



HUAZHONG UNIVERSITY OF
SCIENCE AND TECHNOLOGY

ATM | **TEXAS A&M**
UNIVERSITY.

Texas A&M Digital Twin Prototype

2024.08.30
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1 Introduction



■ Education

Huazhong University of Science and Technology

Wuhan, China

- **M.Eng.** in Urban and Rural Planning / **GPA:** 87.47/100 / 2020.09 – 2023.06 / **Tutor:** Helin Liu
- **B.Eng.** in Urban and Rural Planning / **GPA:** 85.22/100 / 2015.09 – 2020.06 (*Postgraduate Recommendation*)

■ Research & Working Experience

5 Research Project (Publication: 5 Journal Article; 5 Conference Paper)

- Topics: Rural Shrinkage Identification; Territorial Space Planning; low-carbon Industry; EV Charging Station

4 Working Experience (Base: 4 Cities, Wuhan; Guangzhou; Beijing; Shenzhen)

- Position: MCC Southern Engineering Technology Co., Ltd. / Urban and rural planner / 2023.07 – Present

■ Honors & Skills

11 Competition Award; 6 Honorary title; 15 Proficient Skills

- Outstanding Graduate(10%); Merit Postgraduate(10%); Outstanding Undergraduate(10%)
- Python; R; ArcGIS; QGIS; SPSS; Stata; Photoshop; Illustrator; SketchUp; AutoCAD; Office

■ Research Interests

- **Urban digital twin; AI-enabled participatory planning; Resilience and low-carbon cities; Flow space**

2 Analysis

The Plan Integration for Resilience Scorecard (PIRS)

01

Gather Plans & Policies

Gather all community plans and extract applicable policies.

02

Analyze Plans

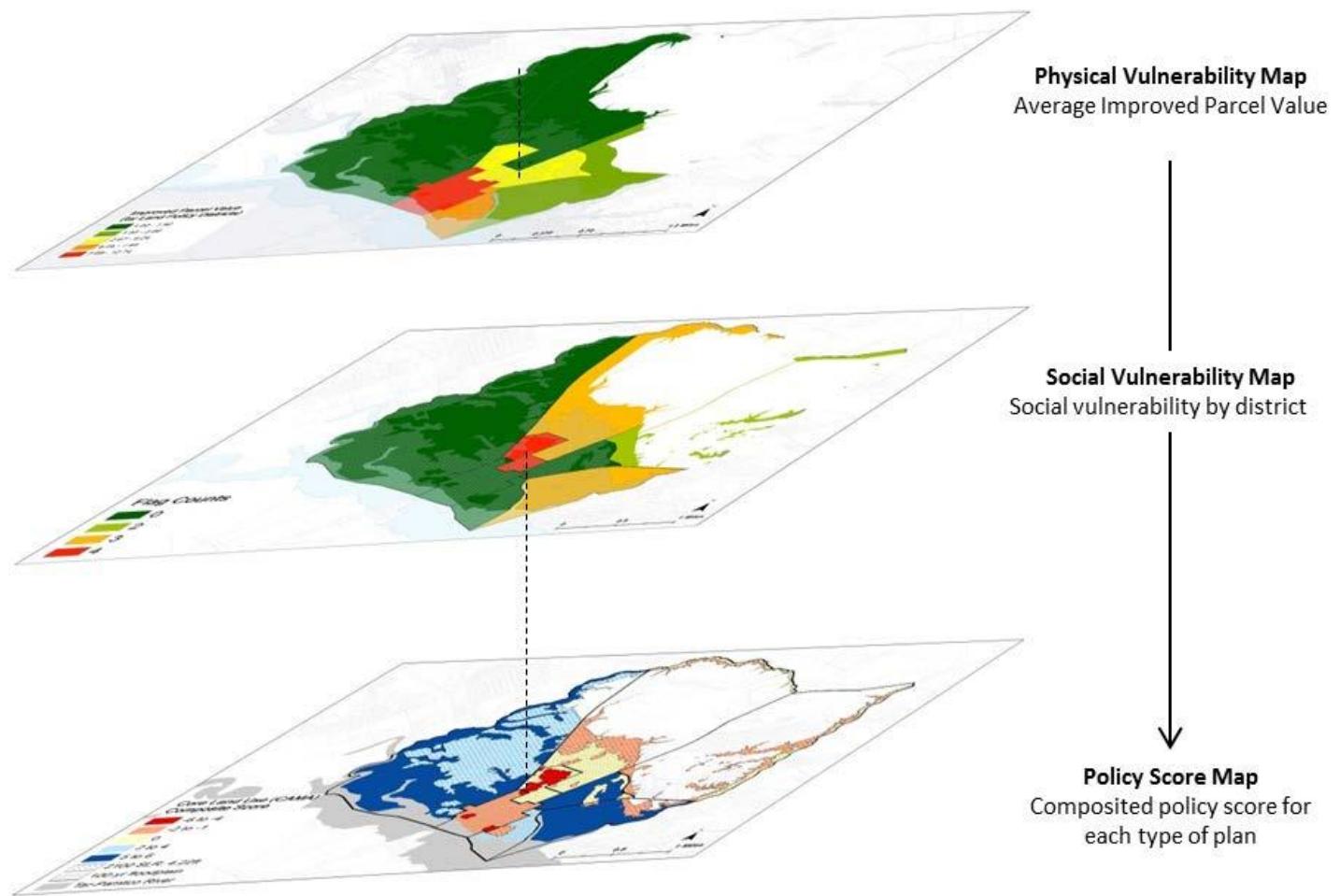
Plans are evaluated and scores are given to districts for each.

03

Understand Vulnerabilities

Compare vulnerability value to the policy scores.

District	Core Land Use (CAMA)		2023 Comprehensive		Hazard Mitigation		Parks & Recreation		All Four Plans (Combined)	
	Current Hazard Zone	Future Hazard Zone	Current Hazard Zone	Future Hazard Zone	Current Hazard Zone	Future Hazard Zone	Current Hazard Zone	Future Hazard Zone	Current Hazard Zone	Future Hazard Zone
District 1 (Downtown)	-2	-6	-5	-5	10	2	0	0	3	-9
District 2	6	2	0	0	9	2	1	1	16	5
District 3	0	-2	-1	0	1	2	1	1	1	1
District 4	0	-1	0	0	3	2	1	1	4	2
District 5	0	-4	0	0	6	2	1	1	7	-1
District 6	6	0	2	2	11	2	0	0	19	4
District 7	5	-1	-2	-2	12	2	1	1	16	0
District 8	4	-2	-1	-1	10	0	1	1	14	-2
TOTAL	19	-14	-7	-6	62	14	6	6	80	0



2 Analysis

Campus Sustainability Assessment Tools (CSAT)

- Origin:** Sustainability in higher education” was firstly mentioned in the Stockholm Declaration of 1972. (Alshuwaikhat and Abubakar, 2008)
- Definition:** “...the minimization of **negative environmental, economic, societal, and health effects...**”(Velazquez et al., 2006)
- CSATs:** Most of these CSATs come from North America, Europe, and East Asia. **ASSC, GASU, STARS** are more popular than other CSATs.
- CSATs' topics:** Categories are more related to **social and humanistic dimensions**, but **less attention is paid to categories at the spatial level**.

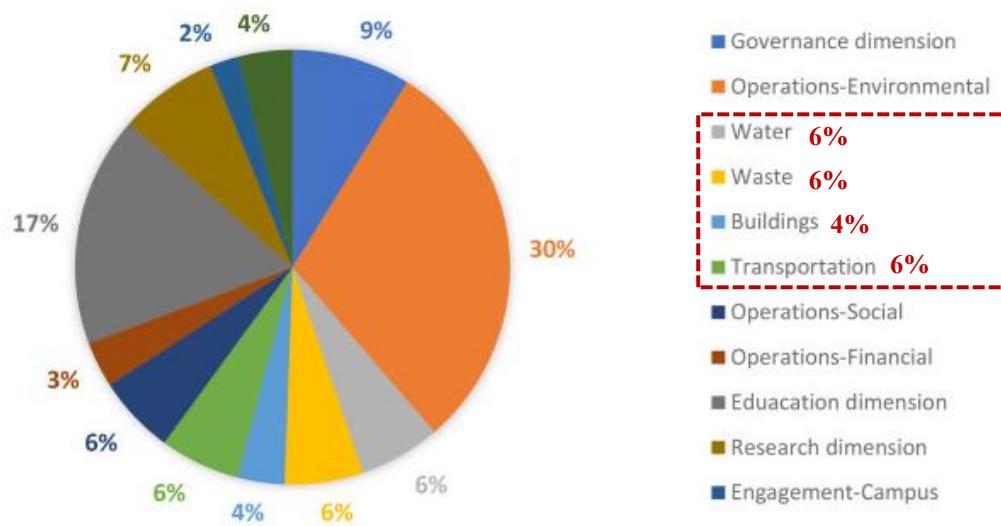


Figure1. The distribution of included CSATs' topics.

Table1. CSATs included in the reviewed literature.(Dawodu A et al., 2022)

No	Tool	Origin	Year	Citation Count
1	Assessment Instrument for Sustainability in Higher Education (AISHE)	Global	2009	30
2	Adaptable Model for Assessing Sustainability in Higher Education (AMAS)	Chile	2014	25
3	Assessment System for Sustainable Campus (ASSC)	Japan	2013	170
4	Campus Sustainability Assessment Framework Core (CSAF Core)	Canada	2009	48
5	Graphical Assessment of Sustainability in University (GASU)	Global	2011	174
6	Green Metric World University Rankings (GM)	Global	2019	39
7	People & Planet Green League (P&P)	UK	2019	69
8	Pacific Sustainability Index (PSI)	USA	2011	83
9	Sustainability Assessment Questionnaire (SAQ)	Global	2009	25
10	Sustainability Tracking, Assessment and Rating System for Colleges and Universities (STARS)	North America	2019	69
11	Sustainable University Model (SUM)	Global	2016	27
12	Sustainability in Higher Education Institutions (SusHEI)	Portugal	2013	16
13	Greening Universities Toolkit (Toolkit)	Global	2013	134
14	Unit-based Sustainability Assessment Tool (USAT)	Africa	2009	75
15	Assessment Standard for Green Campus (ASGC)	China	2019	57

2 Analysis

Campus Sustainability Assessment Indicator

Table3. Sustainability Tracking, Assessment and Rating System for Colleges and Universities (STARS) indicators. **North America.** 2019

No	Indicators	Sub-indicators
1	Air & Climate	Greenhouse Gas Emissions
2	Buildings	Building Design and Construction
3		Building Operations and Maintenance
4	Energy	Building Energy Efficiency;
5		Clean and Renewable Energy
6	Transportation	Campus Fleet Commute Modal Split
7		Waste Minimization and Diversion;
8	Waste	Construction and Demolition Waste Diversion;
9		Hazardous Waste Management
10	Water	Water Use Rainwater Management

Table2. **Spatial-based** campus sustainability indicators.(Adenle Y A et al., 2020)

Categories	Indicators	The function of GIS and other related spatial software in spatial-based indicator appraisal
Environment	(1) Land (2) Public Space (3) Landscape (4) Greenspace and forest land (5) The ratio of open space area to the total area (6) Total area on campus covered in forest vegetation (7) Total area on campus covered in planted vegetation (8) Total area on campus for water absorption besides the forest and planted vegetation	- The acreage/area of green area, land, public space, and public space in m ² - Area of heat islands in m ²
Setting and infrastructure	(9) Physical structure (10) Natural Heritage (11) Buildings (12) Green buildings	- Area of buildings, green building with Certified LEED, natural heritage and physical structure in m ² - Location of green buildings/buildings, natural heritage, and physical structure
Energy and climate change	(13) Number of renewable energy sources in campus (14) Energy Efficiency (15) Greenhouse Gas Emissions (16) Building Energy Efficiency (17) Energy consumption (18) Air & Climate (19) Annual energy consumption rate (20) Concentration of greenhouse gases (21) Production of emission, effluents, and waste (22) Concentration of emissions, effluents, and waste	- Location of renewable sources, greenhouse gas concentration, emissions, effluents, and waste concentration - Energy consumption in kWh - Quantity of electricity per area of solar - Area and percent of buildings that generate greenhouse gases - Greenhouse gases in CO ₂ equivalent
Waste	(23) Sewage disposal (24) Waste reduction (25) Construction and Demolition Waste Diversion	- Amount of waste disposal and reduction in m ³ and metric tons - Location of sewage disposal - Area of waste collection in m ²
Water	(26) Treated water consumed (27) Water efficiency (28) Water consumption (29) Rate of water consumption and quality (30) Amount of water supplied and distributed/collected for purification	- Amount of water in m ³ /litres/ft. ³ /gallons - locations of water supply - Area of water supply
Transportation	(31) Access for Handicapped People (32) Campus Fleet (33) Flow planning (34) Pedestrians and cycling (35) Green transportation	The dimension (1D, 2D, 3D) of cycling, pedestrian, ramp and campus route in m/km/km ²

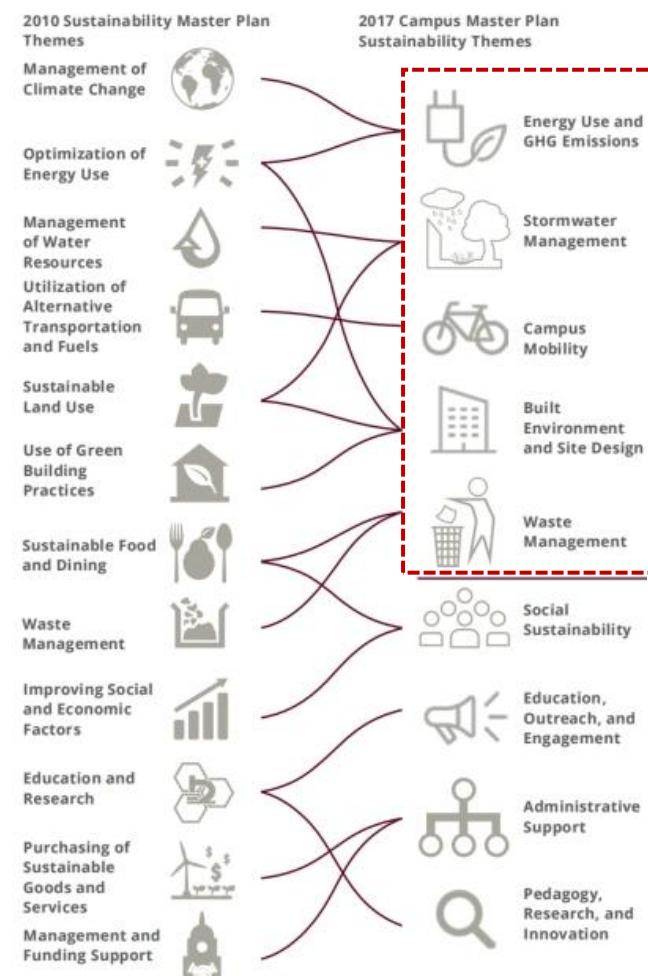
2 Analysis

Sustainability Themes in Texas A&M's 2017 Campus Master Plan

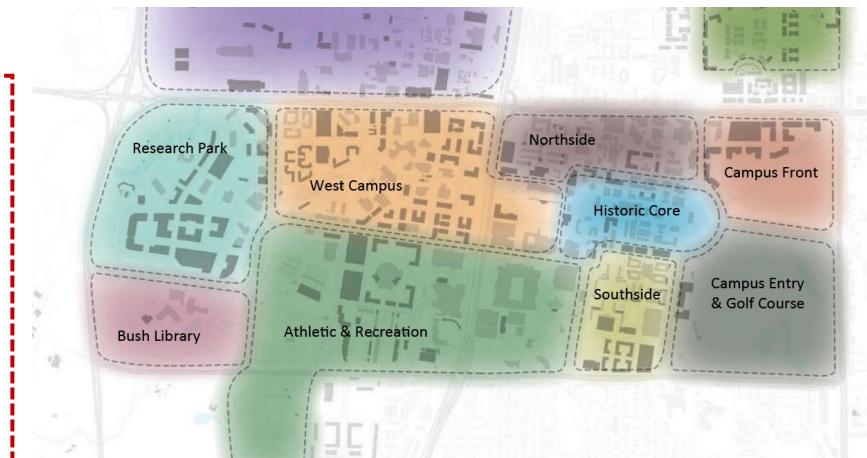
1. Energy Use and GHG Emissions
2. Stormwater Management
3. Campus Mobility
4. Built Environment and Site Design
5. Waste Management
6. Social Sustainability
7. Education; Outreach; and Engagement
8. Administrative Support
9. Pedagogy, Research, and Innovation

Sustainability at Texas A&M is the efficient, deliberate, and responsible preservation of environmental, social, and economic resources to protect our earth for future generations of Texas Aggies, the Texas A&M University community, and beyond.

—Texas A&M's 2017 Campus Master Plan

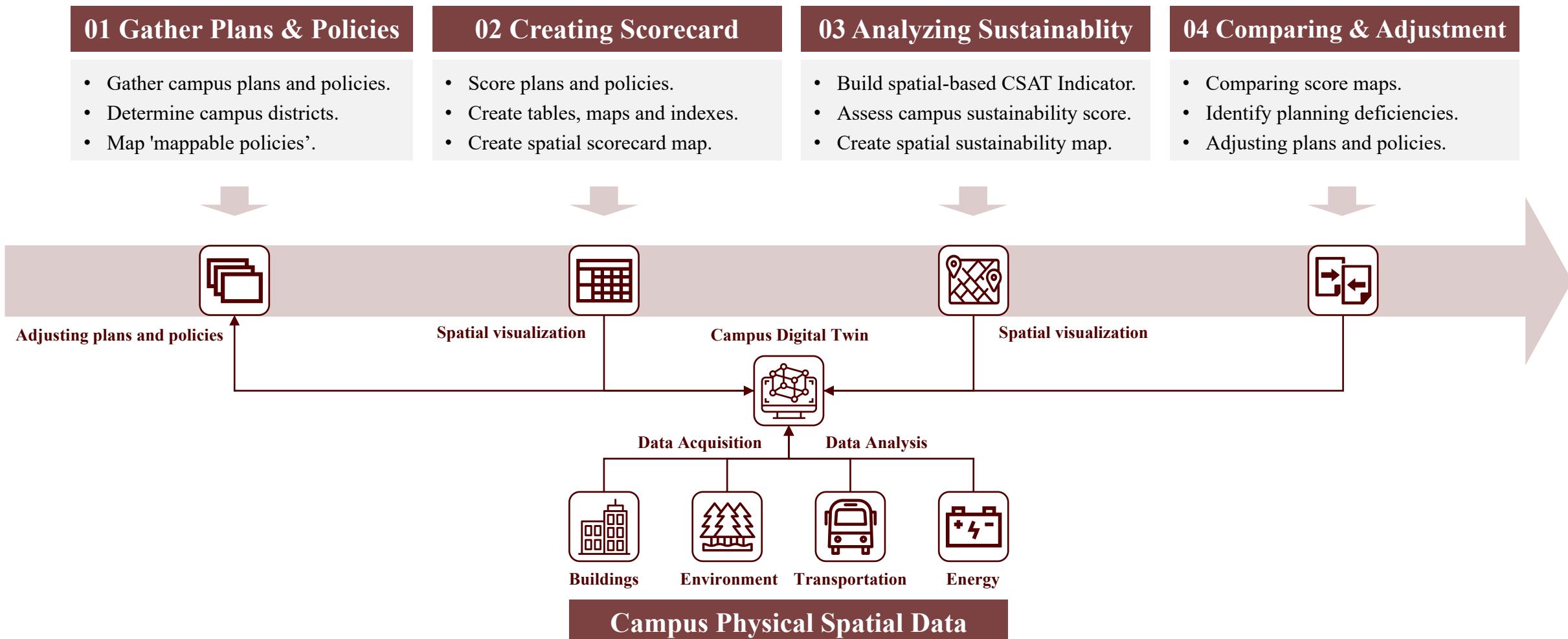


Resource: <https://facilities.tamu.edu/departments-committees/cpdc/standards-guidelines.html>



3 Solution

■ Technical Route Framework about Campus Sustainability Scorecard, based on Digital Twin



3 Solution

Campus Sustainability Assessment Indicator System for Scorecard

C1 Buildings	C2 Environment	C3 Transportation	C4 Energy
			
C1.1 Building space utilization rate(%)	C2.1 Environmental noise(dB)	C3.1 Traffic volume(pcu/h)	C4.1 Water consumption(t)
C1.2 Building damaged area(m ²)	C2.2 Environmental air quality(mg/m ³)	C3.2 Parking space ratio(%)	C4.2 Power consumption(kWh)
C1.3 Building settlement distance(m)	C2.3 Surface water quality(mg/L)	C3.3 Bus stop coverage rate(%)	C4.3 Natural gas consumption(t)
C1.4 Building light intensity(lx)	C2.4 Soil environmental quality(mg/kg)	C3.4 Motor lane density(km/km ²)	C4.4 Photovoltaic power generation(kWh)
C1.5 Building indoor temperature(°F)	C2.5 Green coverage rate(%)	C3.5 Cycle lane density(km/km ²)	C4.5 Carbon emission(t)
C1.6 Building indoor air quality(mg/m ³)	C2.6 Waste disposal rate(%)	C3.6 Pavement density((km/km ²)	C4.6 Carbon sink(t)

4 Prototype

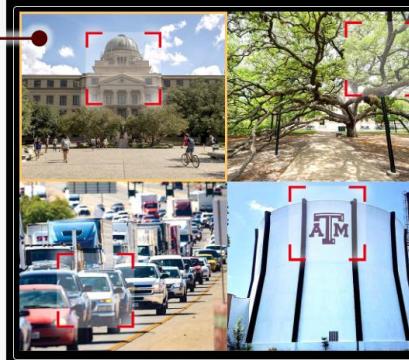
■ Home Page

More details of the developed prototype will be demonstrated in the presentation.

CDT-3D Dynamic Display



AI Abnormal Monitoring

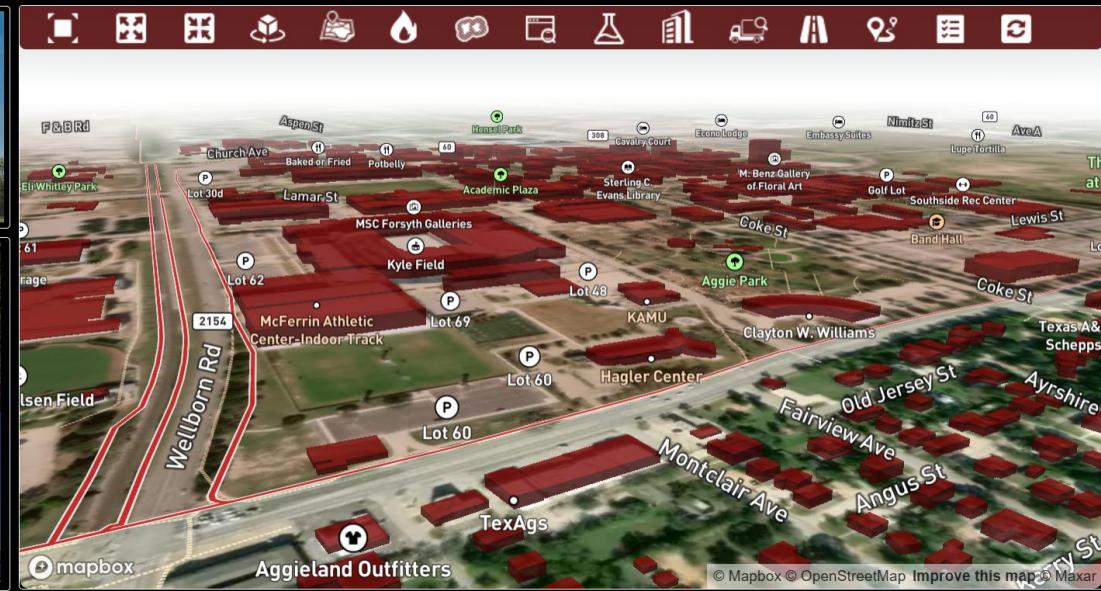


Abnormal point basic information

Type: Buildings Description: Broken windows
Time: 2024-08-13 11:40 Address: 306 University Dr, College Station, TX 77843
content: The building's walls are falling off and windows are broken

Type	Time	Description	Address
Buildings	08-13	-	TX 77843
Environment	08-13	-	TX 77823
Transportation	08-13	-	TX 77867
Energy	08-13	-	TX 77812
Transportation	08-13	-	TX 77890
Buildings	08-13	-	TX 77812
Transportation	08-13	-	TX 77825
Buildings	08-13	-	TX 77828
Buildings	08-13	-	TX 77879
Transportation	08-13	-	TX 77812
Transportation	08-13	-	TX 77889

Texas A&M Digital Twin



Transportation Data Monitoring

Plate number	Type	Speed	Transport Content	Destination	Entry time	Departure time
TX1234	Students	20km/h	Manned	Wehner Building	2024-08-13	2024-08-14
TX1223	Employees	30km/h	Manned	Bright Building	2024-08-13	2024-08-14
TX1223	Visitors	25km/h	Manned	Chemistry	2024-08-13	2024-08-14
TX1223	Vendors	20km/h	Loading cargo	Engineering Building	2024-08-13	2024-08-14
TX1223	Visitors	30km/h	Manned	ZACH	2024-08-13	2024-08-14

Campus Population Flow

6 2 , 3 0 5

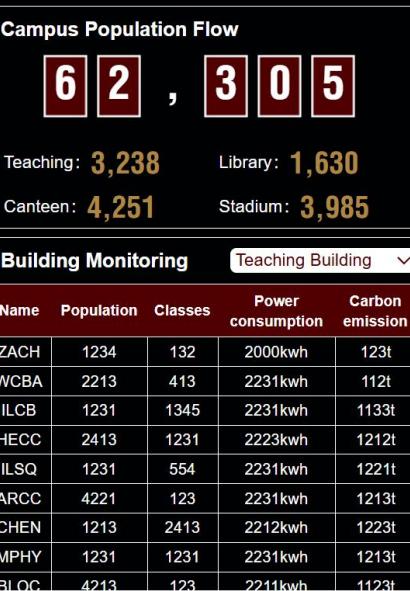
Teaching: 3,238 Library: 1,630
Canteen: 4,251 Stadium: 3,985

Building Monitoring

Teaching Building

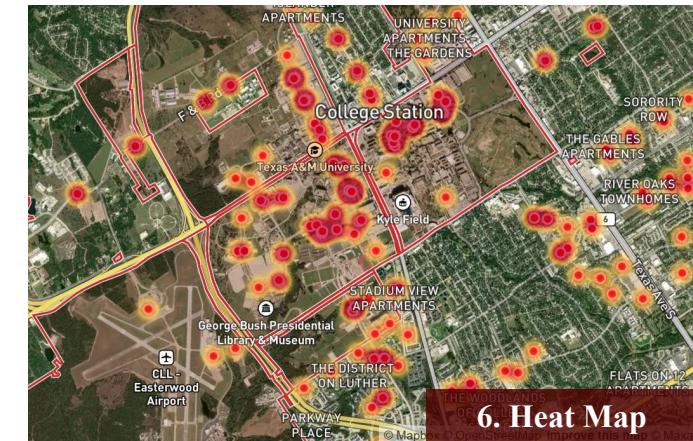
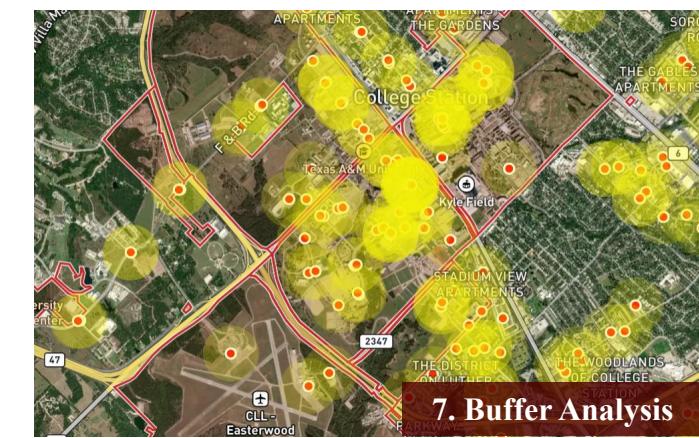
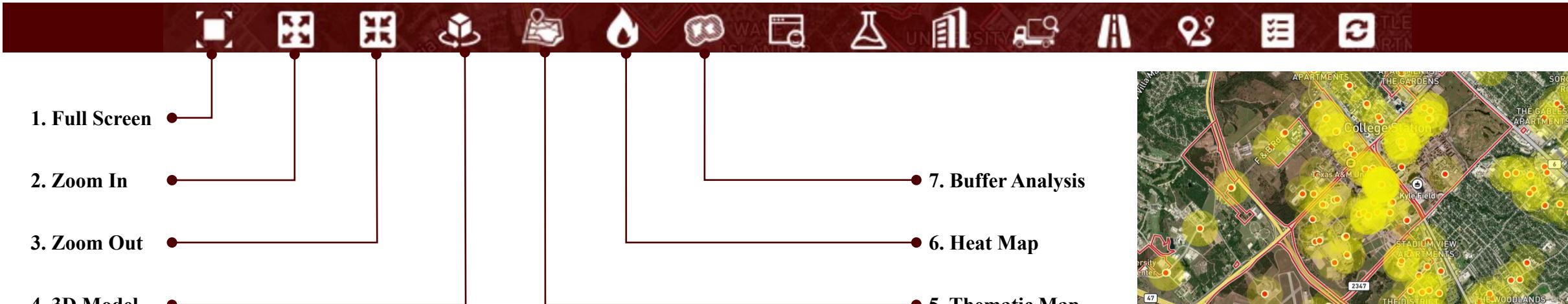
Name	Population	Classes	Power consumption	Carbon emission
ZACH	1234	132	2000kwh	123t
WCBA	2213	413	2231kwh	112t
ILCB	1231	1345	2231kwh	1133t
HECC	2413	1231	2223kwh	1212t
ILSQ	1231	554	2231kwh	1221t
ARCC	4221	123	2231kwh	1213t
CHEN	1213	2413	2212kwh	1223t
MPHY	1231	1231	2231kwh	1213t
BLOC	4213	123	2211kwh	1123t

Scorecard for Campus Sustainability



4 Prototype

■ Map Interaction



4 Prototype

■ Map Interaction

The toolbar integrates 15 functional buttons.

Vehicle search:

Number: <input type="text"/>	Name: <input type="text"/>	
<input type="button" value="Search"/>		
TX 1234	<input type="checkbox"/> Students	<input type="checkbox"/> Vendors
Passenger car	<input type="checkbox"/> TX 1224	<input type="checkbox"/> TX 1414
Passenger car	<input type="checkbox"/> TX 1224	<input type="checkbox"/> TX 1414
Passenger car	<input type="checkbox"/> TX 1414	<input type="checkbox"/> Vendors
Lorry	<input type="checkbox"/> TX 1414	<input type="checkbox"/> Vendors
Lorry	<input type="checkbox"/> TX 1414	<input type="checkbox"/> TX 1414

11. Vehicle Search

Course location search:

Course: <input type="text"/>	Name: <input type="text"/>
<input type="button" value="Search"/>	
Planning Theory and History	<input type="checkbox"/> Wehner Building-210, College Station, TX 77843
Applied Planning	<input type="checkbox"/> Kleberg Center-474 Olsen Bl, College Station, TX 77843
Facilities Management	<input type="checkbox"/> Student Recreation Center-187 Cornington Dr, TX 77843
Applied Planning	<input type="checkbox"/> Kleberg Center-474 Olsen Bl, College Station, TX 77843
Applied Planning	<input type="checkbox"/> Kleberg Center-474 Olsen Bl, College Station, TX 77843

10. Course Search

Important Lab Search:

Lab: <input type="text"/>	Name: <input type="text"/>
<input type="button" value="Search"/>	
Department of Chemistry	<input type="checkbox"/> 3255 TAMU, 580 Ross St
Department of Psychological	<input type="checkbox"/> 4235 TAMU, College Station
Department of Chemistry	<input type="checkbox"/> 3255 TAMU, 580 Ross St
Department of Psychological	<input type="checkbox"/> 4235 TAMU, College Station

9. Lab Search

Address Search:

Type: <input type="text"/>	Name: <input type="text"/>
<input type="button" value="Search"/>	
School of Architecture	<input type="checkbox"/> 789 Ross St, College Station, TX 77843
Reed Arena	<input type="checkbox"/> 730 Olsen Blvd, College Station, TX 77843
Mays Business School	<input type="checkbox"/> 210 Olsen Blvd, College Station, TX 77843
Hullabaloo Hall	<input type="checkbox"/> 306 University Dr, College Station, TX 77843
Kyle Field	<input type="checkbox"/> 161 Wellborn Rd, College Station, TX 77840

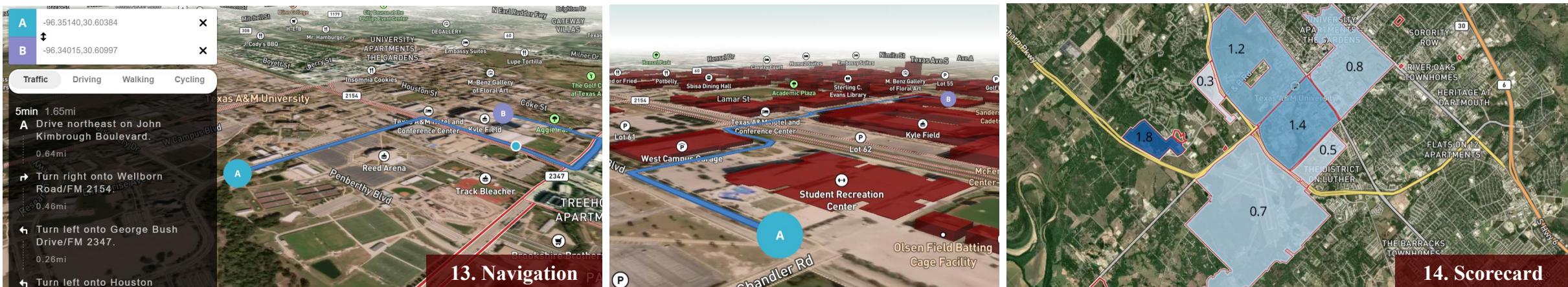
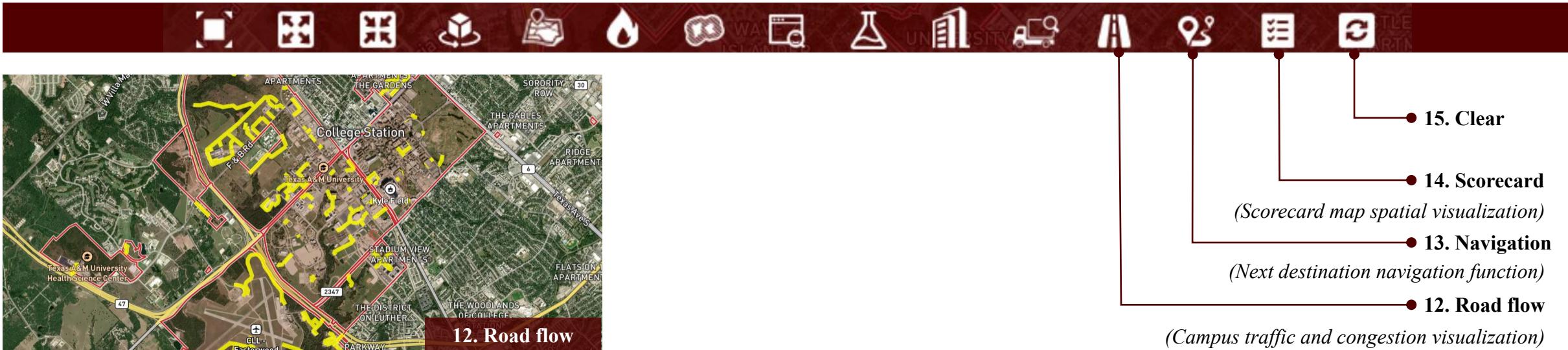
8. Address Search

Powered by Mapbox

4 Prototype

■ Map Interaction

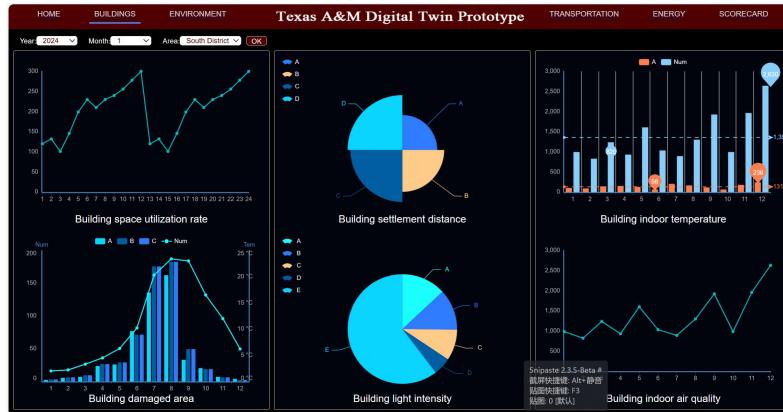
The toolbar integrates 15 functional buttons.



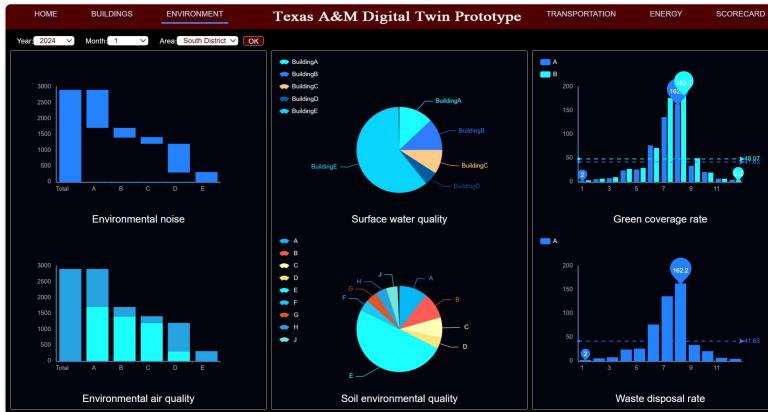
4 Prototype

Campus Sustainability Indicator and Scorecard Display Page

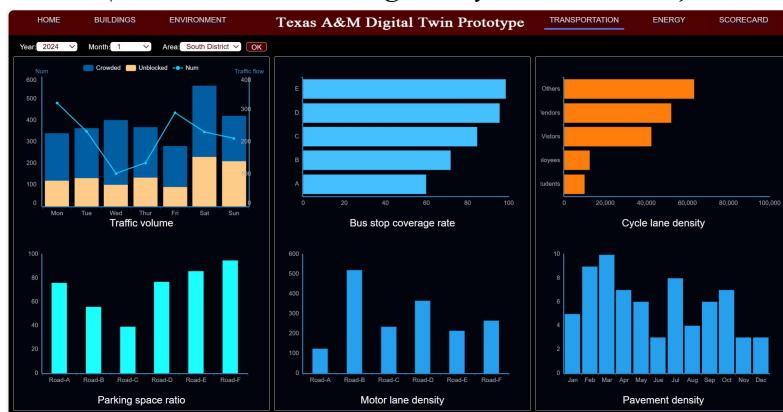
Indicators analysis is only schematic due to lack of data.



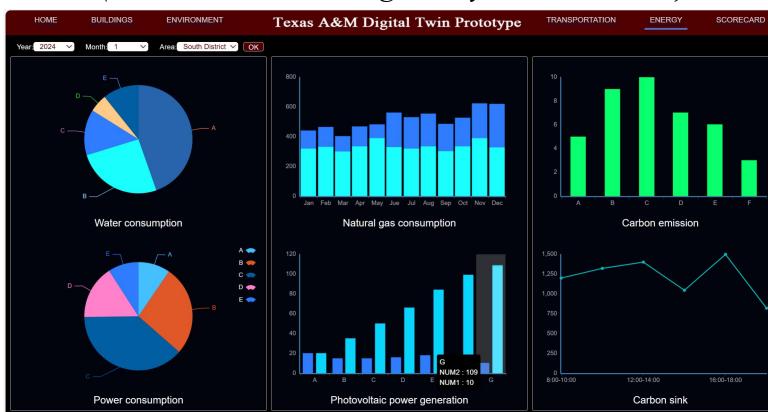
C1 Buildings Dimension Page
(Indicators Monitoring, Analysis and Predict)



C2 Environment Dimension Page
(Indicators Monitoring, Analysis and Predict)



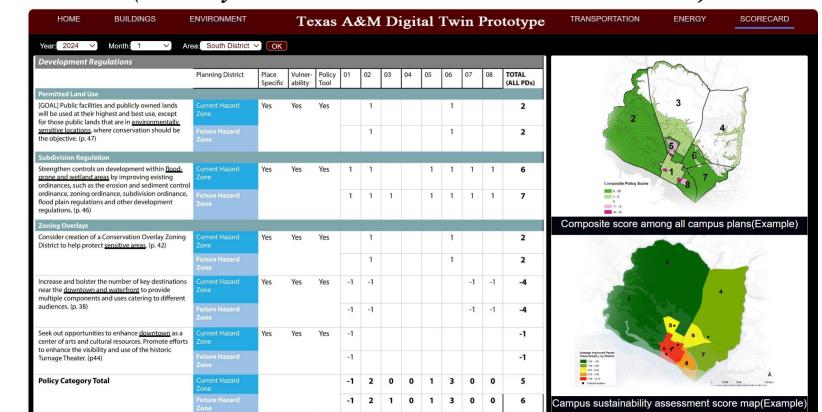
C3 Transportation Dimension Page
(Indicators Monitoring, Analysis and Predict)



C4 Energy Dimension Page
(Indicators Monitoring, Analysis and Predict)



Indicators Search Box
(History and Forecast Simulation Indicators)



Scorecard Display Page
(Spatial plan scorecard and Sustainability map)

5 Appendix

■ Reference

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THANKS