Integrated Modeling of the Food, Energy, and Water System

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Overview of My Talk

- Present a conceptual model of the FEW System
- Building an integrated model
- Willamette Water 2100
- Key challenges
Production

Land \rightarrow Inputs \rightarrow Producers

Energy \rightarrow Inputs \rightarrow Producers

Food \rightarrow Outputs \rightarrow Producers

Water \rightarrow Inputs \rightarrow Producers
Markets

Markets

Land

Energy

Food

Inputs

Prices

Inputs

Prices

Prices

Outputs

Producers

Water

Inputs
Externalities

Markets
- Land
- Energy
- Food

Inputs
- Prices

Outputs
- Prices

Environment
- Water
- Air
- Soil

Externalities

Producers
Closing the Loop

Markets

Land | Energy | Food

Inputs Prices | Inputs Prices | Prices

Outputs

Producers

Policy

Environment

Water | Air | Soil

Inputs

Externalities

Feedbacks

Feedbacks
Building an integrated model

- What is the study region?
- What are the spatial and temporal scales?
- How are the economic and biophysical models linked?
Willamette Water 2100

Roy Haggerty (Principal Investigator)

water.oregonstate.edu/ww2100
Willamette Basin
29728 km²  12% of Oregon

- Will climate change and human activity create water scarcity?
- Where is water scarcity most likely to impact ecosystems and communities?
WW2100 Modeling Framework

**Water Supply**
- Snow Dynamics
- Hydrology

**Water Allocation**
- Reservoir Operations
- Water Rights

**Water Demand**
- Urban
- Agriculture
- Forests
- Fish
- Land Use Transitions
- Irrigation and Crop Decisions
- Forest State & Transition
- Land Rent
- Urban Expansion
- Fire & Harvest Disturbance

**Additional Components**
- Climate Change
- Population Growth
- Stream Temperature
- Water Rights
- Urban Expansion
- Irrigation and Crop Decisions
- Fire & Harvest Disturbance
Spatial Scale of WW2100

IDUs range from 2-20 ha

Temporal scale is daily
Land-use models

- Parcel-level data on land values and parcel attributes (e.g., slope, water rights, population of nearest city) used to estimate hedonic property value models
- Hedonic results are combined with fine-scale land-use data to estimate models of land-use transitions as a function of property values
- Given the attributes of an IDU, we can predict the probability that the land will be put to developed, agricultural, or forest use
- Other models predict crop type, water withdrawals for agriculture and urban uses, and evolution of urban growth boundaries
- Land use is the key link between the hydrological system and human uses of water
Results

Simulated Historical Summer (May-Oct): 1950-2010

Reference Case Summer (May-Oct): 2070 - 2100
Key Challenges

• Scale vs. extent

• Striking the right balance of detail/realism in the economic and biophysical models
  • Tradeoff becomes especially clear in the case of forward-looking economic models
  • Pros and cons of building on existing models

• For economic models, accounting for fine-scale heterogeneity and representing long-term structural adjustments in markets
  • Hedonic models vs. sectoral optimization models

• Assembling a good team!