A Geodesign Approach for Energy Development-enabled Sustainability

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What geodesigners do:
Envision—the potential within the existing situation
Project—where and how change may occur
Evaluate—the good and bad effects of change
Illustrate—so that all embrace the same vision
Monitor—to ensure change occurs as promised
Learning outcomes

1. Understand landscape design and planning challenges in areas undergoing rapid natural resource development.

2. Develop awareness of the regulatory context for unconventional oil and gas development.

3. Understand the role of rule-based design in identifying working solutions for communities.

4. Encourage alternate strategies for communicating sustainable, long-term design solutions for communities.
Shale gas in the US and world

- 6,622 Tcf recoverable gas reserves
- Marcellus shale gas in NE US – +/- 200 Tcf
- Annual use of natural gas in US – 22 Tcf
Outstanding rural PA landscapes
Marcellus – big changes...
Effects of Marcellus gas development

- $250 billion in royalty payments for Pennsylvania landowners
- Jobs in gas industry support and suppliers.
- Reduced reliance on farming for income.
- New development in an economically depressed area.
- Impact of pipelines, traffic, staging areas, on visual/tourism amenities.
- Disposal of wastes.
- More forest openings, less core wildlife habitat
- Accidents and unintended outcomes.
What shapes gas development?

- **Geology**
  - Drilling units coincide with NE-SW orientation of underlying geology to maximize well productivity.
What shapes gas development?

- **Exemptions (Energy Policy Act, 2005)**
  - Clean Air Act (1970)
  - National Environmental Policy Act (1970)
  - Clean Water Act (1972)
  - Safe Drinking Water Act (1974)
  - CERCLA (Superfund) (1980)

- **Pennsylvania laws**
  - Oil and Gas, Act 13 (2012)
  - Scenic Rivers Act (1972)
  - Safe Drinking Water Act (1984)
  - Air Pollution Control Act (1960)
  - Flood Plain Management Act (1978)
What shapes gas development?

• **Pennsylvania Act 13 (2012)**
  – Overhauls Pennsylvania Oil and Gas law
  – Increases minimum setbacks between wells and streams, schools, buildings and water sources
  – Implements per-well impact fee
  – (Denial of impact fees to communities with local zoning struck down by courts)
What shapes gas development?

• **County Planning Commissions**
  - Persuasive powers
    - Assist in creation of comprehensive plans
    - Technical assistance to municipalities for Subdivision & Land Development Ordinances
  - Strategic investment
    - Identify means to effectively link land use, transportation, and economic development
    - Employment training, employee relations, benefits, compensation and safety
    - Social services, housing, health
  - Recording
    - Leases
    - Pipeline locations
What shapes gas development?

• Landowner choices or negotiations:
  – Lease conditions may be imposed by the mineral rights owner
  – Pipeline locations may be negotiated by the surface owner
  – Water withdrawal and impoundment locations
  – Equipment storage and staging areas

• “Good neighbor” industry policies:
  – Proactively upgrade roads and infrastructure
  – Protect landowner values—agricultural, wildlife, recreational, scenic—to maintain community goodwill
Implementing Geodesign

• Emphasize geodesign thinking vs. doing
  – Unsure of the robustness of students’ GIS skills
  – Completely confident about my own lack of skills
  – IT staff not able to provide GIS support

• Example project foci
  – Impacts of different gas development scenarios
  – Implications of land use change for downstream flood-prone communities.
  – Impacts of resource development on existing landscape values.
  – Long-term energy security of the region.
  – Alternative futures for existing small-towns.
Build-out of the Marcellus gas industry

- Base data for impact estimates: Nature Conservancy projections of well numbers
Estimating extent of land impacts

- **Alternate pipeline location strategies**
  - Shortest-distance, Market-driven, Conservation

![Diagram showing pipeline locations and environmental impacts](image)

158 Stream crossings
18 Homes displaced
84 Wetlands impacted
1,648 Properties impacted
0.56 Miles per well

148 Stream crossings
3 Homes displaced
49 Wetlands impacted
1,248 Properties impacted
0.63 Miles per well

124 Stream crossings
10 Homes displaced
19 Wetlands impacted
2,198 Properties impacted
0.66 Miles per well

Geodesign analysis and images: Megan Prikockis, Danielle Sette
Watershed protection

- Run-off, downstream flood impacts, effects of alternate pipeline corridor treatments

- Montoursville, PA Tropical Storm Lee, Fall 2011
- Reduced land cover, full gas build-out
- Pipeline corridor BMP mitigation

Geodesign analysis and images: Emily Carlson, Elliott Shibley
Protecting visual values

• Impacts of land use change
  – Project impacts on visual quality rating

Regression model projects visual quality implications of land use change

Geodesign analysis and images: Michelle Zucker, Brianna Hammond
Renewable energy potential

- Future adaptations of gas infrastructure

Land suitability for wind, solar, biomass—and return on investment

Geodesign analysis and images: Chris Maurer, Mick Humes, Preston Linck
Plan to preserve future opportunities

- Walkability and retail vs. sprawl

Example of Change: **Mixed Use zoning in Downtown Dushore**
Currently 238,047 sq. ft. of Commercial Space - Could add approximately 15,000 sq. ft. or a 6% increase
Currently 1,235,213 sq. ft. of Residential Space - Could add approximately 45,000 sq. ft. or a 3.6% increase
Block size restricted to 300’x500’
Street trees on both sides of street
Zero foot front set back
Min. 2 stories max. 3
On-street parking both sides of street

**Walkability scores**

Geodesign analysis and images: Jennie Ryan
Telling the story

• **Illustrative web interface**
  – Under development using Drupal 7.0 CMS – mobile-friendly and providing consistent interface to student work.
  – Display interface designed to address range of typical design questions.
  – Solutions accompanied by data and algorithms used in analyses.
  – Allow reapplication of rules with changed model parameters.
  – Feed to tablet-based interactive tool for field use.
Anticipate the implications of plans

Geodesign analysis and images: Nick Monroe

Geodesign analysis and images: Sarah Rumbaugh, Kyle Altenbach
...and propose alternates
Meaningful change by landowners...

Visualize the impacts of alternate design approaches

Geodesign analysis and images: Nick Monroe
...can have broad benefits

Align pipelines and roads, buffer riparian areas

Geodesign analysis and images: Nick Monroe
Geodesign in design and planning…

- Reconciles multiple needs and values
- Operates at multiple scales, simultaneously
- Engages citizens and communities in finding solutions
- Communicates the implications of change, for the short term and over time
- Engaging, interactive, revealing, repeatable
On-line geodesign coursework: http://geodesign.psu.edu

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