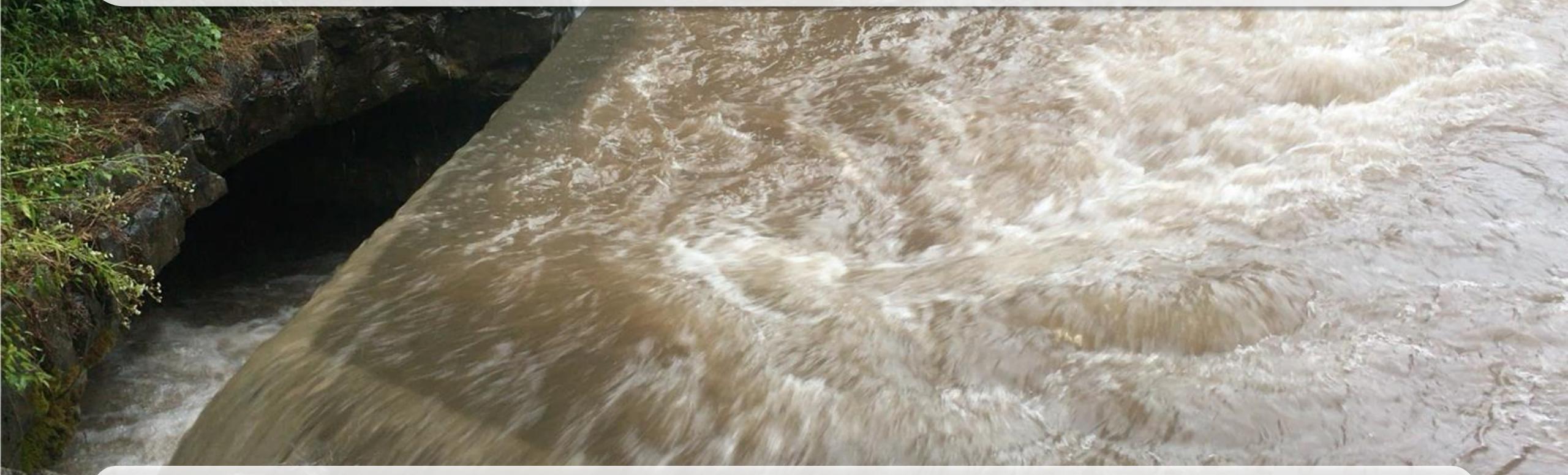


Developing a Comprehensive Water Resources Monitoring Dashboard using Big Data Analytics and Modeling



ARTP

Applied Research &
Technology Program



Jack Galloway¹, Gianna Claros¹, Jason S. Polk¹, James Shelley²

¹Center for Human GeoEnvironmental Studies (CHNGES), Western Kentucky University

²Kentucky Water Resources Research Institute, University of Kentucky

WKU | EEAIS | Earth, Environmental & Atmospheric Sciences


CHNGES
CENTER FOR HUMAN GEOENVIRONMENTAL STUDIES



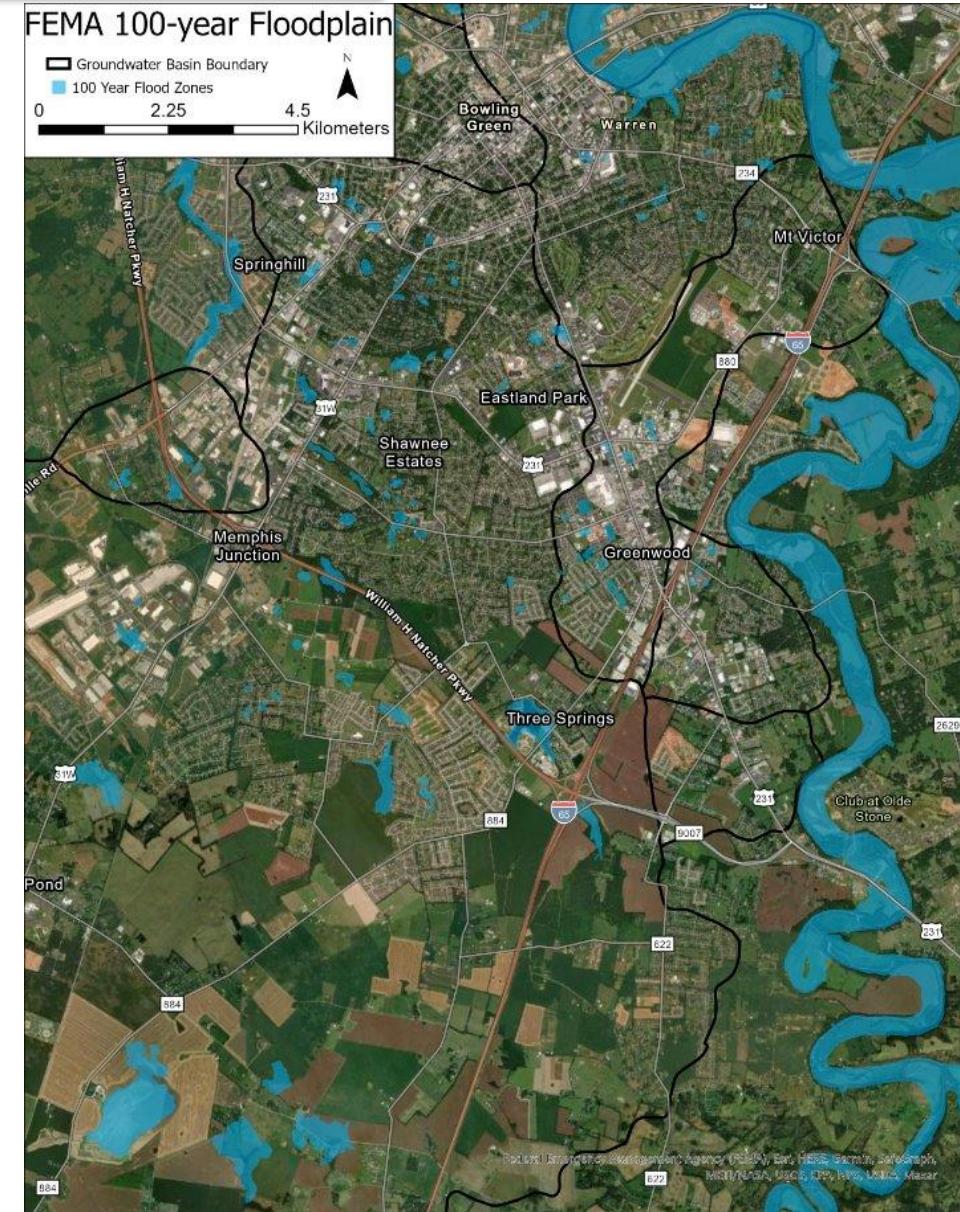
Why a Monitoring Network Dashboard?

- Address water quality issues, flood impacts, and related ecosystem concerns.
- Provide real-time data streaming for informed decision-making.
- Enhance community engagement and awareness of water resource issues.
- Enable proactive measures for water resource management and conservation.
- Support scientific research and data-driven approaches to address water challenges.



Monitoring Network Specifications

- Ensure proper site distribution to obtain best possible coverage for environmental monitoring needs
 - Network spatial density is an important factor
 - Reliable, consistent data transmission is paramount to the success of the network (relies on cellular telemetry data)





Monitoring Data: Meteorological Parameters

Meteorological Parameters:

- Temp
- Rainfall
- Barometric pressure
- Relative humidity
- Solar radiation
- Wind speed & direction
- Soil moisture & temp
- ETo





Monitoring Data: Hydrologic Parameters





Monitoring Data: Hydrologic Parameters

- Water Quality Parameters:
 - pH
 - Temp
 - Specific Conductivity
 - Dissolved Oxygen
 - Turbidity



Carver Well Cave



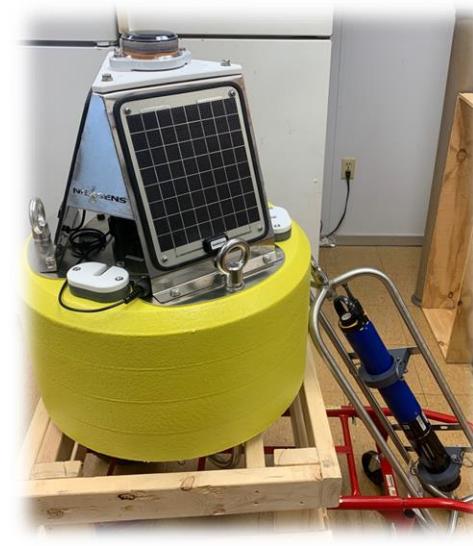
New Spring



Lost River Rise



Lost River Blue Hole #4



Barren River @ I-65



Church Karst Window



Pit Stop Cave



Data Collection Equipment

Onset Equipment:

- RX3000 weather stations
- RX2102/2104 Real-time Loggers
- Rainfall (Davis rain gauges)
- Water level
- Temperature

Water Levels

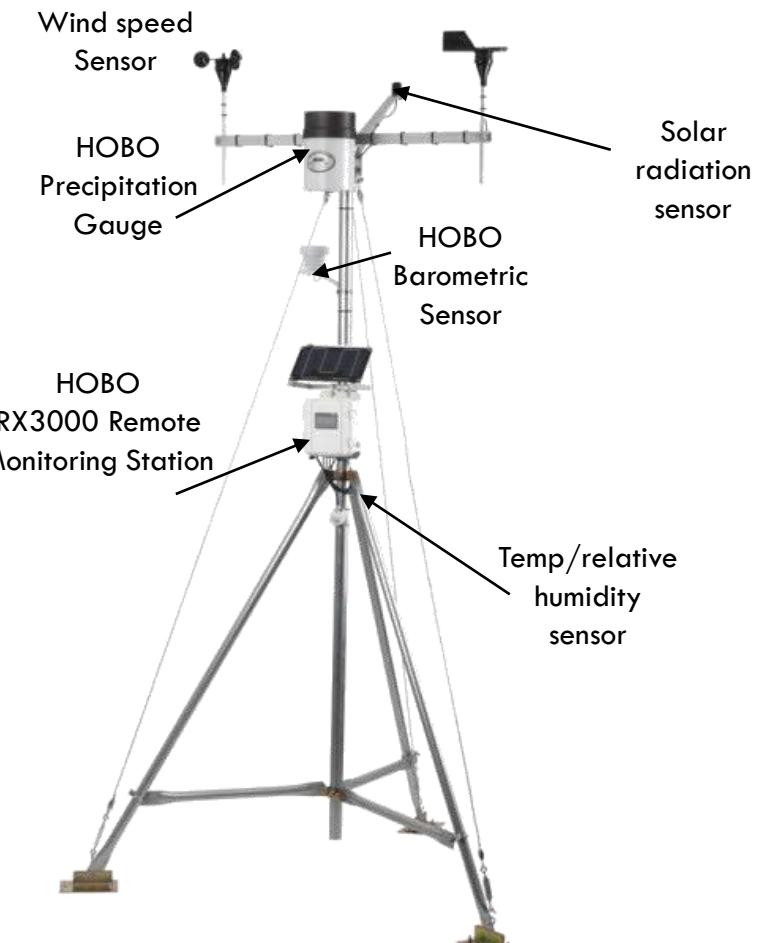


HOBO RX2101 Real-time Telemetry Logger



HOBO Vented Water Level Data Logger (30m)

Precipitation/Meteorological Data





Data Collection Equipment

YSI/NexSens Equipment:

- NexSens V2 and X2 data loggers (real-time telemetry)
- YSI EXO II Water Quality Sondes

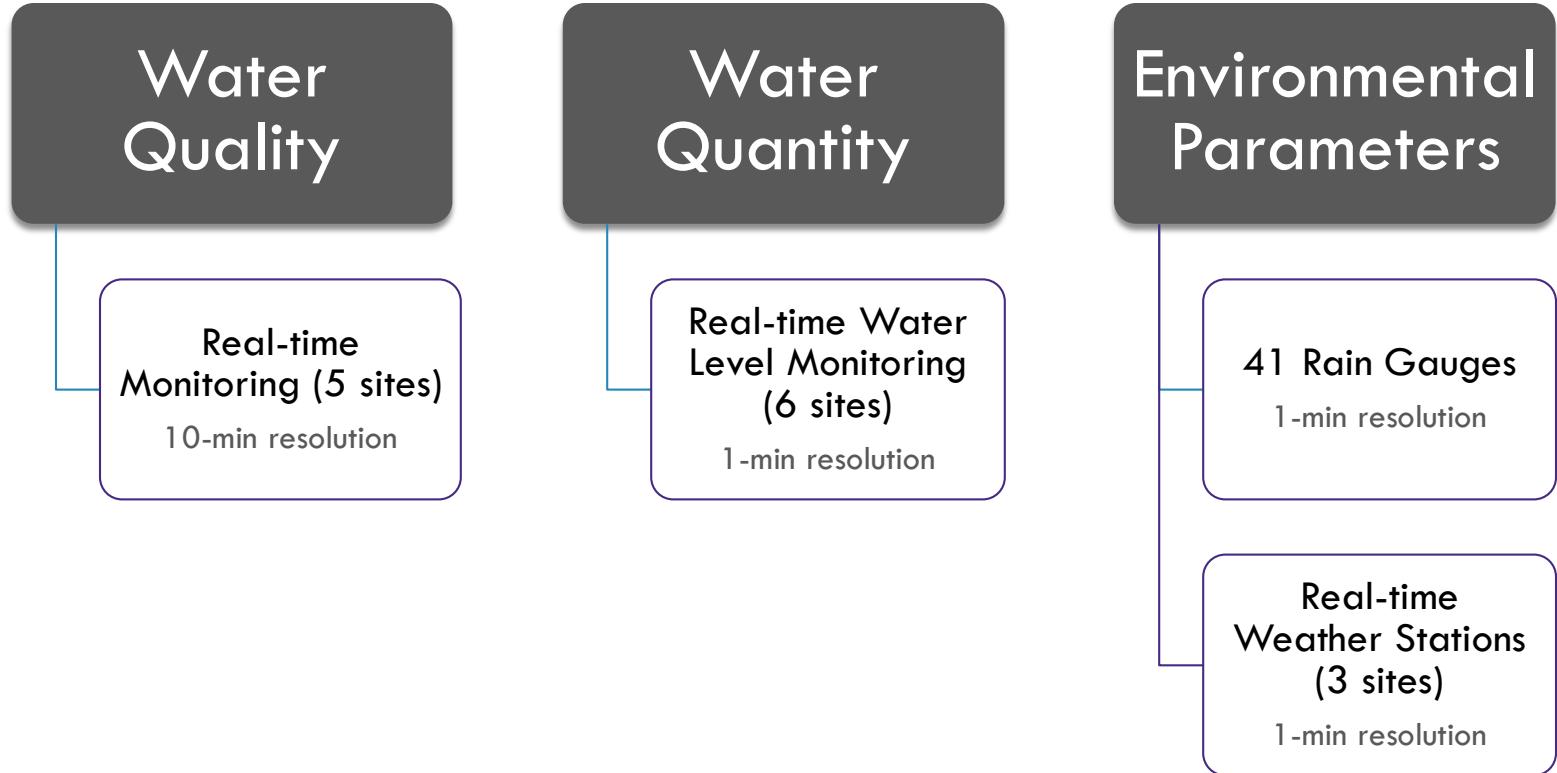


exo^{™2}





Monitoring Network in BG

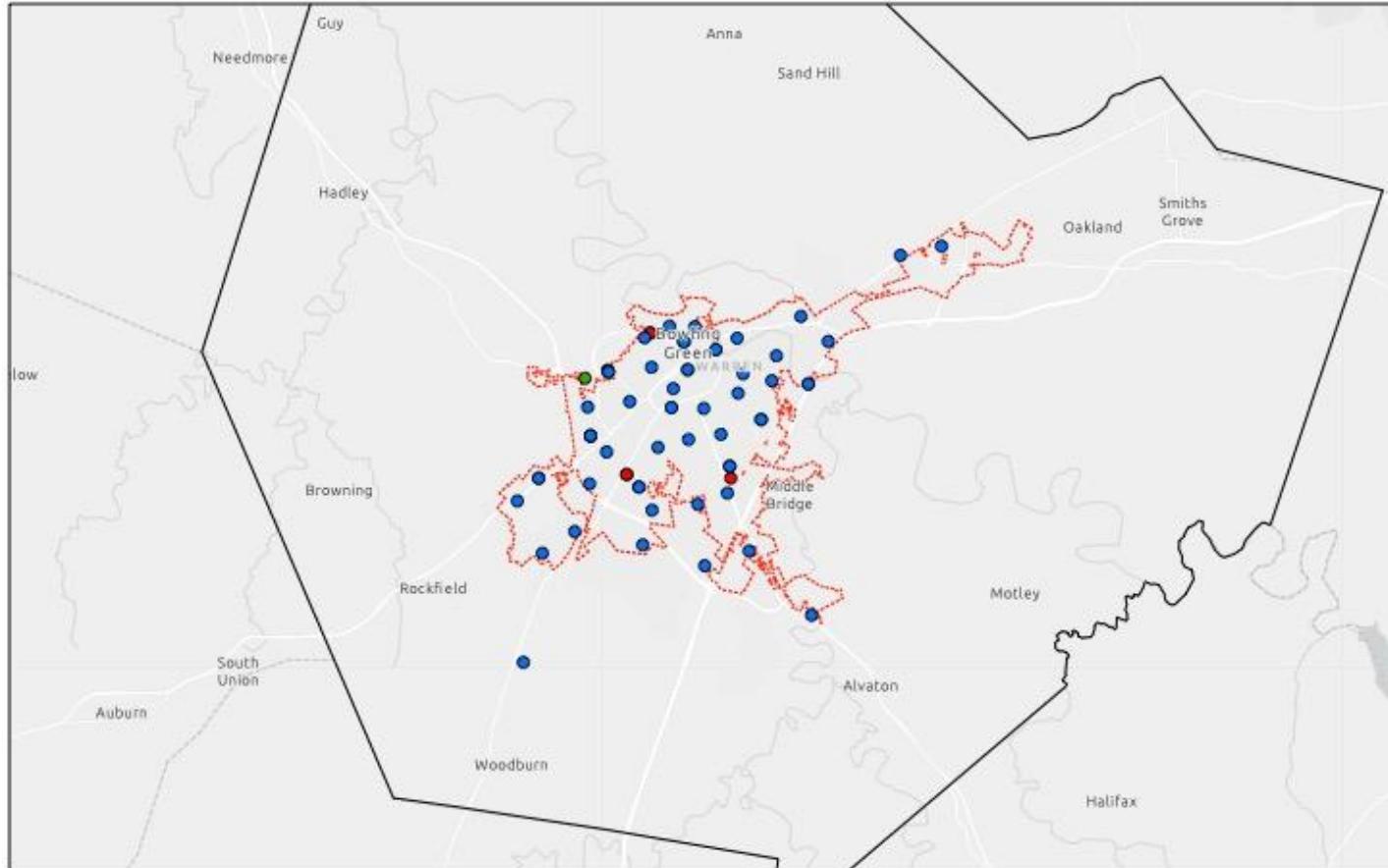


- Ingests over 100,000 data points per day via telemetry alone
- Used to supplement water quality data collection and future watershed management



Monitoring Sites in BG

Real-time Monitoring Network



3/31/2024

- Precipitation Stations
- Stormwater Precipitation Stations
- Water Quality Sites

- Gauging Stations
- Weather Stations

BG City Boundary

Warren County Boundary



1:288,895

0 2 4 8 mi
0 3 6 12 km

Esr. TomTom, Garmin, SafeGraph, METINASA, USGS, EPA, NPS, USDA, USFWS

Kara Brunst
WKU CHNGES

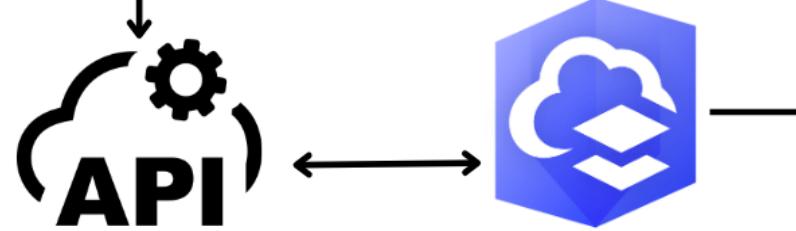
1. Set Up Data Collectors



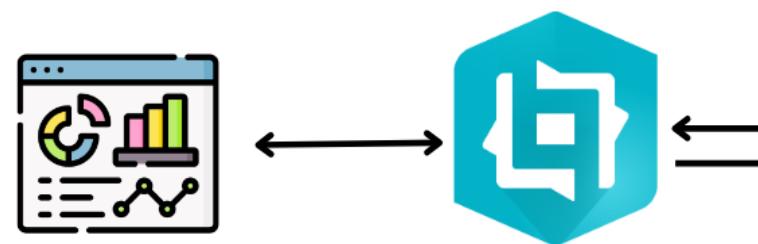
2. Store Data



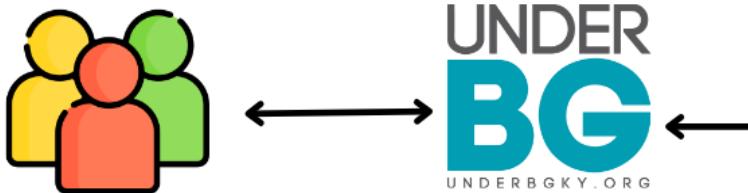
3. Connect Data to ArcOnline



4. Create Dashboard Interface



**5. Connect Dashboard to Website
for Public Use**





Dashboard Development

UNDER
BG
UNDERBG.ORG

WQData LIVE Jason Polk

Lost River Blue Hole Dashboard ▾

Last Contact Time
Lost River Blue Hole : X2-C-VZ4G-01353 ✓ ⚠
2024-03-31 00:01:56

Lost River Blue Hole Parameters

X2-C-VZ4G-01353

- _Date
- _Time
- Battery
- Cable Pwr
- pH
- Temperature
- Sp Cond
- ODO
- Turbidity FNU
- Depth

Lost River Blue Hole

D W M

15.05C 9.48mg/L

15C 9.36mg/L

14.95C 9.24mg/L

14.9C 9.12mg/L

14.85C 9mg/L

14.8C 8.88mg/L

14.75C 8.76mg/L

02:00 04:00 06:00 08:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 Mar 31

Legend: X2-C-VZ4G-01353 : pH, X2-C-VZ4G-01353 : Temperature (C), X2-C-VZ4G-01353 : Sp Cond (uS/cm), X2-C-VZ4G-01353 : ODO (mg/L), X2-C-VZ4G-01353 : Turbidity FNU

Date 33024 m/d/y ⚠
2024-03-31 00:00:00

Time 230100 hhmmss ⚠
2024-03-31 00:00:00

Battery 5.7 v ⚠
0 20 2024-03-31 00:00:00

Cable Pwr 12.3 v ⚠
2024-03-31 00:00:00

pH 7.14 ⚠
0 14 2024-03-31 00:00:00

Temperature 14.86 c ⚠
-5 50 2024-03-31 00:00:00

Sp Cond 476 uS/cm ⚠
0 200000 2024-03-31 00:00:00

ODO 8.93 mg/L ⚠
0 50 2024-03-31 00:00:00

Turbidity FNU -1.340 FNU ⚠
0 1000 2024-03-31 00:00:00

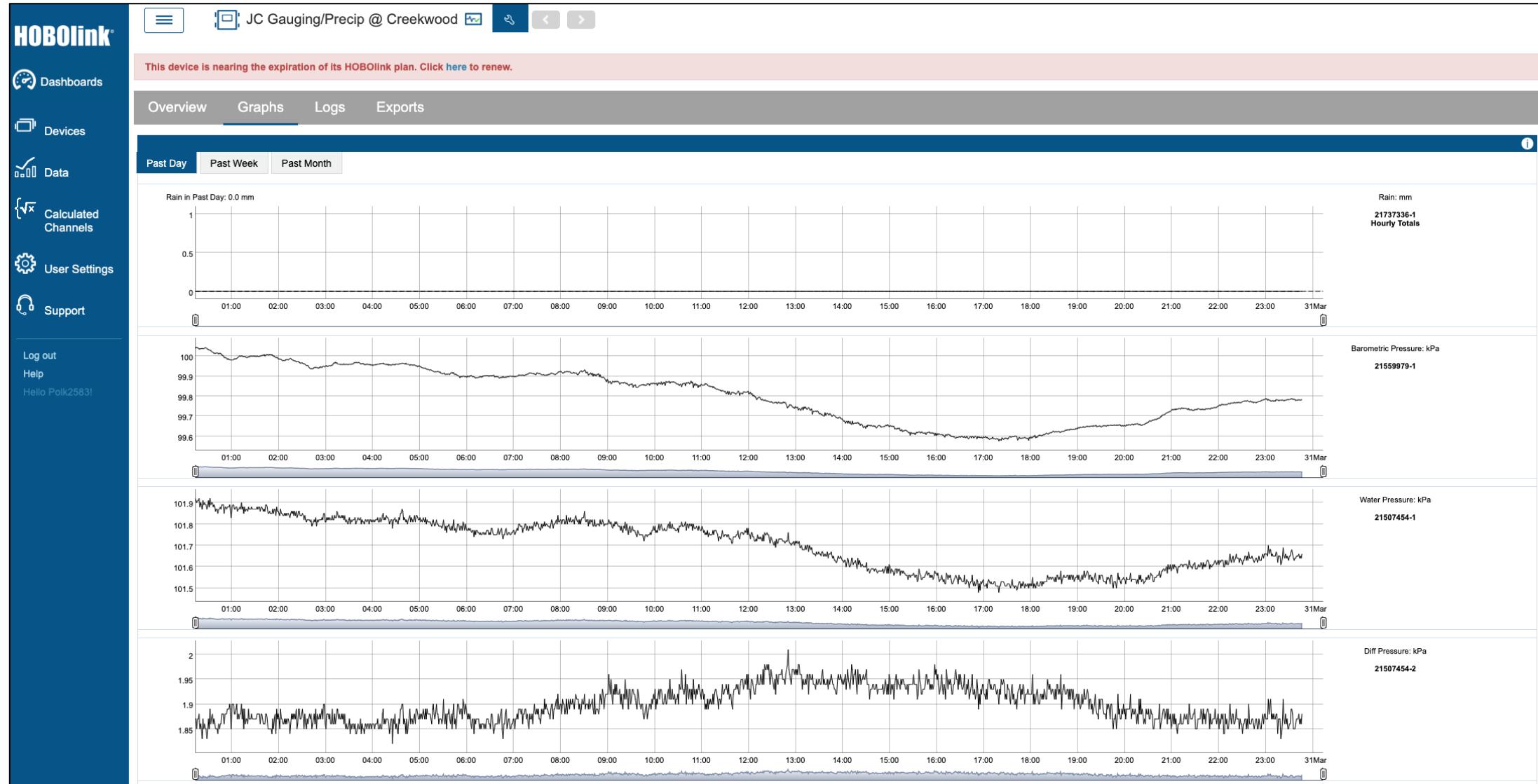
Depth 0.572 m ⚠
0 100 2024-03-31 00:00:00

Alarm Summary

#	Name	Type	Status	Event Time
1	LRR Amy Alarm	Alarm	Trigger	2024-03-23 16:00:00



Dashboard Development





Dashboard Development

☰ WQDATALive to AGOL Script (Lost River Rise Spring) 🛡 (saved)

Search Bell ☰ WKU CHNGES wkuchnges

Add Analysis Code snippets Files Tasks Snapshots Share Info

File Edit View Insert Cell Kernel Help Python 3 (ipykernel) ⌂ | ⌈

+ ❌ 📁 ⌄ ⌄ Run C ⌄ Markdown

```
FROM arcgis.features import FeatureLayer

# Setup for date range
end_date = datetime.now()
start_date = end_date - timedelta(days=30) # Adjust as needed

# Format dates for the API call
start_date_str = start_date.strftime('%Y-%m-%d %H:%M:%S')
end_date_str = end_date.strftime('%Y-%m-%d %H:%M:%S')

# Nxesens API details
apiKey = 'b56fe42929fe49cb915ae22b84074c1e'
deviceId = 2603 # Device ID as an integer

# Parameter IDs for Nxesens data
parameters = {
    "Temperature": 50582,
    "pH": 50581,
    "SpC": 50583,
    "ODO": 50584,
    "Turbidity": 50585,
    "Depth": 50586
}

# Function to get data from Nxesens API for all parameters
def get_nxesens_data(parameter_ids):
    data = {}
    for name, parameter_id in parameter_ids.items():
        api_url = f"https://www.wqdatalive.com/api/v1/devices/{deviceId}/parameters/{parameter_id}/data?apiKey={apiKey}&from={start_date_str}&to={end_date_str}"
        response = requests.get(api_url)
        print(f"Fetching {name}: {api_url}") # Diagnostic print
        if response.status_code == 200:
            response_json = response.json()
            if 'data' not in response_json:
```



Dashboard Development

- Changes per site
- Unique device ID and number for each parameter

```
# Nexsens API details
apiKey = 'b56fe42929fe49cb915ae22b84074c1e'
deviceId = 3396 # Device ID as an integer

# Parameter IDs for Nexsens data
parameters = {
    "Temperature": 79015,
    "pH": 79014,
    "SpC": 79016,
    "ODO": 79017,
    "Turbidity": 79018,
    "Depth": 79019
}
```



Dashboard Development

+ Add

Search Fields

Table Default Filters

Filters 1 - 9 of 9 Schema updated: Apr 2, 2024, 11:48 PM

<input type="checkbox"/> Display Name	Field Name	Type
<input type="checkbox"/> OBJECTID	OBJECTID	ObjectID
<input type="checkbox"/> pH (S.U.)	pH	Double
<input type="checkbox"/> Temperature (°C)	Temperature	Double
<input type="checkbox"/> Data/Time	Tyme	Date
<input type="checkbox"/> Dissolved Oxygen (mg/L)	ODO	Double
<input type="checkbox"/> Specific Conductivity (µS/cm)	SpC	Double
<input type="checkbox"/> Turbidity (NTU)	Turbidity	Double
<input type="checkbox"/> Depth (m)	Depth	Double
<input type="checkbox"/> Photos And Files	Photos And Files	Attachment

Type
Number
String
Date
ID
Attachment
Related Table

> Field Value Type

+



Dashboard Development

Home Gallery Map Scene Notebook Groups Content Organization



WKU CHNGES
wkuchnges

Lost River Rise Spring

Overview

Data

Visualization

Usage

Settings

Table Fields

Double-click a value in the table to change it.

Data updated: Apr 10, 2024, 8:01 PM

Lost River Rise (Features: 4312, Selected: 0)

pH (S.U.)	Temperature (°C)	Date/Time	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Depth (m)	Photos and Files
7.36	14.86	3/11/2024, 7:10 PM	9.43	460	1.27	0.43	(0) Add
7.39	14.86	3/11/2024, 7:20 PM	9.42	460	1.34	0.43	(0) Add
7.36	14.86	3/11/2024, 7:30 PM	9.43	460	1.36	0.43	(0) Add
7.36	14.86	3/11/2024, 7:40 PM	9.43	460	1.41	0.43	(0) Add
7.36	14.86	3/11/2024, 7:50 PM	9.42	460	1.2	0.43	(0) Add
7.36	14.86	3/11/2024, 8:00 PM	9.42	460	1.26	0.42	(0) Add
7.36	14.86	3/11/2024, 8:10 PM	9.43	460	1.25	0.42	(0) Add
7.37	14.85	3/11/2024, 8:20 PM	9.43	460	1.17	0.42	(0) Add
7.36	14.86	3/11/2024, 8:30 PM	9.42	460	1.17	0.42	(0) Add
7.37	14.86	3/11/2024, 8:40 PM	9.43	460	1.28	0.42	(0) Add
7.37	14.85	3/11/2024, 8:50 PM	9.44	460	1.27	0.42	(0) Add



Dashboard Development

Data Ingest Process:

- Limited number of data points due to size
- Python code designed to retrieve maximum number for each site, then clear the cache
- Data are appended to previous set to create continuous data stream

Home Gallery Map Scene Notebook Groups Content Organization WKU CHNGES

Jennings Creek Overview **Data** Visualization Usage Settings

Double-click a value in the table to change it. Data updated: Mar 31, 2024, 12:02 AM

Jennings Creek (Features: 4320, Selected: 0)							
pH (S.U.)	Temperature (°C)	Date/Time	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Depth (m)	Photos and Files
7.95	17.16	3/30/2024, 8:10 PM	7.45	547.00	46.70	-0.02	(0) Add
7.95	17.12	3/30/2024, 8:20 PM	7.29	547.00	46.81	-0.02	(0) Add
7.94	17.11	3/30/2024, 8:30 PM	7.19	547.00	47.79	-0.02	(0) Add
7.93	17.05	3/30/2024, 8:40 PM	6.95	547.00	47.15	-0.02	(0) Add
7.92	17.02	3/30/2024, 8:50 PM	6.82	547.00	46.71	-0.02	(0) Add
7.92	17.01	3/30/2024, 9:00 PM	6.68	547.00	46.25	-0.02	(0) Add
7.92	16.97	3/30/2024, 9:10 PM	6.58	548.00	46.04	-0.02	(0) Add
7.91	16.93	3/30/2024, 9:20 PM	6.41	548.00	46.08	-0.02	(0) Add
7.91	16.89	3/30/2024, 9:30 PM	6.38	549.00	45.76	-0.02	(0) Add
7.91	16.86	3/30/2024, 9:40 PM	6.33	550.00	45.13	-0.02	(0) Add
7.91	16.81	3/30/2024, 9:50 PM	6.26	550.00	44.73	-0.02	(0) Add
7.91	16.75	3/30/2024, 10:00 PM	6.24	551.00	44.52	-0.02	(0) Add
7.91	16.69	3/30/2024, 10:10 PM	6.22	552.00	44.06	-0.02	(0) Add
7.91	16.64	3/30/2024, 10:20 PM	6.21	553.00	44.22	-0.02	(0) Add
7.91	16.57	3/30/2024, 10:30 PM	6.21	554.00	44.02	-0.02	(0) Add
7.90	16.49	3/30/2024, 10:40 PM	5.99	555.00	44.36	-0.02	(0) Add
7.90	16.44	3/30/2024, 10:50 PM	5.93	554.00	54.50	-0.02	(0) Add
7.91	16.36	3/30/2024, 11:00 PM	5.92	554.00	51.84	-0.02	(0) Add
7.90	16.27	3/30/2024, 11:10 PM	5.71	555.00	57.23	-0.02	(0) Add
7.90	16.18	3/30/2024, 11:20 PM	5.70	555.00	53.58	-0.02	(0) Add
7.89	16.11	3/30/2024, 11:30 PM	5.66	556.00	49.58	-0.02	(0) Add
7.89	16.03	3/30/2024, 11:40 PM	5.60	556.00	48.07	-0.02	(0) Add
7.89	15.95	3/30/2024, 11:50 PM	5.59	556.00	45.49	-0.02	(0) Add
7.88	15.86	3/31/2024, 12:00 AM	5.51	557.00	45.51	-0.02	(0) Add



Dashboard Development

WQDATALive to AGOL Script (Lost River Rise Spring) 🖊 (saved)



WKU CHNGES
wkuchnges



Add Analysis Code snippets Files Tasks Snapshots Share Info

Save

File Edit View Insert Cell Kernel Help

Kernel error

Python 3 (ipykernel)

```
if add_payloads:
    add_result = feature_layer.edit_features(adds=add_payloads)
    print(f"Add Result: {add_result}")
else:
    print("No new features to add.")

except Exception as e:
    print(f"An error occurred: {e}")

Fetching Temperature: https://www.wqdatalive.com/api/v1/devices/2603/parameters/50582/data?apiKey=b56fe42929fe49cb915ae22b84074c1e&from=2024-03-11 18:01:01&to=2024-04-10 18:01:01
Fetching pH: https://www.wqdatalive.com/api/v1/devices/2603/parameters/50581/data?apiKey=b56fe42929fe49cb915ae22b84074c1e&from=2024-03-11 18:01:01&to=2024-04-10 18:01:01
Fetching SpC: https://www.wqdatalive.com/api/v1/devices/2603/parameters/50583/data?apiKey=b56fe42929fe49cb915ae22b84074c1e&from=2024-03-11 18:01:01&to=2024-04-10 18:01:01
Fetching ODO: https://www.wqdatalive.com/api/v1/devices/2603/parameters/50584/data?apiKey=b56fe42929fe49cb915ae22b84074c1e&from=2024-03-11 18:01:01&to=2024-04-10 18:01:01
Fetching Turbidity: https://www.wqdatalive.com/api/v1/devices/2603/parameters/50585/data?apiKey=b56fe42929fe49cb915ae22b84074c1e&from=2024-03-11 18:01:01&to=2024-04-10 18:01:01
Fetching Depth: https://www.wqdatalive.com/api/v1/devices/2603/parameters/50586/data?apiKey=b56fe42929fe49cb915ae22b84074c1e&from=2024-03-11 18:01:01&to=2024-04-10 18:01:01
Delete Result: {'deleteResults': [{'objectId': 92188, 'uniqueId': 92188, 'globalId': None, 'success': True}, {'objectId': 92189, 'uniqueId': 92189, 'globalId': None, 'success': True}, {'objectId': 92190, 'uniqueId': 92190, 'globalId': None, 'success': True}, {'objectId': 92191, 'uniqueId': 92191, 'globalId': None, 'success': True}, {'objectId': 92192, 'uniqueId': 92192, 'globalId': None, 'success': True}, {"objectId": 92193, "uniqueId": 92193, "globalId": None, "success": True}, {"objectId": 92194, "uniqueId": 92194, "globalId": None, "success": True}, {"objectId": 92195, "uniqueId": 92195, "globalId": None, "success": True}, {"objectId": 92196, "uniqueId": 92196, "globalId": None, "success": True}, {"objectId": 92197, "uniqueId": 92197, "globalId": None, "success": True}, {"objectId": 92198, "uniqueId": 92198, "globalId": None, "success": True}, {"objectId": 92199, "uniqueId": 92199, "globalId": None, "success": True}, {"objectId": 92200, "uniqueId": 92200, "globalId": None, "success": True}, {"objectId": 92201, "uniqueId": 92201, "globalId": None, "success": True}, {"objectId": 92202, "uniqueId": 92202, "globalId": None, "success": True}], "status": "Success"}
```

In []:



ArcGIS Experience Dashboard – in progress

UNDERBGKY HYDRONET

The UNDERBGKY HYDRONET is a research collaboration between the City of Bowling Green and Western Kentucky University's Center for Human GeoEnvironmental Studies.

Weather Stations

- Weather Stations (Snowflake icon)
- Precipitation Stations (Water drop icon)
- Gauging Stations (Wavy line icon)

KEEP IT CLEAN BOWLING GREEN

**UNDER
BG**
UNDERBGKY.ORG

New Spring Weather Station

Last update: 4 hours ago

Temperature | Barometric Pressure | Relative Humidity | Wind Speed | Solar Radiation

Barren River Precipitation Station

Last update: 4 hours ago

Barren River

Lost River Cave Weather Station

Last update: 4 hours ago

Temperature | Barometric Pressure | Relative Humidity | Wind Speed | Solar Radiation

Jennings Creek Gauging Station

Last update: 4 hours ago

Jennings Creek | Lost River Rise | Lost River Blue Hole | New Spring



Outcomes and Conclusions

- Unique combination of Esri ArcOnline with Python coding and proprietary API cloud software to develop real-time platform that integrates across hydrometeorologic datasets.
- Data dashboard will improve understanding and monitoring of water resources in karst areas.
- Facilitate collaboration between stakeholders in the community for effective water resource management strategies and hazard mitigation.

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Atmospheric Sciences



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CENTER FOR HUMAN GEOENVIRONMENTAL STUDIES

www.wkuchnges.com

**Gianna Claros –
Jack Galloway –
Jason Polk – jason.polk@wku.edu**