Optimal Water Allocation using a WEF nexus Approach: MATAGORDA County US, TX

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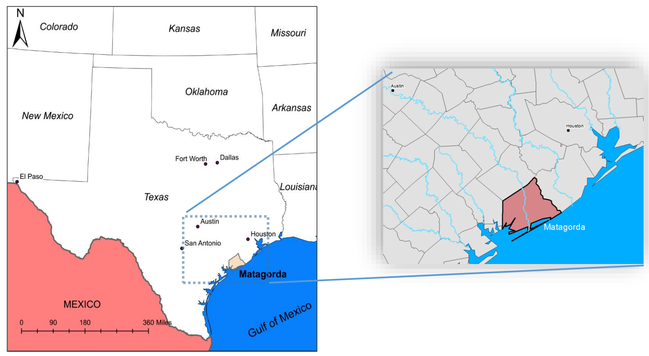
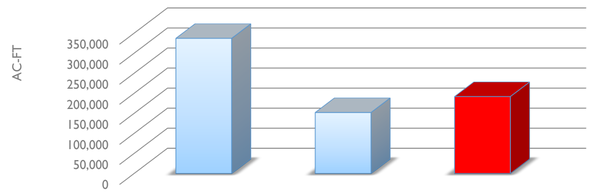
XVI World Water Congress
International Water Resources Association (IWRA)
Cancun, Quintana Roo. Mexico. 29 May- 3 June, 2017

WEF Nexus Research Group
TEXAS A&M UNIVERSITY

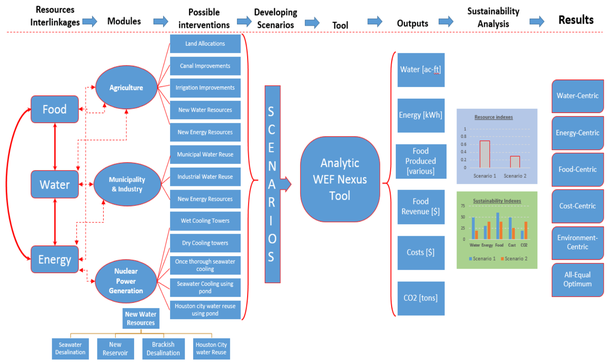
The Problem



Matagorda County Potential Water Shortage in 2020 (Water Shortage)



Framework



General Concepts

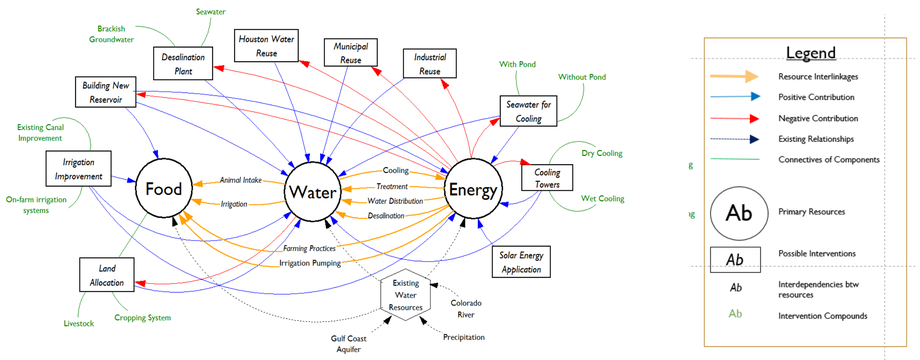
- The year 2070 was used for projections
- Severe conditions considered
- Limitations to Water Resources availability:
  - Existing water rights,
  - Environmental flow,
  - Recommended withdrawal values
- Reliability of water supply is 100%, except for agricultural supply
- Existing energy production not sacrificed

Data Collected & Assumptions

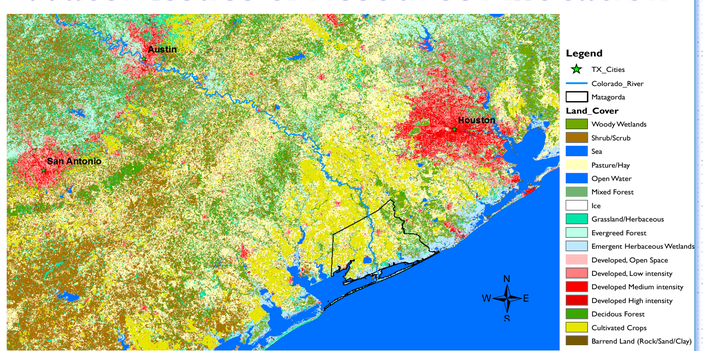
- **USDA:**
  - Historic Food Production
  - Crop Pattern
  - Livestock
  - Market Values
- **TCEQ**
  - Water Rights and Permits
- **NOAA**
  - Temperature & Precipitation
  - Wind
  - Solar
- **USNRC & IAEA**
  - Nuclear Generation
- **NREL**
  - System Advisor Model (SAM) for Solar Energy
- **TWDB**
  - Municipal & Industrial Water Demand
  - Natural Evaporation
  - Groundwater Depth and availability
  - Existing Conveyance Systems
  - Cost estimations for hydraulic projects in TX
- **USBR**
  - Historical Project Cost Values & Trends
- **Other Studies and Data Sources for:**
  - Population
  - Efficient On-farm Irrigation Systems
  - Farming Operations
  - CO2 emissions
  - Other Cooling Systems
  - Cost Values of Water-Related Projects
  - Desalination
  - Water Treatment
  - Available Wastewater From Houston

Assumptions
1. Current irrigation efficiency = 70%
2. 10% more water added to irrigation scheduling
3. No need to treat groundwater for any purpose
4. Oil & Gas, Aquaculture not included
5. Distance assumptions for pipelines

Possible Interventions and Nexus

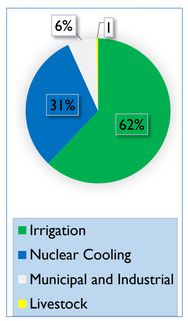


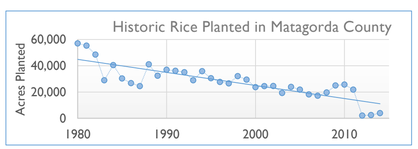
Water Issues & Resource Allocation

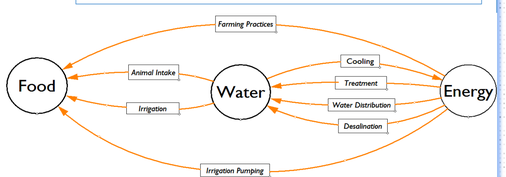


Legend
- TX_Cities
- Colorado_River
- Matagorda

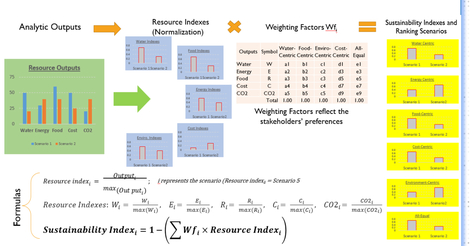
Land_Cover
- Woody Wetlands
- Shrub/Scrub
- Sea
- Pasture/Hay
- Open Water
- Mixed Forest
- Ice
- Grassland/Herbaceous
- Evergreed Forest
- Emergent Herbaceous Wetlands
- Developed, Open Space
- Developed, Low intensity
- Developed Medium intensity
- Developed High intensity
- Decidous Forest
- Cultivated Crops
- Barrend Land (Rock/Sand/Clay)







Sustainability Analysis



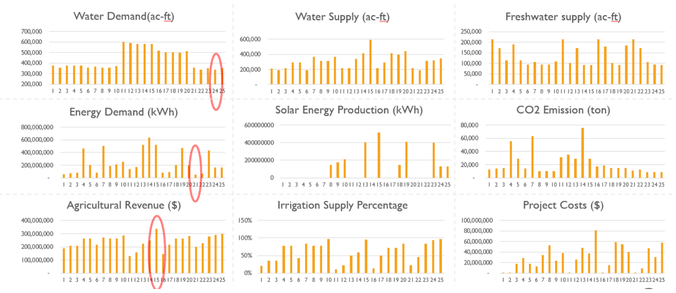
Output Parameters	Symbol	Water-centric	Energy-centric	Food-centric	Cost-centric	Environment-centric	All Equal
Water	W	0.40	0.15	0.15	0.15	0.15	0.2
Energy	E	0.15	0.40	0.15	0.15	0.15	0.2
Agricultural	R	0.15	0.15	0.40	0.15	0.15	0.2
Cost	C	0.15	0.15	0.15	0.40	0.15	0.2
CO2 Emission	CO2	0.15	0.15	0.15	0.15	0.40	0.2

Developed Scenarios

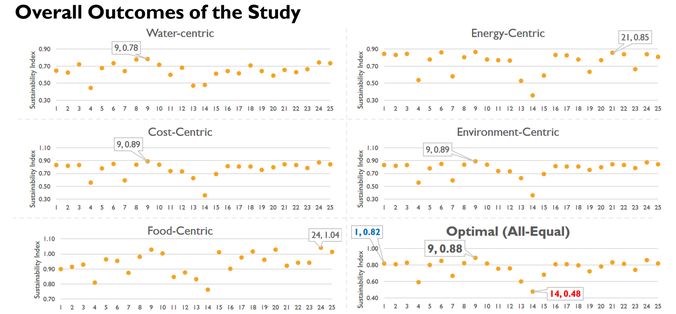
Modules	Interventions		Scenarios (1–25)
Agriculture	Land Allocation*	Current Ag. Land and Crop Allocation	✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
		More Ag. Land and More Water Demanded Crops	✓ ✓ ✓ ✓ ✓
		More Ag. Land and Less Water Demanded Crops	✓ ✓ ✓ ✓ ✓
		Current Ag. Land and Less Water Demanded Crops	✓ ✓ ✓ ✓ ✓
	Irrigation Applications	Conveyance System Improvement	✓ ✓
		On-farm system Improvement	✓ ✓
	Water Resources	New Reservoir	✓ ✓
		Seawater Desalination 50,000 [ac-ft]	✓ ✓
		Seawater Desalination 100,000 [ac-ft]	✓ ✓
		Brackish Groundwater 50,000 [ac-ft]	✓ ✓
		Brackish Groundwater 100,000 [ac-ft]	✓ ✓
		Houston Water Reuse 50,000 [ac-ft]	✓ ✓
		Houston Water Reuse 100,000 [ac-ft]	✓ ✓
		Houston Water Reuse 200,000 [ac-ft]	✓ ✓
M & I	Municipal Water Reuse	Water Reuse 50%	✓ ✓
	Industrial Water Reuse	Water Reuse 80%	✓ ✓
		Water Reuse 50%	✓ ✓
		Water Reuse 80%	✓ ✓
Nuclear Generation	Cooling System	Current Practice	✓ ✓
		Water from reservoir	✓ ✓
		Seawater using pond	✓ ✓
		Houston water reuse	✓ ✓
		Solar farm	✓ ✓

Results & Discussions

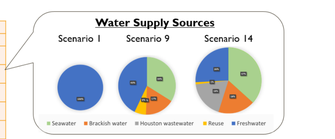
Outputs of Analytic WEF Nexus Tool



Overall Outcomes of the Study



	Base	Best	Worst
	1	9	14
Water Demand (ac-ft)	374,874	355,419	583,628
Water Supply (ac-ft)	212,843	299,520	549,279
Energy Demand (kWh)	59,458,409	144,334,764	754,143,733
Solar Energy Production (kWh)	0	103,990,216	0
CO2 Emission (ton)	12,284	10,086	102,397
Ag. Revenue ($)	188,218,475	239,187,955	270,599,514
Project Costs ($)	190,772	19,159,627	57,765,111
Ag. Supply percentage	21%	61%	57%



- Sectors driving water-energy-food do their job without sacrificing routine work:
  - Municipal users get all indoor & outdoor water use demanded
  - Industrial users receive water for manufacturing, mining, processing

Acknowledgements

General Directorate of State Hydraulic Works of Turkey, WEF Nexus Research Group at TAMU

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