Bentrup, G. Schoeneberger, M.M., Dosskey, M.G., Wells, G., and Kellerman, T. 2005. Tool Time: Melding Watershed and Site Goals on Private Lands. In: Brooks, K.N. and Ffolliot, P.F. (eds) Moving Agroforestry into the Mainstream. Proc. 9th N. Am. Agroforest. Conf., Rochester, MN. 12-15 June 2005 [CD-ROM]. Dept. Forest Resources, Univ. Minnesota, St. Paul, MN, 8 p.

TOOL TIME: MELDING WATERSHED AND SITE GOALS ON PRIVATE LANDS

Gary Bentrup, Michele Schoeneberger, Mike Dosskey.
Gary Wells, and Todd Kellerman
USDA National Agroforestry Center
East Campus-University of Nebraska-Lincoln

ABSTRACT

Creating effective agroforestry systems with broad public support requires simultaneously addressing landowner and societal goals while paying respect to ecological processes that cross spatial and political boundaries. To meet this challenge, a variety of planning and design tools are needed that are straight-forward and flexible enough to accommodate the range of issues and the many individual decision-making processes involved. In this paper, we offer some principles that should be considered when developing planning and design tools for agroforestry. To illustrate how these principles might be used, we will present a few tools from the *Comprehensive Conservation Buffer Planning* project at the USDA National Agroforestry Center. At the regional scale, the ***Regional Atlas for Conservation Planning*** enables stakeholders to quickly review and incorporate a range of issues in their agroforestry planning effort. The landscape scale is supported by GIS-guided assessments addressing water quality, wildlife habitat, and income diversification options for landowners. The real value of these assessments is the ability to combine them to identify locations where multiple objectives can be achieved with a buffer investment. At the site scale, landowner's economic and social concerns can be addressed with ***Buffer$***, an economic analysis tool, and the ***CanVis Visual Simulation Kit***, a computer-based visualization tool for creating photo-realistic simulations of buffer alternatives. Combining information generated by these tools can help planners and landowners to meld site and watershed goals on private lands.

Keywords: Planning, GIS, Agroforestry, Buffers, Multiple Objectives, Decision-making

INTRODUCTION

"Few things disappoint a landowner more than spending money, time, and effort on a project that fails….especially one like agroforestry, where it can be years before problems become apparent" (Dosskey and Wells 2000).

Integrating agroforestry into crop and livestock operations has the potential to achieve many of the environmental, economic, and social objectives being demanded from working landscapes by landowners and society. By adding structural and functional diversity to the landscape, these tree-based practices can perform many functions that have significance far greater than the relatively small amount of land they occupy (Guo 2000; Ruark et al. 2003). Realizing this potential is, however, a multifaceted and dynamic task of determining what opportunities, limitations, and tradeoffs exist in each situation, and of designing an agroforestry system that achieves the best balance among them. When agroforestry systems are implemented, there are numerous impacts ranging from intended to non-intended and from beneficial to detrimental. In addition, these impacts will vary with time and occur both on and off-site. Simply put, agroforestry can create a complex system of interactions that should be managed for multiple objectives, diverse alternatives, and a range of social interests and preferences, while being applied over a wide range of landscapes. This challenge can be greatly facilitated by the use of planning and design tools. The first part of this paper will explore some of the factors that need to be considered when developing and applying these tools while the second half of the paper will focus on some specific tools to address the opportunity of melding watershed and site goals on private lands.

PRINCIPLES FOR DEVELOPING TOOLS

“We need to avoid having powerful methodologies in search of meaningful questions to answer; rather we need to seek the right techniques to answer pressing questions” (Wu and Hobbs 2002).

The success of agroforestry systems in melding watershed and site goals is dependent upon the use of planning tools that answer society’s and landowner’s questions. As developers of these tools, we have a responsibility to create well-designed tools that respond to user’s needs, resources, and capabilities. Some of the principles that should be considered when developing planning tools include:

- Focused on the what, where and how,
- Capable of addressing biophysical, economic, and social issues,
- Developed with user participation,
- Suitable for multiple scales, and be
- Loosely coupled.

The What, Where and How

Currently, many tools and models developed for agroforestry systems were created for testing research hypotheses (Ellis et al. 2004). These models primarily explore and evaluate biophysical parameters for determining the key interrelationships in agroforestry practices and play a key role in laying down a scientific foundation for agroforestry. Researchers assume that their models can be used as planning tools and yet these models are generally incapable of providing the type of answers the public needs for decision making (Ellis et al. 2004). The primary purpose for tools in research is to address the *why* of agroforestry practices, whereas in the planning and design world, the focus is on the *what*, *where* and *how* (Hobbs 1997). For instance, landowners want to know if they can eliminate fertilization with a particular agroforestry practice and are less interested in the types of mycorrhizal relations that contribute to nutrient cycling.

Biophysical, Economic, and Social Issues

Research-based models by necessity tend to focus on a limited number of issues in order to control the variables in the process being studied. Very rarely do these models try to integrate the broad considerations that are constantly being weighed in each decision. Landowners incorporate numerous and diverse issues in their decision-making process on whether to adopt agroforestry practices (Walker and Lowes 1997). Due to each individual's unique situation, resources, and personal value system, these biophysical, economic, and social issues are weighted differently in every potential application of agroforestry. The challenge is to develop tools that capture the range of issues while maintaining the flexibility to allow for the desired assimilation of issues.

User Participation

Because planning tools require a significant investment in time and resources to develop, they need to be targeted to match end-user's needs and resources (Robinson 1996). Users of agroforestry tools for planning and design are primarily landowners and resource professionals working together in partnership to develop agroforestry plans. When these end-users are not directly involved in the tool development process, the result will be ineffective tools that do not respond to their problems, needs, resources, and capabilities, creating a waste of project funds and bitter feelings between developers and users (Hoag et al. 2000; Turner and Church 1995). Tool adoption can be facilitated when the tool is based on elements, procedures, and data that are familiar to the user (i.e., the ubiquitous soil survey and soil loss equation). Tools that rely on readily available data will more likely be effectively used while tools and models requiring specialized data that are expensive and time consuming to collect will render these models worthless in most planning efforts. Even when default values are used in data-intense models, this gives the appearance of an overly complex and unwieldy tool that resource professionals will often not incorporate into their work (Goicoechea et al. 1992; Turner and Church 1995). These problems are exacerbated when tool developers also strive for more precision in their models and yet this increase in scientific precision is often of little consequence in the actual application of an agroforestry practice (Ellis et al. 2004). In essence, users need to conceptually understand the principles involved in the tool or else it is perceived as a "black box" and they will not accept and utilize the results (Hoag et al. 2000). Furthermore, it must be remembered that users do not want the decision made for them by the tool; the tool is only supporting the decision-making process (Walker and Lowes 1997).

Multiple Scales

The impact and success of agroforestry are influenced by decisions made at multiple spatial and temporal scales. Ideally, planning and design tools should be capable of funneling appropriate information into at least three critical decision-making points: national or regional scale, state, and watershed or site level (Ndubisi 2002). At the national scale, tools should provide data to guide policy and program development on the role agroforestry can play in achieving broad societal goals. At the state level, resource managers need landscape assessments to prioritize projects and resources and to develop technology transfer programs. In addition, results from these tools may provide direction for future research on agroforestry. At the site or small watershed level, the tools should yield specific information for designing and implementing agroforestry systems, including where practices *should* and *should not* go to achieve the desired objectives. Tools at this scale can also foster local cost-share and partnership projects because stakeholders can see how they are all part of the watershed and that to solve a problem requires a cooperative approach. For instance, Helenius (1995) points out the advantages of being able to plan for ecological pest management at the watershed level where "the benefits of improved logistics and economy of scale may provide sufficient incentive for the necessary local cooperation between farmers."

Loosely Coupled

Because one agroforestry tool cannot satisfy all of these demands, a suite of tools must be created to address the range of issues across multiple spatial and temporal scales. These tools should be loosely coupled rather than intricately woven together, offering several advantages. This approach allows users to select the tools appropriate for their situation and to weigh the issues according to their goals and values. Because planning is an iterative process and not a linear one, loosely organized tools can be utilized when the resource manager and landowner want to use them. This strategy also facilitates the easy integration of new tools in the planning process without causing disruption to the existing tools.

SPECIFIC TOOLS AND THEIR APPLICATIONS

At the USDA National Agroforestry Center (NAC), we have tried to incorporate these principles into the *Comprehensive Conservation Buffer Planning Project* which is a collection of loosely coupled tools built to support buffer planning and design at multiple scales (Figure 1). Although these tools were created for conservation buffer applications, many of these tools also work with other agroforestry practices and systems. Each of these tools was extensively peer-reviewed to ensure scientific validity in addition to being developed with end-user participation to guarantee the tools address the needs, resources, and capabilities of the users. The following section describes some of these tools and how they are applied in the decision-making process.

The ***Regional Atlas for Conservation Planning*** is a web-based tool containing more than 100 assessment and resource maps from a variety of agencies and nonprofit organizations (http://www.unl.edu/nac/conservation/atlas/index.html). This atlas of national and regional scale maps covers a wide range of topics from soil and water resources to demographics to climate change. The primary purpose of this tool is to provide a quick regional context that encourages stakeholders to move beyond single issue projects and to capitalize on the capabilities of buffers to meet several issues simultaneously.

With the availability of free and easy-to-access geospatial data, GIS-guided assessments have become the cornerstone of our suite of tools (Bentrup and Leininger 2002; Bentrup and Kellerman 2004). Multi-scale assessments have been developed using data layers (i.e., soil type, slope, land use/cover) to identify suitable locations for agroforestry to solve society and landowner needs (http://www.unl.edu/nac/conservation). For instance, our water quality assessments depict where buffers will be the most effective to capture and treat surface runoff and shallow groundwater flow from agricultural fields. One of the wildlife assessments highlights gaps in riparian corridors that can be restored to provide habitat and a movement corridor (Bentrup and Kellerman 2004). Income diversification opportunities for landowners have also been demonstrated with our assessments that show promising locations for growing marketable agroforestry specialty products such as woody florals and ginseng (Bentrup and

Leininger 2002). These assessments conducted at regional, state and county scales have provided support for decision making from national policy discussions to site implementation.

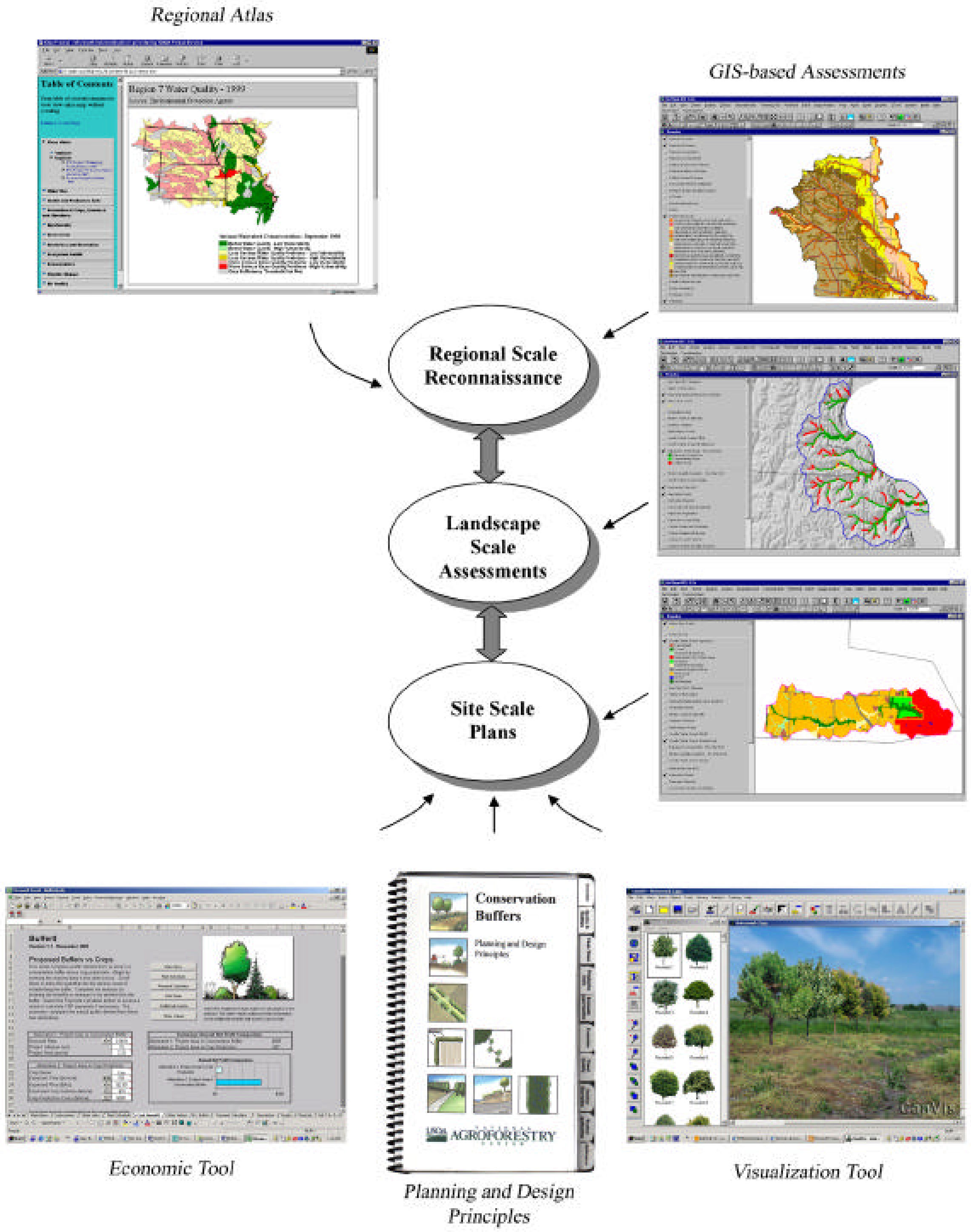

Figure 1. A suite of multiscale tools being developed for planning and designing multi-objective conservation buffers.

The real strength of GIS, however, is the ability to combine individual assessments to determine where multiple objectives can be achieved that simultaneously satisfy community and landowner goals. Using our assessments as an example, we can identify locations where landowners can grow high value specialty products while also improving water quality and wildlife habitat.

Buffer$*** is a simple-to-use spreadsheet tool that calculates the cost-benefits of implementing a conservation buffer in comparison to a traditional cropping practice (http://www.unl.edu/nac/conservation/buffer$.xls). Potential economic impacts can be calculated by weighing the implementation and maintenance costs against the income derived from the proposed buffer (i.e., government programs, hunting leases, alternative products), giving the landowner critical information for decision making. In our current agricultural environment where the removal of noncropped vegetation patches and field consolidation is the norm, there is also a real need to evaluate the economics of existing buffers in working landscapes. ***Buffer$ allows landowners and resource managers to explore the economic consequences of removing an existing buffer, highlighting the often negative financial impact of eliminating a buffer. In addition, this tool has an educational component that informs users about the real but hard-to-quantify economic values of the environmental services that buffers provide to society.

Research on natural resources and social sciences has yielded a vast storehouse of information useful for conservation buffer planning and design. Unfortunately, this information is sequestered in scientific journals, books, and proceedings and is not easily accessible for many resource professionals. NAC recently synthesized research from this diverse body of literature into 85 illustrated and easy-to-understand design principles for buffers. This field guide, entitled ***Conservation Buffers: Planning and Design Principles***, shows how to apply current scientific knowledge into the design of buffers that address biophysical, economic, and social issues. This tool is currently being field tested by numerous resource professionals around the United States.

Despite having a wide range of tools that present numerical and spatial information to stakeholders in a variety of ways, many people still have difficulty in conceptualizing what an agroforestry practice or system will actually look like on the landscape. This lack of understanding often creates difficult barriers in the planning process, especially when landowners consider the long-term commitment required by agroforestry. Photo-realistic 2-D visual simulations can break down these barriers by illustrating what the agroforestry practice will look like at a specific location and time period. To help promote the use of simulations in agroforestry planning and design, NAC has prepared the ***CanVis Visual Simulation Kit*** (http://www.unl.edu/nac/simulation/). This kit consists of the *Visual Simulation Guide* and the *CanVis* image editing software.

The *Visual Simulation Guide* is a multi-media, CD-reference manual on how to use image-editing software to create visual simulations for natural resource planning. The *Guide* provides instruction on how to plan a simulation project, acquire images, edit an image, and accurately locate and size imported objects. *CanVis*, a program created with a commercial software developer, allows resource professionals to create realistic simulations with minimal computer skills. Simulations can be created by adding images of plants and other materials from the software's object libraries onto a base image of the landowner's property. In a relatively short time, windbreaks, riparian buffers, and other agroforestry practices can be illustrated at various stages of development, compositions, and arrangements on the landscape. By readily translating ideas into real life pictures, simulations encourage public participation in the planning and design process, instilling a sense of ownership and increasing the adoption of agroforestry.

CONCLUSION

"Products of science are best assessed not on their intrinsic interest or popularity in the scientific literature, but on the impact they have on the planning and management of real landscapes" (Hobbs 1997).

Melding landowner and societal goals with agroforestry depends upon pulling together diverse sources of information in a manner that responds to stakeholders' needs, capabilities, and resources. Planning and design tools that accommodate these tasks can greatly facilitate the decision-making process resulting in the positive management of working landscapes. As resources professionals, we have a mandate to create tools that satisfy these requirements. We provided a few ideas to consider when developing these tools, no doubt there are other key principles in addition to the ones we discussed. When we develop appropriate tools for planning and designing agroforestry systems, we must be cautious not to become too infatuated with new technology just for technology's sake. New technology can offer new and exciting opportunities but we need to measure it against the impact it will have on the management of real landscapes. We must also be careful not to view the tools as the ends but just as a means to assist decision-making. Most importantly, Nassauer et al. (2001) say we must go beyond providing tools that only address the ecological and economic aspects of sustainability and provide those which also enhance the cultural sustainability of agroforestry systems; that is, it must elicit sustained human attention over time or else benefits may be compromised as land ownership changes, as development pressure increases, or as different political viewpoints arise.

REFERENCES

Bentrup, G., and T. Kellerman. 2004. Where should buffers go?—modeling riparian habitat connectivity in northeast Kansas. *Journal of Soil and Water Conservation* 59:209-213.

Bentrup, G., and T. Leininger. 2002. Agroforestry: Mapping the way with GIS. *Journal of Soil and Water Conservation* 57:148a-153a.

Dosskey, M., and G. Wells. 2000. Planning agroforestry practices. Agroforestry Notes #20. USDA National Agroforestry Center. 4 pgs.

Ellis, E. A., G. Bentrup, and M. M. Schoeneberger. 2004. Computer-based tools for decision support in agroforestry: current state and future needs. *Agroforestry Systems* 61:401-421.

Goicocehea, A., E. Z. Stakhiv, and F. Li. 1992. Experimental evaluation of multiple criteria decision models for application to water resources planning. *Water Resources Bulletin* 28:89-102.

Guo, Q. 2000. Climate change and biodiversity conservation in the Great Plains. *Global Climate Change* 10:289-298.

Helenius, J. 1995. Regional crop rotation for ecological pest management (EPM) at landscape level. In *Integrated Crop Protection: Towards Sustainability? Proceedings of the British Crop Protection*, 255-260; 1995, September 11-14, Edinburg, Scotland. Surrey, UK: BCPC Registered Office.

Hoag, D. L., J. C. Ascough II, and W. M. Frasier. 2000. Will farmers use computers for resource and environmental management? *Journal of Soil and Water Conservation* 55:456-462.

Hobbs, R. 1997. Future landscapes and the future of landscape ecology. *Landscape and Urban Planning* 37:1-9.

Nassauer, J .I., S. E. Kosek, and R. C. Corry. 2001. Meeting public expectations with ecological innovation in riparian landscapes. *Journal of American Water Resources Association* 37:1439-1443.

Ndubisi, F. 2002. Managing change in the landscape: a synthesis of approaches for ecological planning. Landscape Journal 21:138-155.

Robinson, B. 1996. Expert systems in agriculture and long-term research. *Canadian Journal of Plant Science* 76: 611-617.

Ruark, G.A., M. M. Schoeneberger, and P. K. Nair. 2003. Agroforestry—Helping to achieve sustainable forest management. UNFF (United Nations Forum for Forests) Intersessional Experts Meeting on the Role of Planted Forests in Sustainable Forest Management, 24-30 March 2003, New Zealand.

Turner, B. J., and R. Church. 1995. Review of the use of the FORPLAN (FORest PLANning) model. Victoria, Australia: Department of Conservation and Natural Resources.

Walker, D. H., and D. Lowes. 1997. Natural resource management: opportunities and challenges in the application of decision support systems. *AI Applications* 11(2):41-51.

Wu, J., and R. Hobbs. 2002. Key issues and research priorities in landscape ecology: an idiosyncratic synthesis. *Landscape Ecology* 17:355-365.