities
- Universities should consider joint advisors to help students choose their plans of study
- The governmental sector should provide training for extension staff
- More workshops that are jointly sponsored should be held

Other suggestions were:

- The government should play a critical role in alerting its staff of what training and educational opportunities are available in IWRM
- Job descriptions that are derived by the governmental sector should be more interdisciplinary in nature
- The government should play a key role in the development and operation of national training centers of excellence
- They should play a role in the development of professional licenses related to IWRM
- They should provide incentive-based training programs through grants, scholarships, summer-hires and apprenticeships
- Restore/increase centralized funding for training within the various federal agencies
- Host a national workshop on IWRM and IWRM training needs

Awareness of Incentives

Respondents were asked if they were aware of any incentives that were available to them or their organizations designed to encourage employees

to pursue a graduate degree or training in IWRM. Over a third decided to skip this question and most of those who answered were unaware of any incentives at their disposal. A few made it clear that there were no options available to them, while others suggested that training programs were simply not encouraged. Those who responded favorably offered the following options that they were aware of:

- Partial funding of tuition
- Grants
- Scholarships
- NSF Integrated Graduate Education and Research Traineeship program
- Post-completion reimbursements
- One-time cash bonuses
- EIT programs for engineers
- Professional development incentives

One respondent offered the following observation: "In recent years, our organization began requiring a professional license for all middle and upper level management positions, including most team leader positions. Since most of these are classified as civil engineering positions, that means a PE is required. Unfortunately, the Civil Engineering curriculum and the PE have *little or no relevance* [their emphasis] to the work that we do. I would much rather have someone with graduate training in water resources operation and management than half a dozen with PE licenses. However, the current policy does not qualify you to apply for anything but an entry level position, unless you have the PE. Better support and recognition of the American Institute of Hydrology Professional Hydrologist certification could be part of the solution to move away from focusing strictly on a PE license."

Distance Learning

The final question was whether or not there was an interest in pursuing a graduate degree or certificate program in IWRM via distance learning if it were available; 64 percent responded positively. In spite of this favorable response, distance learning was met with mixed reviews in the written responses. For those who have no physical means to reach a

class, distance learning provides a viable substitute. It also provides a flexible option for a professional workforce that is either in the field for extended periods or working long hours. Some individuals, however, felt that it was simply not suited to the field of IWRM.

Observations

The responses to the survey, particularly the written ones, suggest a vibrant interest in IWRM in the U.S. In many instances, there are opposing views as to where the discipline should be focused and who bears responsibility for its design and execution. There is a clearly recognized need to promote inter-disciplinary approaches to water resources management. The recurring argument between engineers, environmentalists, economists, and political science approaches to water resources management was evident in the responses. Rivalries between these disciplines will in all likelihood persist. The IWRM process provides a means to achieve a balanced perspective, and it was clear that many of those completing the survey recognize that strength. As always, the devil is in the details, and further challenges exist in:

- Gaining a fuller appreciation of what constitutes IWRM in the U.S.
- Devising an IWRM curriculum that is truly multi-disciplinary and addresses practitioner
- Defining the roles of the public and private sector in the educational process
- Creating incentives that attract more students to the field of IWRM
- Identifying research opportunities that promote IWRM principles
- Making more people aware of the importance of IWRM and the various training opportunities that exist.

Possible Next Steps

While some of the respondents maintained that IWRM training should be market-driven, the vast majority felt that further incentives are in order. In considering whether or not to build upon the foundation laid by the Corps and a few universities, key questions emerge that merit further exploration, namely:

- Is there a need to develop guidelines on what constitutes a given university's IWRM program?
- Which incentives, if any, should be promoted to develop sustainable IWRM training programs?
- What incentives are needed to sustain a multi-university approach should it prove to be warranted?
- What exceptions are allowable to attract a broad-based network of researchers and practitioners?

Several respondents suggested that a workshop to address these issues is warranted, and the need to prepare a broadly acceptable approach defining and using IWRM. Ideally, such a workshop would be attended by a balanced blend of academicians who can address the course requirements, and practitioners who can speak to the training needs of their respective organization. At the federal level, agencies such as the Bureau of Reclamation, the Environmental Protection Agency, the U.S. Geological Survey, the Department of Energy, the National Resources Conservation Service, and the Bureau of Land Management all play major roles in water resources management. State and regional interest groups are also critical players in issues framing IWRM training and educational programs that more fully address practitioner needs.

The primary focus of this particular survey related to training and educational needs internal to the United States. International organizations, such as the Global Water Partnership, have made great strides in recent years in terms of advancing the principles of IWRM. They also need to be taken into account as we struggle to customize IWRM to suit needs peculiar to the U.S.

Endnotes

1. The participating universities include: the University of Arizona, the Johns Hopkins University, the University of Florida, Southern Illinois University Carbondale, and Harvard University.
2. Those who developed the survey were: Paul Bourget, David DeWalle, Richard Engberg, Gerald Galloway, and Ari Michelsen.
3. The entire list of specialty areas consisted of: water quality, water supply and security, legal/institutional aspects, water resources

management, drought management, flood risk and system reliability, floodplain management, public participation, environmental impact analysis, aquatic ecosystems, water resources economics, water resources engineering, water conservation, watershed planning, social/cultural/behavioral issues, ethics of water resources, flood damage reduction/storm water management, urban supply and sanitation, watershed management, and other.

4. The education/training disciplines that were provided were: civil engineering, watershed hydrology/modeling, biology/life sciences, water chemistry, geology, microbiology, law/regulatory, GIS/geography, soils/agronomy, economics, public policy, statistics, meteorology, forest/rangeland management.

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