2018

# Water-Energy-Food Nexus Stakeholder Information Sharing and Engagement Workshop

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# WATER-ENERGY-FOOD

## NEXUS STAKEHOLDER INFORMATION SHARING AND ENGAGEMENT WORKSHOP

Workshop Held
**January 10, 2018**

Location
**Texas A&M University-San Antonio**

THE TEXAS A&M UNIVERSITY SYSTEM
TEXAS A&M UNIVERSITY SAN ANTONIO
ENGINEERING TEXAS A&M UNIVERSITY
THE COLLEGE OF GEOSCIENCES
TEXAS A&M UNIVERSITY DIVISION OF RESEARCH
NSF
TEES TEXAS A&M ENGINEERING EXPERIMENT STATION
The Bush School of Government & Public Service Texas A&M University
TEXAS A&M AGRILIFE RESEARCH
AGRICULTURE & LIFE SCIENCES TEXAS A&M UNIVERSITY
TEXAS A&M UNIVERSITY WEF NEXUS INITIATIVE

## WEF NEXUS INITIATIVE

# REPORT TO STAKEHOLDERS

## WATER-FOOD-ENERGY

The interconnection of water, energy, and food resources is complex, with the availability of these resources increasingly stressed by climatic, social, political, economic, demographic, technologic, and other pressures. Addressing these challenges requires a better understanding of the nexus formed by the interconnections between the resources.

On January 10, 2018, the Texas A&M University System Water-Energy-Food Initiative held the Water-Energy-Food Nexus Stakeholder Information Sharing and Engagement Workshop on the campus of Texas A&M University-San Antonio. The workshop involved over 70 stakeholders drawn from the water, energy, and food sectors in San Antonio and surrounding region.

Stakeholders attending the workshop heard presentations on the status of San Antonio Case Study pilot projects and other WEF nexus work. Facilitated small-group sessions were held at the workshop to obtain stakeholder input on research questions to be asked, and on limitations and opportunities for stakeholder engagement on WEF nexus-related work in the San Antonio and the South Texas Region. Workshop participants also took before and after surveys to gauge knowledge about the WEF nexus.

This report provides information on the outcomes of surveys, the workshop presentations and discussions, and the facilitated stakeholder sessions. Contact: wefni@tamu.edu.

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- The Texas A&M Water Energy Food Nexus initiative
- The Water Energy Food Nexus Research Group

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Copies may be obtained at https://libguides.tamusa.edu/ld.php?content_id=41591901 and at Texas A&M WEF Nexus Initiative, 306 Scoates Hall, Texas A&M University, College Station, TX 77843.

# CONTENT

## WEF NEXUS INITIATIVE

# LEADERSHIP TEAM

The Texas A&M University System Water-Energy-Food Nexus Initiative is composed of Texas A&M University System scientists who are committed to finding solutions to the WEF nexus grand challenges. These scientists and educators make up multidisciplinary teams and share their skills, knowledge, and scientific abilities to produce analytics grounded in state-of-the-art science intended to provide an information platform to facilitate inclusive stakeholder dialogues at local, regional, and global levels.

**Jack Baldauf** - Executive Associate Dean, Associate Dean for Research, Professor, College of Geosciences

**David Baltensperger** - Professor and Head, Department of Soil and Crop Sciences, College of Agriculture and Life Sciences

**Bruce McCarl** - University Distinguished Professor, Department of Agricultural Economics, College of Agriculture and Life Sciences

**Rabi Mohtar** - Texas A&M Engineering Experiment Station Research Professor, Biological and Agricultural Engineering, Zachry Department of Civil Engineering, College of Engineering, and College of Agriculture and Life Sciences

**Elsa Murano** - Director, Norman Borlaug Institute for International Agriculture and Professor, Department of Nutrition and Food Science, College of Agriculture and Life Sciences

**Efstratios Pistikopoulos** - Interim Co-Director, Texas A&M Energy Institute and TEES Distinguished Professor, Artie McFerrin Department of Chemical Engineering, College of Engineering

**Kent Portney** - Professor and Director, Institute for Science,Technology & Public Policy, Bush School of Government and Public Service

**Rudolph Rosen** - Director, Institute for Water Resources Science and Technology and Visiting Professor, Texas A&M University-San Antonio

**John Tracy** - Director, Texas Water Resources Institute, Professor, Zachry Department of Civil Engineering, College of Engineering

**Arnold Vedlitz** - Professor and Bob Bullock Chair in Government and Public Policy; Director Emeritus and Distinguished Research Scholar in the Institute for Science, Technology, and Public Policy, Bush School of Government and Public Service, and Division Head for the Science, Technology and Public Policy Division, Texas A&M Engineering Experiment Station

# GOALS & AGENDA

## WEF NEXUS INITIATIVE

### GOALS

- Facilitate science-based policy for the WEF nexus.
- Raise awareness among academe, society, government and industry for holistic approaches to address grand challenges and sustainable development goals for the WEF nexus.
- Identify and respond to national and global opportunities in WEF nexus research, education, outreach and policy implementation.
- Assist in the effective management of WEF nexus resources.
- Establish a WEF nexus Community of Science and Practice.

### AGENDA

10:00-10:05 Welcome (Rudy Rosen and Mike O'Brien)

10:05-10:15 Overview of Water-Energy-Food Nexus Initiative (Rabi Mohtar)

10:15-11:30 Science Panel (Moderator: David Baltensperger

Panelists: Bruce Mc Carl, Kent Portney, Valentini Papas, Debalina Sengupta)

1. Key findings from water-energy, water-food, governance, and modeling groups.
2. What are key challenges you face in conducting WEF 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?

11:30-12:00 Q&A

12:00-12:45 Networking Lunch

1:00- 1:20 Engagement Activity 1 (Elsa Murano, John Tracy)

Are we asking the right questions?

1:20 - 1:40 Engagement Activity 2 (Ali Fares, Jack Baldauf)

Incentives, limitations, and opportunities of working across disciplines?

1:40 - 2:00 Closing Comments (All)

# WORKSHOP OVERVIEW

## ORGANIZERS

### Workshop Organizers - Texas A&M University System

**Lindsey Aldaco-Manner**, Water Management and Hydrological Science

**David Baltensperger**, Soil and Crop Sciences

**Phil Berke**, Institute of Sustainable Communities

**Bassel Daher**, Water Management and Hydrological Science

**Rob Hogan**, Extension Economist, Texas A&M AgriLife Extension

**Rabi Mohtar**, WEF Nexus Initiative, Biological and Agricultural Engineering

**Kent Portney,** Institute for Science, Technology and Public Policy; Bush School of Government and Public Policy

**Susan Roberts**, Texas Center for Applied Technologies, Texas Engineering Experiment Station

**Rudy Rosen**, Institute for Water Resources Science and Technology

**Garett Sansom**, Institute of Sustainable Communities

**Mary Schweitzer**, WEF Nexus Initiative

# OVERVIEW

## THE OBJECTIVES

***Inform*** stakeholders about ongoing and planned WEF nexus research and educational activities.

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

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

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

## WORKSHOP EXPECTED OUTCOMES

1. Open communication lines between interrelated disciplines and sectors of significance to the WEF nexus.
2. Identify questions that the scientific community should be working on.
3. Engage with stakeholders on WEF nexus matters and research initiatives in the San Antonio and South Central Texas Region.

## WEF Nexus SAMPLE PROJECT OUTCOMES

WET Tool

(Mohtar at al.)

**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

# SAN ANTONIO CASE STUDIES

## WEF NEXUS

**Case studies support the planning for Water-Energy-Food Resources in San Antonio and surrounding regions, as climate alters water supplies.**

***Governance:*** There is a modest amount of communication within the water domain, but very little communication between the water, energy, and food/agriculture domains.

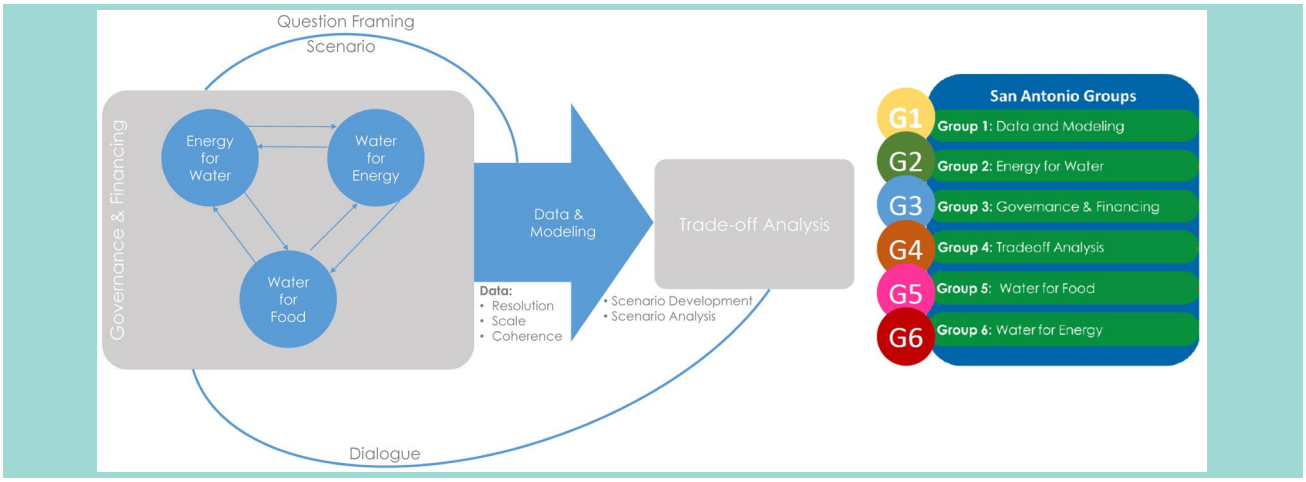
***Modeling:*** Data, identification of major WEF alternatives, mechanisms for implementation and compensation.

***Water-Food:*** Multiway approach identifying energy, water, waste, and food centric scenarios; an in-depth understanding of the effects of waste application on physical soil properties to allow informed waste management and irrigation decisions and optimization of variables contributing in biochar production, and soil physical properties improvement.

***Water-Energy:*** General framework for a water network through a source-interceptor-sink model; data collection for generic water characteristics, water qualities for wastewater and treatment methods; cost data compiled and cost curves constructed for various treatment strategies, and optimization-based decision-making framework.

***Project Goal:*** to support the science for planning the Water-Energy-Food Resources Nexus in San Antonio and surrounding regions as climate and urban growth alter water supplies.

***Background:*** San Antonio demonstrates a complex WEF nexus resource hotspot within Texas. The case studies will attempt to identify a vision for growth that considers the tightly interconnected resources of water, energy, and food by addressing the trade-offs between these resource systems. Home to a rapidly growing population, near the Eagle Ford shale play, and with major agricultural activity in its environs, the area has many competing demands. Stakeholders need the tools to address future resource challenges. This work attempts to address those needs through six distinct, yet interrelated, case studies for which objectives, outcomes, and data collection needs will be identified.




***Project Coordinators:*** Rabi H. Mohtar, Bruce McCarl, Kent E. Portney, Efstratios N. Pistikopoulos, Rudolph A. Rosen, Jack Baldauf, and David Baltensperger.

***Data and Modeling:*** Bruce McCarl, Ag Econ and Gretchen Miller, Civil Engr.; supported by Yingqian Yang, PhD student, Ag Econ.

***Energy for Water:*** Efstratios Pistikopoulos, Energy Institute; Samuel Ma, Civil Engr.; Ying Li, Mechanical Engr.; Mahmoud El-Halwagi, Fuels Research Center; Alaa Elwany, Industrial & Systems Engr.; Debalina Sengupta, Gas and Fuels Research Center; Shankar Chellam, Civil Engr.; supported by Wei Dong, PhD student, Mechanical Engr. and Chi Zhang and Kevin Topolski, PhD students, Chemical Engr.

***Governance and Financing:*** Kent Portney, Bush School; Rabi Mohtar, Civil and Bio. & Agr. Engr; Phil Berke and Garett Sansom, Sustainable Coastal Communities Institute; supported by Lindsey Aldaco- Manner, MSc student, Water Management & Hydrological Sciences.

***Trade-off Analysis:*** Rabi Mohtar, Civil and Bio. & Agr. Engr; Bruce McCarl, Ag Econ, Burak Gunerlap, Geography; supported by Bassel Daher, PhD student Water Management & Hydrological Sciences and Sydney Becker, MSc student, Geography.

***Water for Food:*** Clyde Munster, Bio. & Agr. Engr.; Ali Fares, Prairie View; Kevin Wagner, TWRI; Anish Jantrania, AgriLife Extension; Srinivasulu Ale, AgriLife Extension, supported by Sonja Loy and Jeffry Tahtouh, MSc students, Bio. & Agr. Engr.

***Water for Energy:*** Mark Holtzapple, Chemical Engr.; Efstratios Pistikopoulos, Energy Inst., Mukul Bhatia, Geology; David Burnett, Global Petroleum Institute; supported by students Ahmed Mroue and Jordan Muell, MSc in Energy and Bio and Agri respectively.

## WEF NEXUS FOCUS GROUP

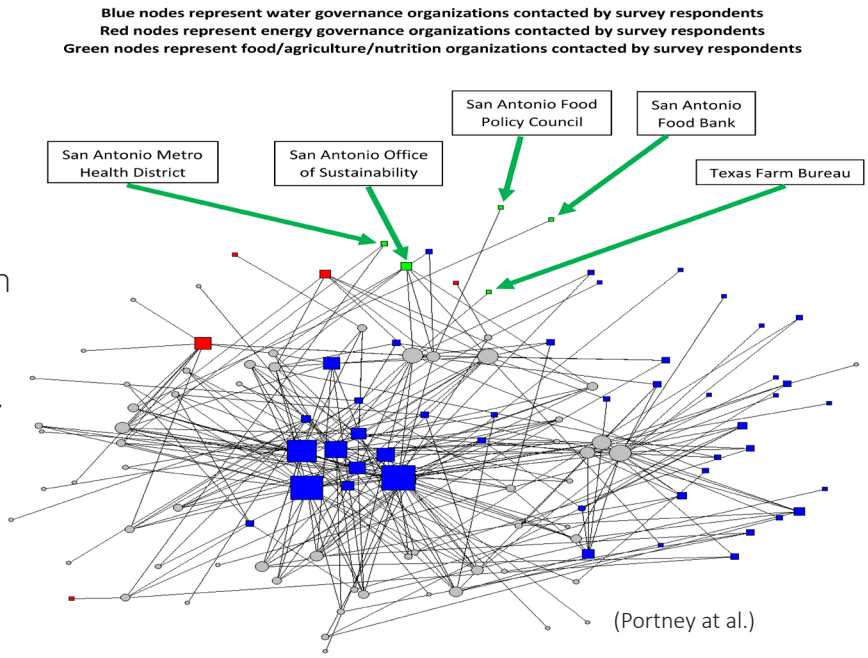
# GOVERNANCE

## 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 WEF nexus decision making.
- Generating relevant, usable, and actionable data.

## KEY FINDINGS

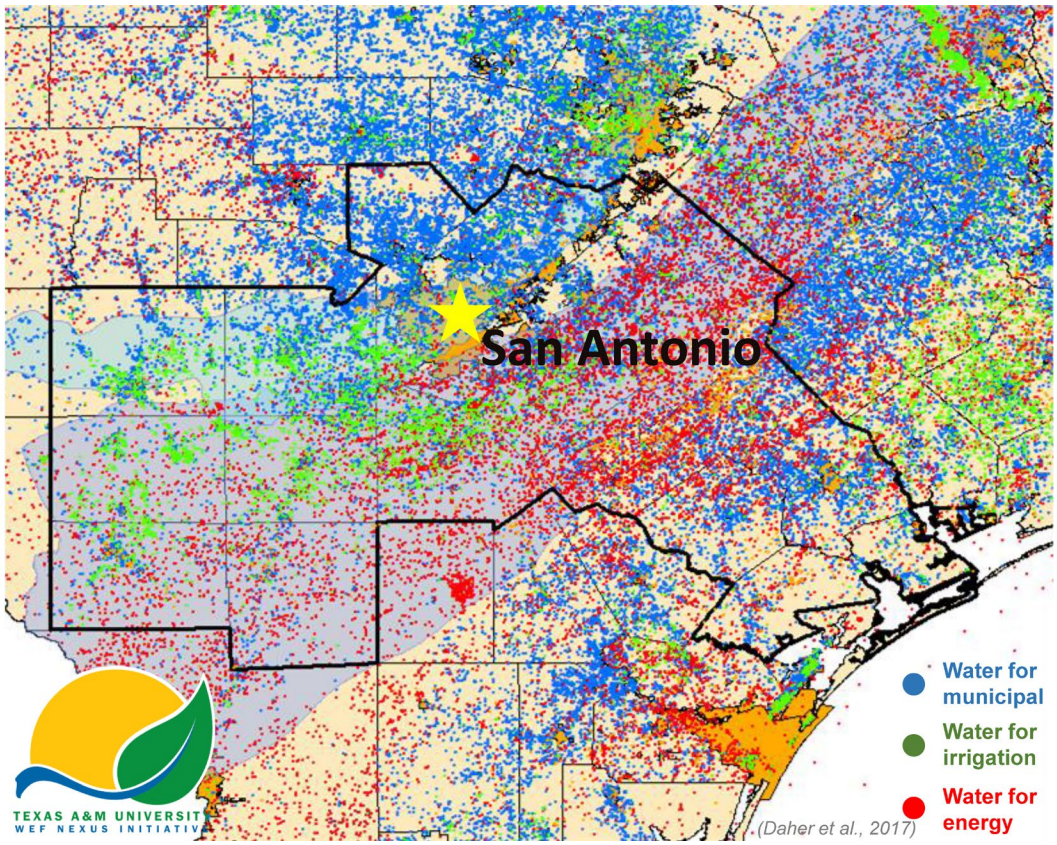
- Modest amount of communication within the water domain.
- Little communication between water, energy, and food/ agriculture domains.




(Portney at al.)

## Well Locations in South Central Texas

### (Texas Regional Water Planning Region L outlined)




## WHAT WE NEED FROM STAKEHOLDERS

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

## WHAT WE CAN OFFER

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

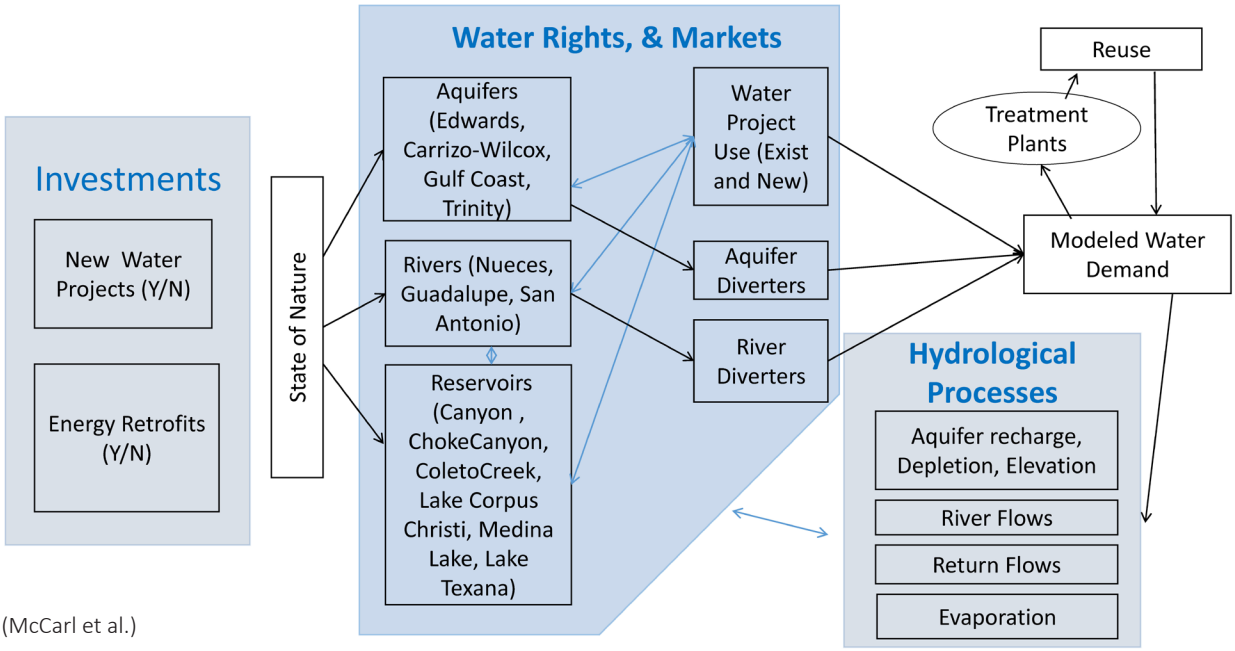
## WEF NEXUS FOCUS GROUP

# MODELING

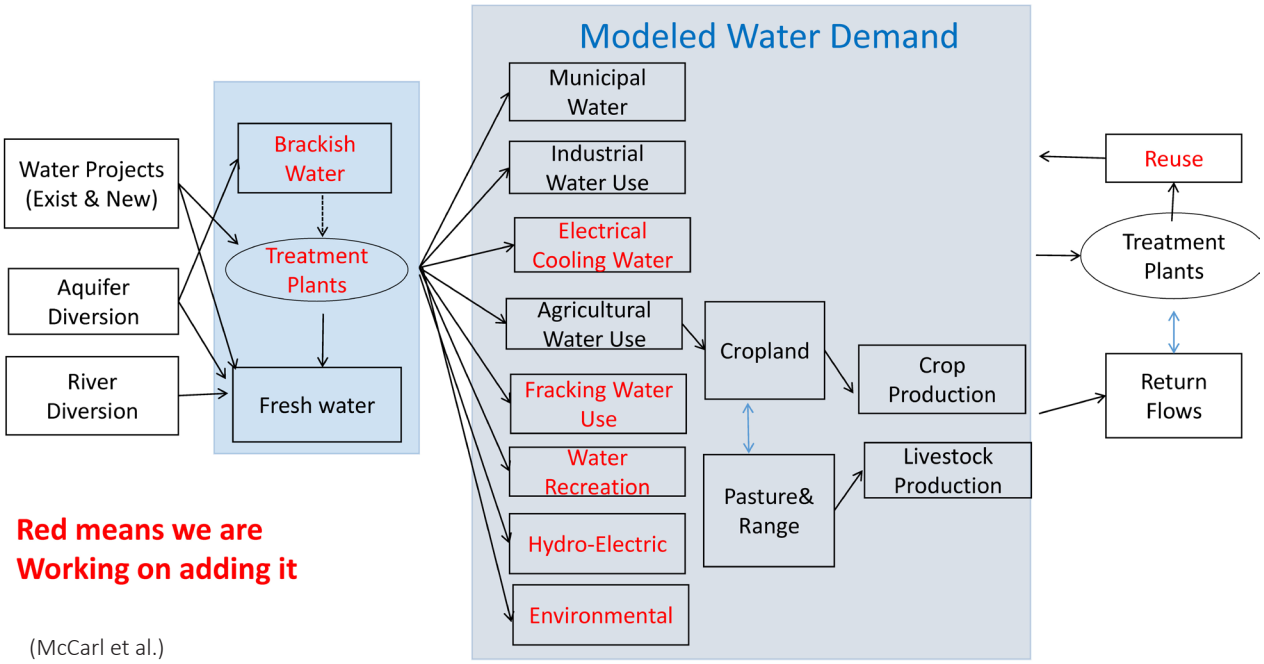
## KEY CHALLENGES

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

## KEY FINDINGS




(McCarl et al.)




## WHAT WE NEED FROM STAKEHOLDERS

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

## DECISION SUPPORT OBJECTIVES

- Evaluation and optimization of WEF alternatives.
- Evaluation of multidimensional implications.
- Modeling that integrates agriculture, municipal, industrial, energy and environment.

## WHAT WE CAN OFFER

- Multi dimensional evaluations.
- Projections of effects of changes in population, water supplies, aquifer depletion, policies, projects, retrofits, alternative energy.

## DATA AND INSIGHTS

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

## WEF NEXUS FOCUS GROUP

# WATER - FOOD

## KEY CHALLENGES

- Providing decision-makers with clear, simple, yet comprehensive answers.
- Combining energy-water-food data to establish a monetary value for several sectors.
- Gaining an in-depth understanding about the effects of waste application on physical soil properties which will allow for making informed waste management and irrigation decisions.
- Biochar characteristics and effects.
- The availability and compatibility of data sets.

## KEY FINDINGS

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

## WHAT WE NEED FROM STAKEHOLDERS

- Data sets.

## WHAT WE CAN OFFER

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

## DECISION SUPPORT OBJECTIVES

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

## WEF NEXUS FOCUS GROUP

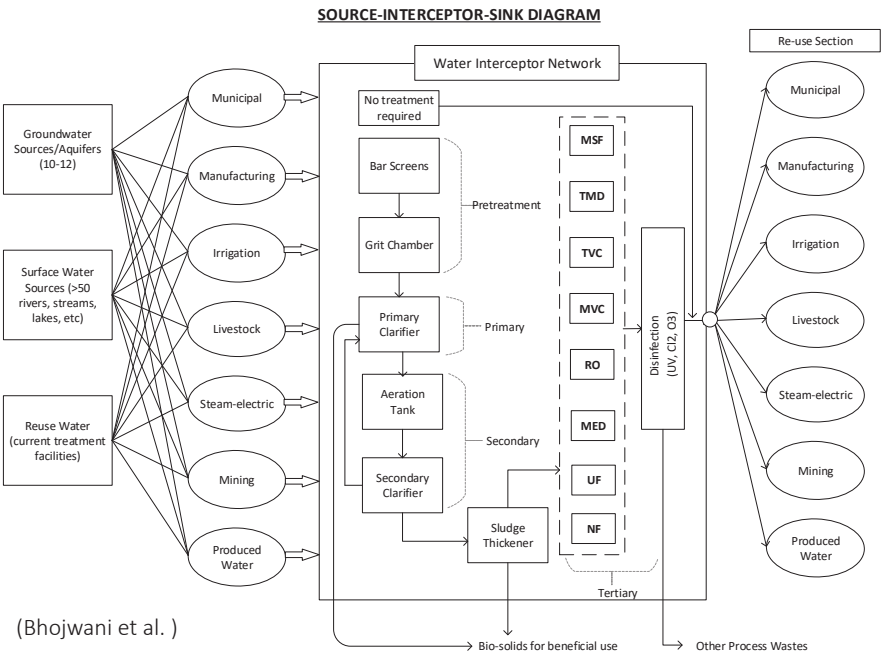
# WATER-ENERGY

## KEY CHALLENGES

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

## KEY FINDINGS

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




(Bhojwani et al. )

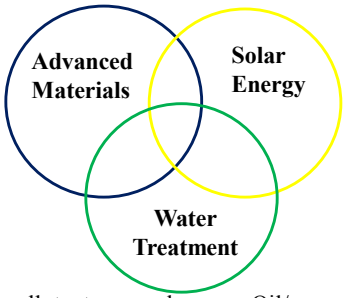
## WHAT WE NEED FROM STAKEHOLDERS

- Specific data for the San Antonio Region (some of it is publicly available).
- Engagement of municipal utilities in the model and results validation.

## WHAT WE CAN OFFER

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

- 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

# STAKEHOLDER ENGAGEMENT Are we asking the right questions?

***What questions should we be working on?***

**ACTIVITY 1**

Workshop participants were divided into nine working groups, based on a pre-arranged formula intended to evenly distribute sector representatives among groups.

# DISCUSSION TABLE 1

## TOP THREE POINTS FROM STAKEHOLDERS

1. Stakeholders have a huge desire to be a part of the conversation. Stakeholders buy in and questions: "Who is looking out for me? Who has my best interest in mind if I engage in the WEF nexus work?"
   - Who are trustworthy stakeholders to engage with?
   - Is trustworthy information available for stakeholders?
2. Does the work envisioned focus enough on application of research and actionable items? How are we looking at the application of this research? What steps are being taken to actually apply this research to policy? Is the research being applied?
3. What are the predictors of the future?

## ADDITIONAL POINTS

Is there a future "shock" to the system that we need to consider? Could include changes in system due to policy change (i.e., people moving to Texas from California due to taxes).

Can we provide food with less water?

How can we convince policy makers with the results of this?

# DISCUSSION TABLE 2

## TOP THREE POINTS FROM STAKEHOLDERS

1. Are the existing governance structures and funding mechanisms appropriate to the WEF nexus (e.g., operational and strategic decision making)?
2. How do we demonstrate equity and equality benefits to different groups?
3. What are the non-monetary costs and benefits of different decisions?

## ADDITIONAL POINTS

What characteristics would a perfect WEF nexus system exhibit?

Is the WEF nexus compatible with the current governance structures such as funding?

What can we do to show the benefit of the WEF nexus? How is it going to affect the bottom line? Can we take the nexus to different regions and make it work?

Who reaches out to whom, e.g., water suppliers, municipalities, farmers, energy companies?

What questions should agencies and stakeholders be asking? WHAT'S IN IT FOR ME? Stakeholders may look at the WEF nexus as an extra, and may not consider it a priority for business.

How can action on the WEF nexus be sustained, because many initiatives are left incomplete after being started out?

We have a public safety issue that is our priority, but we want to do it at a lower cost.

There are uncertainty, equality, equity, and intermittency issues.

Where can cost offsets be found?

What do you do with the savings generated? Layers of bureaucracy are not clear.

How do you align operational and strategic decision making?

How do you sustain the WEF nexus solutions, especially those of high cost?

How is it possible to hold utility stakeholders accountable for natural resources cost? They just account for their own physical costs to run the plants.

Who pays and who benefits?

What is the compensation across the WEF nexus? There should be fairness and equality when assessing the trade offs.

How does the nexus directly tie up to your business priorities?

# DISCUSSION TABLE 3

## TOP THREE POINTS FROM STAKEHOLDERS

1. What are the right set of matrices to define WEF nexus, which is in silos and may be integrated.
2. The E in WEF can also be considered the "environment."
3. Who are the right experts? What are the trade-offs.

## ADDITIONAL POINTS

May not be including and talking about consumer communication, but that should be done.

Need to work with communication between agencies and firms as well as stakeholders.

Start inviting communications specialists to WEF nexus discussions.

Increase opportunities between people for connections and networking.

Figure out the problem: Are the agencies reluctant to change? Should there be communication between and with various WEF industries?

Who, what, when, and where needs to be determined in order to understand what kind of questions to ask?

Asking at the right time.

Who are the right people to ask?

Understand the consumer's wants.

We need to define the outline and the matrices in order to define the WEF nexus.

Bridge gaps with integrated models.

We need to integrate "environment" into the WEF model. Is environment a constraint?

What are the inputs and outputs? (Water versus food versus energy versus environment).

Who benefits and who loses?

What are the tradeoffs?

# DISCUSSION TABLE 4

## TOP THREE POINTS FROM STAKEHOLDERS

1. How can we use the WEF nexus to develop disruptive technologies?
2. Are we reaching and then involving the right people?
3. How do you transform a collection of expert ideas from WEF nexus experts to WEF nexus policy?

## ADDITIONAL POINTS

Are we chasing Band-Aid solutions?

What is the changing societal perspective?

Are we using the right metrics for the WEF nexus?

How do you get unbiased/globally optimum solutions?

How can urban architecture be included in WEF planning?

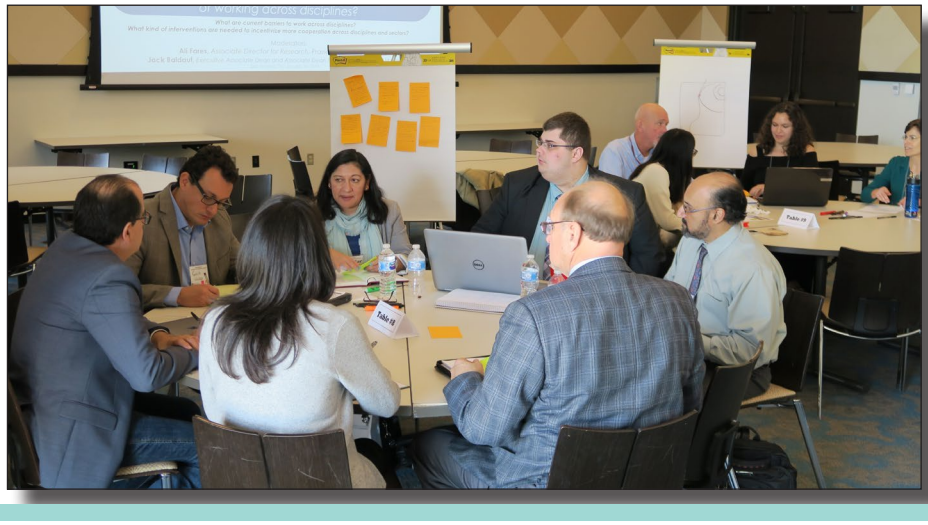
How does one group's planning and objectives differ from another?

Are our estimates and predictions accurate? What if we're making policies with the wrong or inaccurate information?

Can an unbiased decision about the WEF nexus be reached given that every individual has his own personal preference?

Everything is driven by availability of water. Therefore, is the WEF nexus weighted more towards water than energy and food?

Organizations in the water, energy and food sectors tend to have their own projects, accomplishments, data and so on, rather than tending to work with other organizations in different sectors. Are organizations just justifying their own existence to fulfill their own goals or can they begin to work towards a common goal?



# DISCUSSION TABLE 5

## TOP THREE POINTS FROM STAKEHOLDERS

1. How do we go about achieving behavioral change? Can our approach to the WEF nexus and modelling help change behavior?
2. What are the best ways to incentivize changes in work for water, energy, food nexus (financial incentives seem to be best)?
3. Do we have the right values in the water, energy, food nexus system? How do we evaluate it?

## ADDITIONAL POINTS

Consider the endpoint, what would it look like if the WEF Nexus was working perfectly?

You can have all the technology in the world, but you need behavior change. We have to look at human behavioral questions. How can we influence the behavior of people to consume less e.g., 230 to 140 gal/person/day from mid-80s to now)? What are the economics of doing so?

What if we had water, energy, food education in schools?

What if we focus on conservation practices, such as for outdoor use of water?

There should be policy changes so that the usage of water matches the cost of water because of its scarcity. Why is water so cheap in Texas? That is a total mystery. Is there no pumping cost – average revenue has to equal average cost.

The WEF nexus seems focused on technology-based solutions.

Can technology, modeling, and trade-offs address this problem?

Can there be water quality initiatives with Natural Resources Conservation Service to match private industry with private land owners? For example, financial incentives to encourage water conservation and full payments for ecosystems services.

Renewable energy and community development.

What are incentives that will encourage people to think about water as a crop?

How can the WEF nexus diffuse tension between the sectors and encourage synergy?

How does climate change effect the water, energy, food nexus interactions?

# DISCUSSION TABLE 6

## TOP THREE POINTS FROM STAKEHOLDERS

1. Are the right people involved, including the right community groups (public perception will affect results; nonprofits must be involved)?
2. How will people become invested (incentives for tradeoffs and grant sharing may be needed)?
3. How can WEF nexus tools be adapted for potentially disruptive technologies in industry?

## ADDITIONAL POINTS

How do we compare tradeoffs, because it is difficult to compare water values?

What about sustainability issues?

Equity will be an important issue to address, but there does not seem to be much social science work done in the WEF nexus.

We must discuss large scale matters (e.g., agriculture, industry, etc.).

What can be done to get good buy-in? How will we get people on board at the community level?

Are we talking to the right people? Are there unrepresented groups not present in the discussion?

There is a need for more public relations outreach.

Why should stakeholders care about WEF nexus?

Stakeholders don't necessarily capture everyone in the community. Outreach should include social media to appeal to a wider demographic.

Citizen science can be engaged through schools.

There may be key players who don't know about the WEF nexus or any work that's being done on it.

How do we incentivize industry or community partners with projects on the WEF nexus?

Do WEF nexus tools ask the right questions around technology and advancements?

WEF nexus tools must be adaptive.

We need facilitation skillset that employs cross-cutting knowledge.

# DISCUSSION TABLE 7

## TOP THREE POINTS FROM STAKEHOLDERS

1. Who are the Stakeholders? What are their incentives? Are they willing to accept changes in Status Quos?
2. Life cycle analysis: What are the element of our life cycle analysis with regard to food, water, and energy? To address the entire WEF nexus we need to use a systems approach. There will be gaps if we don't examine life cycles.
3. What are the opportunities or crisis that should be articulated to stakeholders to compel them to engage? Scare tactics? Is there resilience? Some changes are out of anyone's control. Can your work withstand shocks, such as a Hurricane Harvey? How do we build safe guards to address shock?

## ADDITIONAL POINTS

Are the stakeholders willing to accept the answers to the questions? There are sustainability issues. What recommendations are they willing to accept? Carbon dioxide emissions trade off in some policies versus other tradeoffs?

Do we think too pessimistically, rather than optimistically on whether or not people are willing to change? Does change need to be driven by policy or regulations?

What are some incentives? Just looking at San Antonio, how willing are citizens and industry willing to change for their own benefit?

What is a stakeholder? Who are the stakeholders we are missing? If we don't have a defined concept for them then a lot could be missed. Who all is involved?

Land owners and utilities may differ in outlook on WEF nexus. What about selling water to other areas, such as will happen with Vista Ridge? Is this a crisis response or an opportunity?

Some science questions are continuations of questions held prior to the grant under discussion. We investigate what we are interested in. WEF nexus grants are still new. Now that we have several grants from different places we shouldn't lose focus that we can learn from each other to refine our own questions. How do we develop outcome driven solutions that help better refine research? For example, in the area of soil science and biochar, the results from research vary greatly due to the influence of so many factors. How is that going to be applied to San Antonio's benefit?

Are we looking at things that might not affect water Region L? What should be the scope of the region for this work? All of Texas? Just San Antonio Region? Should we compress researchable questions? This may depend on the Stakeholders. The crisis depends on the scope of Stakeholder need and actions. The social science may define the questions we ask. We need stakeholder engagement prior to forming the final questions. We need to bring together various groups to establish or define a shared understanding of tradeoffs. We are seeking to educate an entire population.

# DISCUSSION TABLE 8

## TOP THREE POINTS FROM STAKEHOLDERS

1. Education: How do we break the barriers between local and regional perspectives? We need to educate the different sectors. Each has their own perspective. Education about the WEF nexus is very important. We need to start speaking the same language.
2. How do we maximize the WEF nexus model to include political and cultural aspects in the model, e.g., industrialization of water versus wonderful food. Any WEF nexus model should include social equations.
3. How do we monetize the value of the water? How do you setup a pricing system for water?

## ADDITIONAL POINTS

How do we make the WEF nexus resilient to extreme events?

What are the legal limitations to private sector engagement? Can we influence the government to benefit work on WEF nexus?

What are the deficiencies in the different components of the WEF nexus, e.g., supply chain, cost of distribution of food?

We need to display novel technologies that combine at least two of the WEF sectors.

Can we establish five WEF nexus priorities that we should focus on regionally?

Could work on the WEF nexus create a dream team of agencies?

How robust are the interconnections of the WEF nexus when we have extreme events such as a Flint-type water quality and public health crisis?

How do you maximize the efficiency of the WEF nexus? How does it relate to what's happening politically?

How do we convince people that they should be part of the WEF nexus?

We should create a communication infrastructure similar to what is done for drought management.

Industrial rights to water are disruptive to agriculture.

We don't have enough information about the inefficiencies of the agricultural system to make decisions on water allocation. For example, what's the real cost of shipping a banana from South America to San Antonio?

What role should the private sector play in the WEF nexus?

# DISCUSSION TABLE 9

## TOP THREE POINTS FROM STAKEHOLDERS

1. How do we take specialized research in one area and translate it into policy?
2. How do we communicate to make a change and to influence policy?
3. How do we persuade a larger audience? We need better communications, but even if you have the communication, can you create a change?

## ADDITIONAL POINTS

There is a disconnect between science and integration of the three WEF sectors.

What would happen if a crisis like Harvey happened to crops?

Why are we suddenly having problems like flooding of water and wastewater plants?

Without funding it will be hard to make a change.

There is a compartmentalization of policy into "silos."

Incentives are good when people do not have enough money to go around.

Ecosystems aren't considered because there's "not enough space."

Until we see incontrovertible evidence, people aren't going to care about or understand the WEF nexus.

How do we better inform policy makers about what's already done?

If academia is only trading notes about themselves, then they aren't helping anything.

We must bring all the players to the table, such as industry, government, environmental, and public to share the work and see their efforts make a difference.

We need to build a data platform with usability and accessibility, and then help politicians understand it.

What are the paths to communicate to the larger audience?

Do we need model completed before we present it to stakeholders?

# STAKEHOLDER ENGAGEMENT Incentives, limitations, and opportunities of working across disciplines?

## ACTIVITY 2

Workshop participants were divided into nine working groups, based on a pre-arranged formula intended to evenly distribute sector representatives among groups.

***What are current barriers to work across disciplines?***

***What kind of interventions are needed to incentivize more cooperation across disciplines and sectors?***

# DISCUSSION TABLE 1

## TOP THREE POINTS FROM STAKEHOLDERS

1. There is a lack of coordination between agencies. There is a need for a coordinator between the sectors. Coordination should take place at various levels.
2. Are there time and money constraints?
    - Who is going to pay for it?
    - How much time is there for agencies to take on new projects? The more an agency receives less funding, the more those agencies are forced to focus on their core objectives. Funding factors limit the opportunity for WEF nexus work.
3. A WEF database is a 'larger beast', than say a single water or single energy database.
    - There is a need for this larger database.

## ADDITIONAL POINTS

Add something new to improve the current structure of WEF nexus agencies.

A barrier is different motivations for action (i.e., some may want to be "trend setters" and others may want to be proactive and/or reactive). Is there a need for a central online portal?

Modeling barriers exist. How can we map each resource to a dollar value? How do we assign a non-monetary value to these models? Is the dollar value the only incentive or value that we should convey?

How much time is there for agencies to take on new projects? The more an agency gets cut the more those agencies are forced to focus on their core objectives. These factors limit the opportunity for WEF nexus.

Is "good will" an argument for work on WEF nexus?

# DISCUSSION TABLE 2

## TOP THREE POINTS FROM STAKEHOLDERS

1. Language – The most fundamental barrier is language (e.g., units, abbreviations, and addressing problems and solutions in a different word structure).
2. Time frame barriers (planning horizon) – The time frames are different for water, energy and food processes and planning.
3. Cross-pollination of discipline.
    - Institutional barriers do not reward cross-disciplinary research and initiatives.
    - There is little appreciation for multidisciplinary researchers.

## ADDITIONAL POINTS

When you propose to others that they are doing everything wrong, and they have been doing it that way for 20 years, will they listen to you?

There are mindset barriers as you approach embedded energy and water systems.

There are different ways of thinking about WEF nexus, just as there are a lot of disciplines in water. At the other end the disciplines are separated (e.g., water and electricity).

There may be no alignment between operations and strategy.

There is a business model misalignment as efficiency solutions affect profits but do not incentivize stakeholders.

We will face, "I am not allowed to discuss this with you."

There is a lack of an open data platform. Where can we go to get data?

How reliable is the data?

How do you approach public sectors versus private sectors? What about confidentiality and different interests (e.g., social vs. financial matters)?

# DISCUSSION TABLE 3

## TOP THREE POINTS FROM STAKEHOLDERS

1. We need to communicate in relevant terminology to educate stakeholders.
2. The current rewards structure is a barrier.
3. The different value-system across stakeholders and the community as a whole challenge work on the WEF nexus.

## ADDITIONAL POINTS

**Barriers:**

- Language and communication.
- Education and knowledge of the topic.
- "Communicate to educate."
- Challenge of understanding people's backgrounds
- Current reward structure – not wanting to go above and beyond because of lack of compensation.
- Breadth versus depth trade-offs.
- Too time consuming to deal with. It requires addressing and being good at everything versus being really good at one thing at a time.
- Balance and ratios.
- Putting a dollar value on the correct resources in the correct way. The current value structure is not supportive.
- Knowing what helps other people and regions could potentially help one sector versus any other sector.
- Lack of understanding .
- Space and geographic.
- Sub organizations and organizational cultures can make it difficult to work on the WEF nexus within some and move it to others. This can be called "institutional barriers."
- There are different value systems across disciplines.
- Legality.
- Building Trust.
- Marketing and communicating value.

**Rewards:**

- The WEF nexus promotes unity.
- Trust – the WEF nexus promotes a holistic approach that blends and relates to everyone.
- As an overall factor, it's something you can't buy and sell.
- It may change industries.
- Being that top of the line concept – it provides a new expectation.
- New information will be generated.
- Multi-disciplinary grants.

# DISCUSSION TABLE 4

## TOP THREE POINTS FROM STAKEHOLDERS

1. There may be conflicts of interest between local, regional and global institutions on water, energy and food matters as well as compartmentalization of the sectors. This can even include legal constraints, confidential and proprietary data, and disincentives to collaborate.
2. More clear communication is needed, with less technical jargon to "break the ice" and increase understanding. Communication needs to occur between academia, policy makers, stakeholders, industry and public leaders using relevant terminology.
3. There is a need for better information on who is doing what in the WEF nexus? More communication is needed to provide information to people not in the same "zone."

## ADDITIONAL POINTS

**Barriers:**

- Many will say it's "not my problem. Why should I or anyone else care about it?"
- There will be financial constraints. Everything eventually comes down to money.
- There is a lack of common timelines in the three sectors. For example, 10 years versus 50 years causes an ideological difference and creates barriers to working together. How can time limitations be overcome? Everyone is swamped all the time.
- There is a lack of a centralized data platform to share information among stakeholders and workers in water, energy and food.
- If you optimize water, in most cases there's no gain from it because it's going to be used by someone else. If you optimize, you don't really gain anything.

**Interventions:**

- Government can create incentives or remove barriers for people to work collaboratively.
- People with interdisciplinary interests should be engaged to remove jargon for outreach and education about the WEF nexus.
- Establish a rewards structure to promote collaborative working.

# DISCUSSION TABLE 5

## TOP THREE POINTS FROM STAKEHOLDERS

There will be opportunities to do the following:

1. Reduce food waste.
2. Influence land use and development (consideration of urban agriculture).
3. Increase renewable natural resource reuse opportunities.

## ADDITIONAL POINTS

Limitations include the following:

- The use of jargon – interdisciplinary and inter-sector – that impede communication.
- Legal and procedural barriers to taking some kinds of actions, e.g., the Endangered Species Act.
- The tendency for agencies to work in a compartmentalized fashion. A representative may participate but only be concerned about a narrow aspect of the conversation or action.

Incentives include the following:

- Financial.
- Common goals or values.
- Necessity.

There are urban-rural dynamics that will need to be considered, such as the following:

- Population issues.
- Cultural differences.
- More human burdens to rural populations who are providing resources for urban areas.
- Urban permitting and how it can improve water use.

Opportunities include the following:

- Food waste reduction, including changes in the way we look at food and what is acceptable to buy by consumers, such as "blemished fruit."
- Land use and multi-land uses.
- Reuse of water by different sectors (energy, food, environment).

# DISCUSSION TABLE 6

## TOP THREE POINTS FROM STAKEHOLDERS

1. The top barriers is a perceived conflict across industries and a lack of perceived accountability (i.e., not my problem).
2. The top incentives are better valuing ecosystem services, such as the value of reducing development over recharge zones.
3. The top opportunity is seeking out skilled facilitators with cross disciplinary knowledge and ability to communicate and engage with government sustainability officers and planners.

## ADDITIONAL POINTS

We need to avoid acronyms when providing information so people can understand what's being said.

Individuals from all sectors are so focused and compartmentalized that work on the WEF nexus is limited.

More sustainability officers and city planners need to be brought into the conversation.

Perceived conflict is a barrier.

We need an argument beyond there being a "greater good."

Is there a better way to lay out technical expertise needed?

It's difficult to put value on ecosystem services, so this is an opportunity to help do so.

How can energy industry innovate to utilize waste (e.g., compost, resource recovery)?

Efficiency to save money is an incentive.

How do we get a diverse professional group to discuss scenarios: opportunity?

What is the perceived accountability of government versus individuals in the WEF nexus?

Long term, can work on the WEF nexus be done voluntarily or will regulation be needed?

# DISCUSSION TABLE 7

## TOP THREE POINTS FROM STAKEHOLDERS

1. We must not reinvent the Wheel. We learn from other people studying different things. How do we know what is going on? What are the opportunities to Rebuild?
2. How do we incentivize wins for all? We must address territoriality. We need to establish credibility and resources. What are the success metrics for collaboration?
3. There are very structured and unstructured organizations. Structured organizations get more things done, but may be very vulnerable. The opposite is the case for unstructured organizations. Need a hybrid from the bottom up. We should engage on a regular basis with people of different disciplines, this includes the doers, the stakeholders, and people on all levels. Make everyone part of the solution. This could be part of the incentive.

## ADDITIONAL POINTS

Jurisdictional lines can prevent commutations like administrative rules. There can be a destructive territorial reaction. It may be necessary to break down egos and incentivize people so that everyone sees that everyone wins. Give everyone credit and resources. There must be funding. People become committed to projects because there is funding.

Research systems and institutions have leeway to change the measure to which scientists can assist. Make working in the WEF nexus part of the job description and to engage and communicate with others. What are the success metrics for collaboration?

What are the opportunities to work across disciplines in the next three years? What about Rebuild Texas? How do you implement all of WEF nexus without it becoming too overwhelming and scary? There are large scale opportunities, such as collaborations with other nations.

There are collaborations and grants in action already. We already are learning from others. We need not be reinventing the Wheel.

A barrier for collaboration is Funding. Review panels need to be interdisciplinary.

In Europe they do interdisciplinary collaborations better. We don't have to do the same, but examining how others found solutions to limitations might help us even though the circumstances at issue may be different. One solution may not work everywhere.

Texas is prone to every type of natural disaster due to its large size. This is both advantage and disadvantage, but it does make the state a good laboratory to examine WEF nexus issues and resilience.

# DISCUSSION TABLE 8

## TOP THREE POINTS FROM STAKEHOLDERS

1. What are the legal limitations preventing the private sector from getting engaged? Big players can influence government regulations and policies.
2. How to create a value proposition sufficient for water to have private sectors and other actors to become engaged?
3. There are conflicts of interests between local and regional entities and their needs.

## ADDITIONAL POINTS

We need to create more informal communications and increase familiarity. There is a lack of familiarity with the WEF nexus and those working on it.

Academia prefers conventional communication such as conferences, but should we start communicating more digitally?

We should be able to engage other sectors.

Water is a public interest. Food and energy are private interests.

We should create a permanent forum for collaboration.

We could create a requirement for companies to report their collaboration efforts in order to continue receiving tax credits and subsidies from the state.

We need to capture a sense of urgency in this discussion.

Will anything have changed 10 years from now?

Stakeholder engagement opens a Pandora's box.

Work on the WEF nexus threatens the peer review process.

Academia is too slow to respond to the need.

We should have an academic network similar to Facebook to speed up the decision-making process.

How can we find more efficient ways to interact together? What interests do we have in common?

# DISCUSSION TABLE 9

## TOP THREE POINTS FROM STAKEHOLDERS

1. Current barriers include compartmentalization. The silos are real. We need to fix problems, not just use band aids.
2. What do models show to people who are not researchers? What are the benefits? People don't know about the impending problems, just about what's affecting their own life and the overall quality of life.
3. Multichannel and multilayer communication is needed.

## ADDITIONAL POINTS

We need to define what we are addressing. Is it academic research or market sector economics? The market sectors are water, energy, and food.

Do we need a wholesale restructuring to incentivize work on the WEF nexus?

Would key players in the nexus sectors agree that a new platform is needed? Platform may mean models, such as economic models of water, food, and energy. But we have to be careful with models because people often perceive that models have a level of precision that isn't there.

Crisis events can push concrete actions that provide benefits. Incentives, crisis, and personal benefits may drive people to come together to solve a problem. Timing is an issue to consider. Looking for such opportunities, recognizing them, and getting others to see the same opportunities may be effective in accomplishing an end. This is also where politicians come in to communicate with larger groups for advantage.

Everyone wants to discuss everything to death. We must have a direction. People have to agree on the goal.

CONCLUSION

# SUMMARY

## ARE WE ASKING THE RIGHT QUESTIONS?

Stakeholders provided a large number of questions in response to the facilitators' request to list the right questions that researchers should be asking in order to improve work on the WEF nexus. Leading the response were questions about practical applicability of work, identification and involvement of stakeholders, public education, lack of compelling incentives, and proceeding with work that requires a high degree of integration in a world where water, energy, and food are compartmentalized in our institutions and throughout civil society.

According to stakeholders, researchers should focus on how their work will apply to real matters of importance and on policy. Will there be actionable results, and if so, are researchers seriously looking at application in the community?

Stakeholders indicated a huge desire to be a part of the conversation, but questioned if the researchers are looking out for them. For example, one of the questions listed was, "Who has my best interest in mind if I engage in the WEF nexus work?"

Education was brought up in the context of its importance to the success of any research conducted. WEF nexus research must be seen as important and useful to address real problems, but the concept of the WEF nexus is new, complex, and not part of past educational efforts by any sector of society or at any level of education and outreach. Stakeholders identified questions at local and regional levels, and a need to educate multiple sectors of society that see water, energy, and food as very separate things.

Stakeholders listed questions about what may be needed to drive work forward on the WEF nexus. Financial incentives and disaster disincentives made up the basis for several questions listed. Several questions were framed around the low cost of water to consumers versus the actual cost of our water systems and extraordinarily high value of clean water to society where it is absent. They asked, "How do you set up a true pricing system for water, and what are the opportunities or crises that should be articulated to stakeholders to compel them to engage?"

Perhaps the greatest discussion focused around questions on the current compartmentalization of activities on water, energy, and food in our institutions and society. Our public utilities, academic departments in schools, government agencies, occupational classifications, and even our committees in congress and state legislatures compartmentalize water, energy, and food activities in different places with different policies, rules, budgets, and so on. Here are some of the questions that illustrate the dilemma: Who are the real Stakeholders for WEF nexus? Are existing governance structures and funding mechanisms appropriate to the WEF nexus? Can our approach to the WEF nexus and modelling help change behaviour?

# WHAT ARE THE INCENTIVES, LIMITATIONS, AND OPPORTUNITIES OF WORKING ACROSS DISCIPLINES?

Stakeholders identified numerous barriers, incentives, and opportunities to work on the WEF nexus. Discussion largely carried over from the previous engagement sessions, with topics that drove greatest discussion on "questions to ask" being largely the same topics that drove discussion on barriers, incentives, and opportunities.

The leading topic discussed was the difficulty of managing work on the WEF nexus in a world where water, energy, and food are historically and firmly compartmentalized in our institutions and throughout civil society.

Stakeholders mentioned compartmentalization in the context of walling off work from one WEF area to any another.

They discussed professional and financial disincentives for crossing from one sector to another. They even cited conflicts of interest and competition between water, energy, and food sectors within and between public utilities and agencies, between sector-related associations, and between academic and discipline departments within educational and research institutions.

Statements like these illustrated the discussion:

- "Current barriers include compartmentalization. The silos are real."
- "There is a lack of coordination between agencies."
- "The top barriers is a perceived conflict across industries and a lack of perceived accountability (i.e., not my problem)."
- "Institutional barriers do not reward cross disciplinary research and initiatives. There is little appreciation for multidisciplinary researchers."
- "The top opportunity is seeking out skilled facilitators with cross disciplinary knowledge and ability."

Stakeholders also listed various financial matters affecting work on the WEF nexus. They asked, "Who will pay?" In a time when funding is being reduced, stakeholders see available funds going to core programs and projects, not new initiatives. One stakeholder stated, "Funding factors limit the opportunity for WEF nexus work."

Connected to lack of available funding is a lack of time available to do new things or learn to do things differently. Available time needed for action on the WEF nexus may affect the three sectors differently as well. "The time frames are different for water, energy, and food processes and planning," according to one stakeholder.

Education was raised as both limitation and opportunity. Stakeholders stated that their lack of understanding of language used by researchers is a fundamental barrier to public understanding of the WEF nexus. They cited a constant use and reliance on abbreviations, jargon, unfathomable model diagrams, unfamiliar units of measure, and more.

One stakeholder mentioned graphics shown in a presentation during the opening plenary session and said, "What do models show to people who are not researchers?" Stakeholders advised that outreach, communication, and educational materials use relevant and readily understood images and terminology to educate stakeholders.

The large volume, availability/access, and complexity of data was identified as a limitation on WEF nexus work. One stakeholder said, "A WEF database is a 'larger beast', than say a single water or single energy database."

Different public and private organizations and agencies have collected large amounts of water, energy, and food data for different purposes and at different scales for many years. These data are scattered across multiple platforms with different standards, often making important data sets inaccessible or in-

compatible. This leaves significant amounts of data that might be of great value for work on the WEF nexus inaccessible and of limited use to support research and decision making.

And finally, questions remain about whether changing the way we work on water, energy and food will have any real benefits to people or to the economy, locally or beyond.

Stakeholders asked, "What are the benefits? People don't know about the impending problems, just about what's affecting their own life and the overall quality of life."

## CONCLUSION AND THANK YOU

The workshop achieved its objectives, with anticipated outcomes well covered by workshop dialogue:

- Communication lines were established with stakeholders in interrelated disciplines and sectors of significance to the WEF nexus.
- Many questions were identified that the scientific community should be working on.
- Researchers engaged with stakeholders through presentations and discussion on WEF nexus matters and research initiatives in the San Antonio and South Central Texas Region.

Most participants expressed satisfaction with the workshop (Appendix III). Results of the workshop and stakeholder connections will help the WEF nexus researchers vet ideas and test models over the next years as work progresses. The researchers learned about stakeholder issues and concerns, and in particular heard about concerns and real-world constraints on working in an arena unfamiliar to many workers in the water, energy, and food sectors. The workshop will help researchers understand how to overcome obstacles through continued dialogue and involvement of stakeholders.

The Texas A&M System WEF nexus researchers and workshop organizers are grateful to all the workshop participants for taking their time to meet with us and help us better understand the water, energy, and food sectors in San Antonio and the South Central Texas region. We know this dialogue must continue in various forms for our work to be relevant and useful, in the region and elsewhere. We thank all for participation and intend to follow up in the future.

## WEF NEXUS WORKSHOP

# APPENDIX I

## WORKSHOP PRESENTATION

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

Registration

9:30 -10:00 AM

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*

*Dean, Faculty of Agriculture and Food Sciences, American University of Beirut*

10:05-10:15 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

## WEFNI – GOALS

***Launched in 2015 to:***

***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.*

***WEFNI established:***

- 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 refereed journals* ***Special Issues***
- *18 INFEWS proposals submitted*
- *Over 60 National and Global Partnerships*

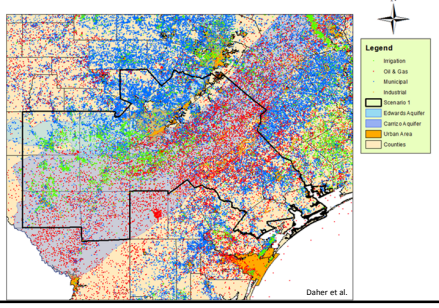
## Welcome Note

**Dr. Cynthia Teniente-Matson**

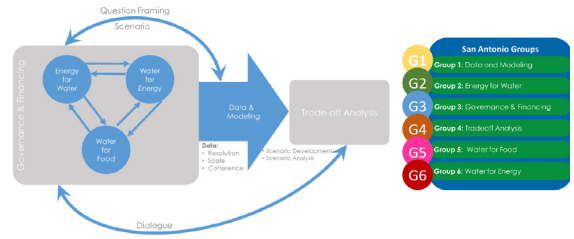
President, Texas A&M University–San Antonio

San Antonio, TX| January 10, 2018

## Why Region L? Hotspot for Case Study



## The San Antonio Case Studies




## Science for the Total Environment 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

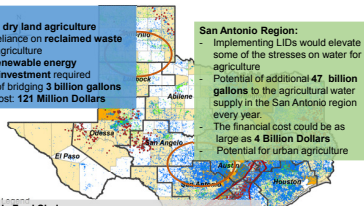
## Texas Water Gap: Sample Study Outcomes

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 )

## Workshop Objectives

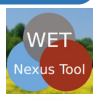
1. **Inform** stakeholders about *ongoing* and *planned* Nexus research and educational activities.
2. **Identify** possible and desirable *information sharing opportunities* and actions.
3. **Identify** and "test" the concept of *coordinated stakeholder engagement* for future Nexus-related matters.
4. **Establish** an *ongoing dialogue* between scientists, Nexus-related policy makers, government officials, civil society advocates, and industry leaders.



## WEF Nexus SAMPLE PROJECT OUTCOMES

**WET Tool**

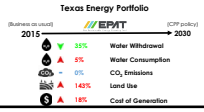
**Quantify the interrelations and trade-offs between the water, energy, and transportation sectors under different scenarios:**
1. Increasing (or decreasing) production
2. Changes in oil and gas market price
3. Different lateral lengths
4. Amount of reused water
5. Varying modes of transport for water/oil/gas




**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%.**

## 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

## Workshop Agenda

1. Science Panel
2. Networking Lunch
3. Roundtable Engagement Session
   1. *Are we asking the right questions?*
   2. *Incentives, limitations, and opportunities of working across disciplines?*
4. *Session Reporting and final remarks*



## 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?



## Science Panel

**David D. Baltensperger , Moderator**

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

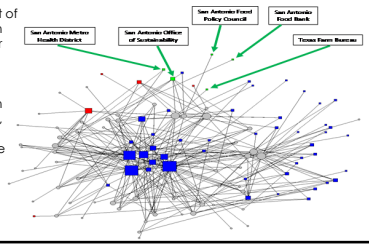
1. Key findings in sub-group
2. What are key challenges you face in conducting FEW nexus research?
3. What are your needs from governmental and industry/business institutions?
4. What do you have to offer governmental and industry/business institutions?

10:15-11:30 AM



## Key findings

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




## 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)*



## 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

## What do we need from San Antonio Institutions?

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

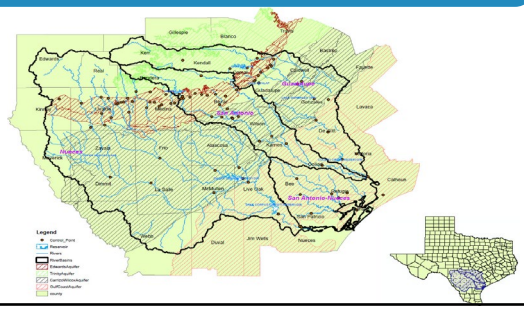
## Team Objectives and Activities

- **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**

## What do we have to offer San Antonio Institutions?

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

## Key Activities – Geographic & Hydrologic Scope

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NSF
TEXAS A&M UNIVERSITY WEF NEXUS INITIATIVE
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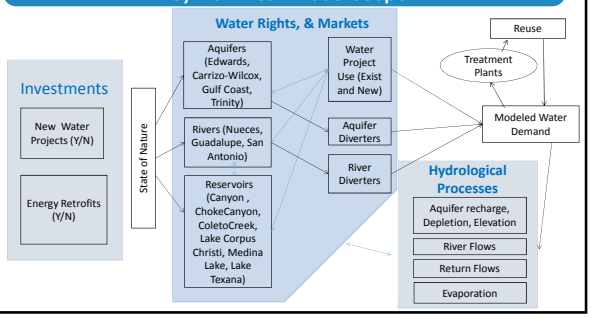
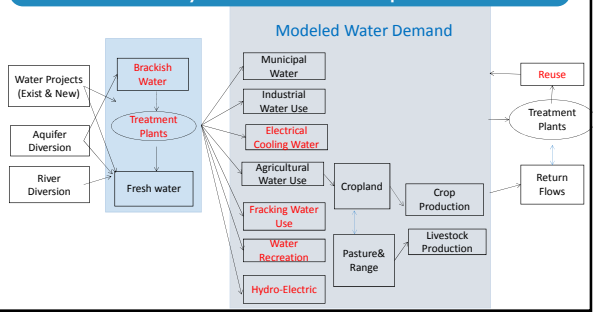
## Modeling Group

San Antonio, TX | January 10, 2018

## Key Activities – Model Scope



## Key Activities – Model Scope




## WEF Alternatives – a starting point

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

## 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

## 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?)

## 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)

## 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

## Water-Food Group

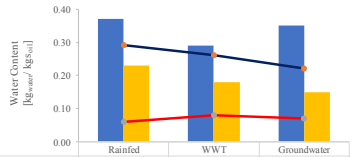
1. Key findings in sub-group
2. What are key challenges you face in conducting FEW nexus research?
3. What are your needs from governmental and industry/business institutions?
4. What do you have to offer governmental and industry/business institutions?

San Antonio, TX | January 10, 2018

## 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 |

## 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)

## 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)

## 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)

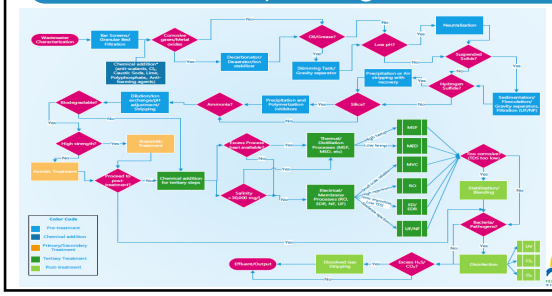
## What help do we need from Regional Stakeholders?

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

## 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)

## Key findings



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## Water-Energy

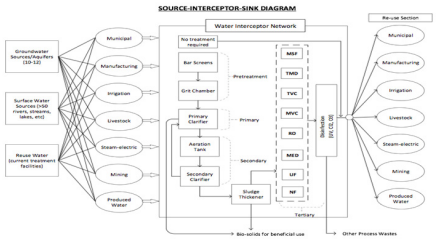
1. Key findings in sub-group 2 Energy for Water
2. What are key challenges you face in conducting FEW nexus research?
3. What are your needs from governmental and industry/business institutions?
4. What do you have to offer governmental and industry/business institutions?



## Key findings

- **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

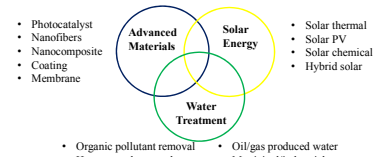
## Key findings




## Key findings

**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

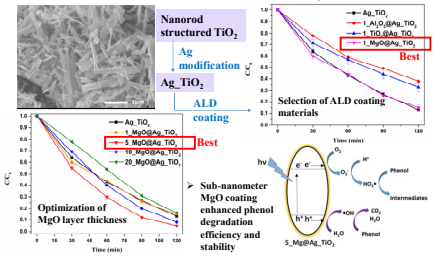
- Organic pollutant removal
- Heavy metal removal
- Disinfection
- Desalination

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

## Key findings

**Atomic layer deposition (ALD) modified Ag_$TiO_2$ photocatalyst for phenol degradation under sunlight**

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



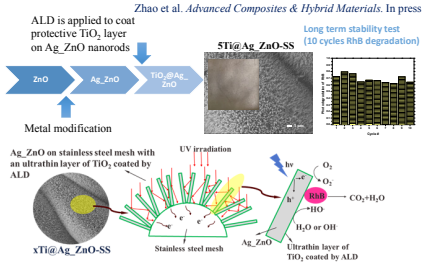

## What help do we need from Regional Stakeholders?

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

## Key findings

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

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




## 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

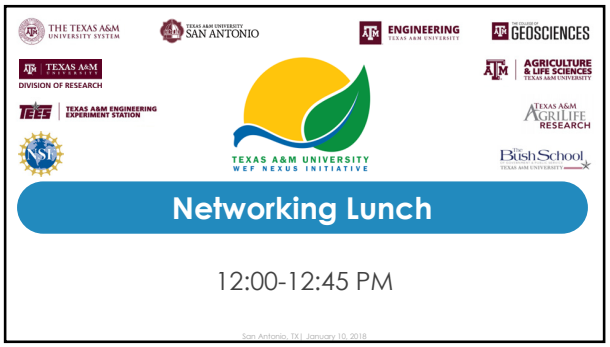
## Key challenges

- 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

## Science Panel – Q&A

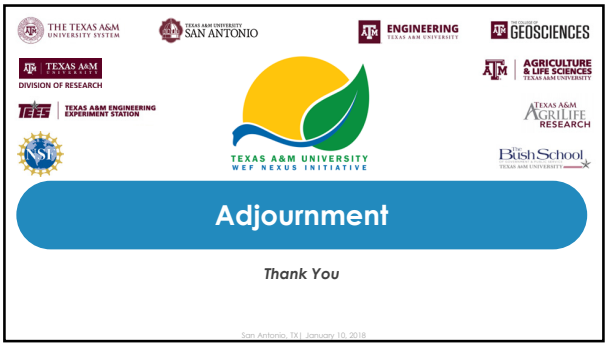
David D. Baltensperger , Moderator
Kent Portney
Bruce Mc Carl
Valentini Pappa
Debalina Sengupta

11:30 -12:00 AM
San Antonio, TX | January 10, 2018


Networking Lunch
12:00-12:45 PM


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


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

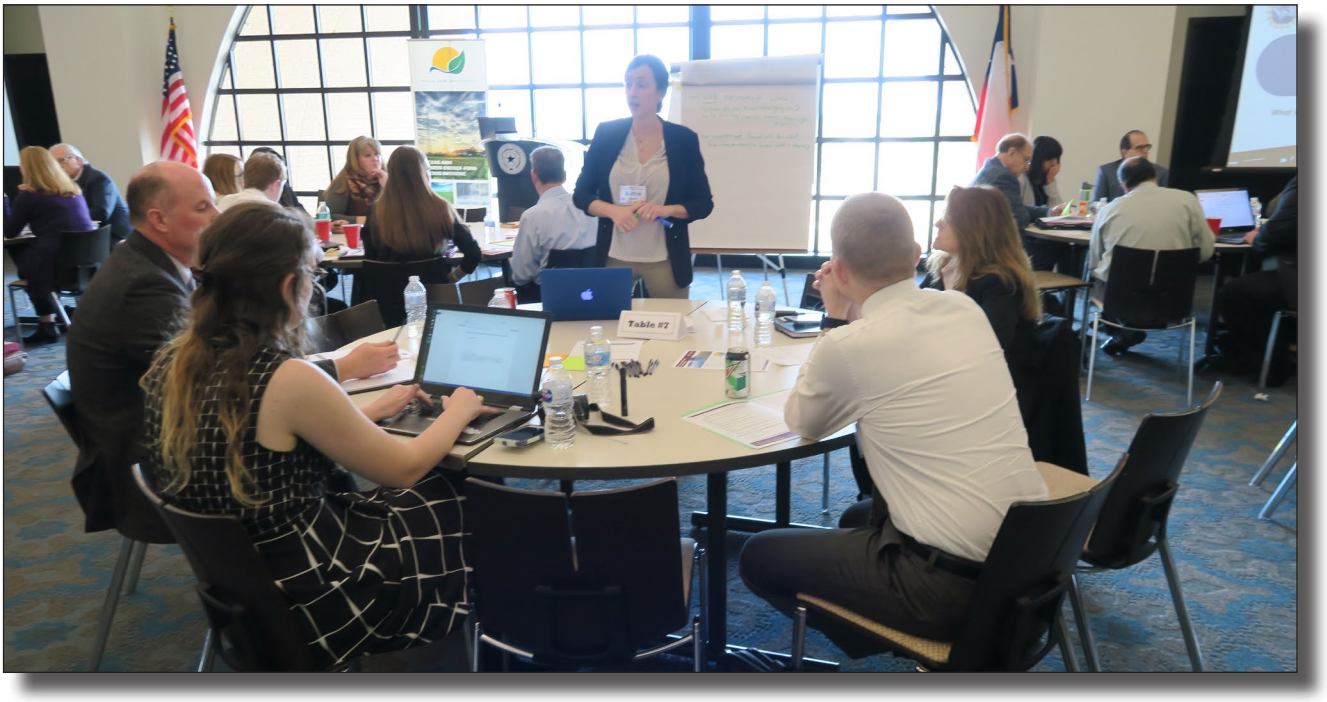

Adjournment
Thank You


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

WEF NEXUS WORKSHOP

# APPENDIX II

## WORKSHOP SUMMARY IN BRIEF



The transfer of scientific knowledge into the hands of the stakeholders who will use these outcomes is an essential part of any project. The San Antonio Stakeholder Engagement Workshop "***The Water-Energy-Food Nexus (WEF) Stakeholder Information and Engagement Workshop*"** took place January 10, 2018, at the Texas A&M University-San Antonio campus. Members of the water, energy, and food sectors came from governmental, business, and civil society institutions in the San Antonio region to interact with academia and learn of the outcomes of the work of the Initiative over the last two years. The Workshop was funded by WEFNI and by NSF award 1739977. The research reported there was also funded in part by NSF grant OAC-1638283. It should also be noted that the work with the San Antonio Case Studies will be continued, in part, through NSF 1739977.

**Organizing Committee:** (contact: wefnexus@tamu.edu). Rabi Mohtar, Jack Baldauf, David Baltensperger, Phil Berke, Ali Fares, Rob Hogan, Kent Portney, Susan Roberts, Rudolph Rosen, John Tracy, Bassel Daher, Lindsey Aldaco-Manner, Mary Schweitzer

**The program for the day included:**

**10:00-10:05** **Welcome Note** *(Rudy Rosen and Mike O'Brien)*
**10:05-10:15** **Overview of Water-Energy-Food Nexus Initiative** *(Rabi Mohtar)*
**10:15-11:30** **Science Panel** *(Moderator: David Baltensperger*
*Panelists: Bruce Mc Carl, Kent Portney, Valentini Papas, Debalina Sengupta)*

1. Key findings from water-energy, water-food, governance, & modeling groups.
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?

**11:30-12:00** **Q&A**
**12:00-12:45** **Networking Lunch**
**1:00- 1:20** **Engagement Activity 1** *(Elsa Murano, John Tracy)*
**Are we asking the right questions?**
**1:20 - 1:40** **Engagement Activity 2** *(Ali Fares, Jack Baldauf)*
**Incentives, limitations, and opportunities of working across disciplines?**

A full proceedings is in preparation and will be published. A brief summary of primary discussion points follows.

- **Governance**: There is a modest amount of communication *within* the water domain, but very little communication *between* the water, energy, and food/agriculture domains.
- **Modeling:** Data, *identification* of major WEF *alternatives*, mechanisms for *implementation and compensation.*
- **Water-Food:** *Multiway approach* identifying energy, water, waste, and food centric scenarios; an *in depth understanding* of the effects of waste application on physical soil properties to allow informed waste management and irrigation decisions and *optimization* of variables contributing in biochar production, soil physical properties improvement.
- **Water-Energy:** *General framework* for a water network through a source-interceptor-sink model; *data collection* for generic water characteristics, water qualities for wastewater and treatment

methods; *cost data* compiled and cost curves constructed for various treatment strategies, and *optimization* based decision making framework.

***Engagement Session 1: Are we asking the right questions?***

1. **Stakeholder Identification, trust, benefits, tradeoffs**
    a. Who are the Stakeholders? What incentivizes them? Are they willing to accept changes in their status quo? How is societal perspective changed? Which opportunities/crises should be articulated to compel stakeholders to engage (Scare tactics? Resilience? How do we build these safeguards)?
    b. How do we identify *trustworthy* stakeholders and build confidence in the information provided? (Who is looking out for me? Who has my best interest in mind if I engage in the Nexus?)
    c. Who are the right experts? Are the right people/communities involved (public perception as part of solution, nonprofits)?
    d. What are the *trade-offs*? What are the non-monetary costs and benefits of different decisions?
    e. How does one group's planning/objectives differ from that of another? How does one leverage commonalities among groups?
    f. What are the legal limitations to private sector engagement? (How can government be influenced to benefit the nexus?)
    g. How can institutions from a variety of sectors to engage for the common good, rather than on individual accomplishments?

2. **Application of research and action to policy.**
    a. What steps are being taken to actually *apply* this research to policy? Are existing governance structures and funding mechanisms appropriate to the nexus (e.g., operational and strategic decision making)? What are the current effective practices? What are new strategies?
    b. What is the correct set of matrices for integrating FEW Nexus silos? Are we using the right metrics?
    c. How do we achieve: unbiased, globally optimum solutions? How do we educate different sectors, each with their own perspectives?. How do we break the barriers between local and regional perspectives? How do we manage across specific zones of influence, i.e. territorial, political, zone of influences, etc
    d. How do accomplish behavioral change, and in what ways do the approach and the modelling account for behaviors regarding WEF issues?
    e. *Life cycle analysis.* What are the elements of the life cycle analysis related to food, water, and energy? The entire nexus system approach has gaps that must be identified in terms of the deficiencies of the different components of the nexus. (Examples: supply chain, cost of distribution of food)

3. **What are the predictors of the future?**
    a. Are our estimations/predictions accurate? Are we using the correct data proxies? What if we're making policies with the wrong/inaccurate information?
    b. Political and cultural aspects must be included in the model.
    a. Resilience to extreme events is an important factor to be included.

4. **WEF System Values and evaluation?**
    a. How do we demonstrate *equity and equality of benefits* to different groups?
    b. How can we *incentivize change* for water, energy, food nexus actions?
    c. **Is there** a more focused, directed pathway for science to impact policy?

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

**Incentives & Opportunities**

- *Reward cross-disciplinary research* initiatives and multidisciplinary researchers: the current rewards structure is a barrier; create financial incentives.
- *Reward collaboration*: seek out skilled facilitators with cross disciplinary knowledge and the ability to communicate (engaging with more sustainability officers and planners).
- *Change the educating policy* to include people from other states not currently facing the problem.
- *Leave the Comfort Zone:* Learn and interact with different cultures/disciplines/sectors.
- *Reduce waste in food, water, and energy use. Optimize Land use* and development (consideration of urban agriculture).
- *Improve urban-rural dynamics*: Population issues, Cultural differences.
- *Value ecosystem services*, reduced development over recharge zones.

**Limitations**

- *Lack of coordination between agencies, sectors, and levels:* legal constraints to and lack of incentives for collaborating.
- *Communication and coordination between academia, policy makers, stakeholders, and industry leaders*: who is doing what? There is a need for a common, centralized platform for information sharing. Less technical jargon, more relevant terminology. Jargon: interdisciplinary and inter-sectoral.
- *Incompatibility of existing communication and decision making structures* with the reality of the challenges: can we improve these to better address the existing challenges?
- *Time and money*: who is going to pay for it? Can agencies take on new projects?
- *WEF database* is a 'larger beast,' than a one-water or one-energy database
- *Language* (units, abbreviations, addressing problems and solutions in a different word structure).
- *Planning Horizon* is different for water, for energy, and for food: the lack of common timelines (10 years vs. 50 years) causes ideological differences and creates barriers to working together.
- *Values-systems* across stakeholders are different (perceived conflicts and perceived accountability).
- *Conflict/competition* between local, regional, and global organizations and across industries: confidentiality, restricted data. Self-interest verses collective goals.
- *Legal/procedural barriers* (endangered species act).
- *Silos* are real.
- *Consider identification of shared priorities, common goals, and leveraged efforts where appropriate*.

WEF NEXUS WORKSHOP

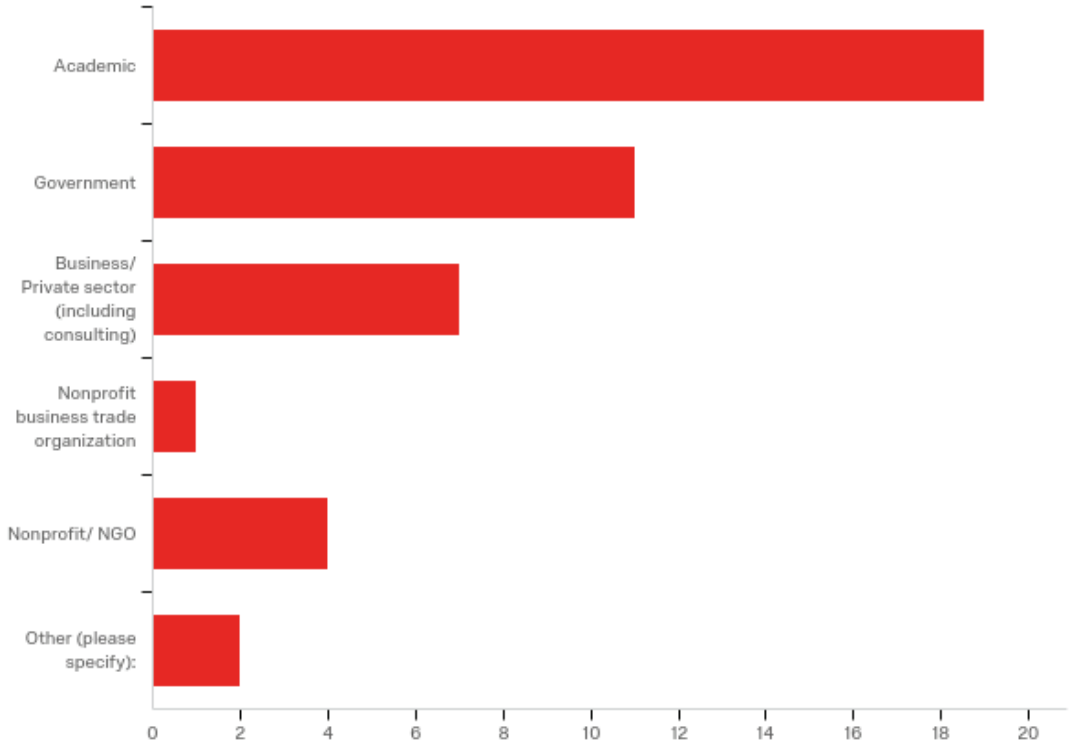
# APPENDIX II

## STAKEHOLDER SURVEY RESULTS: BEFORE AND AFTER

# Pre-Workshop Survey Results

February 10th 2018, 9:53 am MST

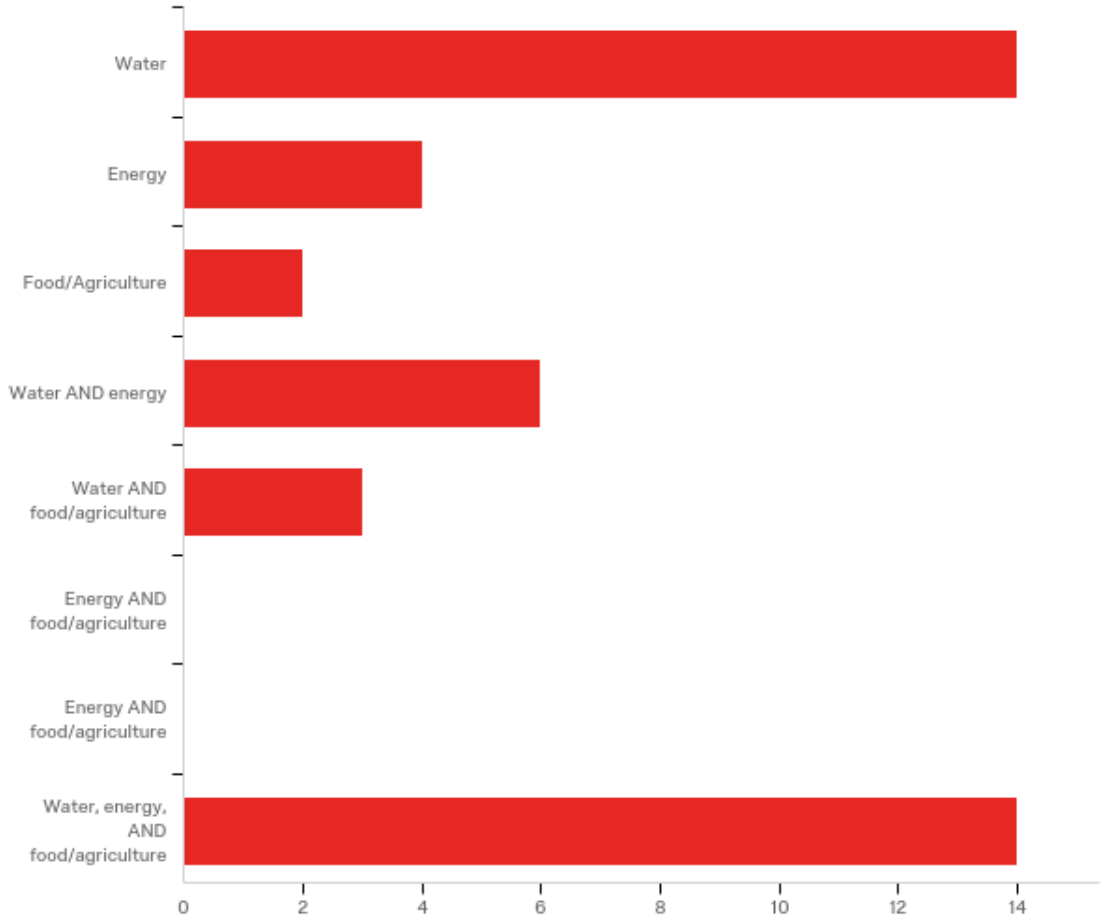
## Q1 - What type of organization are you primarily a part of?




| # | Answer | % | Count |
|---|---|---|---|
| 1 | Academic | 43.18% | 19 |
| 2 | Government | 25.00% | 11 |
| 3 | Business/ Private sector (including consulting) | 15.91% | 7 |
| 4 | Nonprofit business trade organization | 2.27% | 1 |
| 5 | Nonprofit/ NGO | 9.09% | 4 |
| 6 | Other (please specify): | 4.55% | 2 |
| | Total | 100% | 44 |

| Other (please specify): - Text |
|---|
| Housing Authority |
| Academic, Nonprofit and commmunity center |

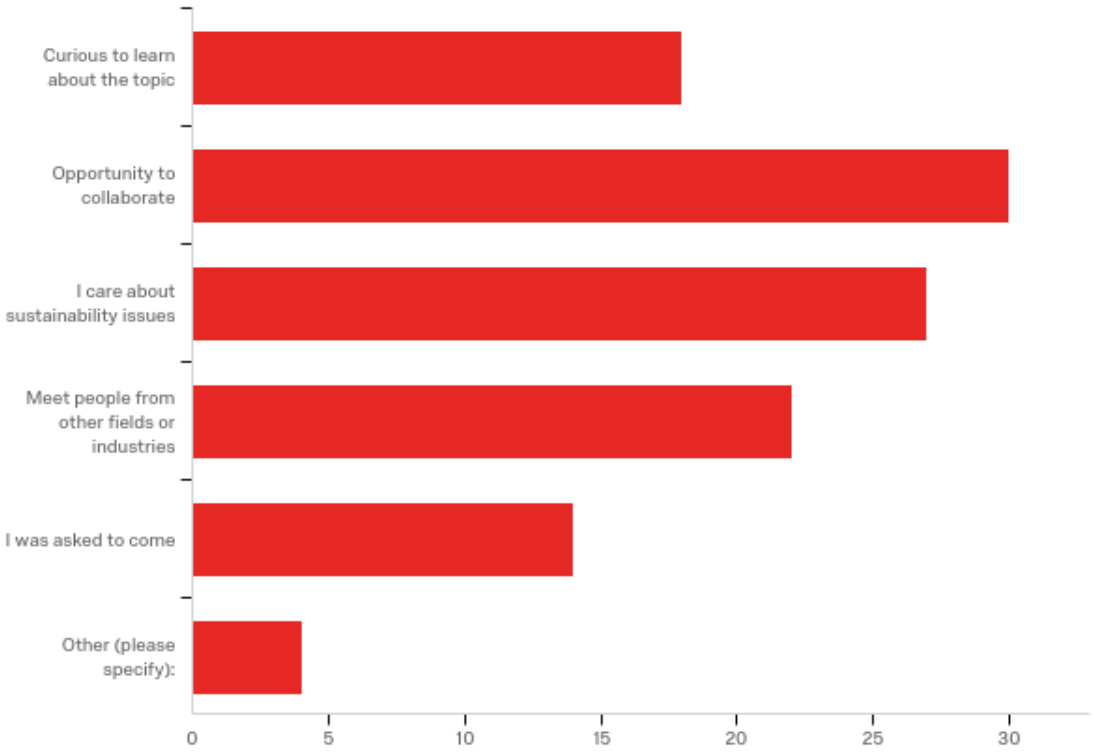
## Q2 - Is the organization you primarily work for most associated with water, food/agriculture, energy, or a combination of these?




| # | Answer | % | Count |
|---|---|---|---|
| 1 | Water | 32.56% | 14 |
| 2 | Energy | 9.30% | 4 |
| 3 | Food/Agriculture | 4.65% | 2 |
| 4 | Water AND energy | 13.95% | 6 |
| 5 | Water AND food/agriculture | 6.98% | 3 |
| 6 | Energy AND food/agriculture | 0.00% | 0 |
| 7 | Energy AND food/agriculture | 0.00% | 0 |
| 8 | Water, energy, AND food/agriculture | 32.56% | 14 |

| | | | |
|---|---|---|---|
| | Total | 100% | 43 |

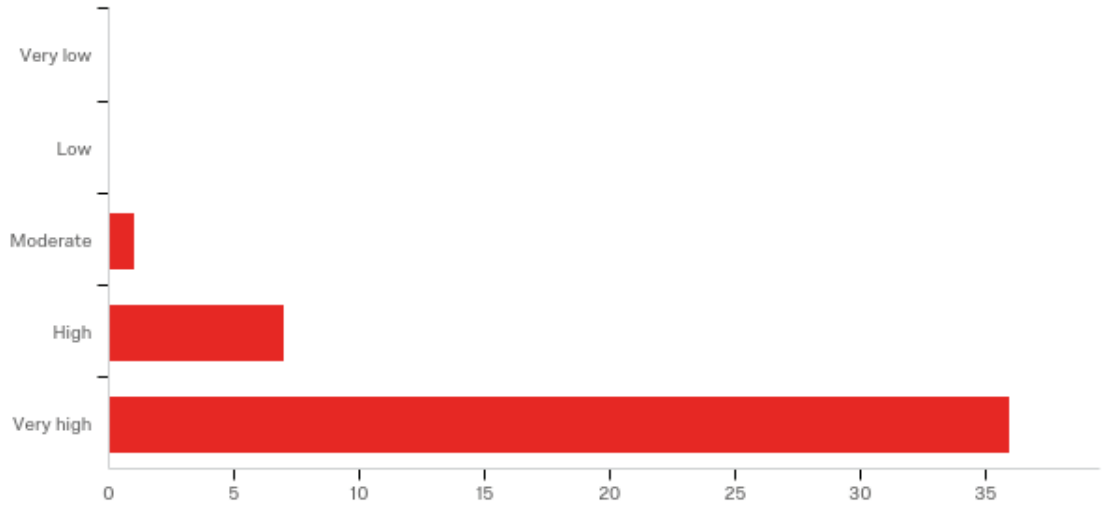
## Q3 - What brings you to the workshop? (Check all that apply)




| # | Answer | % | Count |
|---|---|---|---|
| 1 | Curious to learn about the topic | 15.65% | 18 |
| 2 | Opportunity to collaborate | 26.09% | 30 |
| 3 | I care about sustainability issues | 23.48% | 27 |
| 4 | Meet people from other fields or industries | 19.13% | 22 |
| 5 | I was asked to come | 12.17% | 14 |
| 6 | Other (please specify): | 3.48% | 4 |
| | Total | 100% | 115 |

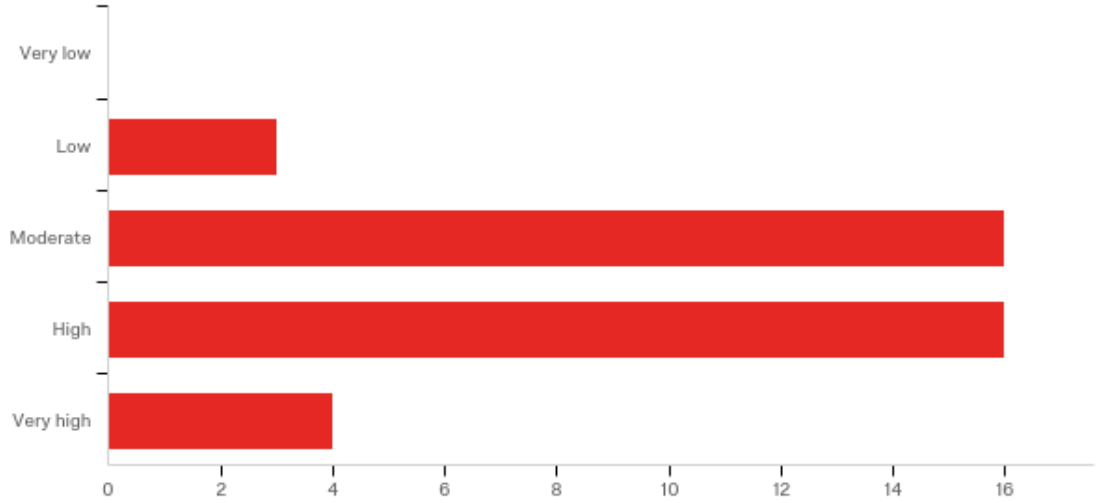
| Other (please specify): - Text |
|---|
| Co-Organizer |
| Unfortunately I won't be able to attend. I have another commitment that day. |

## Q4 - To what extent do you think water, energy, and food resources are interrelated?




| # | Answer | % | Count |
|---|---|---|---|
| 1 | Very low | 0.00% | 0 |
| 2 | Low | 0.00% | 0 |
| 3 | Moderate | 2.27% | 1 |
| 4 | High | 15.91% | 7 |
| 5 | Very high | 81.82% | 36 |
| | Total | 100% | 44 |

## Q5 - To what extent do you think you understand the concept of the Water-Energy-Food nexus?



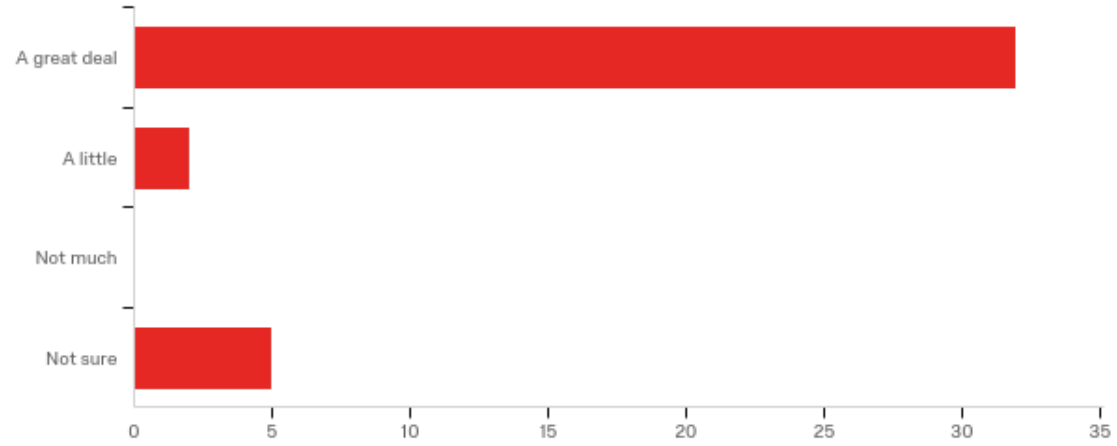

| # | Answer | % | Count |
|---|---|---|---|
| 1 | Very low | 0.00% | 0 |
| 2 | Low | 7.69% | 3 |
| 3 | Moderate | 41.03% | 16 |
| 4 | High | 41.03% | 16 |
| 5 | Very high | 10.26% | 4 |
| | Total | 100% | 39 |

## Q12 - What do you expect to get out of this workshop?

| What do you expect to get out of this workshop? |
| --- |
| Networking with others I would like to better understand this NEXUS. |
| Collaboration and learn more on the specific data |
| I will not be able to attend. However I intneded to continue my education on the topic and see how the topic would apply to groundwater management. |
| Depthen the understanding of wef |
| Becoming more familiar with the food and energy stakeholders in the city. |
| Networking |
| An understanding of the relationships between water, energy and food and how to communicate that relationship to others. |
| an understanding of the synergies |
| Better understanding of  Nexus  issures |
| Broad linkages to help resolve the issues |
| I'd like to learn more about regional collaboration and provide feedback/expertise from a communication perspective. |
| Get briefed on progress of this initiative. |
| networking, information on local agencies focusing on water/energy/food sustainability |
| Knowledge and Vision of WEF project direction in San Antonio region |
| Latest info from experts. |
| Increased knowledge of the give and take between the three items, contacts of others working in this field, and potential items to impact my work. |
| Deepen my knowledge related to WEF, collaborate, find opportunities to partner |
| Presentations and dialogue about WEF nexus with regard to its components, possible engagement platforms between WEF components |
| to learn more about the integration of water, energy and food planning. |
| Better understanding of what NSF and other grant agencies mean when they say "water-energy-food nexus". I know they are interconnected based on own research and experience, but what do the grantors mean? |
| Networking |
| Understand unmet needs from academic perspective and voice the concerns from industry perspective |
| collaboration |
| Opportunity to collaborate. Contribute to expand the concept and applicability of the water-energy-food nexus. |

| |
|---|
| To improve the knowledge of WEF Nexus To know people focused on this issue and understand collaboration possibility To improve knowledge of San Antonio region to gain a better/wider view about the Water-Energy-Food relations |
| Enhanced the knowledge on this subject |
| Greater understanding of the Water-Energy-Food nexus |
| Information about current and future research, networking |
| I hope to learn new ideas in conservation and water safety issues. |
| Develop connections for future collaboration |
| I would like to learn from others about what is out there already and where there is opportunity that in my role with the City am able to assist with. |
| Learn more about water-energy-food relationship |
| opportunities for collaboration and potential direction/focus for student and faculty research, as well as community outreach |

## Q6 - In general, to what extent do you think that agencies and organizations should cooperate across issues of water, energy, and food?



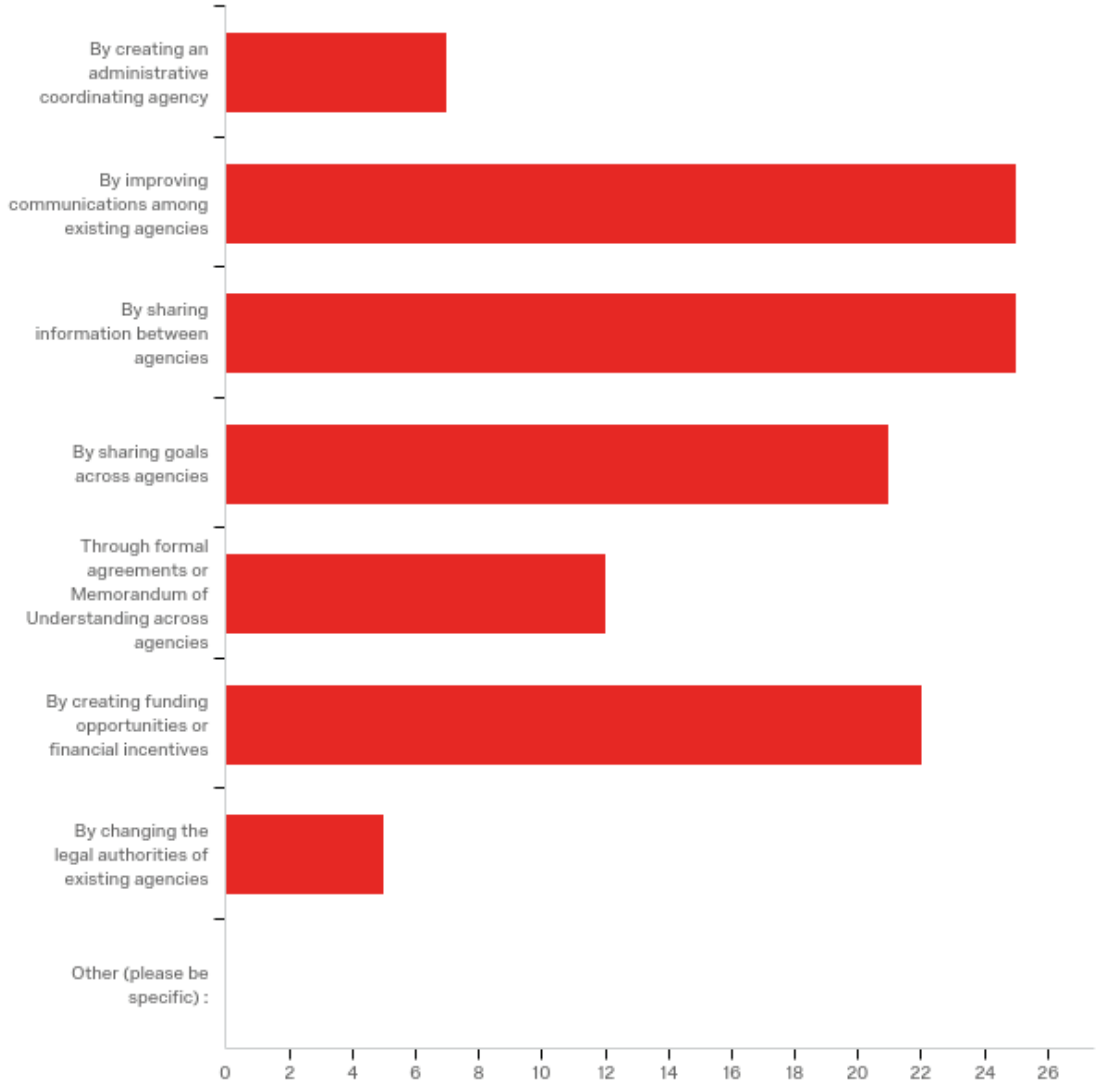

| # | Answer | % | Count |
|---|---|---|---|
| 1 | A great deal | 82.05% | 32 |
| 3 | A little | 5.13% | 2 |
| 4 | Not much | 0.00% | 0 |
| 5 | Not sure | 12.82% | 5 |
| | Total | 100% | 39 |

## Q7 - In general, what are the two or three most important impediments to agencies and organizations collaborating over issues of water, energy, and food?

| In general, what are the two or three most important impediments to agencies and organizations collaborating over issues of water, energy, and food? |
|---|
| I think the biggest impediment is government rules and regulations. Probably because no department wants to give over their authority in their little kingdom. |
| Funding and time |
| Lack of understanding across the topic and a lack of understanding of what each organizations current or potential role. |
| Historical work environment Luck of awareness |
| Organizations tend to focus on their own issues. |
| Mission, resources and lack of leadership. |
| the pressure on the water, energy side to subsidize the agricultural/food areas |
| 1) different agendas 2) Bureaucracy 3) Funding |
| Bureaucratic silos, time and focus. |
| individual scientists knowing what others can provide them |
| 1. Working in silos 2. Not communicating enough 3. Not speaking each other's language |
| Everyone is focused on their own mission. |
| time, budgets, staffing |
| Budgetary funding |
| Traditional silo mentality and organizational hierarchies that continue to support and reward silo structures. |
| 1) Differences in primary objectives/policies, 2) Lack of staff to meet existing workload, much less take on new items, and 3) lack of shared information. |
| lack of mandate, funding and capacity |
| Individual agency missions tied to agency funding, rules and standards. Historical precedence and expectations of agency's personnel. Leadership that is tied to furthering the agency's goals. |
| lack of shared information and lack of incentives. |
| 1. Non-communication or lack of awareness about the expertise and experience that others have and would be good collaborators across the state. 2. Personnel not awarded/rewarded for long-term commitments by their home institutions (i.e., they have to produce something this year) and support staff at home institutions do not understand the nature of collaboration between institutions (i.e., sometimes so much so they will try to limit it from their position). 3. Budgets (limited)... we all want to do the work but state and federal budgets are reduced, which places more competitive burden on researchers interested in these issues. |
| Water reuse |
| Lack of common goals Lack of collaborative projects |

| |
|---|
| bureaucracy operating re-actively instead of forward thinking |
| Not been aware of the nexus and interconnection between the three component or even between either of the two components. Many practical examples should be provided to these organizations to help them visualize it. |
| Lack of communication Different working structures related to regulations and politics |
| NSF, USDA |
| Regulatory silos, territorial attitudes, lack of understanding |
| 1. Funding 2. Support for other agencies and individuals involved in the private industry. |
| lack of incentives to collaborate; lack of institutional mechanism to cooperate. |
| Lack of regular communication Silo culture Not knowing what the first step is and what the outcomes could be |
| Lack of communication and competing goals between agencies. Competition for financial resources. |
| 1. time and money 2. policy limitations 3. lots of disconnected players 4. disconnect between research, policy and practice |

## Q8 - In your view, how could cooperation across issues of water, energy, and food best be accomplished?

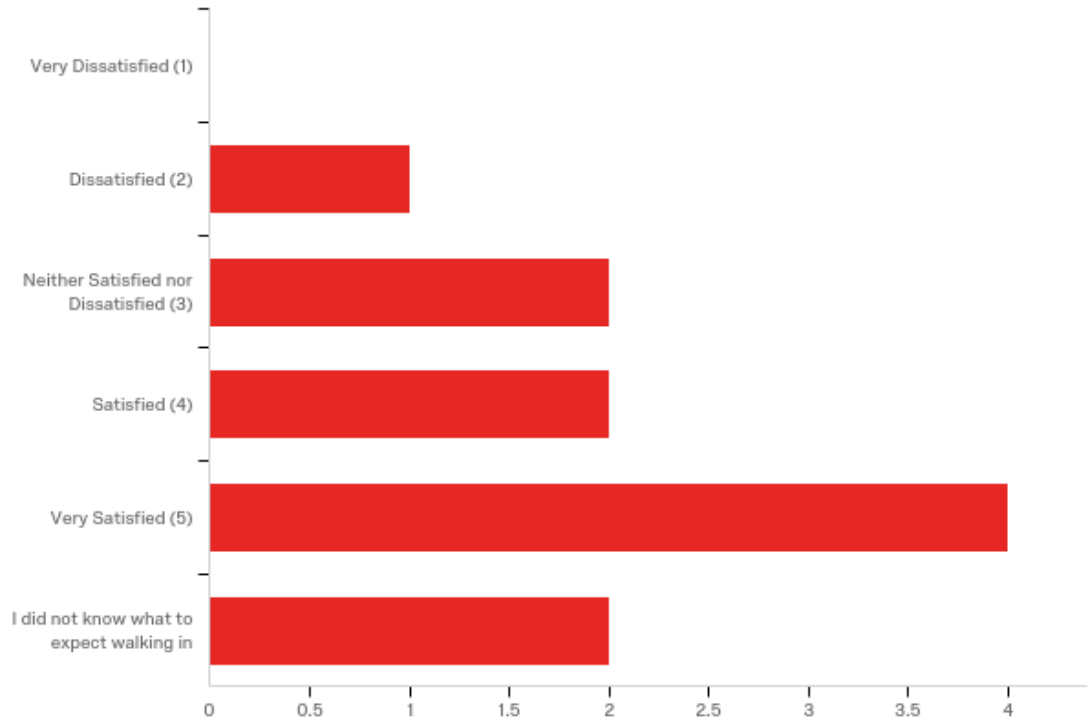


| # | Answer | % | Count |
|---|---|---|---|
| 1 | By creating an administrative coordinating agency | 5.98% | 7 |
| 2 | By improving communications among existing agencies | 21.37% | 25 |
| 3 | By sharing information between agencies | 21.37% | 25 |
| 4 | By sharing goals across agencies | 17.95% | 21 |
| 5 | Through formal agreements or Memorandum of Understanding across agencies | 10.26% | 12 |
| 6 | By creating funding opportunities or financial incentives | 18.80% | 22 |
| 7 | By changing the legal authorities of existing agencies | 4.27% | 5 |
| 8 | Other (please be specific) : | 0.00% | 0 |
| | Total | 100% | 117 |

# Post-Workshop Survey Results

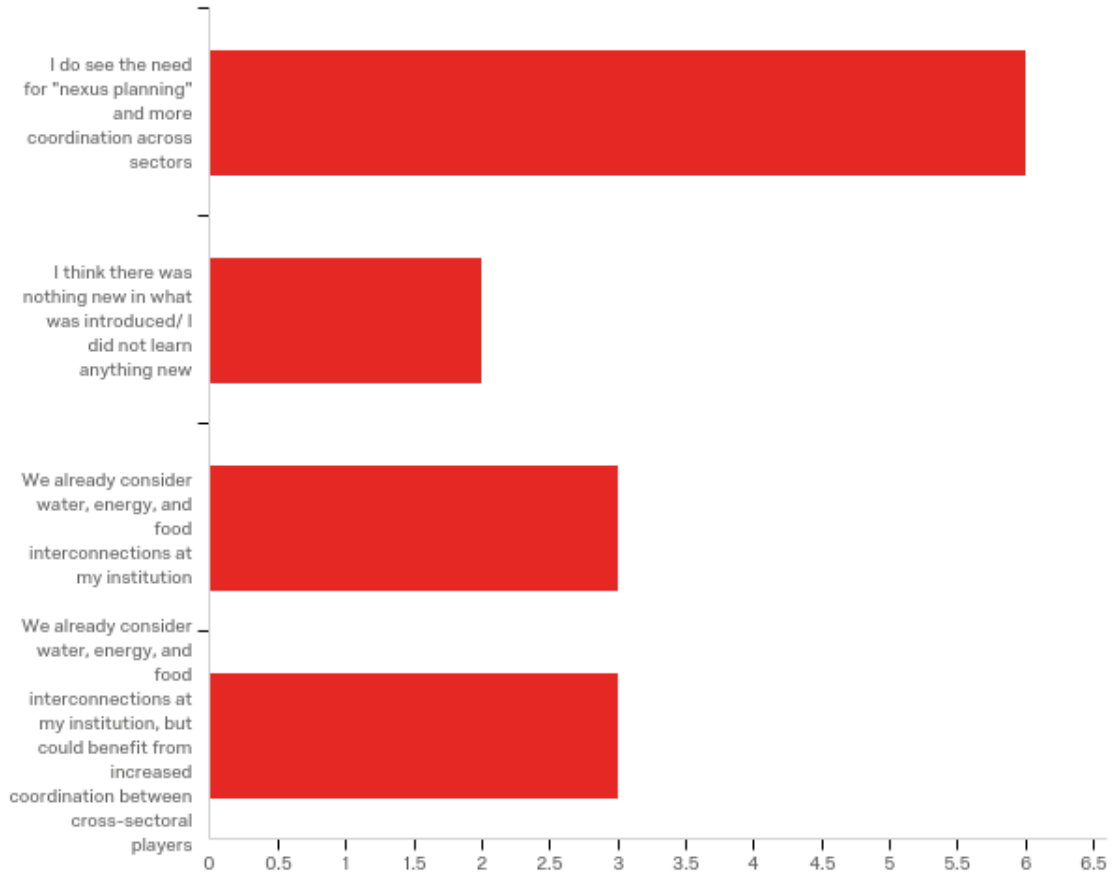
February 10th 2018, 9:45 am MST

## Q1 - Did this workshop meet your expectations?



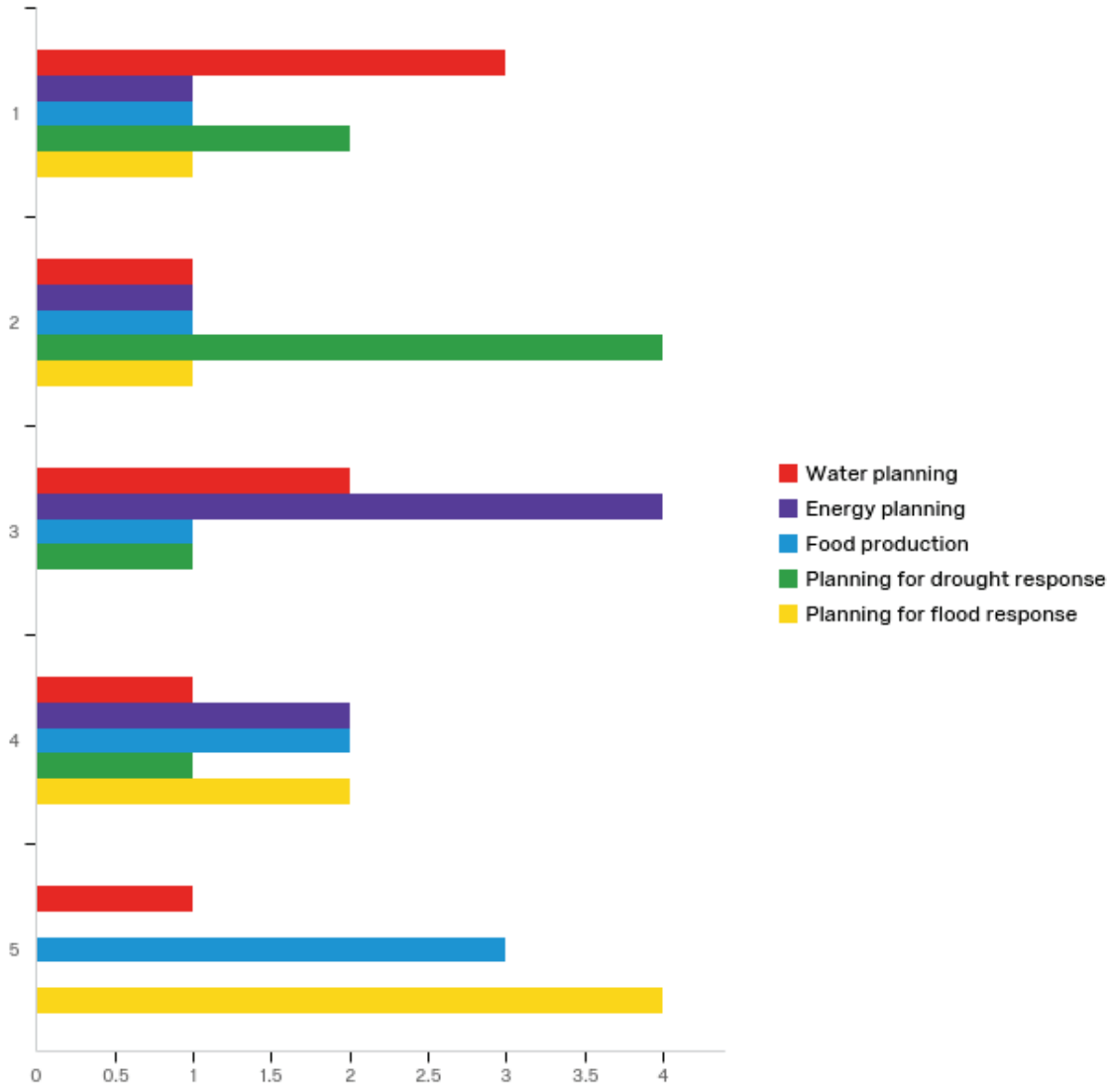

| # | Answer | % | Count |
|---|---|---|---|
| 1 | Very Dissatisfied (1) | 0.00% | 0 |
| 2 | Dissatisfied (2) | 9.09% | 1 |
| 3 | Neither Satisfied nor Dissatisfied (3) | 18.18% | 2 |
| 4 | Satisfied (4) | 18.18% | 2 |
| 5 | Very Satisfied (5) | 36.36% | 4 |
| 6 | I did not know what to expect walking in | 18.18% | 2 |
| | Total | 100% | 11 |

## Q2 - Which of these statements reflect your thoughts after this forum?




| # | Answer | % | Count |
|---|---|---|---|
| 1 | I do see the need for "nexus planning" and more coordination across sectors | 42.86% | 6 |
| 2 | I think there was nothing new in what was introduced/ I did not learn anything new | 14.29% | 2 |
| 3 | We already consider water, energy, and food interconnections at my institution | 21.43% | 3 |
| 4 | We already consider water, energy, and food interconnections at my institution, but could benefit from increased coordination between cross-sectoral players | 21.43% | 3 |
| | Total | 100% | 14 |

**Q3 - Do you feel there is an urgency to work towards addressing resource allocation issues with a WEF Nexus mindset in San Antonio? Please rank the following issues from most to least urgent.**

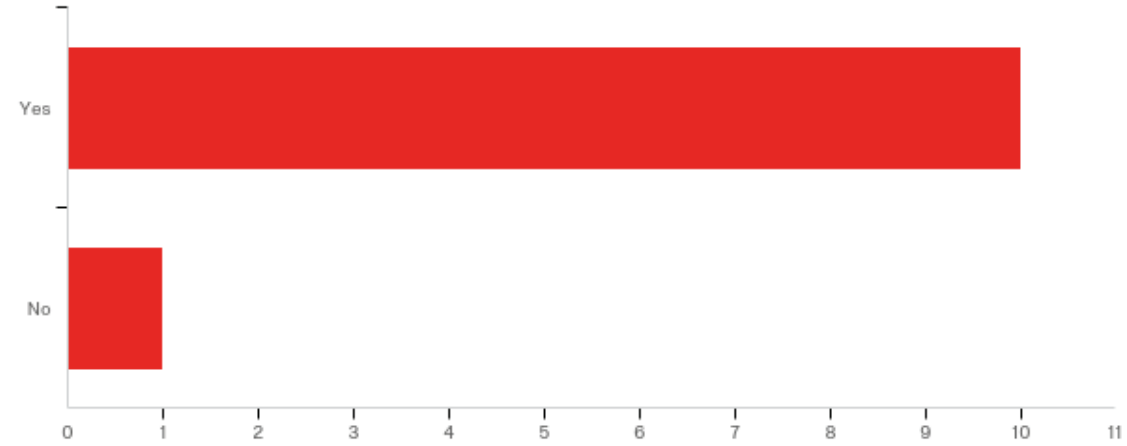



| # | Question | 1 | | 2 | | 3 | | 4 | | 5 | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Water planning | 37.50% | 3 | 12.50% | 1 | 25.00% | 2 | 12.50% | 1 | 12.50% | 1 | 8 |
| 2 | Energy planning | 12.50% | 1 | 12.50% | 1 | 50.00% | 4 | 25.00% | 2 | 0.00% | 0 | 8 |
| 3 | Food production | 12.50% | 1 | 12.50% | 1 | 12.50% | 1 | 25.00% | 2 | 37.50% | 3 | 8 |
| 4 | Planning for drought response | 25.00% | 2 | 50.00% | 4 | 12.50% | 1 | 12.50% | 1 | 0.00% | 0 | 8 |
| 5 | Planning for flood response | 12.50% | 1 | 12.50% | 1 | 0.00% | 0 | 25.00% | 2 | 50.00% | 4 | 8 |

## Q4 - What do you think you could contribute / bring to the table moving forward?

| What do you think you could contribute / bring to the table moving forward? |
| --- |
| A perspective on aquifer water management - quantity and quality. |
| Innovative flood forecasting models. |
| Food |
| Engaging communities and decision-makers, especially at the local level; social learning processes; socioeconomic analyses |
| Education and Outreach to other classmates and professionals. |

## Q5 - Would you like to continue to hear about the progress of the nexus activities at Texas A&M?




| # | Answer | % | Count |
|---|---|---|---|
| 1 | Yes | 90.91% | 10 |
| 2 | No | 9.09% | 1 |
| | Total | 100% | 11 |

## Q6 - Are there others whom you think we should add to our list of stakeholders?

| Are there others whom you think we should add to our list of stakeholders? |
| --- |
| food retailers |
| Cameron Turner, Manager, Agricultural Water Conservation, Texas Water Development Board |
| Extension |
| Not at this time but will keep thinking! |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Copies may be obtained at https://libguides.tamusa.edu/ld.php?content_id=41591901 and at Texas A&M WEF Nexus Initiative, 306 Scoates Hall, Texas A&M University, College Station, TX 77843.