SETx-UIFL: Equitable solutions for communities caught between floods and air pollution

Collaborating institutions and PIs:
University of Texas at Austin (Paola Passalacqua), Lamar University (Liv Haselbach),
Texas A&M University (Michelle Meyer), Prairie View A&M University (Noel Estwick),
Oak Ridge National Laboratory (Ethan Coon), Los Alamos National Laboratory (Christa Brelsford)

PAOLA PASSALACQUA
Professor, Fariborz Maseeh Dept. of Civil, Architectural & Environmental Engineering, The University of Texas at Austin

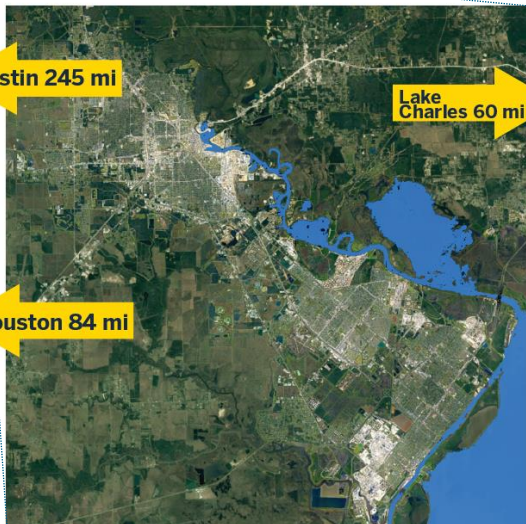SETx URBAN IFL

https://www.setx-uifl.org

Southeast Texas: acute on chronic hazards impacting vulnerable communities
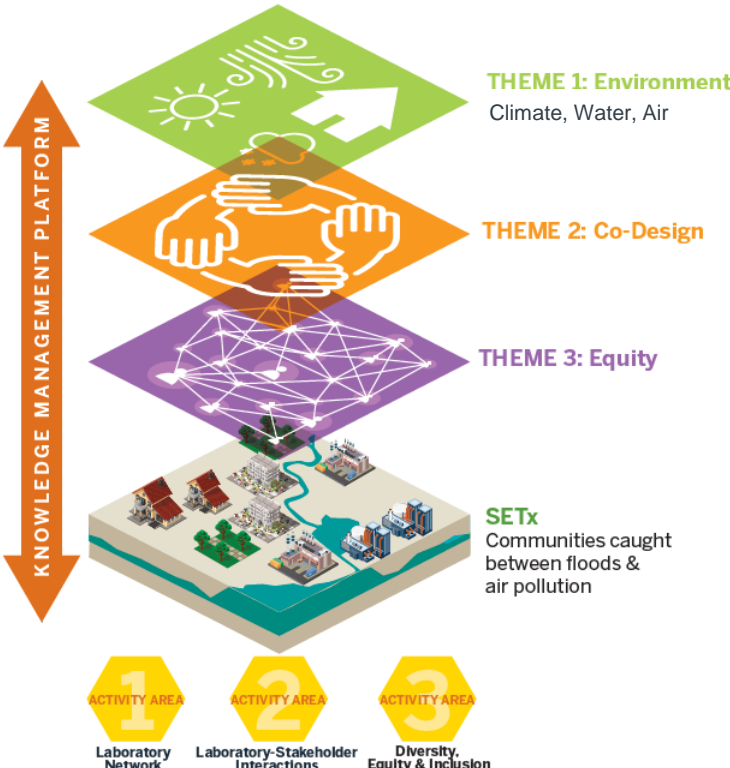
Beaumont-Port Arthur Metropolitan Statistical Area

- Frequent acute (e.g. compound flooding) on chronic (e.g. toxic air pollution) hazards, expected to worsen with climate change, aging infrastructure, etc.

- Continuous urban expansion and increased impervious cover over past several decades

- Home to one of the largest petrochemical industrial complexes

- Ranks in the top 10% of most polluted US communities

- Represents urban conditions along the Gulf Coast – experiencing population and industrial transitions but in inequitable ways and with less resources available than larger cities

- A quarter of families and 40% of children in poverty

- SETx-UIFL builds on existing work, including major expansion of the flood sensing and air sensing networks

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Providing better data, modeling, & planning to support climate adaptation in SETx and the Gulf Region

- Which processes and variables need to be captured in regional scale hydrological and atmospheric models so that they are representative of the conditions experienced by local communities and help inform adaptation strategies?

- How can we understand the linkages between and within natural, built, and social systems in urbanized regions to better support natural and human resilience?

KNOWLEDGE MANAGEMENT PLATFORM

THEME 1: Environment
Climate, Water, Air

THEME 2: Co-Design

THEME 3: Equity

SETx
Communities caught between floods & air pollution

1 ACTIVITY AREA
Laboratory Network

2 ACTIVITY AREA
Laboratory-Stakeholder Interactions

3 ACTIVITY AREA
Diversity, Equity & Inclusion

SETx URBAN IFL

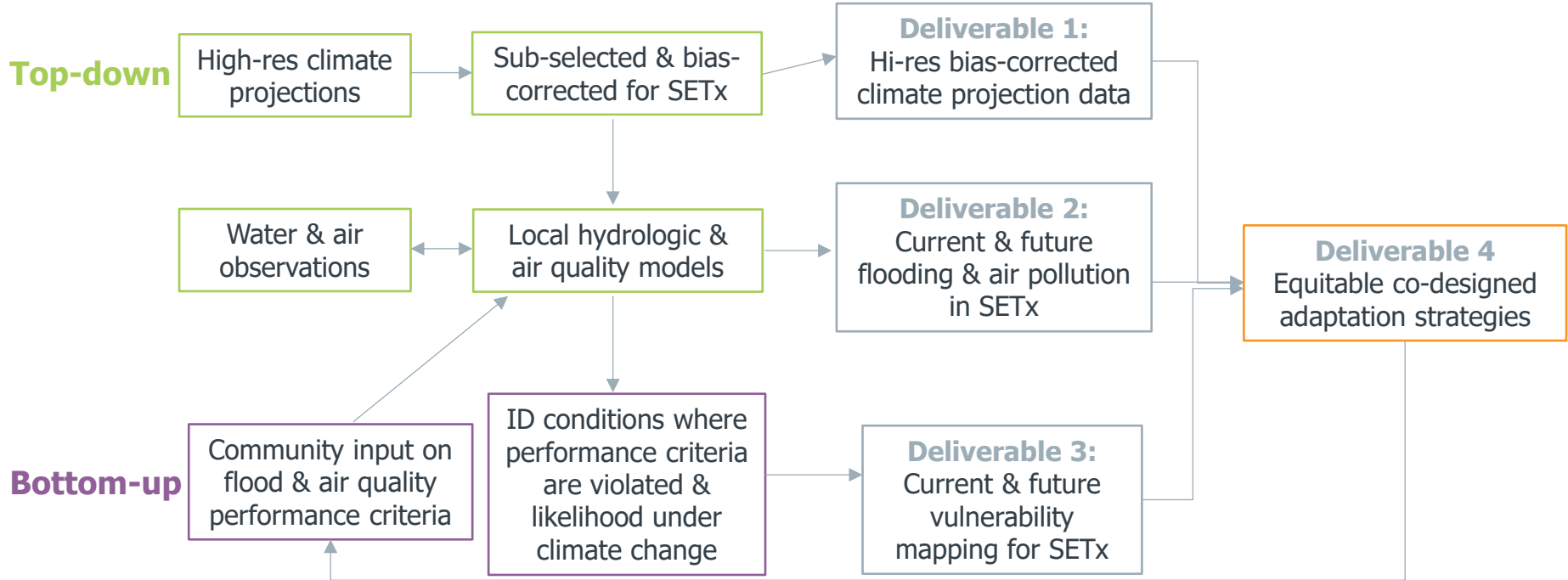# We collaborate with a group of more than 100 stakeholders

Goal: Co-develop data and decision-making frameworks with stakeholders to aid community-led development of equitable climate change adaptation strategies

Approach to engagement: engage in two-way relationships between decision makers/residents and researchers to ensure stakeholder knowledge is incorporated into modeling and scenarios development and that data from SETx-UIFL research are useful for and incorporated into community-led climate adaptation decision-making

- SETx-FCS (Flood Coordination Study): led by Liv Haselbach (Lamar University PI) includes SETx counties, cities, river authorities, drainage districts, industries, federal agencies
  URL: https://www.setxfloodcoordstudy.org/members.html

- Resident groups working with Texas Target Communities and community-level stakeholders and community leaders experienced in the challenges faced by marginalized populations

![SETx URBAN IFL logo]

SETx-UIFL approach: top-down and bottom-up

Top-down

High-res climate projections → Sub-selected & bias-corrected for SETx → **Deliverable 1:** Hi-res bias-corrected climate projection data

Water & air observations ↔ Local hydrologic & air quality models → **Deliverable 2:** Current & future flooding & air pollution in SETx

Bottom-up

Community input on flood & air quality performance criteria → ID conditions where performance criteria are violated & likelihood under climate change → **Deliverable 3:** Current & future vulnerability mapping for SETx

Deliverable 4 Equitable co-designed adaptation strategies

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Environment **Equity** **Co-design**

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- Identified global climate models that best capture climate conditions over SETx
- Developed algorithm to create ultra-high resolution climate projections for SETx
- Piloted new techniques for capturing and projecting rainfall events that drive flood risk over SETx
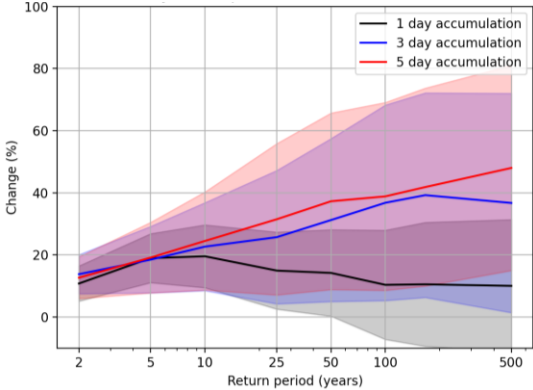
Historical (1950-2014) average temperature (K)

Low resolution model

Ultra-high resolution (1 km)
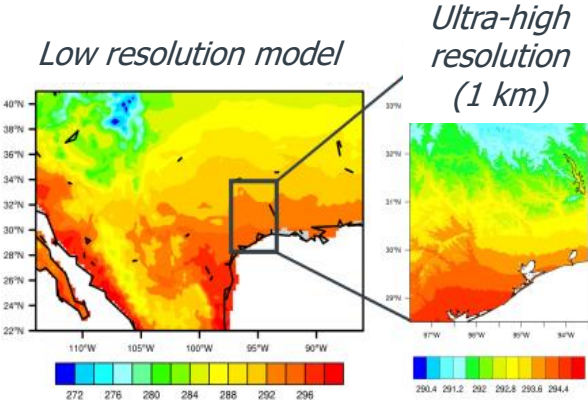
Replicating SETX hurricane statistics in climate models to enable projection
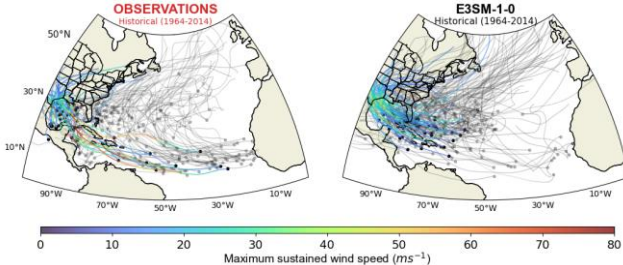
Future change in SETx storm rainfall using new storm transposition technique

Lead: Geeta Persad (UT Austin)   6

First filter (35→30 GCMS): Regional Climate Basic Statistics over Southern US
*Is the model reasonable with the **big picture**?*

Second filter (30→20 GCMS): Regional Climate Pattern over Southern US
*Does the model capture the dominant weather patterns that are **important for air quality** over SETx?*

Final filter (20→10 GCMS): Regional Climate and Flooding Control Indices over SETx
*Does the model capture basic climate statistics over SETX that are most important for driving **high frequency and extreme flood events**?*

Model	Rank
MPI-ESM1-2-HR	1
CNRM-ESM2-1	2
EC-Earth3	3
CMCC-ESM2	4
FGOALS-g3	5
MRI-ESM2-0	6
GFDL-CM4	7
BCC-CSM2-MR	8
UKESM1-0-LL	9
NorESM2-MM	10
INM-CM4-8	11
ACCESS-CM2	12
IPSL-CM6A-LR	13
MIROC6	13
KACE-1-0-G	15

**Metrics** defined with input from across SETx-UIFL allow **locally-specific ranking and sub-selection of climate data**

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Lead: Geeta Persad (UT Austin)

Water: flood modeling, flood inundation mapping, and increased observation network

- Expanded the flood monitoring sensor network.

- Developed & demonstrating hydrologic modeling framework: completed prototype work on Village Creek Basin, including running 5000 storm events consistent with current climate/land cover conditions.

- Simulated wetland stability and wetlands as a buffer from coastal and fluvial flooding using a coupled land surface model.

- Augmenting capability of measuring coastal process and hurricane impacts (drones + Ameriflux tower).
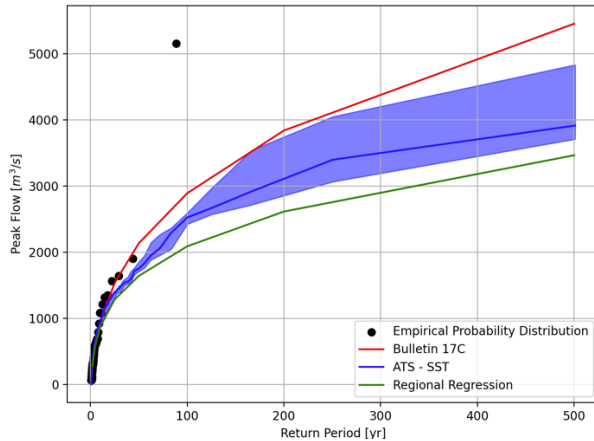
Storm 500

Flood frequency curve derived from 5000 storm events in Village Creek

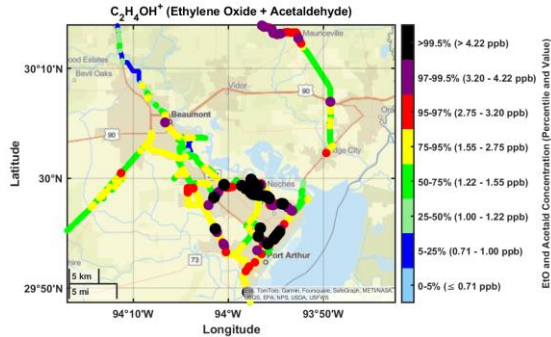**Lead: Ethan Coon (ORNL)**

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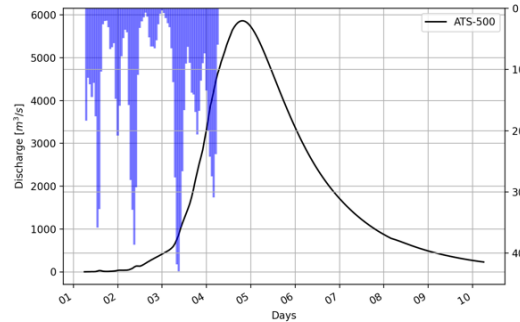
Air: identifying pollution hot spots and predicting air toxics concentrations
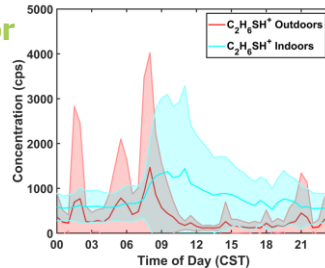
Observations

Identifying Major Pollution Hotspots and Chemical Markers

Concentrations of diverse volatile organic compound (VOC) species from many source plumes were measured using a Vocus PTR-TOF-MS (The Sniffer)

Evaluating Exposure Reduction Solutions

Outdoor and Indoor Stationary Measurements at a Community Site

Night-time plumes of odorous S-containing VOCs (DMS+ethanethiol)

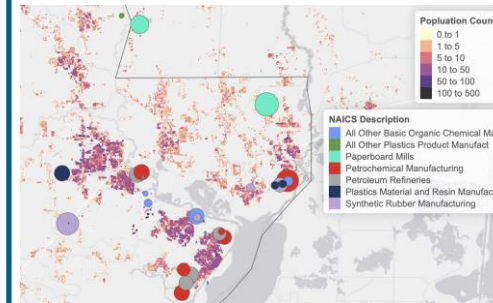Affordable Indoor Air Filter
(Corsi-Rosenthal Box)

Emissions Inventories and Modeling

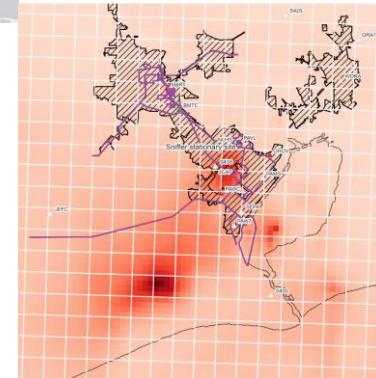We use **Federal and state emission inventories** to characterize sources of air toxics in SETx, support atmospheric modeling and exposure assessments, and inform measurement campaigns

Population distribution and industrial facilities with benzene, styrene, acetonitrile, acetaldehyde, and/or 1,3-butadiene emissions in the EPA 2022 Toxics Release Inventory (TRI)

We use the **Comprehensive Air Quality Model with Extensions (CAMx)** to indicate contributions of different emission source categories (e.g., point, area, mobile) to predicted concentrations of air toxics regionally and at specific geographic locations

Modeled 90th percentile benzene concentrations (4/1-10/31/2019)

Lead: Kerry Kinney (UT Austin), Clayton Jeffreys (Lamar University)

Co-design: Translating Task Force members' values, visions, & problem definitions into potential climate adaptation strategies

Activities with Technical Task Force & Community Organization Task Force:

- Community engagement strategy that is sensitive to community context
- Quarterly meeting with task force members
- Selected sites of interest with task force members and gathered + integrated data + site visits
- Developed workflow to generate visualizations of co-designed strategies
- Starting interviews and continuing surveys


Example of strategy visualization

Task Force meetings

Site selection process

Lead: Katherine Lieberknecht (UT Austin)
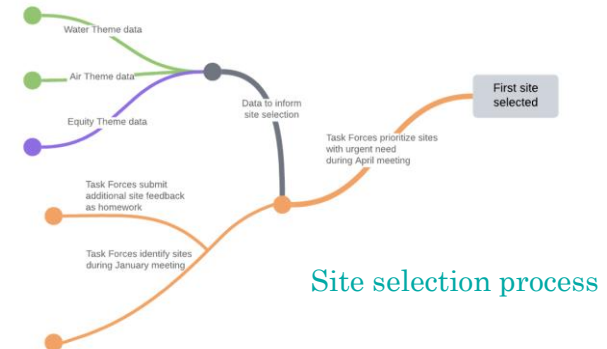
Equity: Developing research specific indicators for Social Vulnerability

## Open Source Tool for Calculating SVIs

- Preisser et al., (2024), *Under Review*
- Open-source tool using Factor Analysis and Ranking methods.
- Tailor made Census based SVIs for any study area in US.
- Automate comparisons between years and calculation methods
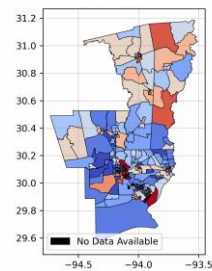
2013-2022 Factor Analysis Method
Block Group SVIs for SETx

## Explicitly Document SVI Assumptions

- What are the basic assumptions that Social Vulnerability Index (SVI) modelers must consider before generating or using an SVI?
- Defined assumptions for demographic data, spatial data, and index construction.
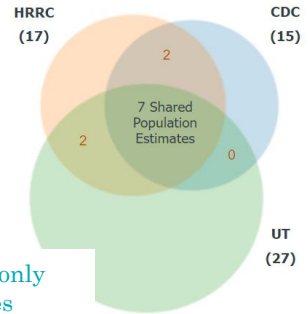
Three SVI options only
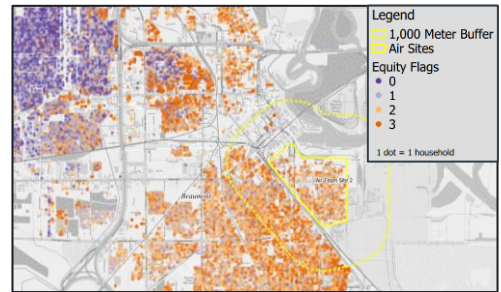share 7 variables

ZIP code level SVI for Health Equity

- Followed CDC/ATSDR SVI, gathered ACS based 16 indicators and calculated 4 themes
- Each data extracted by ZIP Code Tabulation Areas (ZCTA) Level in Texas.
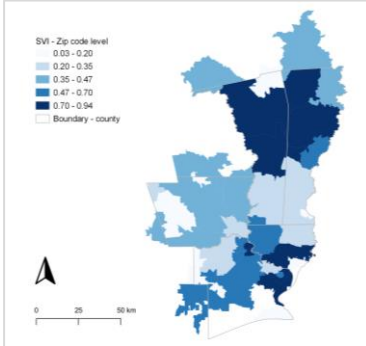
2020 ZIP code level SVI

Housing Unit Allocation with Equity Flags

- Presented test maps during community engagement task force meeting.
- Maps used to inform decision for selection of flood and air team study sites.

Community with pollution concerns
& significant number of
low-income minority renters

Leads: Michelle Meyer & Nathanael Rosenheim (Texas A&M) 11

Developing workflows that improve collaboration and analyses through cookbooks on TACC.

Support of the co-design site selection process.

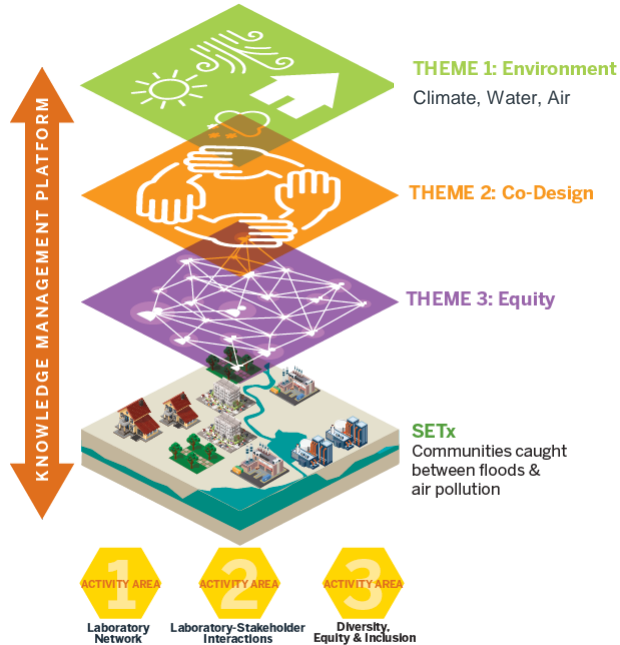2024 SETx-UIFL Summer Institute

Photos from 2023 Annual Meeting

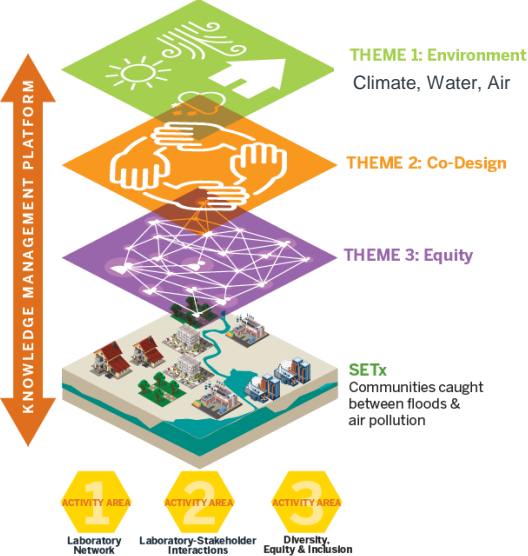Photos TAMU Land Design Field Trip

Additional activities:

- Cross-institutional course
- Support team field campaigns
- Support community projects
- Task force meetings

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Collaboration across UIFLs via monthly coordination, seminar series, and supplementary projects

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ACTIVITY AREA **1** Laboratory Network

ACTIVITY AREA **2** Laboratory-Stakeholder Interactions

ACTIVITY AREA **3** Diversity, Equity & Inclusion

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- Monthly PIs meetings
- Quarterly seminar series with 2 UIFLs presenting (coordinated by BSEC)
- 7 supplementary project funded (SETx-UIFL leads 5 and participates in 2):

1. MSD Urban Working Group Cross-IFL Community Building (Lead: Christa Brelsford, LANL)
2. Unified Multilayer Interface for Cataloguing Spatiotemporal Observation across IFLs (Lead: Will Mobley, UT)
3. Green infrastructure representations in hydrologic models (Lead: Ethan Coon, ORNL)
4. Coordinating urban land surface modeling across UIFLs (Lead: Ben Sulman, ORNL)
5. Coordinated inter-IFL measurements of gas-phase and particle-phase pollutants in joint intensive observation periods (Lead: Misztal, UT)
6. Collaborative Evaluation of the Urban Integrated Field Laboratories (UIFLs) Transdisciplinary Team Science (SETx-UIFL representative: Lieberknecht, UT)
7. Greenhouse gas, criteria air pollutant, and anthropogenic heat flux inventories for the UIFL domains at the asset scale (SETx-UIFL representative: Misztal, UT)

Opportunities for collaboration

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ACTIVITY AREA 2 — Laboratory-Stakeholder Interactions
ACTIVITY AREA 3 — Diversity, Equity & Inclusion

For more information:

Southeast Texas Urban Integrated Field Laboratory

Website: https://www.setx-uifl.org

Email: setx-uifl@utexas.edu

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