Marcellus Shale Academic Research Conference, May 30-31, 2012 in Pittsburgh, PA

Workshop "The Changing Landscape: Planning and Design for Land Use Impacts"

Position paper[1]

Introduction

The Marcellus shale gas exploration and exploitation taking place in much of Pennsylvania, parts of West Virginia, New York, Maryland and Ohio has emerged as a widespread phenomenon with the potential to bring significant change to land use, the landscape, and economic well-being in the region. This phenomenon is founded on a multitude of individual transactions between landowners and natural gas companies in areas where centralized planning is viewed with skepticism. The gas extraction relies on new and unconventional methods of drilling that have dramatically transformed peoples' expectations of a familiar industry; there are no accumulated community resources of scientific knowledge or learned consensus on the benefits and risks of gas extraction; the political and jurisdictional landscape is fragmented; and planning and zoning authorities are few.

The speed with which the potential of the resource has been identified and then moved to aggressive development is unprecedented and provides a unique challenge. Elsewhere in the U.S. when similar-sized challenges have emerged in the past, identification of a significant need for concerted planning has been addressed by the establishment of major planning authorities. Examples include the Tennessee Valley Authority, the Chesapeake Bay Partnership, the Appalachian Regional Commission, the Delaware Valley Regional Planning Commission, and the San Francisco Bay Conservation and Development Commission. These initiatives have been established to find integrated solutions for landscape development, including the economy, communities, and the environment. Currently there are no such collective planning and design efforts for the Marcellus Shale region in the context of natural gas extraction.

While our current political climate both locally and regionally appears to dictate against the creation of coordinated planning bodies with broad authority to regulate development, the scale and potential impact of Marcellus shale gas development requires that we ask if the science and art of planning can help address these profound challenges? This paper identifies four key issues that we feel need to be discussed for future research. State of the art concepts are briefly described for each key issue and questions for the workshop are asked. The examples and questions are meant to trigger discussion. Participants of the workshop are asked to bring in more examples and to ask new questions for the discussion. The goal of the workshop is to develop a shared understanding of research and study priorities for land use planning in the Marcellus Shale region that will lead to a research and knowledge-development agenda for academics, industry and planning advocates. Workshop conveners will help participants articulate clear action items and commitments that will lead to the creation of such an agenda.

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Key Issue 1: Building a Body of Knowledge

The positive and negative impacts of natural gas extraction on the social and biophysical landscape in the Marcellus Shale Region vary in scale, pace and intensity. The quality, scope and widespread acceptability of the information available to communities and planners will be the foundation upon which any concerted response will rest. Much research is already available on these impacts. Research is done by:

- universities, e.g. the universities participating in this workshop;
- industry (R&D), e.g. the energy industry;
- community-based organizations, e.g. watersheds groups.

Research findings are shared on the following websites (among others):
http://www.marcellus.psu.edu
http://extension.psu.edu/naturalgas
http://marcelluscoalition.org
http://www.marcellus-shale.us
http://www.portal.state.pa.us/portal/server.pt/community/marcellus_shale/20296
http://www.epa.gov/region3/marcellus_shale/

Problems exist, though, in moving the available information to the status of an accepted Body of Knowledge. There is no single accepted scope or scale of inquiry around which concerns about either natural or social systems are focused or coordinated. Thus there is huge variation in datasets, the scale of existing studies, research approaches, research outcomes, their reliability and uncertainties. Different worldviews and the balance of advocacy and discovery in individual studies can also have an impact on the type of research and the utility of research outcomes.[2]

From a planning perspective it would be extremely helpful to develop a shared Body of Knowledge that mediates these differences and is based upon a shared conceptualization of the Marcellus Shale impacts. We describe two examples of concepts for illustrative purposes only.

The *Drivers–Pressures–State–Impacts–Responses* (DPSIR) framework includes all elements of the chain between human activities, their environmental impacts, and the societal responses to these impacts (Figure 1).[3]

- Indicators for driving forces describe the social, demographic and economic developments in societies and the corresponding changes in lifestyles, overall levels of consumption and

[2] In a Kuhnian sense, a *worldview* is a set of implicit and explicit guides or examples defining the world and the questions and methods for analyzing the world. Examples of worldviews include 'sustainable development', 'survivalism', 'technological problem solving', and 'green radicalism' (Dryzek, 2005). Also the 'recipients' of science have different worldviews, i.e. the public, planners and decision-makers. Scientific outcomes are often contested because they do not fit in a particular worldview. By *advocacy* we mean the degree by which researchers engage with the public and policy-makers in their research (for scientific, moral or political reasons).

[3] The following description is adapted from: *Environmental Indicators: Typology and Use in Reporting*, Internal Working Paper European Environmental Organization (2003). Marcellus Shale examples have been included by the authors.

production patterns. For the Marcellus Shale region the U.S. and global energy need is an example of a driving force.

- Pressure indicators describe developments in release of substances (emissions), physical and biological agents, the use of resources and the use of land by human activities. All these pressures are at play in the Marcellus Shale region.
- State indicators give a description of the quantity and quality of physical, biological, and chemical phenomena in a certain area. For the Marcellus Shale region state indicators may, for example, describe the forest and wildlife resources present, the existing water quality, or the level of noise near drilling sites.
- Impact indicators are used to describe changes in the functions and use of the environment, such as human and ecosystem health, resources availability, losses of manufactured capital, and biodiversity. The lowering of stream flow levels is an example of a potential impact of water use for natural gas extraction in the Marcellus Shale region.
- Response indicators refer to responses by groups (and individuals) in society, as well as government attempts to prevent, compensate, ameliorate or adapt to impacts, changes in the state of the environment, pressures or driving forces. Examples for the Marcellus Shale region include clean technologies, zoning, permitting, and nature restoration.

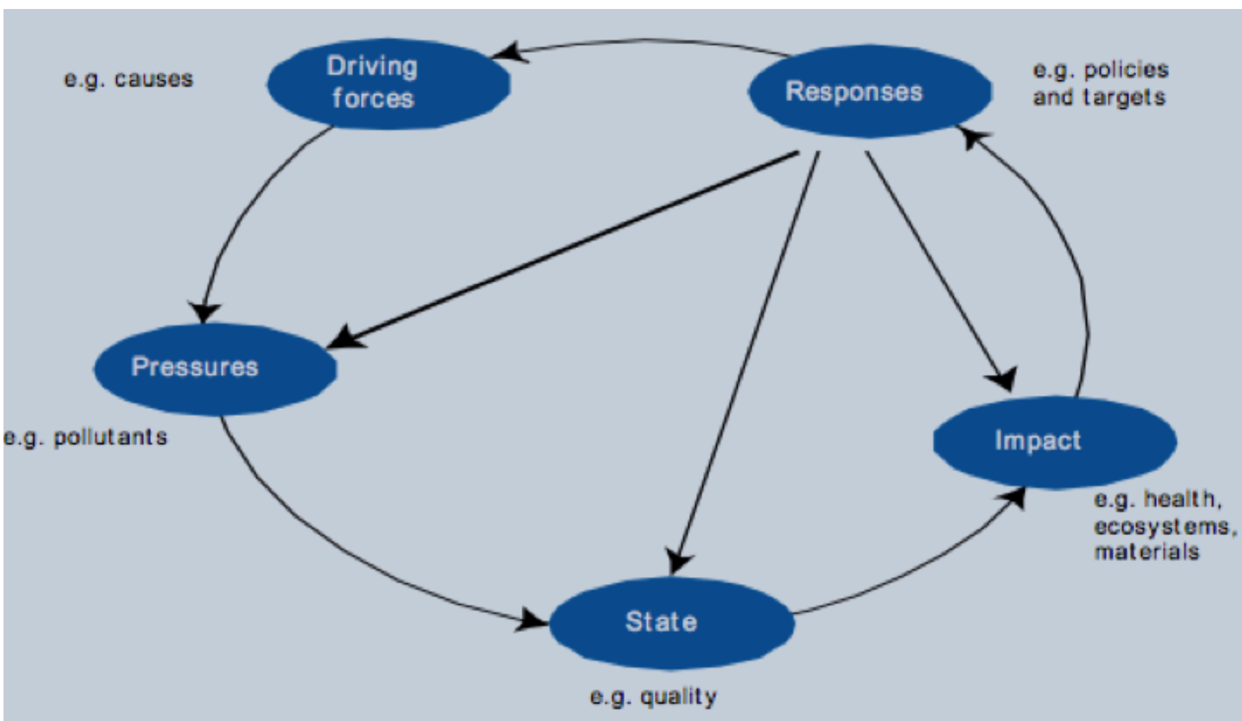


Figure 1. The DPSIR framework for reporting on environmental issues. Source: European Environmental Organization (2003).

The *People-Planet-Profit framework* (Telos, 2006) divides the three capitals of sustainability (socio-cultural, ecological, economic into a number of stocks:

- Socio-cultural ('people'): Citizenship, health, education, living conditions, art & cultural heritage, solidarity, identity and diversity;
- Ecological ('planet'): Nature, soil, groundwater, air, surface water, minerals, landscape;
- Economic ('profit'): Labor, capital, knowledge, raw and auxiliary materials, spatial location conditions, economic structure.

According to the method requirements and indicators are formulated per stock for measuring the stocks. Then the effects of policy measures on these stocks are assessed as well as unforeseen consequences.

Starting questions for the workshop:
(1) How important is a shared knowledge base for future planning efforts?
(2) What would be the major components of such a knowledge base?
(3) What are the main challenges?
(4) How can a knowledge base be organized?

Key Issue 2: Modeling Complex Landscape Systems

The management of natural resources (e.g. natural gas, soil, water, biodiversity) and human activities (e.g. food production, housing, movement, pollution) in the Marcellus Shale landscape can have unintended consequences. There is now growing insight into the often unpredictable behavior of what is called 'social-ecological' systems' (SES). Leading examples of SES research are described below.

Starting from the *Common Pool Resources* framework, Nobel Prize Winner Elinor Ostrom (2009) describes a SES as follows (see also Figure 2): "In a complex SES, subsystems such as a resource system (e.g., a coastal fishery), resource units (lobsters), users (fishers), and governance systems (organizations and rules that govern fishing on that coast) are relatively separable but interact to produce outcomes at the SES level, which in turn feed back to affect these subsystems and their components, as well other larger or smaller SESs."

"[...] the long-term sustainability of rules devised at a focal SES level depends on monitoring and enforcement as well their not being overruled by larger government policies. The long-term effectiveness of rules has been shown in recent studies of forests in multiple countries to depend on users' willingness to monitor one another's harvesting practices [...]. Larger-scale governance systems may either facilitate or destroy governance systems at a focal SES level. The colonial powers in Africa, Asia, and Latin America, for example, did not recognize local resource institutions that had been developed over centuries and imposed their own rules, which frequently led to overuse if not destruction [...]"

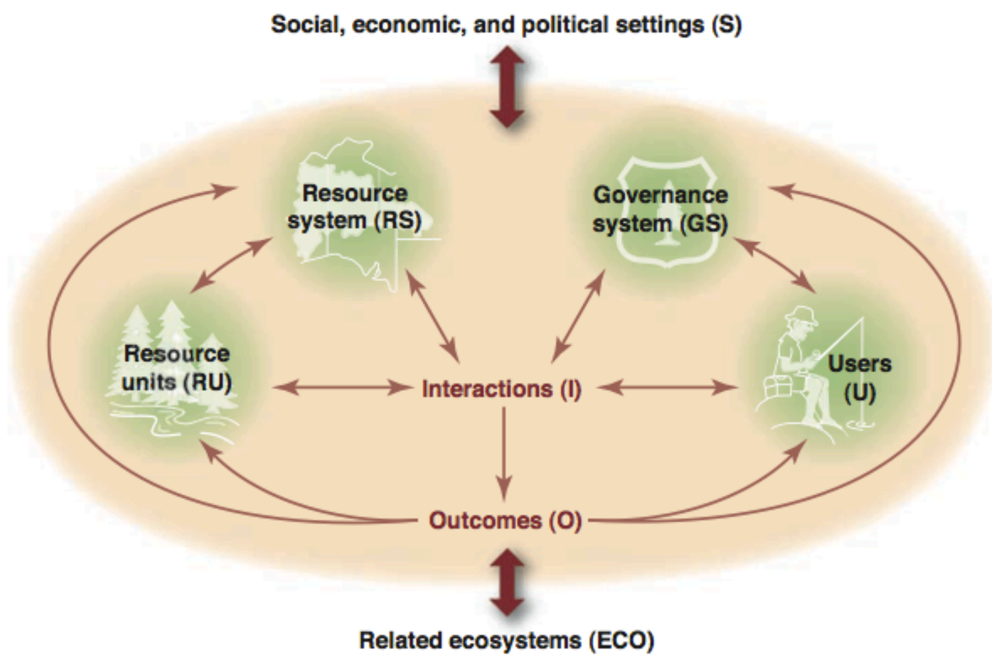


Figure 2. The core subsystems in a framework for analyzing social-ecological systems. Source: A General Framework for Analyzing Sustainability of Social-Ecological Systems, Elinor Ostrom, *Science* 325, 419 (2009).

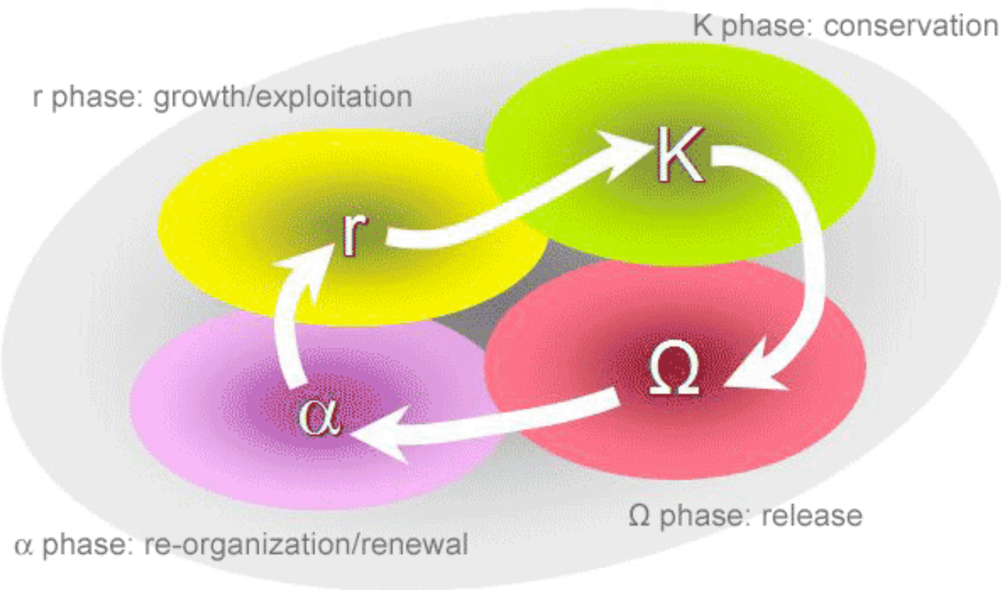
The *Resilience Alliance* is a research organization comprised of scientists and practitioners from many disciplines who collaborate to explore the dynamics of social-ecological systems (www.resalliance.org). The 'adaptive cycle' is one of their key concepts and is described as follows (quoted from the website): "For ecosystem and social-ecological system dynamics that can be represented by an adaptive cycle, four distinct phases have been identified: growth or exploitation (r), conservation (K), collapse or release (omega), and reorganization (alpha). The adaptive cycle exhibits two major phases (or transitions). The first, often referred to as the foreloop, from r to K, is the slow, incremental phase of growth and accumulation. The second, referred to as the backloop, from Omega to Alpha, is the rapid phase of reorganization leading to renewal.

During the slow sequence from exploitation to conservation, connectedness and stability increase and a capital of nutrients and biomass (in ecosystems) is slowly accumulated and sequestered. Competitive processes lead to a few species becoming dominant, with diversity retained in residual pockets preserved in a patchy landscape. While the accumulated capital is sequestered for the growing, maturing ecosystem, it also represents a gradual increase in the potential for other kinds of ecosystems and futures. For an economic or social system, the accumulating potential could as well be from the skills, networks of human relationships, and mutual trust that are incrementally developed and tested during the progression from r to K."

The Resilience Alliance publishes books, workbooks and publishes the Journal of Ecology and Society (http://www.ecologyandsociety.org).[4]

[4] A related book (but not on the website) is *Critical Transitions in Nature and Society* by Marten Scheffer (2009).

Figure 3. Adaptive cycle. Source: http://www.resalliance.org



The *Global Land Project* (GLP) is another joint research project (www.globallandproject.org). It coordinates research for land systems for the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme on Global Environmental Change (IHDP). The focus of GLP is largely 'land-centric' which includes the people, biota, and natural resources (air, water, plants, animals, and soil). The research critically emphasizes changes in coupled human and environmental systems.

Starting questions for the workshop:

(1) How can an interdisciplinary approach for natural and social systems be developed for the Marcellus Shale Region, e.g. by using land use models?

(2) Are the concepts described above helpful or too abstract at this point?

(3) How can such an approach be utilized by planners, industry and government?

Key Issue 3: Scale-sensitive Governance of Complex Landscape Systems[5]

Scale is a means to describe landscape systems. Scale has both spatial and temporal dimensions. Spatial scale describes the size of a landscape system and the full range of levels within a landscape system. Next to spatial and temporal scales, Cash et al. (2006) identify jurisdictional, institutional, management, knowledge, and network scales, see Figure 4. A challenge for planning of responses to Marcellus shale gas development is the necessity for

[5] Governance is described here as the system of actors, political discourse, resources and rules that emerges as a pattern from policy activities and at the same time structures these policy activities.

planning NOT to be scale-bound. Regional-scale effects are demonstrably the outcome of numerous individual actions, each with its own built-in constraints and logic. Scale-sensitive and scale-responsive governance of landscape systems must anticipate cross-level and cross-scale dynamics in landscape systems.

Scale is both a characteristic of a complex landscape system (ontology: the nature of being) and a 'lens' through which that landscape is observed and analyzed (epistemology: how is knowledge acquired). This means that the description of a landscape system is not simply neutral, but also depends on the scale of observation, data collection, and data representation. At a deeper level it means that the scientific practice itself defines the landscape system and hence policy decisions that rest upon this definition.[6]

Scale can also be used as a political device to influence policy outcomes. People bring forward different scales (administrative, geographic, agricultural, temporal) and specific levels to make their point. They mix scales to build their arguments and to reveal or obscure the interests at stake. They frame scales to include or exclude arguments and other actors and to shift responsibilities. Not being aware or neglecting how the interests of various groups will try to influence the scale of planning may lead to plans reflecting self-interest and often leading to social conflict.[7]

Different governance approaches exist that address scale:[8]

- In monocentric governance the state is the center of political power. Through hierarchical mechanisms the power of the lower level governments is restricted by the higher level governments. This approach searches for the ideal scale to do this job (e.g. by creating new authorities).
- In multilevel governance, government and private entities operate at and between several administrative scale levels to realize collective goals. The underlying assumption is that dispersion of governance across multiple scales is more efficient and normatively superior to monocentric governance.
- Adaptive governance acknowledges that managed resources will change as a result of human intervention, that surprises are inevitable, and that new uncertainties will emerge. Adaptive governance embraces learning processes aimed at enhancing the fit between and among (1) relevant governance scales (jurisdictional, institutional, management, knowledge scales) and the spatial and temporal scales of a landscape system and (2) creating better linkages between levels. Adaptive governance is increasingly considered the appropriate way of governing complex landscape systems.

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[6] How scientific practices influence public policy is the field of Science, Technology and Society studies.

[7] There is now an extensive body of literature on this field of the 'politics of scale' in human geography and political ecology.

[8] Katrien Termeer et al., Disentangling Scale Approaches in Governance Research: Comparing Monocentric, Multilevel, and Adaptive Governance, *Ecology and Society* 15 (4): 29 (2010).

The Earth System Governance Project (www.earthsystemgovernance.org) is a global research program exploring various types of governance and is a core project of the International Human Dimensions Programme on Global Environmental Change (IHDP). Its Science Plan is organized around five analytical problems:

- The emergence, design and effectiveness of governance systems as well as the overall integration of global, regional, national and local governance.
- The agents that drive earth system governance and that need to be involved, especially the influence, roles and responsibilities of actors apart from national governments, such as business and non-profit organizations.
- The inherent uncertainties in human and natural systems and the adaptiveness of earth system governance, i.e. the combination of stability to ensure long-term governance solutions with flexibility to react quickly to new findings and developments.
- The accountability, legitimacy and the democratic quality of earth system governance.
- Justice, fairness, and equity in the access to goods and their allocation.

The role of power, knowledge, norms and scale are cross-cutting research themes.

Starting questions for the workshop:

(1) In the adaptive governance model there is no single hierarchical control point that can control development but rather a network of actors, jointly influencing decision making. How can a planning model be developed that bridges the adaptive approach with the extant fragmented jurisdictional landscape in the Marcellus Shale region? Who has the authority to plan?

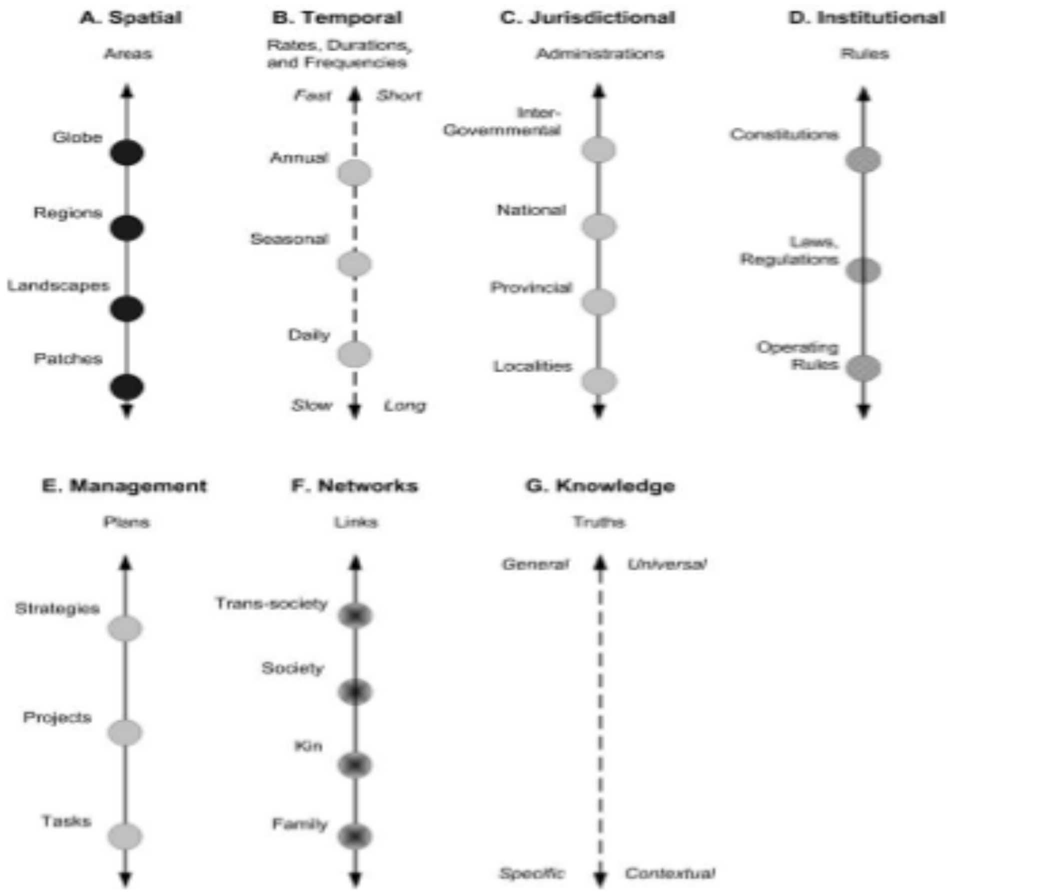
(2) Below are a few practical planning questions. The answers are never easy because many scale and governance aspects are involved (see above). How can we incorporate these aspects in the planning model?

"How will the increased sediment run-off from that heavy vehicle parking lot impact my stream, depending on the slope, permeability, and vegetation on the ground in-between?"

"If all of the landowners in the valley lease all of our property today how will that change the aesthetic character of the landscape for our children and grandchildren? Could we balance our leases to provide income today, while preserving the core values of our rural landscape?"

"The pipeline company wants all of its gathering lines to run through the woods opposite--but that view is the main reason people around here chose these spots to build. What can we do to maintain the beauty of the landscape yet still give the pipeline company an economically viable option?"

Figure 4. Schematic illustrations of different scales and levels that are critical in understanding complex landscape systems. Source: Scale and Cross-Scale Dynamics: Governance and Information in a Multilevel World, David Cash et al., *Ecology and Society*, 11 (2) (2006).



Key Issue 4: Planning Tools and Technologies

A comprehensive approach to planning for the Marcellus Shale region as outlined above is obviously a high ambition. In practice this high ambition can be problematic because of a lack of data, workable knowledge, and planning capacity in the community, government and industry. Impacts Assessments (IA) and Planning Support Systems (PSS) can empower communities to create and implement plans and designs that work.

At an elementary level, IA and PSS can help planners to identify and evaluate available data, system dynamics, the scales of planning, jurisdictions, laws and regulations, available data, and potential impacts and to bring such information to their desk in a meaningful way. At an advanced level, the planning tools and technologies will help planners in the community, government, and industry to build their own planning approach, ideally using the outcome of the previous research (knowledge base, landscape models, scale-sensitive planning models).

Impact Assessment (IA)
An Impact Assessment (IA) is the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made. An IA has a dual nature, each with its own methodological approaches. On the one hand it is a technical tool for analysis of the consequences of a planned intervention (policy, plan, program, project), providing information to stake-holders and decision-makers; or unplanned events, such as natural disasters, war and conflicts. On the other hand, an IA is a legal and institutional procedure linked to the decision-making process of a planned intervention.[9] A landscape assessment is a special type of IA and is concerned with the quality of the landscape.

Planning Support Systems (PSS)
PSSs include a wide range of tools and processes which help support planning activities by presenting decision-makers with information germane to the planning question they face, presented to reveal the value judgments inherent to the data and analytical models available, and designed to reveal the implications of actions and evaluations applied in the decision-making process. Technical tools may include computer-based databases and models, websites and other user interfaces used at meetings. They supplement more traditional mean of gathering feedback on planning proposals, and for empowering citizens to explore potential scenarios and comprehend and address project impacts.

A wide range of geo-technology tools have evolved to help support planning processes. Geographical information systems (GIS) and spatial decision support systems (SDSS) are among the forms of PSS, as well as more integrated software and modeling tools such as CommunityViz, What If?, and INDEX.[10] Visual displays are widely used as a means to convey complex and technical information to non-expert audiences. Those range from hardware devices such as MapTable, to photo-realistic renditions, animations and virtual realities. Websites and interactive user interfaces used at meetings as well as in the field are among the technologies currently being employed to gather feedback and explore alternate futures (see Figures 5 and 6 for examples).

There are several challenges for introducing technologically intensive PPSs, e.g. limited staff capacity, costs of hardware and software, differing abilities among individuals to use technology or to understand spatial information, user-friendliness, lack of data and access to that data.[11] However, the advent of more accessible tools based on wireless tablet and smart-phone technology have the potential to reduce these barriers. The visual displays of phones and tablets increasingly enable users to project and interrogate visual representations of present and future scenarios. Devices with inbuilt camera, GPS, compass and accelerometer could register those representations alongside or over the real landscape captured through the lens of

[9] Quoted and adapted from the website of the International Association for Impact Assessment.

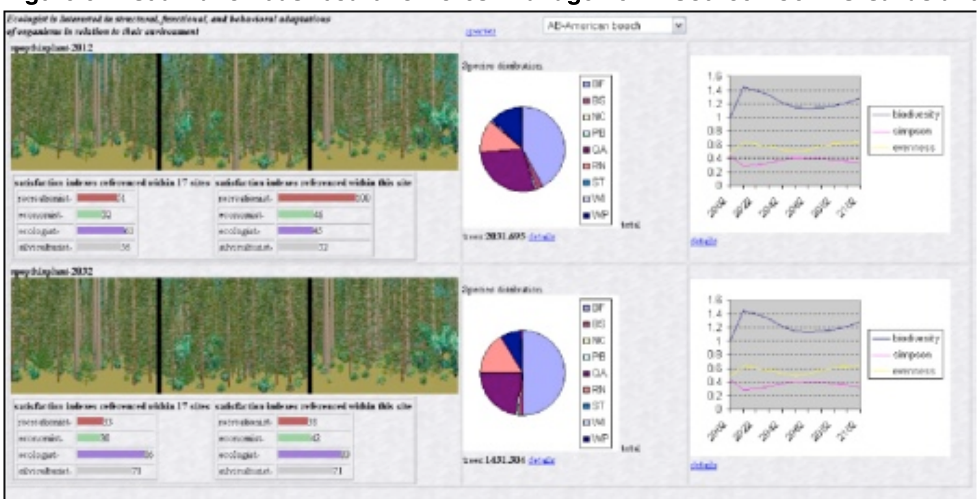
[10] *Technology in Planning and Participatory Processes: Identifying New Synergies through Real World Application*, Carissa Schively Slotterback & John Hourdos, University of Minnesota (2007). See this report for references.

[11] Ibid.

the device. Within their own storage or wirelessly, users could recall a broad range of non-visual information about the setting.

Figure 5. Images of alternate future conditions for a planned neighborhood. Source: Jeffrey Fitzpatrick, MLA Thesis, PSU, 2008.

Figure 6. Visualization dashboard for forest management. Source: Cenk Ursavas and Brian Orland.



Technology intensive PPS will significantly change participatory processes, for example to help the public make more informed decisions and encourage interaction, to increase participants' understanding of planning issues, to facilitate a less top-down approach to planning that emphasizes the communicative (collaborative) component of planning among multiple stakeholders, to facilitate consensus-building as participants become oriented as a group to the relevant data, context, and problems, to empower participants, to allow users to manipulate scenarios and respond to queries by participants, to allow participation in a more efficient and engaging manner, and to capture participants' comments at a meeting in a public setting.[12]

Starting questions for the workshop:

(1) What do you think of the idea of developing new tools and technologies for planning and managing Marcellus Shale activity?

(2) How would they look like, what 'building blocks' already exist?

[12] Ibid.