Incorporating Bioenergy into Sustainable Landscape Designs

Summary of a workshop held in New Bern, North Carolina, on March 4-6, 2014

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Landscape design provides an approach under which bioenergy production systems can be integrated into other components of the land, environment and socioeconomic system. Landscape design is a spatially explicit collaborative plan for resource allocation and management. It should be applied to a particular area and developed with the involvement of key stakeholders. Appropriately applied, landscape design can guide choices toward more sustainable provision of bioenergy and other services. The approach includes elements of design, monitoring and reporting of measures of sustainability along the bioenergy supply chain and within specific contexts. Landscape designs should be implemented in a way that is doable from the perspective of producers along the supply chain. Hence it requires clear communication of environmental and socioeconomic opportunities and concerns to both the participants in production and stakeholders.

Workshop participants learned about how a landscape design approach might focus on bioenergy production systems and integrate it into other components of the land, environment and socioeconomic system. The workshop began with an interesting overview provided by a field trip that highlighted forestry activities in eastern North Carolina. The workshop agenda, list of participants, field tour guide, and presentations can be found at http://web.ornl.gov/sci/ees/cbes/workshop.shtml.

As a case study for landscape design, the workshop provided an opportunity to learn about the eastern North Carolina system and how bioenergy is a part of it. Information presented about the land-use history, multiple waves of disturbance, and current pressures on eastern North Carolina enhances understanding of that particular context. Today's lowland forests and wetland landscape is the product of centuries of extreme disturbance including pests, fire, ice, drought, flood, mining, drainage and other human activities. Forestry has been a major component of land use in the region from the 1700 pine tar boom to the expansion of tree farms, parks and hunting areas in the late twentieth century. The greatest pressure on forests comes from development associated with urbanization. "Natural forests" in the region have been harvested 2-3 times. Hence current biodiversity is a product of dynamic changes and management of hardwood bottomlands remains a conflictive issue. There are robust legal and regulatory frameworks to protect biodiversity, water and air quality.

One challenge to engagement in landscape design is that 90% of timber land is privately owned and 65% of total forest area is in small, non-industrial holdings. Diverse markets for forest products promote management; options can improve returns; and incremental return can support enhanced management. For example, fire and safety issues can be reduced with improved management. Without a market, residues left on the ground can lead to more fires or decay without displacement of fossil fuels. Forestry certification systems used by large commercial land owners do not include calculations for greenhouse gas (GHG) emissions. Estimating GHG emissions for forestry operations at landscape scale is complicated due to the uncertainties surrounding land use and disturbances over long time horizons.

Workshop participants discussed tangible actions that can be taken under the paradigm of landscape design to enable and expand sustainable development of the bioeconomy in the southeast. Proposed actions are listed below under five topic areas.

1. Stakeholder engagement in the southeast forestry sector
    a. Determine process to decide on overall goal for landscape design for a region. The process could involve zoning, plans for economic growth, targets for air and water quality, aesthetic concerns, or management practices and guidelines. It may be important to consider how local landowner and stakeholders' goals align with regional and state objectives.
    b. Engage stakeholders and understand their concerns/needs; what's in it for them.
        i. Address landowner concerns: Provide information to address concerns about risk.
        ii. To reduce risk, landowners in the southeastern United States don't manage with just one goal or product in mind. They try to reach diverse markets.
        iii. Define clear specifications of what biomass materials are demanded by the current market and the projected market dynamics.
        iv. Recognize the complex relationships between loggers and end-users.
            1) Determine who talks to whom
            2) Consider how activities of one logger may influence others
    c. Recognize that partnerships are required in order to bring together policy makers, scientists, and managers so they are able to communicate their ideas and concerns.

   d. Identify a neutral party that can serve as a facilitator and "honest broker" to convoke meetings and bring diverse stakeholders together.
   e. Conduct outreach and informational activities.
      i. Communicate potential opportunities and conduct outreach to share research results (e.g., resource and market analysis). Participants include state extension offices, biofuels centers and biorefineries ("start at the end"), SC Bioenergy Commission, AFRICAP Projects, land grant universities, existing industry procurement organizations, and landscape conservation cooperatives (LCC), which are designed to get agencies, nongovernmental organizations (NGOs), and industry people together to discuss topics like landscape design.
      ii. Share available data in a timely fashion including information on
         1) Potential supplies
         2) What fraction of total woody biomass potential could be supplied based on transport infrastructure, land owner objectives, etc.?
         3) Relevant data from the USDA Forest Inventory Analysis (FIA http://www.fia.fs.fed.us/) (e.g., monitoring supply growth and removals)
         4) Sustainable Forestry Initiative (SFI) or Forest Stewardship Council (FSC) fiber sourcing program (see http://www.sfiprogram.org/ and https://ic.fsc.org/certification.4.htm)
      iii. States can help to integrate many stakeholders in developing landscape designs
2. Certification
   a. Blend certification programs into landscape design (e.g., consider spatial patterns of forest lands certified under different programs)
   b. Devise means to ease participation of small landowners in certification programs
      i. Work through procurement and manufacturing organizations to meet "sustainability" requirements, for certification is a challenge when working with multiple small landowners
      ii. Can existing systems (SFI, FSC, etc.) better communicate their goals and benefits?
      iii. Can certification systems be improved to better meet the needs of small landowners?
   c. Consider legal and economic risk to small farmers who want to participate [e.g., what if certification or regulation identify endangered species habitat, which then limits land use? (consider "safe harbor" policy options)]
3. Market stability
   a. Engage crop insurers to identify lessons that may be applicable to the forestry sector (e.g., how they assess risk, create markets and assign value to insurance?)
   b. Share the risk along supply/value chain
   c. Build from what is already available and develop a clear understanding of how different stakeholders can benefit.
   d. Recognize that stability of state programs and regulations influences forest management and investment. Uncertainty undermines investment and management.

   e. Build upon State policies designed to support achievement of the Renewable Fuel Standard (RFS http://www.epa.gov/OTAQ/fuels/renewablefuels/)
4. Planning and guidance tools
   a. Provide guidelines to describe the steps needed for bioenergy facility siting (permits, supply contracts, how to assess/understand competing demands, etc.).
   b. Assess what can be learned from recent experience (e.g.,Chemtex in NC)
   c. Identify opportunities to build on existing expertise (e.g., pulp and paper industry have long history of fiber procurement) to reduce or manage risks
   d. Develop appropriate tools, models and technical approaches to monitor and guide policy and management decisions toward incremental improvement and goal achievement
   e. Build from harvesting guidelines along the same lines as the forest guilds [e.g., South Carolina has water quality Best Management Practices (BMPs)]
      i. States could create biomass harvesting guidelines that are linked to existing policies or BMPs that are already in place.
      ii. The guidelines would have a higher chance of being adopted if the actions were added to already existing BMPs.
      iii. Challenge: People who are already using BMPs are a little bit resistant to new additions.
      iv. This action could be taken either proactively or when the demand for biomass starts to grow.
5. Analysis tools
   a. Identify parks, reserves, protected waterways and other set-aside areas (state, federal, local) along with private conservation easements, riparian buffers, wetland reserves and other existing set-asides into landscape design base case.
   b. Develop optimization procedures based on multiple objectives
      i. Facility location
      ii. Size of the facility
      iii. Existing infrastructure
   c. Conduct case studies on sustainability to quantify and test proposed indicators.
      i. New Bern area is one candidate because a lot of data has already been collected. Lowland forestry in this area is distinct from other areas.
      ii. Consider a joint case study of SFI "sustainable fiber sourcing" in coastal plain of the southeast (several states have relevant data)
      iii. The region that supplies pellets to the Savannah port is about the same size as a large scale biorefinery
   d. Conduct cost/benefit analysis for investment in chippers and woody debris collection
      i. Where does it make sense economically and environmentally?
      ii. Break even time-frame for various biomass price scenarios
   e. Explore tradeoff assessment
      i. There needs to be a comprehensive assessment of multiple objectives based on understanding that saw timber markets are the primary driver of forestry industry activities in the region and considering other demands on resources like water.

   ii. It's important to not perform assessments in isolation with the end goal being the production of energy crops.
   iii. There are environmental and economic tradeoffs with each alternative land-use plan.
f. Use geographic information systems (GIS) to evaluate different scenarios of landscape design.
   i. GIS could inform on the potential supply and demand as well as the environmental parameters around that.
   ii. GIS could be used as a tool for spatial design.
   iii. Existing GIS-based monitoring platforms (e.g., USDA Forest Service FOREWARN) could be adapted to support landscape design planning and monitoring.
g. Develop better definition of terms and concepts
   i. What does "natural forest" mean in different settings?
   ii. How are management activities in natural forests quantified?
   iii. How can prior history of forest disturbance be fairly and consistently described and communicated?
   iv. How is the management intensity spectrum defined?
      1) How deep, how often, and with what equipment and tools are soils disturbed manipulated or compacted?
      2) Where are soils disturbed? How is the effect defined spatially and volumetrically and relative to what other parameters?
      3) What pressures are added with bioenergy (rates, volumes, frequency)?
      4) What is being removed by bioenergy operations (rates, volumes, frequency)?
      5) What other disturbances occur (rates, frequency, volumes affected)?
   v. How are values for above and below ground carbon stocks determined?
   vi. How are the flows and fluxes of nutrients and water defined and measured?

One breakout group summarized the landscape design approach in three basic steps:

1) Develop landscape design scenarios with stakeholders for a defined spatial and temporal context
2) Evaluate the scenarios applying best available science, data and tools
3) Communicate landscape designs that best meet the multiple development goals (those prioritized for the defined spatial and temporal context)

One of the last activities at the workshop was a brainstorming session on the key characteristics of current bioenergy production in the coastal NC landscape (Table 1). Most of these attributes relate to landscape design as it is applied to particular regions and cases of bioenergy sustainability.

Table 1. Components of landscape design for bioenergy sustainability that align with specific attributes were proposed by workshop participants. Attributes with a star (*) are examples that participants associated with the current situation in coastal North Carolina.

Attribute	Components of landscape design for bioenergy sustainability in the southeastern United States
Feedstock availability (*lots of forest residues available)	Supply high and spatially identifiable
Demand for bioenergy (*growing demand from local users and Europe)	Demand high could lead to a better planning and development of supply and processes
Land ownership patterns (*many small forests owners)	Collaboration and communication challenges
Site specific concerns (*wetlands and the water table are an issue for coastal forestry)	Site-specific management
Local and regional coalitions (*small land owner associations exist)	Facilitates communication
Economic conditions (*rural poverty – need for new economic opportunities)	Social services
Potential for multiple benefits to the community	Benefits across the community
Potential for local processing of bioenergy	Economic/social benefits at the local scale
Matching spatial opportunities with local services (*e.g., hog spray-fields)	Site-specific management
Bioenergy doesn’t exist in a vacuum across the landscape	Integration of landscape objectives
The history of the landscape disturbances	Site-specific considerations
Parks, protected areas, and hunting activities, military lands/federal presence	Important baseline conditions: opportunities for synergy with managed forest landscapes
Human migration (* influx of “Yankee retirees”)	Site specific issues need to be addressed. Consider zoning.
Increase of extreme disturbances	Resilience and adaptive management; planning that considers current landscape and potential changes
Identifying sites with high biodiversity and high conservation value for appropriate protections	Guiding informed decisions for conservation set asides or special management
Capturing long-term data from multiple sources to address multiple environmental aspects	Knowing the baseline and trends
Different governance structures (BMPs, regulatory)	Building on and recognizing the variety of governance structures
Markets are drivers for land management; high-value saw timber market drives forestry activity	Connection between economics, available residues and ecological interests
Infrastructure – impact from roads, ports, railways	Infrastructure defines limits and opportunities
Historic patterns of land change (*fluidity of change from forestry to agriculture)	Resilience and reversibility of decisions, lack of constraints
Urban growth and development pressure	Spatial constraint

Opportunity for multiple benefits from an integrated approach. Timing offers opportunity to influence implementation.	Value of integration, and challenge of carrying ball forward. How can you create incentives to carry it forward?
Topography (*low gradient landscape; contributes to vulnerabilities to flooding and climate change)	Data requirements, tools, and management. Spatial constraint and opportunity to engage developers
Coordination amongst federal agencies to look at landscape design from a larger scale	Collaboration challenge
Use of remote sensing and optimization tools to assess feasibility of options	Landscape design tools
New tools – using gaming to predict how scenarios may play out	Landscape design tools
Landscape design offers new opportunities to address web of regulations and the pace of change of regulations	Landscape design tools offer ways to meet regulations. Planning is ongoing
Adaptive management – in situ optimization	Landscape design tools
Consider biomass factors in parallel with other priorities and tradeoffs	Planning within context, optimization
Difficulty to predict product success	Maintain flexibility
Need to deal with uncertainties	Tools and data that contain uncertainty, Optimization under uncertainty
Risk identification and mitigation	Long-term perspectives
Collaboration and integrative planning process that uses spatial analyses of current and future landscape conditions are done to develop a suite of landscape design aspects	Holistic management prescriptions
Influence of politics (*State legislature shut down the North Carolina Biofuel Center)	Policy context, need for consistency and support from organizing body