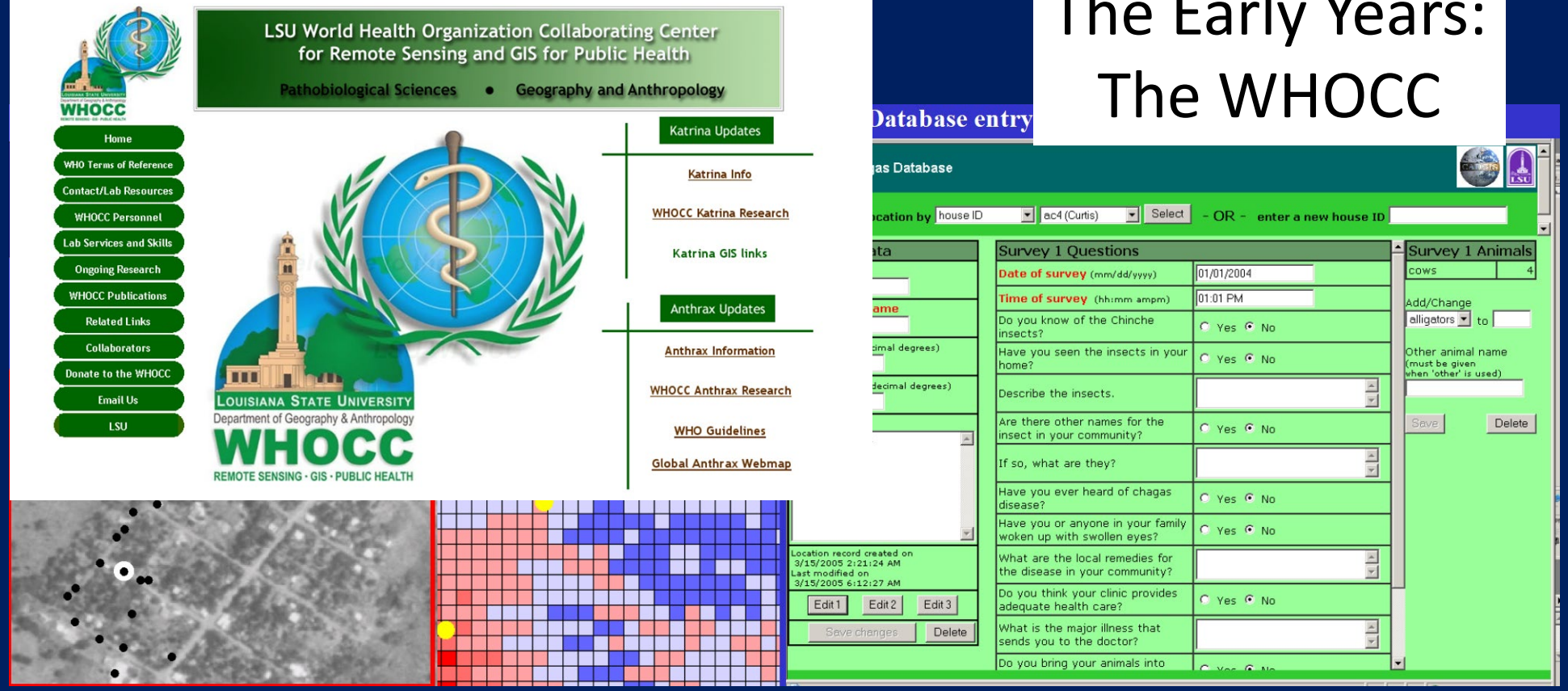
ADVENTURES IN SPATIAL DATA ANALYTICS: WORKING AT THE SCALE OF INTERVENTION / OPERATIONS

Andrew Curtis
&
Jayakrishnan Ajayakumar

GIS Health & Hazards Lab
Department of Population and Quantitative Health Sciences, School of Medicine
Case Western Reserve University

ajc321@case.edu
jxa421@case.edu

The Early Years: The WHOCC



T. dimidiata Embra (Female) adult collected in LaPalma, Mexico

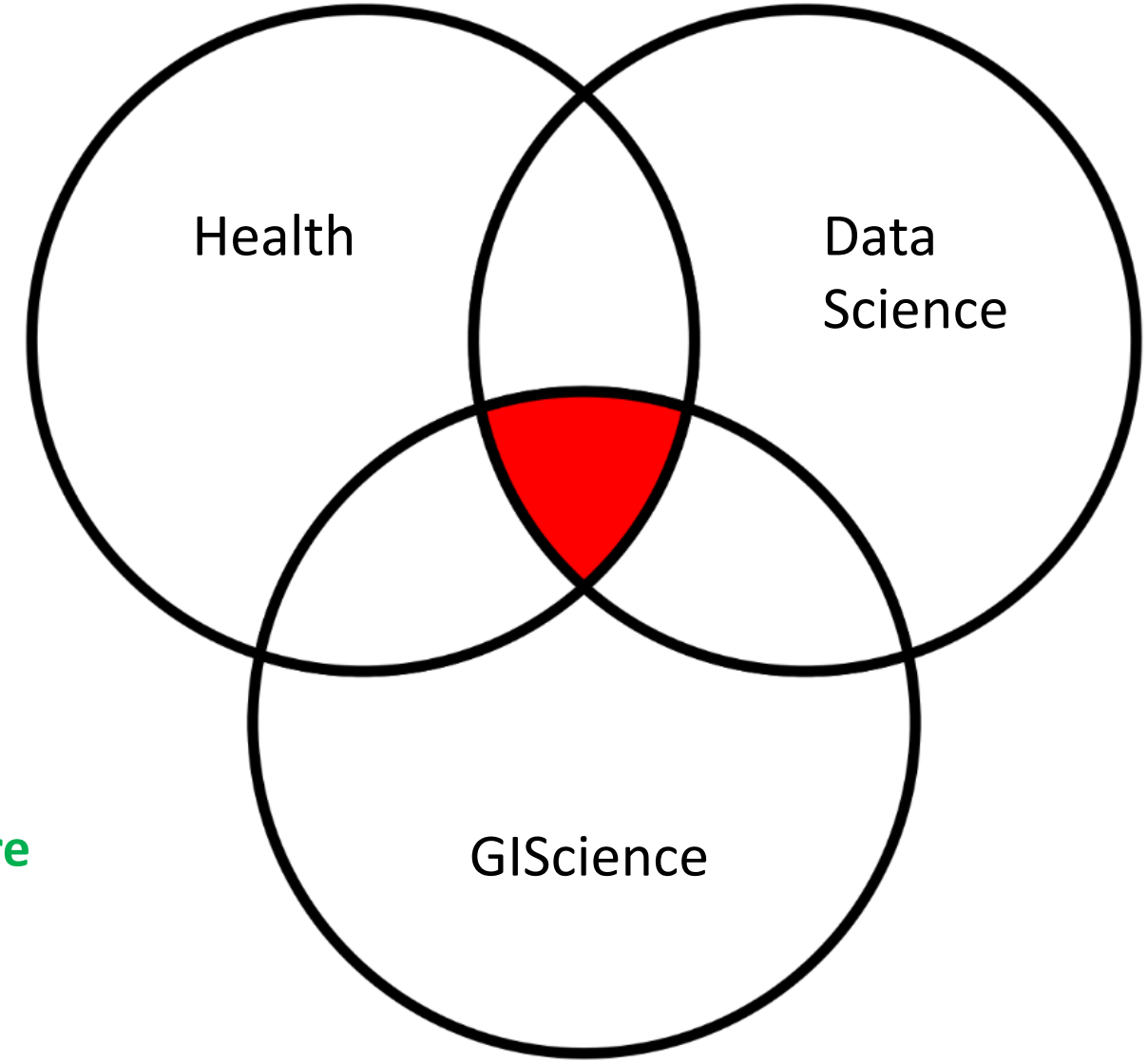
15 March 2005

Collecting Chagas Disease Data – The Interactive Web Map

The Tools Geoscientists Use

- Geospatial Technologies
- Geographic Information Systems
- Remote sensing
- Spatial Analysis
- Mobile Technologies
- Spatial Data Analytics (Information Science)

Spatial Data Analytics?



Computational Problem Solving

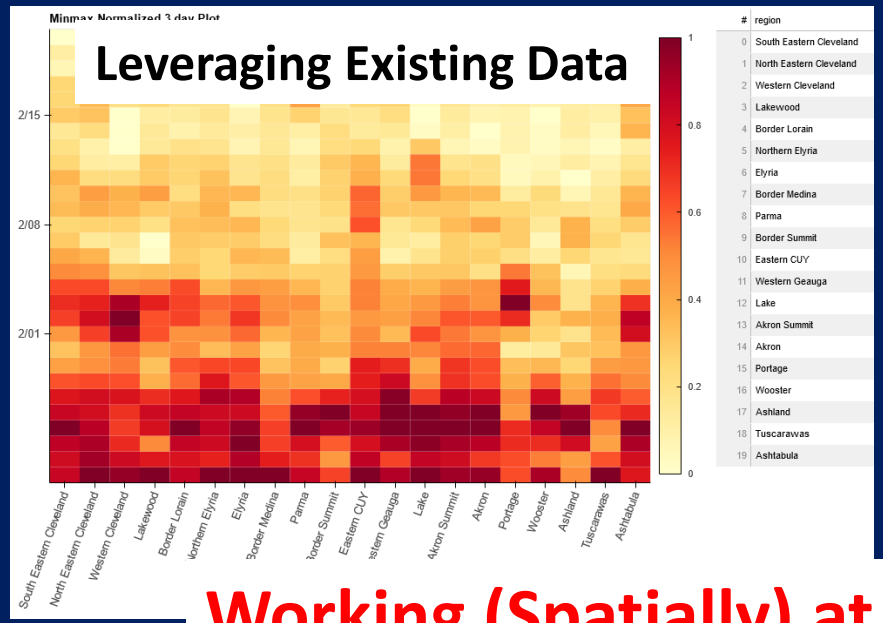
Developing Cyberinfrastructure

Applies Spatial Thinking

Develop novel end-to-end **Geospatial Data Collection Systems**

Develop geospatial **Cyberinfrastructure and Analytics** for Health Care Systems

Develop cutting edge **Machine Learning methodologies** for extracting Spatial Insights from **Big Geospatial Data**.



Leveraging Existing Data

#	region
0	South Eastern Cleveland
1	North Eastern Cleveland
2	Western Cleveland
3	Lakewood
4	Border Lorain
5	Northern Elyria
6	Elyria
7	Border Medina
8	Parma
9	Border Summit
10	Eastern CUY
11	Western Geauga
12	Lake
13	Akron Summit
14	Akron
15	Portage
16	Wooster
17	Ashland
18	Tuscarawas
19	Ashtabula

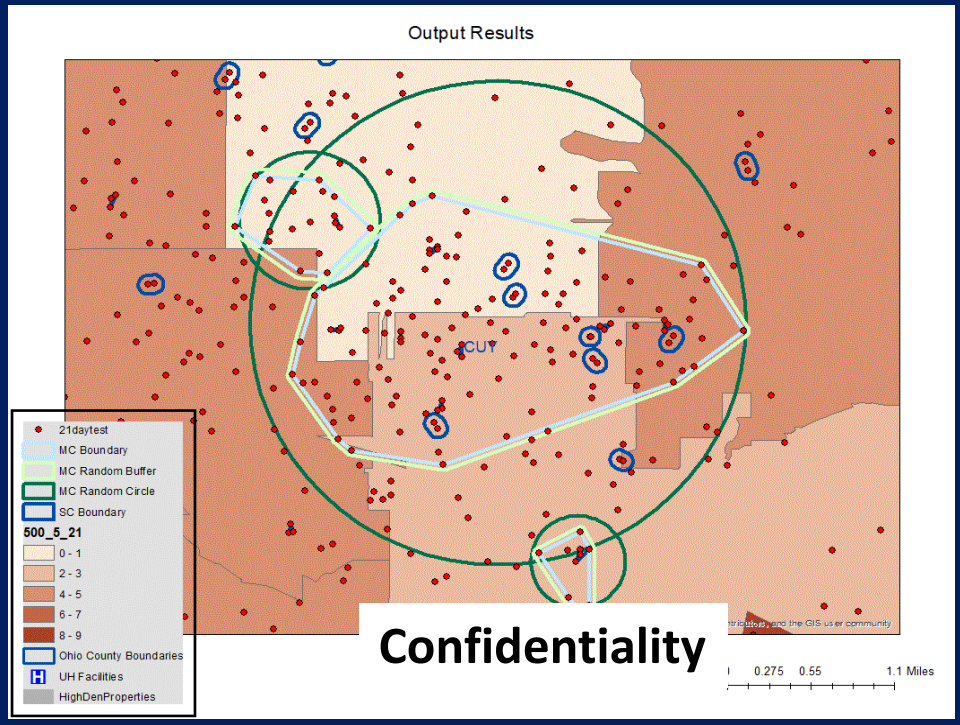
Operations / Near Real Time

Working (Spatially) at the Scale of Intervention

New Technologies : spatial video

- Off-the-shelf extreme sports / police camera
- Contains a built in GPS
- Drive a neighborhood with 2 to 4 cameras

Developing New Field Methods

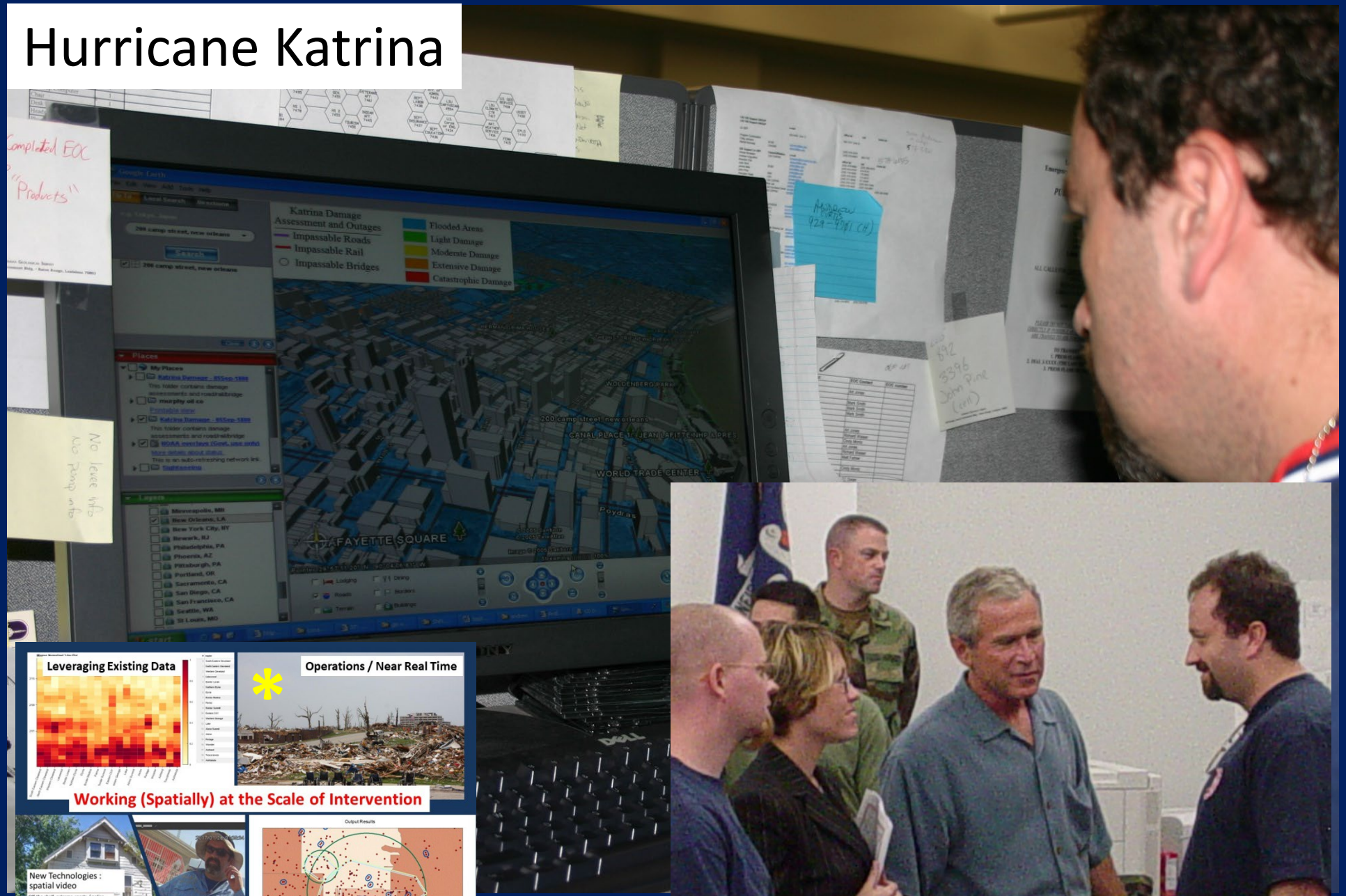


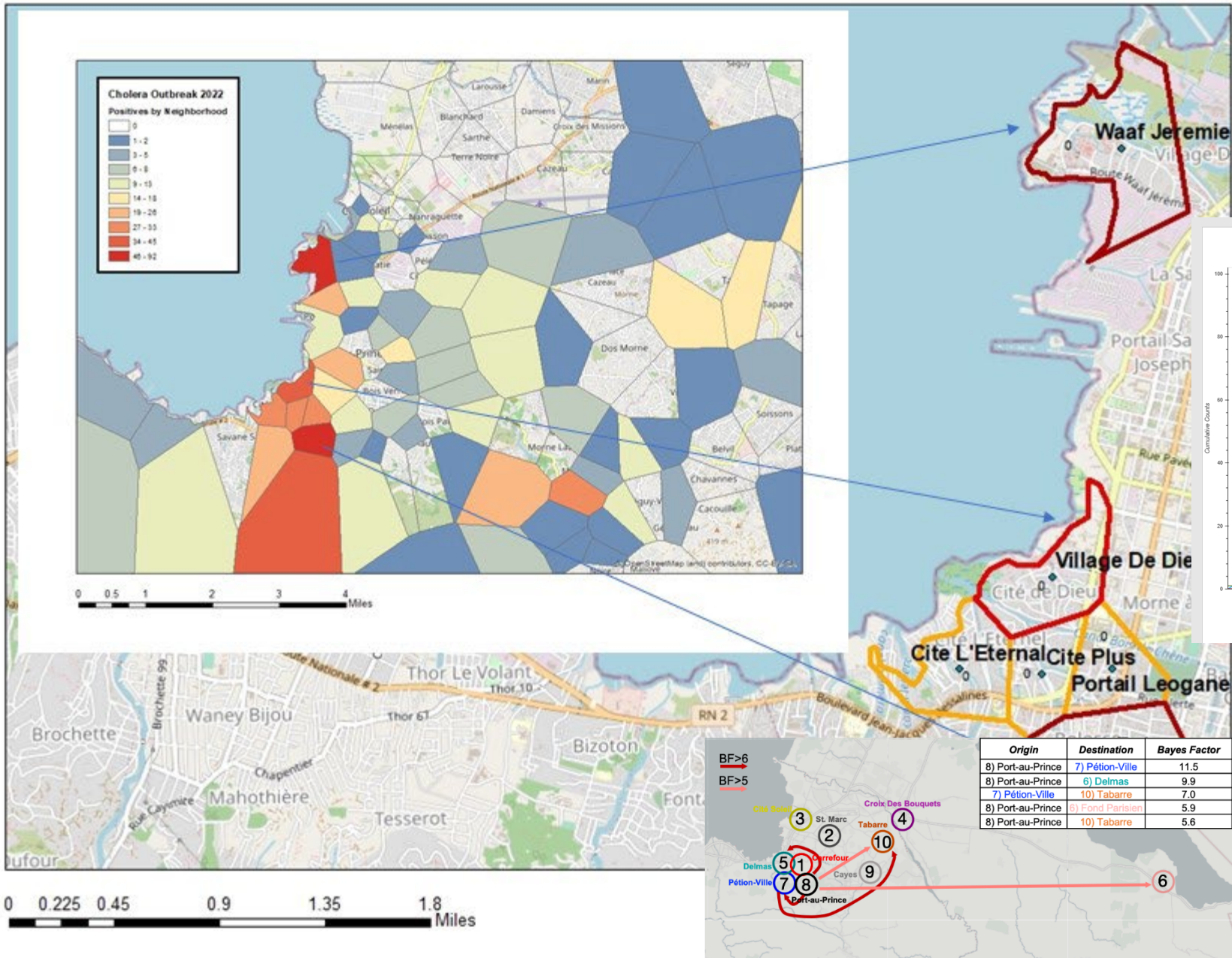
Confidentiality

Care home

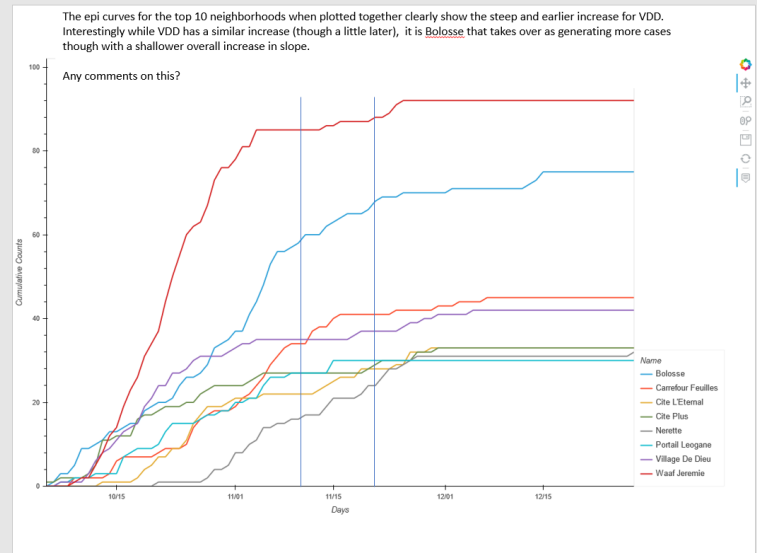
Congregate Buildings

Hurricane Katrina





Origin	Destination	Bayes Factor
8) Port-au-Prince	7) Pétion-Ville	11.5
8) Port-au-Prince	6) Delmas	9.9
7) Pétion-Ville	10) Tabarre	7.0
8) Port-au-Prince	6) Fond Parisien	5.9
8) Port-au-Prince	10) Tabarre	5.6



Haiti

Working with the Emerging Pathogens Institute, University of Florida

Covid19 -- Introducing a Syndromic Surveillance at the Scale of Intervention

In times of no disease –
indications of something
happening

In times of endemic disease –
Are we seeing flare ups /
outbreaks /
new variants?

In times of epidemic surge –
Where is there emergence and what impact will that have on the hospital system?

Collaboration: University Hospitals & The Cleveland Clinic

Spatial Response to COVID 19

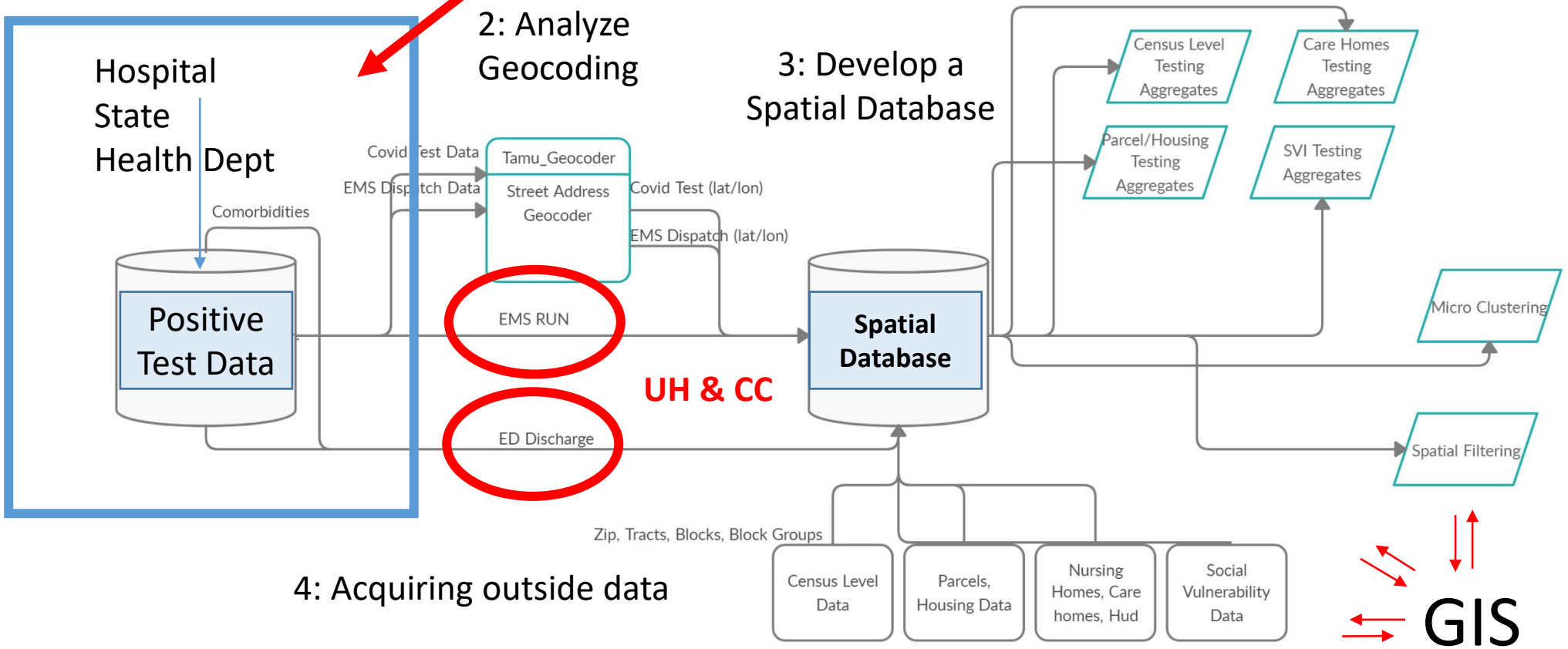
How do the various hospital databases talk to each other?

1: Understand & Map Data Flows

2: Analyze Geocoding

3: Develop a Spatial Database

5: Run automated queries



4: Acquiring outside data

7: Daily feedback to the team / health departments & hospitals (Dashboard)

6: Traditional mapping Analytical development

Spatial Response to COVID 19

A coordinate is not a coordinate is not a…

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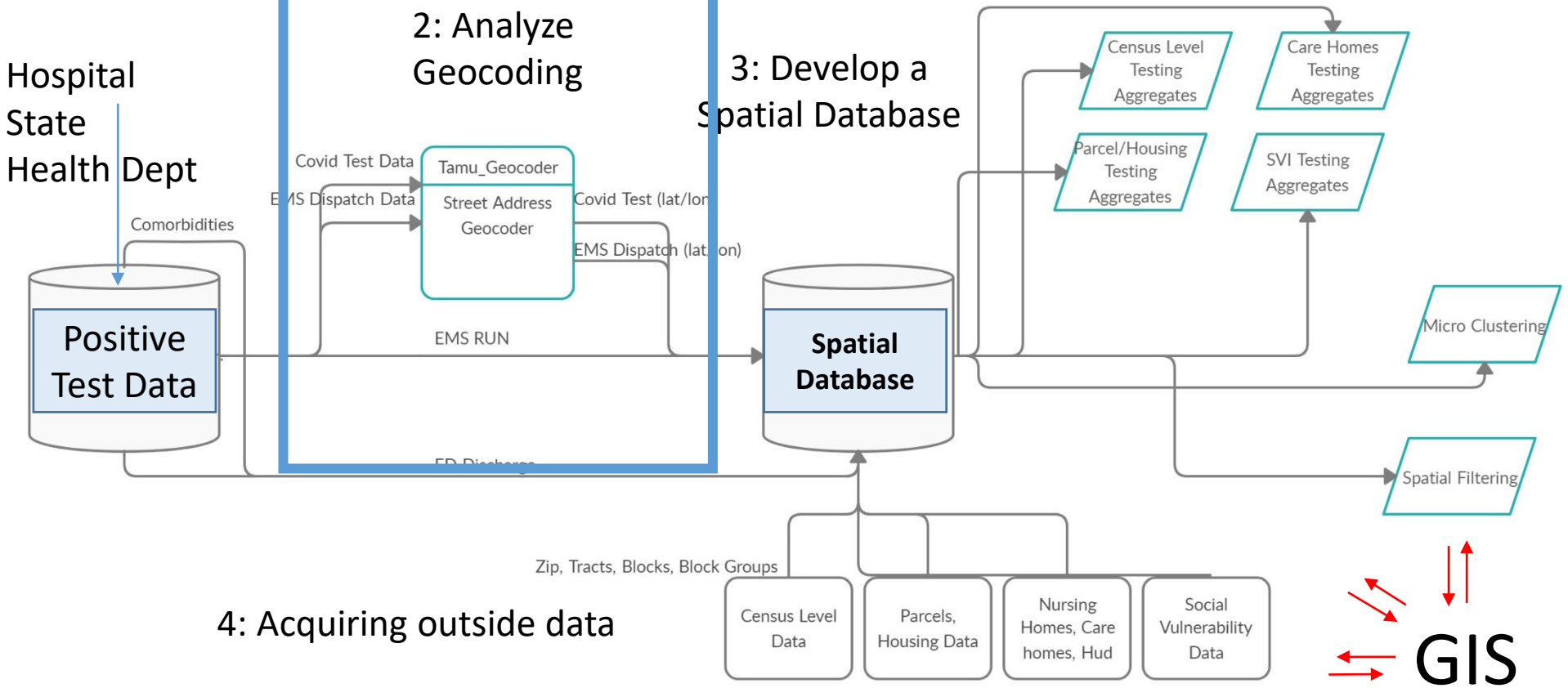

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GIS

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Analytical development

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Spatial Response to COVID 19

The key to effective operations is automation

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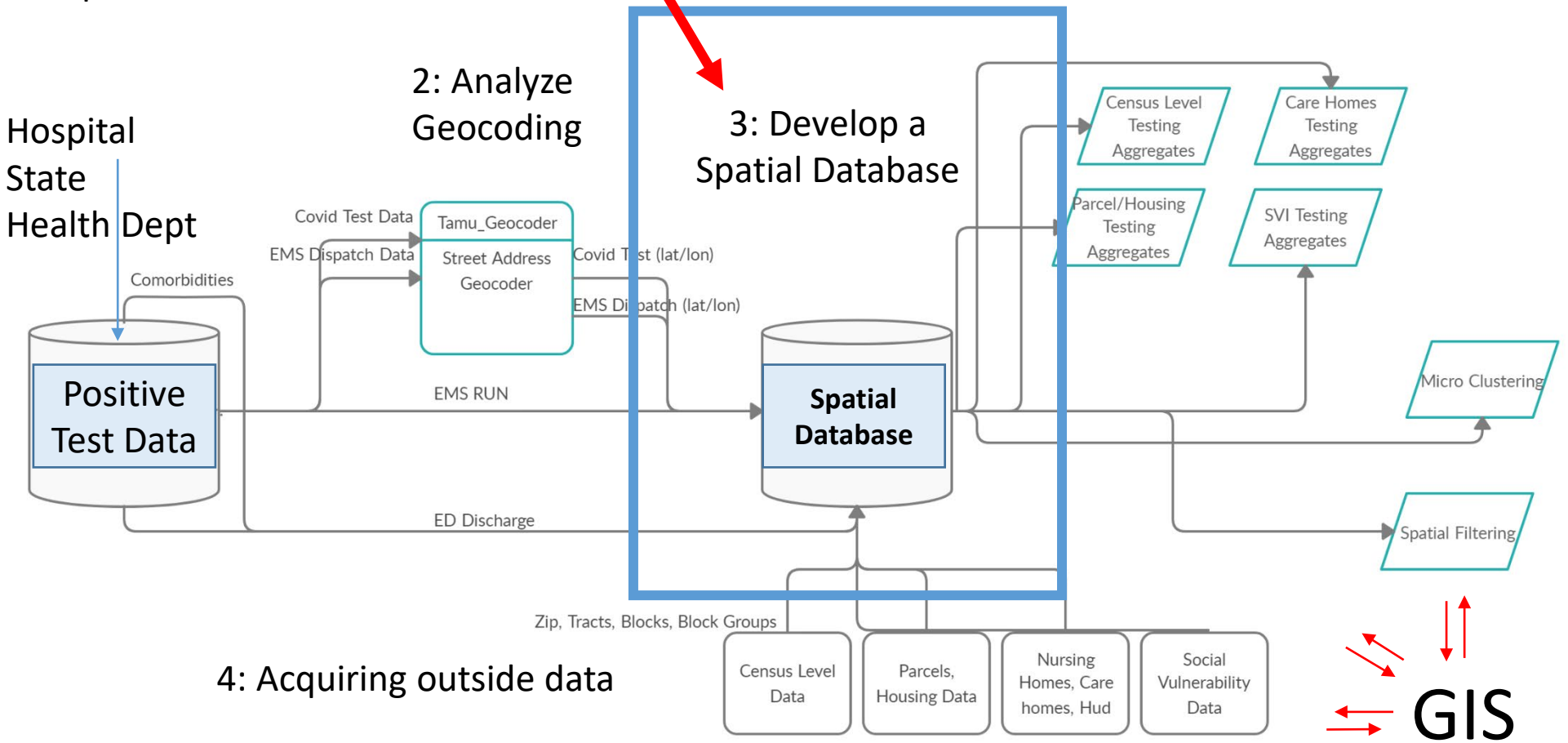
5: Run automated queries



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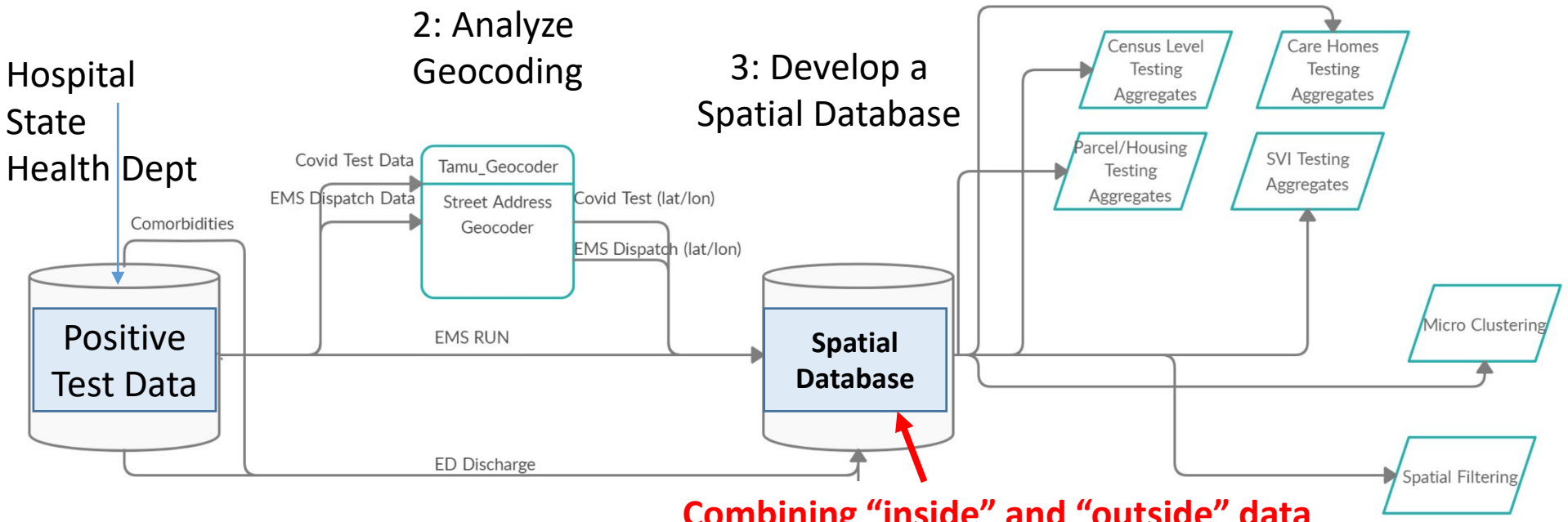
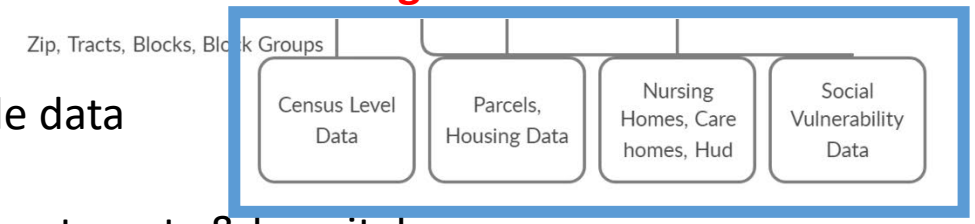


Combining "inside" and "outside" data



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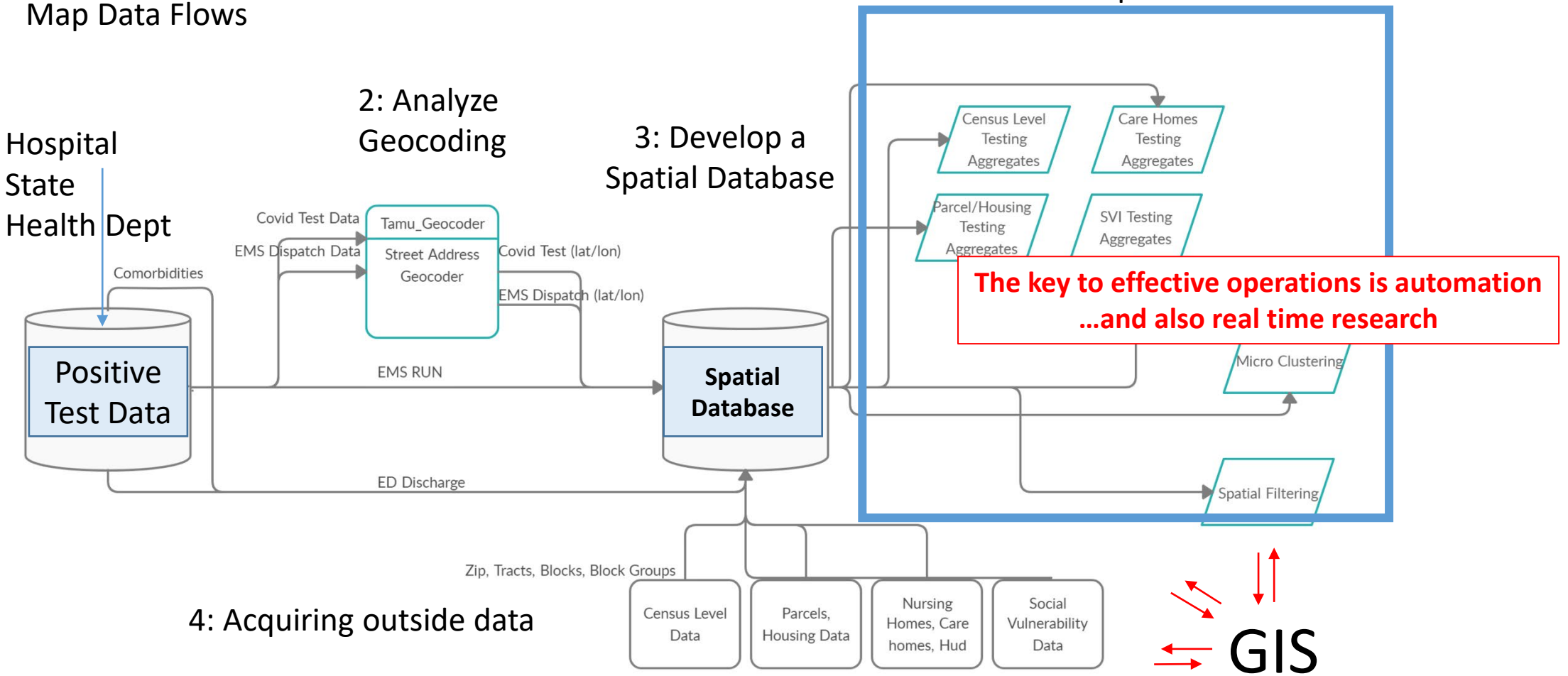

The key to effective operations is automation …and also real time research

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Spatial Response to COVID 19

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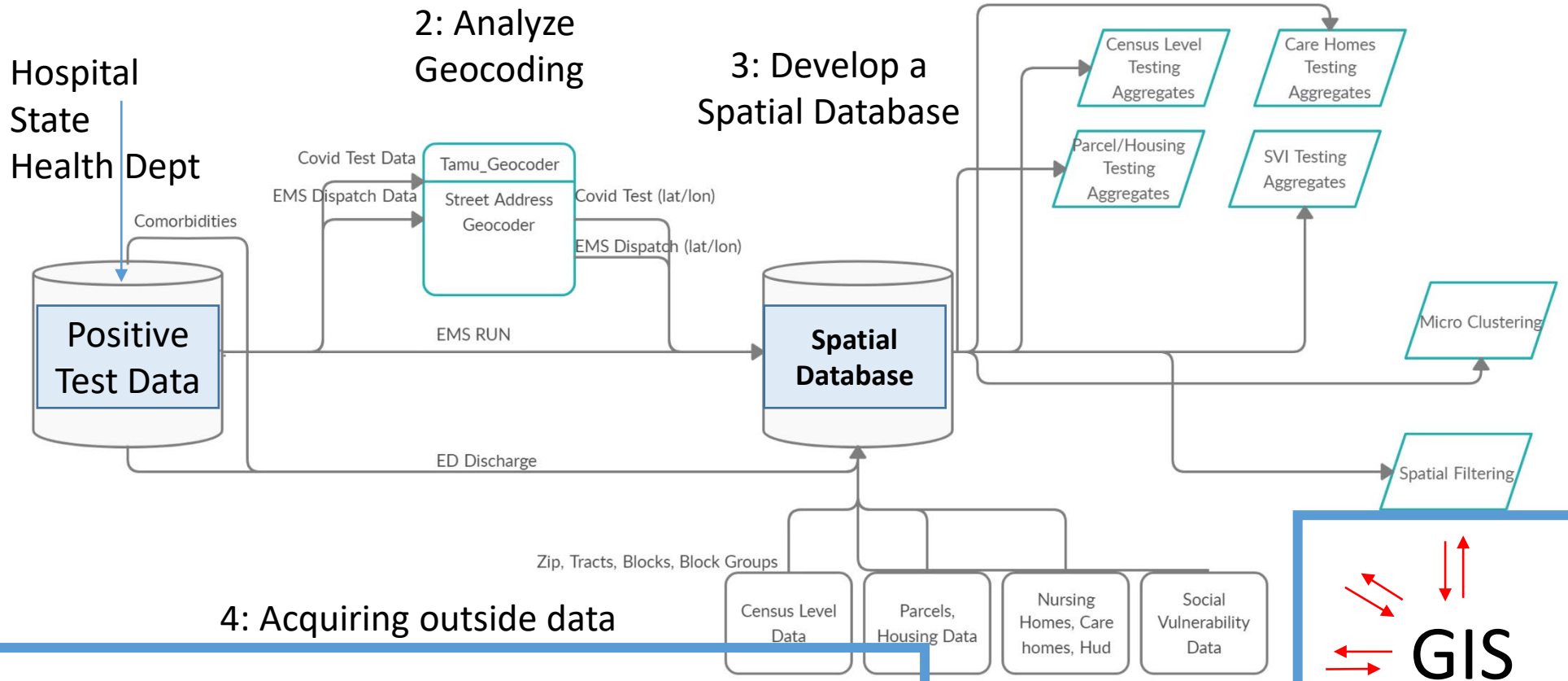

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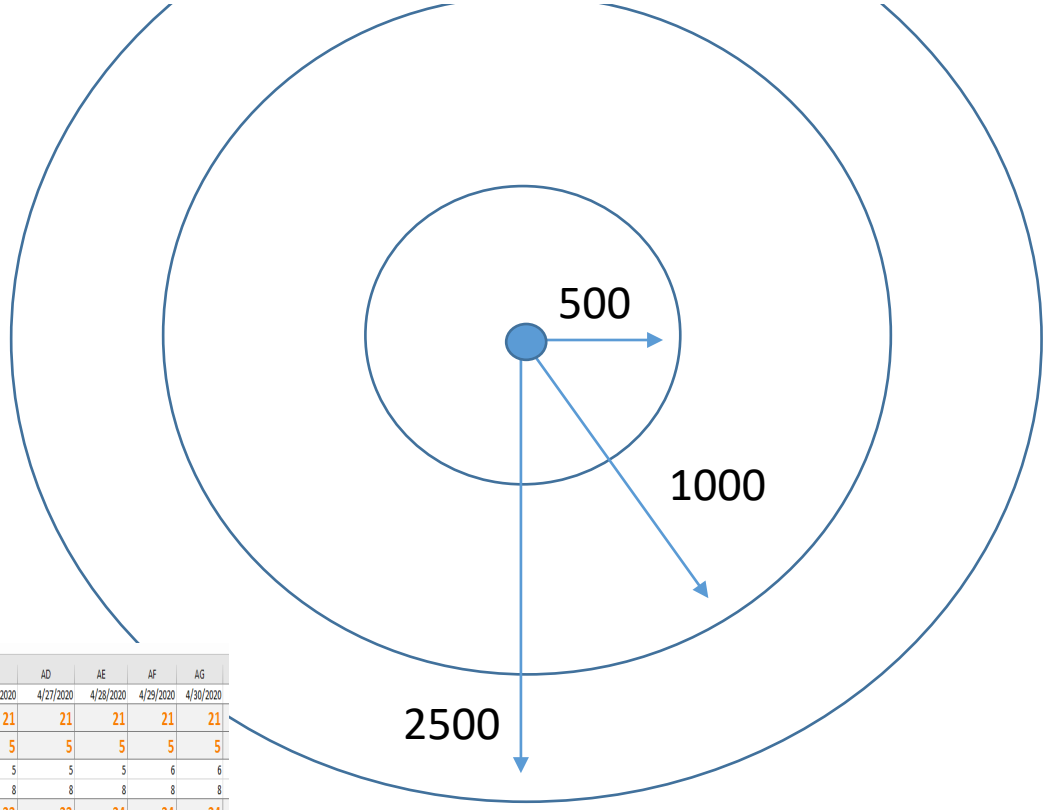
Automatic Monitoring of Key Buildings

- Care Homes
- Public Housing
- Churches
- Correctional facilities
- Schools
- Universities
- Hospitals

Ongoing Surveillance



G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
4/4/2020	4/5/2020	4/6/2020	4/7/2020	4/8/2020	4/9/2020	########	########	########	########	########	########	########	########	########	########	########	########	########	########	########	4/25/2020	4/26/2020	4/27/2020	4/28/2020	4/29/2020	4/30/2020
0	6	8	8	8	8	8	10	16	20	20	20	20	20	20	20	21	21	21	21	21	21	21	21	21	21	21
0	0	0	0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0	0	0	0	0	0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6
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0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	5	5	7	7

Situation on

3 day super neighborhood 20 in 1000m (# elderly)

3 day neighborhood 10 in 1000m (positivity %)

Care home

Congregate Buildings

Three goals:
Where will the hospital system be stressed?
Do we need to send in intercept teams?
Where should we prioritize vaccine outreach?

0 0.5 1 2 Miles

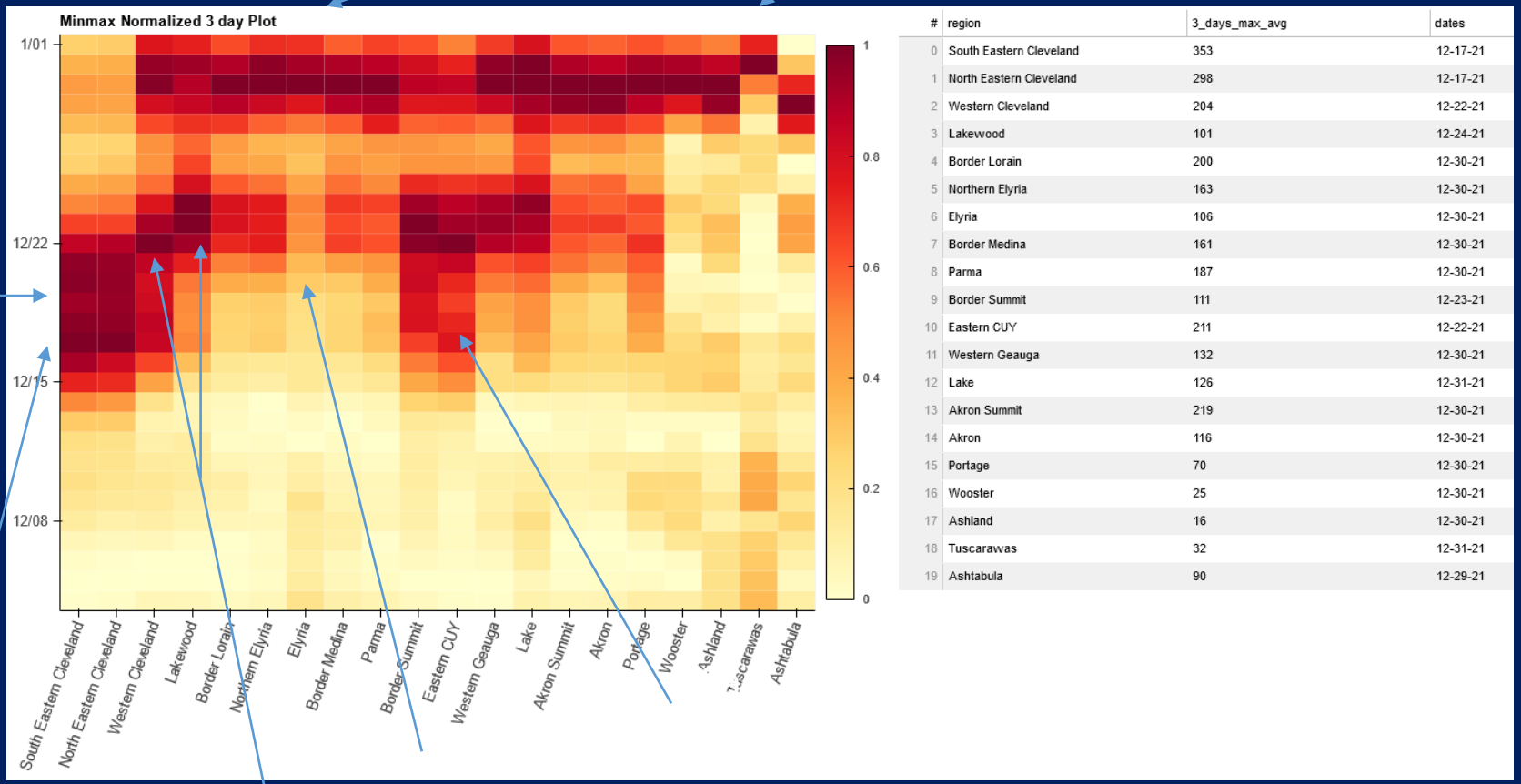
Clusters are modified to preserve confidentiality

We have a problem Houston / Jim

More rural counties not Influenced by CUY have a different pattern

Short rise and crest

Second peaks (not in crescent)

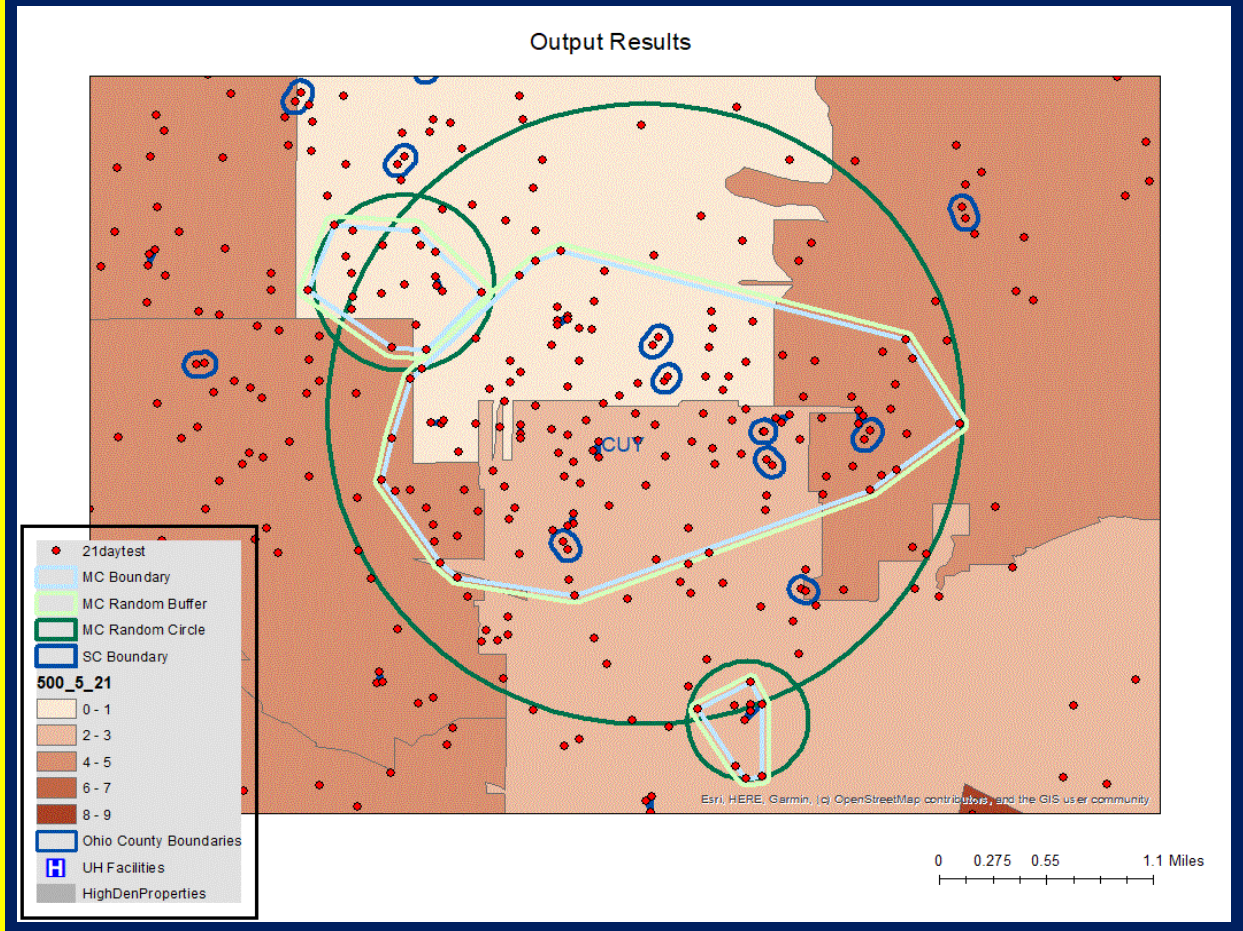


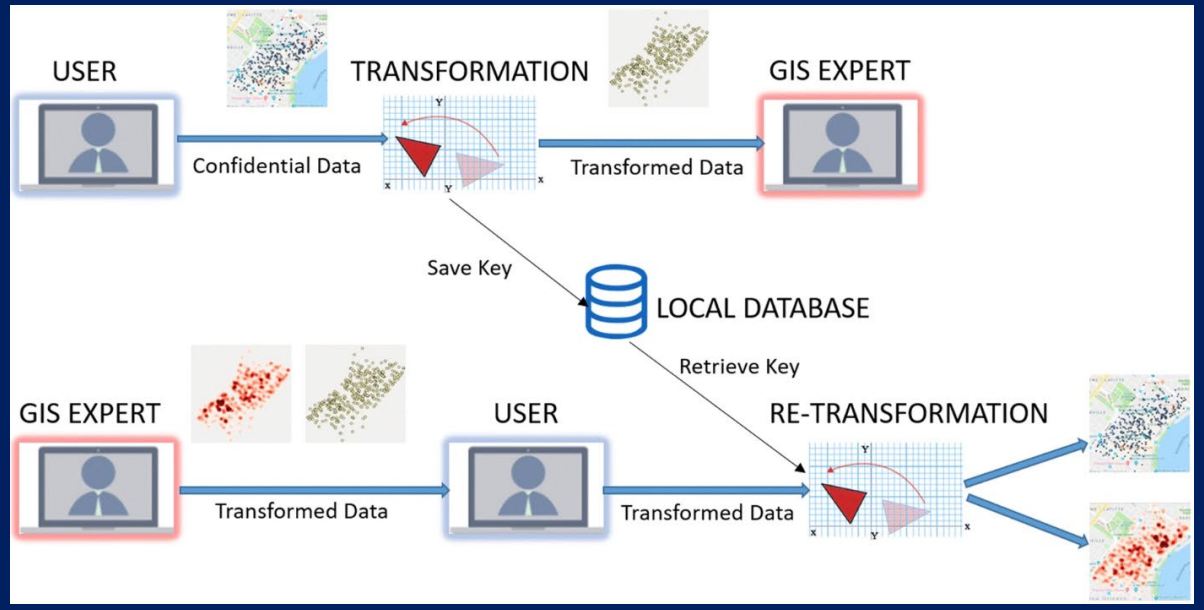
#	region	3_days_max_avg	dates
0	South Eastern Cleveland	353	12-17-21
1	North Eastern Cleveland	298	12-17-21
2	Western Cleveland	204	12-22-21
3	Lakewood	101	12-24-21
4	Border Lorain	200	12-30-21
5	Northern Elyria	163	12-30-21
6	Elyria	106	12-30-21
7	Border Medina	161	12-30-21
8	Parma	187	12-30-21
9	Border Summit	111	12-23-21
10	Eastern CUY	211	12-22-21
11	Western Geauga	132	12-30-21
12	Lake	126	12-31-21
13	Akron Summit	219	12-30-21
14	Akron	116	12-30-21
15	Portage	70	12-30-21
16	Wooster	25	12-30-21
17	Ashland	16	12-30-21
18	Tuscarawas	32	12-31-21
19	Ashtabula	90	12-29-21

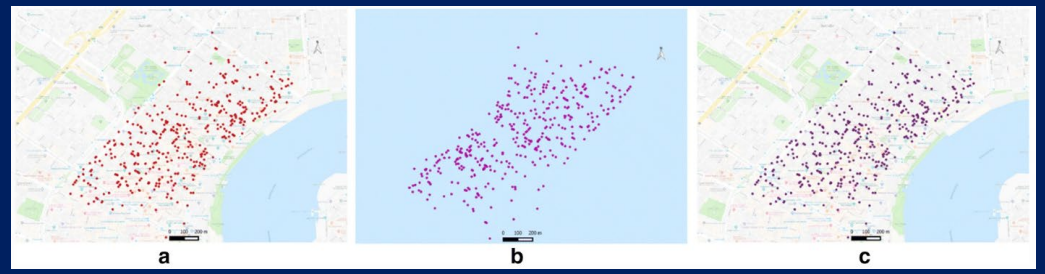
Beginning of the surge (crescent)

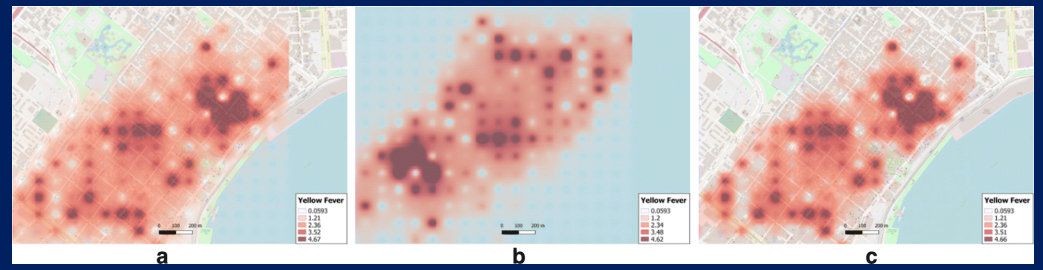
Elyria is late to this pattern but then dramatic rise

Western Cleveland & Lakewood next (that order)

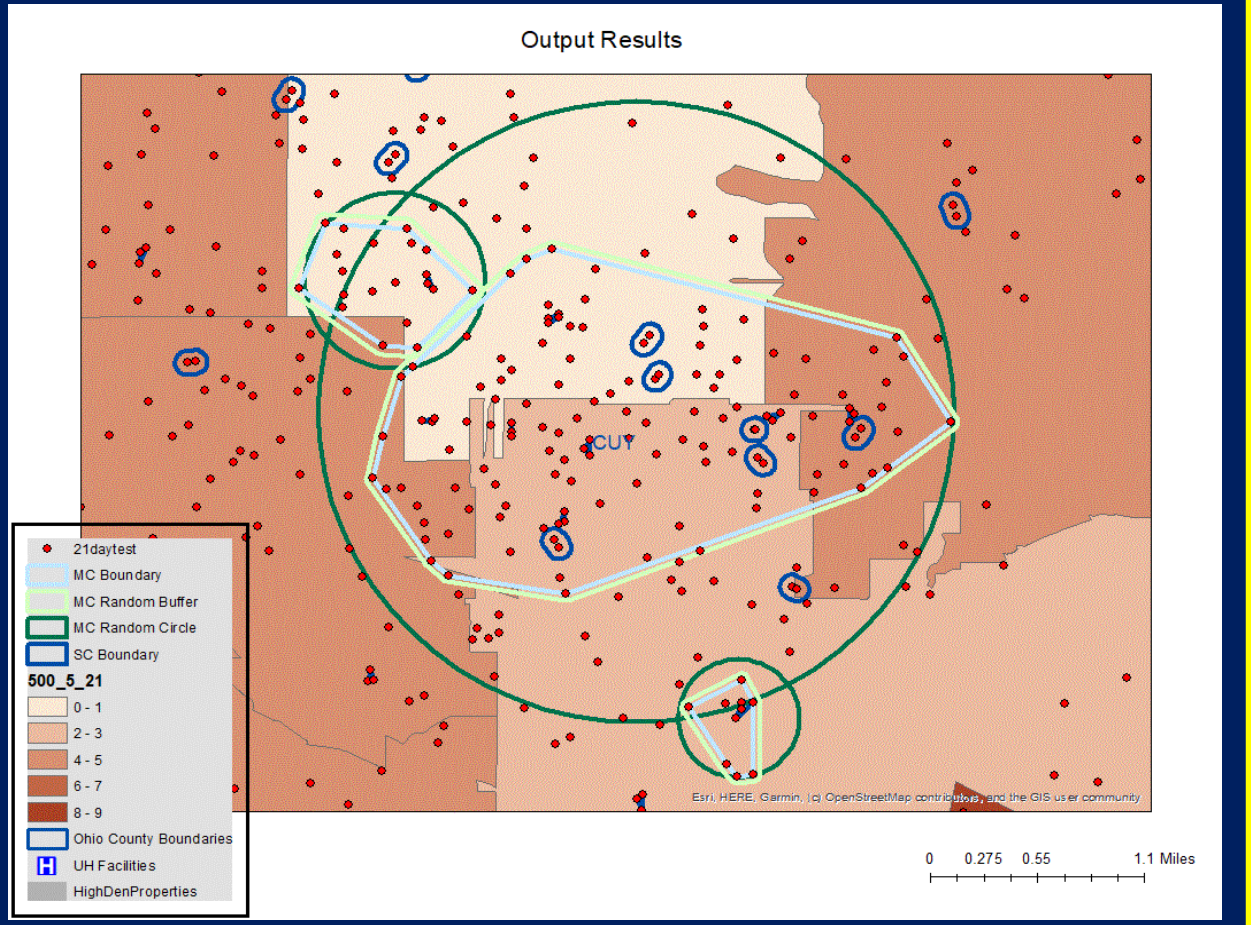


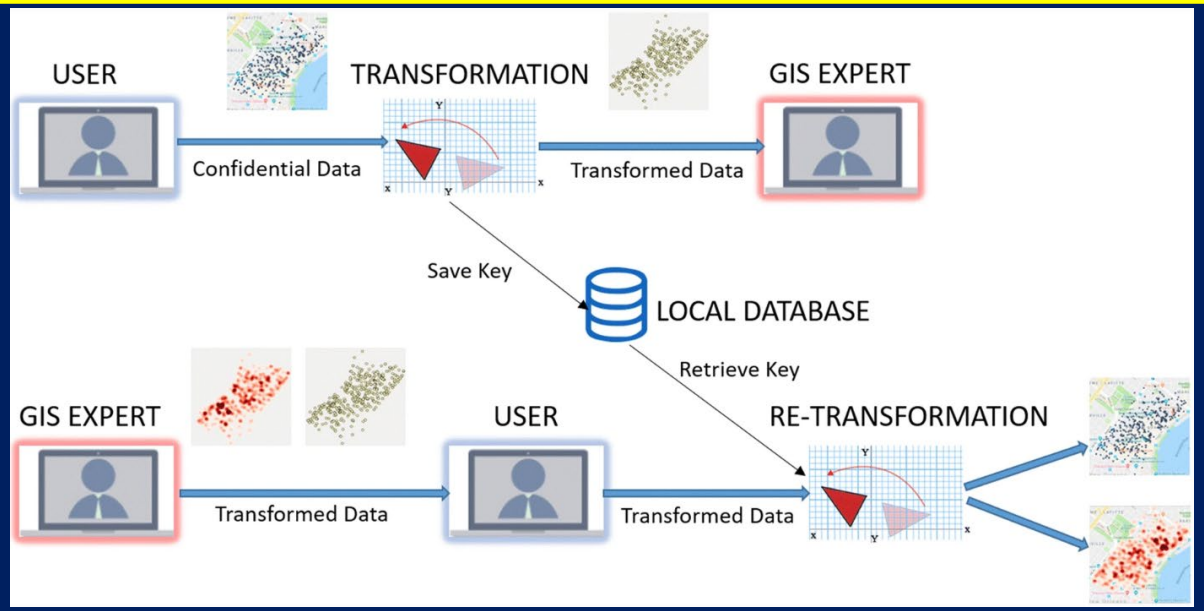


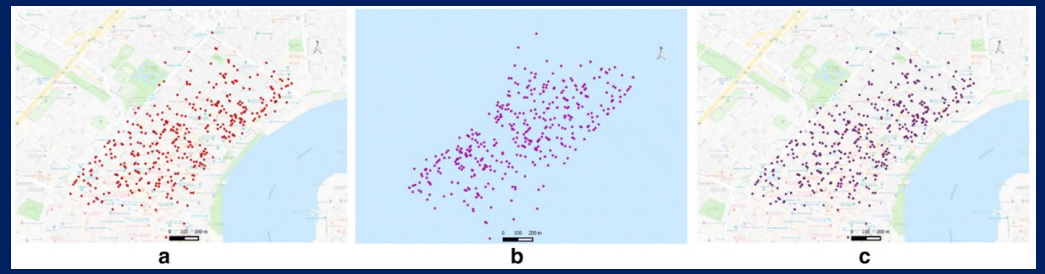


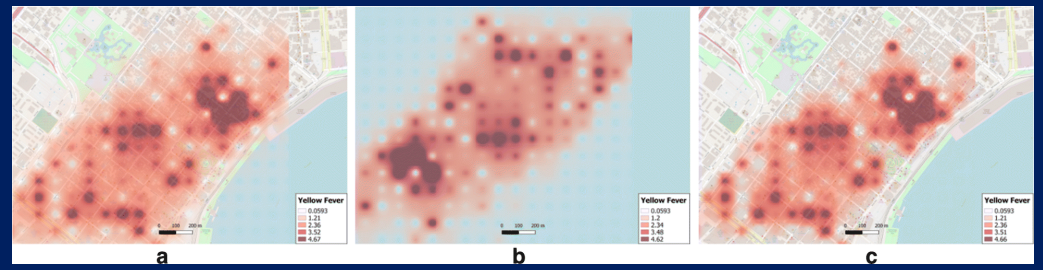


- Developing Spatial Privacy preserving applications for data guardians





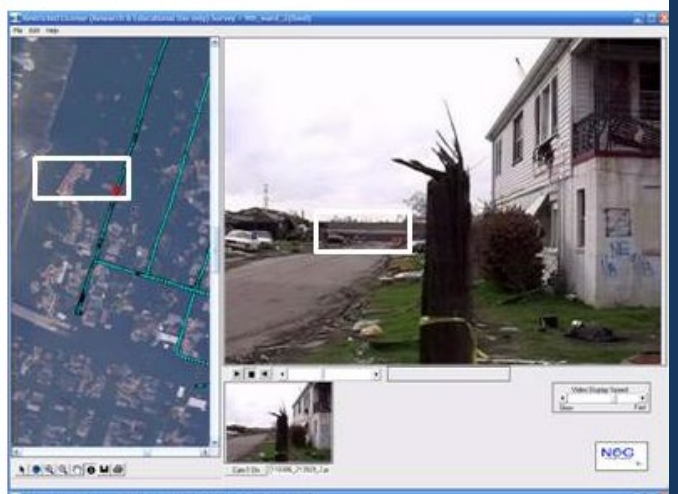


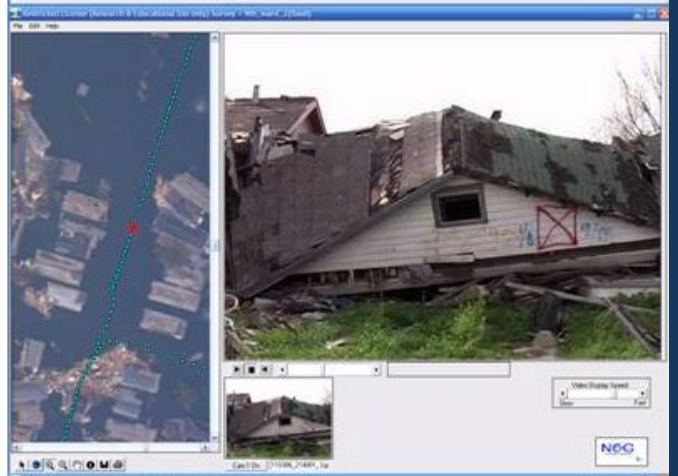


- Developing Spatial Privacy preserving applications for data guardians

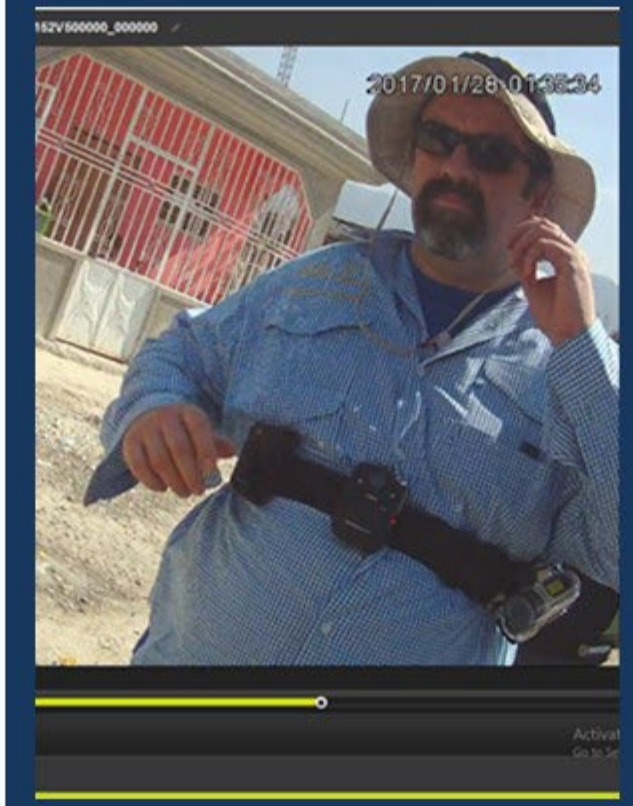
What is a spatial video?

A spatially encoded video which “stamps” each video frame with a coordinate, which then becomes a digitizing source.

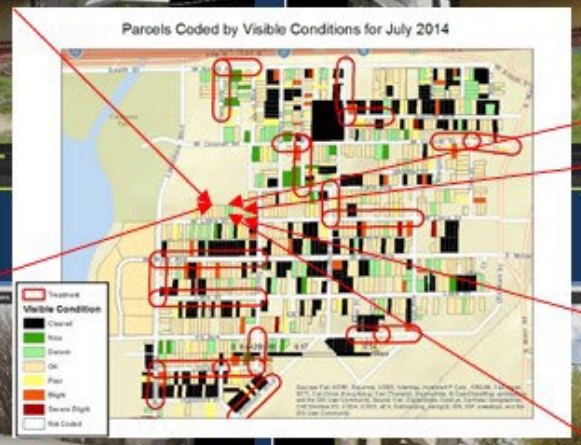




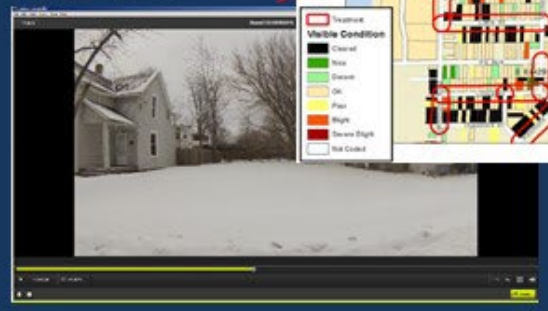
- By Car
- By Hand
- By Boat
- By Bike
- By Wheelchair



4/21/14



10/28/14

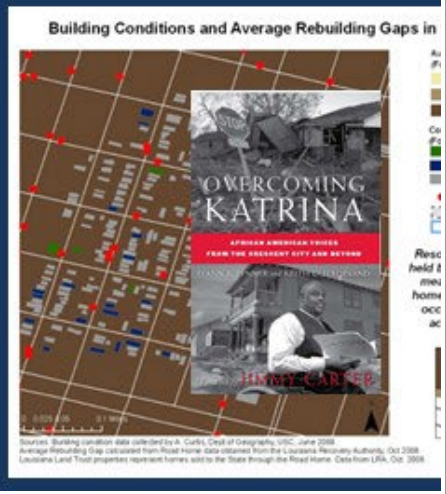


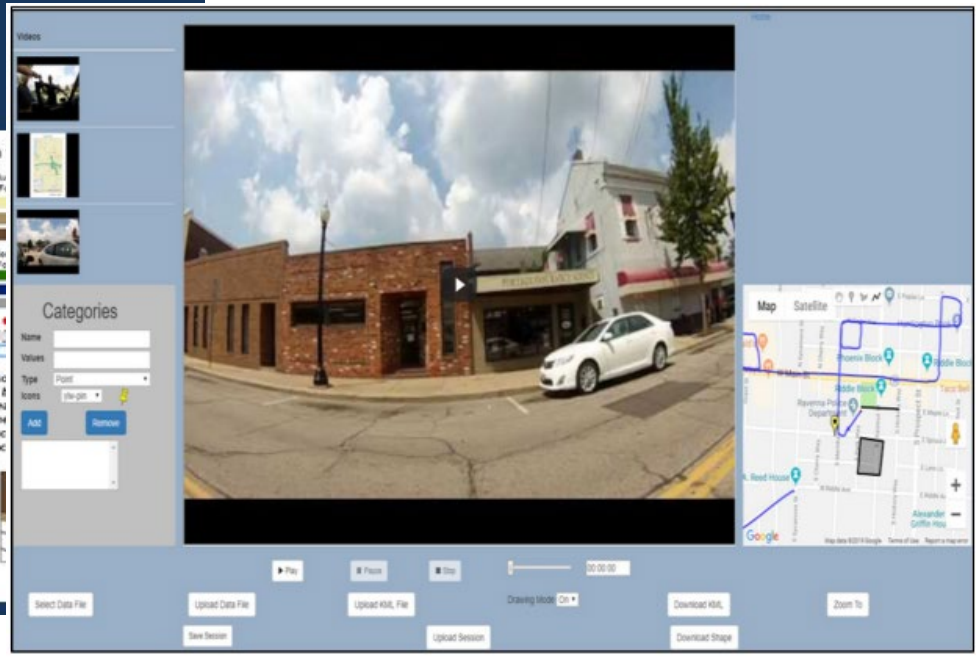
1/30/15

5/08/15

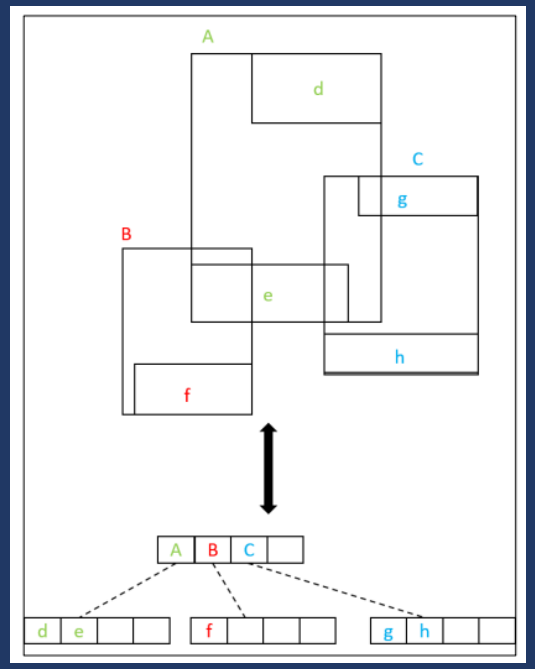
8/10/15

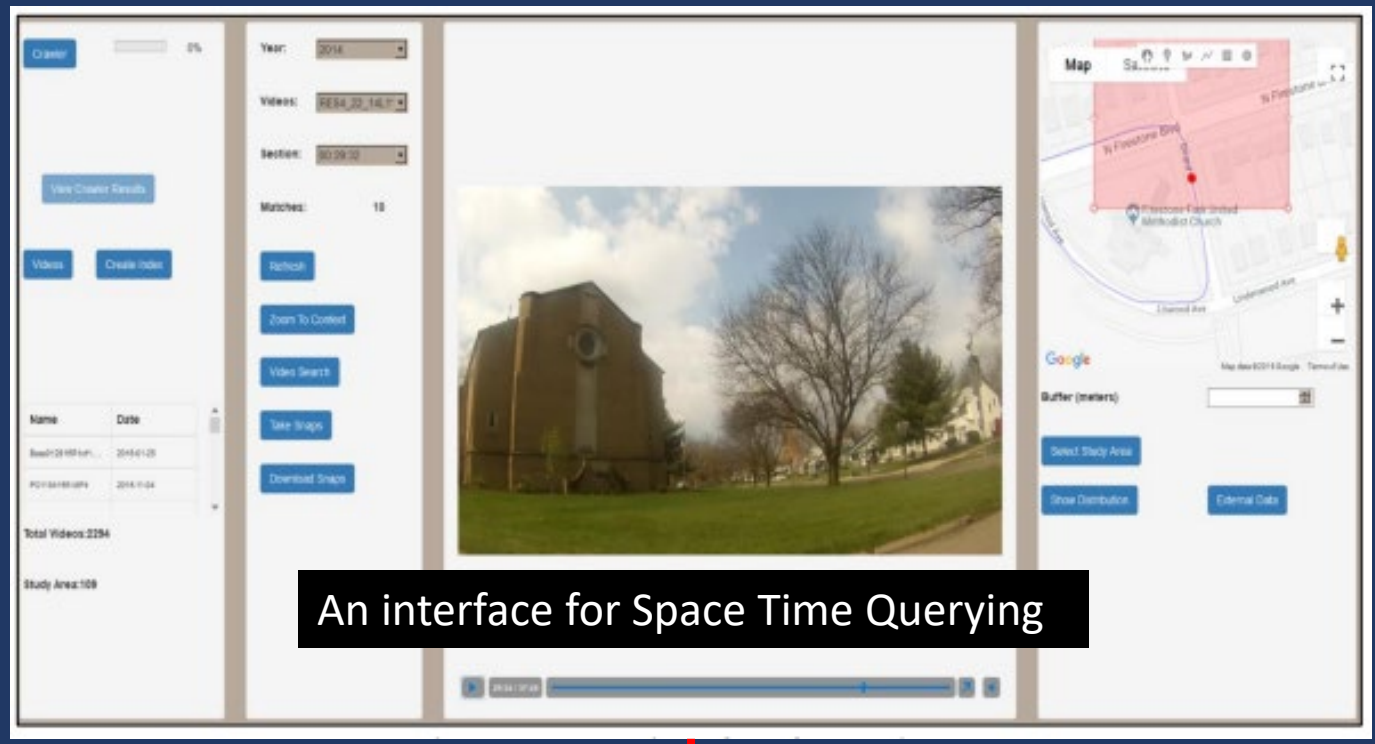
We modified the spatial video techniques we have been developing since being part of the response to Hurricane Katrina, which then morphed into a community recovery mapping tool, and then a neighborhood audit to capture granular dynamism

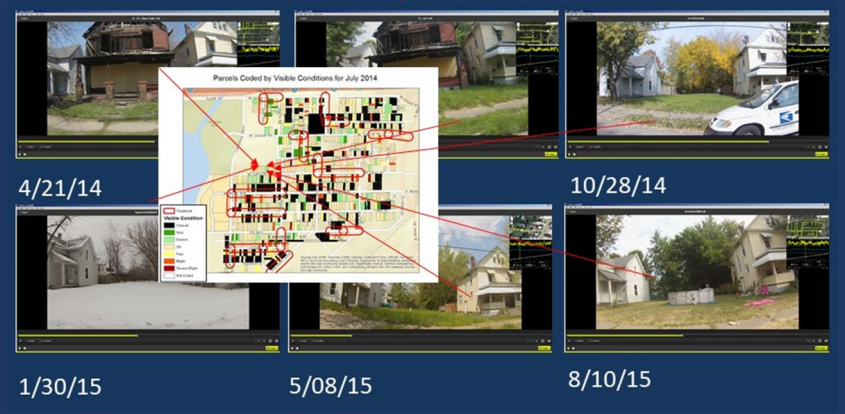


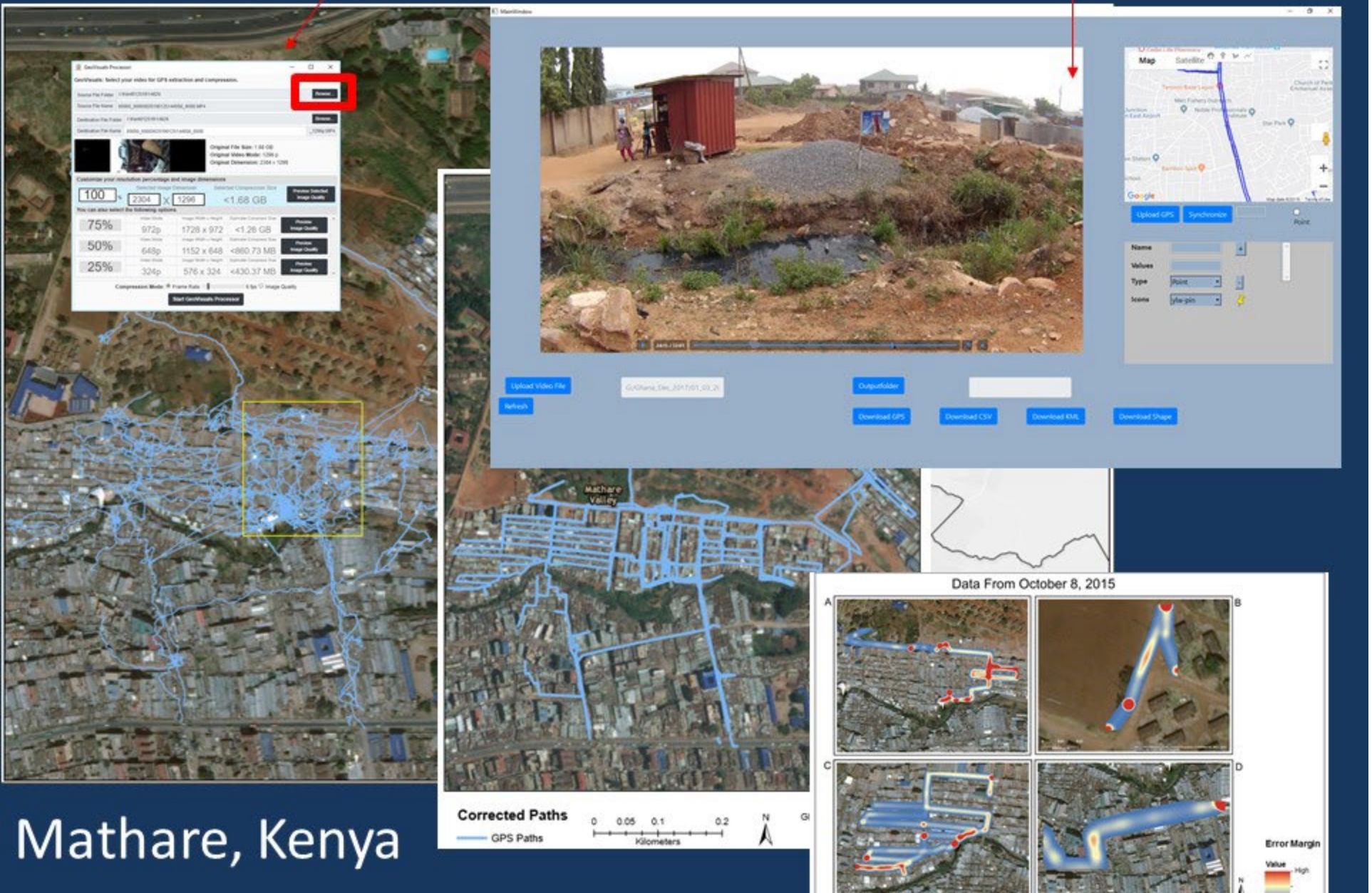


Spatial Video (Querying and Retrieval)









Developing tools to process, store, retrieve, and visualize SV

Addressing challenges related to GPS

Providing interfaces to generate new spatial data through digitization from the video and GPS data

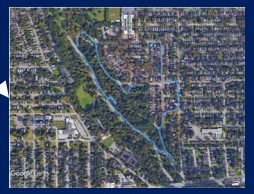
Data Flow for EpiExplorer

Spatial Video

Via email

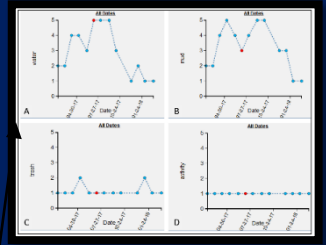
Automated GPS Extractor

Video



GPS

Spatio-Temporal Database



Synthesize

	Latitude			Longitude			Type of water point	Physical Address	Date Collected	Physical Parameters							Results	
	°	'	"	°	'	"				DO (mg/L)	Temp (°C)	Cond (µS/cm)	TDS (mg/L)	Salinity (g/L)	pH (log[H+])	Faecal Coliform cfu/100 ml	Vibrio Cholerae O1	
3	18	32	16.6	72	20	59	city water	Village de	11/13/2017	5.86	26.2	365	176	0.1	8.23	0	0	
4	18	32	17.3	72	1'00	3	city water	Village de	11/13/2017	4.82	28.9	364	175.4	0.1	8.15	0	0	
5	18	32	45.8	72	21	17.3	crete cist	Village de	11/13/2017	6.92	28.8	1395	391	0.1	7.71	192	0	
6	18	32	47.5	72	21	19	crete cist	Village de	11/13/2017	4.92	29.2	976	479	0.4	7.74	2600	0	
7	18	32	48.4	72	21	24	crete cist	Village de	11/13/2017	5.93	28.3	365	176	0.1	8.13	317	0	
8	18	32	57.1	72	23	13.6	Ocean	Village de	11/13/2017	8.8	30.6	50700	32000	33.3	8.41	700	0	
9	18	32	50	72	21	18.3	Ocean	Village de	11/13/2017	2.52	31.1	31600	25600	26.7	7.84	5400000	0	
10	18	32	54	72	21	42	Ocean	Village de	11/13/2017	6.76	31.1	55400	35400	36.9	7.82	1310000	0	
11	18	32	48.1	72	21	28	crete cist	Village de	11/13/2017	7.54	27.4	453	219	0.2	9.6	98	0	
12	18	32	42.1	72	21	29	crete cist	Village de	11/13/2017	5.72	27.5	891	416	0.4	9.1	>3000	0	
13	18	32	26	72	21	31.5	lic water f	Village de	11/13/2017	5.3	28.2	717	349	0.3	8.92	510	0	
14	18	32	40.3	72	21	32.4	age/dirty	Village de	11/13/2017	1.07	24.8	4330	2260	2.5	7.7	87000000	0	
15	18	32	39	72	21	31	age/dirty	Village de	11/13/2017	1.17	24.7	4220	2190	2.2	7.79	126000000	0	
16	18	32	37	72	21	31	age/dirty	Village de	11/13/2017	5.59	25.2	4480	2340	2.4	7.82	103000000	0	
17	18	32	33.4	72	21	31.3	e sewer p	Village de	11/13/2017	1.13	25.1	1518	754	0.7	8.05	54000000	0	
18	18	32	29.6	72	21	20.3	an water	Village de	11/13/2017	0.51	28.9	3690	1907	1.9	7.68	29010000	0	
19	18	32	25.2	72	21	3.1	crete cist	Village de	11/13/2017	6.21	26.6	366	176.5	0.1	8.81	0	0	
20	18	32	23	72	21	0.1	crete cist	Village de	11/13/2017	6.8	26.1	368	177.5	0.1	8.59	4	0	

Water Quality Data

	id	water	mud	trash	activity
2	DRC02132023_Mu1of10	2	4	4	2
3	DRC042023_Mu1of13	2	2	3	3
4	DRC052023_Mu1of12	2	3	3	3
5	DRC072023_Mu1of10	2	3	4	4
6	DRC042023_Mu2of13	3	4	3	3
7	DRC052023_Mu2of12	2	3	3	2
8	DRC072023_Mu2of10	2	3	2	3
9	DRC042023_Mu3of13	2	3	2	4
10	DRC052023_Mu3of12	2	4	3	3

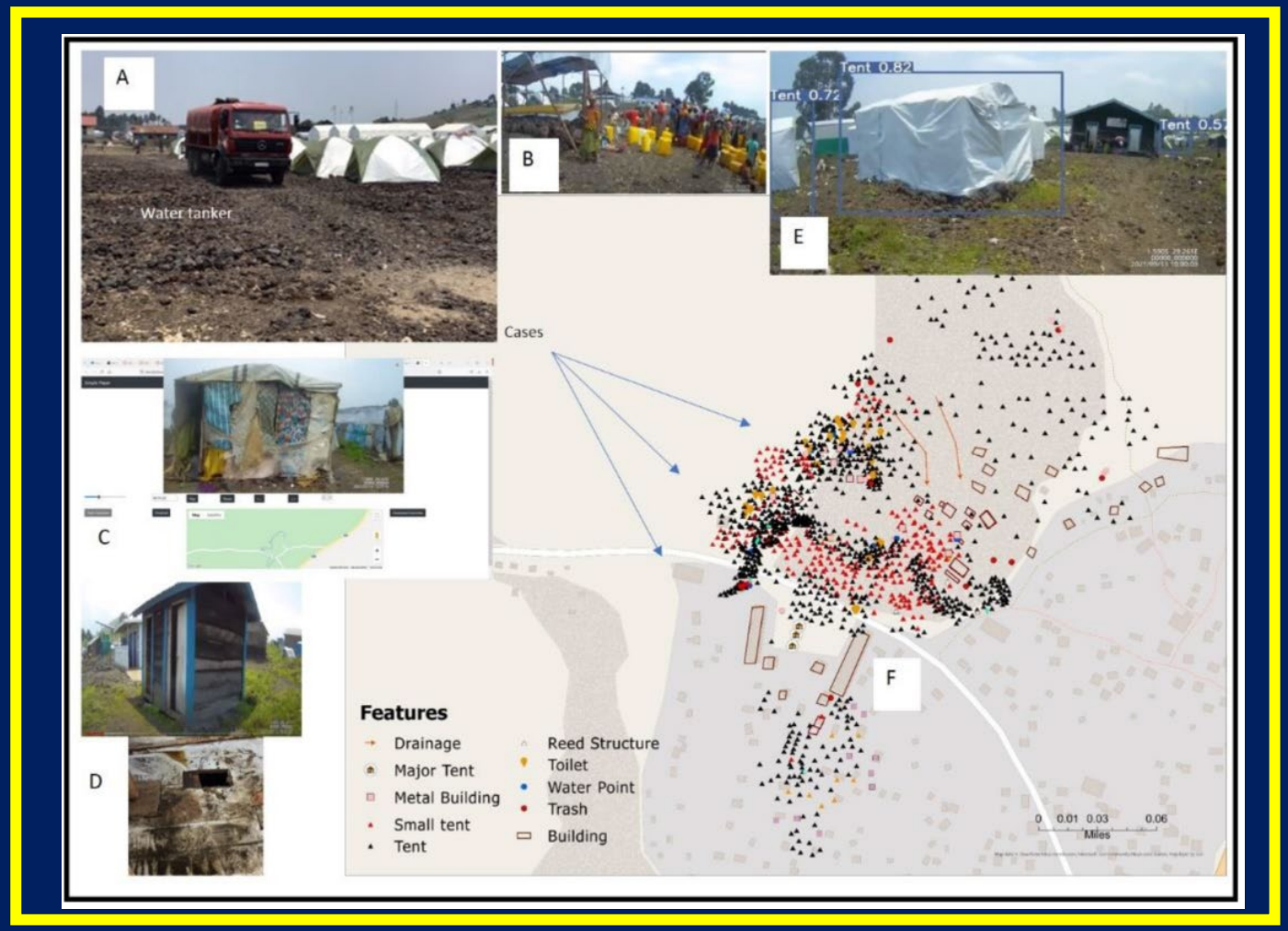
Environmental Assessment

AGE	RESULT_DATE	SEXE	ADRESS
46	12/2/2022	M	RUE SAINT MARTIN #
5	12/2/2022	F	TORCELLE
40	12/5/2022	F	PERNIER 48
4	12/2/2022	F	TORCEL
31	12/2/2022	F	E INNOVATION/MANDE POU KA
28	12/2/2022	M	martissant 17 #3
1	12/5/2022	M	AVENUE NICOLAS
53	12/5/2022	M	MARA 43 RUE MENOS PROLONG
34	12/5/2022	F	NATIONAL #1, RUE BRISSON #22
83	12/5/2022	F	Dieu (bicentenaire, en face du
29	12/5/2022	M	SAINT MARTIN ET RUE DU CENT
64	12/7/2022	F	LALUE
45	12/7/2022	F	TABARRE 29
34	12/7/2022	F	CARREFOUR FEUILLES

Test Results

Working with the Emerging Pathogens Institute, University of Florida

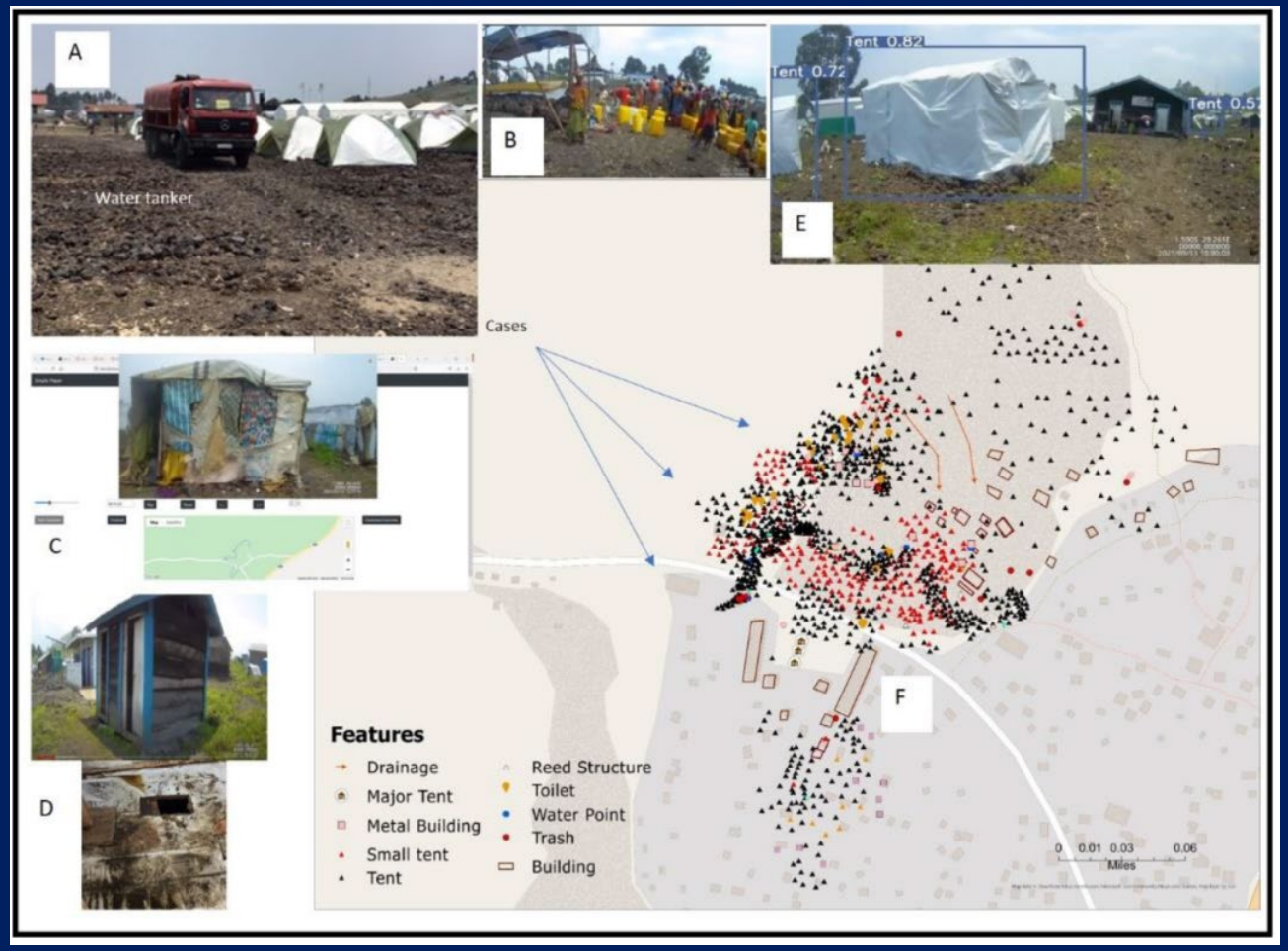
Working with the Emerging Pathogens Institute, University of Florida



While mapping/digitization is important, manual mapping is time consuming and expensive. For near -real time mapping we need automation

Need to tap in the latest developments on Image Analysis using Neural Network architectures (such as convolutional neural network).

Working with the Emerging Pathogens Institute, University of Florida



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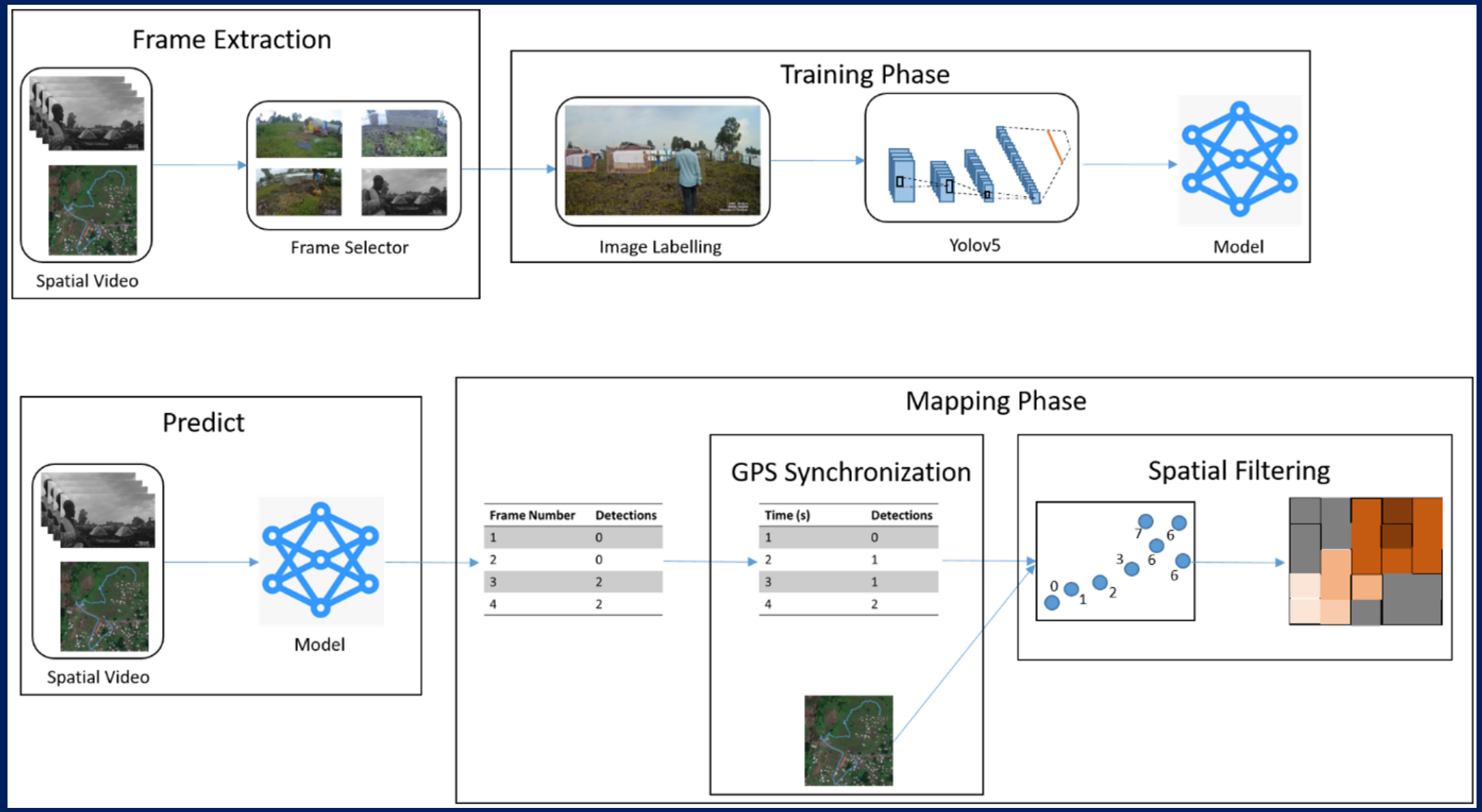
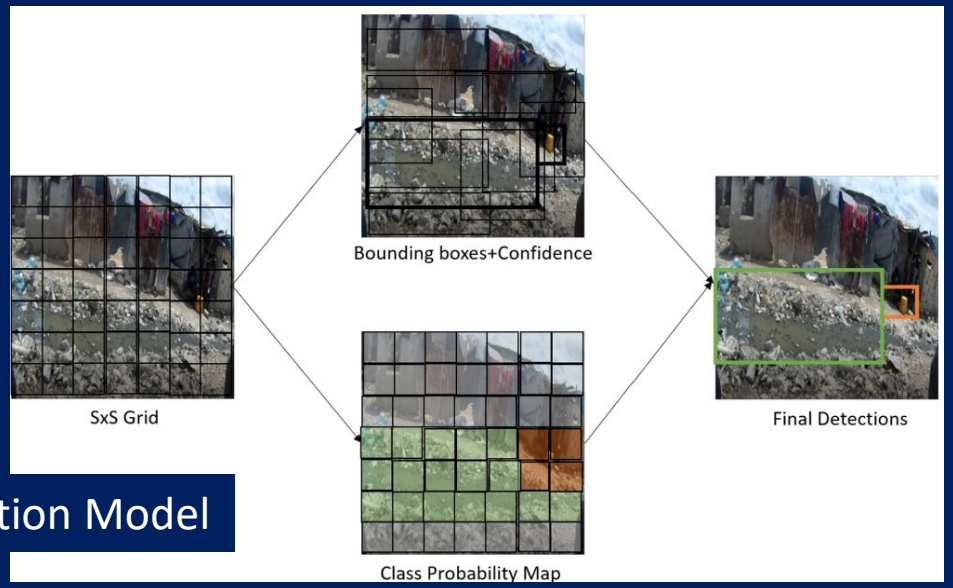
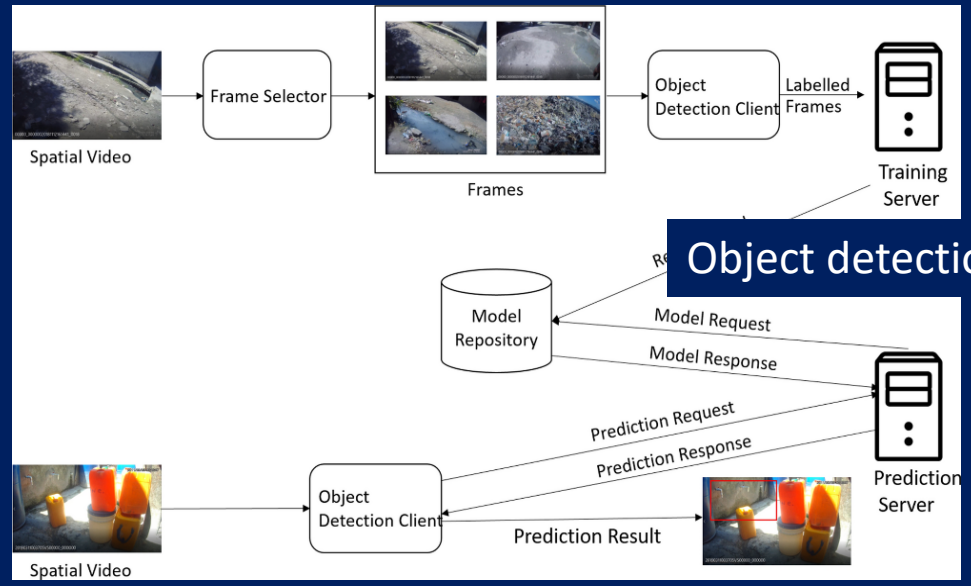
A Pipeline For Automatic Risk Mapping



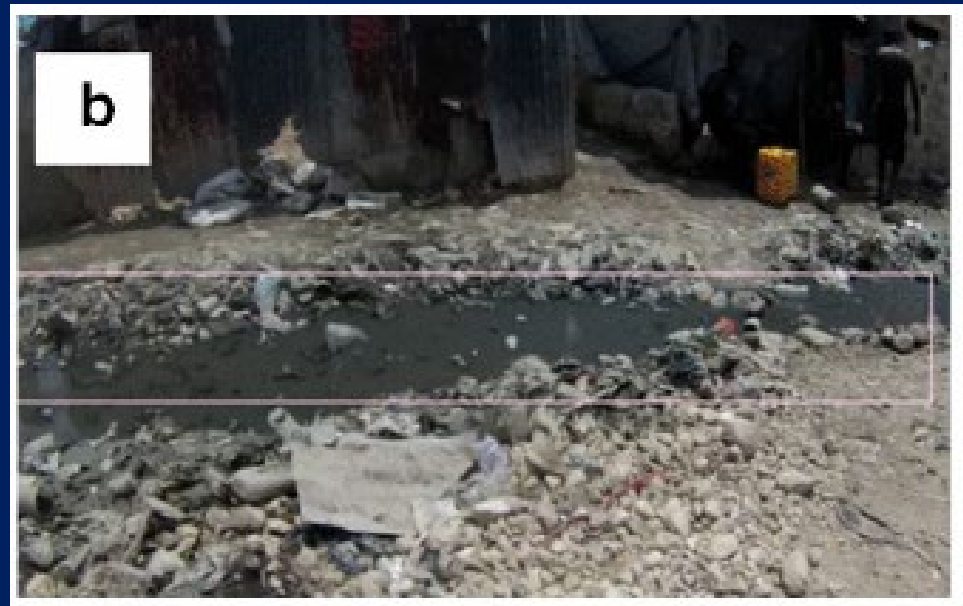
Identifying features using Object Detection



Object detection Model



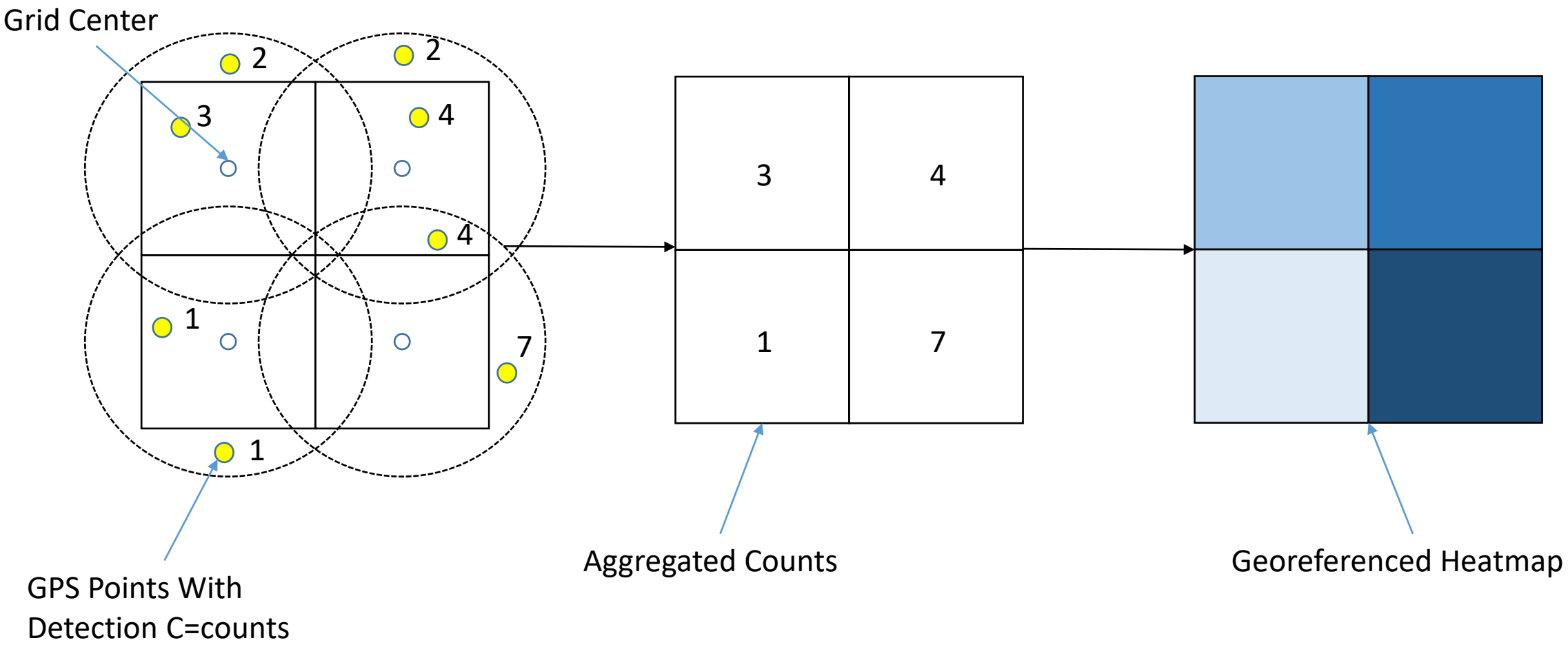
Object detection pipeline



Sample Detections

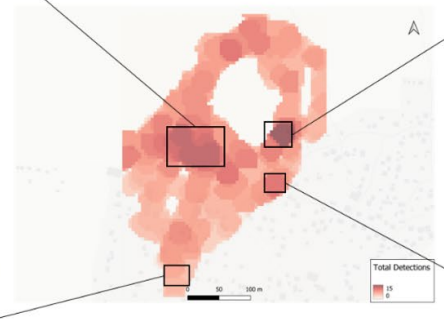
Mapping Detected Images

Spatial Filtering Approach (for addressing uncertainty)



Heat maps to show feature density…. and change maps for longitudinal analysis

A



June 2021

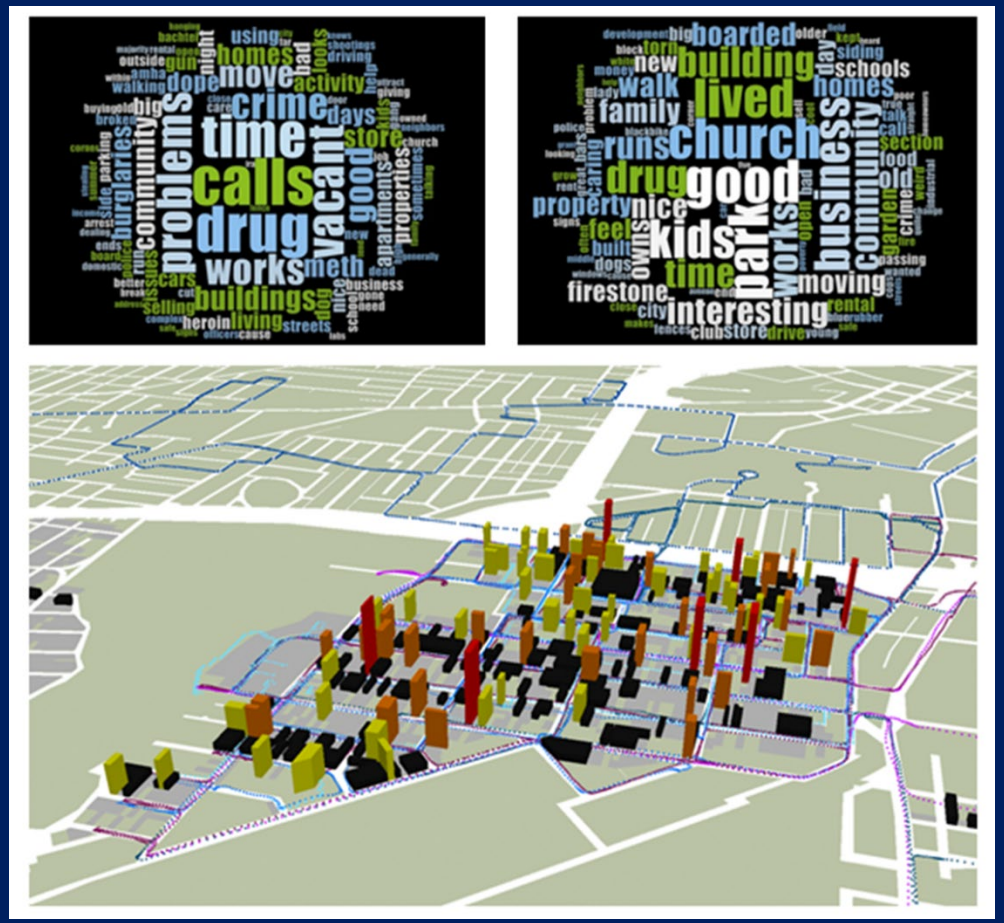
September 2021

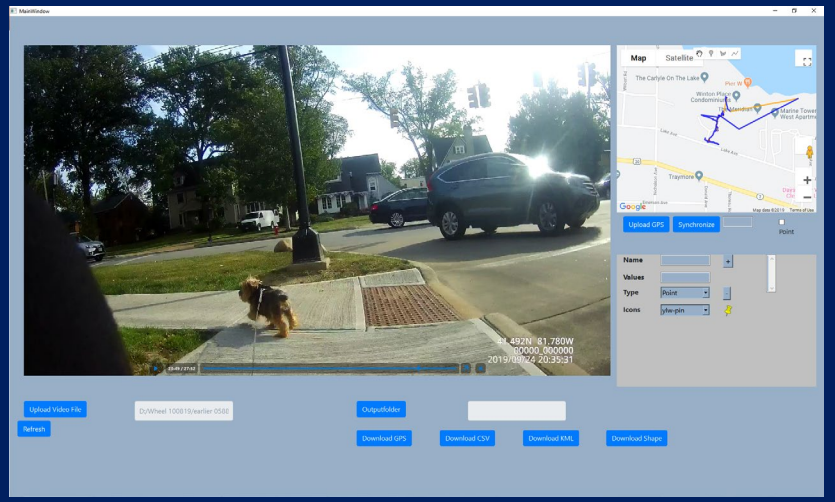
Working with the Emerging Pathogens Institute, University of Florida

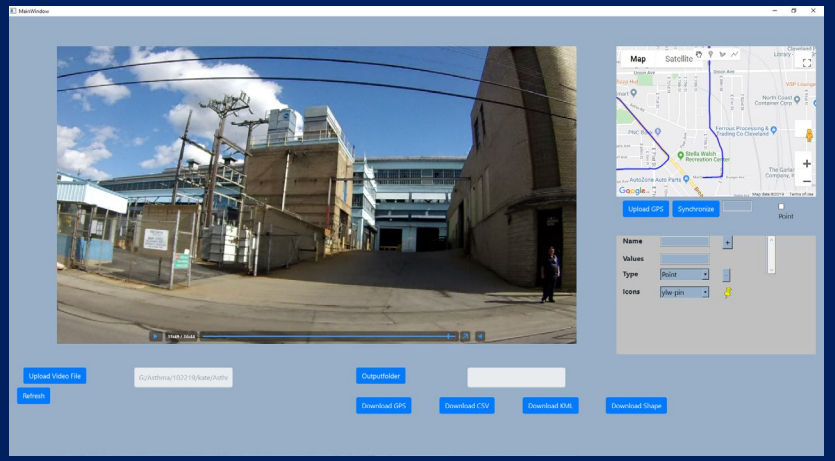
Cambodia
DRC
Ghana
Haiti
Kenya

Spatial Video Geonarratives

Overdoses
Homelessness
Violence
Mobility
Asthma



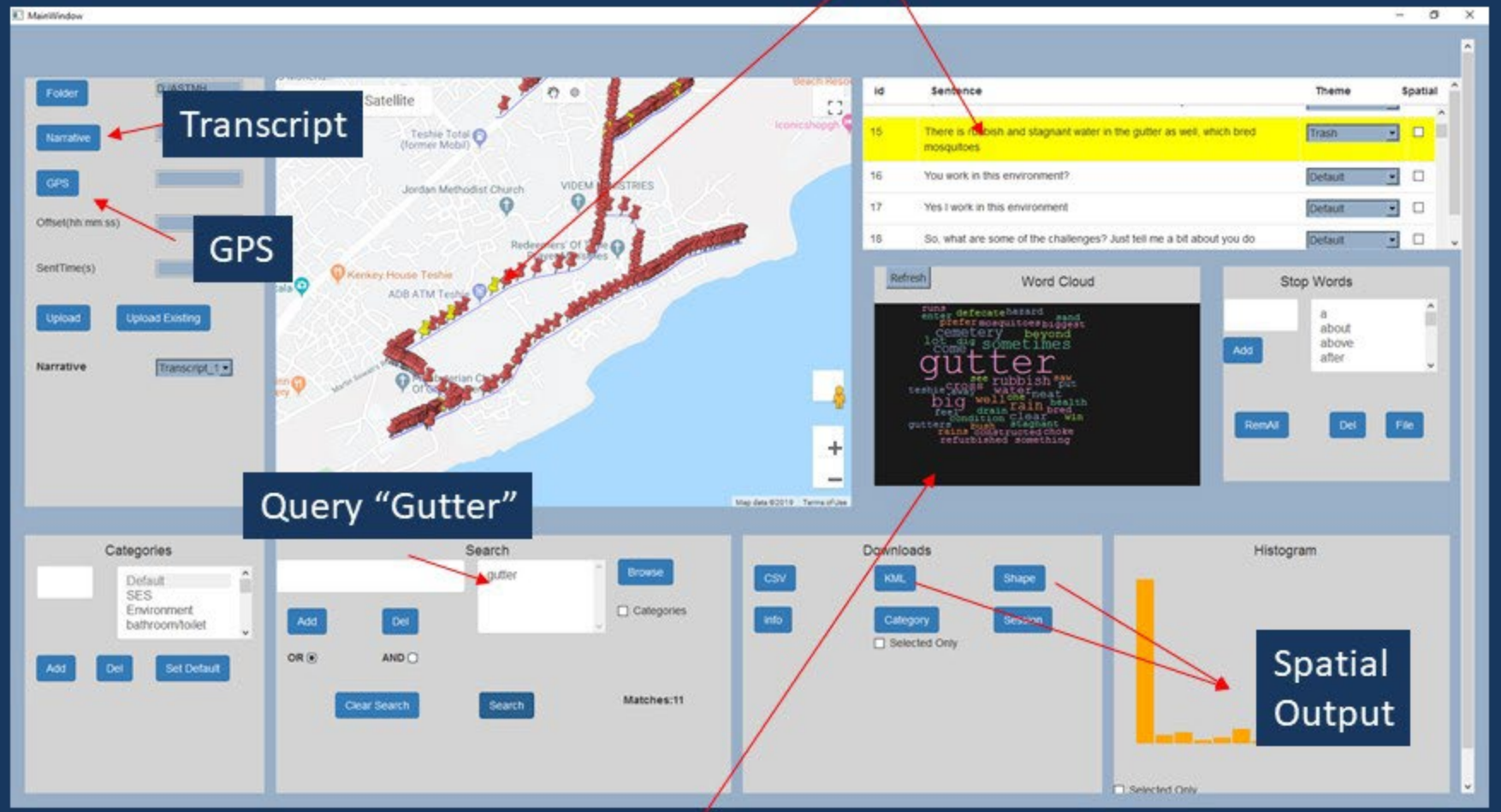




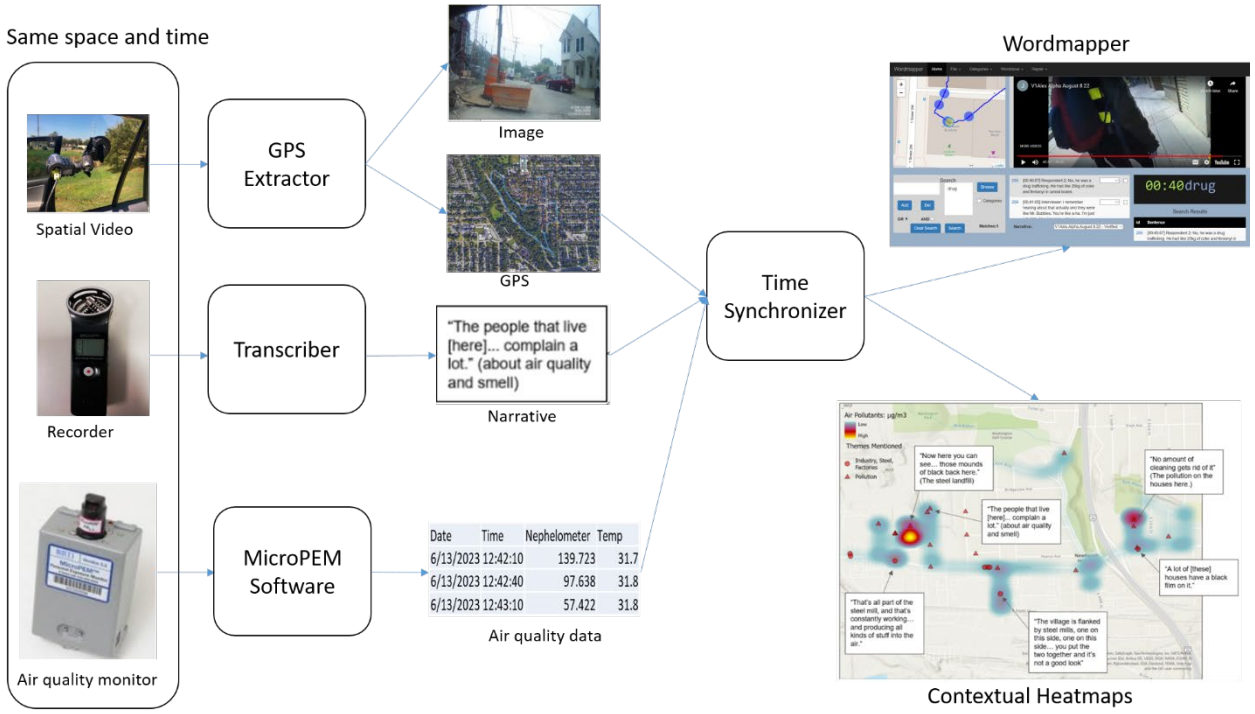
Two perspectives on the same space

Sandra Bempah, Kent State University
West African Center for Cell Biology of Infectious Pathogens, University of Ghana

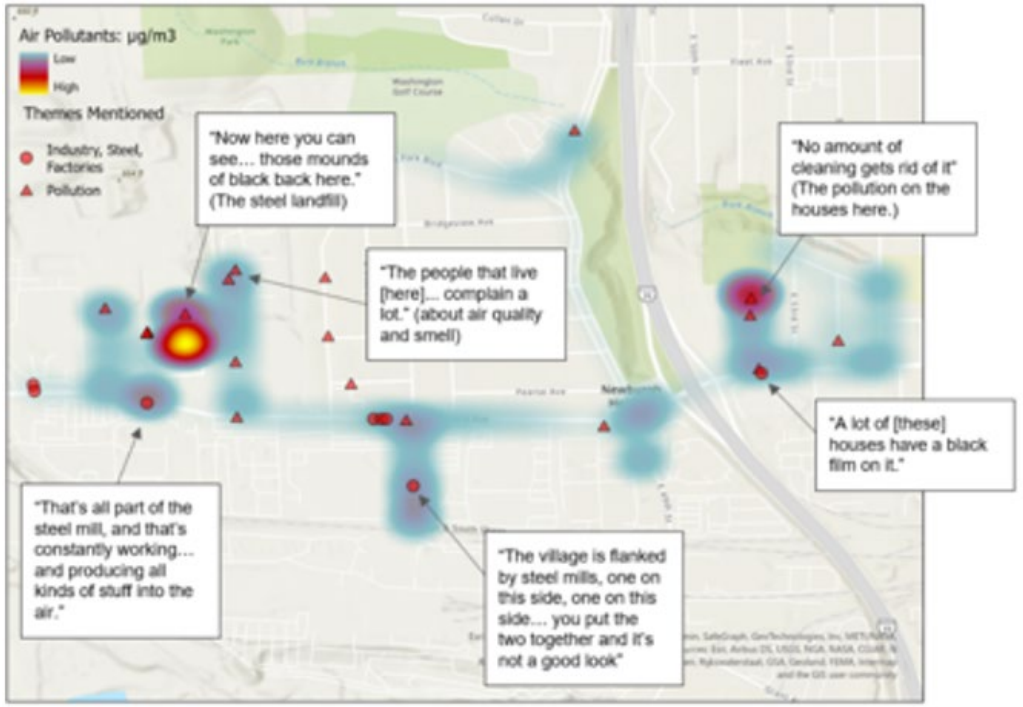
Wordmapper



Combining Spatial Video Data with other sources (Spatial Video + Air quality data + Narrative)



Combining Air Quality and SV Data



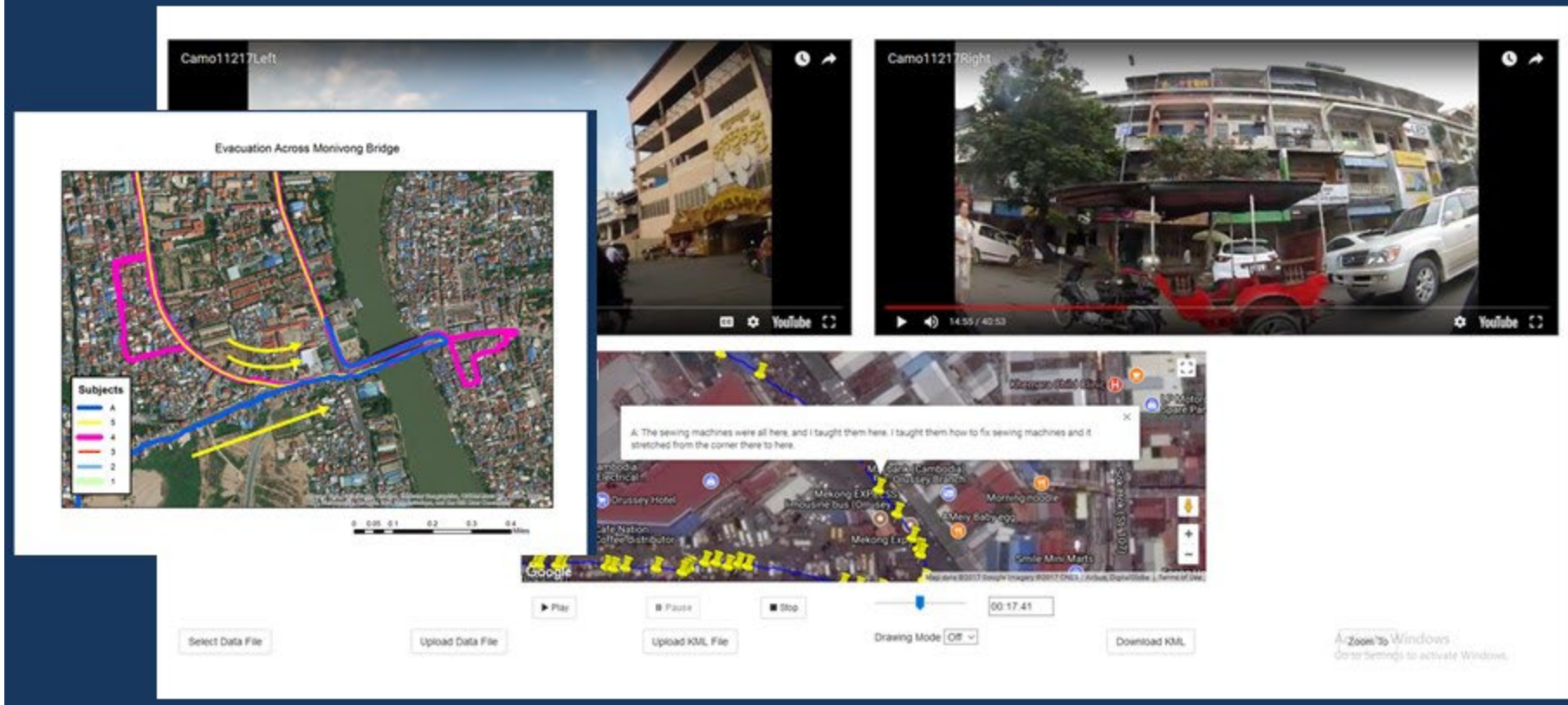
Contextual Heat maps

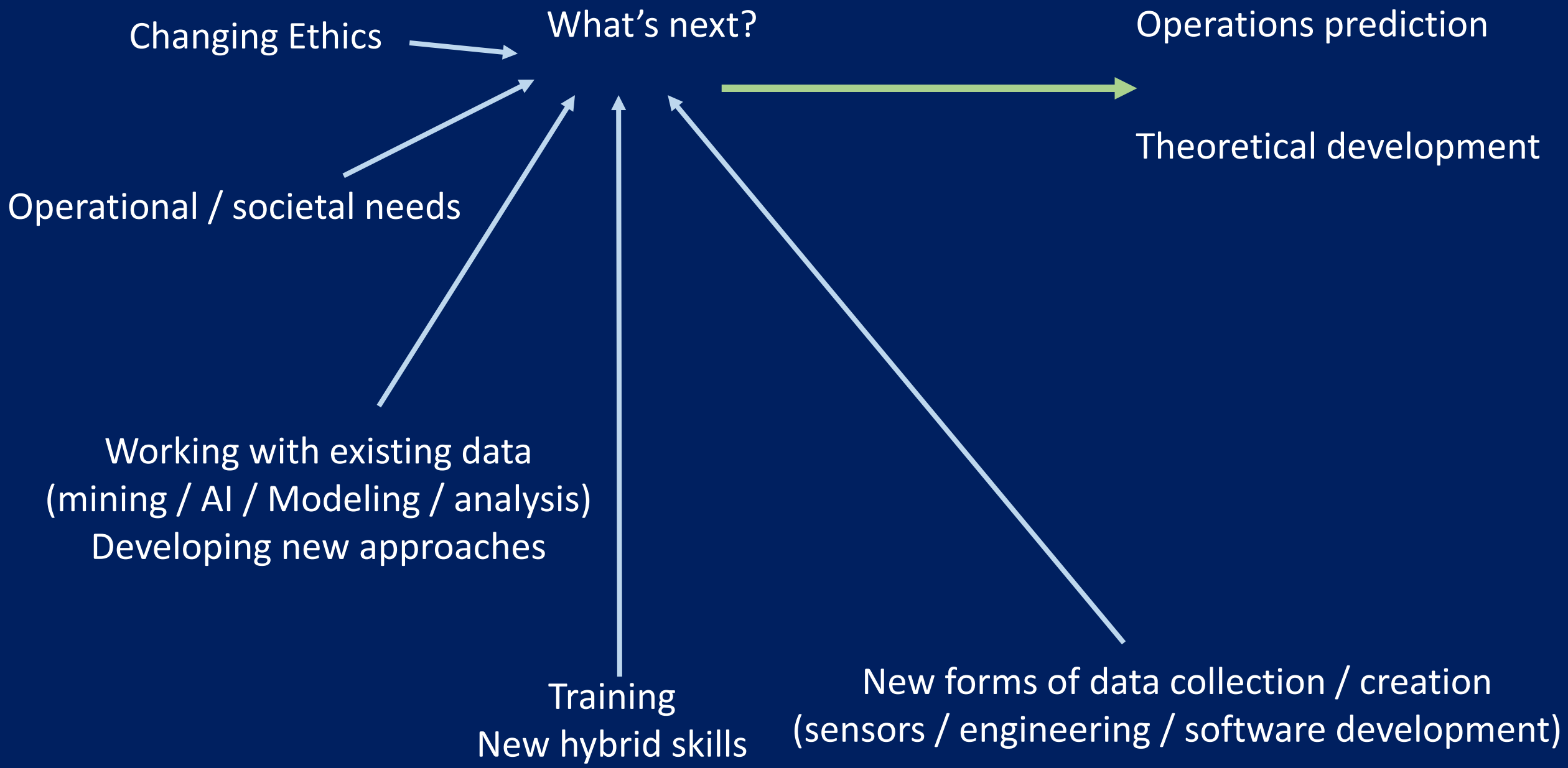
Thanks to Maeve Macmurdo and Grace Armstrong

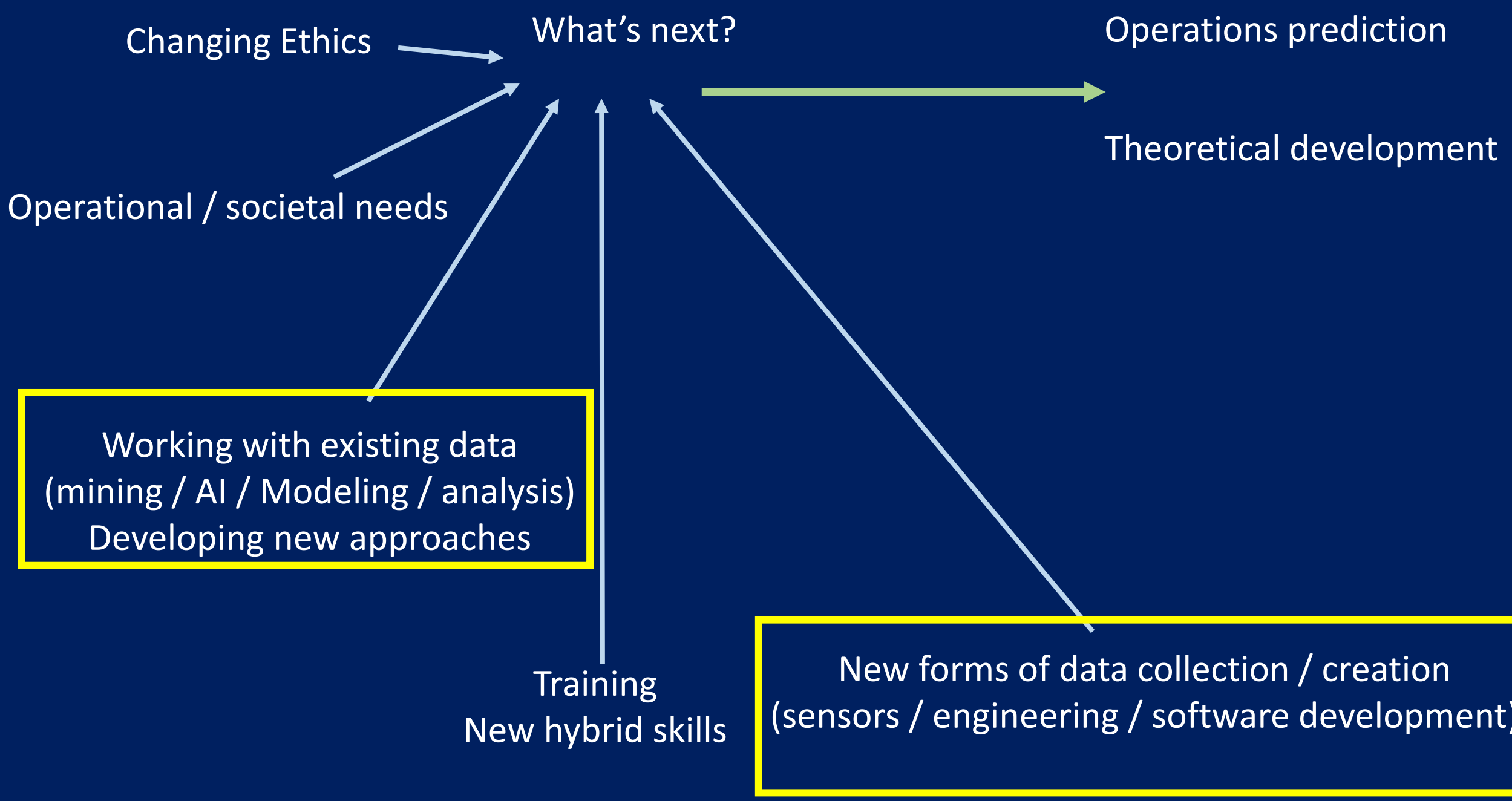
Learning from the Digital Humanities

Question Map / Narrative / Video

Cambodian Genocide




Changing Ethics
What's next?
Operations prediction
Theoretical development
Operational / societal needs
Working with existing data
(mining / AI / Modeling / analysis)
Developing new approaches
Training
New hybrid skills
New forms of data collection / creation
(sensors / engineering / software development)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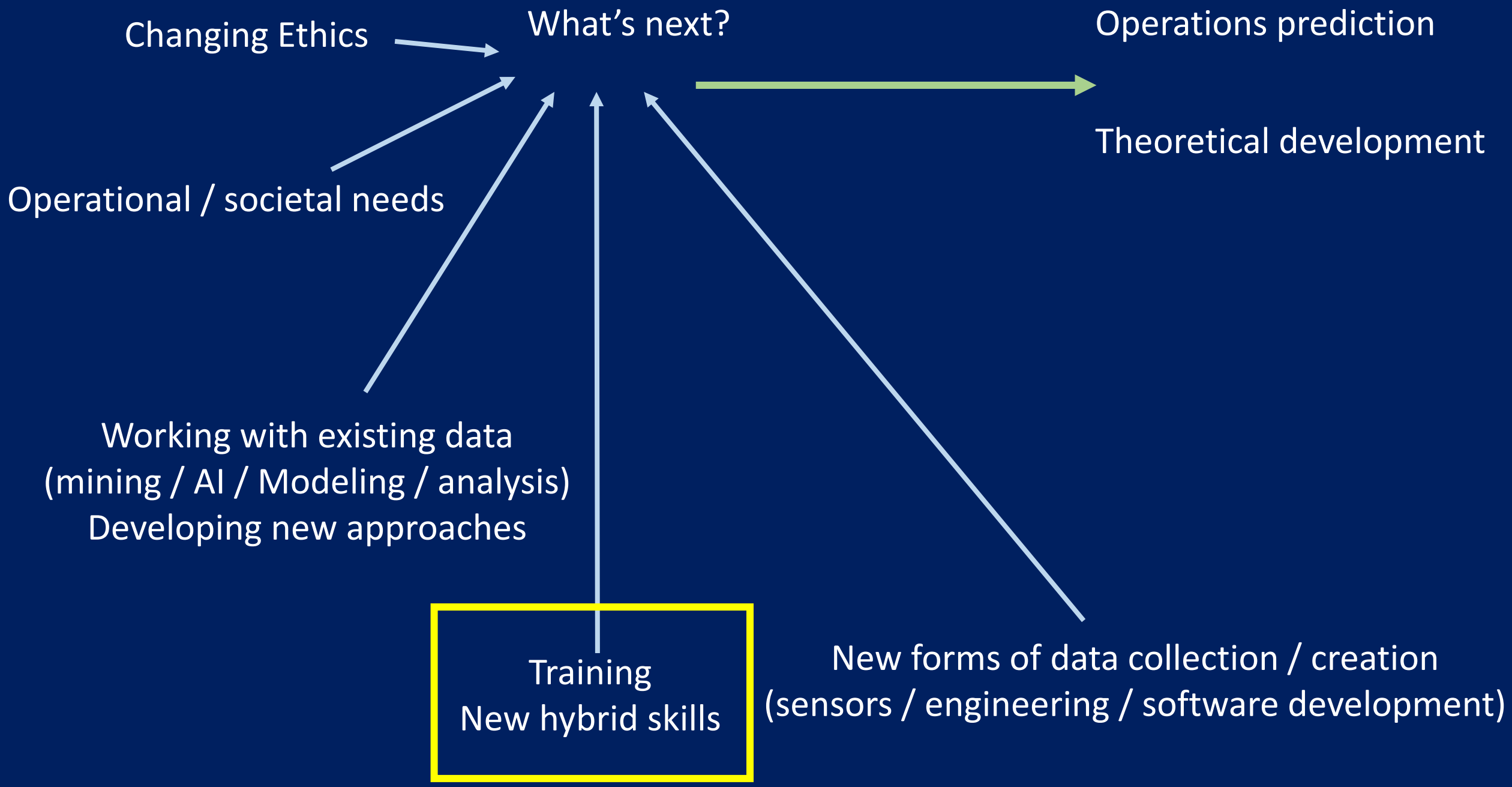
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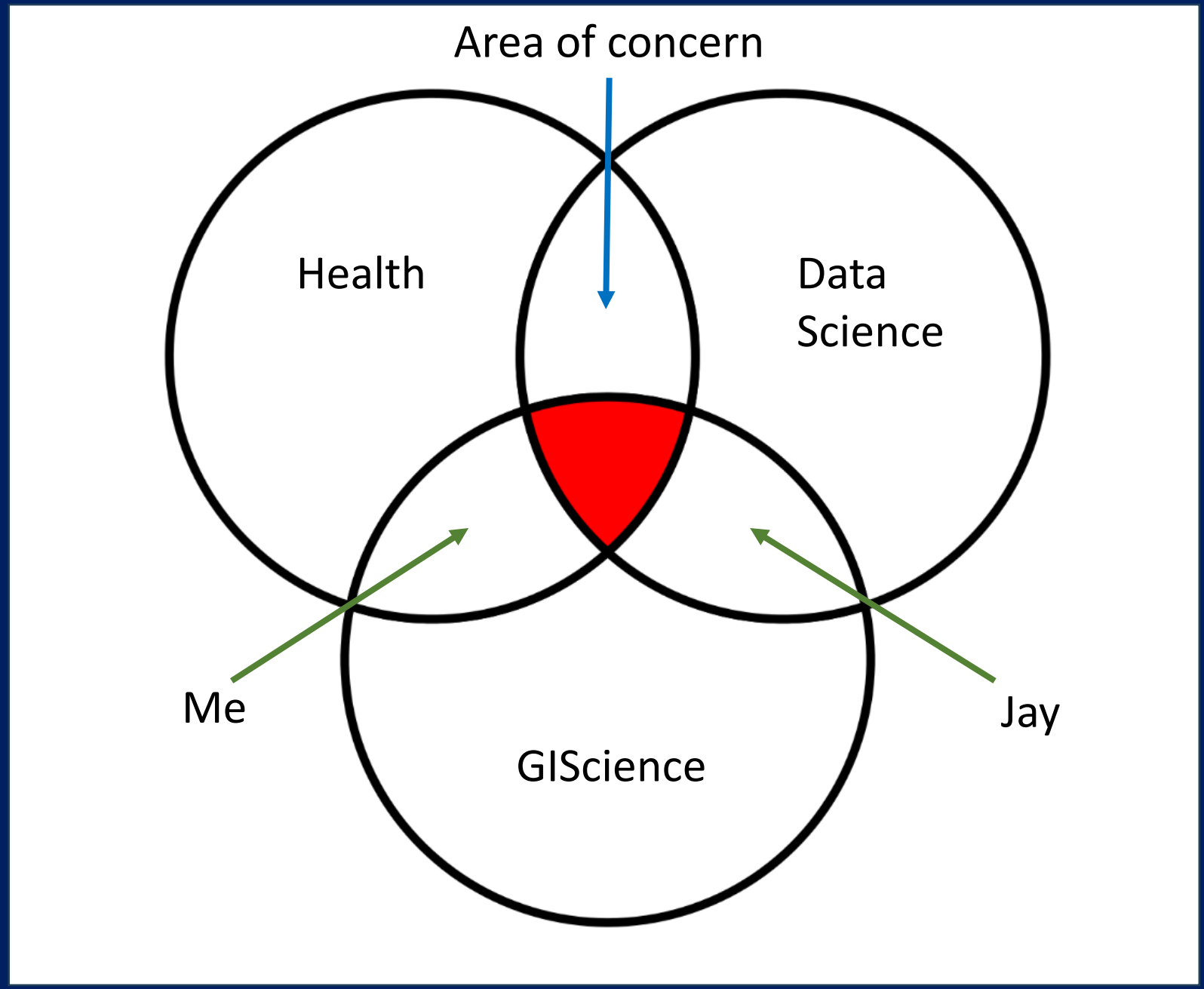

Acknowledgements

NSF - PIPP RES600126 Jing (PI) Phase I: comprehensive, integrated, intelligent system for early and accurate pandemic prediction, prevention, and preparation at personal and population levels

RO1 AI126357 Morris (PI) Cholera Transmission and Evolution in Port-au-Prince, Haiti. Sub-award to Case Western Reserve University

RO1 AI138554 Morris (PI) Cholera in Goma, Sub-award to Case Western Reserve University

University Hospitals of Cleveland UH Venture – Curtis GIS Lab

Ohio Hospital Association -- Building GeoMEDD surveillance for Ohio

Ohio Department of Higher Education Third Frontier Research Incentive Mapping Expert Knowledge to Identify the Geographic Context of Opiate Use.

Ohio Department of Higher Education Geographic Monitoring for Early Disease Detection (GeoMEDD): An Actionable Warning System for Opiate Overdoses in Ohio

US Dept of Justice Jefferis (PI) (NCE) Research on Offender Decision-Making Utilizing Geo-Narratives

Students and researchers in the GIS Health & Hazards Lab at Case Western Reserve University, Department of Population and Quantitative Health Sciences, School of Medicine especially Jacqueline Curtis and at Kent State University, Sandra Bempah, and all the other students who worked on projects with us. All those who collaborated in the Cleveland Department of Public Health & Case Western Reserve University Covid 19 joint response, especially the MPH interns (Grace Armstrong & Claire Keanna). The entire Epidemiology Team at Cleveland Department of Public Health

THAT WAS:

ADVENTURES IN SPATIAL DATA ANALYTICS: WORKING AT THE SCALE OF INTERVENTION / OPERATIONS

Andrew Curtis

&

Jayakrishnan Ajayakumar

GIS Health & Hazards Lab
Department of Population and Quantitative Health Sciences, School of Medicine
Case Western Reserve University

ajc321@case.edu
jxa421@case.edu