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The Water-Energy-Food Nexus (WEF) Stakeholder Information and Engagement Workshop

Registration

9:30 -10:00 AM

San Antonio, TX | January 10, 2018

Master of Ceremonies

Rudy Rosen, Director

Institute for Water Resources Science and Technology

Texas A&M University, San Antonio

10:00 – 10:05 AM

San Antonio, TX | January 10, 2018

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Welcome Note

Dr. Cynthia Teniente-Matson
President, Texas A&M University–San Antonio

San Antonio, TX | January 10, 2018

Overview:
Texas A&M Water-Energy-Food Nexus Initiative (WEFNI)
Workshop Objectives

Rabi H. Mohtar, TEES Research Professor

Coordinator, WEF Nexus Initiative, Texas A&M University

Faculty of Agriculture and Food Sciences, American University of Beirut

10:05-10:15 AM

San Antonio, TX | January 10, 2018

WEFNI – GOALS

I. ***Expand*** *intellectual capacity and scope of TAMU's Water-Energy-Food Nexus Community by developing analytics, policy, and governance best practices;*

II. ***Establish*** *a Nexus Community of Science;*

III. ***Identify*** *opportunities and gaps in current WEF Nexus related research.*

- ***Launched in 2015***
- 200 research and extension faculty from Texas A&M System
- WEFNI supports **6 PhD** and **8 MSc** students from Geosciences, Geography, WMHS, BAEN, Mechanical, and Chemical Engr.
- *2 Special Issues*
- *18 INFEWS proposals submitted*
- *National and Global Partnerships*

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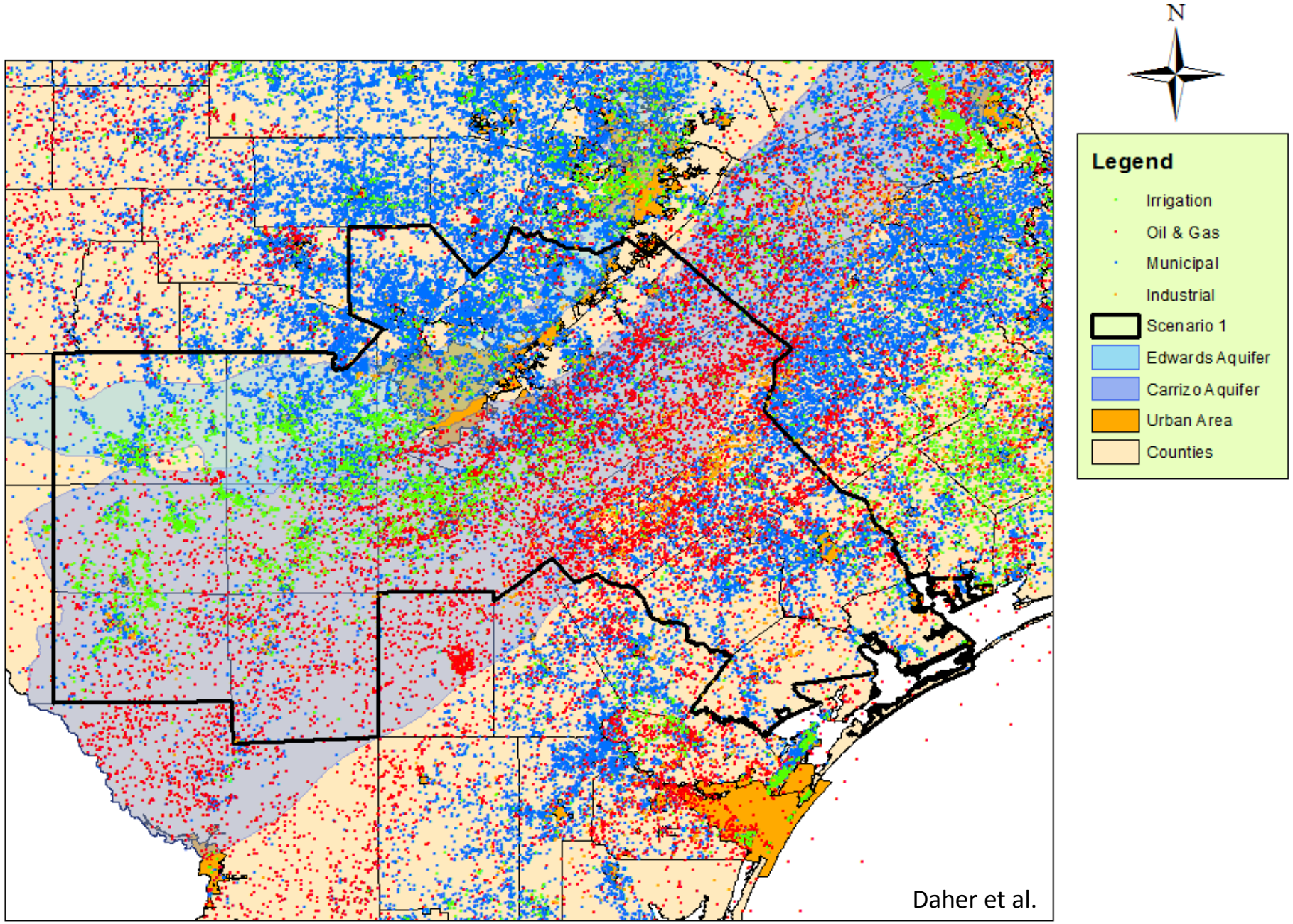
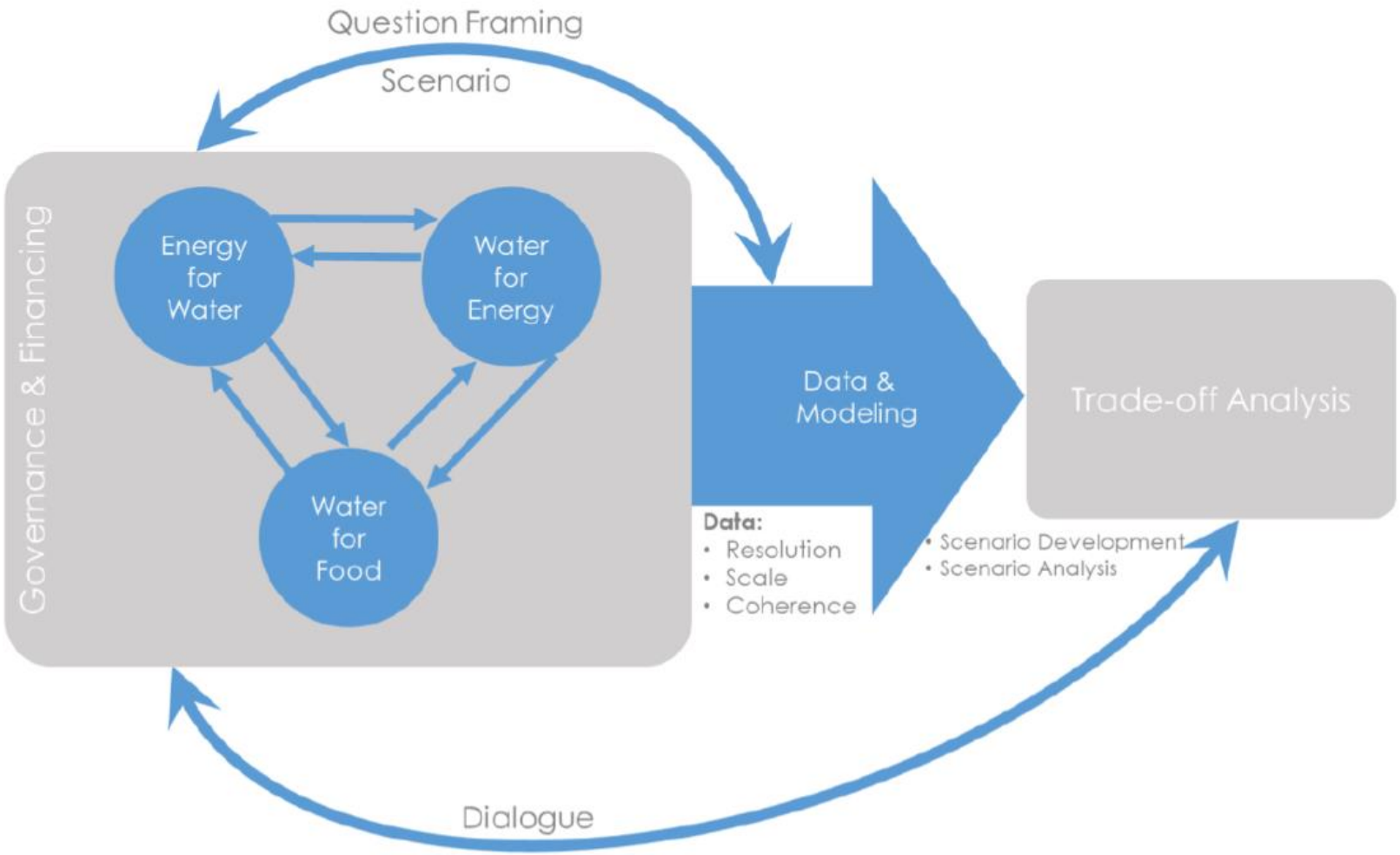
The San Antonio Hotspot



The San Antonio Case Studies



San Antonio Groups

- G1 — **Group 1:** Data and Modeling
- G2 — **Group 2:** Energy for Water
- G3 — **Group 3:** Governance & Financing
- G4 — **Group 4:** Tradeoff Analysis
- G5 — **Group 5:** Water for Food
- G6 — **Group 6:** Water for Energy

Texas Water Gap

How can we bridge the **Texas water gap** *(8.9 Billion cubic meters in 2070)*, given projected **population growth** & **climate change stresses**, while accounting for

- **variable water availability**
- **water demanding sectors**
- across **different regions** of the state?

Lubbock:

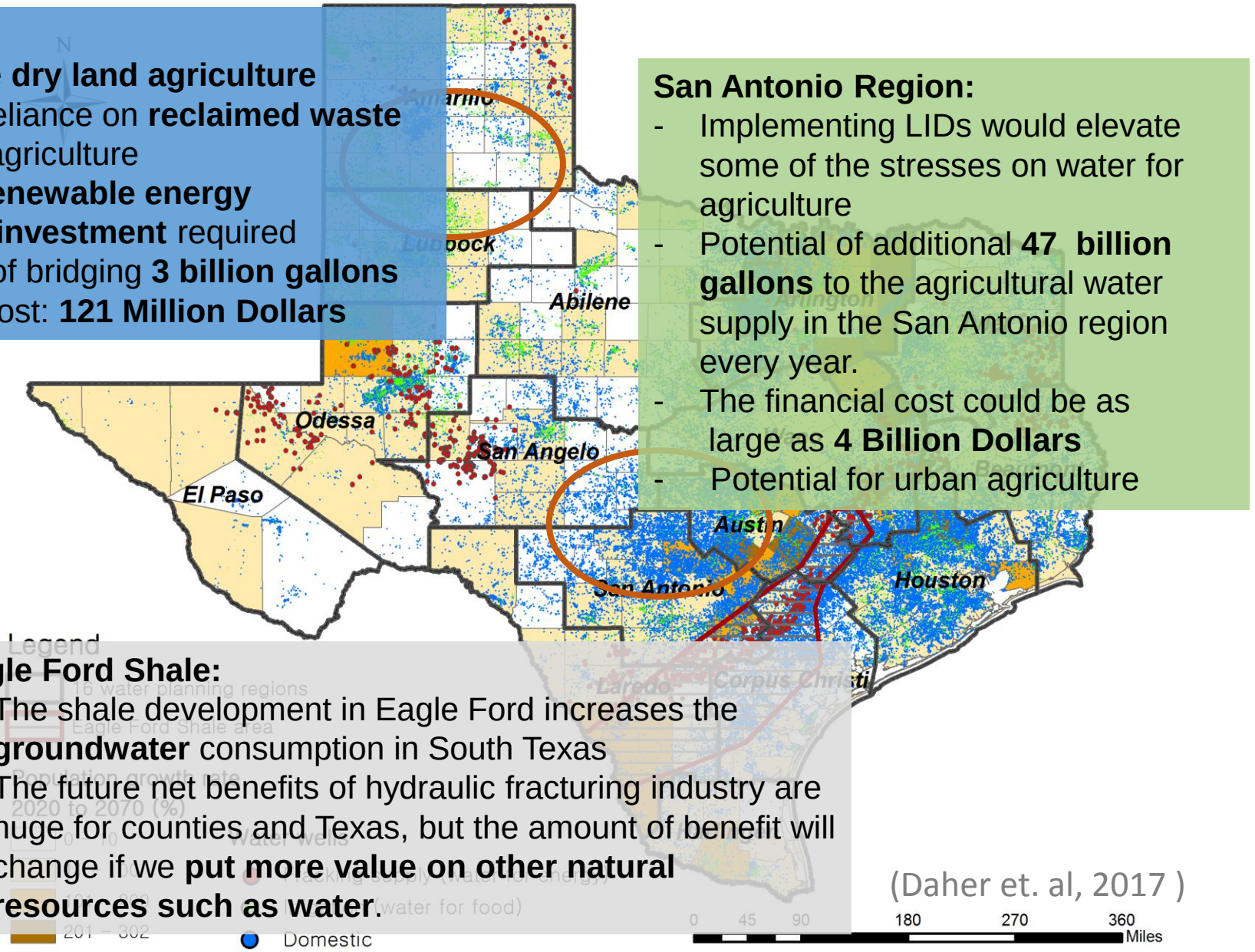
- Encourage **dry land agriculture**
- Increase reliance on **reclaimed waste water** for agriculture
- Invest in **renewable energy**

→ **Financial investment** required

→ Potential of bridging **3 billion gallons**
Potential cost: **121 Million Dollars**

San Antonio Region:

- Implementing LIDs would elevate some of the stresses on water for agriculture
- Potential of additional **47 billion gallons** to the agricultural water supply in the San Antonio region every year.
- The financial cost could be as large as **4 Billion Dollars**
- Potential for urban agriculture



Eagle Ford Shale:

- The shale development in Eagle Ford increases the **groundwater** consumption in South Texas
- The future net benefits of hydraulic fracturing industry are huge for counties and Texas, but the amount of benefit will change if we **put more value on other natural resources such as water**.

(Daher et. al, 2017)

WEF Nexus SAMPLE PROJECT OUTCOMES

WET Tool

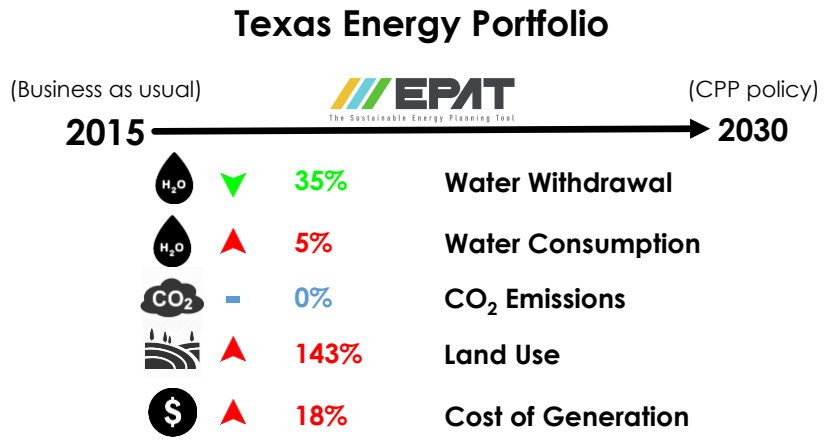
Quantify the interrelations and trade-offs between the water, energy, and transportation sectors under different scenarios:

1. Increasing (or decreasing) production
2. Changes in oil and gas market price
3. Different lateral lengths
4. Amount of reused water
5. Varying modes of transport for water/oil/gas

Matagorda County, Texas

Annual income could increases by as much as $32 million over the current "business as usual" mainly addressing the agricultural sector, which currently suffering from lack of water.

Energy Portfolio Assessment Tool (EPAT)



EPAT shows that the **CPP policy succeeds in mitigating the carbon emissions** by sustaining same level even after capacity increase, and in **decreasing the water withdrawal volumes in generation by 35%.** On the other hand, the **CPP policy increases water consumption by 5%, land use by 143%** and **cost by 18%.**

Special Issue

Paper #1: Are Current Allocation Models Capable of Addressing Increasingly Interconnected and Complex Resource Hotspots?

Paper #2: WEF Nexus Modeling and Climate Change Impact

Paper #3: Water, Energy, and Food Waste Reutilization in San Antonio

Paper #4: Environmental Impact Assessments of San Antonio's Water Expansion Projects Using Life Cycle Analysis

Paper #5: Energy Portfolio Assessment Tool (EPAT): Sustainable Energy Planning Using the WEF Nexus Approach – Texas Case

Paper #6: Development and Application of an Urban Water, Energy, Food Nexus Analytic Tool

Paper #7: WEF Nexus Governance Cooperation in San Antonio

Paper #8: Impact of Secondary Treated Municipal Wastewater Irrigation on Soil Chemistry and Clay Mineralogy

Paper #9: Effect of treated municipal treated wastewater on the hydro-structural properties of a clayey, calcareous soil

Paper #10: Developing a Farm-scale Food-Water-Energy-Soil-Waste Nexus Framework for the Closed-Loop Dairy Concept

Paper #11: Impact of Manure Derived Biochar as a Soil Amendment: Water-Soil-Waste Nexus Study at a Texas Dairy

Paper #12: Hydraulic Fracturing – a WEF Socio-Economic Assessment Tool

Paper #13: Photo Catalysts for Water Treatment Using Solar Energy

Paper #14: Optimal Water Allocation Planning using a Water-Energy-Food Nexus Approach: The Case of Matagorda County, TX

Paper #15: Towards bridging the water gap in Texas: A Water-Energy-Food Nexus Approach

Paper #16: Water-Energy-Food Nexus Review Paper

ELSEVIER

Timeline

Prelim drafts

Final drafts

Workshop Objectives

1. **Inform** stakeholders about *ongoing* and *planned* Nexus research and educational activities.

2. **Identify** possible and desirable *information sharing opportunities* and actions.

3. **Identify** and "test" the concept of *coordinated stakeholder engagement* for future Nexus-related matters.

4. **Establish** an *ongoing dialogue* between scientists, Nexus-related policy makers, government officials, civil society advocates, and industry leaders.

Workshop Expected Outcomes

1. **Identify barriers** to improved communication between interrelated disciplines and sectors

2. **Identify questions** that the scientific community should be working on

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Science Panel

David D. Baltensperger , Moderator

Professor and Head of the Soil and Crop Sciences Department, TAMU

1. Key findings in sub-group
2. What are key challenges you face in conducting FEW nexus research?
3. What are your needs from governmental and industry/business institutions?
4. What do you have to offer governmental and industry/business institutions?

10:15-11:30 AM

San Antonio, TX | January 10, 2018

Science Panel

Kent Portney

Professor and Director of the Institute for Science, Technology and Public Policy

Bruce Mc Carl

Texas AgriLife Senior Fellow, Regents Professor & Distinguished Professor of Agricultural Economics

Valentini Pappa

Adjunct Professor, Biological and Agricultural Engineering

Debalina Sengupta

Associate Director of the Gas and Fuels Research Center for Texas A&M Engineering Experiment Station (TEES)

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Governance Group

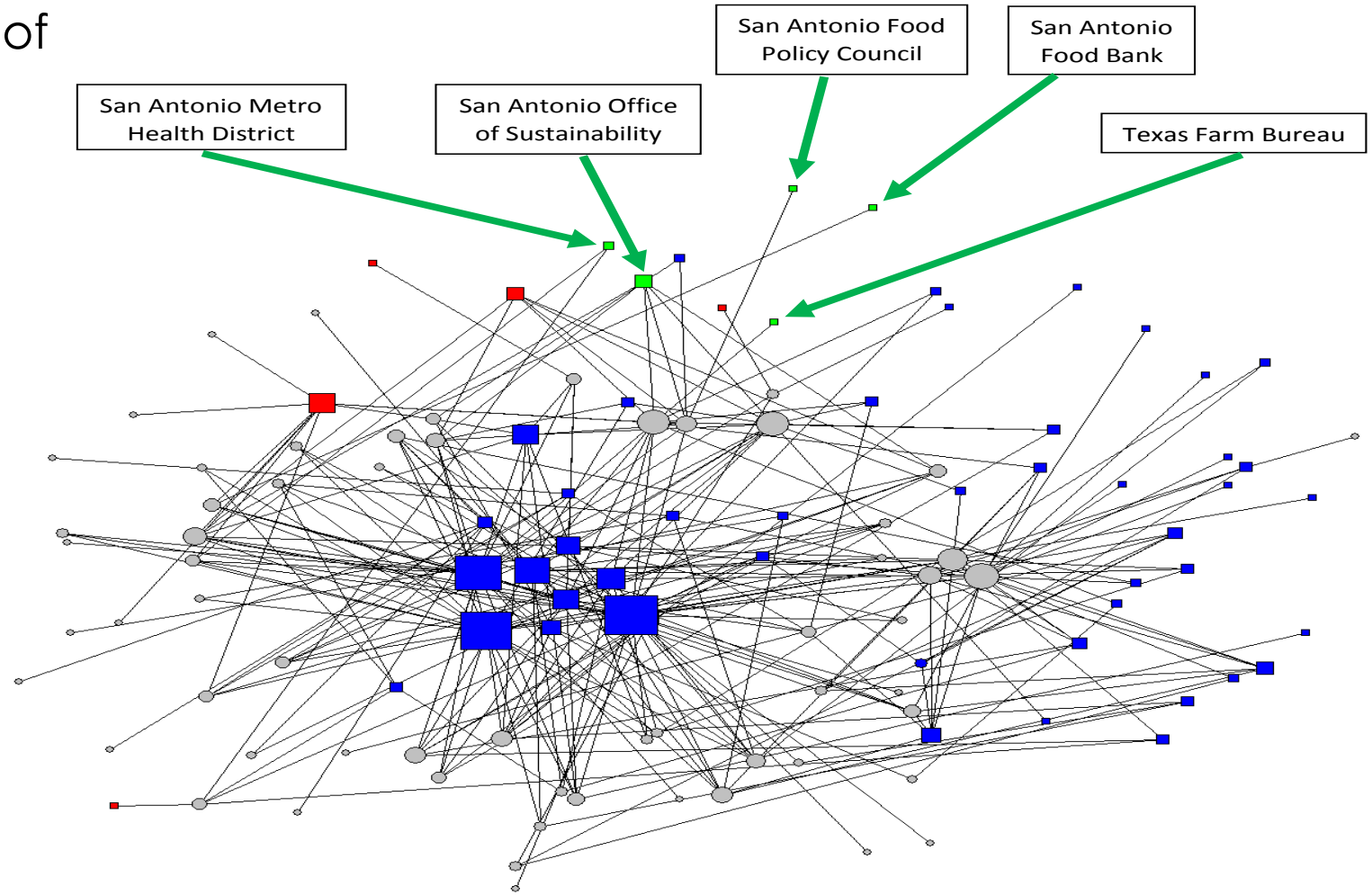
1. Key findings in sub-group
2. What are key challenges you face in conducting FEW nexus research?
3. What are your needs from governmental and industry/business institutions?
4. What do you have to offer governmental and industry/business institutions?

Key findings

Figure 3: Water-Energy-Food/Agriculture Nexus Governance Network in the San Antonio Region

Blue nodes represent water governance organizations contacted by survey respondents
Red nodes represent energy governance organizations contacted by survey respondents
Green nodes represent food/agriculture/nutrition organizations contacted by survey respondents

- Modest amount of communication within the water domain
- Very little communication between water, energy, and food/agriculture domains



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Key challenges

- Engaging a full range of stakeholders and policy makers
- Tapping extensive on-the-ground knowledge, experience, and expertise
- Framing answerable questions to promote improved nexus decision making
- Generating relevant, usable, and actionable data

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What do we need from San Antonio Institutions?

- Partnerships and collaborators
- Substantive guidance for analysis of decision making

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What do we have to offer San Antonio Institutions?

- Cross-sector experiences, knowledge, and opportunities
- Points of potential intervention and cooperation

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Modeling Group

Team Objectives and Activities

- Decision support via Evaluation and optimization of WEF alternatives
- Evaluation of multidimensional implications
- Suggestion of portfolios of approaches through optimization
- Examination of needed compensation to make this work
- Water Centered
- Modeling that integrates agriculture, municipal, industrial, energy and environment
- Model is just coming to life
- Engaged in addition of alternatives

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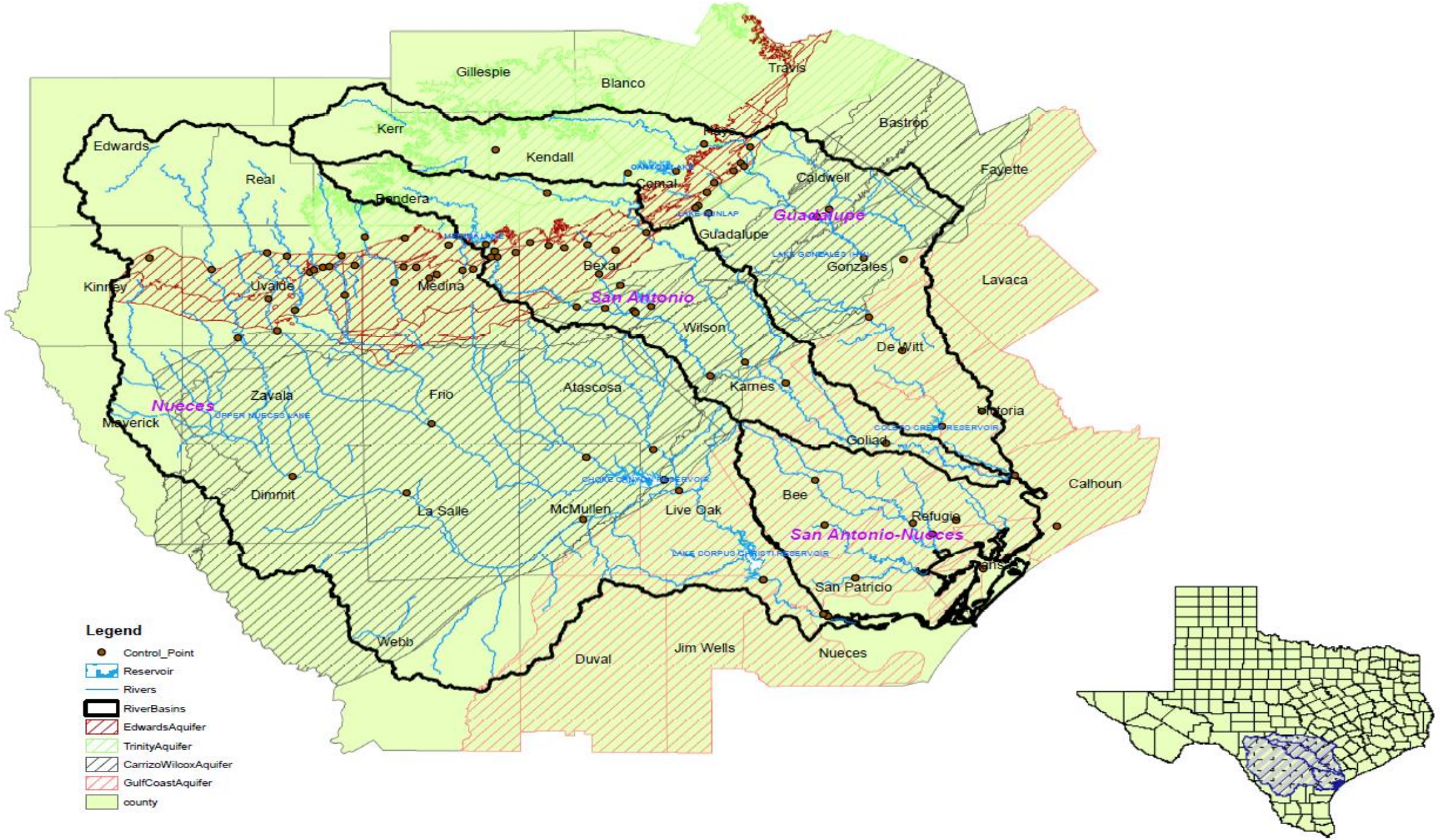
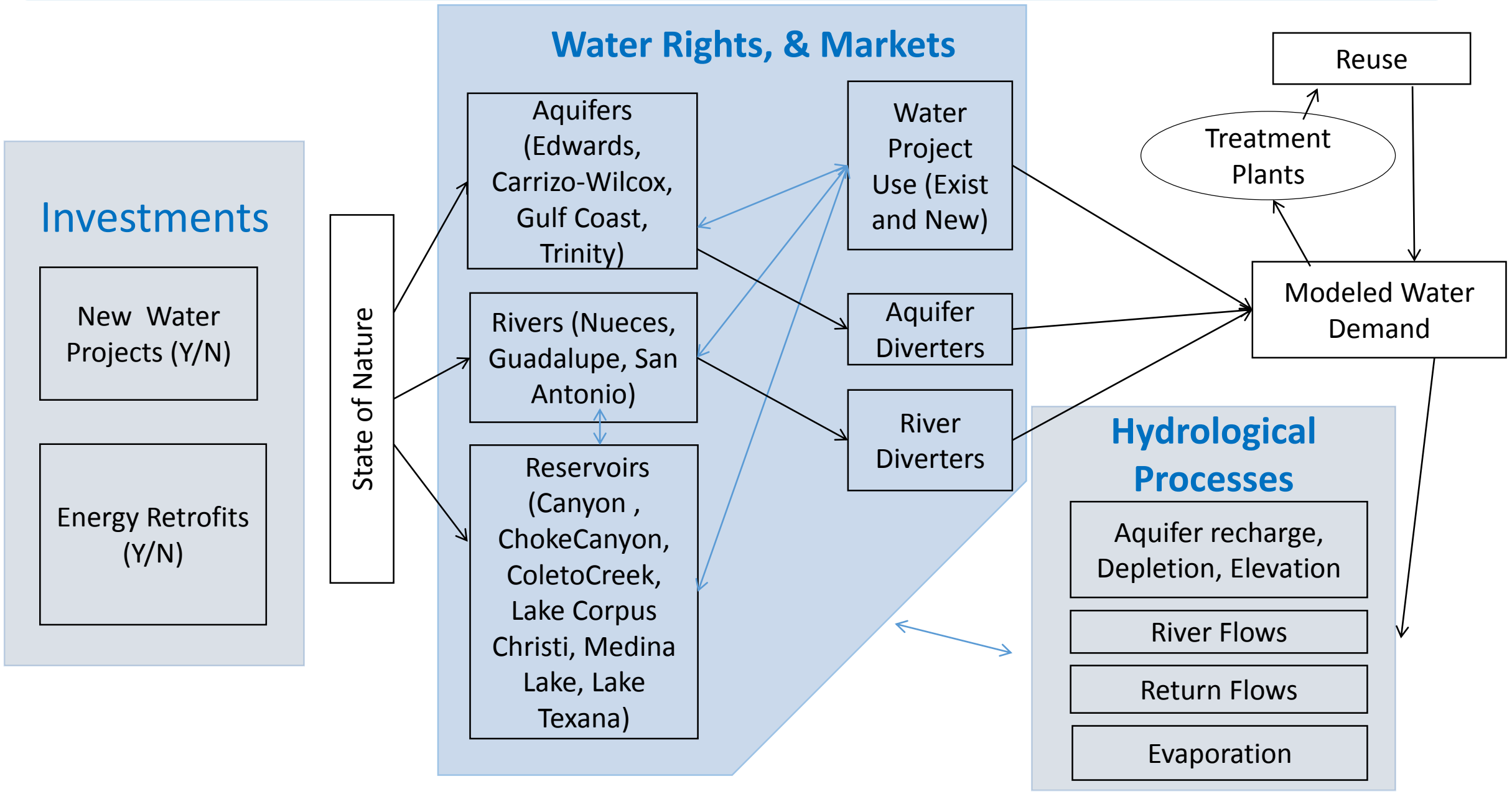
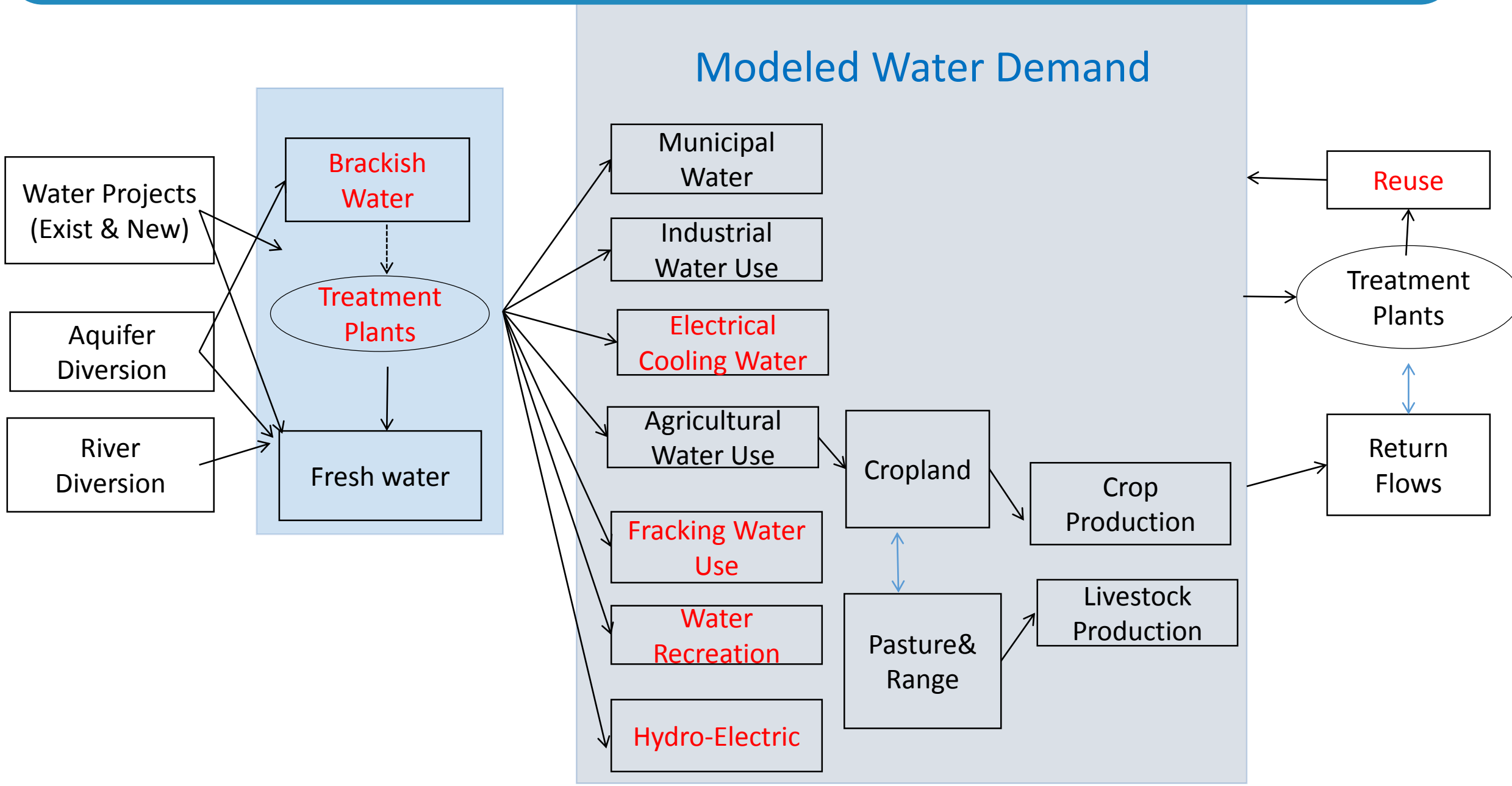
Key Activities – Geographic & Hydrologic Scope



Key Activities – Model Scope



Key Activities – Model Scope



Prior Findings

Versions of model have been around for many years – first study 1990

- **400 k pumping limit expensive – springflow /elevation based better for both habitat and regional economy**
- **Importance of El Nino state knowledge**
- **Water projections high given price response**
- **Water development projects not enough for 2050 if climate continues to evolve**

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Key challenges

- **Data**
- **Identification of major WEF alternatives**
- **Mechanisms for implementation and compensation**
- **Conjunctive water use modeling**
- **Adding in environmental concerns (instream flows, bay and estuary, springflow)**

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WEF Alternatives – a starting point

Ag	Irrigation methods and practices	Alternative crops
	Land to dryland or grazing	Removing minimum limits
	Degraded water use	Crop mix
Water	Use of more distant aquifers	Injection &recovery
	Reservoirs	Saline sources
	Enhanced recharge	Conservation
	Reuse	
Energy	Alternative cooling	Coal to Natural Gas
	Renewable sources wind solar	Import more
	Fracking water reuse	Fracking technology

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What help do we need from Regional Stakeholders?

Data and insights

- **Identification of water conserving approaches and their costs**
- **Agricultural data on**
  - **Effects of alternative irrigation possibilities**
  - **Saline water use effects**
- **Effects on water project yields of drought**
- **Identification of possible policy changes (1 ac ft in ag?)**

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What do we intend to have to offer Regional Stakeholders?

Support for decisions

- **Multi dimensional Evaluations**
- **Portfolios**
- **Projections of effects of changes in population, water supplies, aquifer depletion, policies, projects, retrofits, alternative energy**

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Water-Food Group

1. Key findings in sub-group
2. What are key challenges you face in conducting FEW nexus research?
3. What are your needs from governmental and industry/business institutions?
4. What do you have to offer governmental and industry/business institutions?

Key Objectives

1. Build a nexus-based model for tradeoff analysis and resource allocation for management of livestock production at a farm scale (1)
2. Evaluate the benefits of the closed-loop dairy concept for agricultural yield, environmental quality, and cost of inputs, including water and energy resources (1)
3. Quantify the impacts of dairy farm waste management practices, such as manure application and wastewater irrigation, by determining soil physical properties such as water retention and available water (2)
4. Study the changes in hydro-structural soil properties after long term waste application and their correlations with crop yield (2)
5. Recommend biochar systems for individual applications (3)

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Key findings

….on going research

1. Multiway approach identifying energy, water, waste and food centric scenarios (1)
2. In depth understanding about the effects of waste application on physical soil properties which will allow for making informed waste management and irrigation decisions (2)
3. With optimization of variables contributing in biochar production, soil physical properties improvement would be maximized (3)

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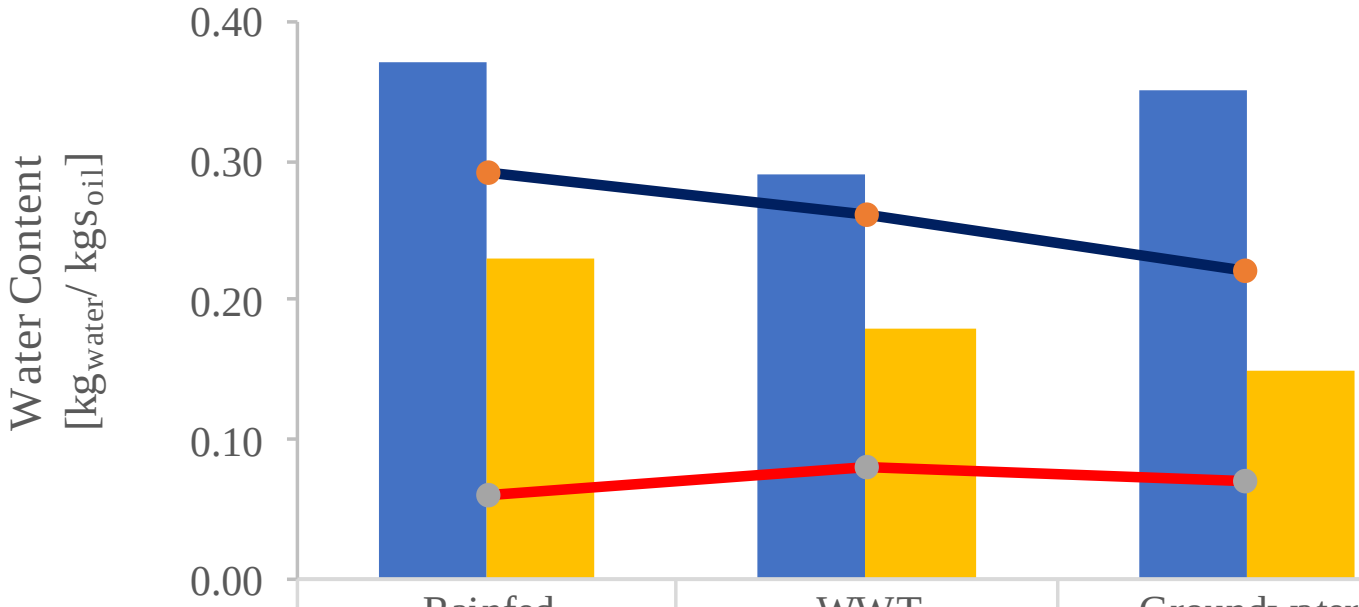
Long-term Impact of Wastewater Reuse on Soil-Water Holding Properties

- More than 10 years of WWT reuse in a cotton field in San Angelo, TX.
- The famer reported an increase in the cotton yield with wastewater reuse.
- Trade-off between quality, cost, and soil health and productivity

Soil-Water Holding Properties for Angelo Soil Series
San Angelo, TX
[A Horizon - Clayey soil]



	Rainfed	WWT	Groundwater
Wsat	0.37	0.29	0.35
Available Water	0.23	0.18	0.15
FC	0.29	0.26	0.22
PWP	0.06	0.08	0.07

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Key challenges

1. Providing those interested decision-makers with clear, simple, yet comprehensive answers (1)
2. Combine energy-water-food data to establish a monetary value for several sectors (1)
3. In depth understanding about the effects of waste application on physical soil properties which will allow for making informed waste management and irrigation decisions (2)
4. Biochar characteristics and effects- multi parameters (3)
5. The availability and compatibility of data sets (1,2,3)

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What help do we need from Regional Stakeholders?

- Additional farm to contrast data
- Any additional set of data?

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What do we intend to have to offer Regional Stakeholders?

- Offer a work in progress model of a dairy farm including manure management and biomass processing (1)
- In depth understanding about the effects of waste application on physical soil properties which will allow for making informed waste management and irrigation decisions (2)
- A guideline for specification of biochar based on soil type and structure (3)

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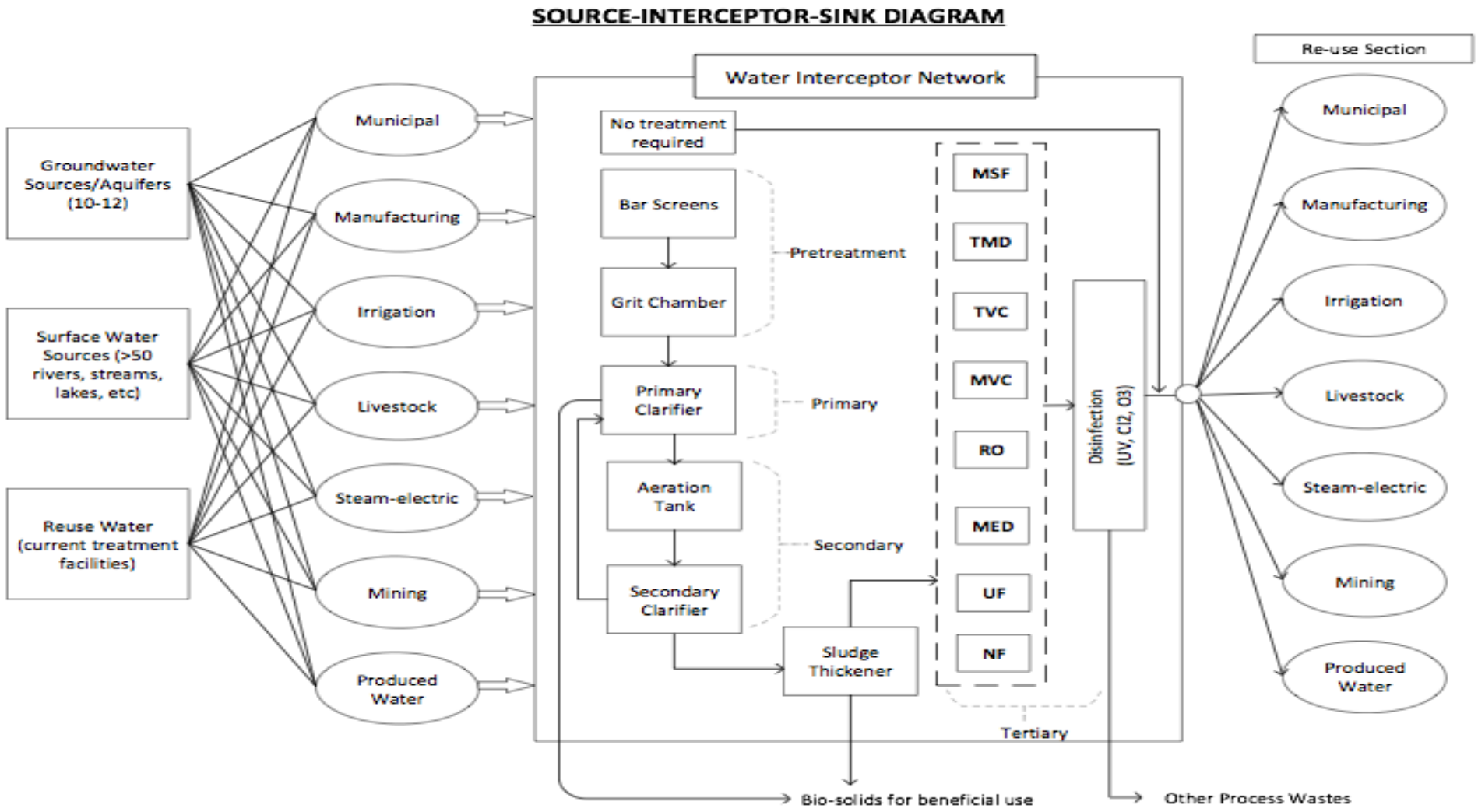
Water-Energy

1. Key findings in sub-group 2 Energy for Water
2. What are key challenges you face in conducting FEW nexus research?
3. What are your needs from governmental and industry/business institutions?
4. What do you have to offer governmental and industry/business institutions?

Key findings



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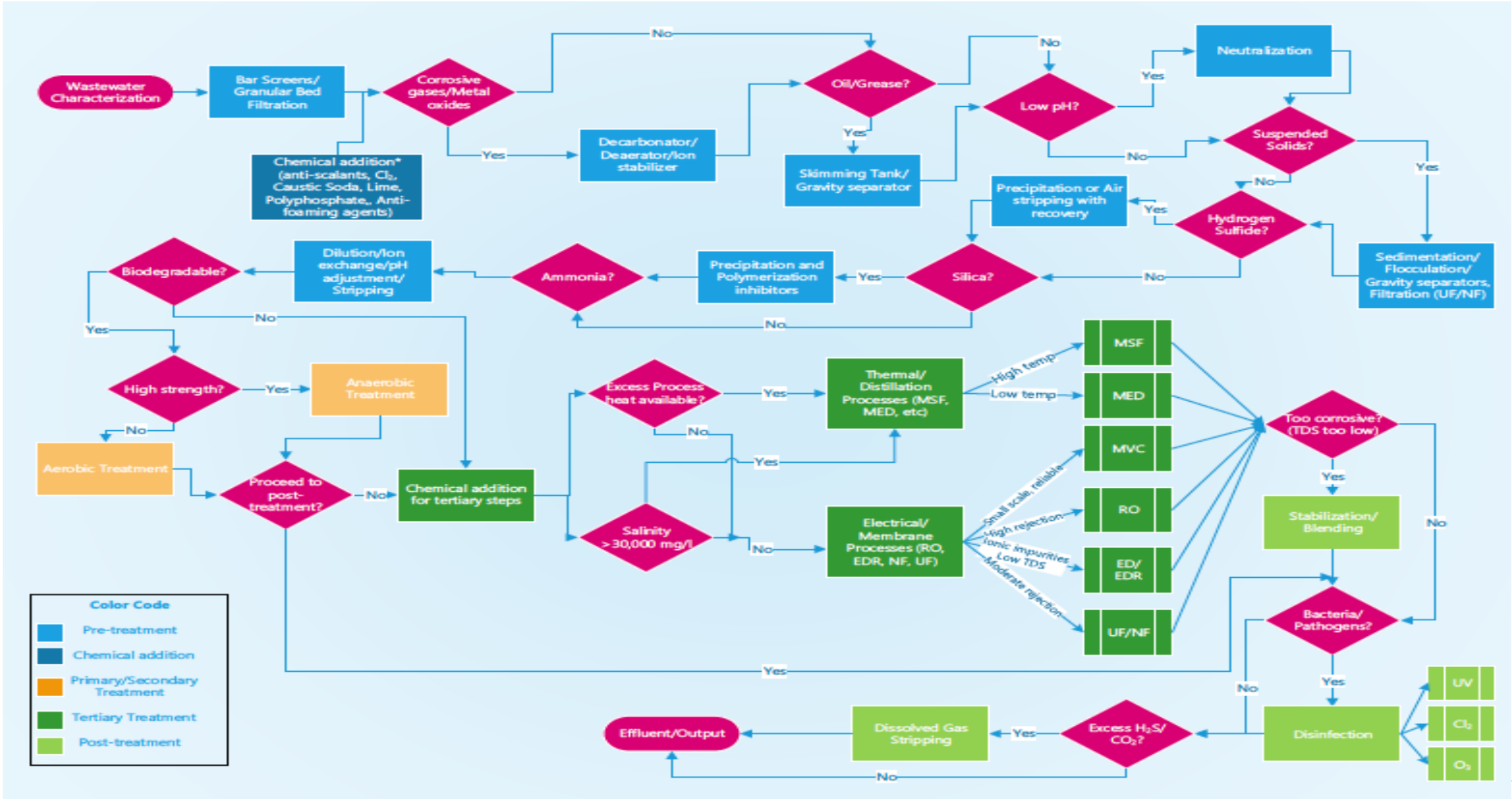
Key findings



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Key findings

- **General Framework** completed for water network through a source-interceptor-sink model
- **Data Collection** completed for generic water characteristics, water qualities for wastewater, and treatment methods
- **Detailed Cost Data** compiled and cost curves constructed for various treatment strategies
- **Flowchart** created for the optimization based decision making framework

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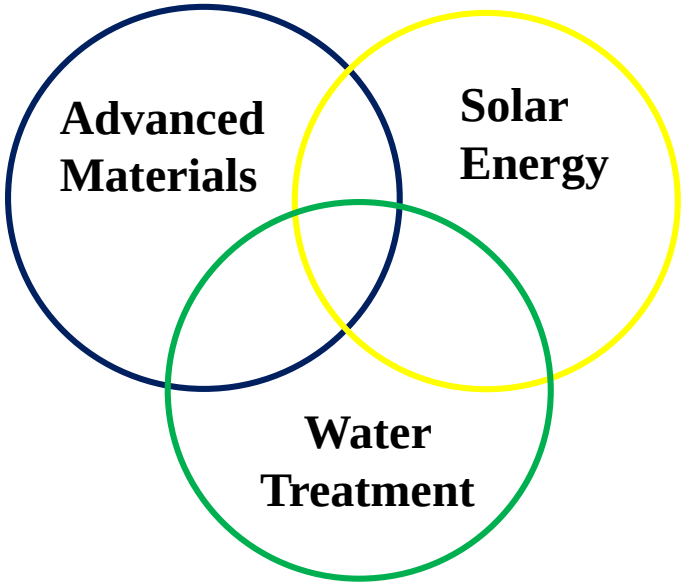
Ying Li, Associate Professor
Pioneer Natural Resources Faculty Fellow

- Advanced materials and solar energy enabled wastewater treatment and clean water production

- Photocatalyst
- Nanofibers
- Nanocomposite
- Coating
- Membrane



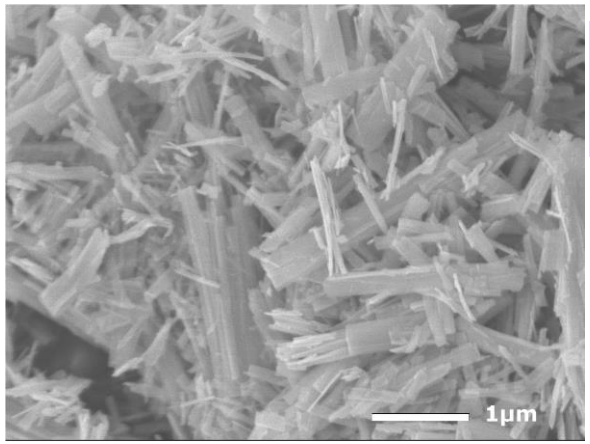
- Solar thermal
- Solar PV
- Solar chemical
- Hybrid solar

- Organic pollutant removal
- Heavy metal removal
- Disinfection
- Desalination

- Oil/gas produced water
- Municipal/industrial wastewater
- Seawater
- Inland brakish water

Atomic layer deposition (ALD) modified Ag_TiO_2 photocatalyst for phenol degradation under sunlight

Scott et al. submitted to *Science of the Total Environment*

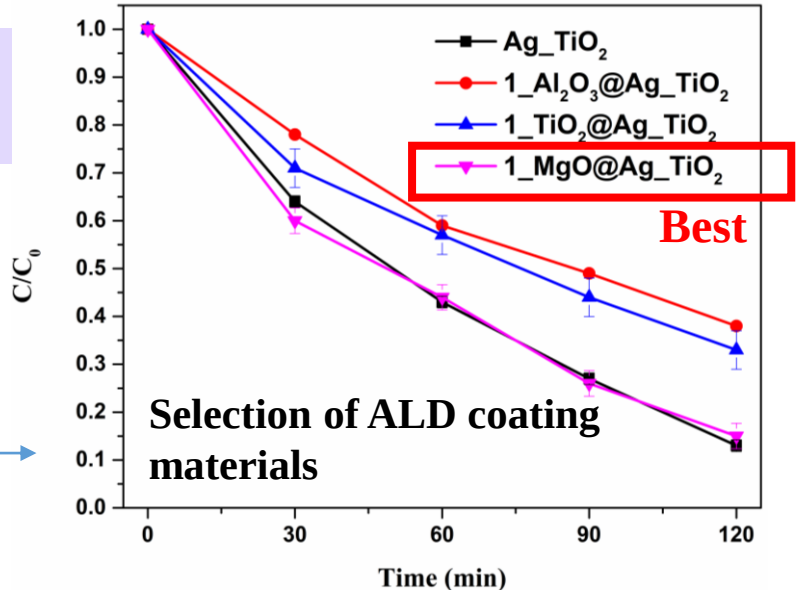


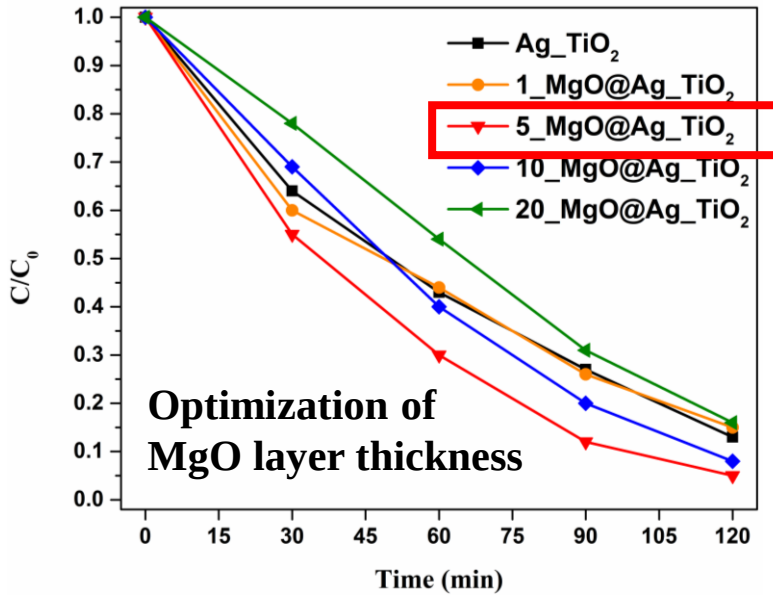
Nanorod structured TiO_2

Ag modification

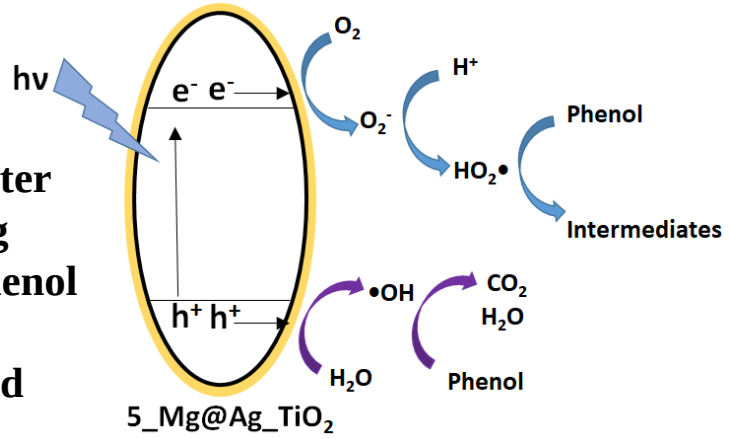
Ag_TiO_2

ALD coating





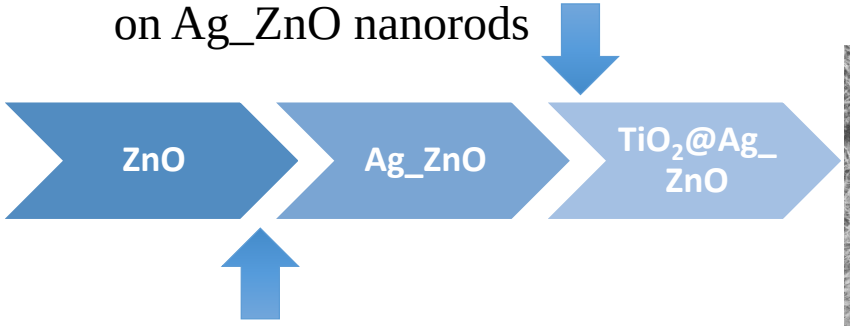
- **Sub-nanometer MgO coating enhanced phenol degradation efficiency and stability**



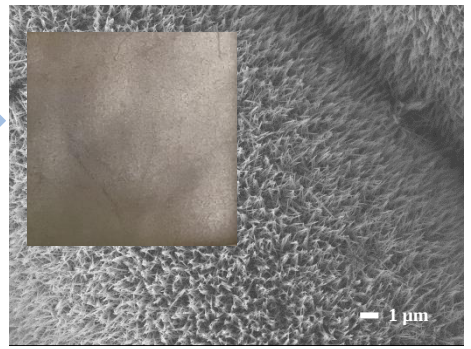
ALD layer protected Ag_ZnO nanorods grown on stainless steel mesh for organic dye degradation

Zhao et al. *Advanced Composites & Hybrid Materials.* In press

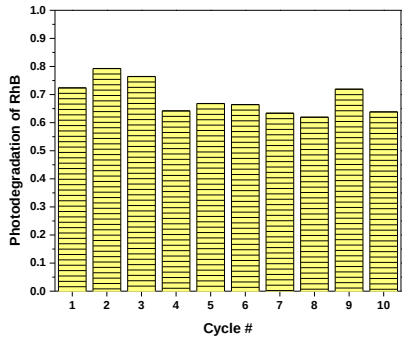
ALD is applied to coat protective TiO_2 layer on Ag_ZnO nanorods

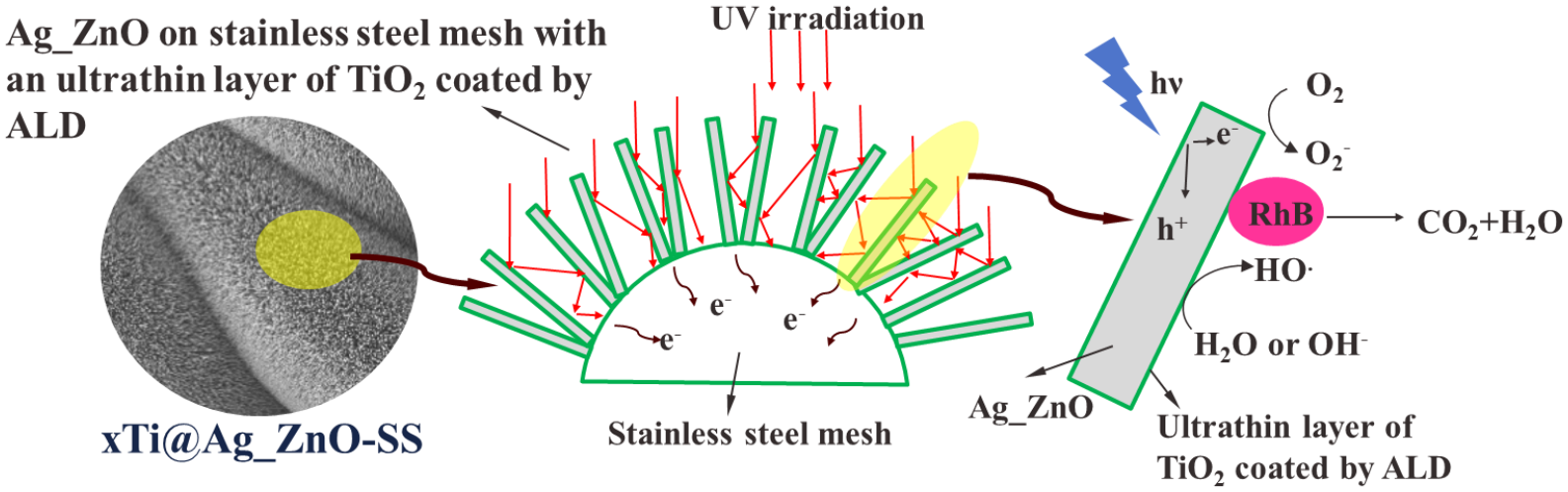


5Ti@Ag_ZnO-SS



Long term stability test (10 cycles RhB degradation)





Key challenges

- Data validation challenges
- San Antonio Case Study Data is required for specific information for the framework
- Model is large, needs to be reduced for solution strategies
- Acceptability of solutions offered, identifying stakeholders

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What help do we need from Regional Stakeholders?

- Specific Data for the San Antonio Region (Some of it is publicly available)
- Engagement of municipal works in the model and results validation

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What do we intend to have to offer Regional Stakeholders?

- Detailed model of energy and material use for purifying water systems
- Models for setting targets for purification
- Challenge identification and providing solutions through data and model based approaches
- Ability to analyze widely collected data on wastewater sources and providing mass, energy, and property integration strategies

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Science Panel – Q&A

David D. Baltensperger , Moderator
Kent Portney
Bruce Mc Carl
Valentini Pappa
Debalina Sengupta

11:30 -12:00 AM

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Networking Lunch

12:00-12:45 PM

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Engagement 1:
Are we asking the right questions?

What questions should we be working on?

Moderators:

Elsa Murano, *Director of Borlaug Institute*

John Tracy, *Director of the Texas Water Resources Institute*

1:00-1:20 PM

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Engagement 2:
Incentives, ***limitations***, *and* ***opportunities*** *of working across disciplines?*

What are current barriers to work across disciplines?
What kind of interventions are needed to incentivize more cooperation across disciplines and sectors?

Moderators:

Ali Fares, *Associate Director for Research, Prairie View A&M University*

Jack Baldauf, *Executive Associate Dean and Associate Dean for Research, Texas A&M University*

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Sessions Reporting and Final Remarks

Rabi Mohtar, **TEES Research Professor**
Coordinator, WEF Nexus Initiative
Texas A&M University
American University of Beirut

1:40-2:00 PM

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Adjournment

Thank You