Disaster Communication Using Intelligent Systems, Holograms and Virtual Reality

Ibrahim Demir

Iowa Flood Center
IIHR
The University of Iowa

Hurricane Irma, 2017
$172b, 134 deaths

Harvey, 2017
$108b, 70 deaths

Sandy, 2012
$170b, 147 deaths

Andrew, 2009
$48b, 65 deaths

Katrina, 2005
$172b, 1833 deaths

LA Quake, 1994
$45b, 57 deaths

Drought, 1988
$42b, 5000 deaths

Mitigation

Monitoring

Brickell Key
Forecasting
Google

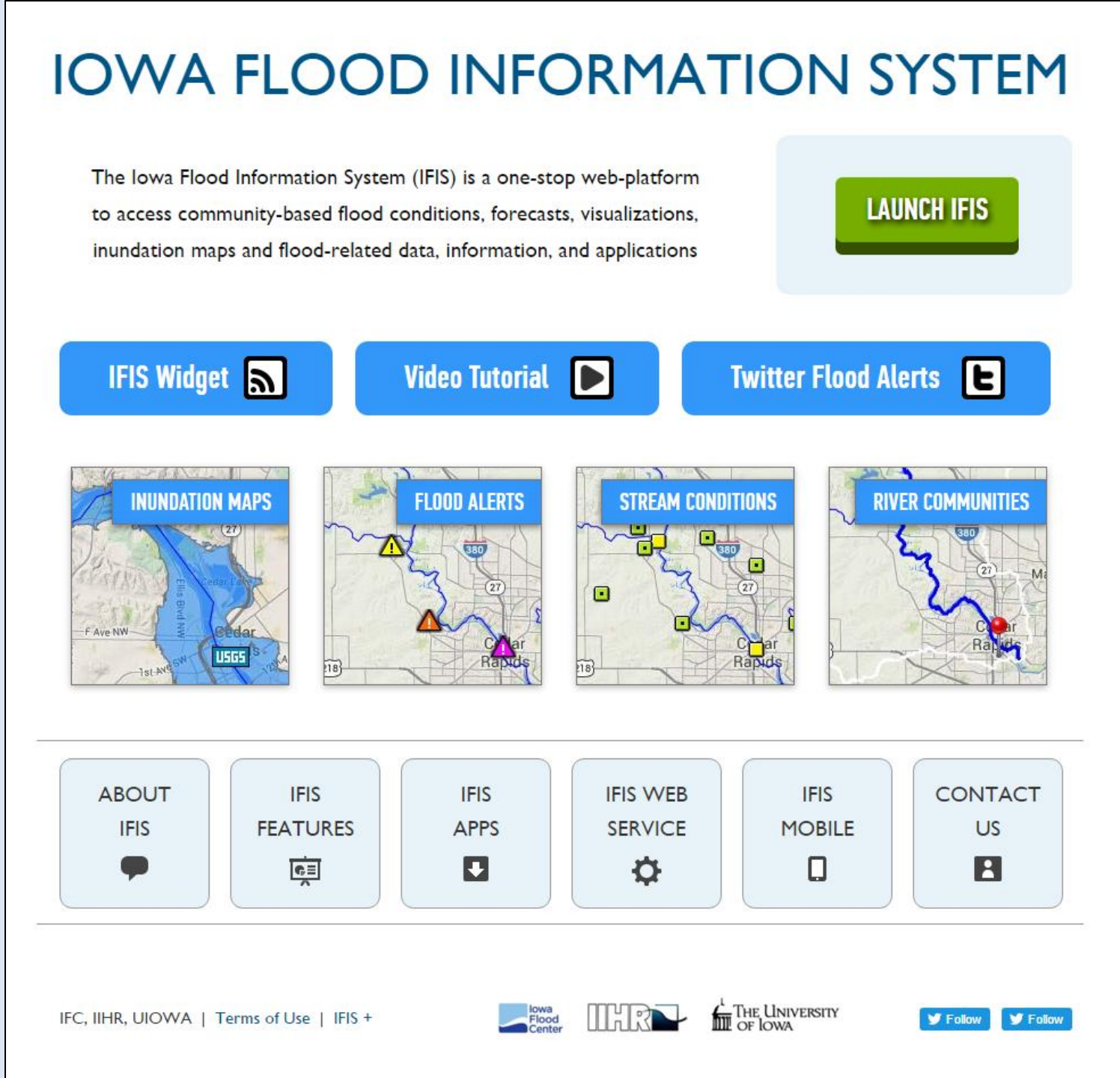
BIG DATA
Integrated
Accessible
Computable

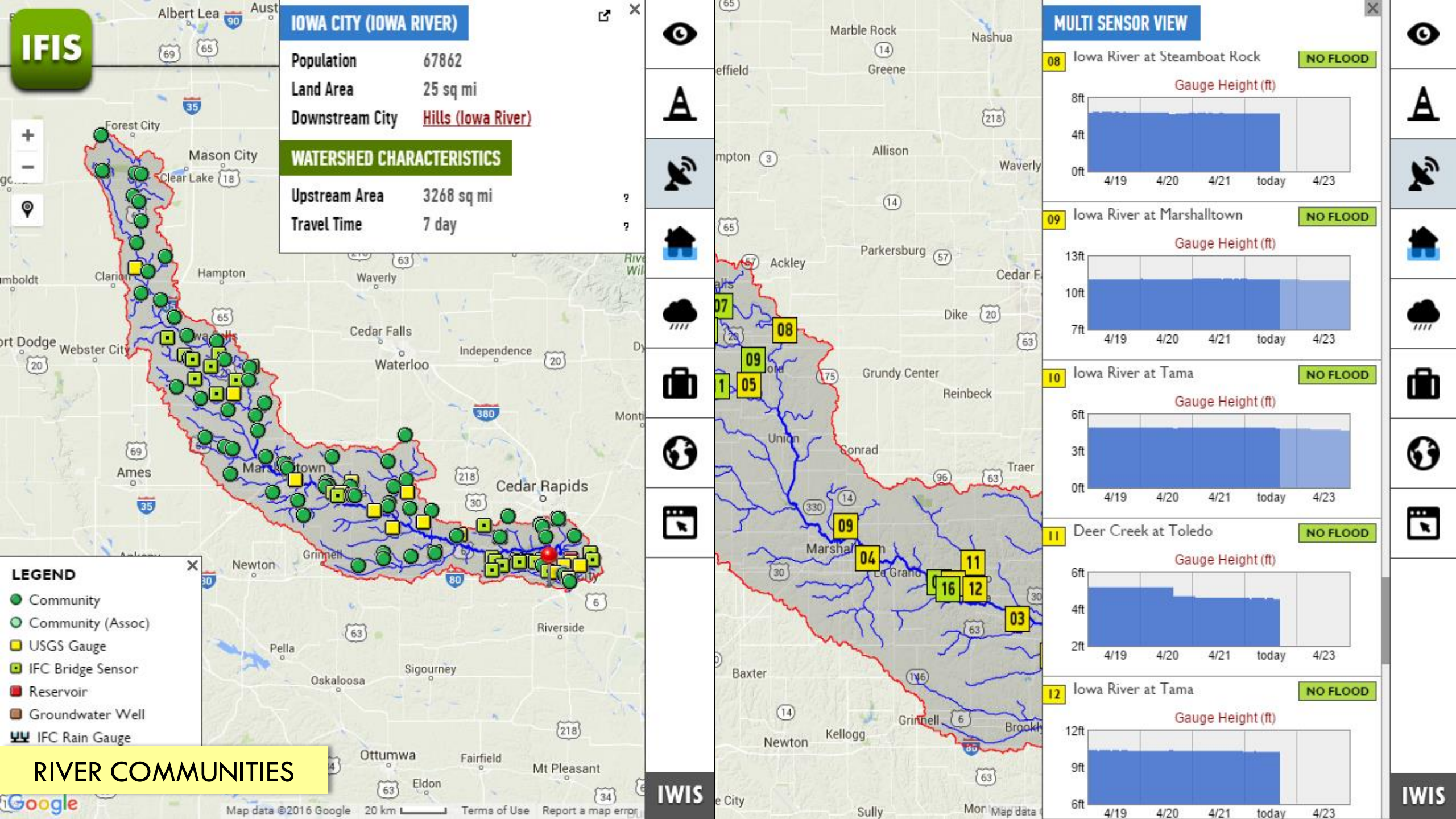
IFIS

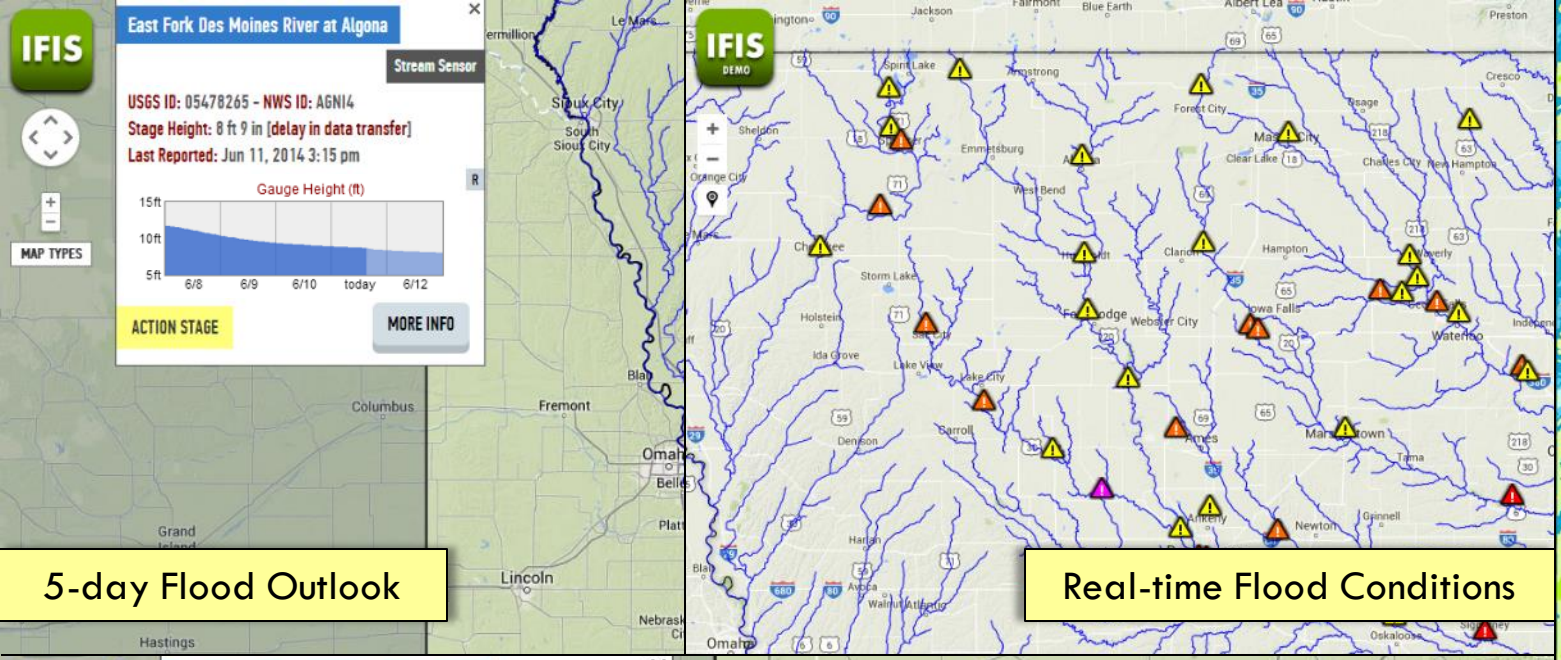
Information System

- ✓ Disaster Communication
- ✓ Decision Making

- ✓ Large Userbase - 300K users
- ✓ Big Data (50GB/day)
- ✓ Optimized User Experience
- ✓ Generalized Infrastructure

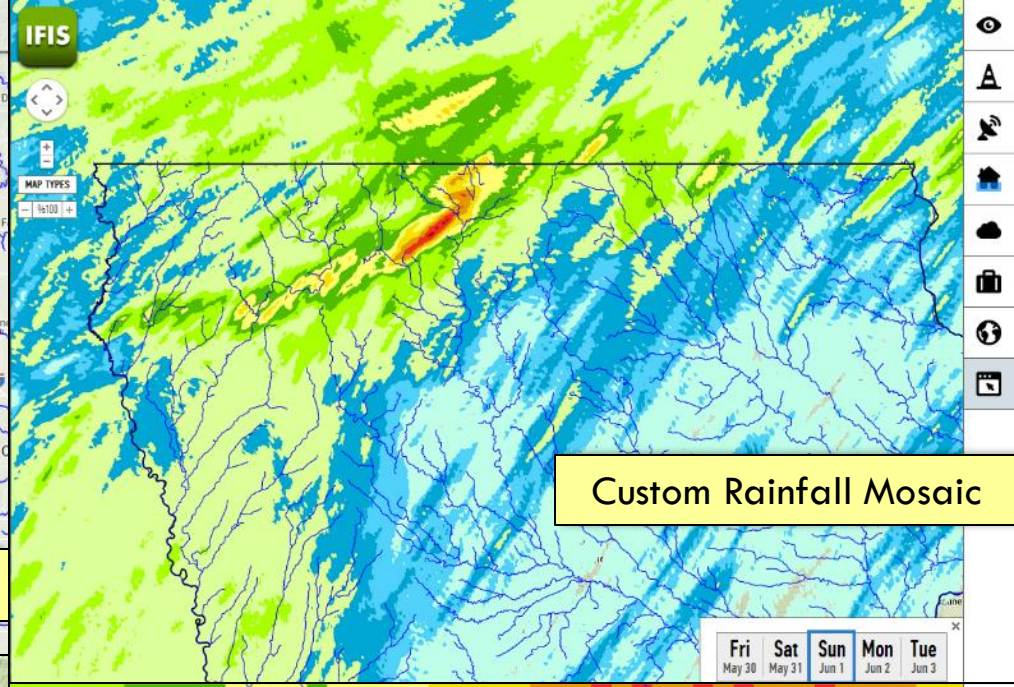



IFIS
IOWA CITY (IOWA RIVER)
Population 67862
Land Area 25 sq mi
Downstream City Hills (Iowa River)
WATERSHED CHARACTERISTICS
Upstream Area 3268 sq mi
Travel Time 7 day
LEGEND
Community
Community (Assoc)
USGS Gauge
IFC Bridge Sensor
Reservoir
Groundwater Well
IFC Rain Gauge
IWIS
MULTI SENSOR VIEW
08 Iowa River at Steamboat Rock NO FLOOD
Gauge Height (ft)
8ft 4ft 0ft
4/19 4/20 4/21 today 4/23
09 Iowa River at Marshalltown NO FLOOD
Gauge Height (ft)
13ft 10ft 7ft
4/19 4/20 4/21 today 4/23
10 Iowa River at Tama NO FLOOD
Gauge Height (ft)
6ft 3ft 0ft
4/19 4/20 4/21 today 4/23
11 Deer Creek at Toledo NO FLOOD
Gauge Height (ft)
6ft 4ft 2ft
4/19 4/20 4/21 today 4/23
12 Iowa River at Tama NO FLOOD
Gauge Height (ft)
12ft 9ft 6ft
4/19 4/20 4/21 today 4/23
IWIS
Albert Lea
Forest City
Mason City
Clear Lake
Hampton
Clarion
Webster City
Waterloo
Cedar Falls
Independence
Ames
Cedar Rapids
Newton
Grinnell
Marshalltown
Pella
Oskaloosa
Sigourney
Riverside
Ottumwa
Fairfield
Mt Pleasant
Eldon
Marble Rock
Nashua
Greene
Allison
Waverly
Parkersburg
Ackley
Dike
Grundy Center
Reinbeck
Union
Conrad
Traer
Baxter
Kellogg
Sully
Map data ©2016 Google 20 km Terms of Use Report a map error
RIVER COMMUNITIES

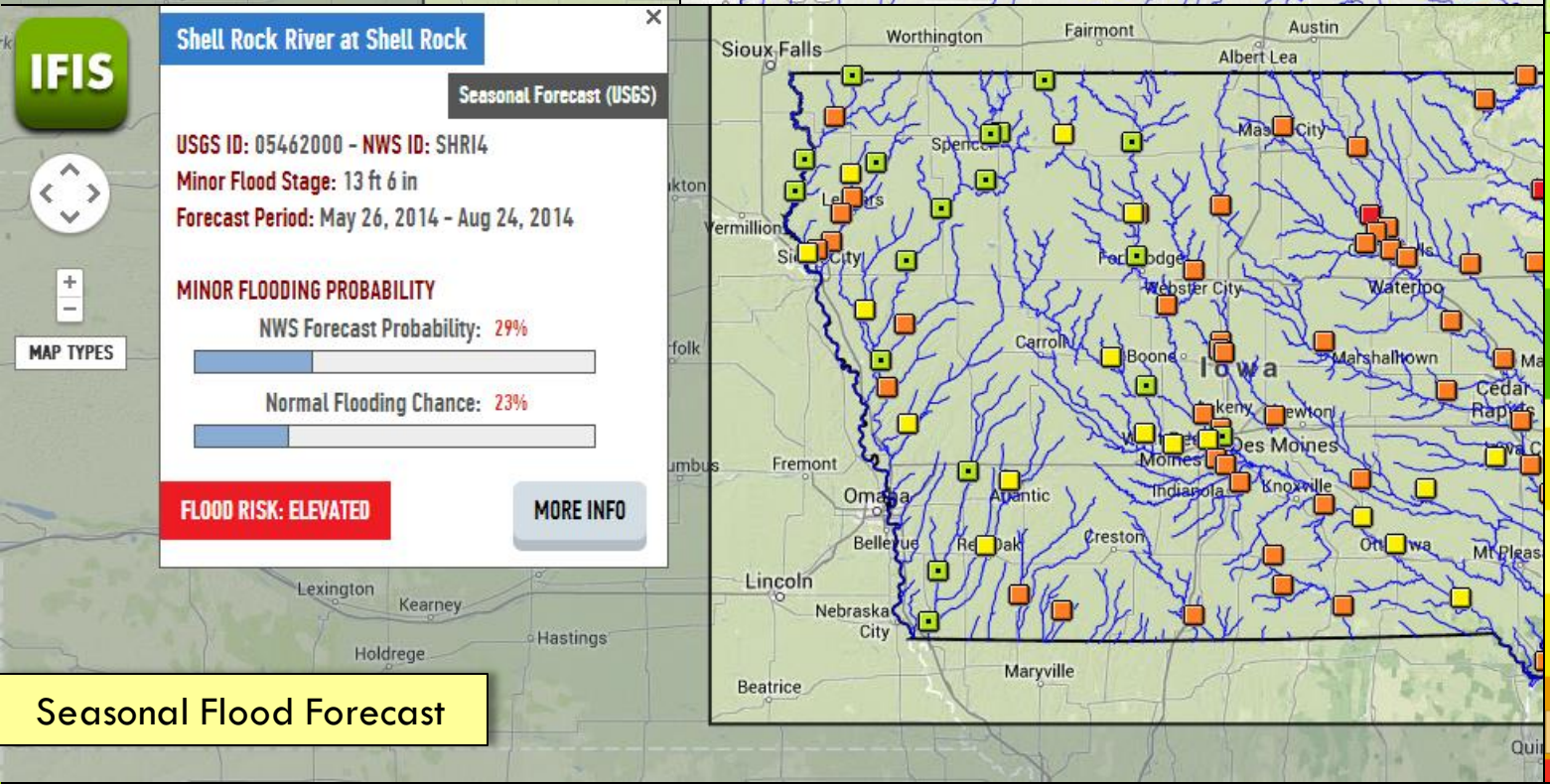


5-day Flood Outlook

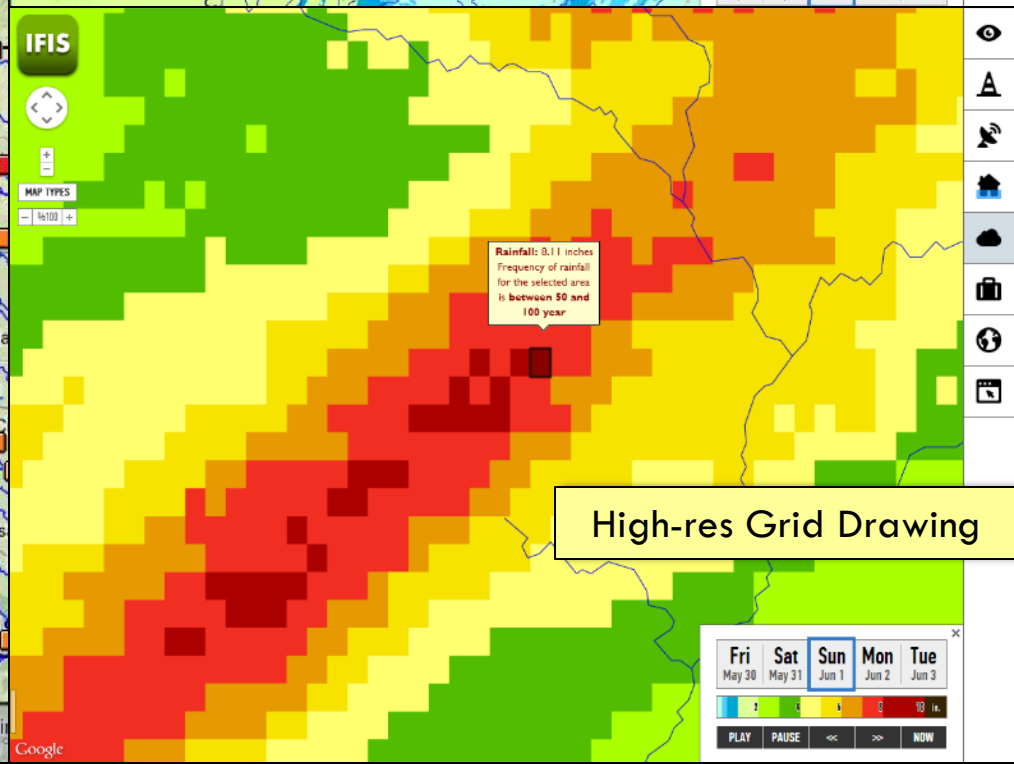
Real-time Flood Conditions



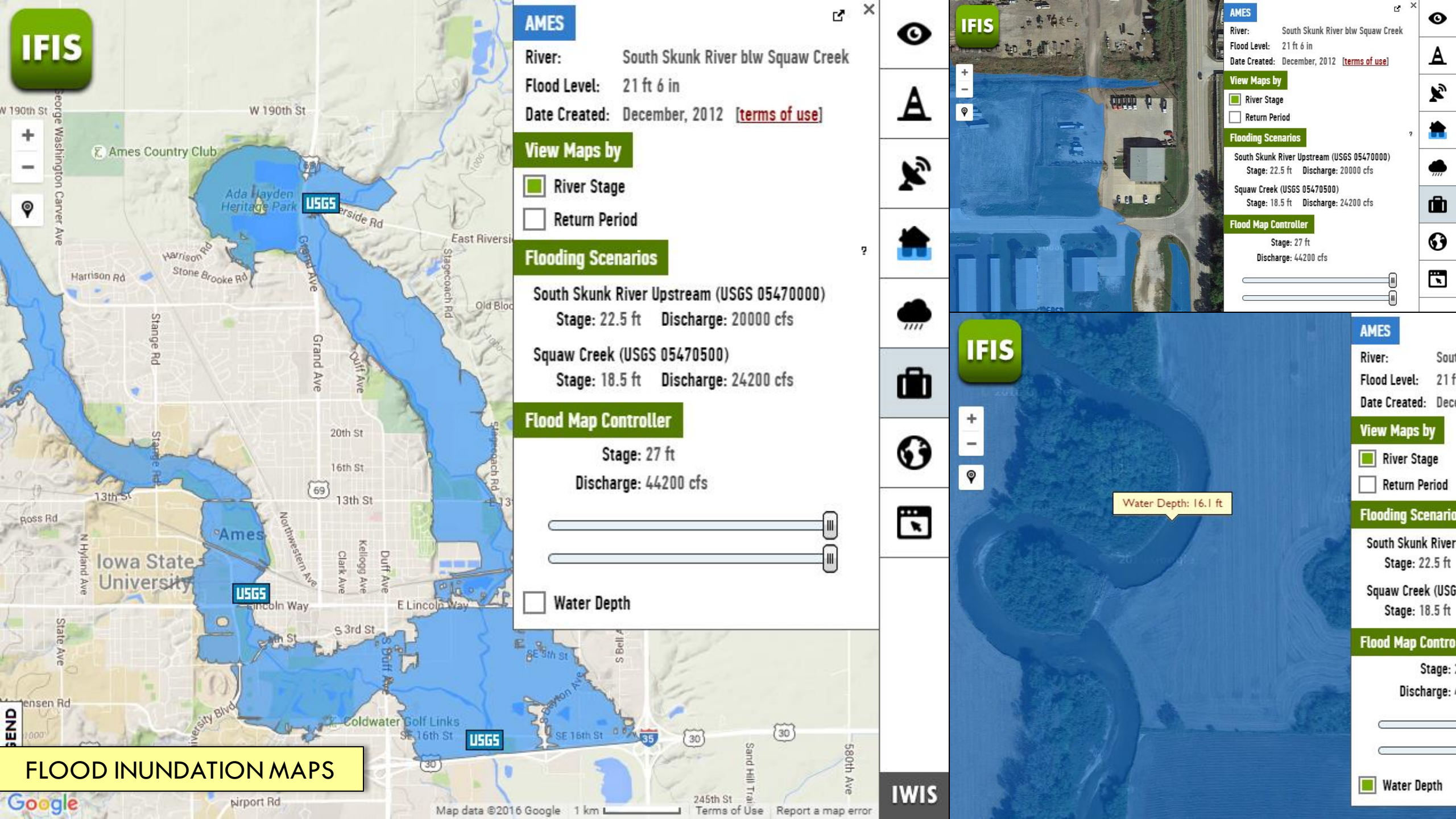
Custom Rainfall Mosaic



Seasonal Flood Forecast



High-res Grid Drawing

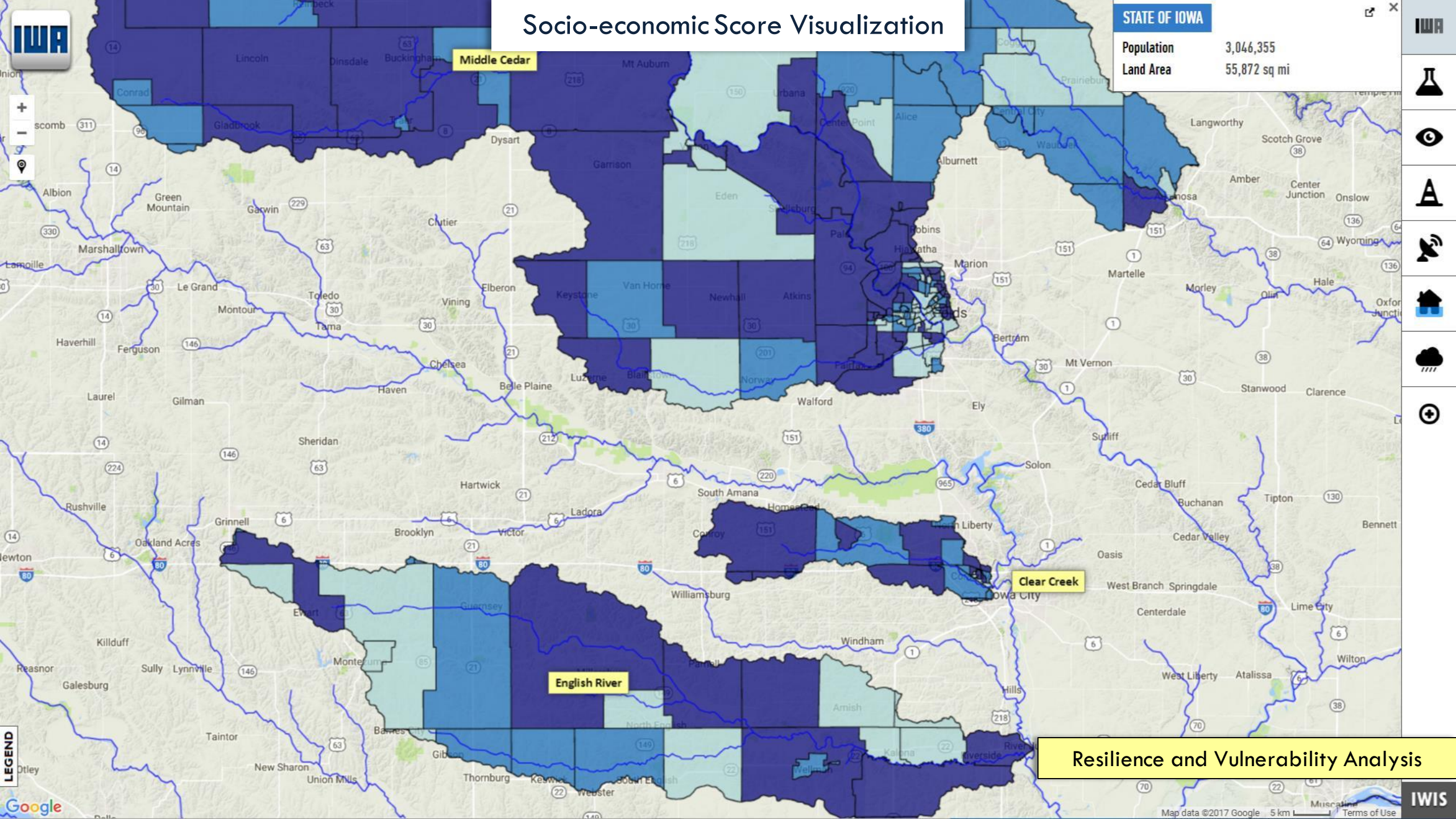


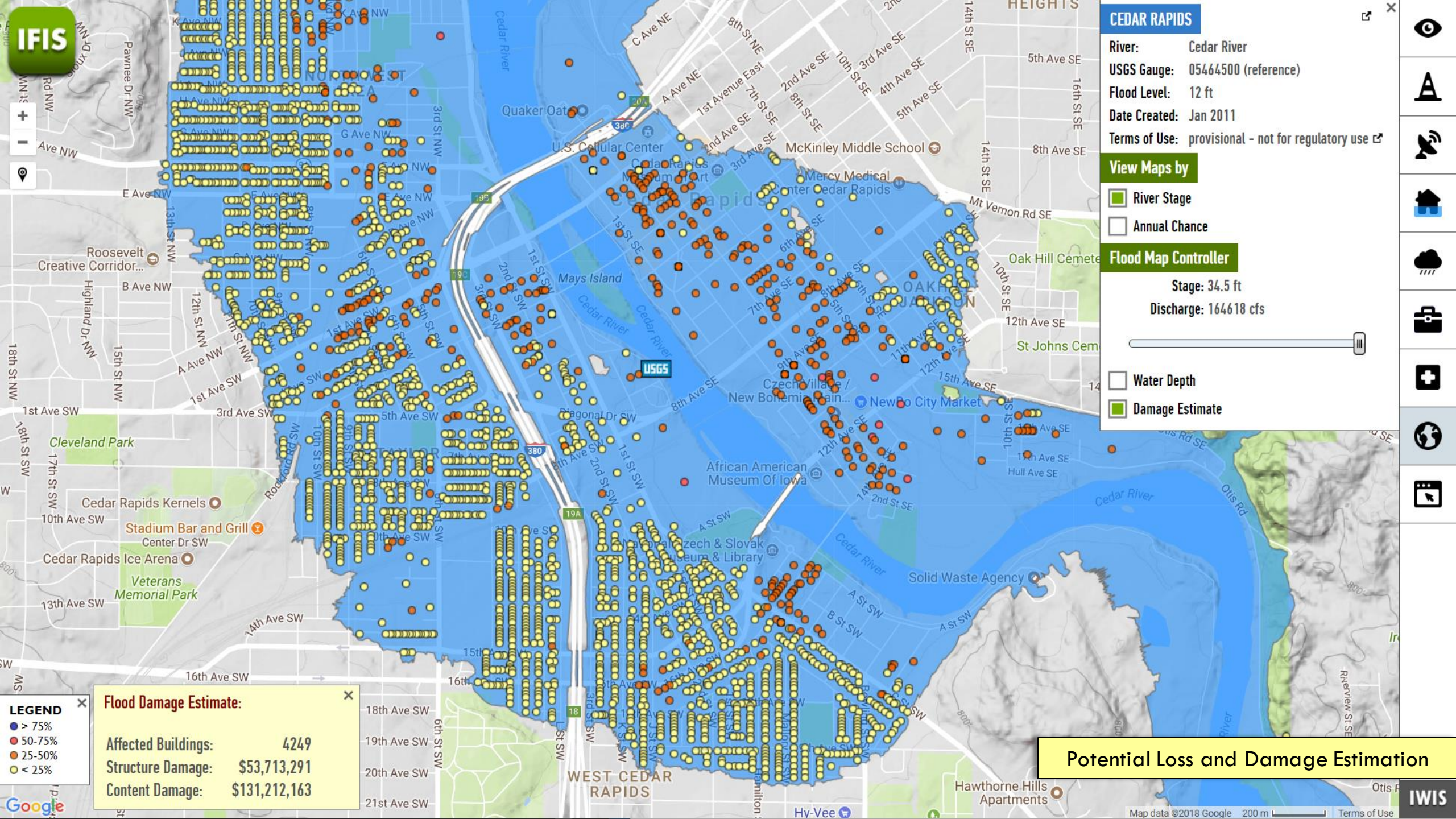
FLOOD INUNDATION MAPS

Decision Support Systems

Serious Gaming

Socio-economic Score Visualization




IFIS
CEDAR RAPIDS
River: Cedar River
USGS Gauge: 05464500 (reference)
Flood Level: 12 ft
Date Created: Jan 2011
Terms of Use: provisional - not for regulatory use
View Maps by
River Stage
Annual Chance
Flood Map Controller
Stage: 34.5 ft
Discharge: 164618 cfs
Water Depth
Damage Estimate
LEGEND
> 75%
50-75%
25-50%
< 25%
Flood Damage Estimate:
Affected Buildings: 4249
Structure Damage: $53,713,291
Content Damage: $131,212,163
Potential Loss and Damage Estimation
IWIS
Google
Map data ©2018 Google
Terms of Use

Iowa Watershed DSS

MULTI HAZARD TOURNAMENT

Search Watershed
Overview
Data Resources
Planning
Support

Middle Cedar

Log Out

Turn 1

Historic Climate Record

Turn Actions

Assess Alternative

Budget

Total:
$0 / $1,600,000,000

Localized Actions:
$0 / $800,000,000

Watershed Actions:
$0 / $800,000,000

O&M Localized Actions:
$0 / $31,000,000

Plan Progress

1 Objective — 2 Resources — 3 Alternative — 4 Assessment — 5 Selection — 6 Implementation — 7 Evaluation

Choose Strategy - Localized Actions

Protect Municipal Water Supply

- ☐ Raise Well Intakes
- ☐ Install New Deep Water Well (IMGD)
- ☐ Install Nitrate Removal Equipment

Structural Action

- ☐ Levees

Non-Structural Action

Elevate Structures

- ◉ None
- ○ Low Number of Structures Elevated
- ○ Moderate Number of Structures Elevated
- ○ High Number of Structures Elevated

Relocate Structures

- ◉ None
- ○ Low Number of Structures Relocated
- ○ Moderate Number of Structures Relocated
- ○ High Number of Structures Relocated

Choose Strategy - Watershed Actions

Land Cover Changes

Grass-Based

Riparian Buffer

- ◉ None

Full Extent | Reset App | Basemaps

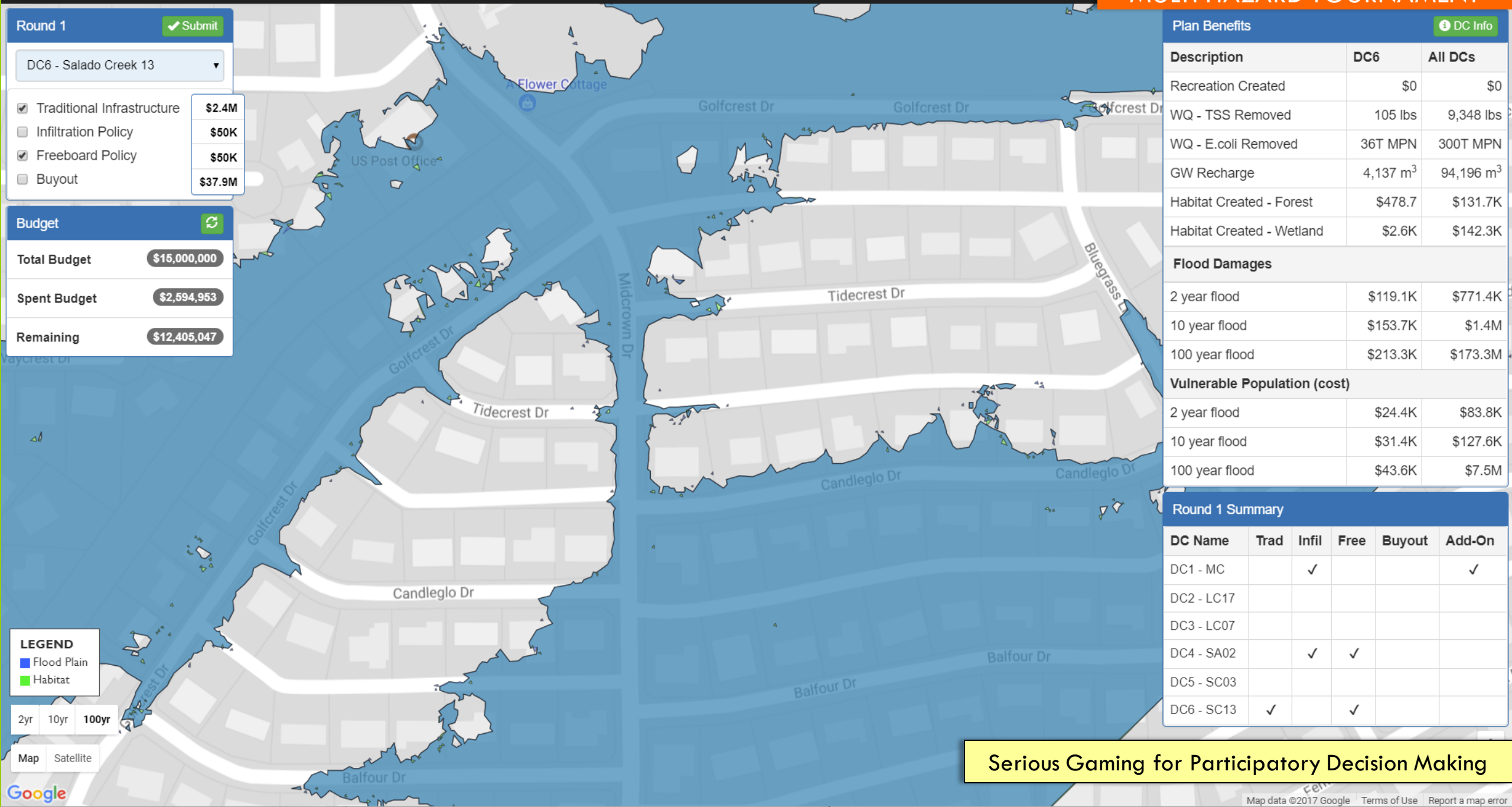
Legend
- POI drainage area
- POI Selected

Serious Gaming for Participatory Decision Making

Leaflet | Map data ©2016 Google | Terms of Use | Report a map error

San Antonio Multi-Hazard Tournament: Bexar County (Upper)

MULTI HAZARD TOURNAMENT



Round 1

Submit

DC6 - Salado Creek 13

☑ Traditional Infrastructure	$2.4M
☐ Infiltration Policy	$50K
☑ Freeboard Policy	$50K
☐ Buyout	$37.9M

Budget

Total Budget	$15,000,000
Spent Budget	$2,594,953
Remaining	$12,405,047

LEGEND
- Flood Plain
- Habitat

2yr | 10yr | 100yr

Map | Satellite

Plan Benefits

DC Info

Description	DC6	All DCs
Recreation Created	$0	$0
WQ - TSS Removed	105 lbs	9,348 lbs
WQ - E.coli Removed	36T MPN	300T MPN
GW Recharge	4,137 m^3	94,196 m^3
Habitat Created - Forest	$478.7	$131.7K
Habitat Created - Wetland	$2.6K	$142.3K
Flood Damages		
2 year flood	$119.1K	$771.4K
10 year flood	$153.7K	$1.4M
100 year flood	$213.3K	$173.3M
Vulnerable Population (cost)		
2 year flood	$24.4K	$83.8K
10 year flood	$31.4K	$127.6K
100 year flood	$43.6K	$7.5M

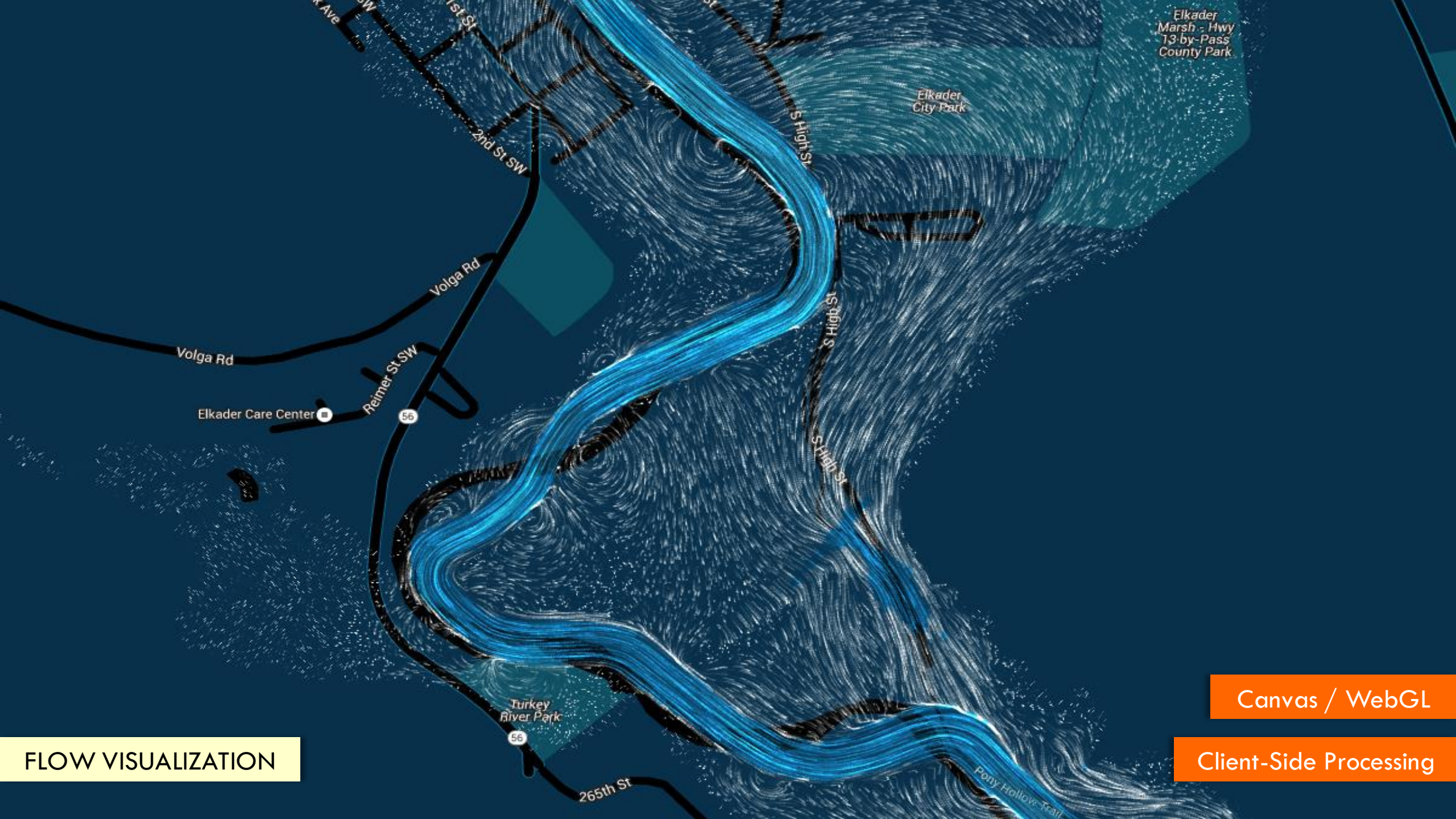
Round 1 Summary

DC Name	Trad	Infil	Free	Buyout	Add-On
DC1 - MC		✓			✓
DC2 - LC17					
DC3 - LC07					
DC4 - SA02		✓	✓		
DC5 - SC03					
DC6 - SC13	✓		✓		

Serious Gaming for Participatory Decision Making

Scientific Visualization

Data Analytics



FLOW VISUALIZATION

Canvas / WebGL

Client-Side Processing

FLOW VISUALIZATION

IFIS RESEARCH PLATFORM

- [ ] Multi-Sensor Box View
- [ ] Iowa Flood Visualizer
- [ ] Iowa Video Stream
- [ ] Iowa 3D City Visualizer
- [ ] Smart Assistant

Rainfall

- [ ] Current Rainfall (demo - 1m)
- [ ] IFIS & MRMS Rainfall Comparison
- [ ] Rainfall Drainage

Water Animation

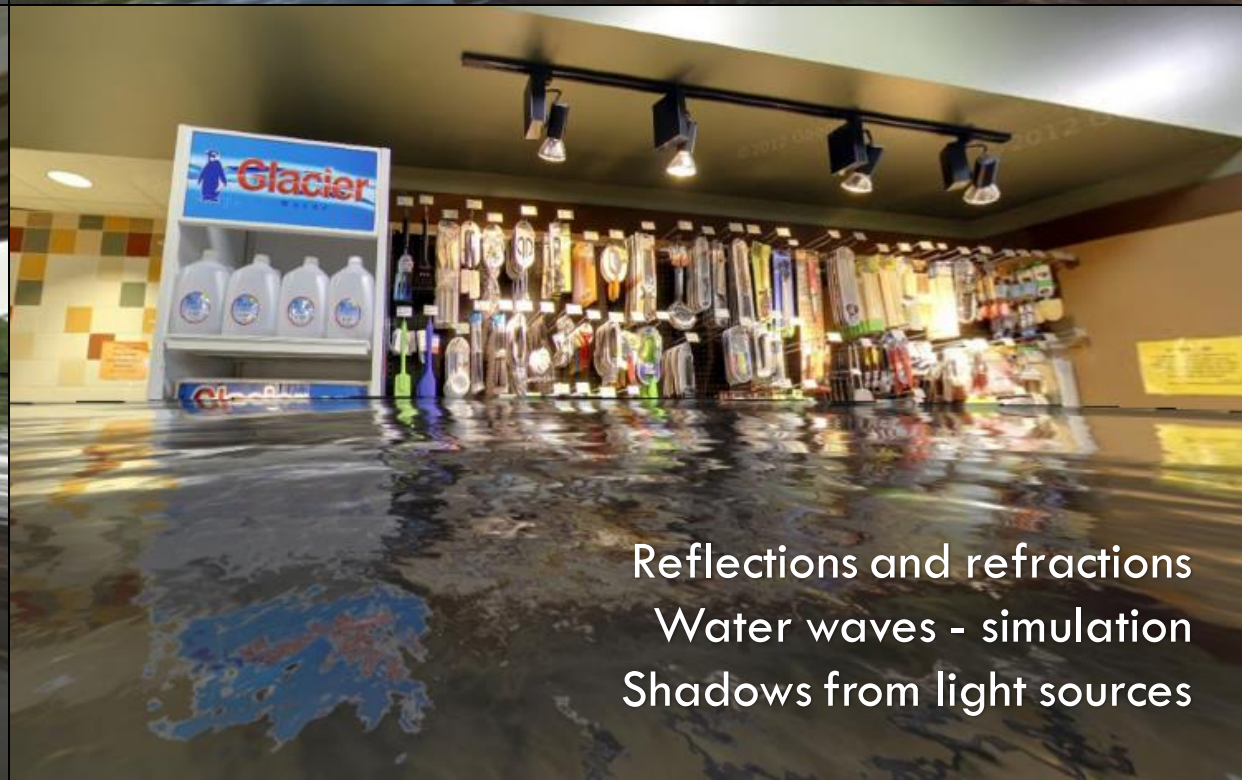
- [ ] Streamflow Forecast
- [ ] Rainfall (daily)
- [ ] Water Quality (stream)
- [ ] Water Quality (model)
- [x] Flood Inundation M

Canvas / WebGL

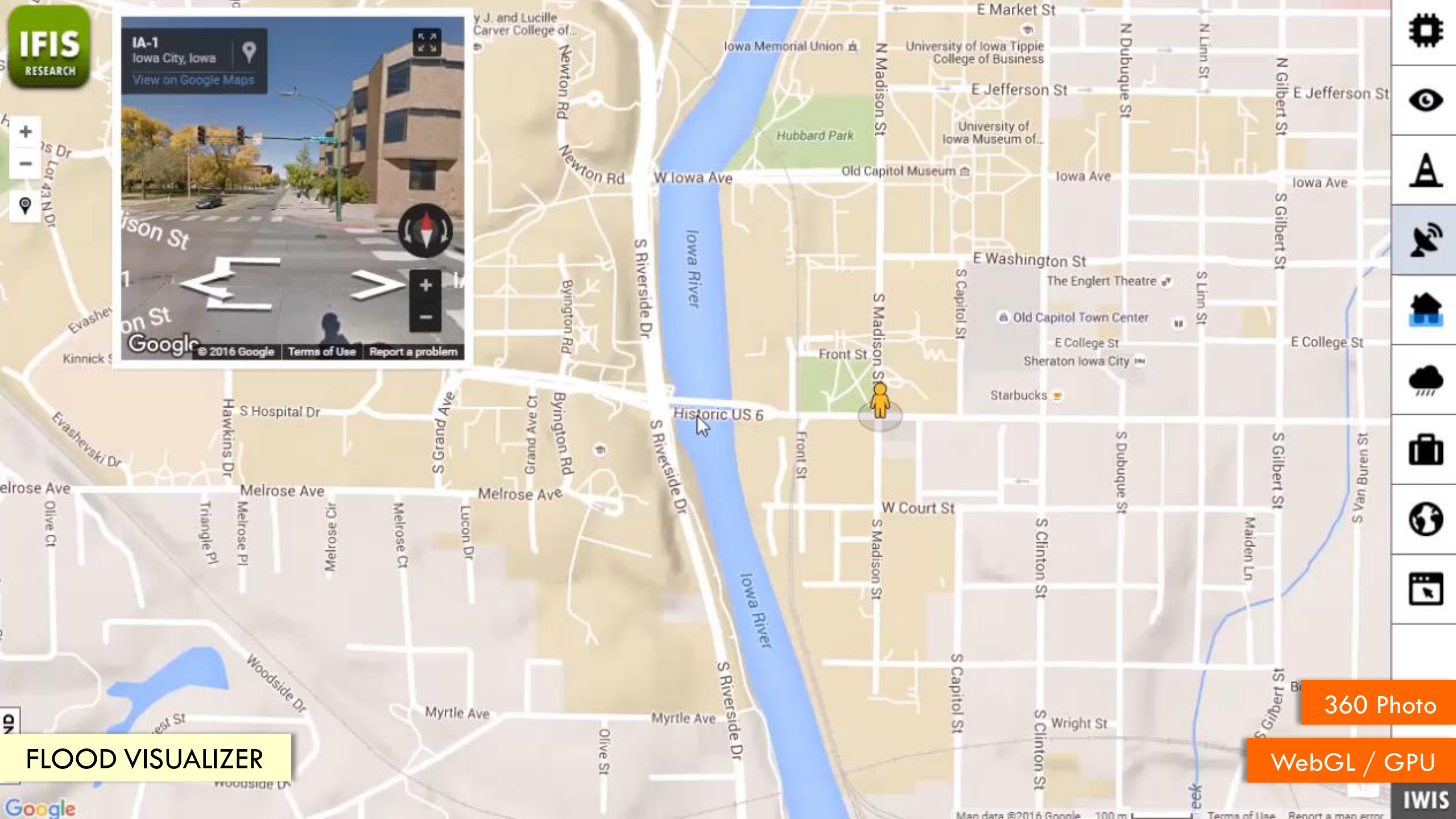
Client-Side Processing

IWIS

FLOOD VISUALIZER



Reflections and refractions
Water waves - simulation
Shadows from light sources


IFIS
RESEARCH
IA-1
Iowa City, Iowa
View on Google Maps
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Report a problem
E Market St
Iowa Memorial Union
University of Iowa Tippie College of Business
E Jefferson St
Hubbard Park
University of Iowa Museum of...
Old Capitol Museum
W Iowa Ave
Iowa Ave
Newton Rd
N Madison St
N Dubuque St
N Linn St
N Gilbert St
S Riverside Dr
Iowa River
E Washington St
The Englert Theatre
Old Capitol Town Center
S Capitol St
S Linn St
S Gilbert St
E College St
Sheraton Iowa City
Starbucks
Front St
S Madison St
Historic US 6
S Hospital Dr
Hawkins Dr
S Grand Ave
Byington Rd
Evashevski Dr
Melrose Ave
Olive Ct
Triangle Pl
Melrose Pl
Melrose Cir
Melrose Ct
Lucon Dr
W Court St
S Dubuque St
S Clinton St
Maiden Ln
S Van Buren St
Woodside Dr
Myrtle Ave
Olive St
Wright St
Google
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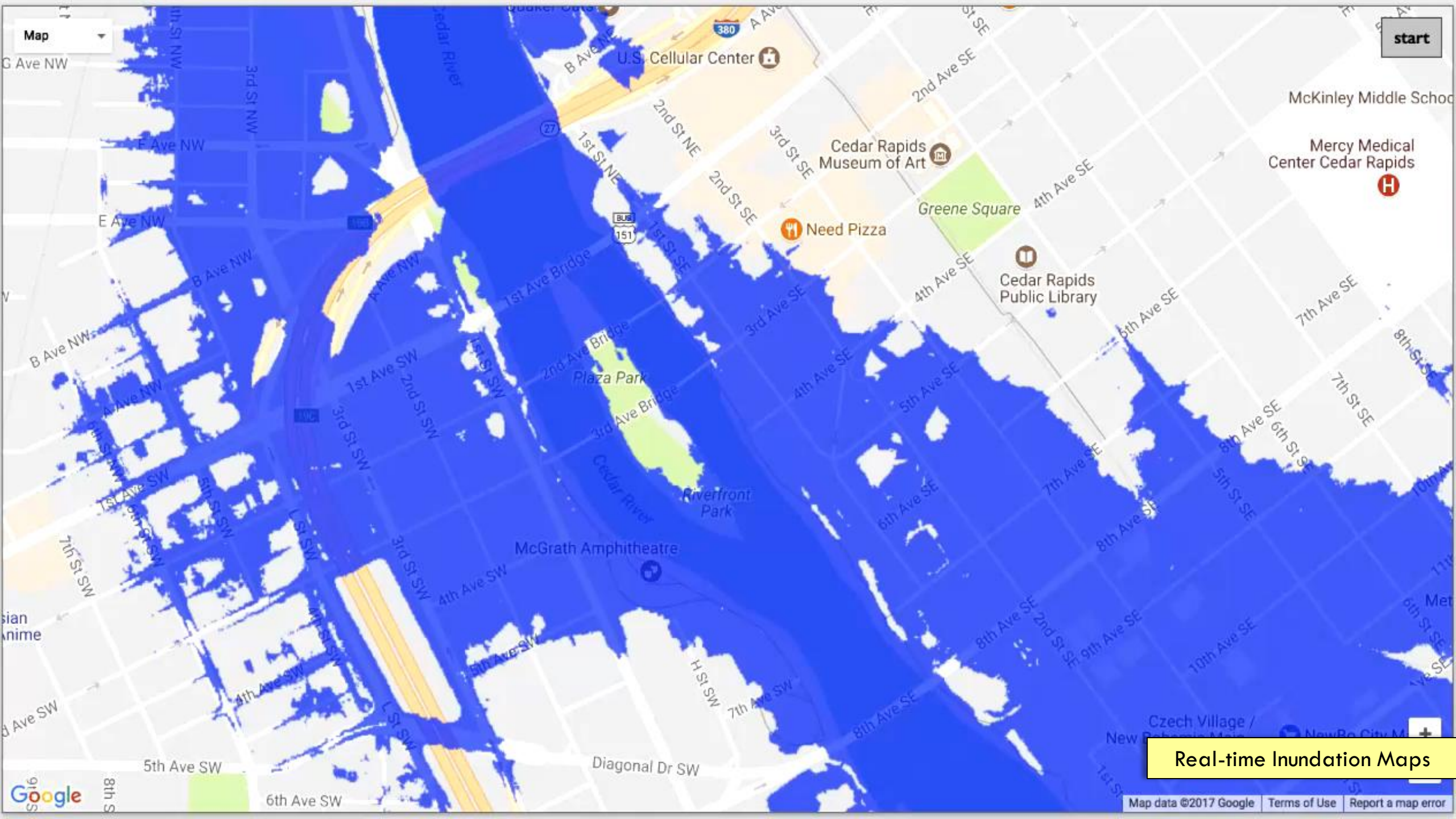
Report a map error
FLOOD VISUALIZER
360 Photo
WebGL / GPU
IWIS


Map
start
U.S. Cellular Center
Cedar Rapids Museum of Art
Mercy Medical Center Cedar Rapids
McKinley Middle Schoo
Need Pizza
Greene Square
Cedar Rapids Public Library
Plaza Park
Riverfront Park
McGrath Amphitheatre
Cedar River
1st Ave Bridge
2nd Ave Bridge
3rd Ave Bridge
2nd St NE
1st St NE
2nd St SE
3rd St SE
4th Ave SE
5th Ave SE
6th Ave SE
7th Ave SE
8th Ave SE
1st Ave SW
2nd St SW
3rd St SW
4th Ave SW
5th Ave SW
6th Ave SW
7th St SW
Diagonal Dr SW
Czech Village /
Real-time Inundation Maps
Google
Map data ©2017 Google
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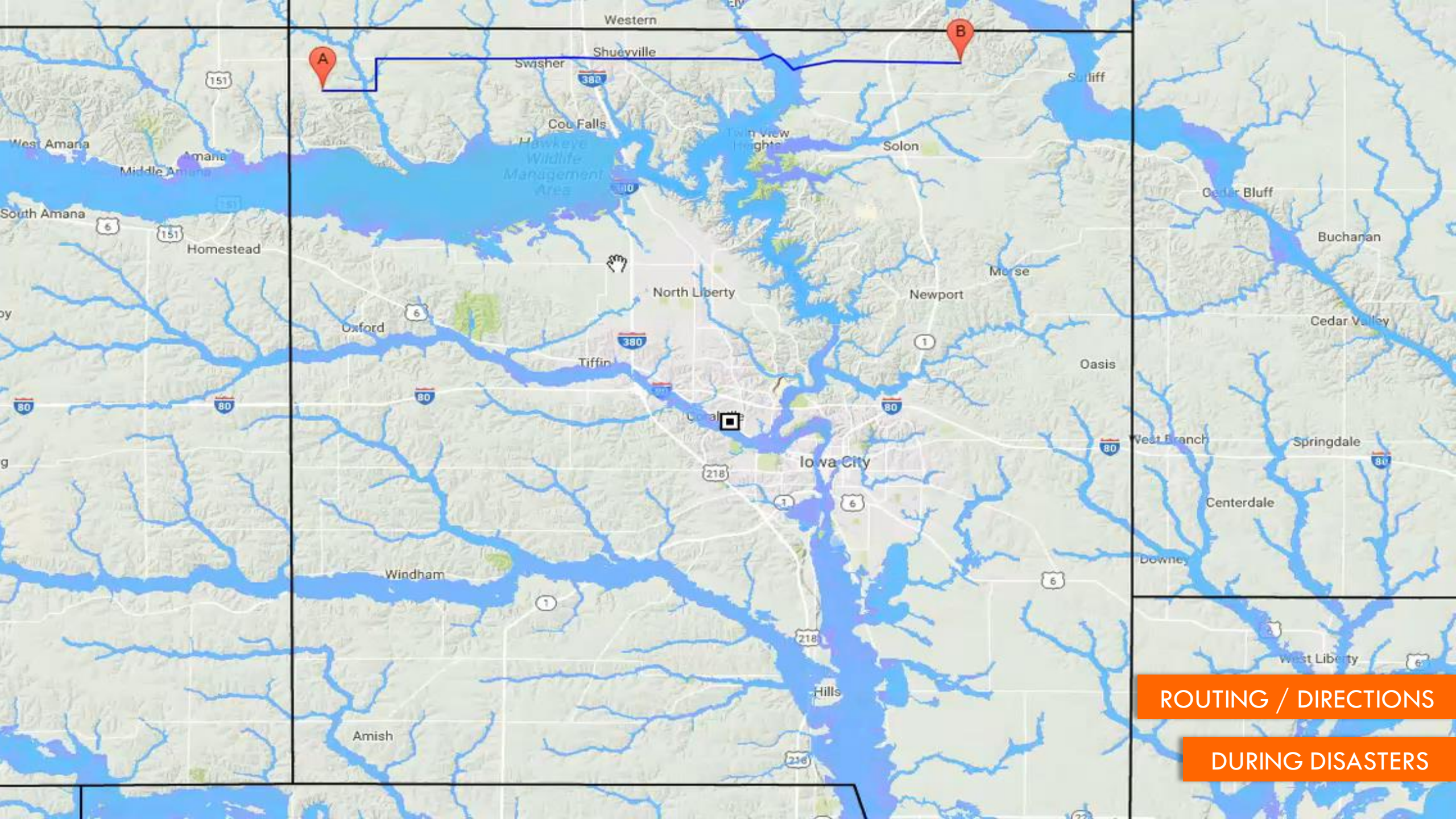
Report a map error

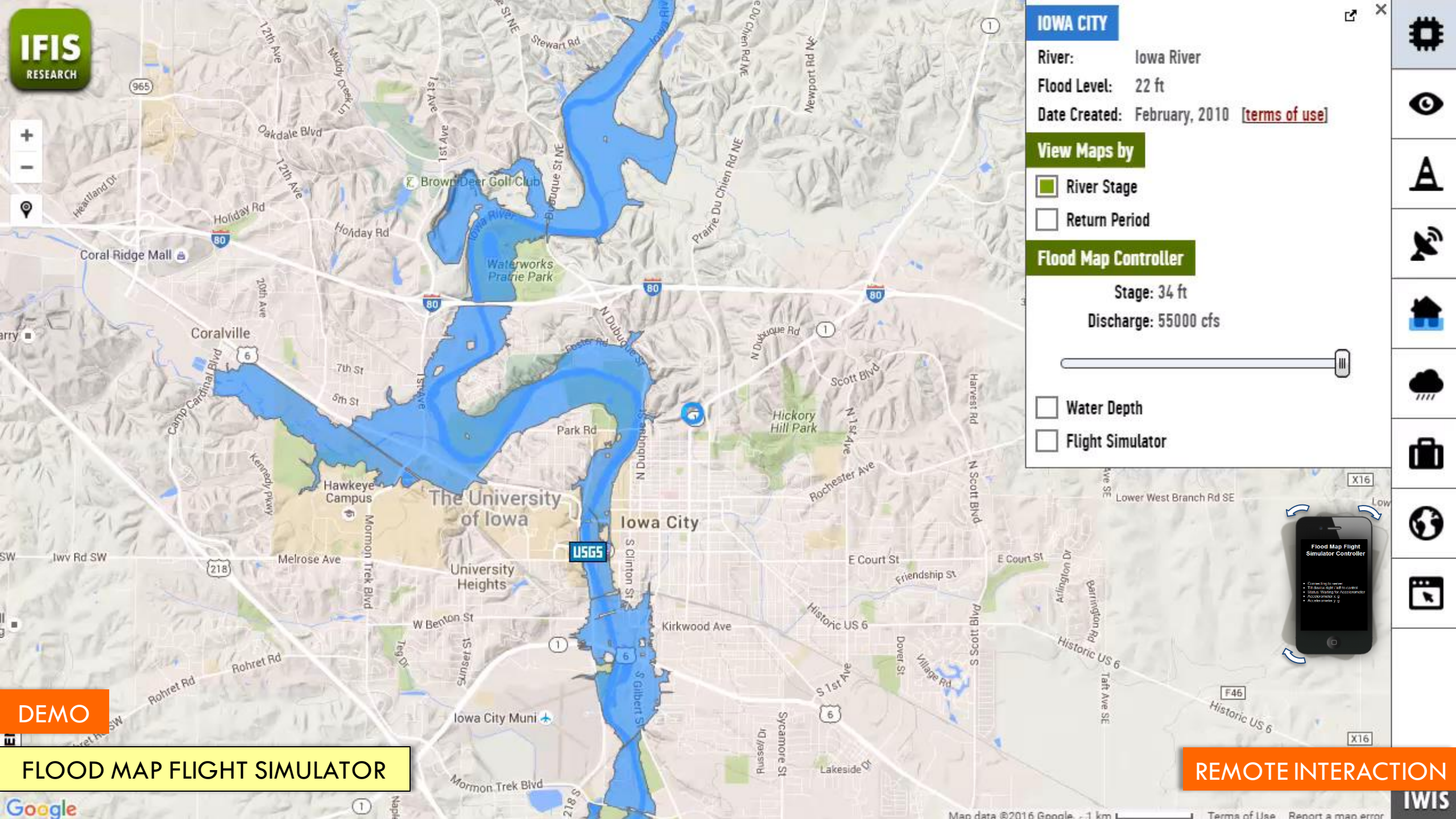


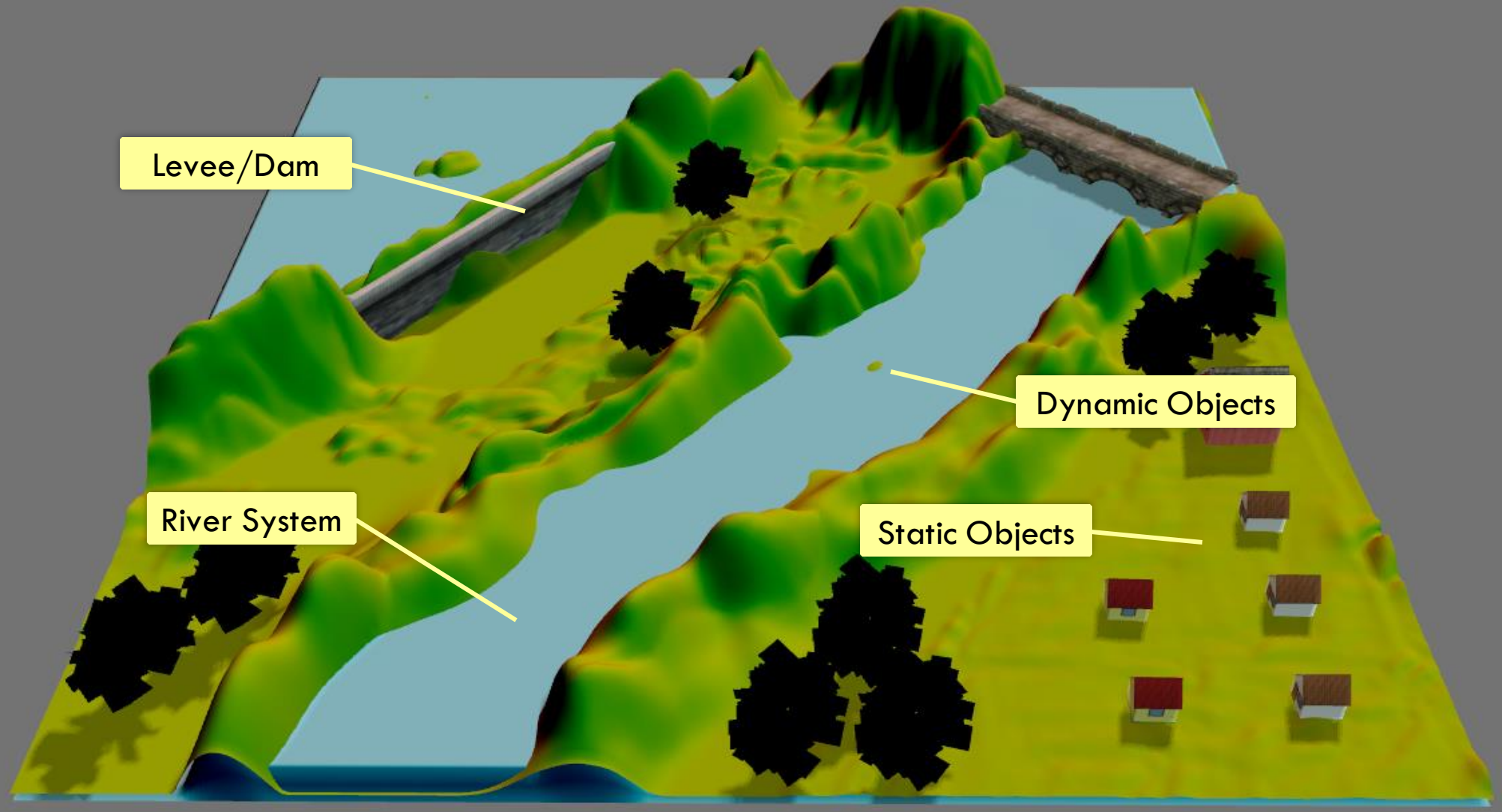
ROUTING / DIRECTIONS

DURING DISASTERS

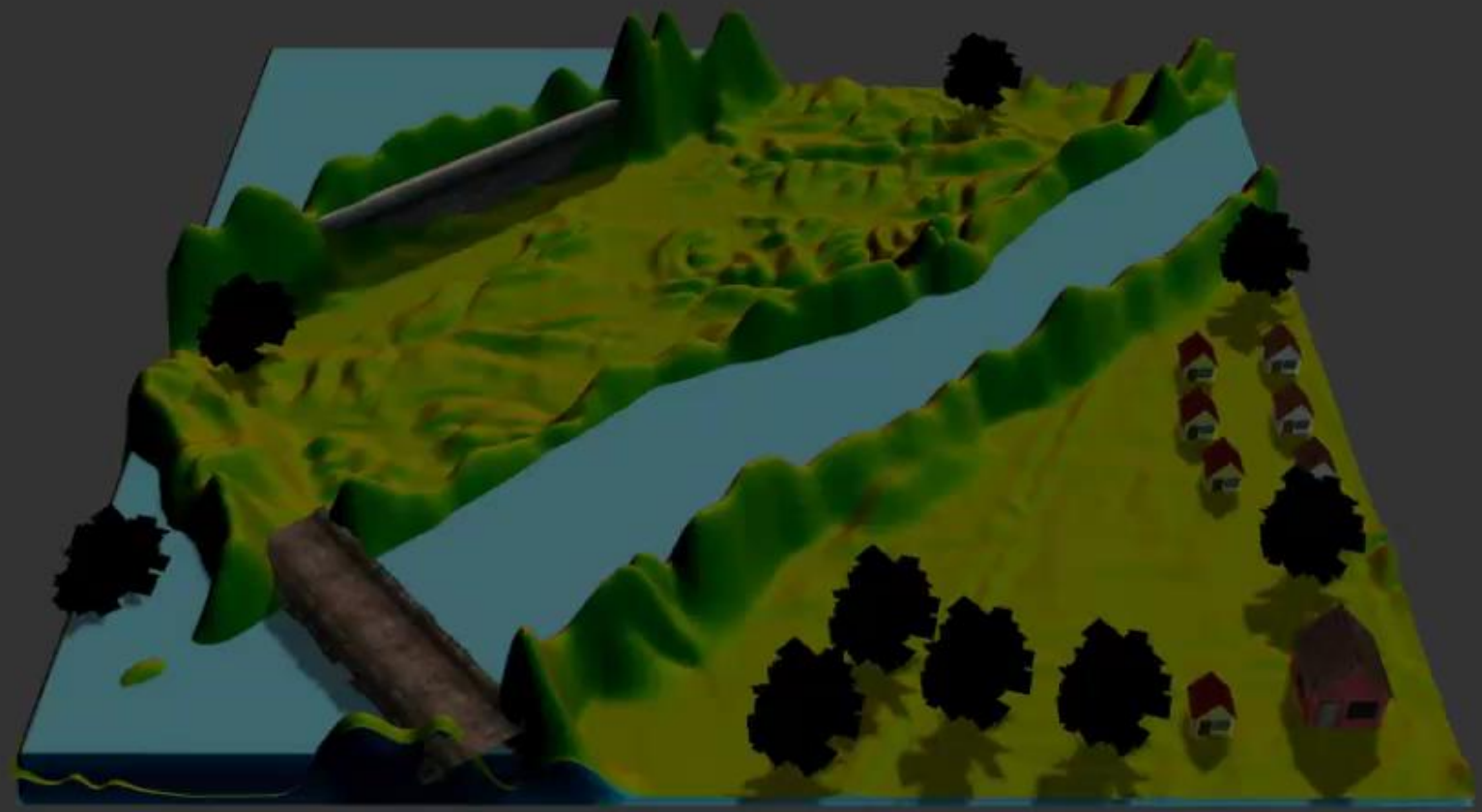
Cyber Learning Systems

Gaming with AR / VR

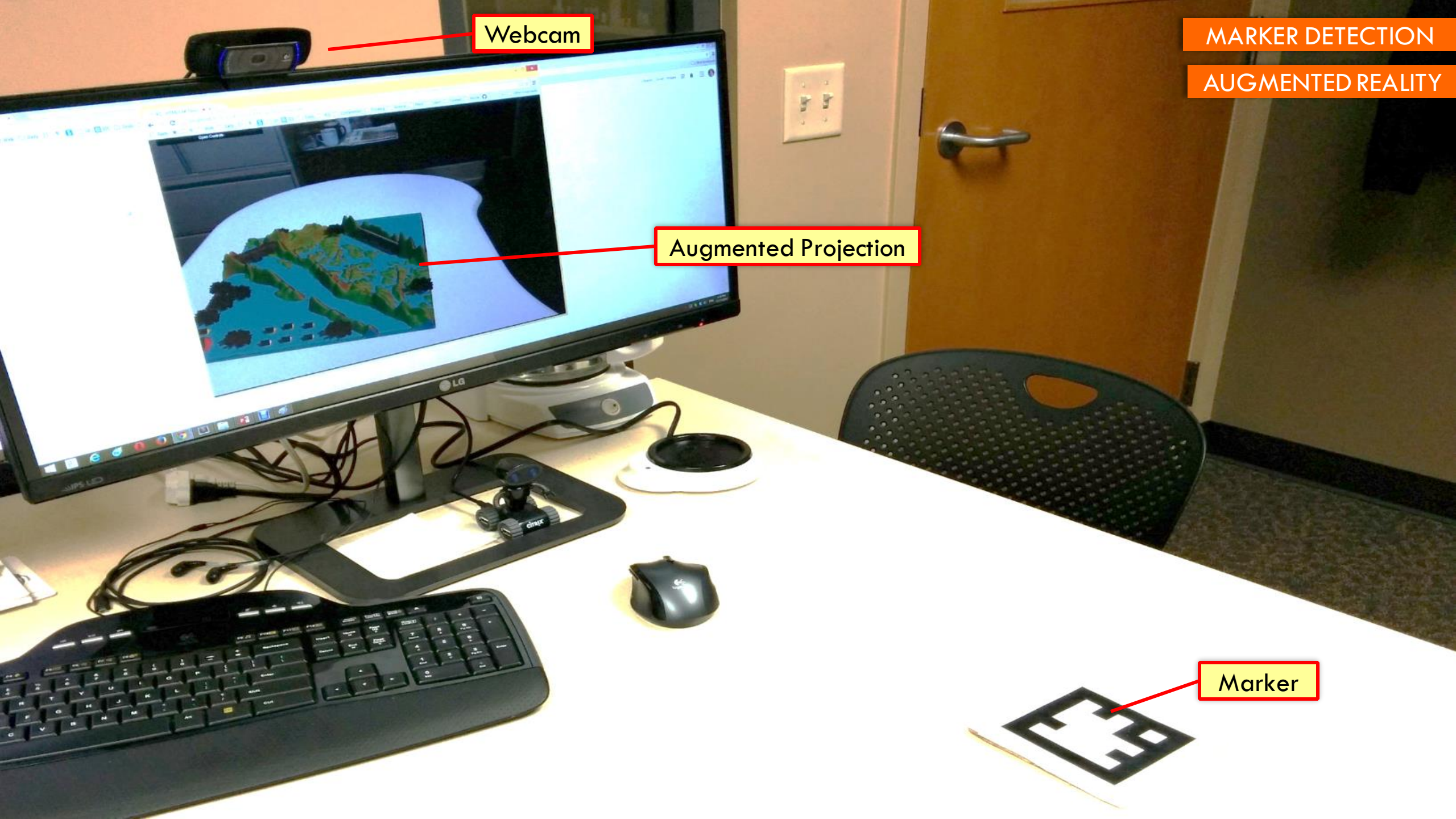

IFIS RESEARCH
IOWA CITY
River: Iowa River
Flood Level: 22 ft
Date Created: February, 2010 [terms of use]
View Maps by
River Stage
Return Period
Flood Map Controller
Stage: 34 ft
Discharge: 55000 cfs
Water Depth
Flight Simulator
Flood Map Flight Simulator Controller
Coralville
Iowa City
The University of Iowa
Hawkeye Campus
University Heights
Hickory Hill Park
Waterworks Prairie Park
Brown Deer Golf Club
Coral Ridge Mall
Iowa City Muni
USGS
DEMO
FLOOD MAP FLIGHT SIMULATOR
REMOTE INTERACTION


Levee/Dam
Dynamic Objects
River System
Static Objects

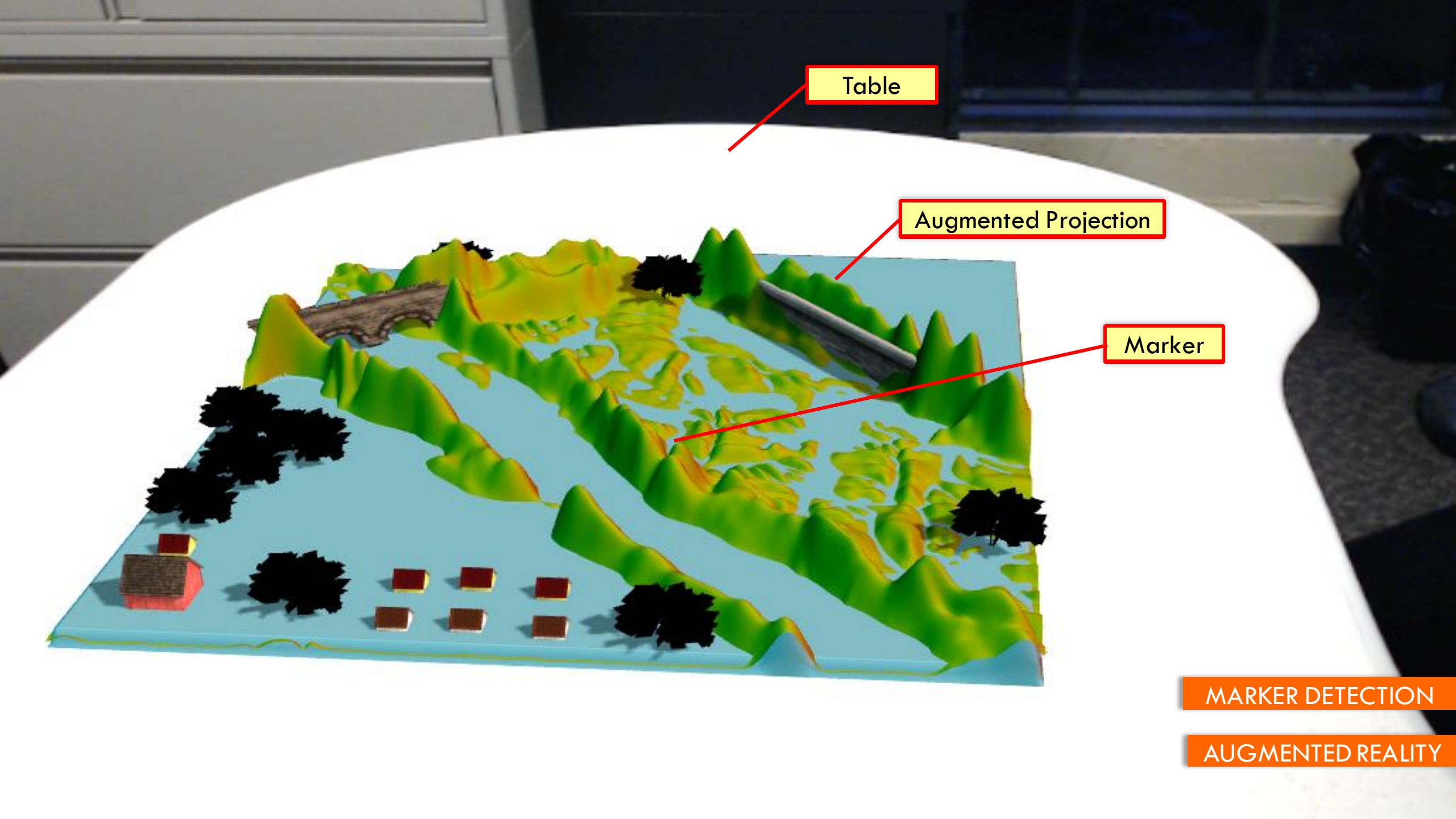
VIRTUAL REALITY



DEMO



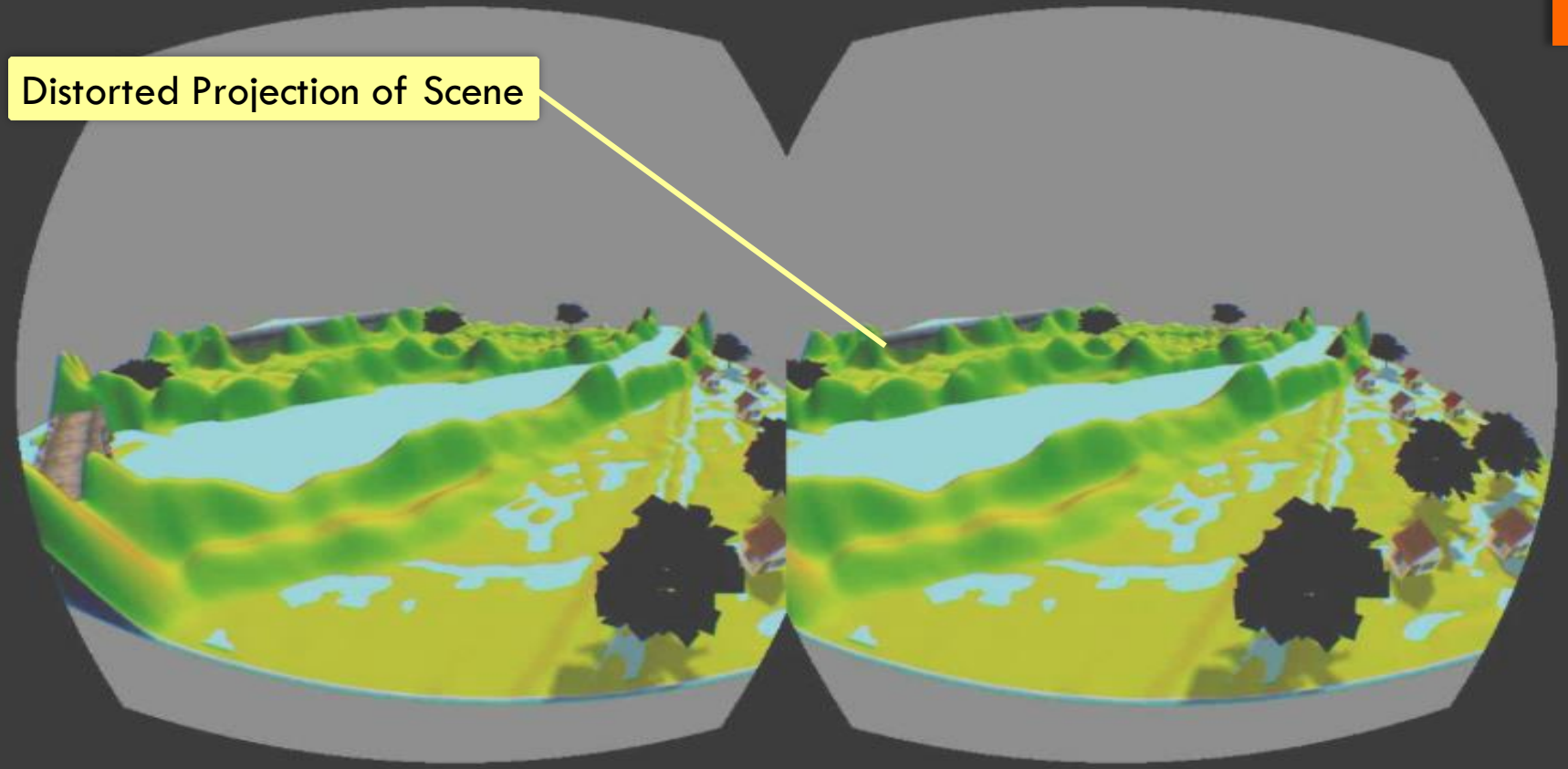
MARKER DETECTION
AUGMENTED REALITY



MARKER DETECTION

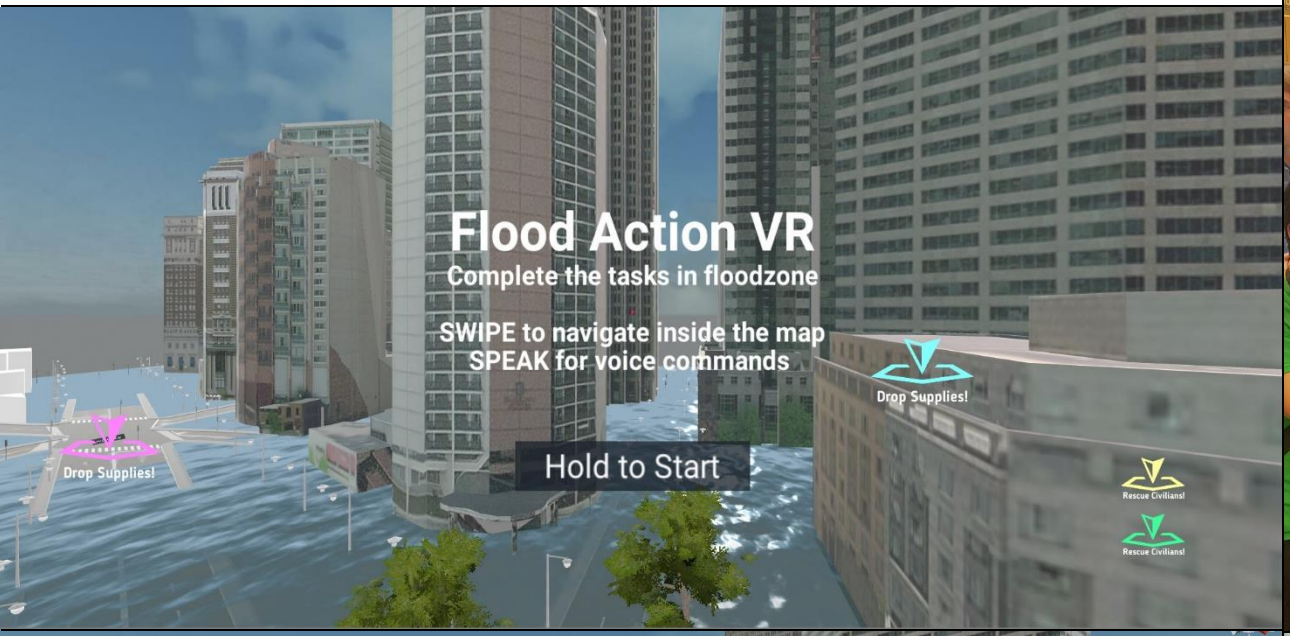
AUGMENTED REALITY

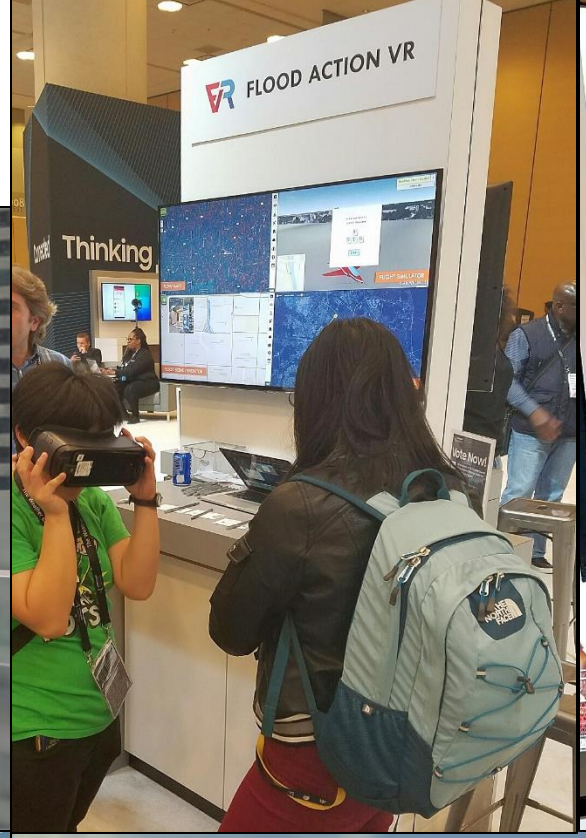
AUGMENTED REALITY
DEMO

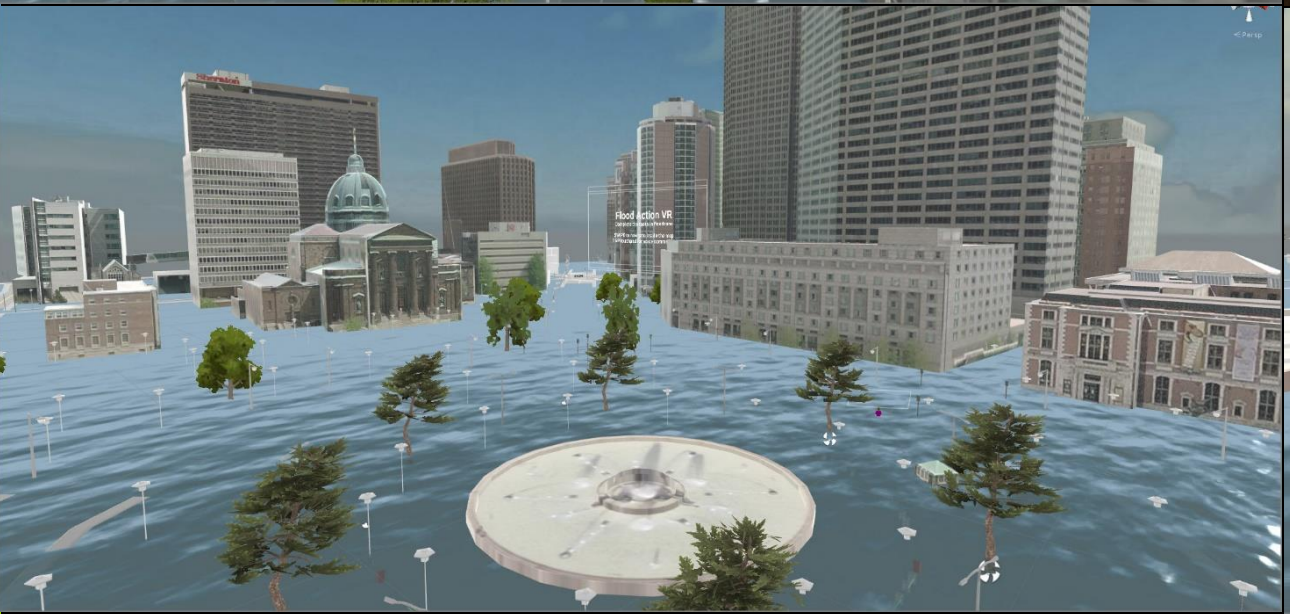


Heads-up Displays

FLOOD ACTION VR



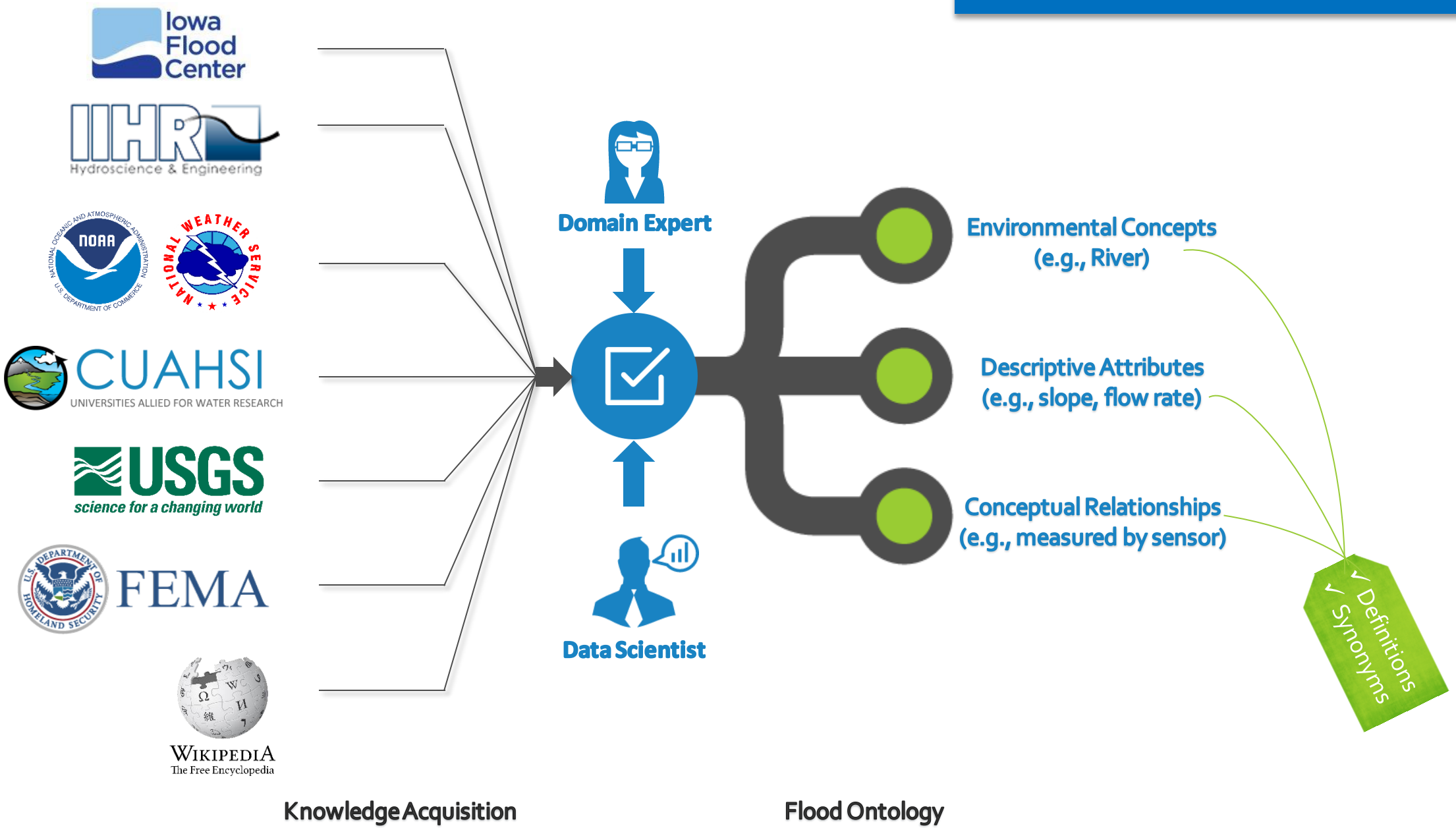




Intelligent Systems

ML and AI

Structured Knowledge



Knowledge Engine

What location did receive the maximum rainfall in Iowa City on 25th of June 2008 at 5:30 PM?

✓ TEXT INPUT

✓ MULTI-SELECTION

✓ VOICE INPUT

KNOWLEDGE BASE

Using our information-centric ontology that captures hundreds of concepts and attributes in flood domain.

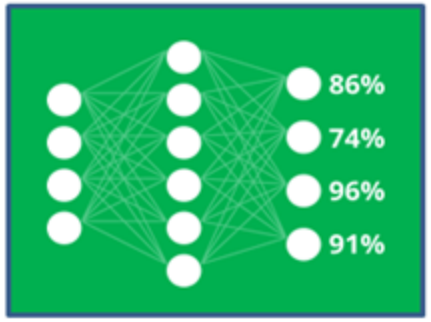
What location did receive the maximum rainfall in Iowa City on 25th of June 2008 at 5:30 PM?

Natural Language Processing

Ontological keywords = rainfall, maximum rainfall
Location = Iowa City
Time = 06/25/2008 17:30
Desired answer type = Coordinate

INFERENCE

- *Matching attributes to concepts*
- *Location & Date Analysis*
- *Intent Specification*



- Predefined Questions
- Scientific Knowledge Base
- IFIS Data Resources & Tools
- IFIS Functions and Interfaces

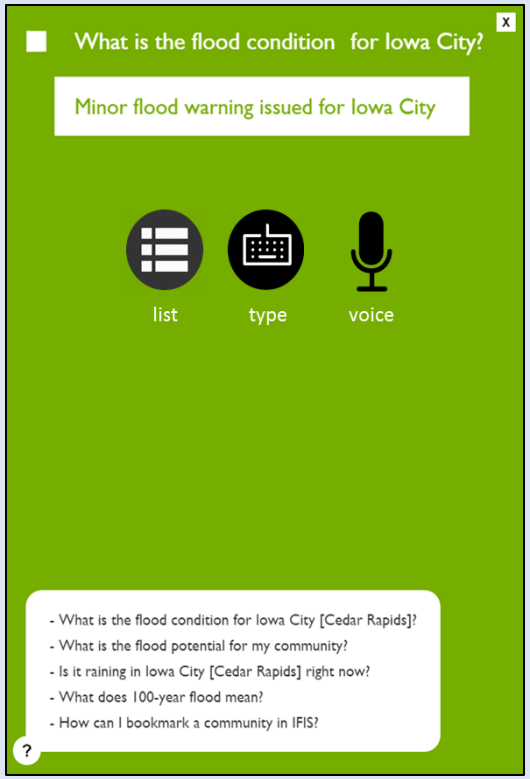
SCORING

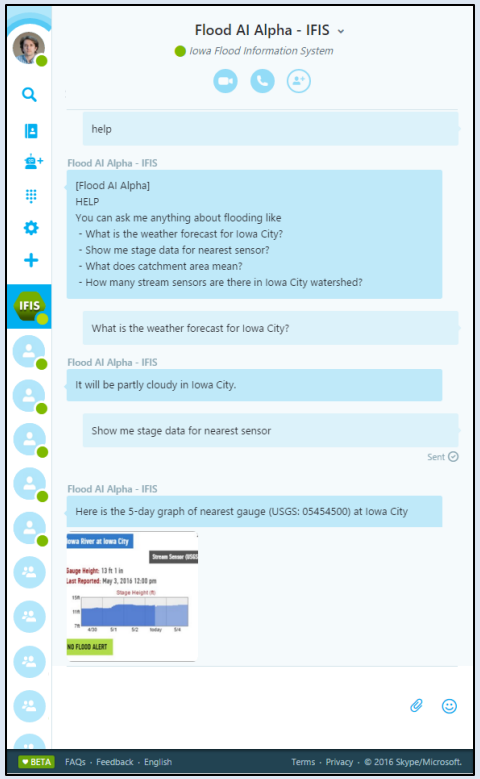
Using the information extracted from the natural language question as a criteria for matching to predefined questions.

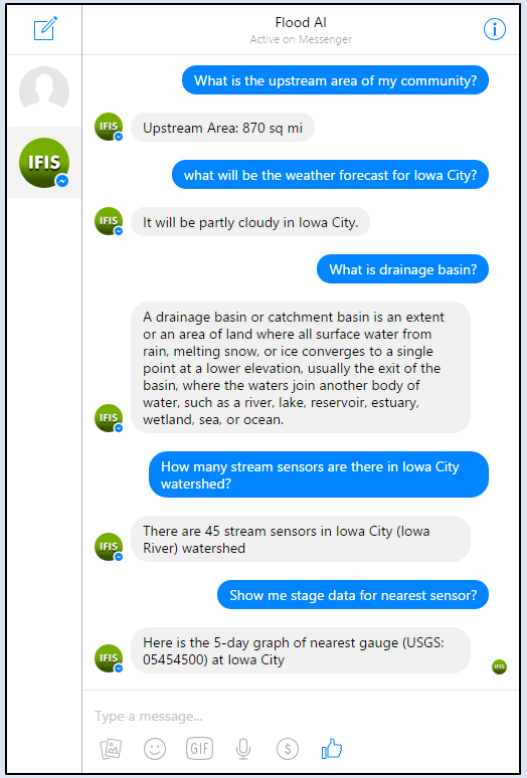
USER INTERFACE

Friendly user interface providing real-time analysis of voice-enabled question

Smart Assistants







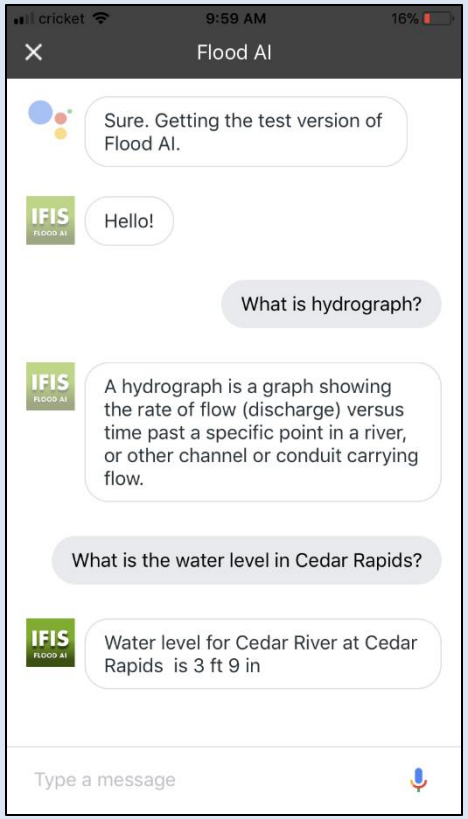
IFIS

skype

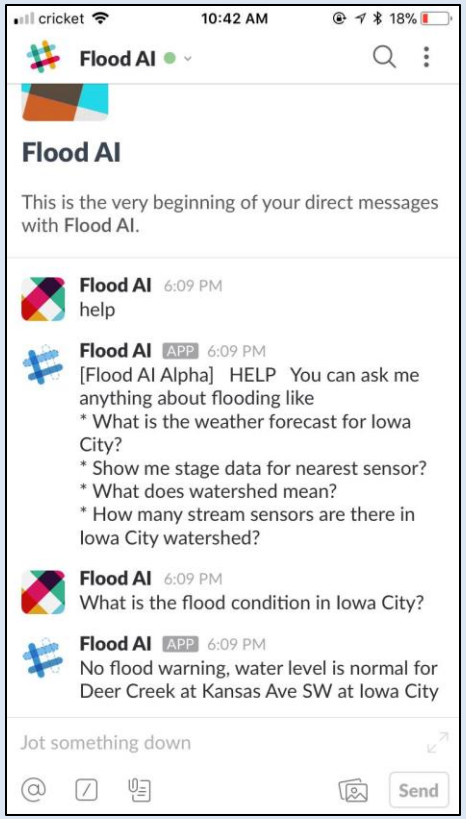
facebook

Smart Assistants

Cortana



Google Assistant



slack

Smart Devices

Google Home

Ok Google **let me talk to Flood AI**

Amazon Echo

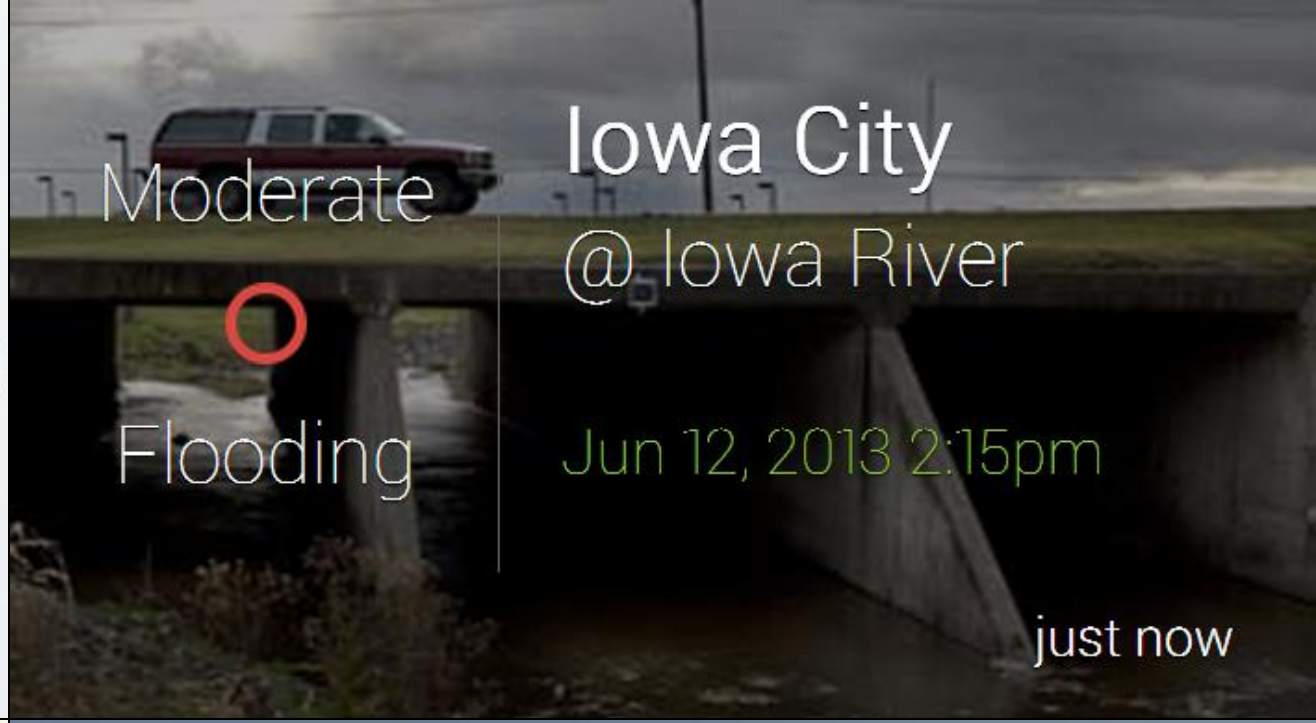
Alexa **ask Flood AI** …

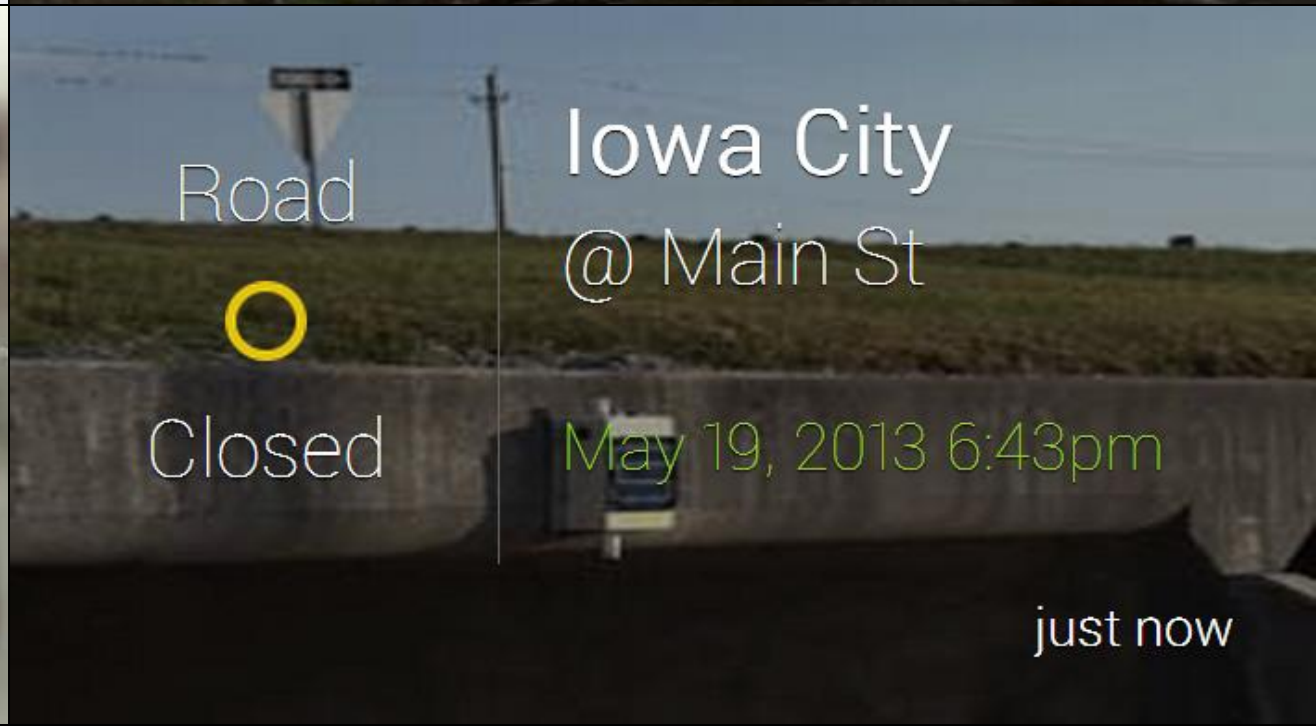
what is the flood condition for Iowa City at 5pm tomorrow

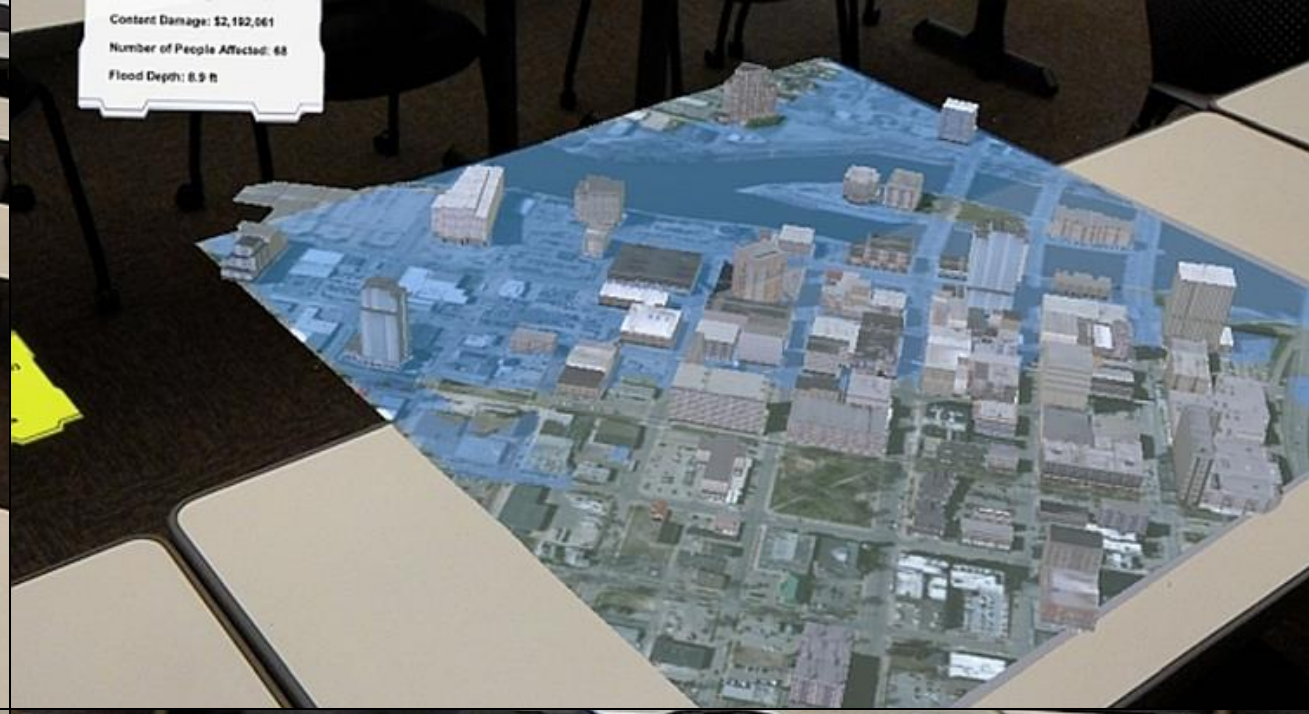
Next Generation Devices

Holography

Google Glass






Content Damage: $2,192,061
Number of People Affected: 68
Flood Depth: 8.9 ft

OVERVIEW
Property Type: Commercial

OVERVIEW
Property Type: Commercial

Holography

What's Next?

What is next for Flood AI?

Brain Computer Interface

Many devices available ($80-$300)

e.g. Emotiv Epoc+

Bone Conduction Headphones

MindFlood

Flood Knowledge by Thought

Thank you

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