

# **Vulnerability and resiliency of wetlands under changing climate in the Cimarron River Basin of Oklahoma**

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# Wetlands

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## Definition:

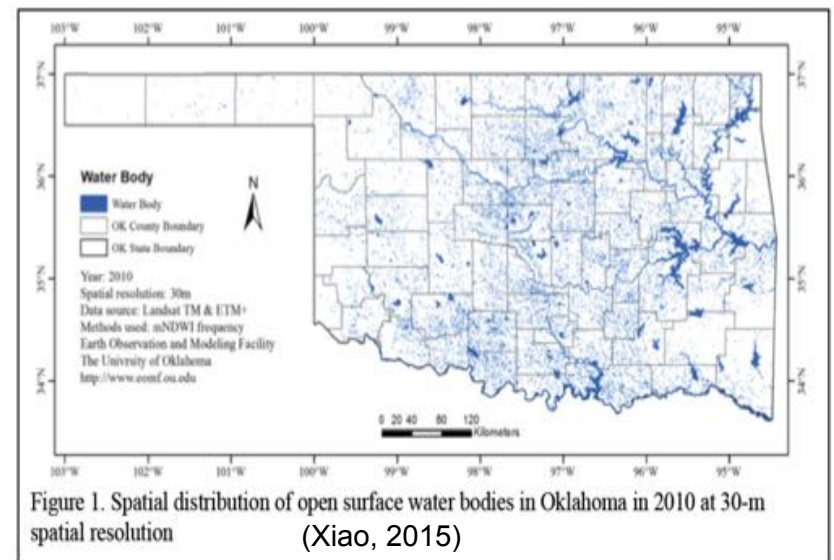
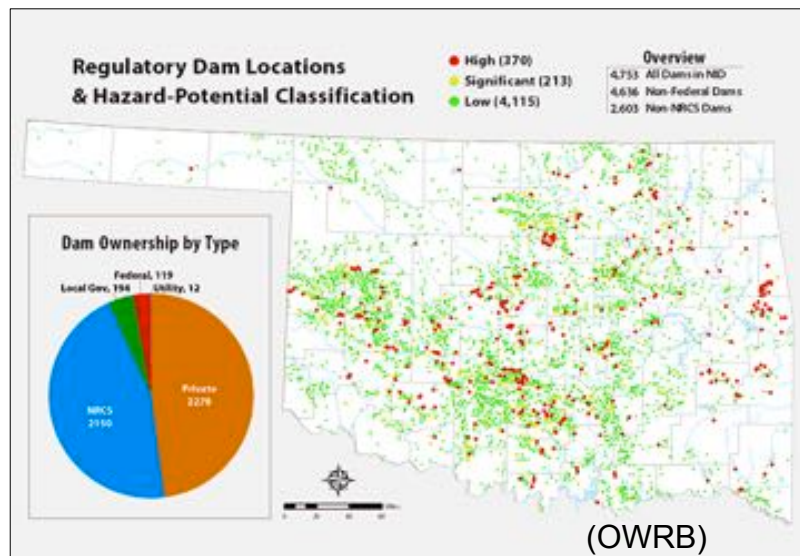
“those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar **areas** [EPA Regulations listed at 40 CFR 230.3(t)]





# Why are wetlands important for Oklahoma?

- Oklahoma is second only to Texas in the number of artificial impoundments, and subsequently, amount of shoreline in the continental United States.
- Wetlands are widely distributed across the state and extensively distributed around the streams and over alluvial aquifers
- The network of wetlands and streams serves an important role in the social-ecological and economic fabric of the State.



# Wetlands are critical to social-ecological and economic fabric of the State

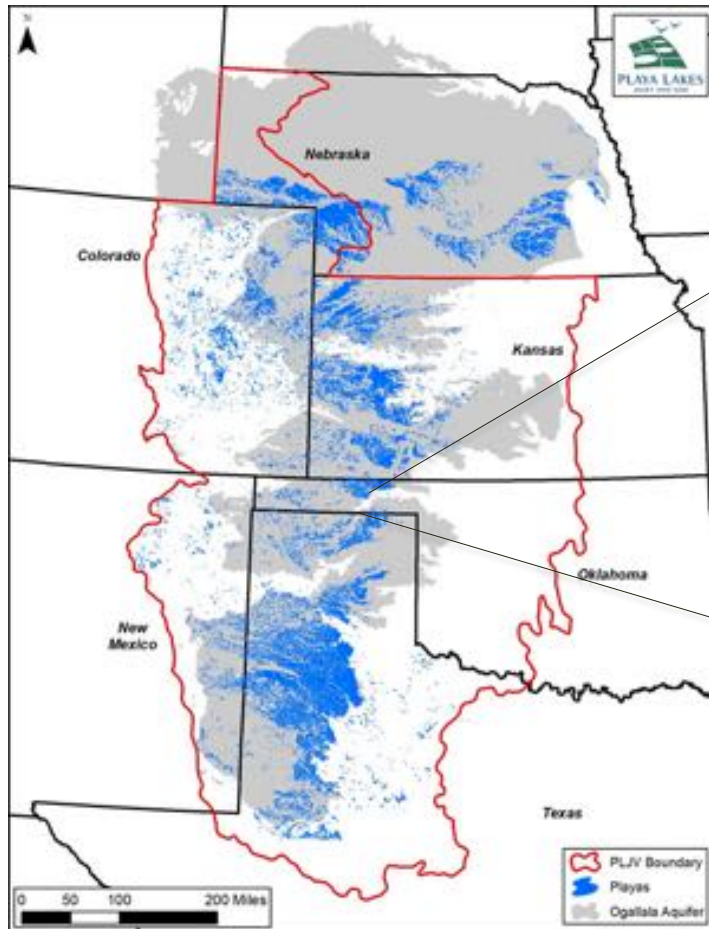
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*“Wetlands deliver a wide range of **Ecosystem Services** that contribute to human wellbeing”*

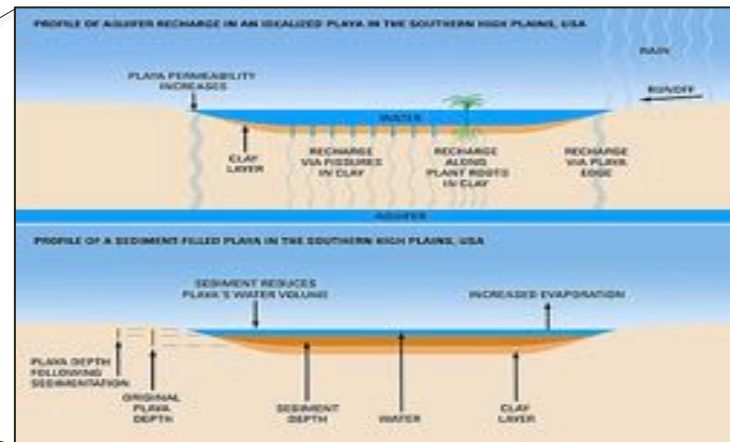
- Provisioning
  - Water, food, wildlife habitats
- Regulating
  - Flood and disease control, water purification, carbon sequestration
- Cultural
  - Spiritual, recreational and ecotourism, educational
- Supporting
  - Nutrient cycling, atmospheric oxygen, soil formation

Source: Millennium Ecosystem Assessment  
<http://www.millenniumassessment.org>

# Wetlands – Important sources for groundwater recharge



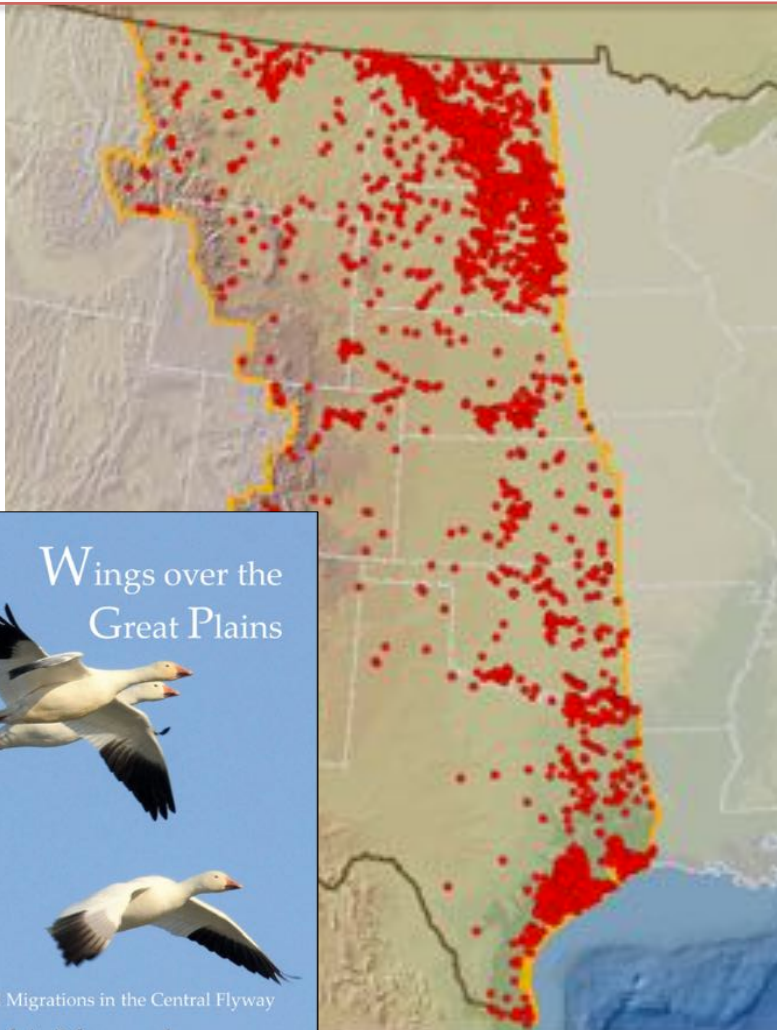
- Regionally, playa lake wetlands are important sources for groundwater recharge



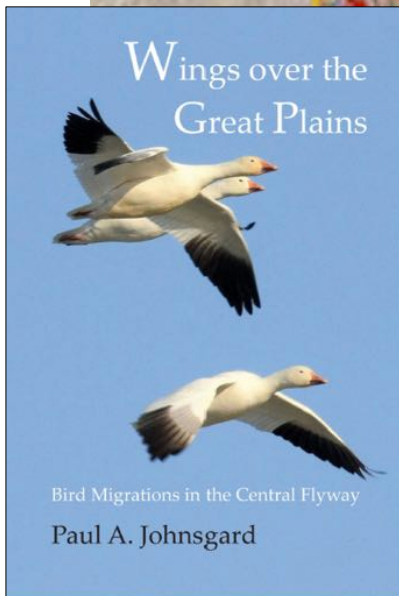
Playa Lake Joint Venture (<http://pljv.org/>)

- Important for groundwater recharge of alluvial aquifers state-wide and flood control

# Wildlife Habitat and Important for Migratory Birds



- Oklahoma is part of the Central Flyway and provides important migration and winter habitat for waterfowl
- \$20 million spent by Duck Unlimited to restore wetland in Oklahoma (through 2012)



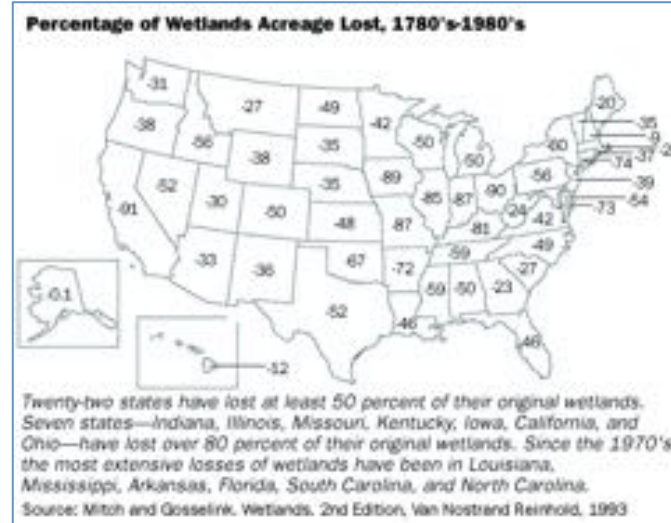
<http://www.ducks.org/>



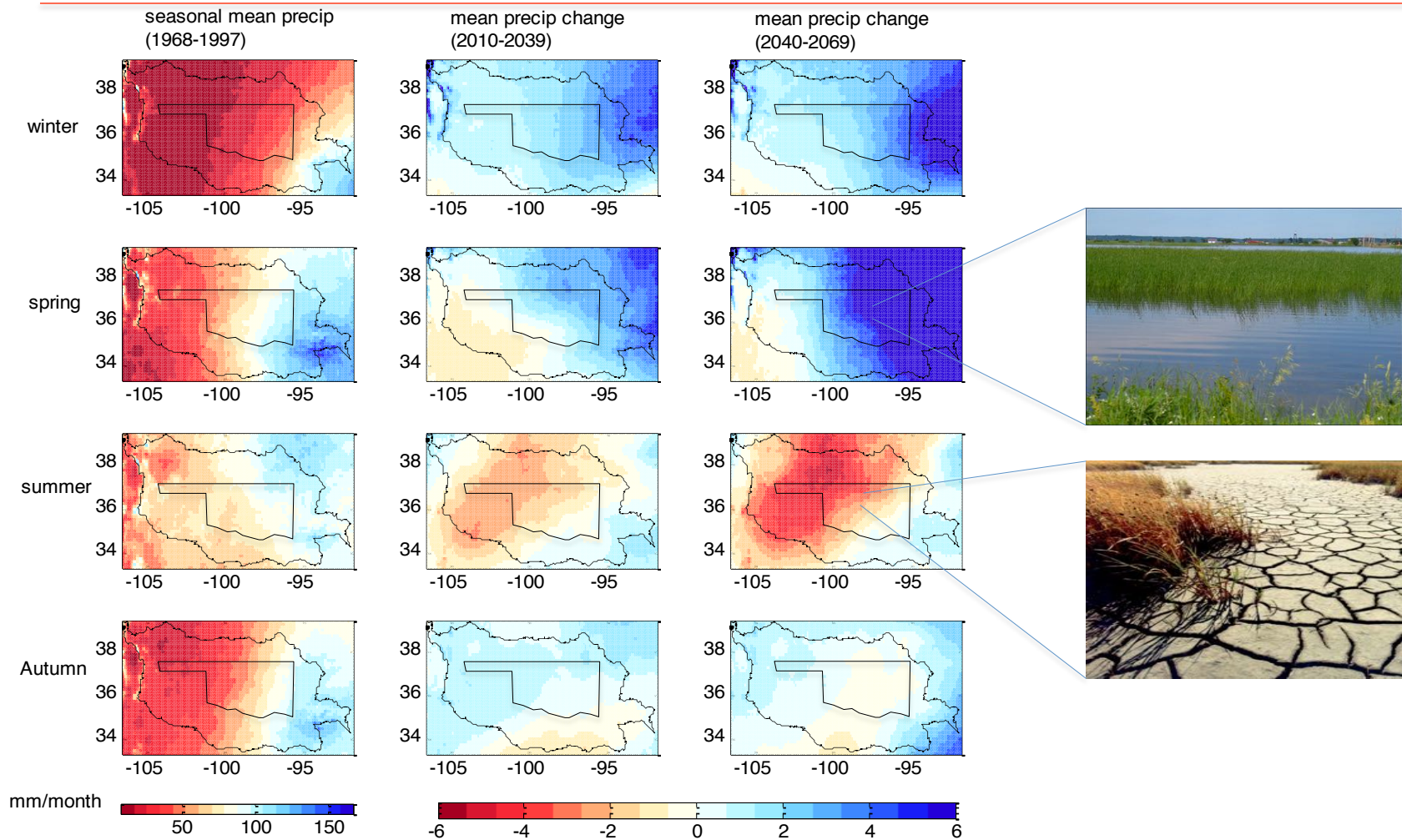
# Threats to Wetlands – Human Activities



- We drained them
- We plowed them
- We filled them with sediments
- We have lost nearly 70% of the original wetlands in Oklahoma



# Threat to Wetlands – Climate Change



The spatial distribution of seasonal mean precipitation of historical period 1968-1997 (left column) and changes for the period 2010-2039 (middle column) and 2040-2069 (right column) over the Arkansas-Red River Basin (Qiao et al., unpublished). The Oklahoma Map is for indication purpose)



# Conservation Challenges for Wetlands

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- Threats to wetlands are mostly human-driven, most notably through individual behavior (most land in Oklahoma is privately owned).
- Dry and wet cycles (hydro-periods) are critical to maintaining wetland functions – climate control.
- Ownership and land use law.
  - Wetlands are landscape features and difficult to identify and delineate their boundaries.
  - The beds of wetlands are often privately owned. Access may be denied to private wetlands.
- Resources to protect wetlands are limited and it is unclear where these resources should be directed.
- A coupled CNH approach is critical to develop conservation policies.

Provide a common frame of reference  
for actors, policies and landscape functions



– Triad of Relationships

<http://envision.bioe.orst.edu/>

# *Proposal* - Vulnerability and resiliency of wetlands under changing climate in the Cimarron River Basin of Oklahoma

Goals: understand impact of land use pattern, land management policies and climate change on wetland vulnerability and resiliency and provide decision supporting tools for wetland protection and restoration for the Cimarron River Basin

## Approach:

Under the **coupled natural/human systems** framework, work closely with **Actors** (land owners, agencies, non-profit organizations) at the beginning of the project to ensure that research leads to effective tools/**Policies** for public and private decision makers for **Landscape/** wetland restoration.





# Objectives

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## *Specific objectives*

### **Landscape**

- Mapping wetlands
- Development of hydrologic model to predict wetland inundation/vulnerability
- Predictions for wetland inundation under climate change

### **Actors and behavior**

- Ownership, ownership patterns, perception to wetland
- Agencies – needs, planning and existing projects
- NGO (Duck Unlimited....) – needs, planning and existing projects.

### **Policies**

- Evaluate a range of strategies (policies, tools such as crop insurance – easement)
- How policy will result in change in behavior under climate change

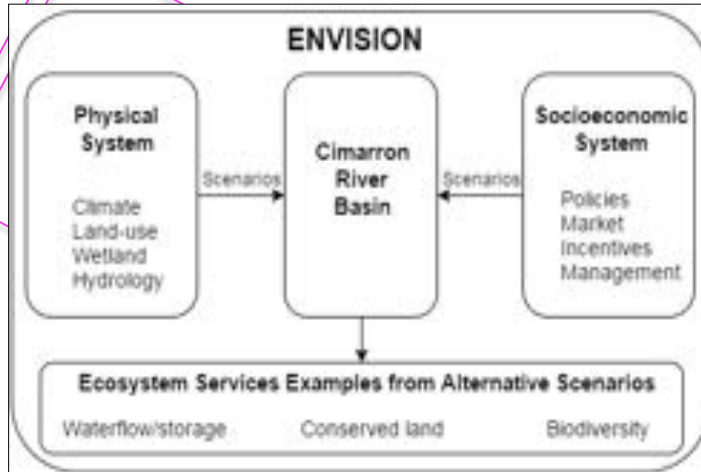
### ***Interactions and Model Integration***

- How policy will result in change in behavior under climate change
- Recommend management strategy for wetland sustainability and resiliency under climate change

## *Outcomes / Deliverables*

- Updated wetland map
- Ecosystem services map
- Wetland vulnerability map under climate change
  
- Database of ownership and ownership types
- Existing restoration project map
- Wetland vulnerability map under human activities
  
- Impact of policies, incentives on land owner behavior
  
- Decision supporting tool
- Recommendation for wetland protection and restoration

# Decision Supporting Tool - Modeling



**ENVISION**  
Integrated Modeling Platform

A spatially explicit, multiparadigm modeling framework for analysis of coupled natural/human systems and alternative future scenarios

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**ENVISION** is a GIS-based tool for scenario-based community and regional integrated planning and environmental assessments. It provides a robust platform for integrating a variety of spatially explicit models of landscape change processes and production for conducting alternative futures analyses.

**ENVISION** is open-source and freely available. It is built on an open, extensible architecture that can be adapted to a variety of geographic locations and application domains. Envision provides a variety of easily-used "plug-ins" that allow for modeling a variety of situations, and can be extended using your own custom plug-ins for specific modeling needs.

**ENVISION** includes a powerful "multiagent modeling" subsystem that allows for the representation of human decision-makers in landscape simulations. Envision "actors" make management decisions in parallel with landscape change models using a variety of decision models that can reflect actor values and incorporate landscape feedbacks.



**Management & Policy**

# What we know, what we need to know and what expertise we need to make this happen?

## Specific objectives

### Landscape

- Mapping wetlands
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### Actors and behavior

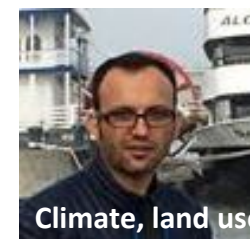
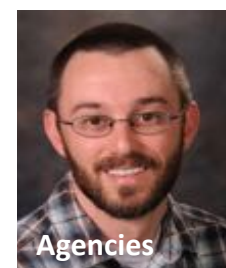
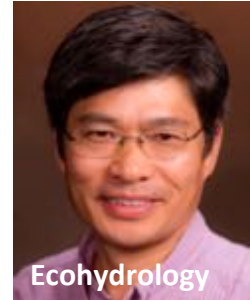
- Ownership and ownership patterns
- Federal agencies - existence of failures/successes in wetland conservation
- NGO (Duck Unlimited....) – restoration projects

### Policies

- Evaluate a range of strategies (policies, tools such as crop insurance – easement)
- How policy will result in change in behavior under climate change

### Interactions/Model Integration

- How policy will result in change in behavior under climate change
- Recommend management strategy for wetland sustainability and resiliency under climate change





If you are interested and want to contribute to this effort -

