Approaches to promote landscape management & design:
Balancing multiple goals related to environmental & resource management

Workshop on Land Use Change at the European Biomass Conference and Exhibit (EUBCE)

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U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
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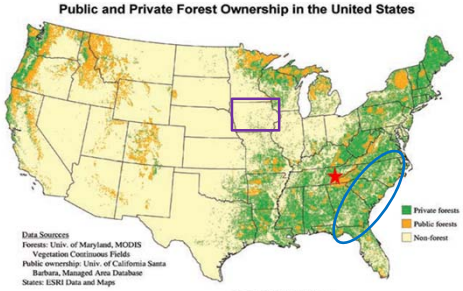
Outline

- Example bioenergy systems: context matters
- Landscape design approach

Examples

- Switchgrass in east Tennessee ★
- Wood based bioenergy from southeastern US
- Corn stover in central US state of Iowa

Public and Private Forest Ownership in the United States



Data Sources
Forests: Univ. of Maryland, MODIS Vegetation Continuous Fields
Public ownership: Univ. of California Santa Barbara, Managed Area Database
States: ESRI Data and Maps

USDA Forest Service
Forest Inventory and Analysis
National Woodland Owner Survey

Landscape Design Provides an Approach for Integrated Resource Management

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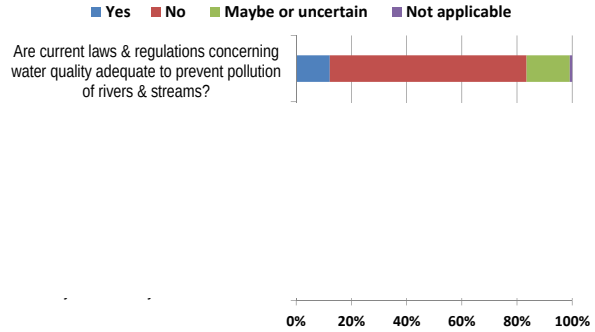
Dale et al. (2016) Renewable & Sustainable Energy Reviews 56:1158-1171.

1. Establish goals specific to context

Selected results from 2015 Drake University survey at conference on "Sustaining Our Iowa Land (SOIL).



Dale, Kline, Richard & Karlen (in review)

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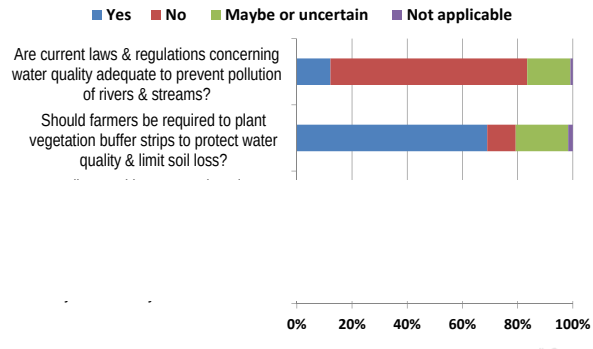

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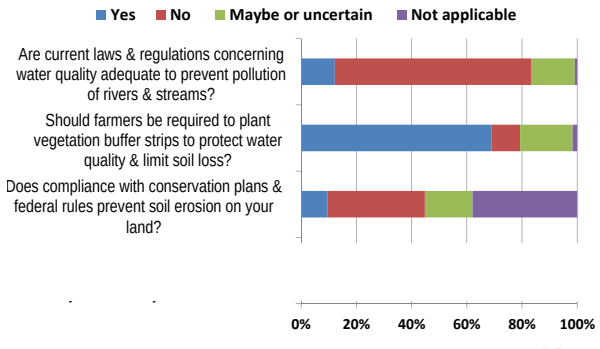

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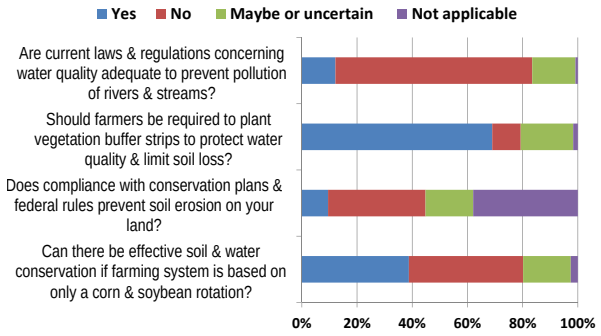


Dale, Kline, Richard & Karlen (in review)

Categories for indicators of environmental and socioeconomic sustainability

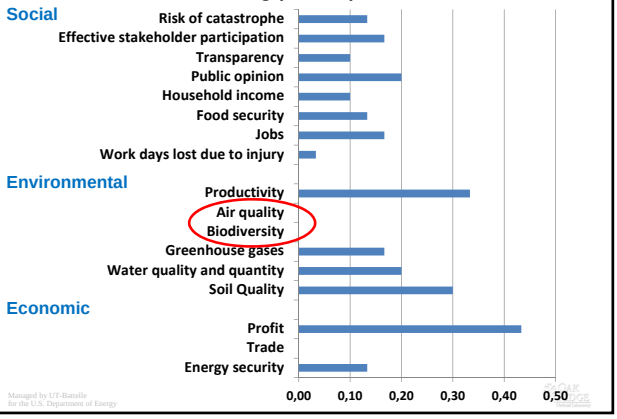
McBride et al. (2011) *Ecological Indicators* 11:1277-1289

Dale et al. (2013) *Ecological Indicators 26:87-102.*

Recognize that measures and interpretations are context specific

Efroymson et al. (2013) *Environmental Management* 51:291-306.

Priority indicators selected by landscape design meeting participants



2. Ascertain constraints and opportunities

Identifying opportunities for Iowa

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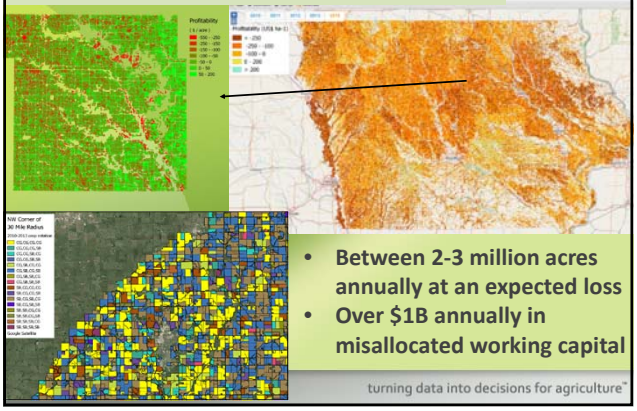
Identifying opportunities for Iowa

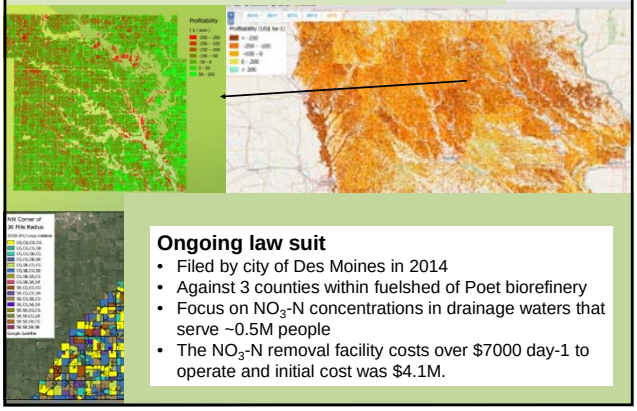


- Between 2-3 million acres annually at an expected loss
- Over $1B annually in misallocated working capital

turning data into decisions for agriculture™

2. Ascertain constraints and opportunities

Identifying opportunities for Iowa



Ongoing law suit

- Filed by city of Des Moines in 2014
- Against 3 counties within fuelshed of Poet biorefinery
- Focus on NO_3-N concentrations in drainage waters that serve ~0.5M people
- The NO_3-N removal facility costs over $7000 day-1 to operate and initial cost was $4.1M.

3. Identify optimal options

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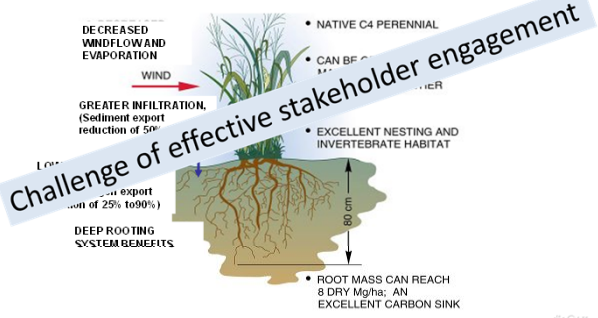
Documented sustainability benefits of switchgrass



Challenge of effective stakeholder engagement

Dale et al. (2011) *Ecological Applications* 21:1039-1054.

Assessing multiple effects of bioenergy choices

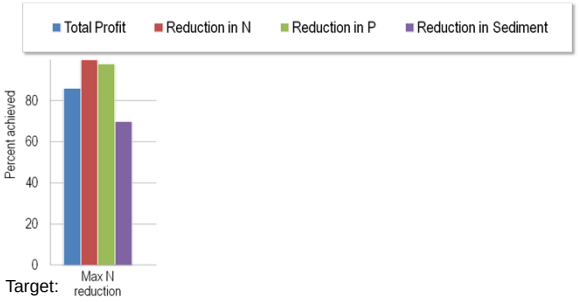
An optimization model identifies "ideal" sustainability conditions for using switchgrass for bioenergy in east Tennessee

Spatial optimization model

- Identifies where to locate plantings of bioenergy crops given feedstock needs for Vonore refinery
- Considering
  - Farm profit
  - Water quality constraints

Parish et al. (2012) *Biofuels, Bioprod. Bioref.* 6:58–72.

Balancing objectives: Design of cellulosic bioenergy crop plantings may both improve water quality and increase profits while achieving a feedstock-production goal



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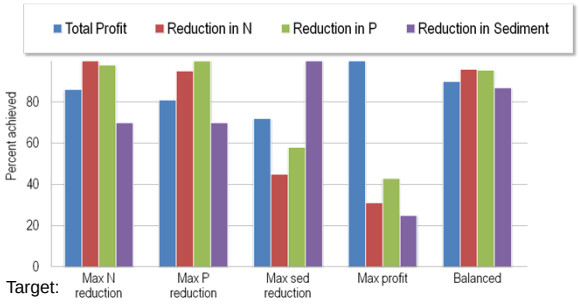
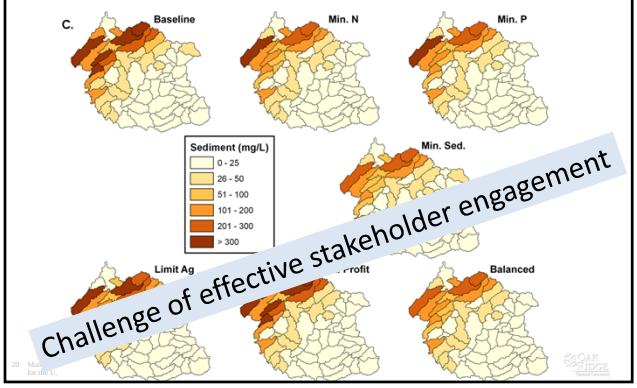


Land area recommended for switchgrass in this watershed:
1.3% of the total area (3,546 ha of 272,750 ha)

4. Evaluate and select design options

Projected sediment concentrations under 6 BLOSM scenarios



Challenge of effective stakeholder engagement

5. Monitor outcomes

USDA Forest Inventory Analysis
- Long-term survey
- All forests in the US
- Information on a variety of forest statistics
  - Forest area and location
  - Species
  - Tree size, growth, health, and mortality
  - Removals by harvest
  - Carbon accumulation

EPT richness
- Number of distinct orders:
  - (mayflies)
  - era (stoneflies)
  - richoptera (caddisflies)
- Monitored by EPA in many states

Challenge of effective stakeholder engagement

6. Adjust decisions as needed

Intense discussion during Bioenergy Study Tour:
http://web.ornl.gov/sci/ees/cbes/workshop.shtml

Challenge of effective stakeholder engagement

Dale + 38 others (in prep) Prospects for renewable wood pellet energy from the southeastern United States

Landscape design approach for bioenergy should be applied via six steps:

1. Set goals
   - Involve key stakeholders
   - Develop consensus approach
2. Consider constraints and opportunities (e.g. wastes)
3. Assess options
4. Evaluate and select solutions
5. Monitor
6. Apply adaptive management

Opportunities Bioenergy Offers to more Sustainable Systems

- **Better management of renewable resources**
  - Reducing wastes and inefficiencies
  - Existing infrastructure, know-how and technologies
  - Retaining land in agriculture or forest
- **Improve environmental conditions**
  - Soils & water
  - Biodiversity
  - Carbon and GHG
- **Enhance food & energy security**
  - Conserving fossil energy resources
  - Reducing risk of catastrophes
- **Increase rates and stability of employment**

Dale and Kline (in review)

Barriers to more Sustainable Systems

- **Public perception**
  - –Unmet expectations
  - –Uncertainty about future demand & prices
- **Economics**
  - –Unstable policy
  - –Up-front costs & risks of new energy systems
  - –Uneven playing field
    - – Subsidies
    - – Lack of Infrastructure for new systems
    - – Easy access to inexpensive fossil fuels
- **Sustainability concerns**
  - –Food security
  - –Biodiversity
  - –Ambitious requirements

Dale and Kline (in review)

Paths Bioenergy Provides to more Sustainable Systems

- **Use wastes and residues**
- **Be context specific**
  - – Build on existing infrastructure and knowhow
  - – Communicate costs and benefits
- **Promote better management**
  - – Integrated agriculture
  - – Landscape design

Lacking markets, woody debris after timber harvests is left to decay; often burns; & can contribute to risk, frequency & intensity of wildfires.

Dale and Kline (in review)

Thank you!

CBES Center for BioEnergy Sustainability

http://www.ornl.gov/sci/ees/cbes/

This research is supported by the U.S. Department of Energy (DOE) Bio-Energy Technologies Office and performed at Oak Ridge National Laboratory (ORNL). Oak Ridge National Laboratory is managed by the UT-Battelle, LLC, for DOE under contract DE-AC05-00OR22725. Many thanks to Keith Kline, Etsher Parish, Latha Baskaran, Kristen Johnson and mnay others for their help in this research.

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