The Lower Cimarron Watershed under Changing Climate
– A coupled nature-human system approach

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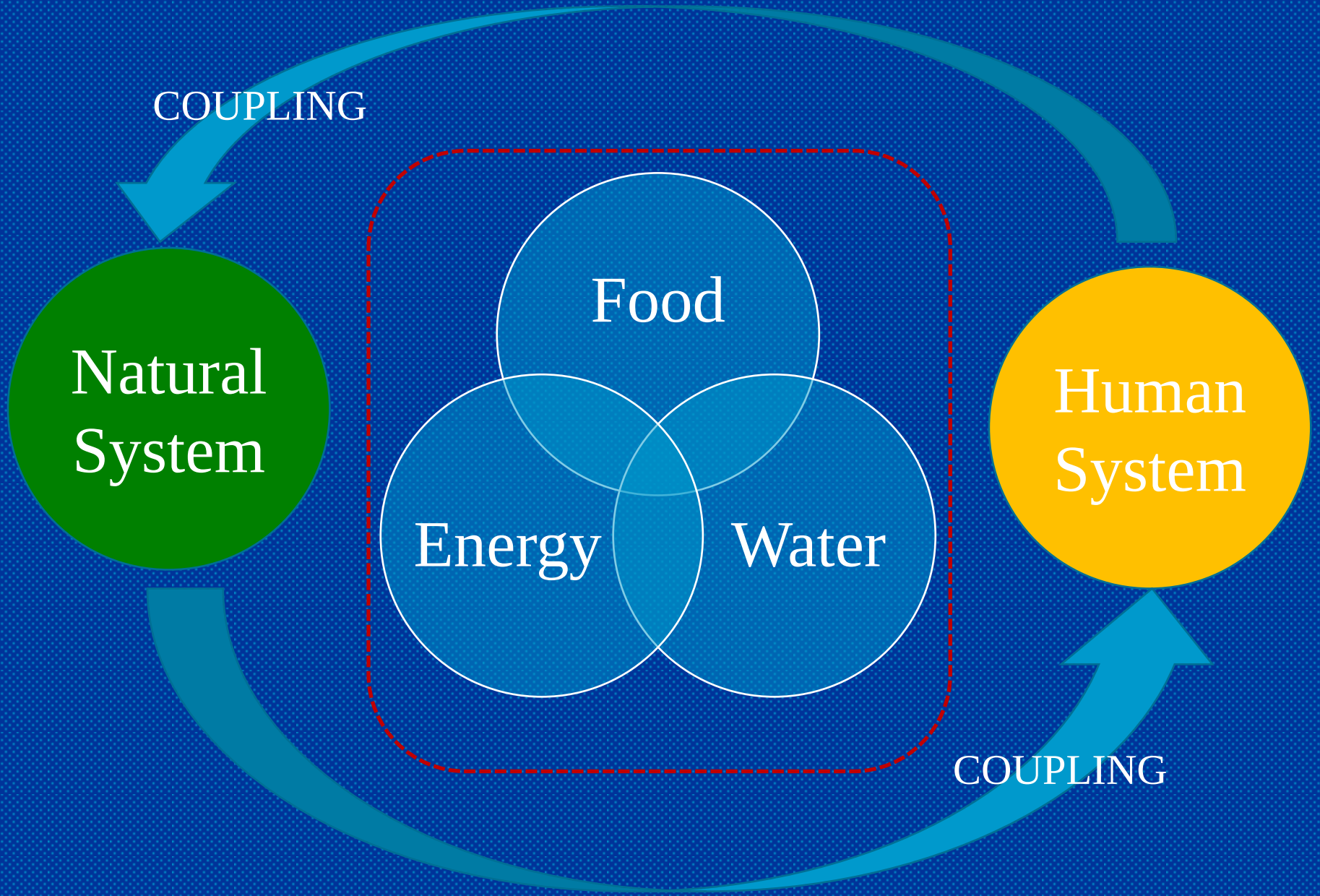
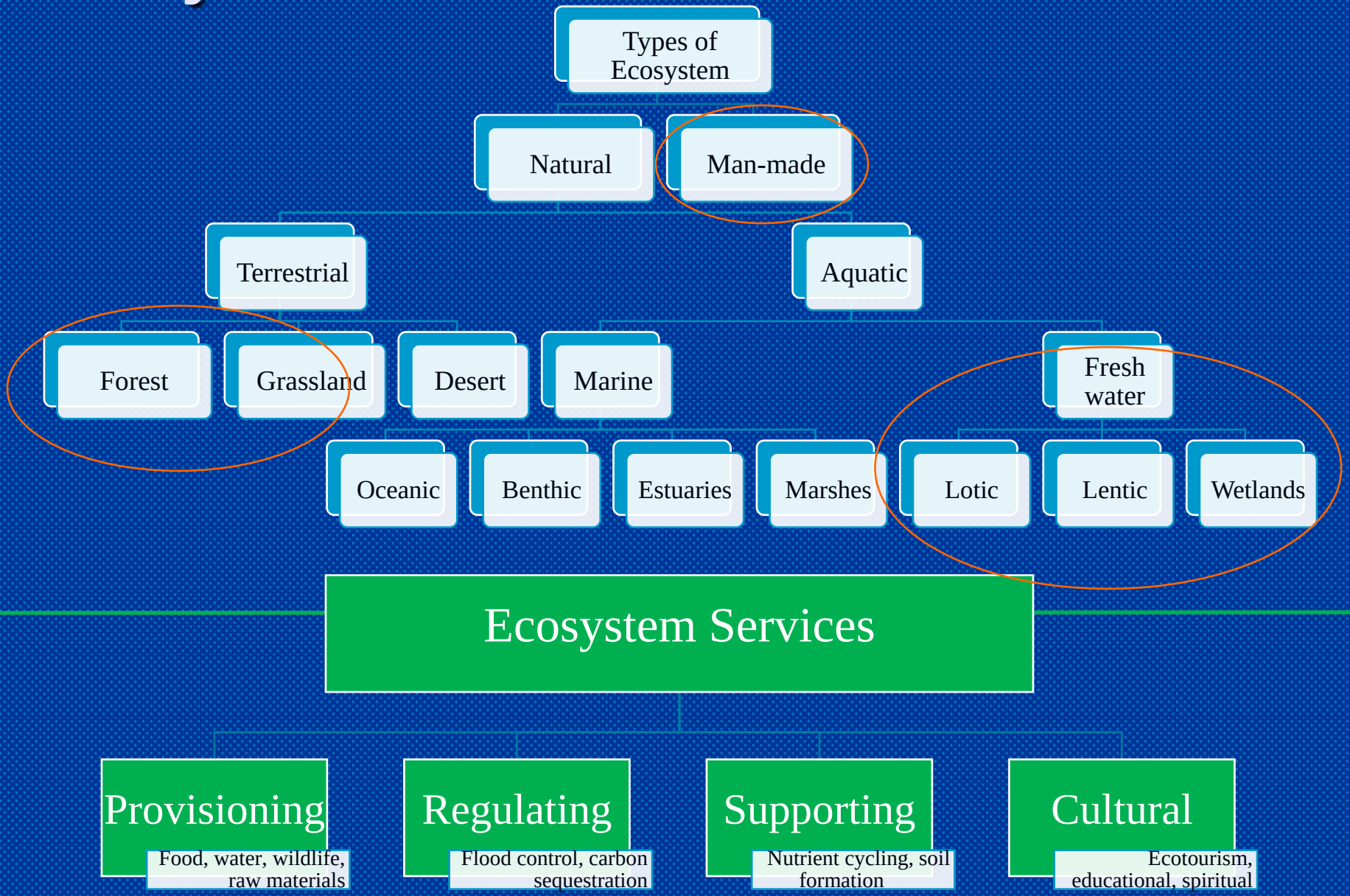
Themes


COUPLING
Natural System
Food
Energy
Water
Human System
COUPLING

Ecosystems


Types of Ecosystem
Natural
Man-made
Terrestrial
Aquatic
Forest
Grassland
Desert
Marine
Fresh water
Oceanic
Benthic
Estuaries
Marshes
Lotic
Lentic
Wetlands
Ecosystem Services
Provisioning
Food, water, wildlife, raw materials
Regulating
Flood control, carbon sequestration
Supporting
Nutrient cycling, soil formation
Cultural
Ecotourism, educational, spiritual

Ecosystem Health

Climate

Variability, Extremes

Human behavior

Activities, Responses, Decisions

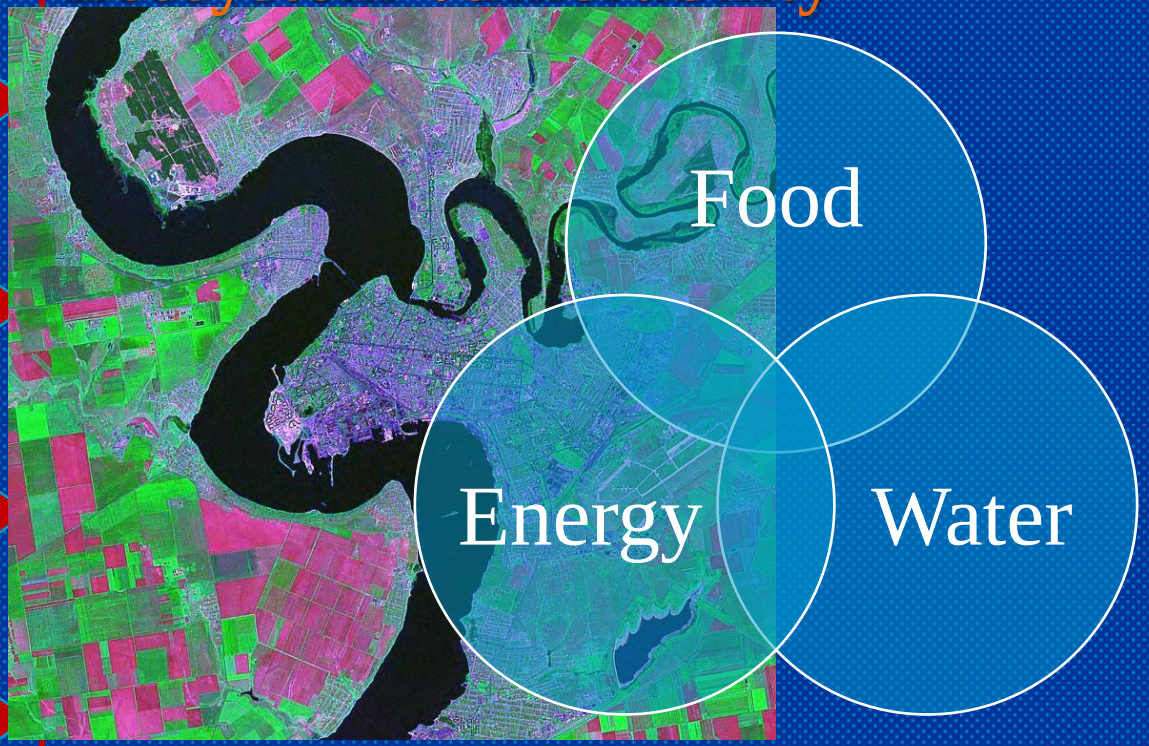
Policies

Enhancing, Preventive, Mitigating

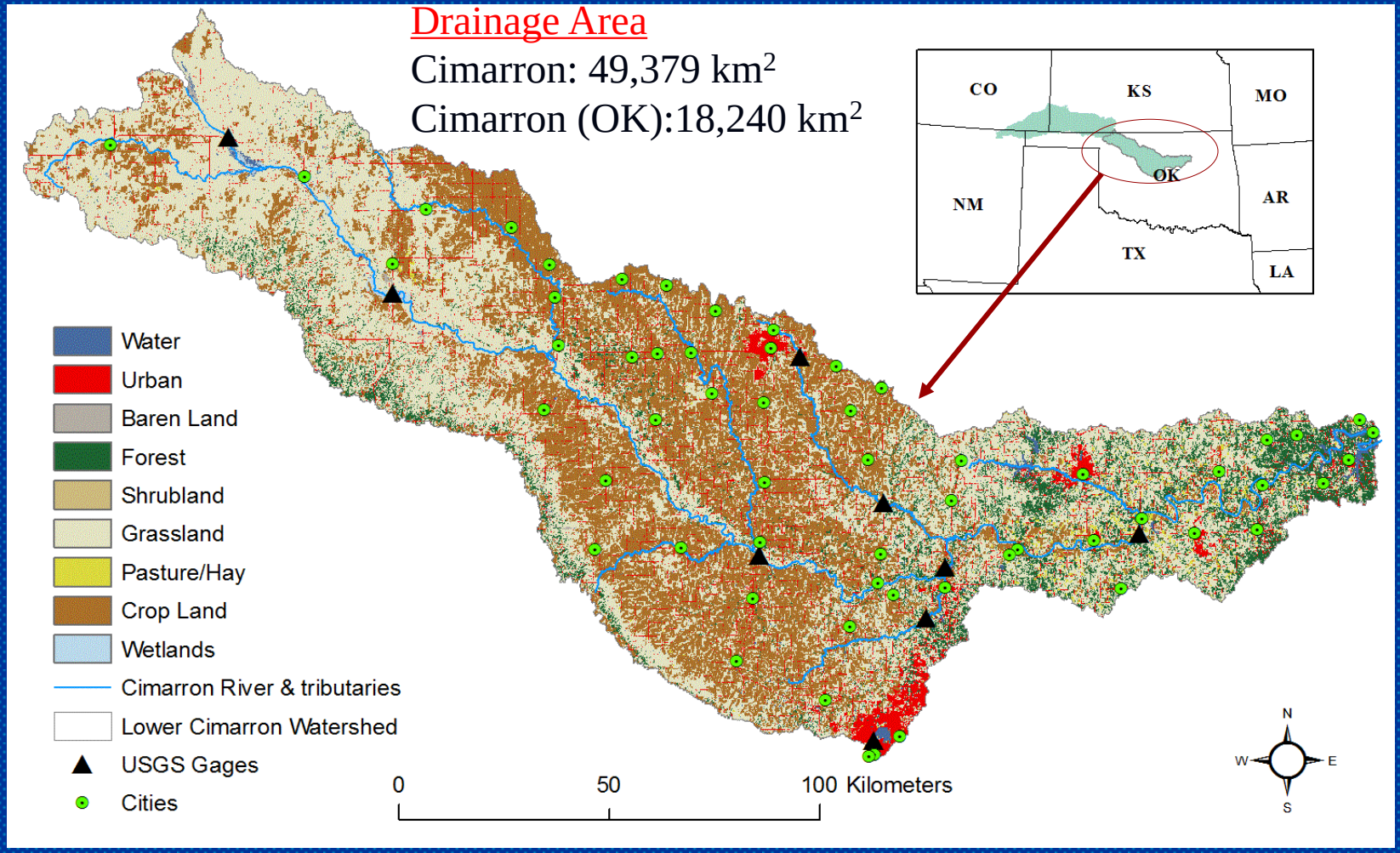
Land use

Modifications, Management

Ecosystem Vulnerability



Cimarron River Watershed



Lower Cimarron River Watershed

Land Use Land Cover

- 2011 National Land Cover Database & National Agricultural Statistics Service

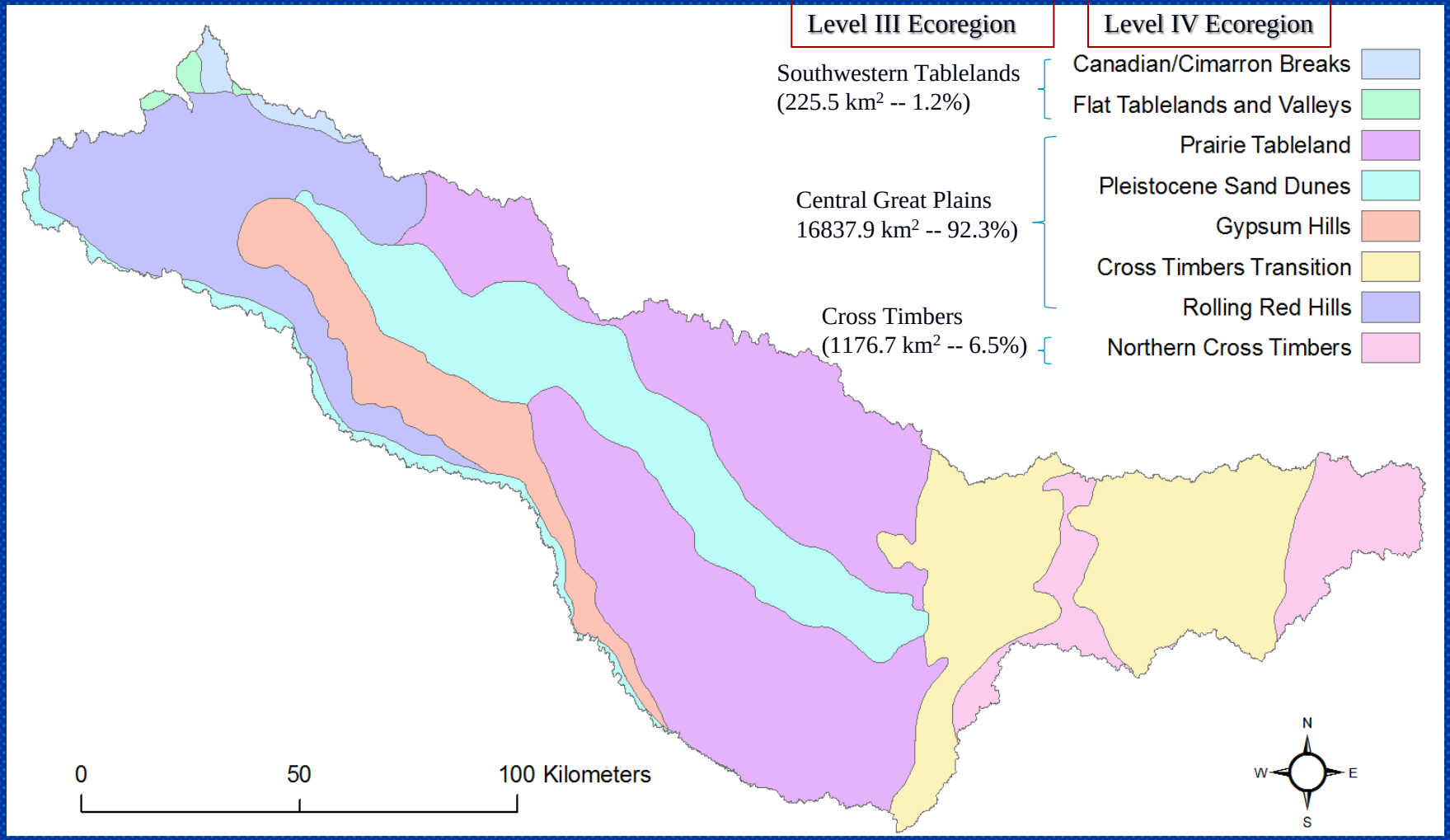
Land use	Area (km^2)	%
Grassland	8,866.1	48.6
Crops	5,960.0	32.7
Forest	1,672.0	9.2
Developed	1,212.0	6.6
Water	240.8	1.3
Pasture/Hay	157.9	0.9
Wetlands	56.9	0.3
Barren Land	41.6	0.2
Shrub	24.1	0.1

Crop type	% Cropland	% Watershed
Wheat	76.7	23.3
Rye	12.0	3.6
Alfalfa	2.9	0.9
Sorghum	2.2	0.7
Corn	1.4	0.4
Canola	1.3	0.4
Soybeans	1.2	0.4

- 1950-2011: 6, 000 km^2 cropland lost to grass, range and urban areas
- Since 1999: grassland encroached by woody plants (red cedar)
  - Reduced streamflow (Zou et al. 2015)

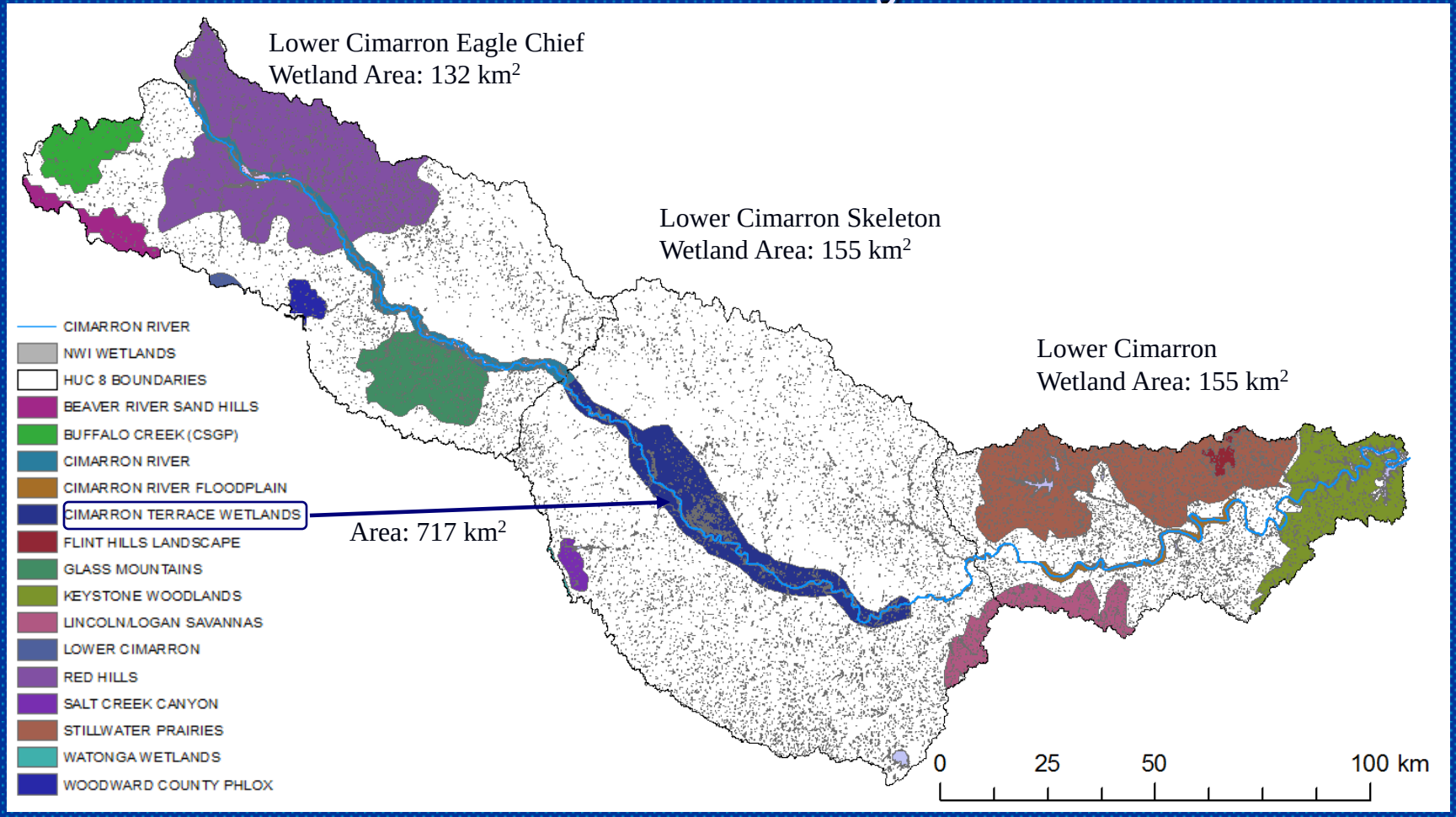
Lower Cimarron River Watershed

Ecoregions



Data source: US EPA

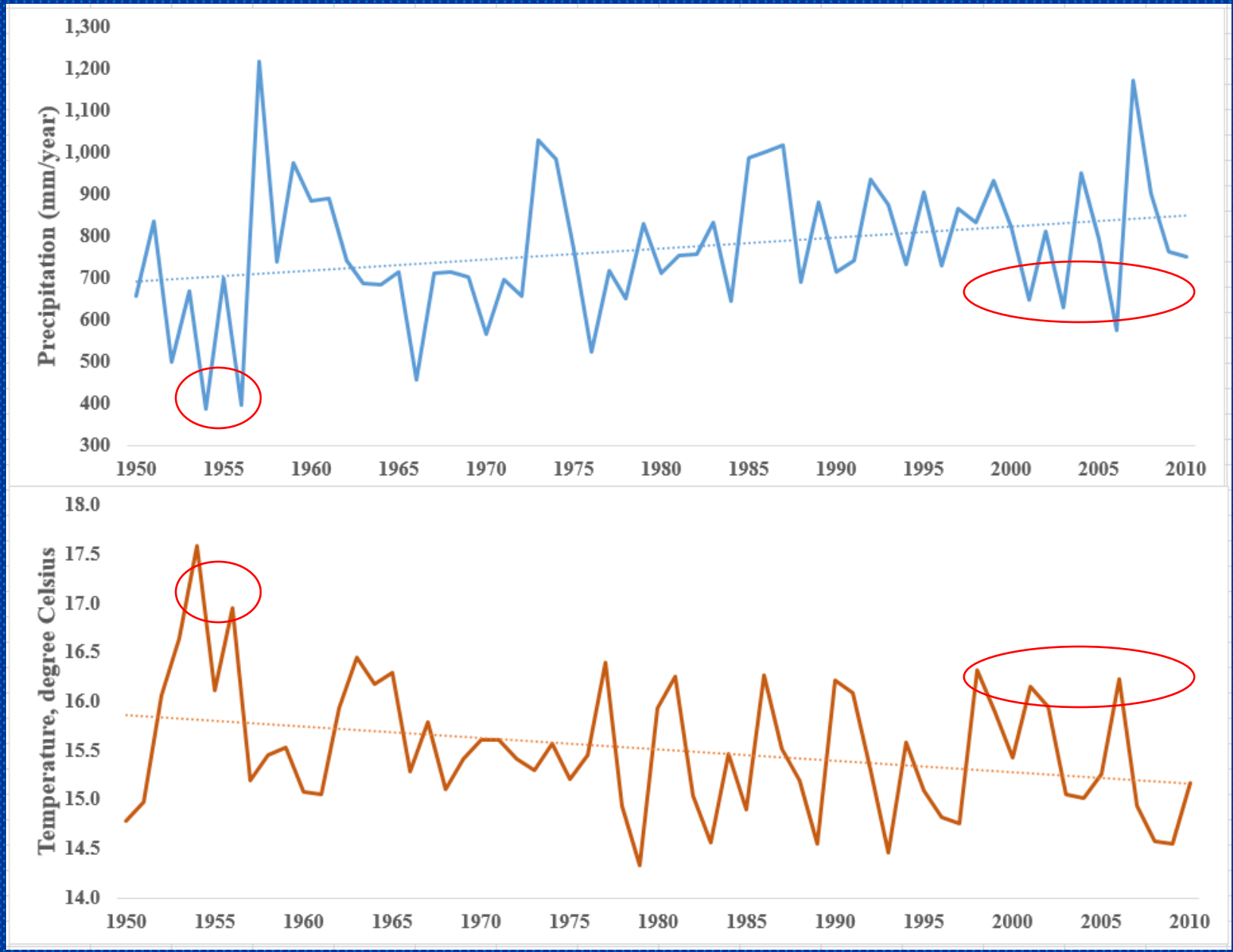
The Nature Conservancy Ecological Portfolio & National Wetlands Inventory



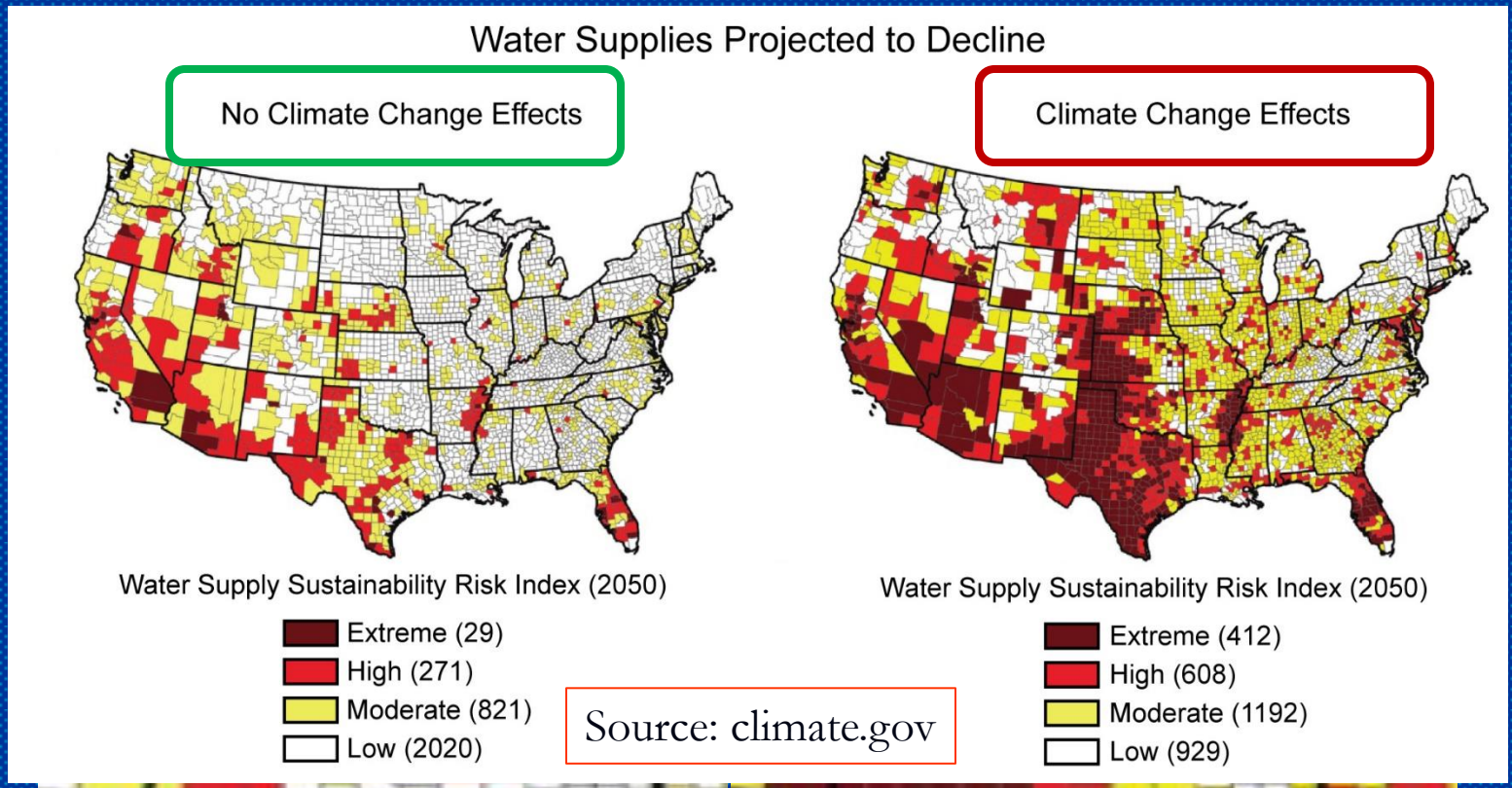
TNC Conservation Priority Area: 4,913 km² (26.9% of the CRW)

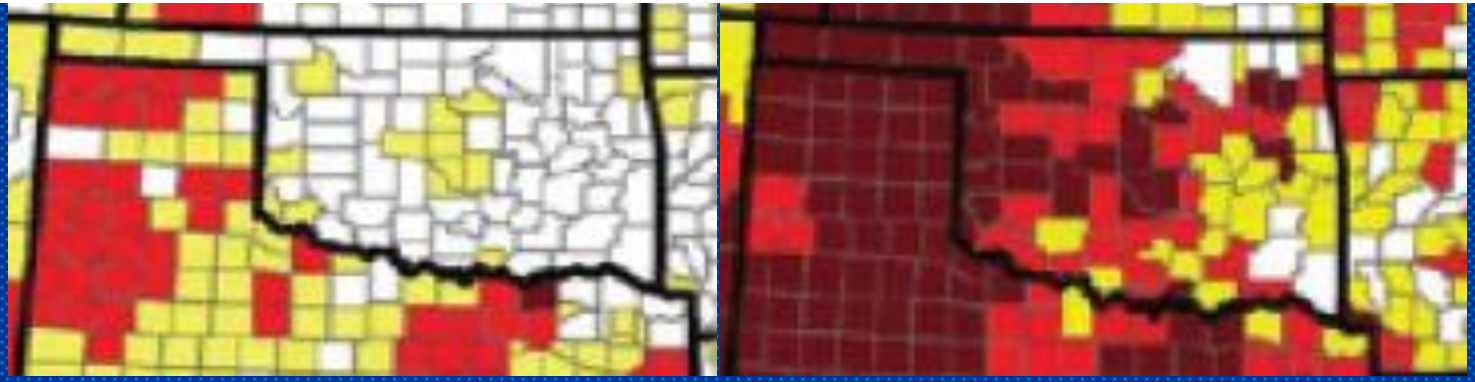
Data source: The Nature Conservancy, Ecoregional Assessments

Historical Climate 1950-2010



Climate Change Impacts





Lower Cimarron River Watershed Assessing vulnerability

- Objectives
  - Explore alternative landscapes under multiple scenarios of climate
    - Coupled Model Intercomparison Project-5 (CMIP-5) climate projections
    - Drought, flood
  - Policy intervention to mitigate climate impacts
    - Farm bill
      - Land management
        - land owners' decision making (behavior)
        - Woodland encroachment

Climate Projections

- Global Climate Models (GCMs): 18
- Representative Concentration Pathways (RCPs): 2.6, 4.5, 6.0, 8.5
- Source: http://gdo-dcp.ucllnl.org/ (Maurer et al. 2014)

72 member ensemble

Modeling Center (or Group)	GCM
Beijing Climate Center, China Meteorological Administration	BCC-CSM1.1
National Center for Atmospheric Research	CCSM4
Community Earth System Model Contributors	CESM1(CAM5)
The First Institute of Oceanography, SOA, China	FIO-ESM
NOAA Geophysical Fluid Dynamics Laboratory	GFDL-CM3
	GFDL-ESM2G
NASA Global Modeling and Assimilation Office	GFDL-ESM2M
NASA Goddard Institute for Space Studies	GISS-E2-R
National Institute of Meteorological Research/Korea Meteorological Administration	HadGEM2-AO
Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Instituto Nacional de Pesquisas Espaciais)	HadGEM2-ES
Institut Pierre-Simon Laplace	IPSL-CM5A-LR
	IPSL-CM5A-MR
Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute, National Institute for Environmental Studies	MIROC-ESM
	MIROC-ESM-CHEM
Atmosphere and Ocean Research Institute, National Institute for Environmental Studies, Japan Agency for Marine-Earth Science and Technology	MIROC5
Meteorological Research Institute	MRI-CGCM3
Norwegian Climate Centre	NorESM1-M
	NorESM1-ME

ENVISION a modeling platform for conducting alternative futures analyses

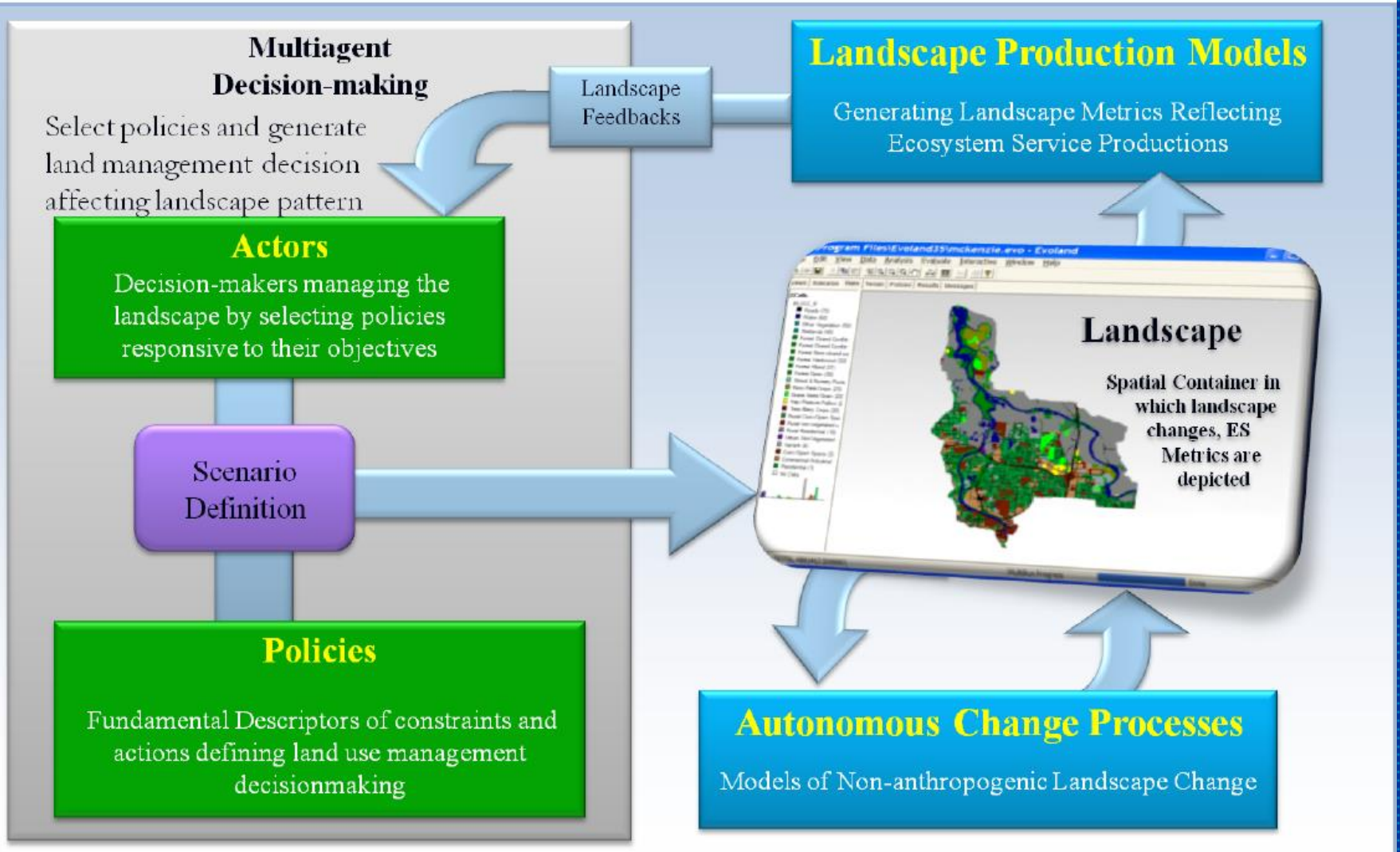
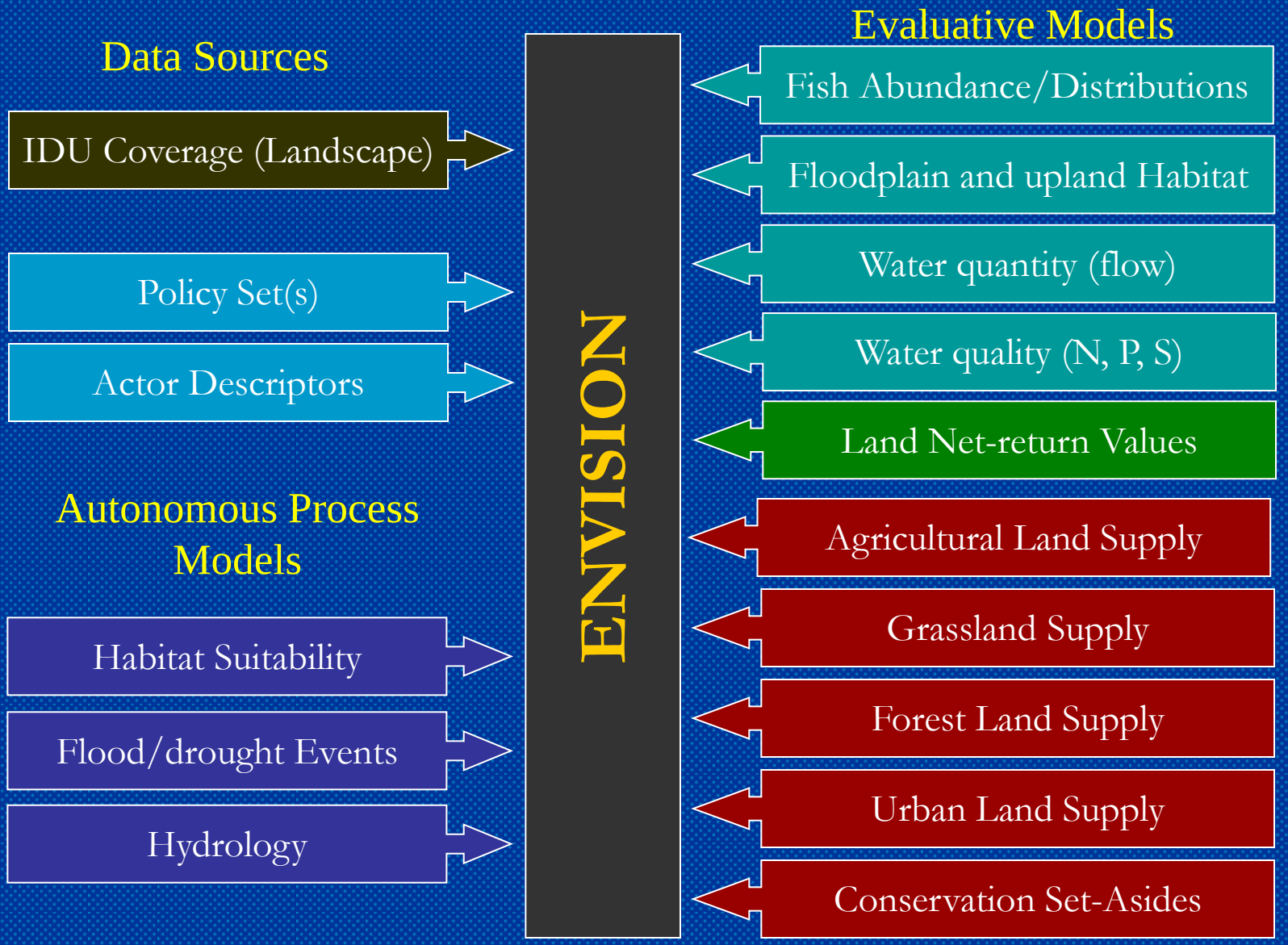


Figure 1. Envision Conceptual Structure

Source: http://envision.bioe.orst.edu/

ENVISION Framework for Lower Cimarron River Watershed

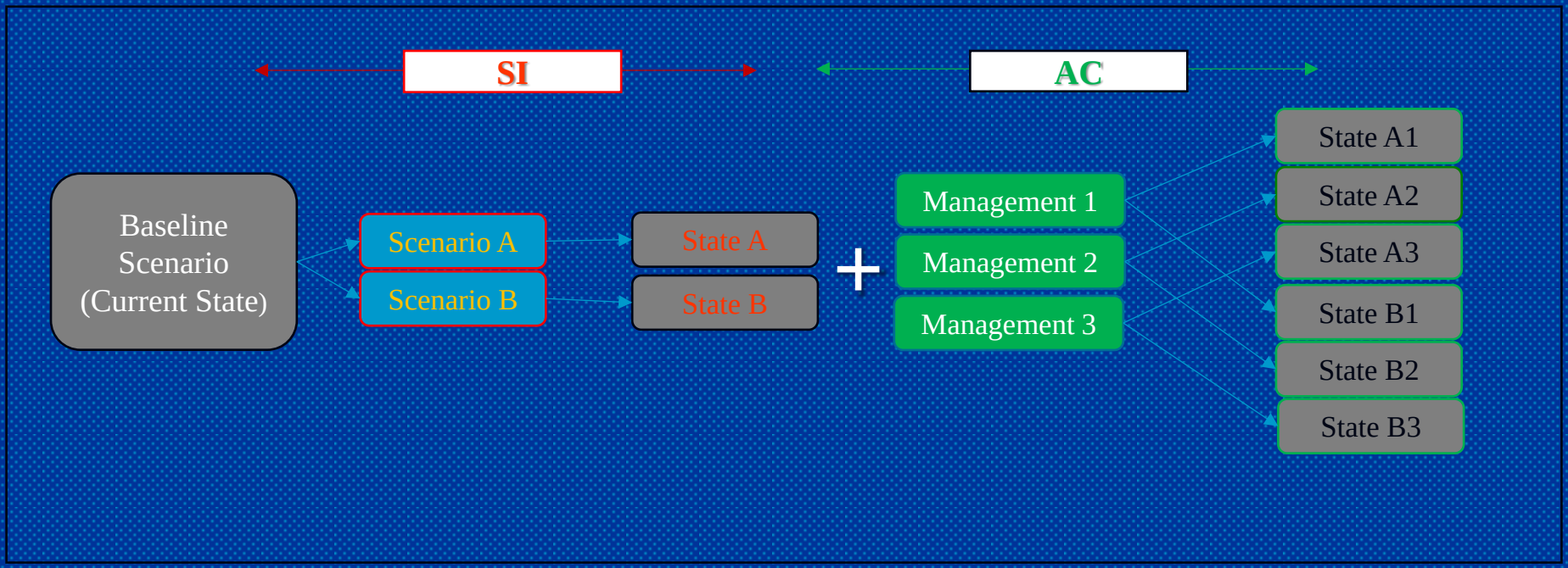


Vulnerability

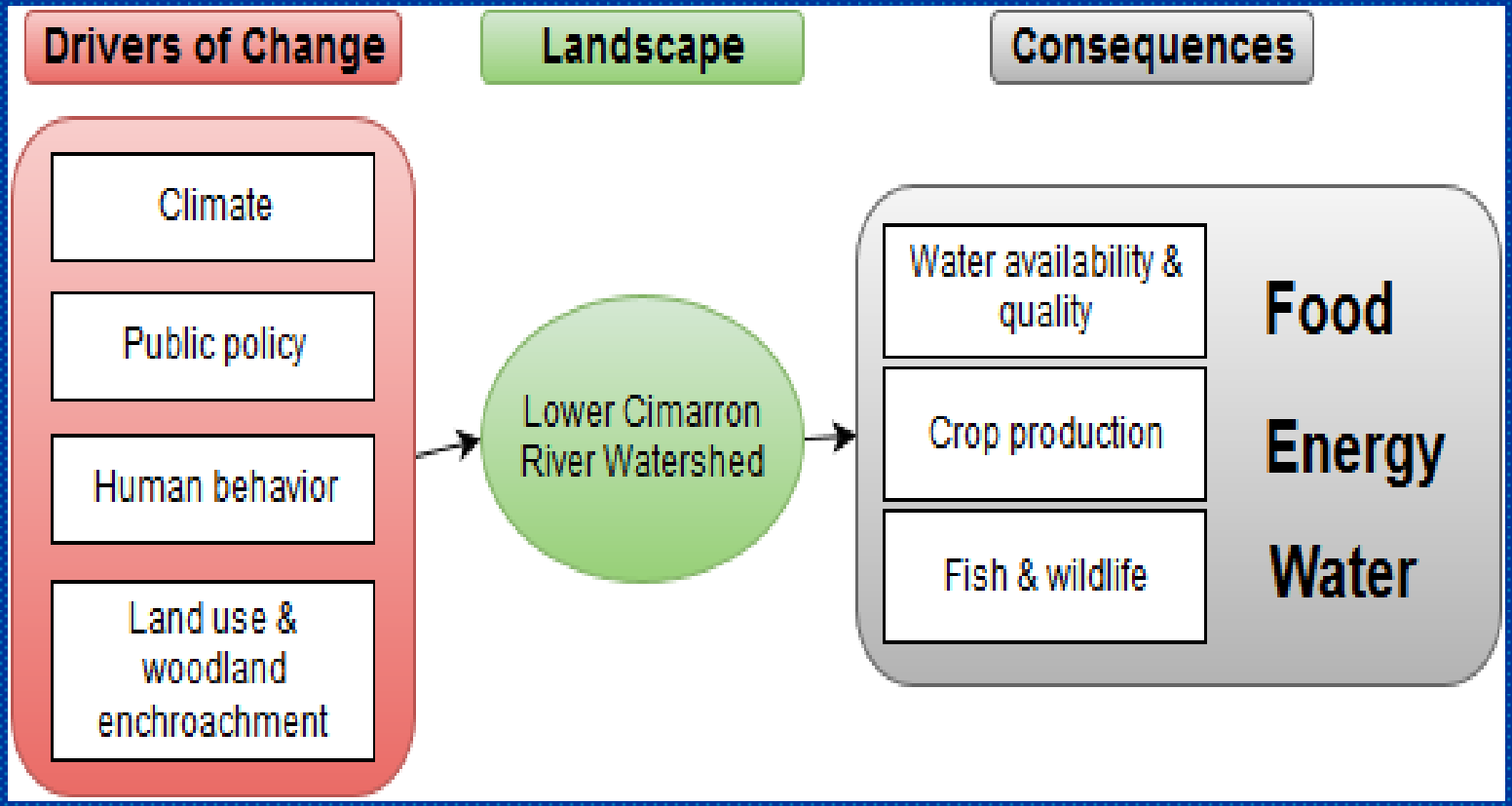
Vulnerability (V) = Stressor Impacts (SI) + Adaptive Capacity (AC)

e.g., climate change, watershed activities including land use and management, demographics

The extent to which SI impacts can be withstood and/or mitigated through management options and solutions



In Summary



- Expected Deliverables
  - Policy tools, decision support system, vulnerability maps and database, alternative management strategies

Thanks!

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