Managing the risks of shale gas development: a new RFF study

Dr. Sheila M. Olmstead

Groundwater Protection Council Annual Forum

Atlanta, GA

September 27, 2011

RESOURCES FOR THE FUTURE

What is Resources for the Future?

- RFF is a nonprofit, nonpartisan, independent research organization in Washington, DC, founded in 1952.
- RFF pioneered the application of economics to the development of more effective policy about the use and conservation of natural resources.
- Currently houses about 40 scholars, primarily PhD economists.
- Research issues include: pollution control, energy and transportation policy, land and water use, hazardous waste, climate change, biodiversity, ecosystem management.

RESOURCES FOR THE FUTURE

Current RFF projects related to shale gas (Center for Energy Economics and Policy)

- Natural Gas: A Bridge to a Low-Carbon Future?
  - Impact of shale gas on energy supply, demand, CO_2 emissions under different climate policy scenarios.

- Several projects on LNG vehicles.
  - Will Natural Gas Vehicles Be In Our Future?
  - Energy, GHG, and Economic Implications of Natural Gas Trucks

- Managing the Risks of Shale Gas: Identifying a Pathway toward Responsible Development
  - Funded by the Alfred P. Sloan Foundation ($1.2 million, 18 mos.)

RESOURCES FOR THE FUTURE

New RFF shale gas study: 5 objectives

1. Survey expert opinions on the risks of shale gas development.
2. Survey public perceptions and preferences regarding the risks and benefits of shale gas development.
3. Assess the drivers of and policy levers to reduce risks.
4. Understand the current and prospective regulatory landscape.
5. Develop recommendations for government regulation (all levels) & voluntary action by firms to reduce risks.

Early work on objective #1: understanding risks from experts' perspective

- Currently developing "risk matrices".
- Next step: develop "impact pathways" for selected risks.
  - Activities/Sources of risk → burden → intermediate impact(s) → final impact(s)
- Impact pathways will form the basis of a survey (of academics, private industry, NGOs, and regulators).
  - Which risks are most salient, given what we know from current science?
  - Can risks be ranked, relative to each other, taking uncertainty into account?

RESOURCES FOR THE FUTURE

Risk matrix example: activities → intermediate impacts

Activities/ sources of risk	Ground water	Surface Water	Soil	Air	Habitat disruption	Community disruption	Seismic activity
Site development		Burden #					
Vertical drilling							
Horizontal drilling							
Fracturing and completion							
Production							
Workovers							
Plugging and abandonment							

RESOURCES FOR THE FUTURE

Risk matrices: categories of potential burdens

- Air pollutants
- Drilling fluids and cuttings
- Fracturing fluids
- Flowback constituents other than fracturing fluids
- Produced water constituents
- Habitat and community disruptions
- Other (e.g., water withdrawals)

Risk matrix: a more detailed look

Table 1: Burdens and Intermediate Impacts from Shale Gas Development	INTERMEDIATE IMPACTS							
ACTIVITY SOURCE OF RISK	Groundwater	Surface water	Soil quality	Air quality	Habitat disruption	Community disruption	Occupational hazard	Seismic activity
Site development and drilling preparation							49, 50	
Clearing of land for roads, well pads, pipelines, evaporation ponds, other infrastructure					40	43		
Construction of roads, well pads, pipelines, evaporation ponds, other infrastructure				5		42, 43		
On-road vehicle activity				5		43, 46		
Off-road vehicle activity				5		43		
Placement of water in ponds	51	51	?			46		
Vertical drilling						40	49, 50	
Drilling equipment operation				I		40		
Cementing								
Casing								
On-road vehicle activity				5		43, 46		
Off-road vehicle activity				5		43		
Use of surface water and groundwater	51	51	?			46		
Gas migration (e.g. biogenic methane) from above formation				3b				
Venting, flaring of methane	3b	3b		3b		44		
Release of fugitive methane								
Storage, leakage of drilling fluids at surface	II	II	II	II	II			
Disposal of drilling fluids	II	II	II	II	II			
Accidental releases from wellbore (e.g. blowouts)	II	II	II	II	II			
Disposal of drill solids, cuttings	II	II	II					

Risk matrix: burdens → final impacts

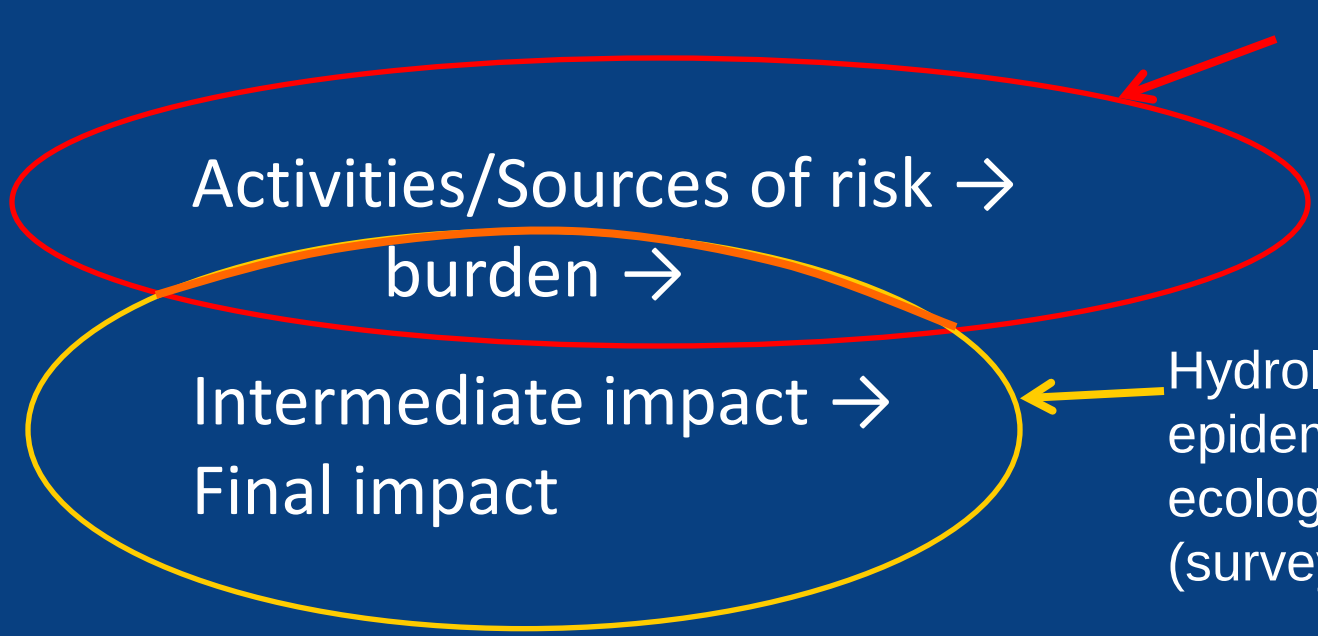
Burdens (full list)	Health (morbidity, mortality)	Market (ag, tourism, Industry)	Ecosystem (biodiversity, habitat)	Climate change	Quality of Life (time loss, aesthetics, recreation)
Air pollutants					
Drilling fluids and cuttings					
Etc.					

RESOURCES FOR THE FUTURE

Priority impact pathways: potential (illustrative) examples

- Well pad construction → diesel emissions → air quality degradation (e.g., PM) → respiratory disease, cancer, mortality
- Produced water treatment and disposal → waste emissions → surface water quality degradation → species or habitat loss
- Casing of vertical well → cement failure → methane entering groundwater → explosion → morbidity, mortality

Impact pathway development: different expertise at different stages



Engineers, other physical scientists (consultants on our team)

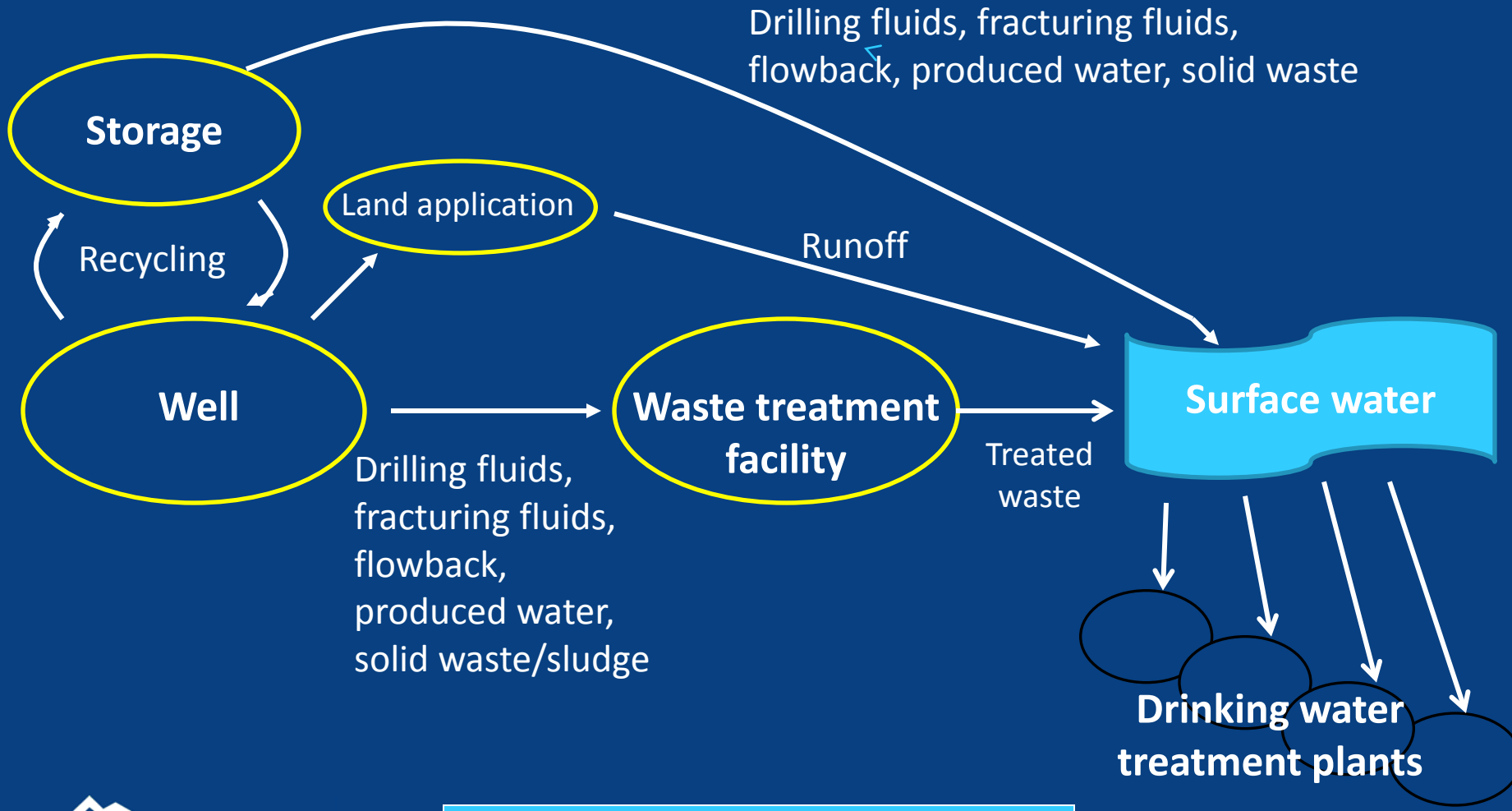
Hydrologists, epidemiologists, agronomists, ecologists,… (survey recipients)

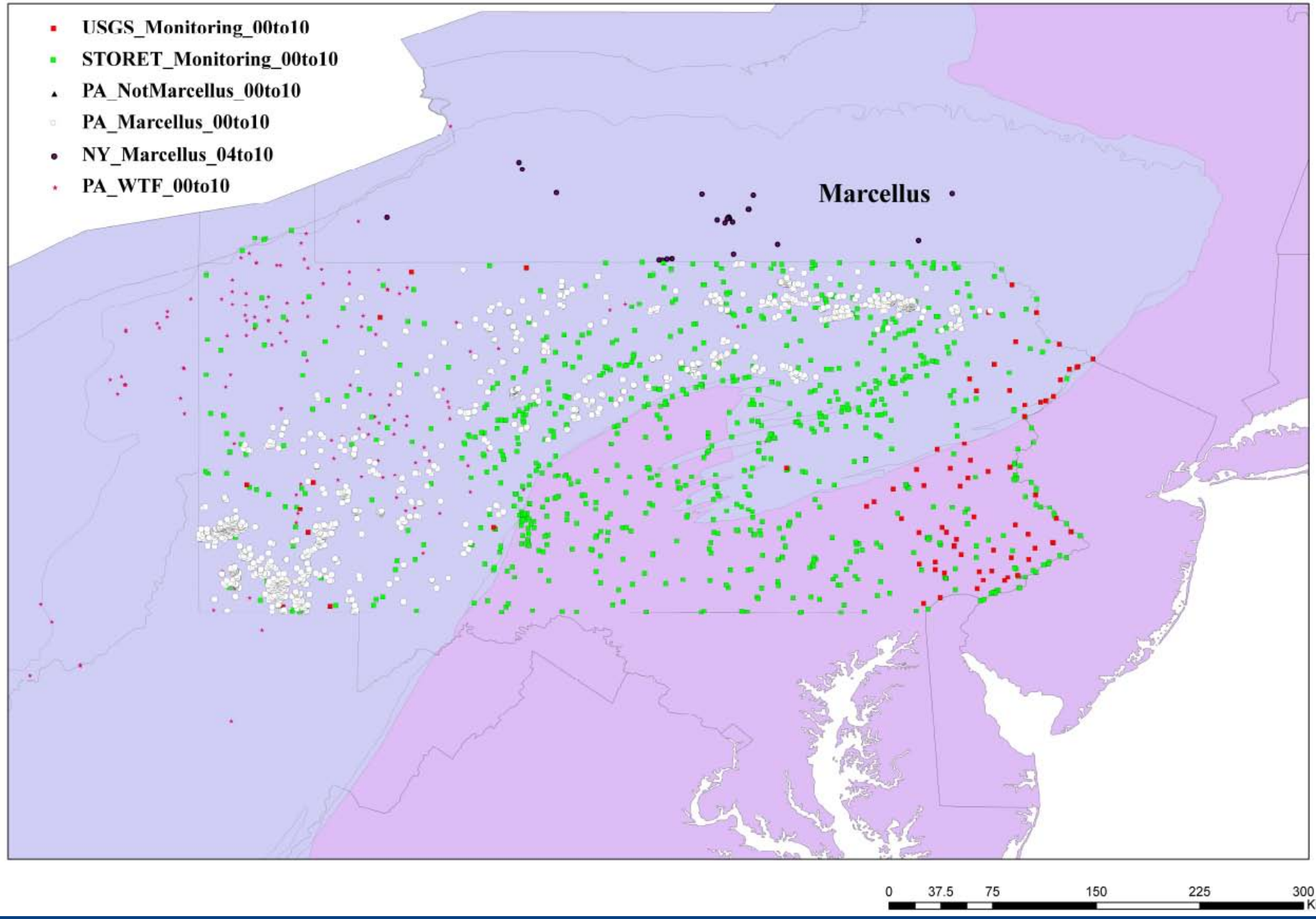
Early work on objective #3: understanding risk drivers

- Much of this work will wait for results of expert and public surveys, so that we analyze “drivers” of risks identified as most salient (to both experts and public).

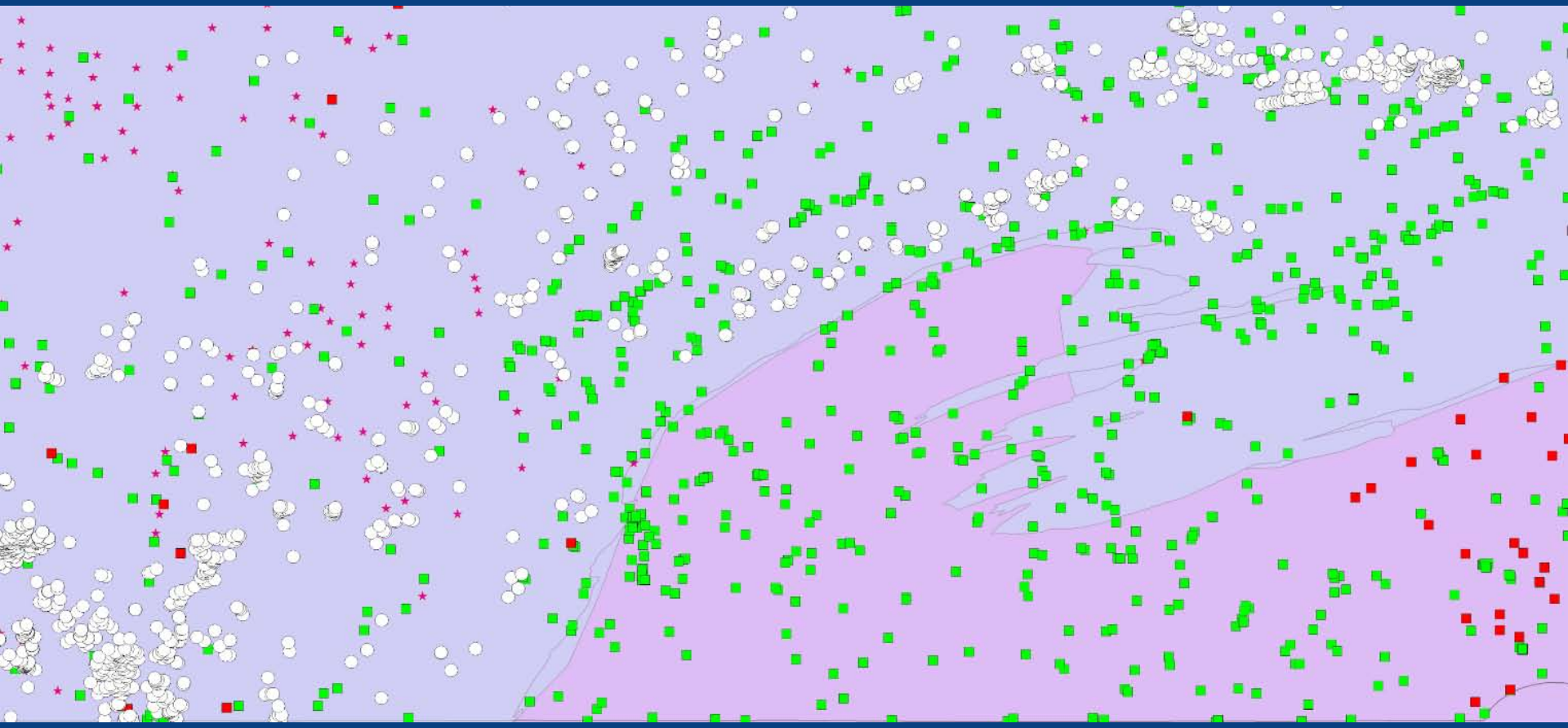
- Given 18-mo. project timeline, have started in two directions:
  - Major data collection effort to support eventual empirical analyses of risk drivers
  - Early focus on surface water quality impacts in Marcellus (PA/NY)

Flowchart for surface water contamination analyses (Marcellus)




USGS_Monitoring_00to10
STORET_Monitoring_00to10
PA_NotMarcellus_00to10
PA_Marcellus_00to10
NY_Marcellus_04to10
PA_WTF_00to10
Marcellus
0
37.5
75
150
225
300
Kilometers

Shale gas wells, WWTPs, and water quality monitors in PA Marcellus



RESOURCES FOR THE FUTURE

Surface water quality analysis, cont.

- Statistical analysis of relationships between:
  - occurrence of surface water contaminants (e.g., TSS, TDS, Chloride) at monitors; and
  - density of shale gas wells upstream, shipments of waste to private and municipal WWTPs upstream.

- Statistical analysis of factors that may be driving these relationships, if any:
  - well characteristics
  - waste shipment characteristics
  - firm characteristics
  - regulatory environment

Several other analyses planned, with other topics TBD after surveys

- Would like to do similar analysis for groundwater, but still identifying a large-N database of groundwater quality monitors (need pre- and post- drilling)
  - Suggestions?
- Local road wear and tear/damage.
- Air quality.

RESOURCES FOR THE FUTURE

Shale gas studies underway by other organizations

- U.S. Environmental Protection Agency
- U.S. Department of Energy SEAB
- University of Texas at Austin
- National Renewable Energy Laboratory
- Groups developing BMPs/model regs (EDF in cooperation with firms, NPC)

RESOURCES FOR THE FUTURE

Unique contributions of RFF study

- Focus on *behavioral* aspects of shale gas development risks
  - How individuals assess risks and benefits
  - How behavior of firms, well operators affect risks
  - How regulations have affected risks to date and can do so cost-effectively in the future

- Analysis of *public* preferences and perceptions
  - Structured economic survey will simulate tradeoffs between risk reduction (firms, regs) and higher costs.
  - Informs "monetization" of potential benefits of regulation/ voluntary actions by firms, to be balanced against costs.

Thank you!

Sheila M. Olmstead
Resources for the Future
1616 P Street, NW
Washington, DC
olmstead@rff.org
www.rff.org/ceep

RESOURCES FOR THE FUTURE