Integrated Modeling of the Food, Energy, and Water System

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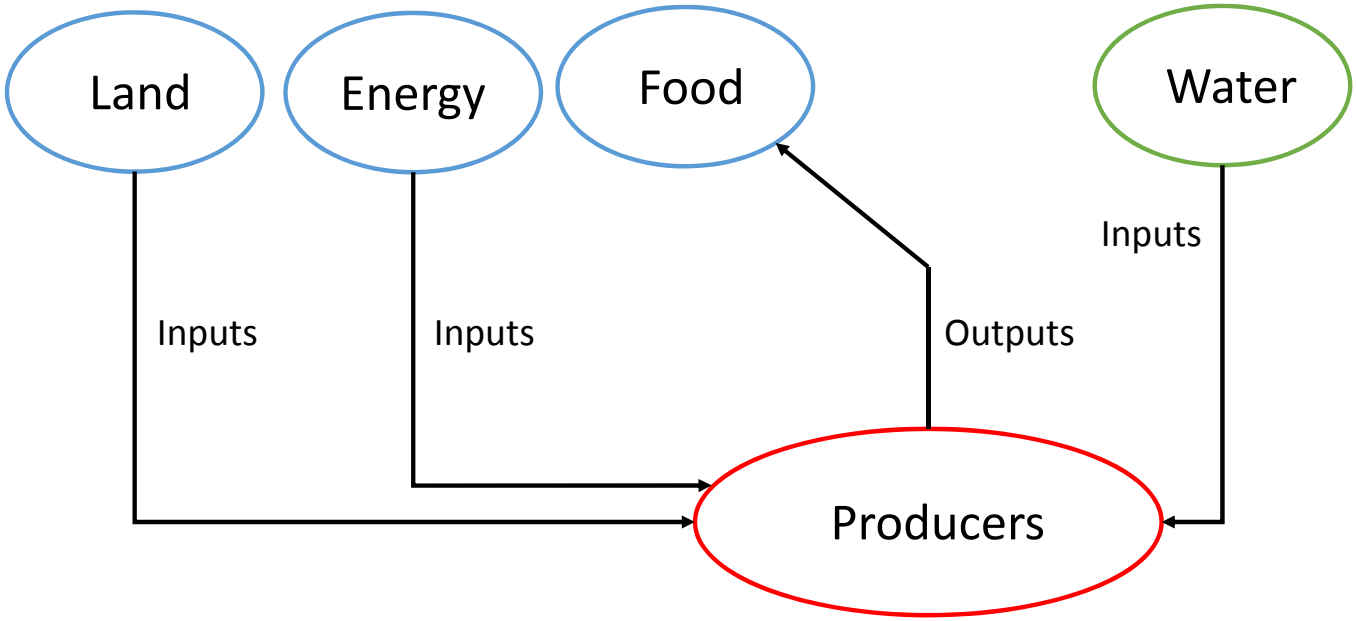
Overview of My Talk

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

Production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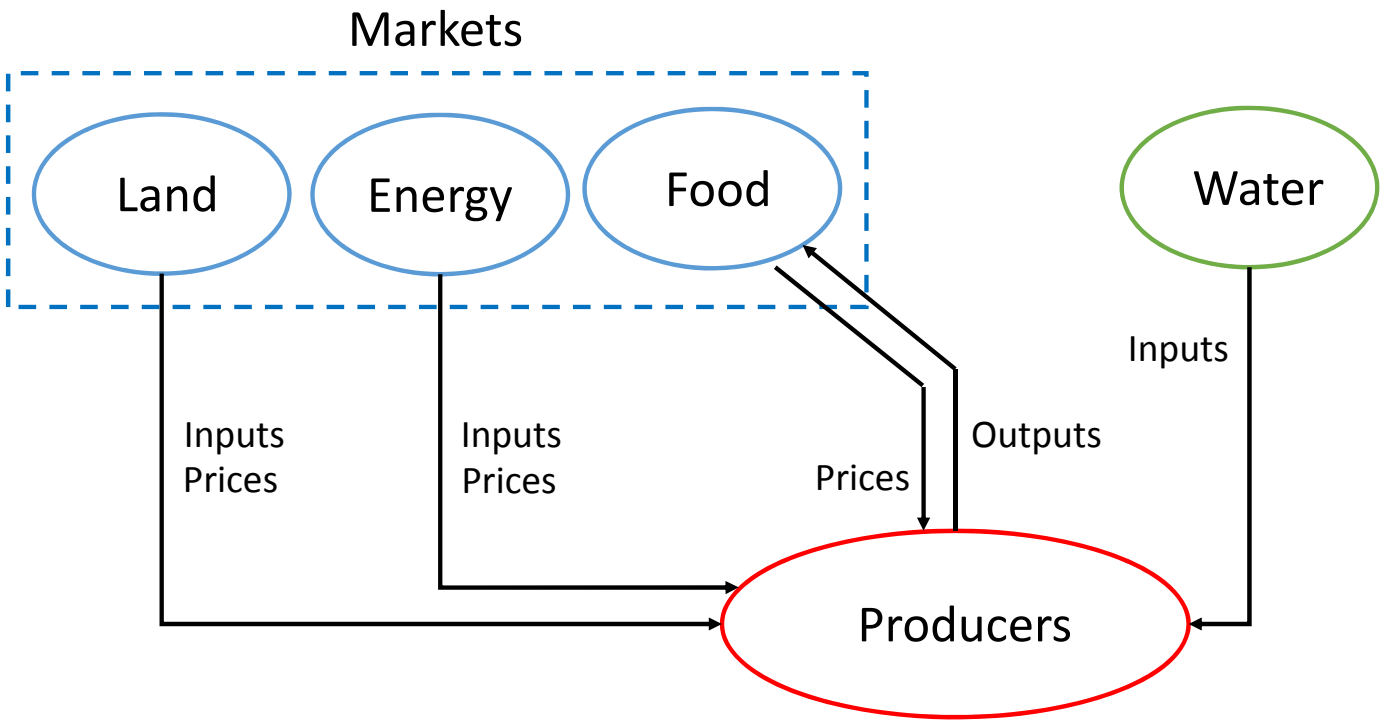
Producers

Markets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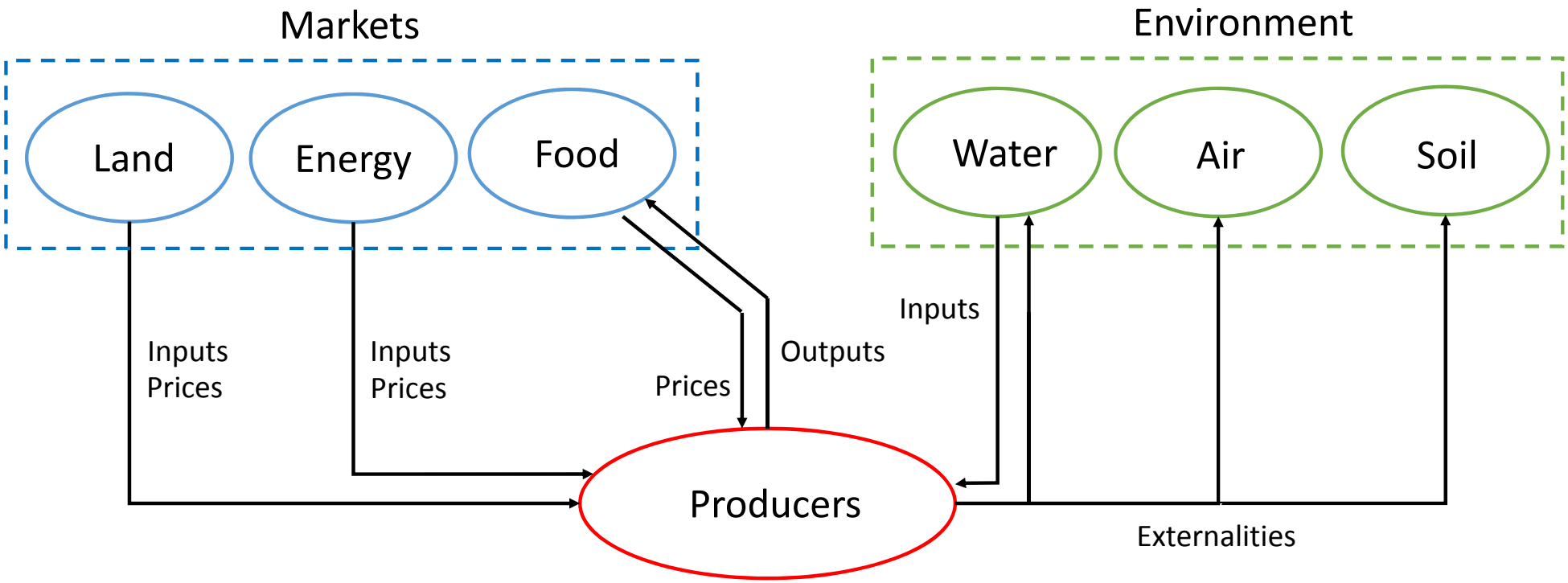
Producers

Externalities



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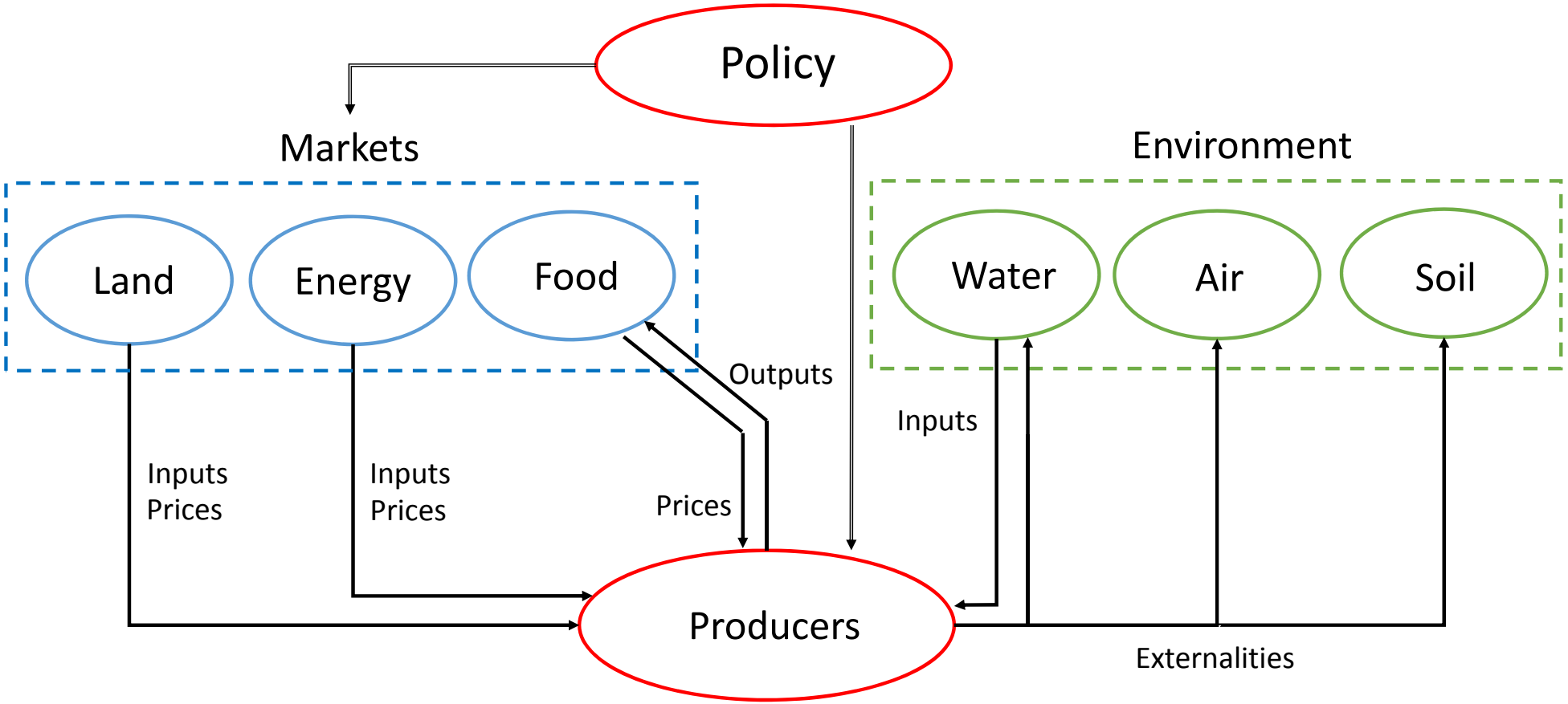
Policy
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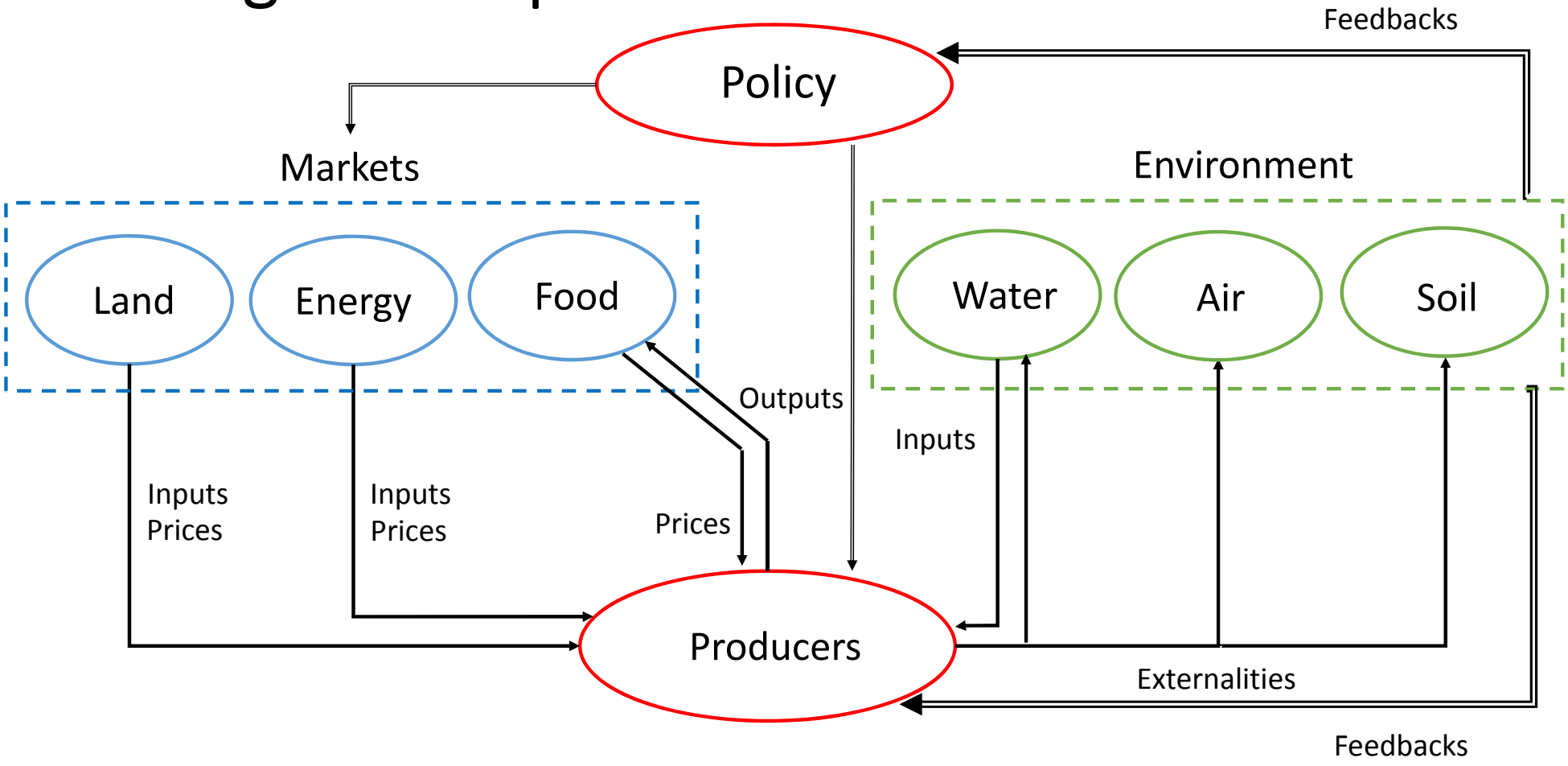
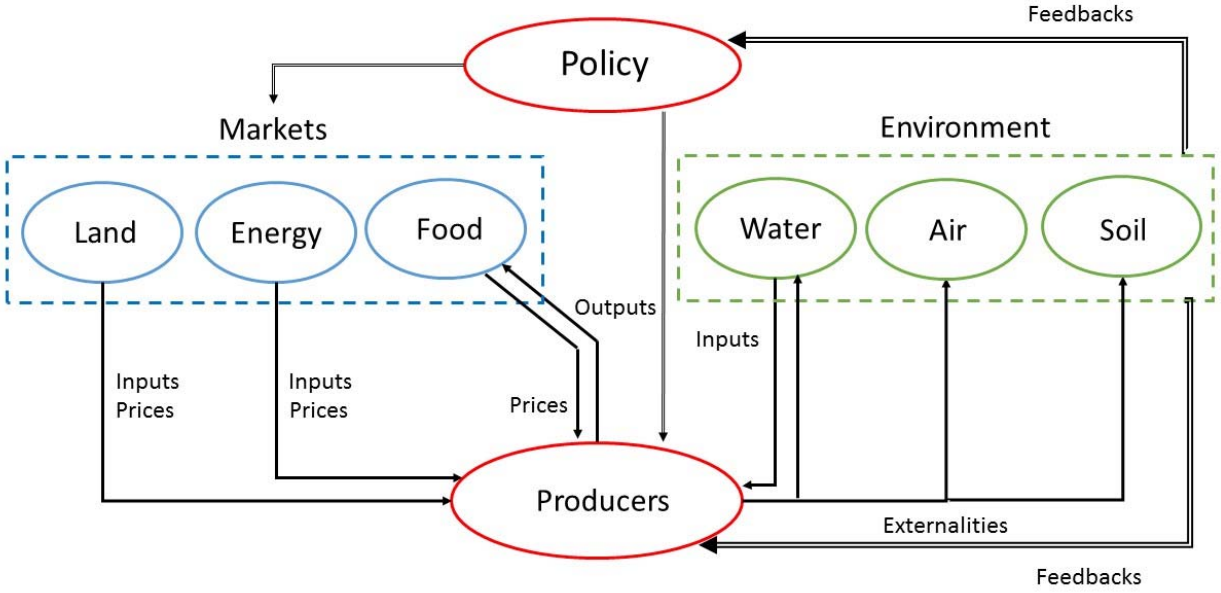
Externalities

Closing the Loop



Building an integrated model

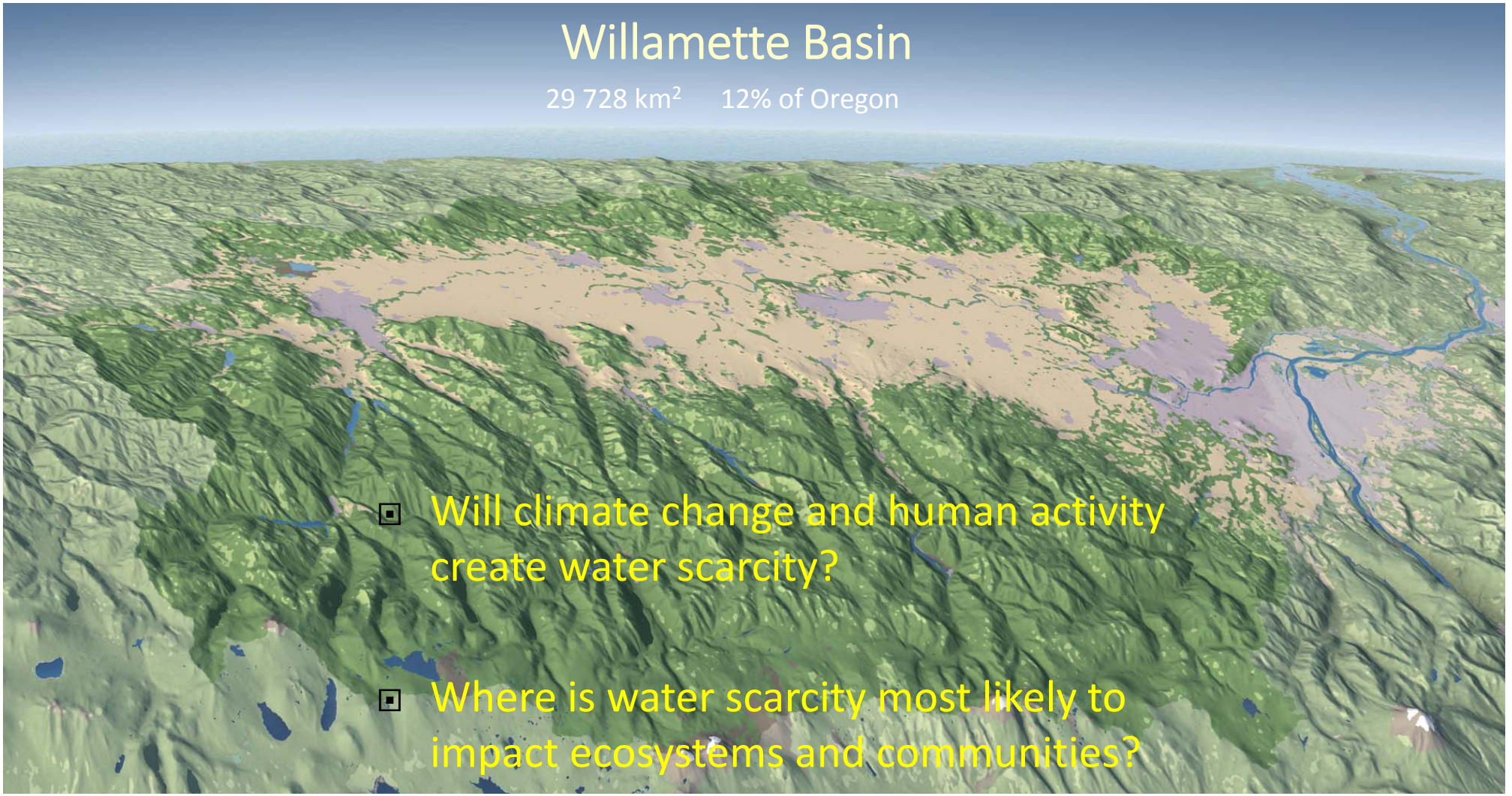
- What is the study region?
- What are the spatial and temporal scales?
- How are the economic and biophysical models linked?




NSF
Willamette Water 2100
Roy Haggerty (Principal Investigator)
OSU
Oregon State
UNIVERSITY
water.oregonstate.edu/ww2100
OREGON
Portland State
UNIVERSITY
UCSB

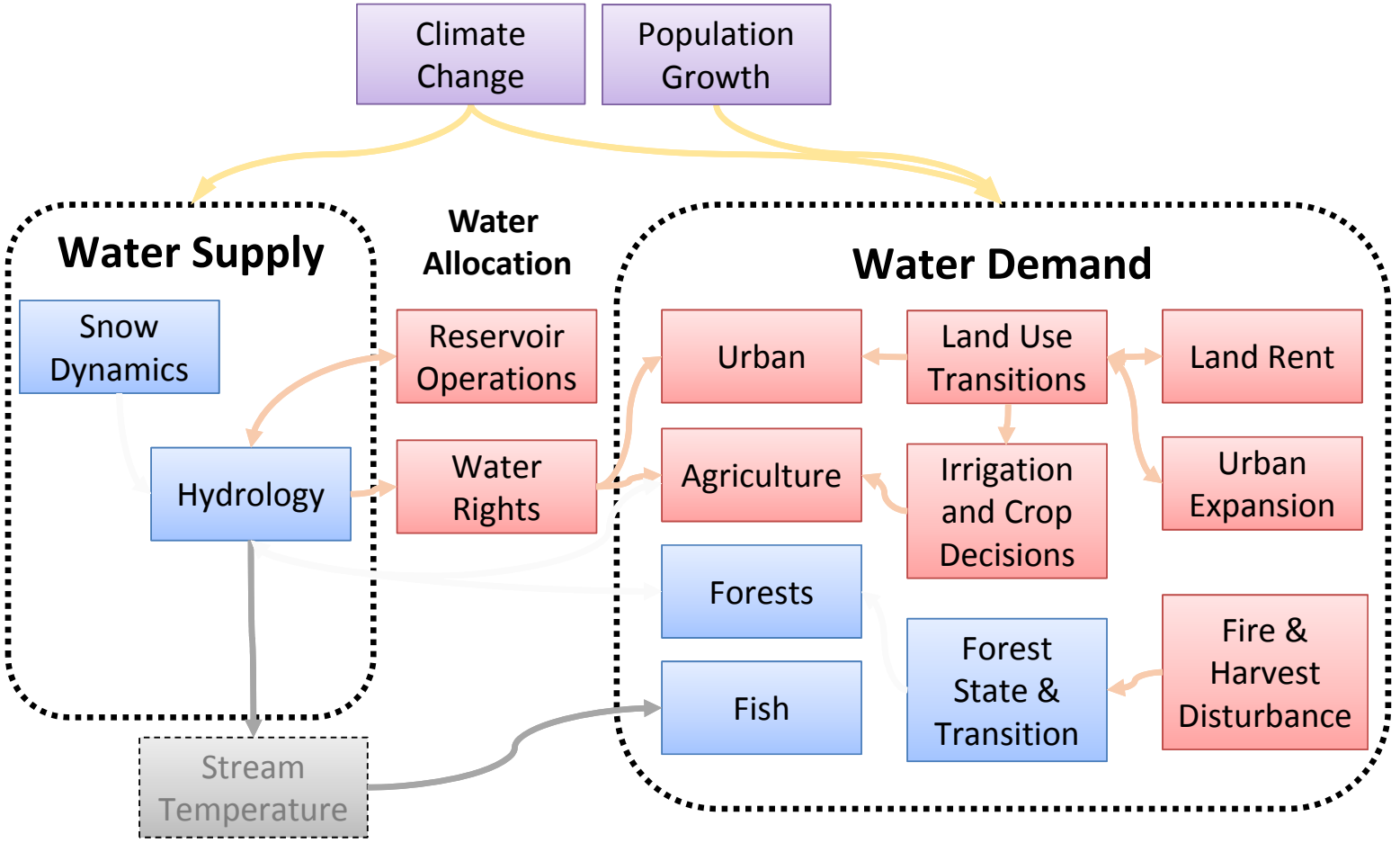
Willamette Basin

29 728 km^2 12% of Oregon

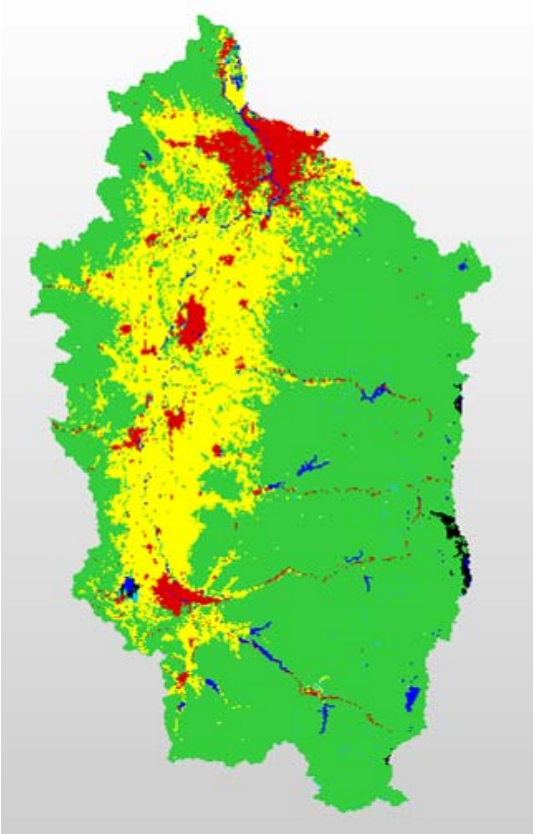


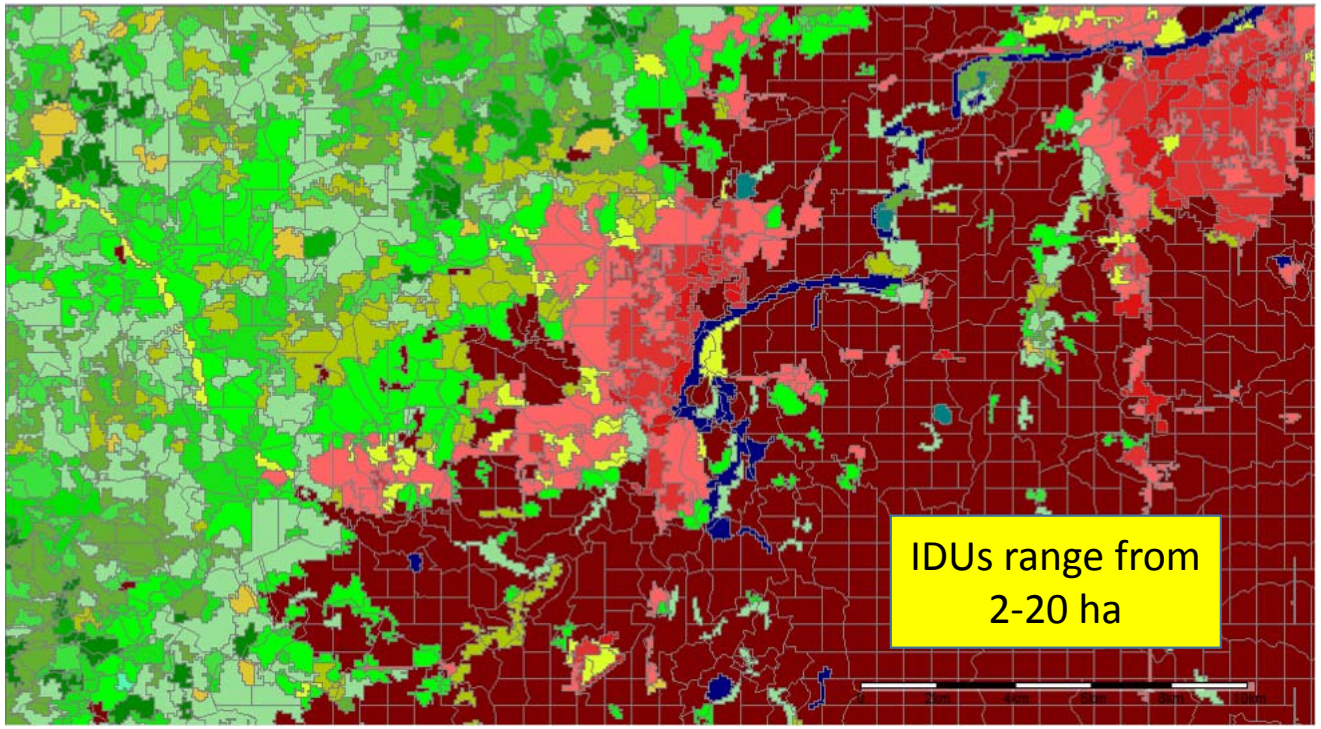
- Will climate change and human activity create water scarcity?
- Where is water scarcity most likely to impact ecosystems and communities?

WW2100 Modeling Framework



Spatial Scale of WW2100





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

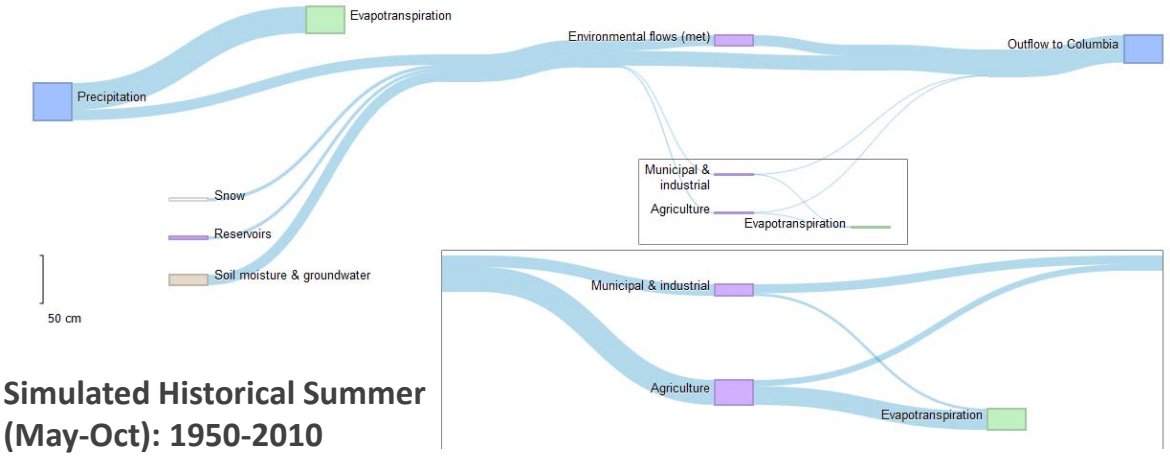
Table 1: Hedonic estimation results

	(1) Developed		(2) Agriculture		(3) Forest	
Variables	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
Slope	-0.019	0.005***	-0.009	0.011	-0.034	0.007***
Parcel size	-0.488	0.019***	-0.003	0.000***	-0.0002	0.000
HH income	0.054	0.008***	0.053	0.009***	0.108	0.014***
HH income^2	-0.0003	0.000***				
Pop. density	0.239	0.041***	0.254	0.043***	0.486	0.103***
Pop. density^2	-0.018	0.006***				
Inverse Mill's ratio	0.295	0.033***				
Improvement value	0.001	0.000***				
UGB (endog)	0.918	0.065***				
UGB*Year2000	-0.444	0.042***				
UGB*Year1992	-0.26	0.042***				
UGB*Year1986	-0.198	0.043***				
UGB*Year1980	0.017	0.043				
Dist. UGB			-0.029	0.012**	-0.112	0.051**
Dist. UGB^2					0.007	0.003**
Dist. city center	-0.041	0.008***				
Dist. city center^2	0.0004	0.000*				
Min. temperature			0.029	0.048		
Precipitation			0.048	0.020**		
Irrigation right			0.691	0.301**		
Precip x Irrigation			-0.048	0.023**		
LCC12			0.53	0.197***		
LCC34			0.332	0.190*		
LCC1234					0.099	0.086
Elevation					-0.001	0.000***
PNI					0.415	0.066***
River presence					-0.078	0.087
Dist. mill					-0.112	0.051**
Dist. mill^2					0.007	0.003**
# of parcels	2,659		586		464	
# of observations	8,387		2,499		1,974	

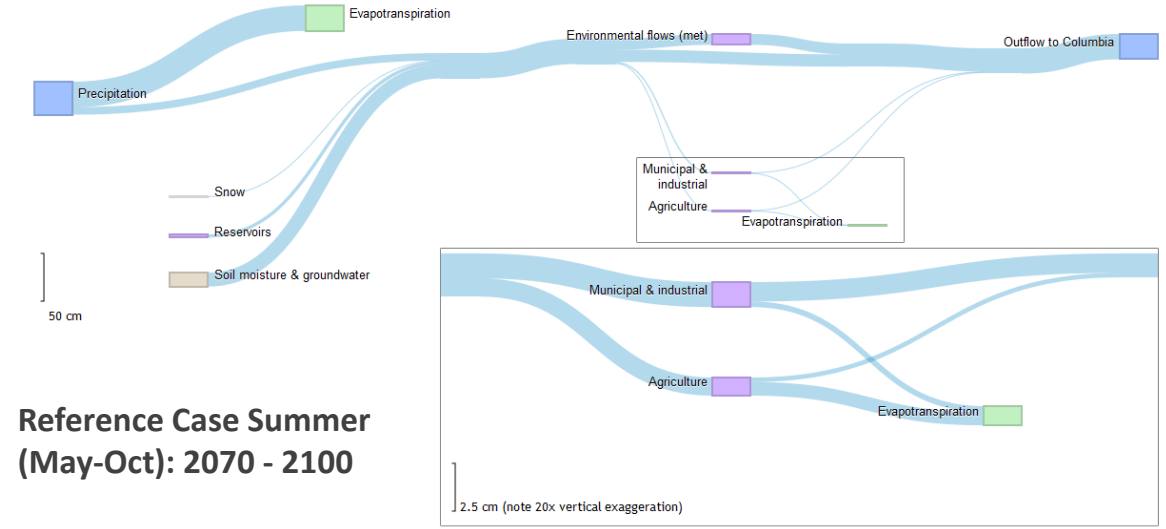
Table 2: Land-use model results

	Agriculture to development			
	(1) Pooled logit		(2) Fixed effects LPM	
Variables	**Marginal effect**	**Std. Error**	**Marginal effect**	**Std. Error**
Developed use value	0.00049	0.00008***	0.00089	0.00010***
Agricultural use value	-0.03573	0.00901***	-0.02241	0.00781***
Mean dev. use val	-0.00026	0.00008***		
Mean ag. use val	0.11833	0.04257***		
Number of plots	41,840			
Number of observations	165,460			
	Forest to development			
Variables	**Marginal effect**	**Std. Error**	**Marginal effect**	**Std. Error**
Developed use value	0.00009	0.00003***	0.00035	0.00006***
Forest use value	-0.09900	0.02755***	-0.18750	0.03817***
Mean dev. use val	0.00001	0.00003		
Mean for. use val	0.16220	0.02606***		
Number of plots	31,476			
Number of observations	125,513			

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!