THE ROLE OF LAND USE EDUCATION IN ASSISTING URBANIZING COMMUNITIES IN THE NEWEST ROUND OF WATER RESOURCE REGULATION

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ABSTRACT

Recent expanded water resource regulation efforts will put increasing pressure on urban and urbanizing communities to come up with solutions to the complicated issue of nonpoint source pollution. At the same time, many studies seem to indicate that nonpoint source pollution control by the use of on-site, mechanical “best management practices” alone is not getting the job done. The water resource community is coming to the realization that the best long term approaches to curbing nonpoint source pollution involve better land use planning and practices. Since land use is largely a local issue, local land use decision makers at the town and county levels are a critical target audience for education and technical assistance. Without an educational support system for local officials that provides land use planning and site design options, the possibility exists for the new wave of regulations to stimulate continued emphasis on on-site structural BMPs, resulting in further degraded water resources and less attractive and functional communities. Professional outreach education and technical assistance is therefore needed as never before. The University of Connecticut Nonpoint Education for Municipal Officials (NEMO) Project is one such educational effort. NEMO has fostered significant impacts in Connecticut communities, is engaged in research and applications development focusing on making geospatial technology useful and useable to local officials, and is at the center of a growing National NEMO Network of projects.

KEYWORDS

Nonpoint source pollution, water regulation, education, NEMO, Stormwater Phase II, TMDL, SWAP

INTRODUCTION

The 1970s and 1980s were dominated by efforts to control point sources of pollution. By the late 1980s, the shifting of emphasis from point source control to nonpoint source control was well under way, with the first wave of attention focused on agricultural lands. Agricultural nonpoint source programs, while dealing with a critical and difficult issue, have the advantage of being able to focus on a fairly well-defined target group (farmers) working on equally well-defined lands (agricultural fields). As a result, “best
management practices” (BMPs), particularly structural BMPs, came to the fore as the solution of choice.

The emphasis on agricultural NPS pollution over the last two decades, while warranted, has not served as a particularly effective springboard to confronting the complexities of dealing with nonpoint source pollution in the urban and suburban environments. There is mounting evidence that our first response to nonpoint source control, with it heavy reliance upon site-level solutions, leaves much to be desired (Horner and May 1999, Schueler 1997, Frederick and Goo 1996). Better land use decisions are needed, and land use decisions in the United States are largely made at the local level, by elected and appointed officials serving on county and municipal boards.

These officials are not chosen for their knowledge about natural resource protection, and in many cases they have little or no professional staff to back them up. In the course of the decision making process, these officials must weigh a complex mix of factors as they decide the future course of their communities on a case-by-case, project-by-project basis. All of these complicating factors have made it exceedingly difficult for water resource professionals to fashion effective “urban” (read: “community”) nonpoint programs based on their previous point source or agriculturally-related nonpoint source experience.

THE NEW ROUND OF WATER REGULATION

Seeking new and more powerful answers to the seemingly intractable problem of nonpoint source control in urban and urbanizing areas, water resource agencies are turning to regulatory solutions. Although a thorough description of these programs is beyond both the scope of this paper and the expertise of its authors, a very brief summary of three major initiatives is given below.

Over the past several years there has been an increased interest in implementing Total Maximum Daily Loads (TMDLs), rules that have been included in Section 303(d) of the Clean Water Act since its inception in 1972. A TMDL is defined as the maximum quantity of a given pollutant that can enter a water body without adversely affecting beneficial uses of the water body (Jarrell, 1999). The idea of managing all sources of pollution – both point and nonpoint – holistically, and on a watershed basis, is an attractive idea. However, the implementation of TMDLs has served to underscore the scientific gaps and technical obstacles in characterizing, assessing and quantifying the nonpoint source pollution part of the equation. In areas where new point sources are being proposed, TMDLs have created momentum for point-nonpoint source trading, placing an even greater premium on the ability of local jurisdictions to reduce nonpoint source pollution, and quantify that reduction.

The Phase II Storm Water program is focused on municipal separate storm sewer systems (MS4s). EPA defines an MS4 as being “a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels or storm drains)” owned or operated by municipalities and
local sewer districts among others. Phase II is essentially an expansion of the Phase I program promulgated in 1990 under the Clean Water Act, which is founded on using the National Pollutant Discharge Elimination System (NPDES) permit system to regulate polluted storm water runoff from urbanized areas. While Phase I was primarily focused on large and medium-sized MS4s serving populations of around 100,000 or greater, Phase II extends the coverage of the program to include smaller systems serving “urbanized areas” defined mainly by population density. EPA defines an urbanized area as a central place with its surrounding densely settled fringe “that together have a residential population of at least 50,000 and an overall population density of at least 1,000 people per square mile.” (EPA, 1999). Based on 1990 census data, EPA estimates that 4,105 urbanized areas and over 100,000 construction sites will be affected.

Phase II dictates the creation of an expanded MS4 storm water management program that is comprised of six major categories of required “minimum control measures”:
1. public education and outreach;
2. public participation and involvement;
3. illicit discharge detection and elimination;
4. construction site runoff control;
5. post-construction runoff control;
6. pollution prevention/good housekeeping.

The guidelines for implementing these measures include planning and site design methods that incorporate infiltration and vegetative techniques to manage storm water. While the Phase II permits are not scheduled to be required by MS4 operators until March of 2003, given the extent and complexity of the material covered in the minimum measures, that is little time for communities to prepare themselves.

[Visit http://www.epa.gov/owm/sw/phase2/ for more information on Phase II]

A third relatively new water protection program stems from the 1996 amendments to the Safe Drinking Water Act. This program requires states to develop comprehensive Source Water Assessment Programs (SWAPs) that will:
(1) identify areas that supply public drinking water;
(2) inventory contaminants and assess water system susceptibility to contamination in those areas, and;
(3) inform the public of the results.

While SWAP is an assessment program, it is the clear intention of EPA and the states that these assessments will provide focus for source water protection programs that make use of any or all regulatory and non-regulatory mechanisms. The Guidance from EPA states that the SWAP program gives the lead role and considerable flexibility for implementation of SWAP to the states, “because prevention is ultimately about land use and water quality management, which generally are exercised at the state and local levels.” (EPA, 1997). As of this writing, 45 of the 50 states had approved SWAP programs. [http://www.epa.gov/safewater/protect/feddata.html]
THE ESCALATING IMPORTANCE OF EDUCATION

Bringing nonpoint source pollution under the regulatory umbrella does nothing to change the underlying causes of nonpoint source pollution -- where and how land is developed. Regulatory programs set permit limits, and then put the onus of meeting those limits onto local governments and, in some cases, individual landowners. Regulatory programs are not solutions, but added “incentive” (mostly sticks with the occasional carrot) for communities to confront the problems of nonpoint source control.

Incentive can be a good thing, but assuming that regulatory pressure will automatically result in huge improvements is a leap of faith. It seems safe to predict that community leaders and developers under pressure will embrace any potential solution out there that will satisfy their state regulators. At the moment, what’s “out there” is still dominated by the structural BMP approach.

EPA and the states are placing more emphasis on land use planning and design solutions. This is true of all three of the programs outlined above, with perhaps the best example being the Stormwater Phase II guidance for the “post-construction runoff control” minimum management measure, which gives planning and development design their due. However, structural BMPs are still the most common method of dealing with nonpoint source issues, for two major reasons.

The first reason is that, as a technology-based approach, water resource professionals and regulators often embrace structural BMPs with a much higher comfort level than the planning-based approaches needed for communities. Many water professionals are engineers, and it’s not a criticism to note the obvious fact that engineers are more comfortable with engineering than with something as “fuzzy” as public policy.

The second reason is that structural approaches often are more easily grasped by the local decision makers. Without the assistance of good educational programs that can help them “step back” from their case-by-case focus and put things in a broader perspective, local officials are much more likely to put credence in the site-level fix (e.g., a detention pond or oil-grit separator) than in a community-level planning solution (e.g., narrower roads or open space planning).

Seen in this light, the need for professional, research-driven outreach and assistance programs is greater than ever. While regulations can help to drive the process and technology can provide some solutions, they are not the ultimate answer to coping with the increasing environmental impact of poorly planned development. The environmental, cultural, social and economic impacts of suburban sprawl cannot be addressed at the site level, yet this is precisely where technology-based approaches focus the attention of local officials.

In the next ten years, local land use decision makers will determine the landscape of America for the foreseeable future. This critical group is in great need of assistance from
research/outreach programs. The ante for these programs has just been “upped,” and upped dramatically.

THE NEMO PROJECT

The University of Connecticut’s Nonpoint Education for Municipal Officials (NEMO) Project is a research-based educational program for land use decision makers that addresses the links between land use and natural resource protection, with a particular focus on water resources. NEMO promotes natural resource-based planning, with programs that help communities to pursue both the conservation and development sides of the equation.

NEMO was created in 1991 by the University of Connecticut Cooperative Extension System, in partnership with two other branches of the University, the Department of Natural Resources Management and Engineering, and the Connecticut Sea Grant Program. NEMO is funded by a number of federal and state agencies, with major external funding coming from the USDA Cooperative Research, Education and Extension Service (CSREES), the U.S. EPA, and the Connecticut Department of Environmental Protection.

The project was originally conceived as a pilot, to explore the potential of using advanced technologies – geographic information systems (GIS), remote sensing (RS), and World Wide Web (WWW) – as tools to educate the target audience of local land use decision makers about the links between land use and water quality (Arnold et al., 1993). Almost nine years later, NEMO encompasses a number of educational programs on the town and watershed level in Connecticut, and is at the center of a growing network of projects around the country founded on the NEMO model.

Figure 1. Town-level maps of hydrography and land cover were part of a map set created for each of Connecticut’s 169 municipalities.
NEMO is tightly focused on its target audience. The world of county and municipal land use commissioners presents a number of thorny problems: high turnover in membership; complex issues; a narrow focus on their regulatory responsibilities; and, most importantly, the inability to track the cumulative impacts of the case-by-case land use decisions that are made on a daily basis. To surmount these problems, NEMO uses a combination of advanced technology and good old-fashioned Extension education. NEMO uses GIS and RS images to present information on land use in a succinct and intuitive way for this very busy audience. Simple and colorful images of land cover, hydrography, soils and other key environmental data can go a long way toward explaining concepts like the workings of a watershed, the importance of riparian buffers, and effects of land use on water resource health. Maps have been delivered in hard copy (figure 1) and are available on the internet at http://www.canr.uconn.edu/ces/nemo/ctpage/319maps.html.

The project is not solely focused on present conditions, however. One of NEMO’s major objectives is to enable local officials to visualize the future impacts of their current land use policies and plans. For instance, NEMO makes use of a zoning-based “build-out” analysis, which contrasts current levels of impervious with future levels estimated from zoning regulations (figure 2). The levels of impervious surface are widely recognized to be a reliable indicator of the potential for water quality degradation (Schueler 1994; Arnold and Gibbons, 1996).

The primary value of this analysis is educational rather than quantitative. Our experience with NEMO is that this type of visualization tool can play a significant part in creating the momentum for change at the local level. As an educational tool and motivator, an indicator that integrates the various quantitative and qualitative aspects of water resource degradation is quite useful, and much easier to understand than trying to break down the complex suite of pollutants into its component parts. In addition, impervious surfaces are a visible, tangible element of the landscape, and therefore able to be intuitively understood and physically measured, whether by RS technology or a tape measure.
NEMO educational programs use RS and GIS as tools to promote natural resource based planning, which can be simplified into three main endeavors for a given community: (1) identifying and prioritizing natural resources; (2) moving to conserve priority natural resources, and; (3) identifying the land most suited for development, and developing that land in a manner that least impacts natural resources. For each of these areas, NEMO offers educational programs and materials. Currently, the project has 13 such follow up programs, on topics ranging from GIS and RS technology to open space planning to impervious surface reduction (figure 3).

To facilitate compliance with the new nonpoint source regulations mentioned earlier in this article, the Connecticut State Nonpoint Source Program and EPA Region One have partnered with the NEMO Project to provide a long-term statewide educational program. (Visit http://www.canr.uconn.edu/ces/nemo/ctpage/ctwide.html). The annual initiative includes statewide regional workshops, focused town programs, watershed programs, research and mapping. Each year newly elected or appointed land use commissioners will be offered the opportunity to attend regional workshops that will help them understand what nonpoint source pollution is, and how they can manage it within the confines of their land use board or commission. These annual regional workshops will insure an even and high level of understanding of nonpoint source pollution for Connecticut’s volunteer land use officials.

In addition to these regional workshops, the NEMO Project will conduct educational programs designed to address specific nonpoint source issues within 5 Connecticut municipalities (each in a different Major Drainage Basin). The purpose is to enable each municipality to MAKE CHANGES to their regulations and planning documents that will address their individual nonpoint problems.
Figure 4. Map of Eightmile River watershed, showing water systems in blue, major roads in red, and unfragmented forest blocks in green.

As mentioned above, The NEMO Project has successfully used estimates of the amount of impervious surface in a watershed to help educate municipal land-use decision makers about the relationship between land use and water resources. The NEMO Project also encourages towns to adopt land-use policies and regulations that will help to reduce impervious surfaces (storm water runoff) in future development. However, the amount of impervious surface within a watershed is difficult to measure. In the past, NEMO Project staff used Connecticut’s 1995 satellite-derived land-use land-cover GIS data (LULC) and land-use specific impervious surface coefficients that were developed in other areas of the country as a way to prepare such estimates.

The Connecticut State Nonpoint Source Program and EPA Region One sponsored The NEMO Project to developed parcel size and zoning specific impervious surface coefficients based on high accuracy planimetric data (figure 5) from a set of towns in Connecticut. This initial study resulted in two sets of impervious surface coefficients, one for rural/suburban towns and another for urban towns. Other Connecticut municipalities having parcel and zoning data in addition to similar demographics can utilize these coefficients. This research also developed a draft set of LULC impervious surface coefficients for rural-suburban municipalities in Connecticut. Further study will provide coefficients that will be useful for all municipalities and will be incorporated into
To compliment this research, we have inventoried and assessed the extent to which Connecticut municipalities are currently using zoning regulations to govern site imperviousness. This information has provided a baseline assessment of the degree to which imperviousness is recognized and used in land use planning and regulation at the local level (to download a copy of this report visit http://www.canr.uconn.edu/ces/nemo/ctpage/ctwide.html “impervious surface research”). There is a correlation between these municipalities and where our regional educational programs have occurred supporting the effectiveness of our educational efforts.

Does the NEMO educational support system actually work? Seven years since the first NEMO town presentation, we can say definitively “yes.” NEMO staff give 125-150 presentations a year, all by request – an indication itself of the value that our target audience places upon the program. The project has worked in some depth with well over half of the 169 municipalities in Connecticut. By addressing water quality as a land use issue with planning and design solutions, the links to other issues in the community unavoidably emerge. For instance, you can’t have a meaningful discussion of reducing road widths without getting into issues of traffic safety, neighborhood character, and public works budgets. While this may seem to complicate matters, it helps to ensure that water resource protection is integrated into the real-life local land use process. Without that integration, local officials are likely to view nonpoint source issues as the environmental “flavor of month,” soon to be forgotten. Linking natural resource protection, land use planning, and community character is critical to a successful result.

NEMO has documented many changes to town plans, policies, and practices that have been catalyzed by education. Types of impacts include: changes to town comprehensive plans; changes to zoning and subdivision regulations; subdivision design criteria that promote infiltration and reduction of impervious surfaces; creation of open space plans and watershed management plans; initiation of scientific research projects and K-12 education projects; and increased cooperation and communication among land use decision makers, both within towns and between towns.

A NEW NASA CENTER DEVOTED TO LOCAL LAND USE APPLICATIONS

Despite NEMO’s success, there is a continual need to improve both the data and the delivery system, if the research and educational communities are to make large-scale, meaningful contributions to community leaders. This need has led to a major new effort at the University of Connecticut. The long-standing, productive collaboration between
the Laboratory for Earth Resources Information Systems (LERIS) and the NEMO Project has been designated as a new NASA Regional Earth Science Applications Center (RESAC).

The Center’s name NAUTILUS stands for *Northeast Applications of Useable Technology In Land planning for Urban Sprawl*. NAUTILUS and other NASA RESACs are charged with developing new methods for bringing together the research, service and user communities to apply NASA’s research results to practical, societal problems. Within those general marching orders, the specific mission of NAUTILUS is to make the power of remote sensing technology accessible and useable to local land use decision makers concerned with suburban/urban sprawl and its impacts on natural resources.

To accomplish this, NAUTILUS consists of a three-part Work Plan that involves remote sensing research, Web and CD-based applications and visualization tools; and on-the-ground educational outreach. The research objectives of NAUTILUS are focused on areas that, while of scientific interest, are largely driven by their potential for improving our educational model.

The three major research objectives of NAUTILUS are:
1. *Improved basic land use and land cover information.*
2. *Improved impervious cover estimates.*
3. *Characterization of suburban sprawl and forest fragmentation.*
4. *Correlations between land use, impervious cover and water quality.*

Research techniques are being tested in a watershed in Connecticut, with the most effective and cost effective techniques to be applied to three additional pilot watersheds in Maine, New Jersey and Massachusetts (figure 5).

![Figure 5. NAUTILUS pilot watersheds are located in 4 Northeastern states.](image)

This information and other data developed by the research side of NAUTILUS will become the basis for GIS-driven applications that will allow land use decision makers to access and visualize the research results. For instance, characterizations of land use change over time will be compiled into animations that can be viewed over the Web, perhaps ending with different forecast options that can help the user visualize the future. Both RS and more detailed local data will be used. For example, the project has taken the planimetric impervious mapping project and used MapObjects® to create an interface demonstrating the growth over time of subdivisions in one of the towns in the Salmon River watershed since the 1940s (figure 6). Similarly, interactive tutorials will enable browsers to enact various development scenarios and see the implications for the health of their
NAUTILUS will also involve on-the-ground educational projects in the four pilot watersheds in Maine, Massachusetts, Connecticut and New Jersey. Watershed groups comprised of different combinations of state and nonprofits organizations have been formed in each watershed, and these partners are kept involved in the research and applications phase of the project through a Watershed Partners Group.

THE NATIONAL NEMO NETWORK

Our hope is that research and applications developed by NAUTILUS, as well as the educational models and materials developed as part of NEMO and the watershed projects, will be made available to a national audience of researchers and educators via the National NEMO Network. The Network is a group of NEMO-adapted projects around the country that share information and educational models and experiences through the “hub” of the Connecticut project.

Currently, 15 states have a funded NEMO project, with an equal number in the discussion or planning stages of adaptation (figure 7). NEMO adapters are typically multi-organization coalitions that include university-based outreach programs (Cooperative Extension and/or Sea Grant Extension), state agencies, regional planning agencies and nonprofit organizations. These projects are not just Connecticut program clones, but...
rather are true adaptations tailored to the issues, landscapes and land use decision-making process of each state context.

The Network provides a venue for those persons and organizations working on education of local officials to share ideas and educational models with their peers around the country. Further information on the National NEMO Network can be found in a companion paper in this volume entitled “Empowering Local Communities Through Land Use Education: A National NEMO Network” (Rozum et al., 2000).

CONCLUSION

The new wave of water resource regulatory programs will place considerable pressure on many of America’s communities to address the issue of nonpoint source pollution. Unless considerable time, effort and funding is put into educating local land use decision makers on the planning and design options available to them, it is likely that our current, unsatisfactory emphasis on site-level BMPs will be the primary “solution” of choice. Community leaders must be given meaningful access to the explosion of remote sensing and geographic information system information becoming available, and provided with truly useable tools to evaluate and envision alternative future growth scenarios for their towns. NEMO, NAUTILUS, the National NEMO Network, and other projects engaged in this type of integrated research and outreach approach need to have a lot more company in the business of educating local officials. An enhanced educational support system for local officials, acting in tandem with the new water resource regulatory programs, can have a lasting positive impact on the health of the country’s natural resources and character of its communities.
REFERENCES


