

Next Generation Hydroinformatics Systems for Big Data Management, Analysis and Visualization

Ibrahim Demir



Big Data

- ❑ We are collecting and generating data on a petabyte scale ($1 \text{ Pb} = 1,000 \text{ Tb} = 1 \text{ M Gb}$)
- ❑ Data contains valuable information that can drive insights and discoveries
- ❑ It can be difficult to access, manage, and generate knowledge and decisions



Scientific Visualization can help us
pair science and design to simplify
the complexity, and drive a deeper
understanding of the context

Why Visualization?

“A visualization is worth a thousand numbers”

Find a story
in the data

[Exploration]

Tell a story to
an audience

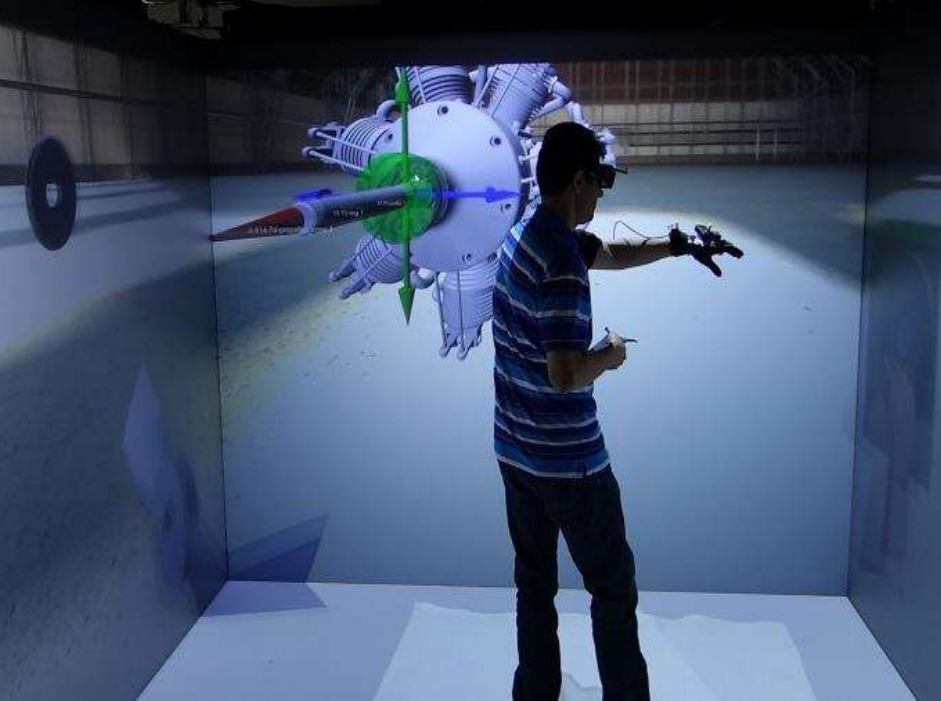
[Explanation]

Represent large data sets in a comprehensible way

Help the user see relationships in the data

Visualization Systems & Hardware

CAVE & Projection



Multiscreen Systems



Display Technology



Visualization & Interaction

Technologies

Web 3.0 and GPU

JS x 100 - Multicore GPU

Big Data Analytics

Rich Interactive Interfaces

Desktop-like Games

Scientific Visualization

Image / Video Processing

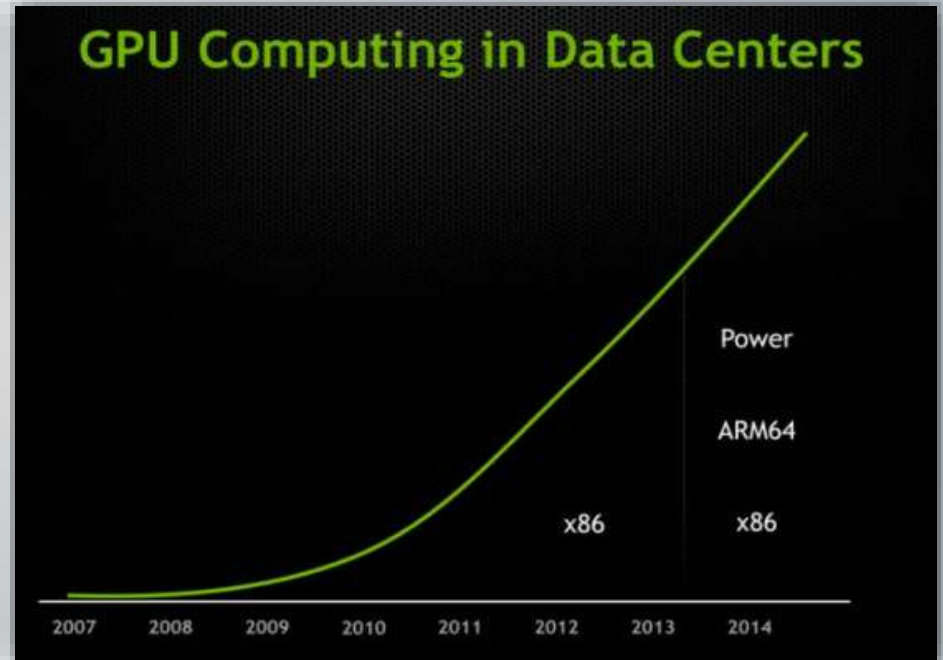
Augmented / Immersive Reality



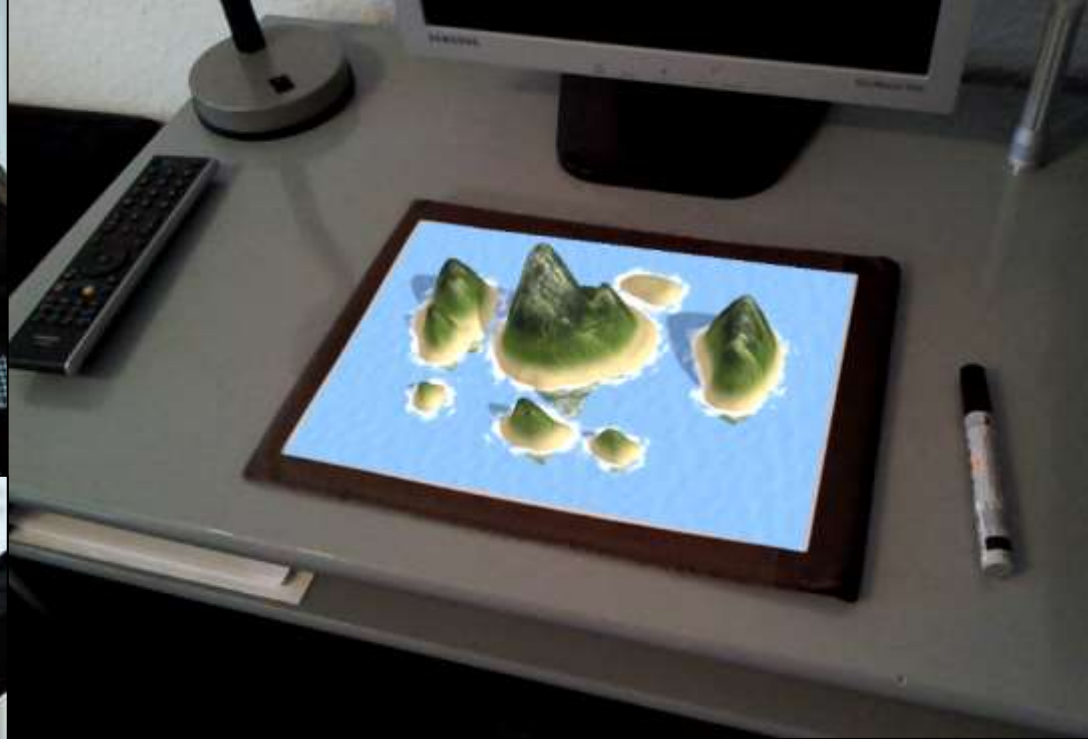
AMD Radeon HD 7990 – 4096 Streaming Processing Units – \$899

8.2 TFLOPs compute power (1st 2001, 6th 2003, 17th in 2004)

82 TFLOPs compute power (10th 2007) – (36,864 cores)



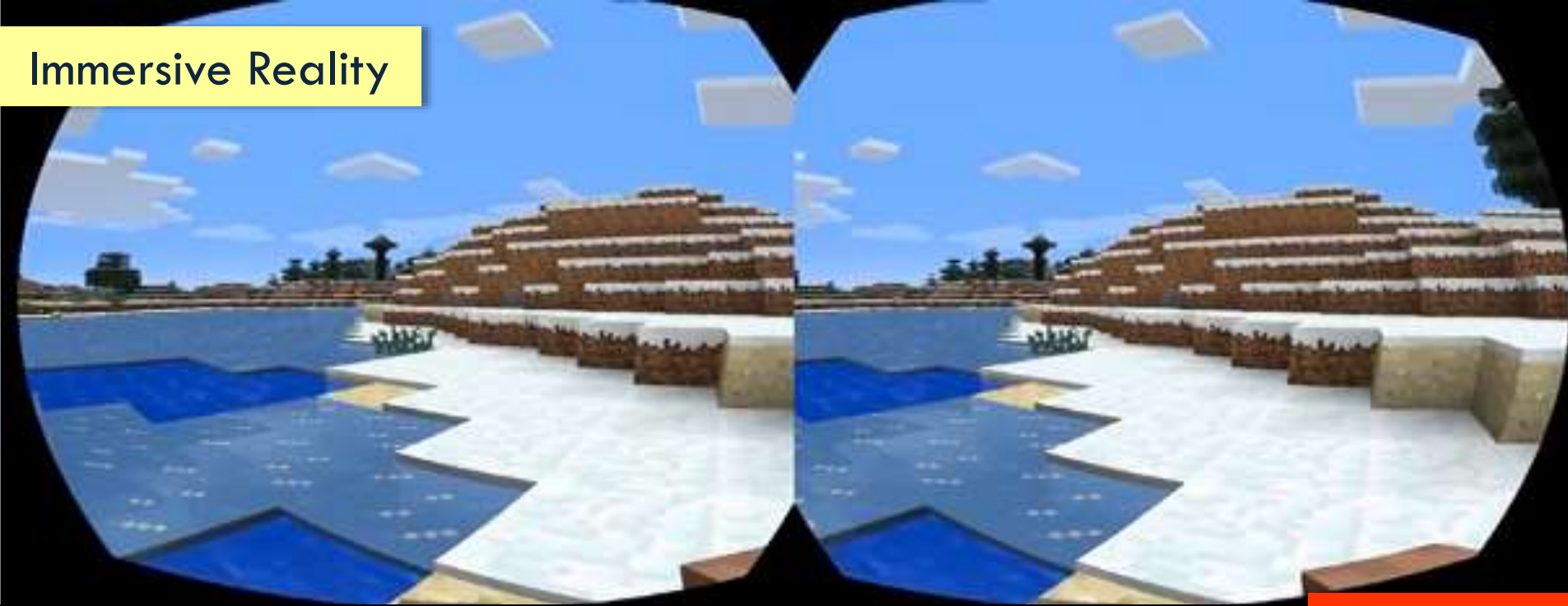
Augmented Reality



Future of Social Networking with Augmented Reality

Concept investigation by Matthew Buckland (matthewbuckland.com) and Philip Langley (@royalalien) of 20fourlabs.com

Immersive Reality



Oculus Rift

Sony Morpheus

DuroVis Dive

VR Headset



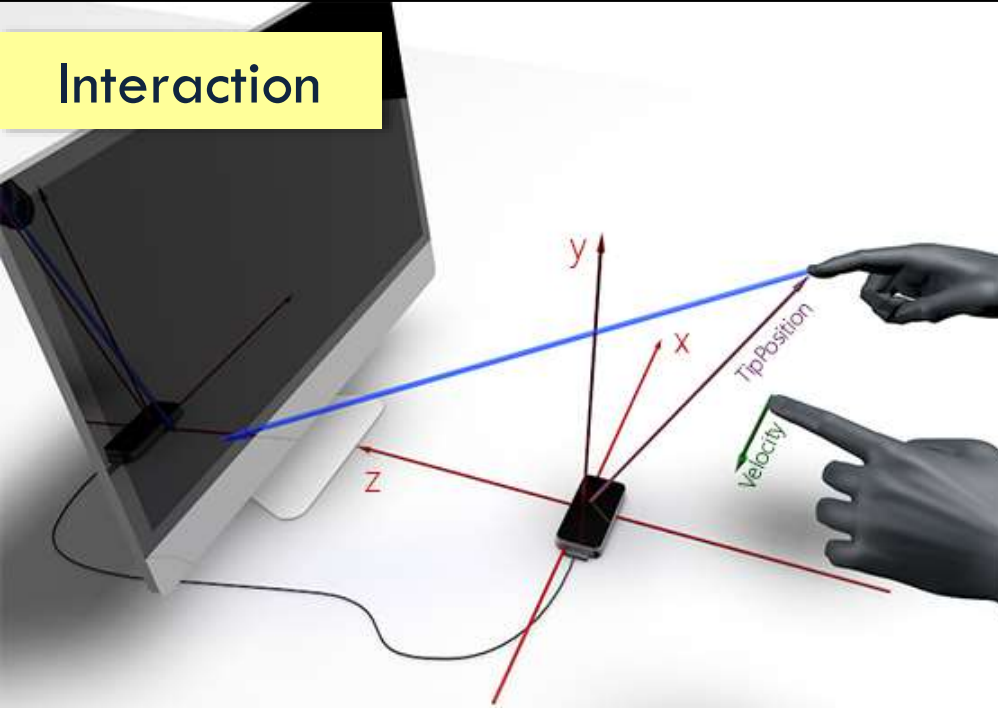
Zeiss Cinemizer

Avegant Glyph

Hasbro My3D

AlteRgaze

Interaction



Hand Gesture



Body Motion

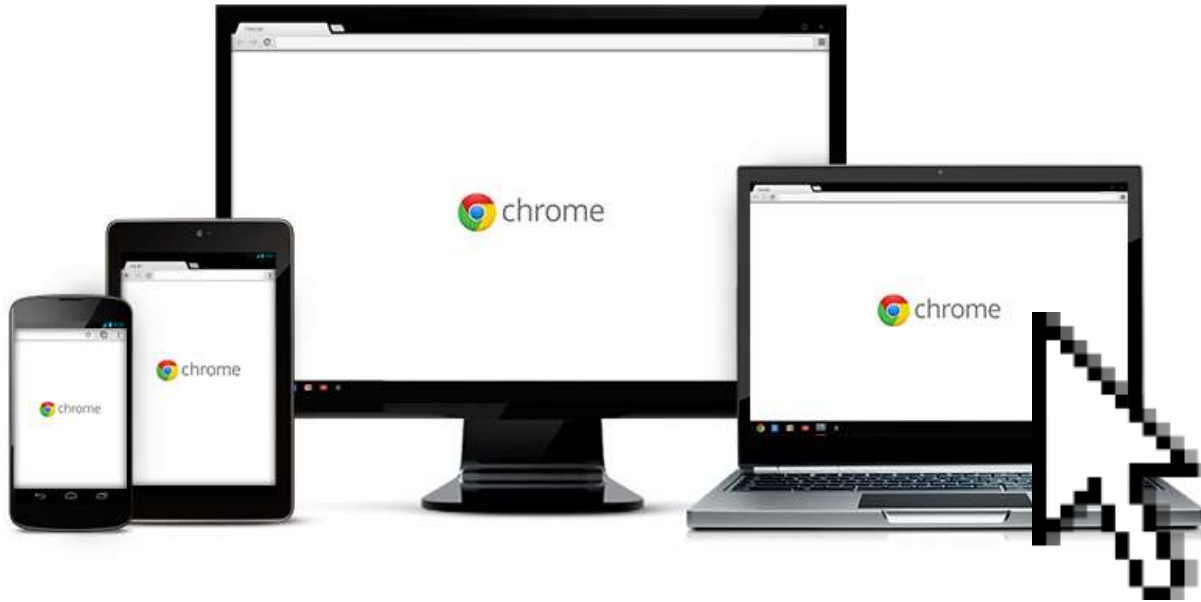
Interaction



Smartphone & Tablets

VR Movement





Concepts & Examples

Rich Graphics



WebGL

Asm.js

IFIS

MAP TYPES

CITY LAYERS

OPEN ACCESS

3D CITY VISUALIZER

FLOOD VISUALIZER



IFIS



MAP TYPES

STATE OF IOWA

Population	3,046,355
Land Area	55,872 sq mi
Downstream City	no downstream community



FLOOD VISUALIZER

IMMERSIVE

REALISTIC

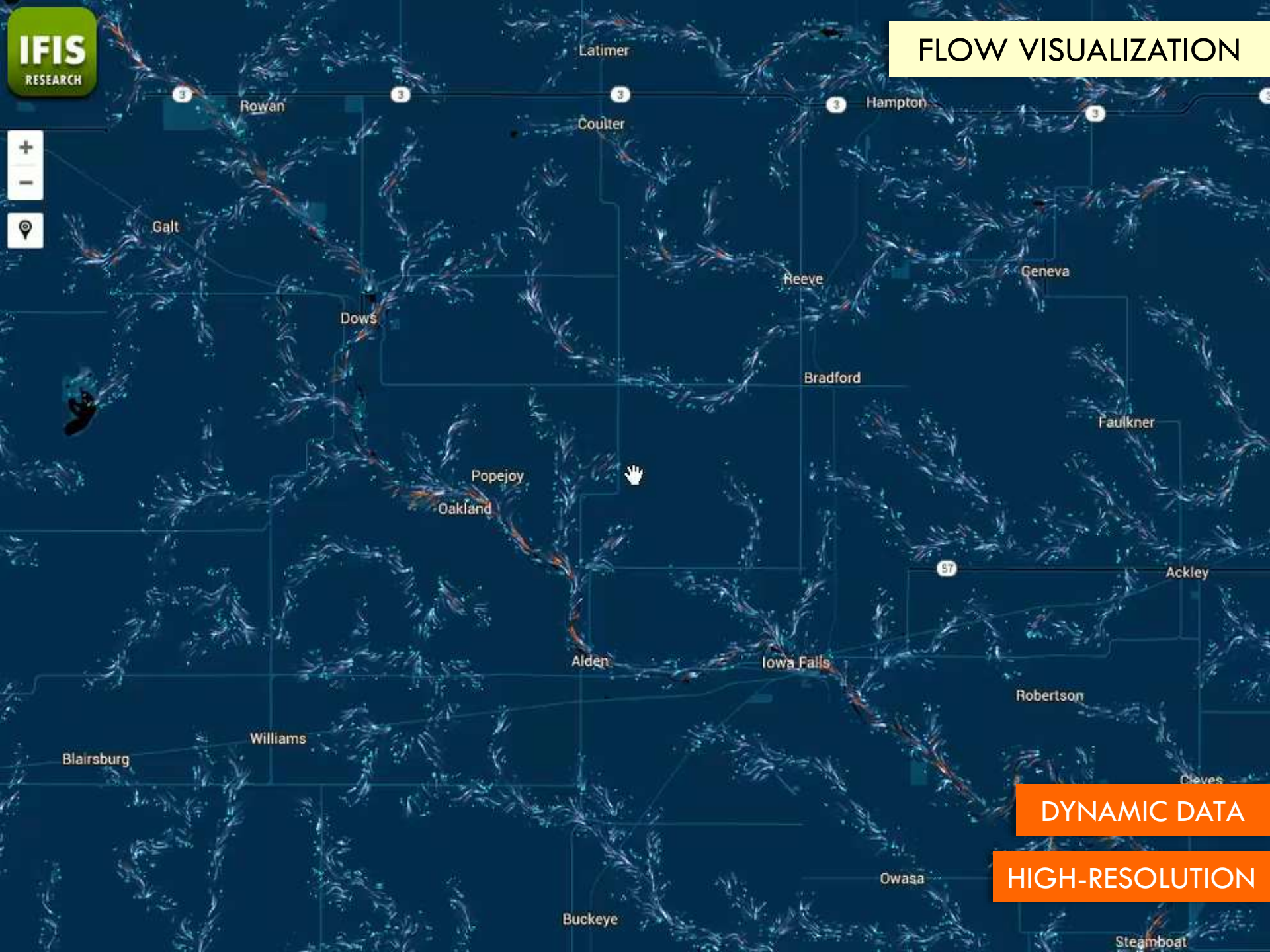
Google

FLOW VISUALIZATION



DYNAMIC DATA

HIGH-RESOLUTION

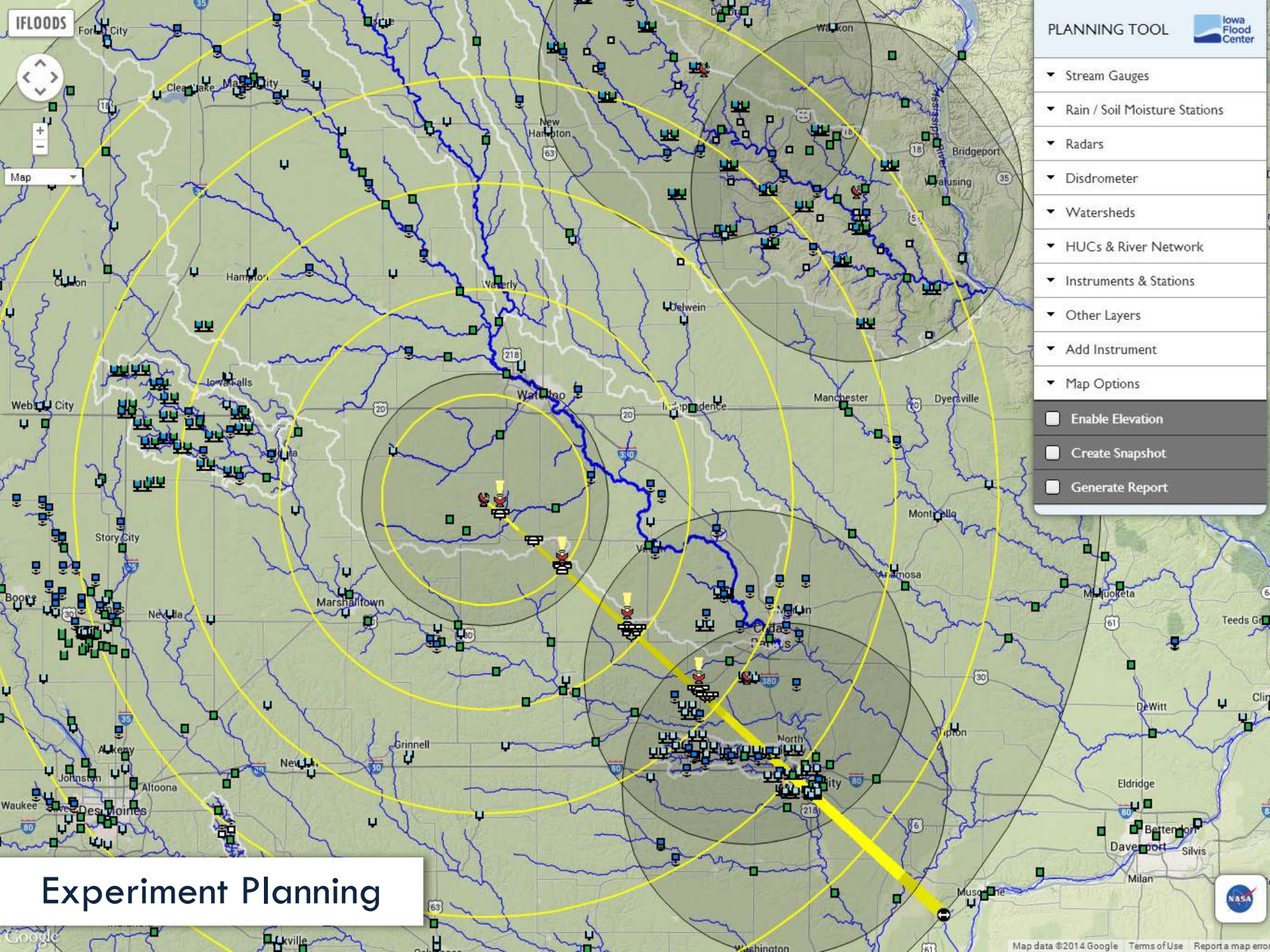


DYNAMIC DATA

HIGH-RESOLUTION

Sensor and Simulation

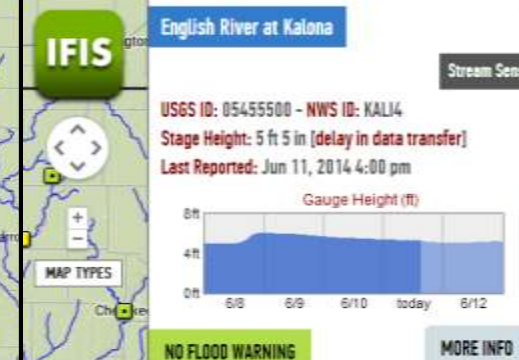
Data Visualization



- ▼ Stream Gauges
- ▼ Rain / Soil Moisture Stations
- ▼ Radars
- ▼ Disdrometer
- ▼ Watersheds
- ▼ HUCs & River Network
- ▼ Instruments & Stations
- ▼ Other Layers
- ▼ Add Instrument
- ▼ Map Options

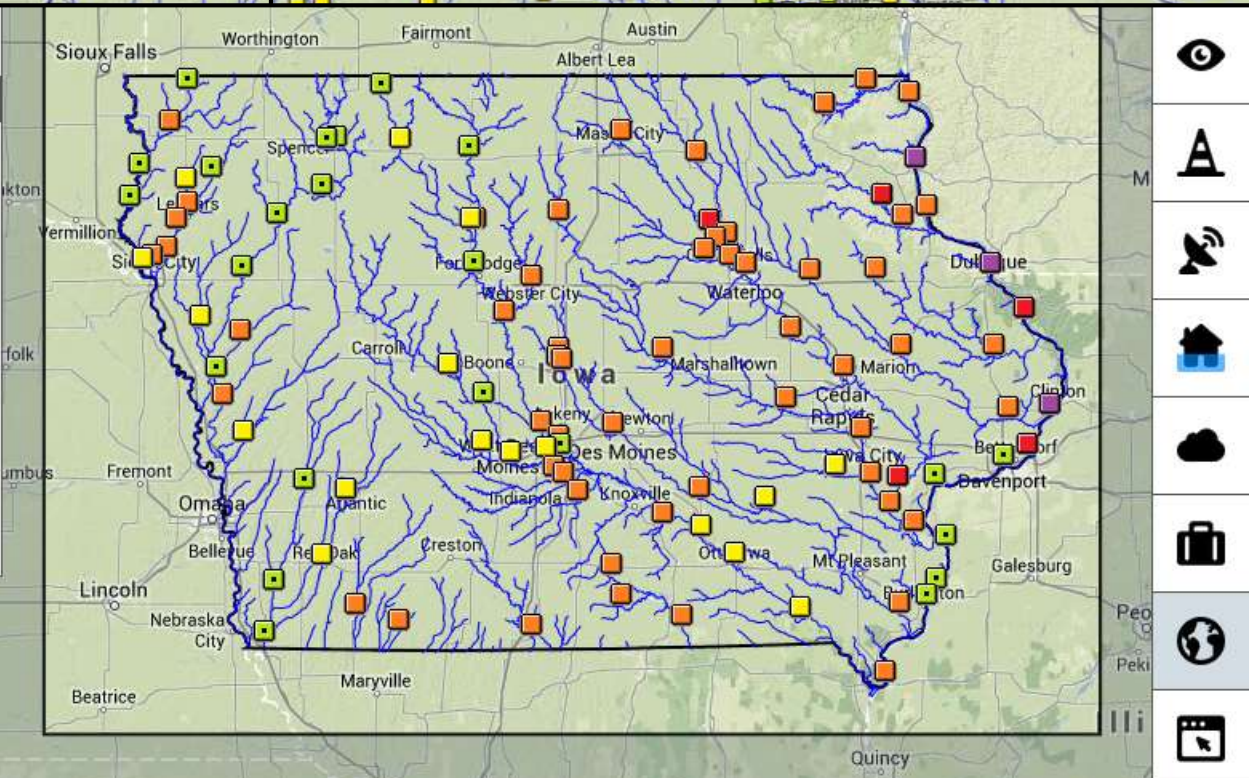
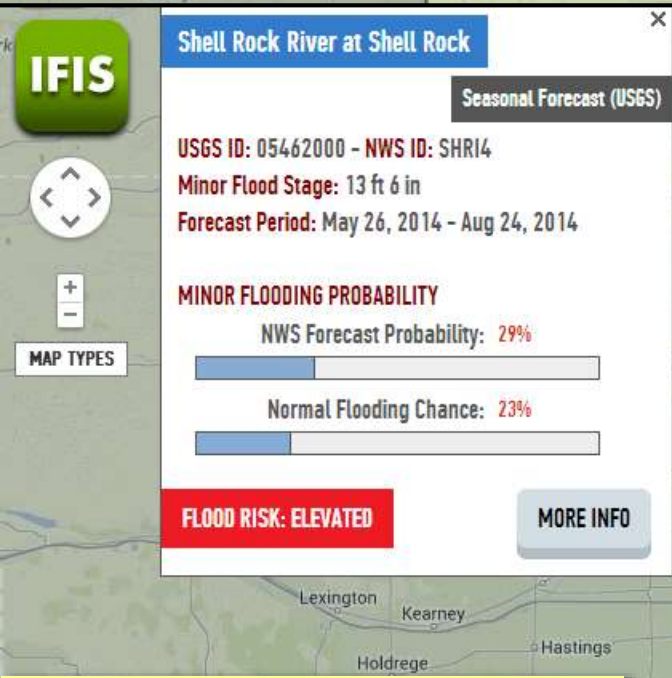
- ☐ Enable Elevation
- ☐ Create Snapshot
- ☐ Generate Report

Experiment Planning



5-day Flood Outlook

Real-time Flood Conditions



Seasonal Flood Forecast

IFIS

Hills 

River: Iowa River

Flood Level: 15 ft

View Maps by

- ☐ River Stage ?
- ☒ Return Period ?
- ☐ Real-time Stage Values

Flood Map Controller

Return Period: 500 yr

Stage: 22 ft

Discharge: 45260 cfs



- ☒ Water Depth ?

Water Depth: 5 ft

WEB-BASED

INTERACTIVE

MAP-BASED

FLOOD INUNDATION MAP

Time Series Visualization

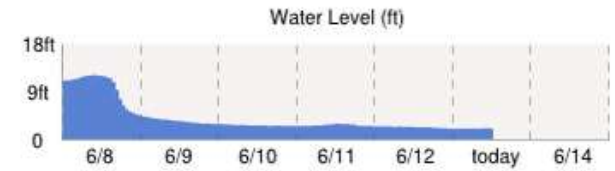
IFC STREAM SENSOR

Chequest Creek || Keosauqua

Station ID: CHQSTCR02

Water Level: 1 ft 11 in

Last Reported: Fri, Jun 13, 2014 3:00 pm UTC



STAGE FORECAST

MORE INFO

IFC BRIDGE SENSOR

Street Name (City): (Keosauqua)

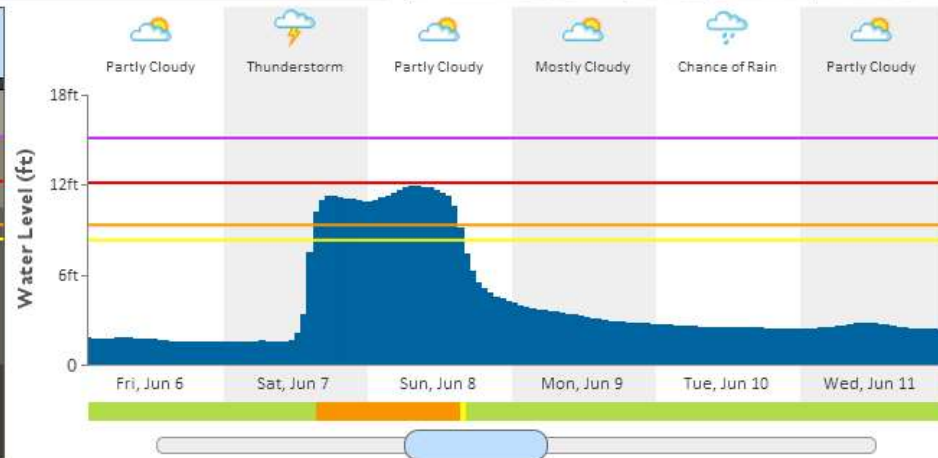
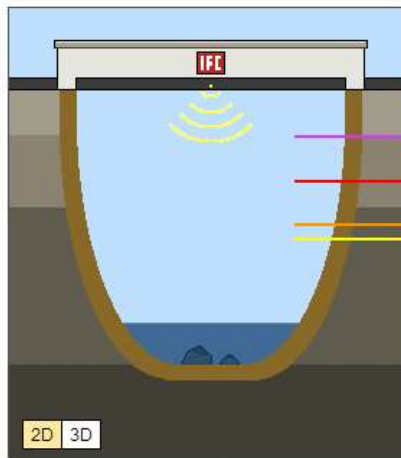
River Name: Chequest Creek

Stream Forecast: not available

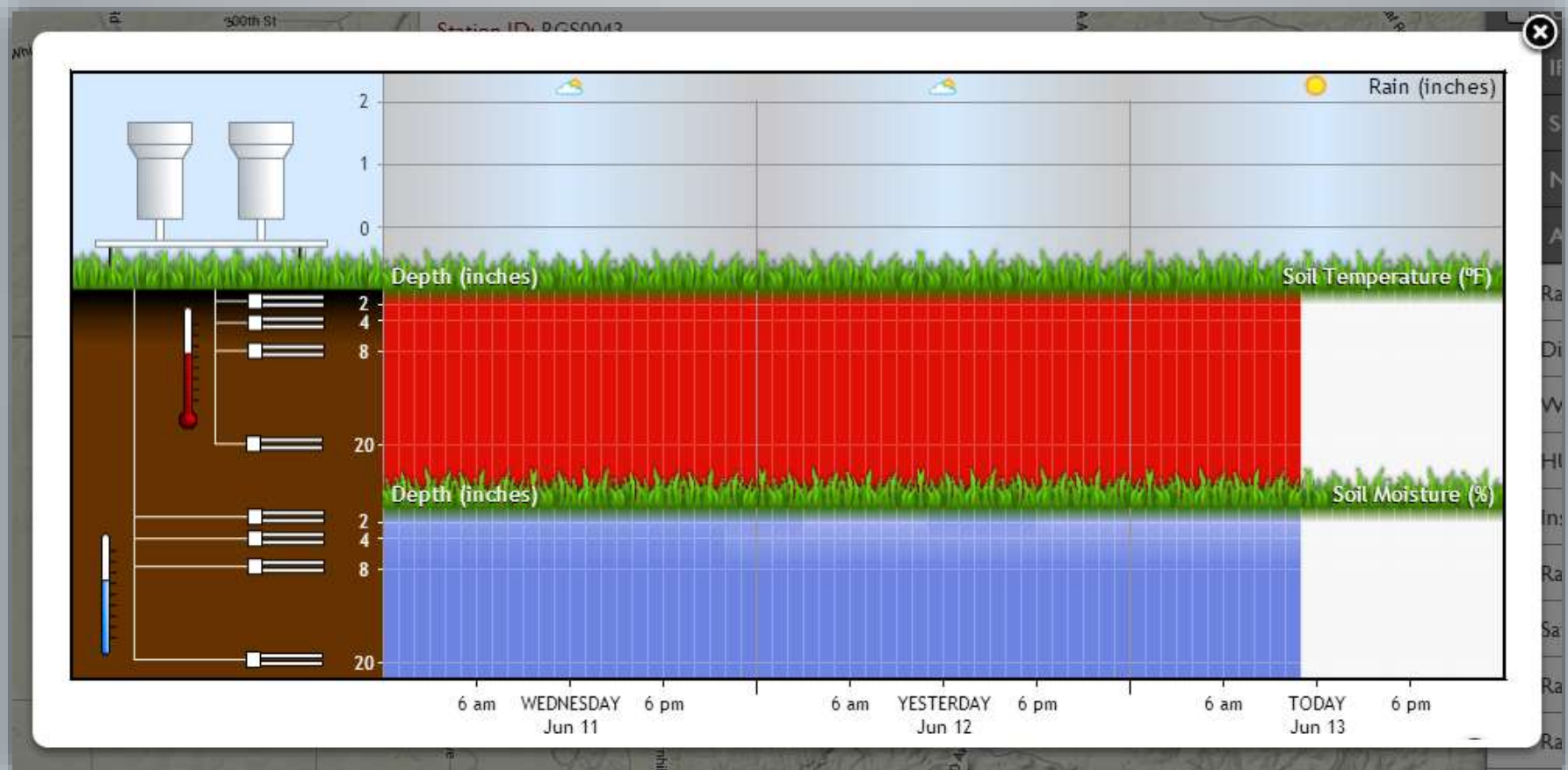
Bridge Height: 17 ft 7 in

Last Reported: Friday, June 13, 2014 10:00 am

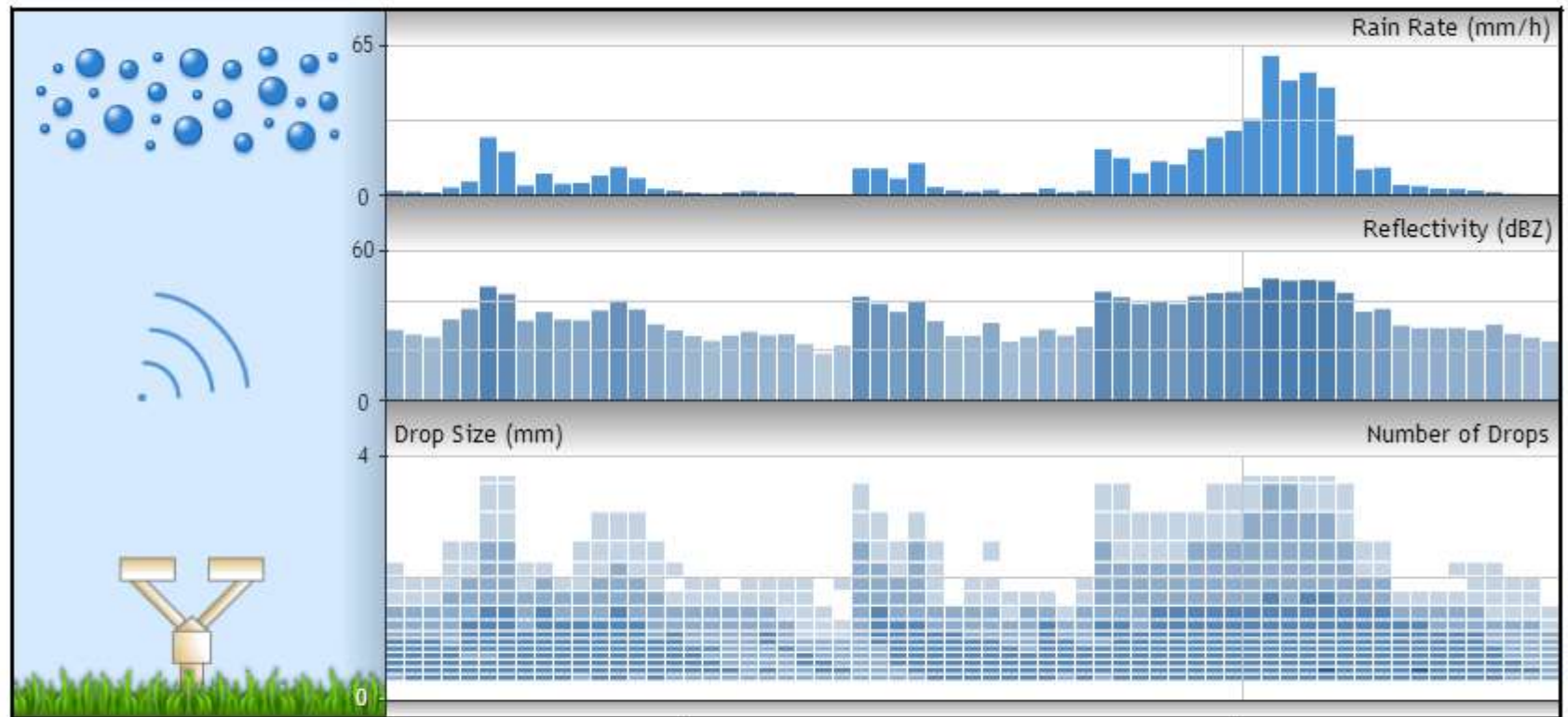
Last Reading: 1 ft 11 in



Rain Gauge / Soil Moisture Visualization



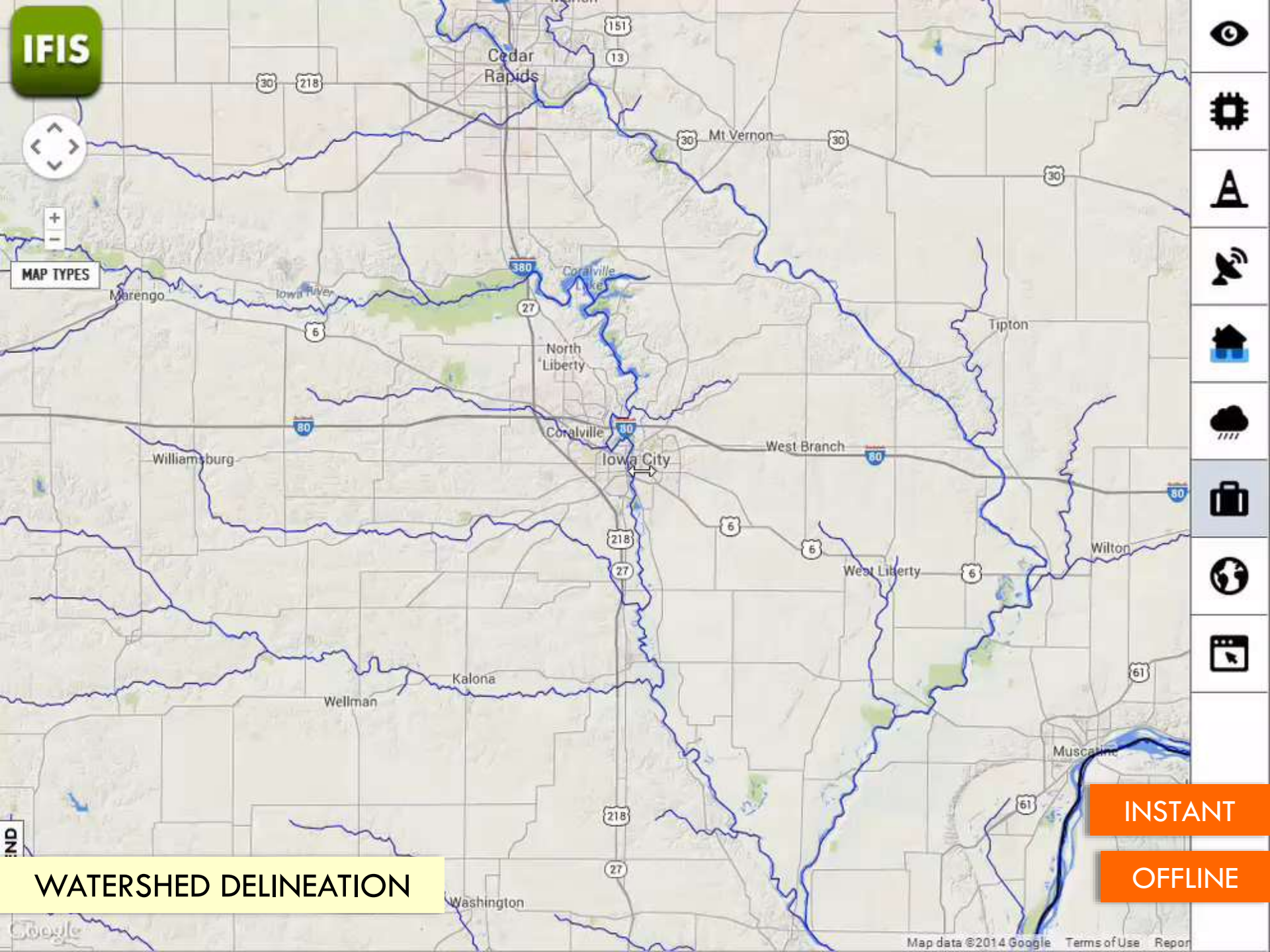
Disdrometer Visualization



IFIS



MAP TYPES



INSTANT

OFFLINE

WATERSHED DELINEATION

IND

Google

Large Scale Geospatial

Data Visualization



Map

Vermillion

Sioux City
South
Sioux City

Fremont

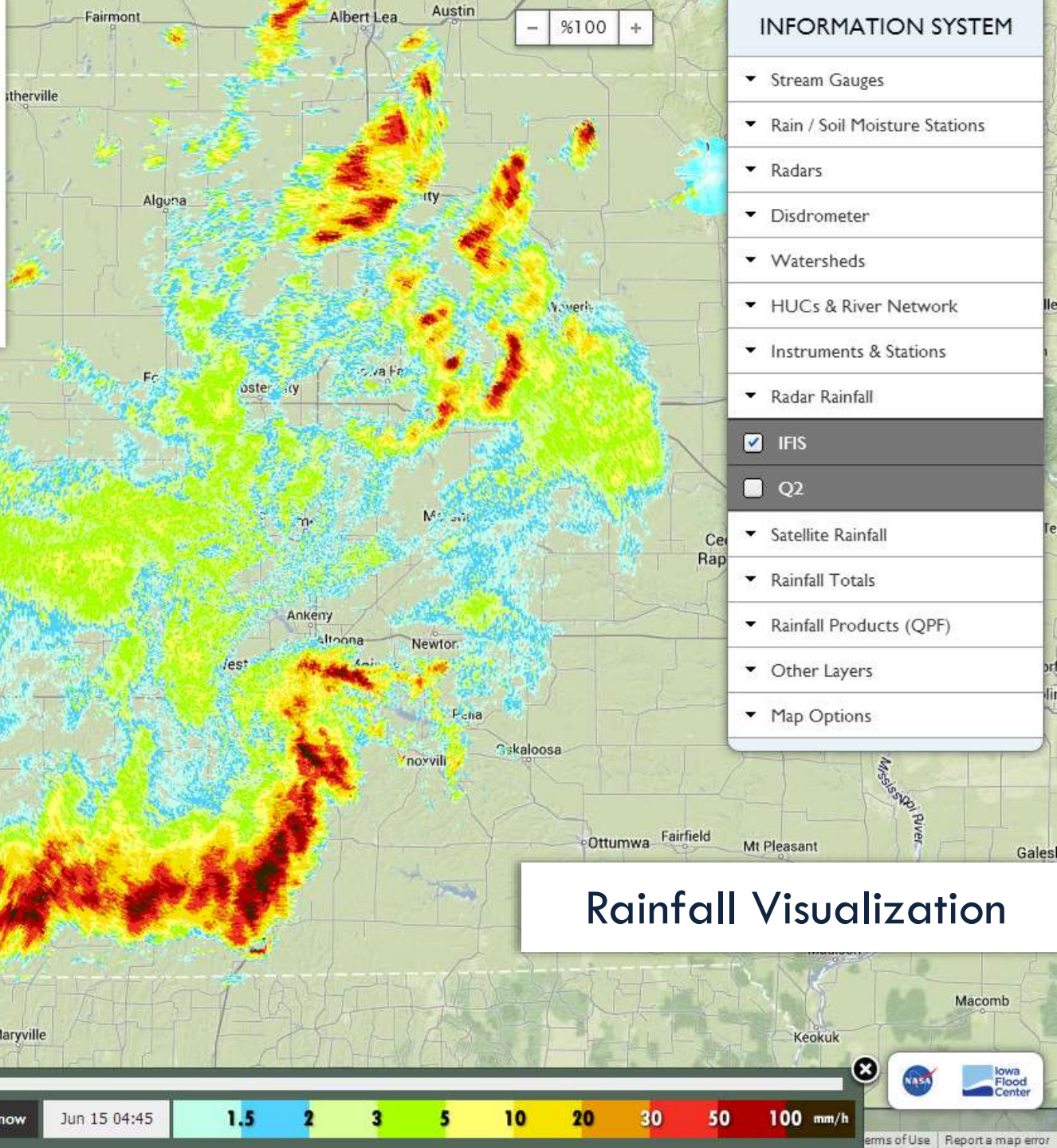
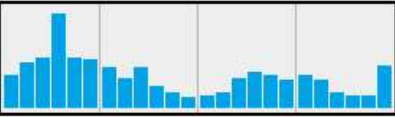
Lincoln

Beatrice

	Apr					May					Jun				
o	1	8	15	22	29	6	13	20	27	3	10	17			
2		9	16	23	30	7	14	21	28	4	11	18	25		
e	3	10	17	24	1	8	15	22	5	12	19				
n	4	11	18	25	2	9	16	23	30	6	13	20	27		
h	5	12	19	26	3	10	17	24	31	7	14	21	28		
	6	13	20	27	4	11	18	25	1	8	15	22	29		
7	14	21	28	5	12	19	26	2	9	16	23	30			

Max

2013-06-15

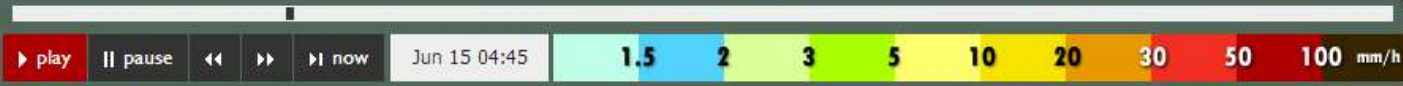


- %100 +

INFORMATION SYSTEM

- ▼ Stream Gauges
- ▼ Rain / Soil Moisture Stations
- ▼ Radars
- ▼ Disdrometer
- ▼ Watersheds
- ▼ HUCs & River Network
- ▼ Instruments & Stations
- ▼ Radar Rainfall
- ☒ IFIS
- ☐ Q2
- ▼ Satellite Rainfall
- ▼ Rainfall Totals
- ▼ Rainfall Products (QPF)
- ▼ Other Layers
- ▼ Map Options

Rainfall Visualization



IFIS



MAP TYPES

100%

IFIS



MAP TYPES

100%

Rainfall: 0.11 inches
Frequency of rainfall
for the selected area
is between 50 and
100 year

Fri May 30 Sat May 31 Sun Jun 1 Mon Jun 2 Tue Jun 3



PLAY PAUSE << >> NOW

Rainfall Maps

Fri May 30 Sat May 31 Sun Jun 1 Mon Jun 2 Tue Jun 3



PLAY PAUSE << >> NOW



+

-

Map

	Apr					May					Jun			
Mo	1	8	15	22	29	6	13	20	27	3	10	17	24	
Tu	2	9	16	23	30	7	14	21	28	4	11	18	25	
We	3	10	17	24	1	8	15	22	5	12	19	26		
Th	4	11	18	25	2	9	16	23	30	6	13	20	27	
Fr	5	12	19	26	3	10	17	24	31	7	14	21	28	
Sa	6	13	20	27	4	11	18	25	1	8	15	22	29	
Su	7	14	21	28	5	12	19	26	2	9	16	23	30	

Max

2013-06-12 23:00



PPI

Zdr

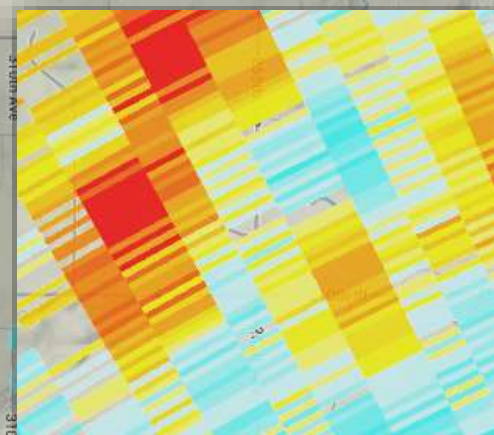


Elevation: 3°

Scan Time: Jun 12, 2013 23:01

Azimuth: 360° - 352.1° - No of Rays: 402

Range: 13.5 km - Resolution: 15 m



INFORMATION SYSTEM

▼ Stream Gauges

▼ Rain / Soil Moisture Stations

▼ Radars

☐ D3R☐ Micro Rain Radar☐ NEXRAD Radars - IFLOODS☐ NEXRAD Radars - Others☐ NPOL Radar☒ XPOL Radars

▼ Disdrometer

▼ Watersheds

▼ HUCs & River Network

▼ Instruments & Stations

▼ Radar Rainfall

▼ Satellite Rainfall

▼ Rainfall Totals

▼ Rainfall Products (QPF)

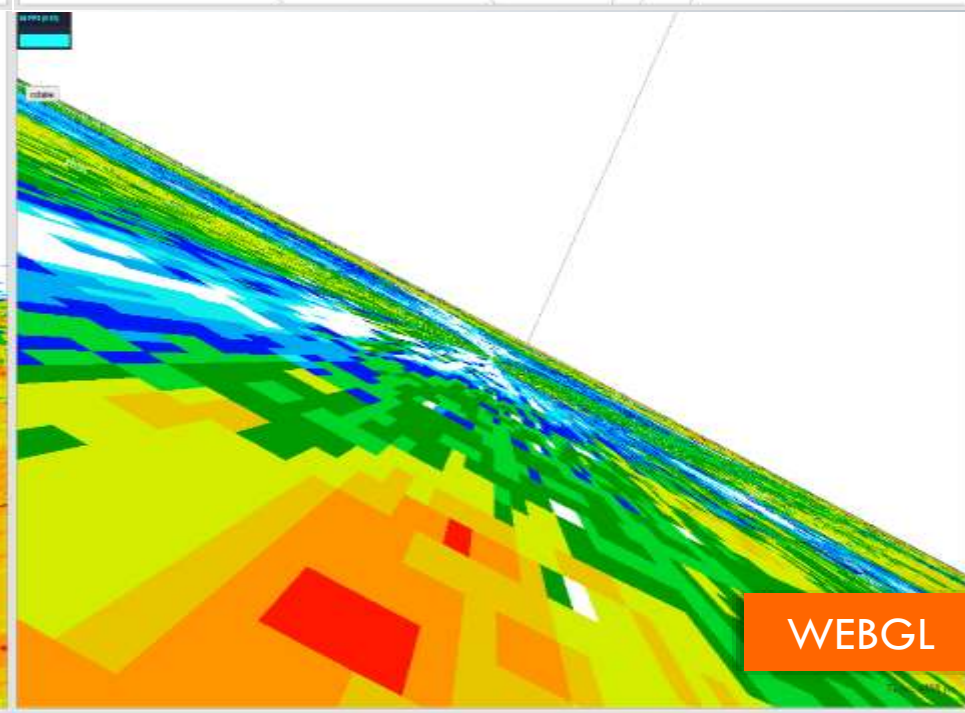
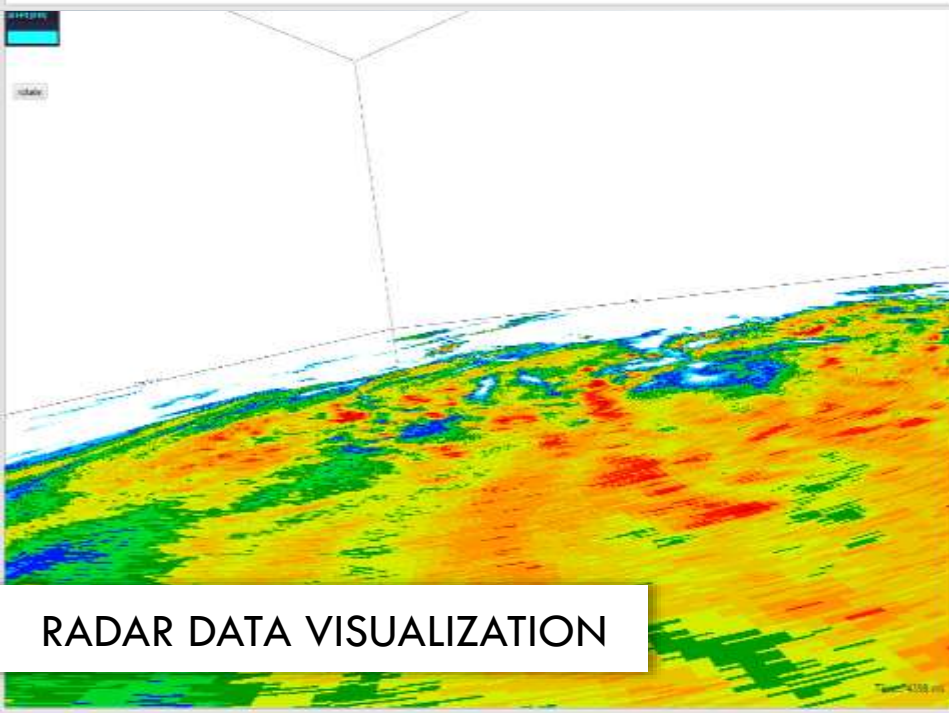
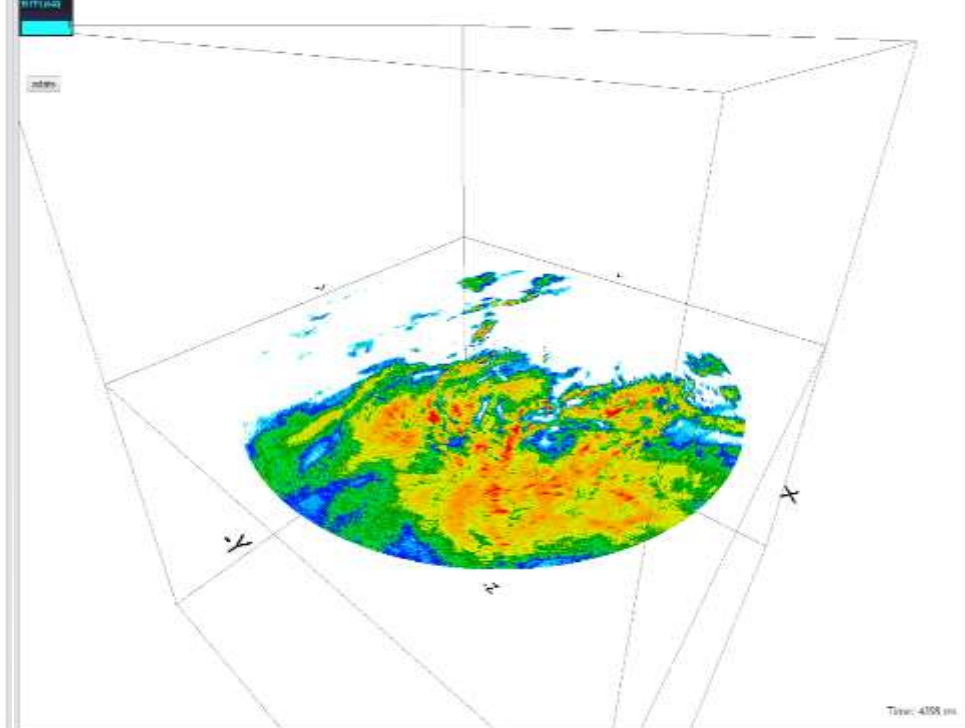
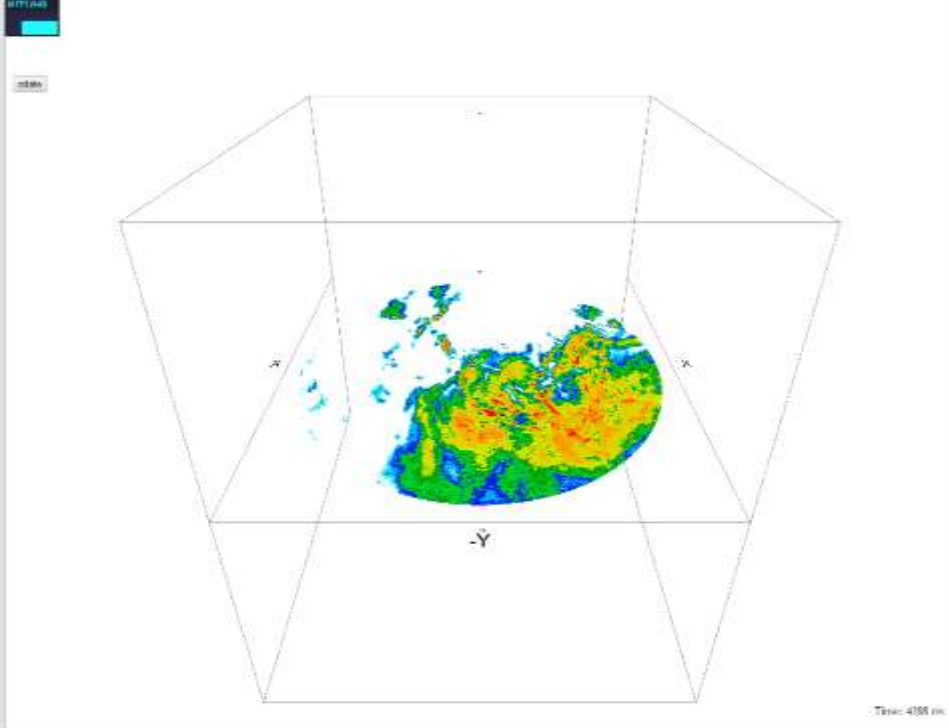
▼ Other Layers

▼ Map Options

WEBGL

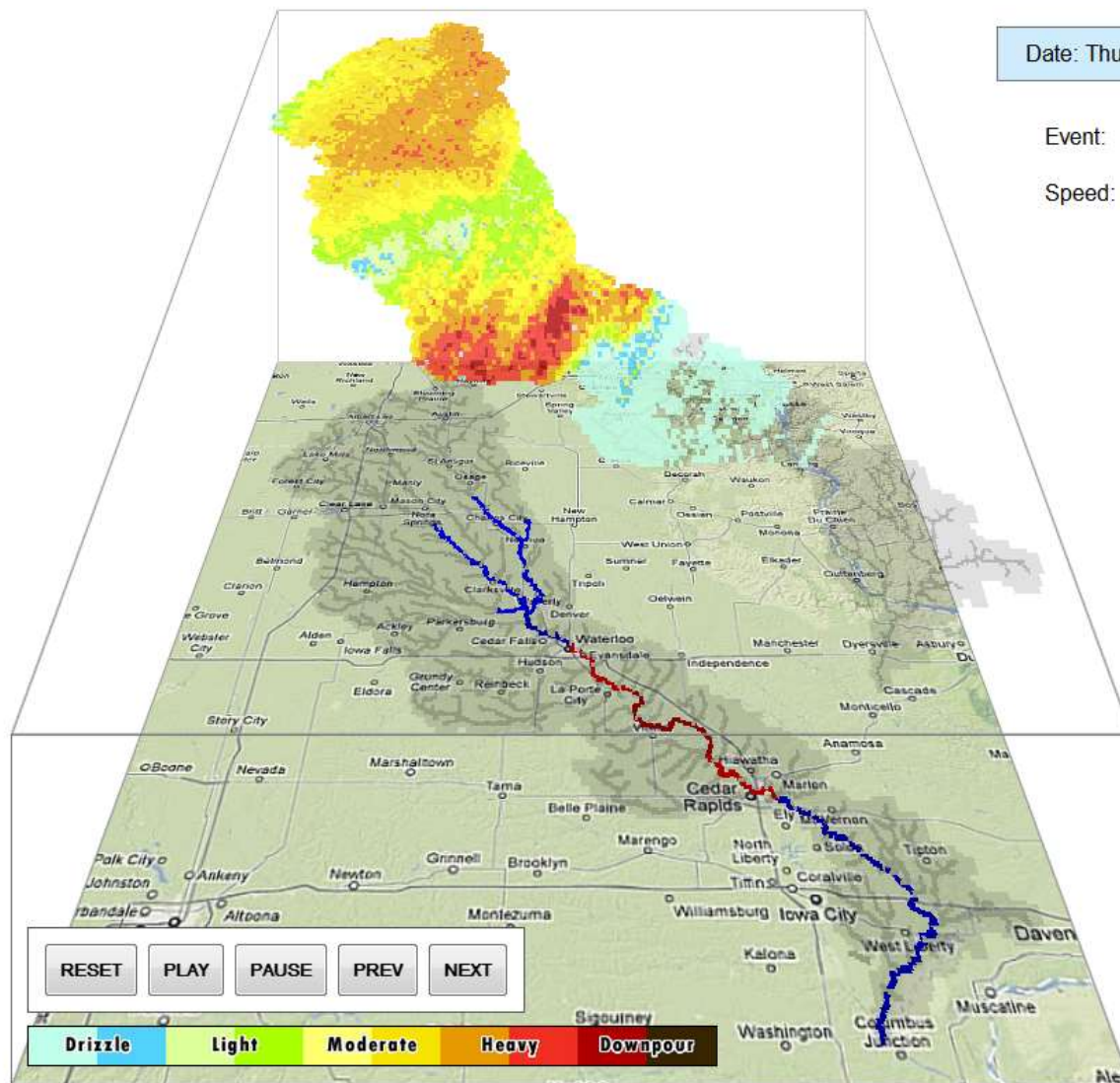
XPOL RADAR DATA BROWSER

GOOGLE MAPS API



RADAR DATA VISUALIZATION

WEBGL



Date: Thursday, 6/12/08 5:30 am

Event: Storm on June 11

Speed: Normal

550 hours (2200 steps) of data

3D PERSPECTIVE VIEW

RAINFALL & RIVER DRAINAGE

Date: Saturday, 6/7/08 5:45 pm

Event: Storm on June 7 ▾

Speed: Normal ▾

RESET

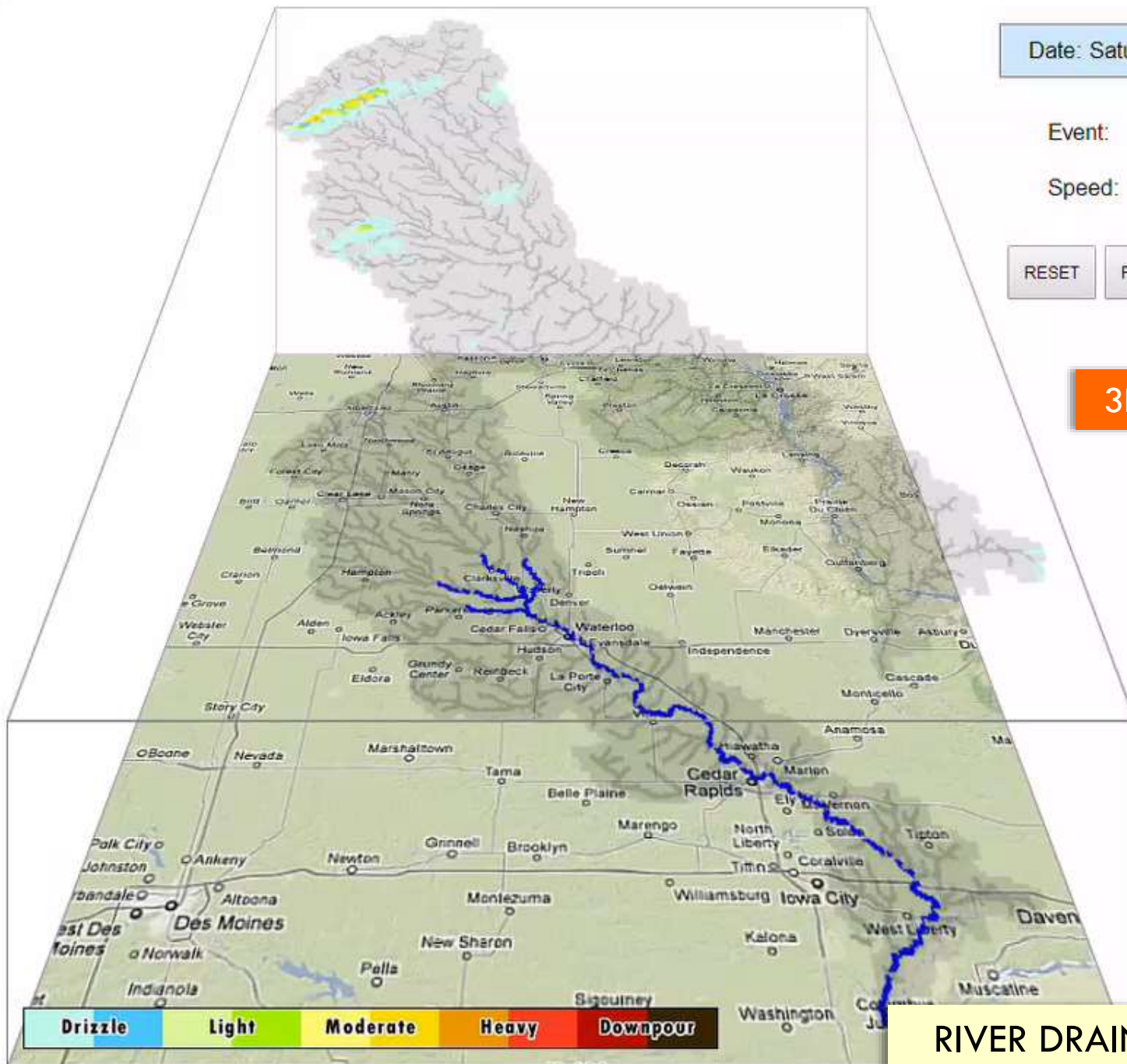
PLAY

PAUSE

PREV

NEXT

3D PERSPECTIVE VIEW

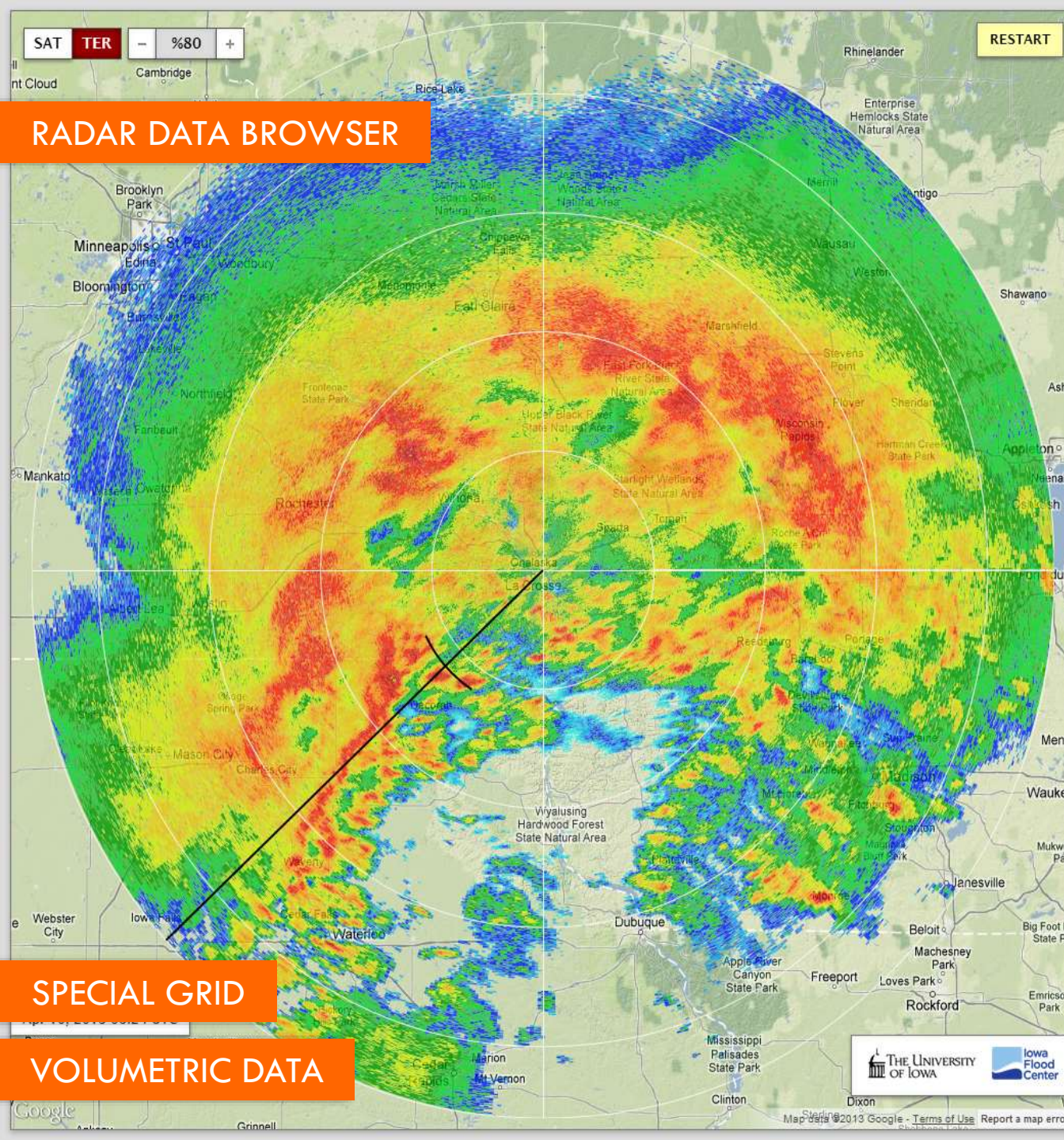


RIVER DRAINAGE & RAINFALL

SAT TER - %80 +

RESTART

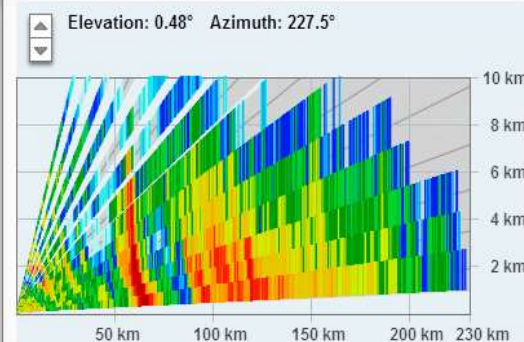
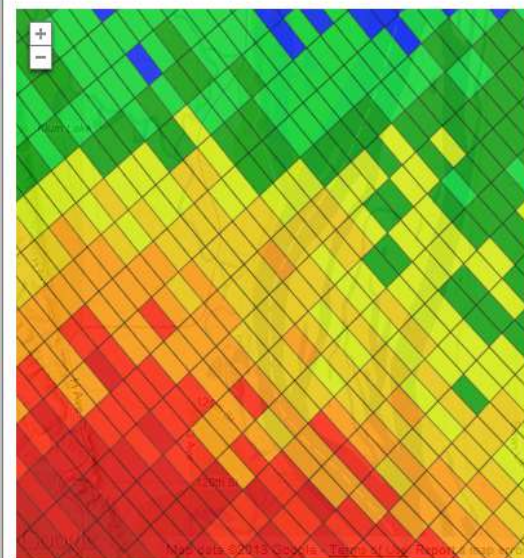
RADAR DATA BROWSER



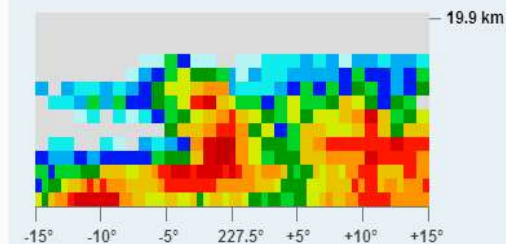
SPECIAL GRID

VOLUMETRIC DATA

LEVEL II DATA BROWSER



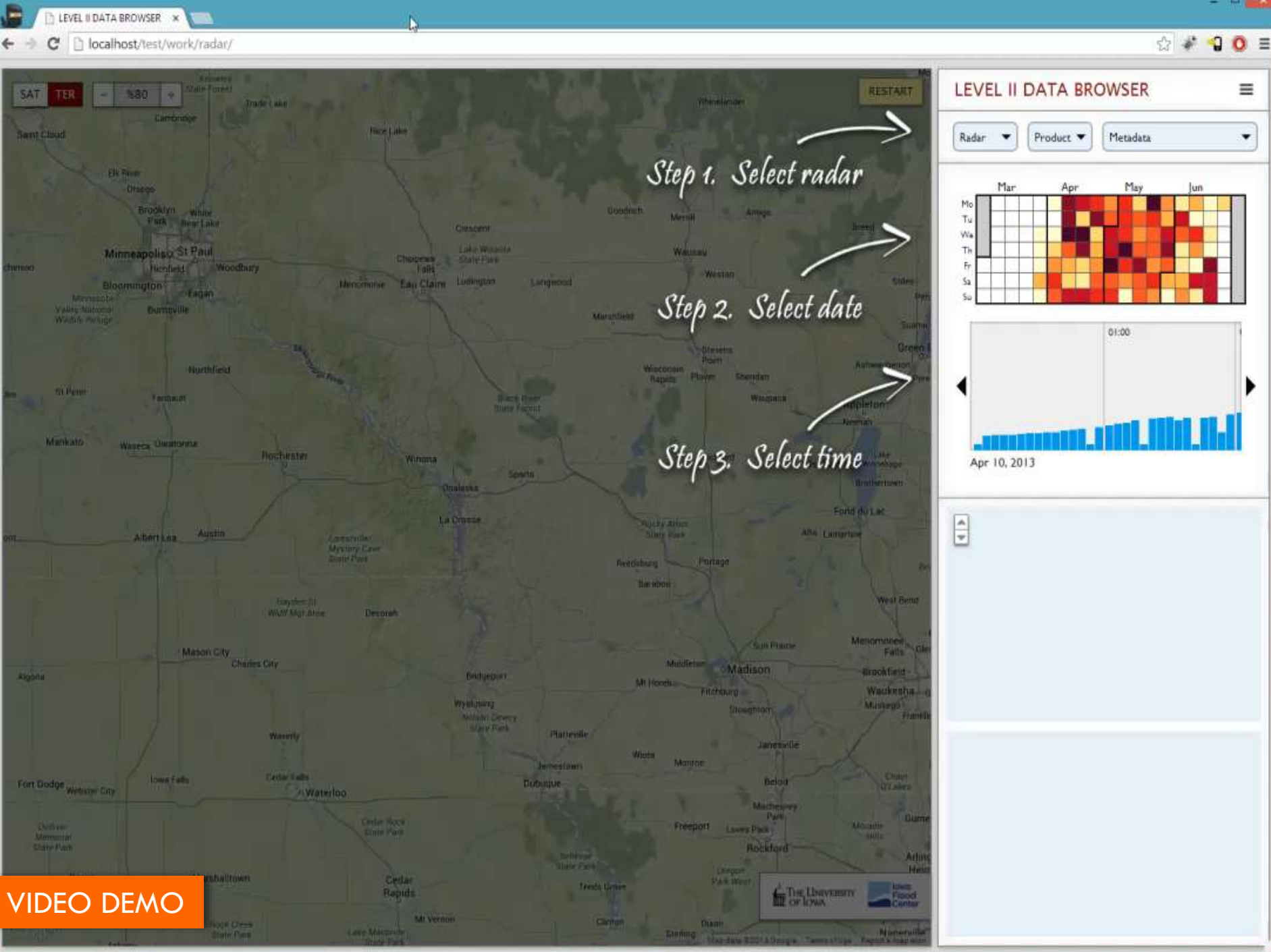
Range: 59.5 km

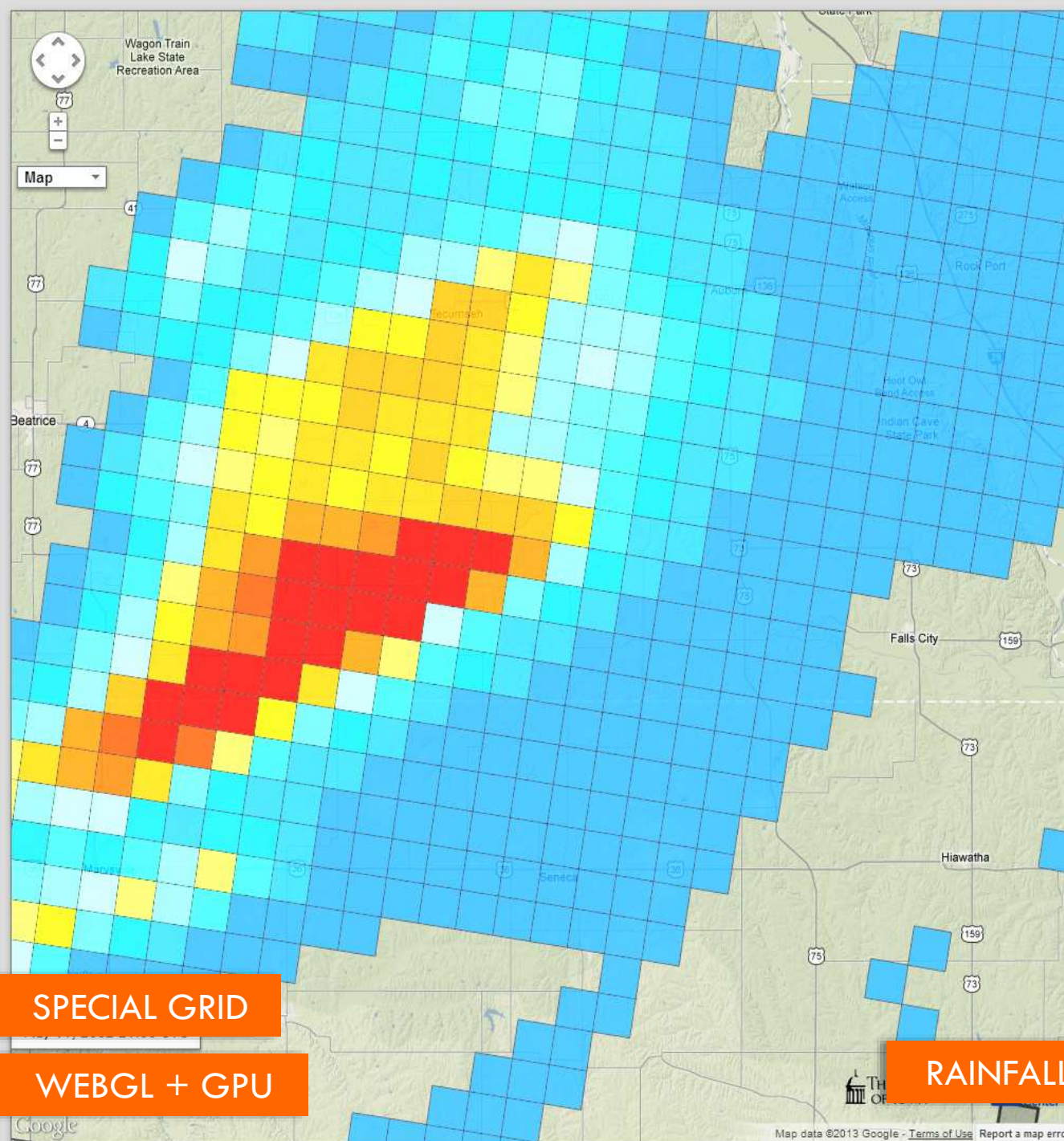


THE UNIVERSITY OF IOWA

Iowa Flood Center

Map data ©2013 Google - Terms of Use Report a map error





SPECIAL GRID

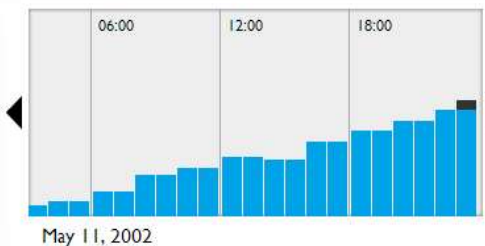
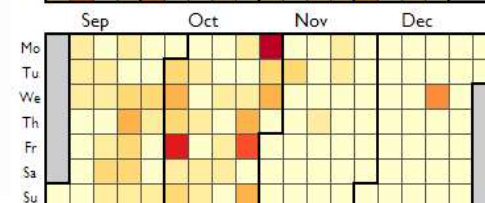
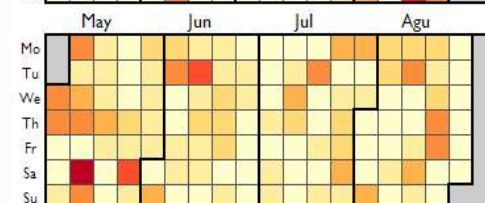
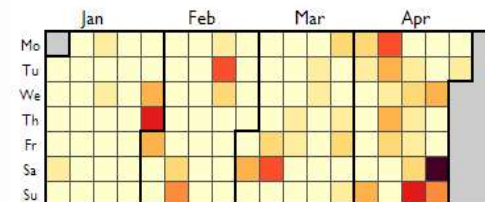
WEBGL + GPU

RAINFALL DATA BROWSER

STAGE IV

% Coverage (Rain > 0mm)

◀ 2002 ▶



RAINFALL PRODUCT DATA BROWSER

Radat / Rainfall Data Brow x

localhost/test/work/rainfall/

Step 1. Select product

Step 2. Select date

Step 3. Select time

RAINFALL DATA BROWSER

Select Product

View Metadata

2002

Jan

Feb

Mar

Apr

Mo

Tu

We

Th

Fr

Sa

Su

May

Jun

Jul

Aug

Mo

Tu

We

Th

Fr

Sa

Su

Sep

Oct

Nov

Dec

Mo

Tu

We

Th

Fr

Sa

Su

06:00

12:00

18:00

Jan 01, 2002

VIDEO DEMO

Game-based Learning

WHAT IS GAMIFICATION?



Gamification is the use of elements of game play in non-game contexts



It provides rewards and engagement for customers

ga•mi•fi•ca•tion [gay-muh-fi-kay-shuhn]
integrating game dynamics into your site, service, community, content or campaign, in order to drive participation.
(see Bunchball)

TRADITIONAL TRAINER



GAMIFIED TRAINER



HOW GAMIFICATION WORKS:

5 COMMON MECHANICS



POINTS

Measure a user's achievements in relation to others

Can double as currency to exchange for rewards



BADGES

Reward achievements visually



LEVELS

Encourage users to progress and unlock new rewards



LEADERBOARDS

Organise players by rank



CHALLENGES

Encourage engagement by offering specific tasks to complete

4 MAIN WAYS TO DRIVE ENGAGEMENT



ACCELERATED FEEDBACK CYCLES



CLEAR GOALS AND RULES OF PLAY



A COMPELLING NARRATIVE

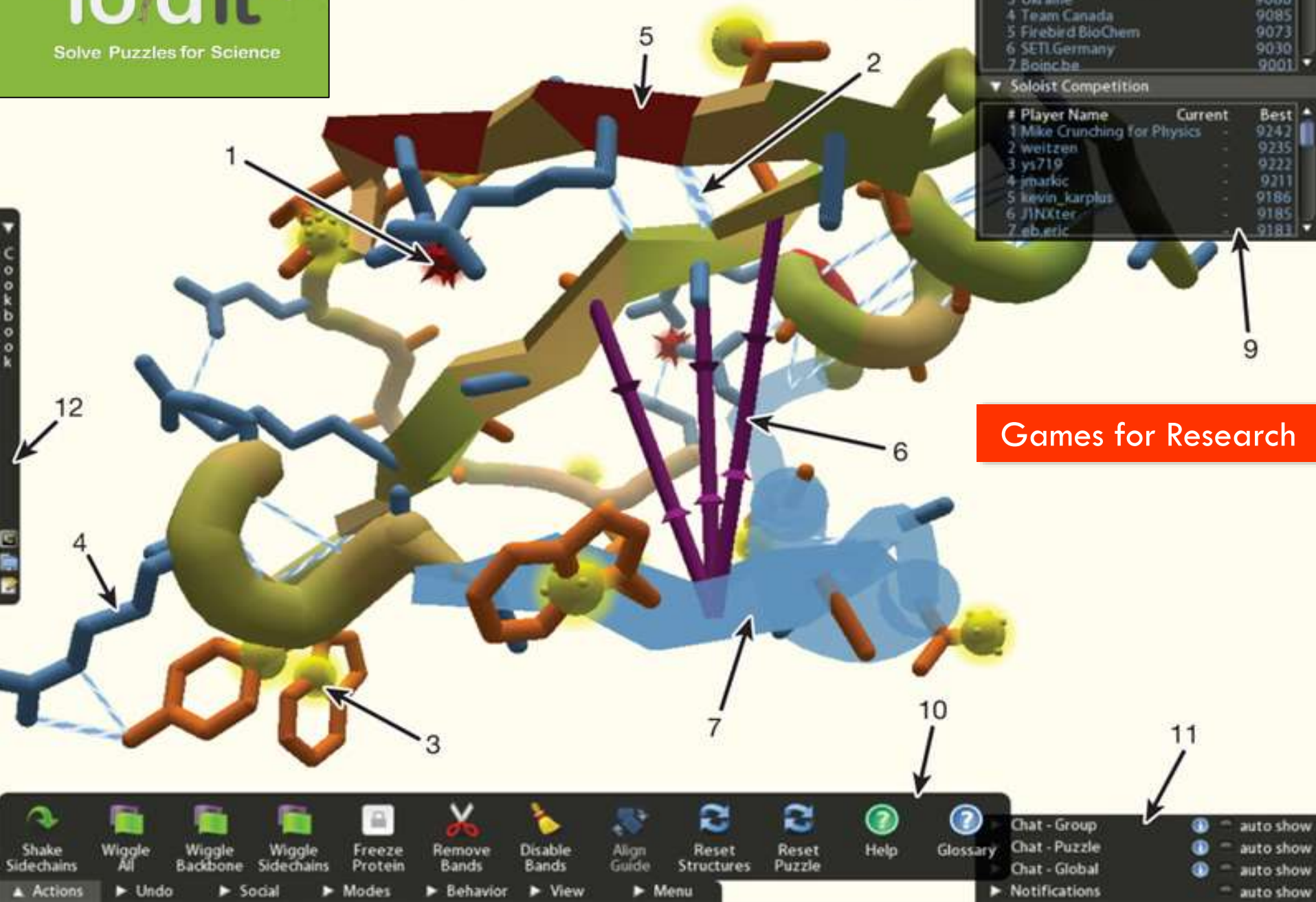


CHALLENGING BUT ACHIEVABLE TASKS



Rank: 317 Score: 2534
Soloist Beginner Puzzle 8 (<150): Fruit Fly
▶ No conditions

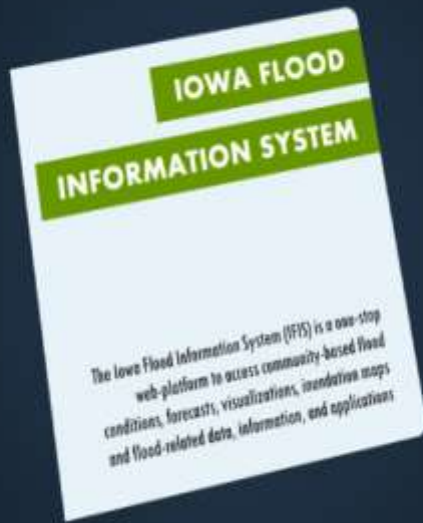
Group Competition		
# Group Name	Score	
1 Rice Biochemistry	9174	
2 Team Commonwealth	9168	
3 Ukraine	9088	
4 Team Canada	9085	
5 Firebird BioChem	9073	
6 SETI.Germany	9030	
7 Boinc.be	9001	
Soloist Competition		
# Player Name	Current	Best
1 Mike Crunching for Physics	-	9242
2 weitzen	-	9235
3 ys719	-	9222
4 jmarkic	-	9211
5 kevin_karplus	-	9186
6 JINXter	-	9185
7 eb.eric	-	9181



Shake Sidechains Wiggle All Wiggle Backbone Wiggle Sidechains Freeze Protein Remove Bands Disable Bands Align Guide Reset Structures Reset Puzzle Help Glossary

Chat - Group Chat - Puzzle Chat - Global Notifications

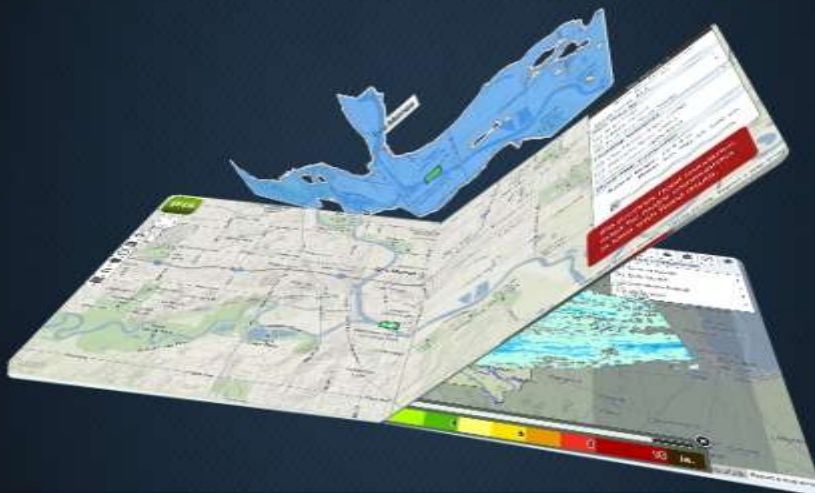
auto show auto show auto show auto show



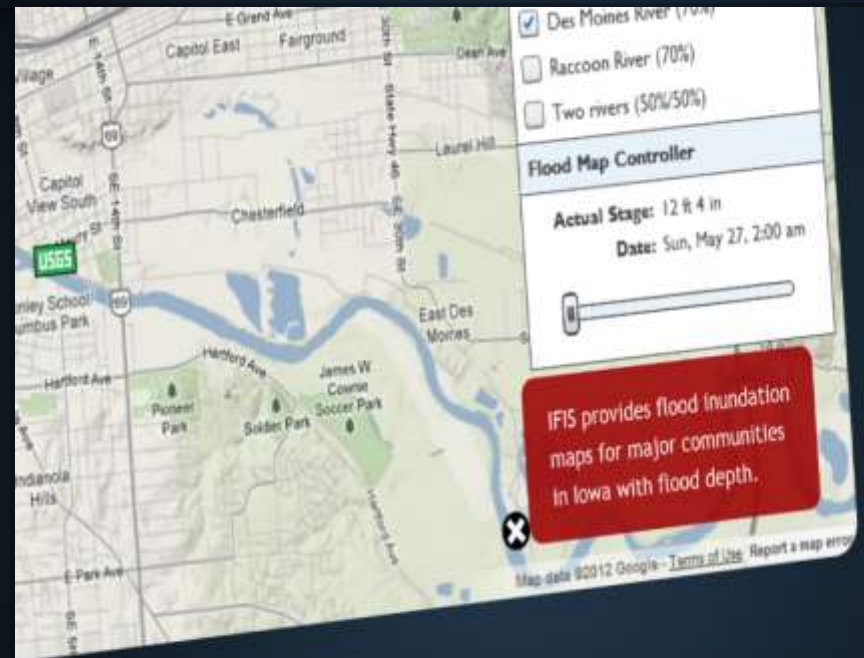
IFIS



IFIS

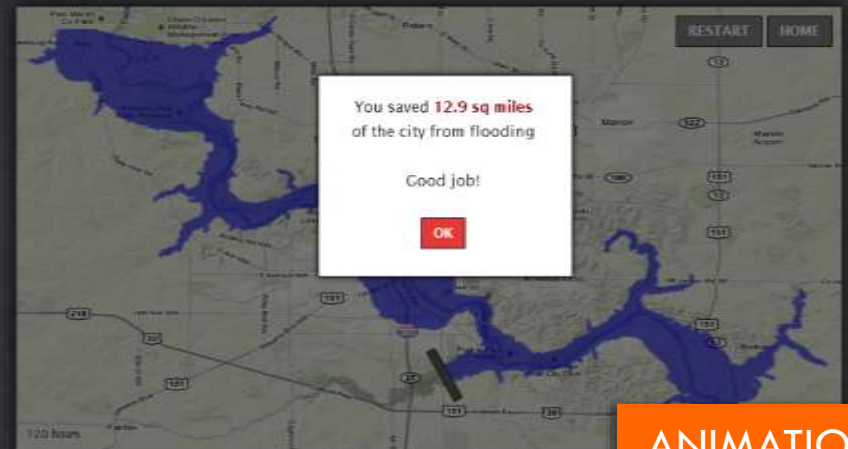


IFIS



FOLDABLE CHILDREN'S BOOK

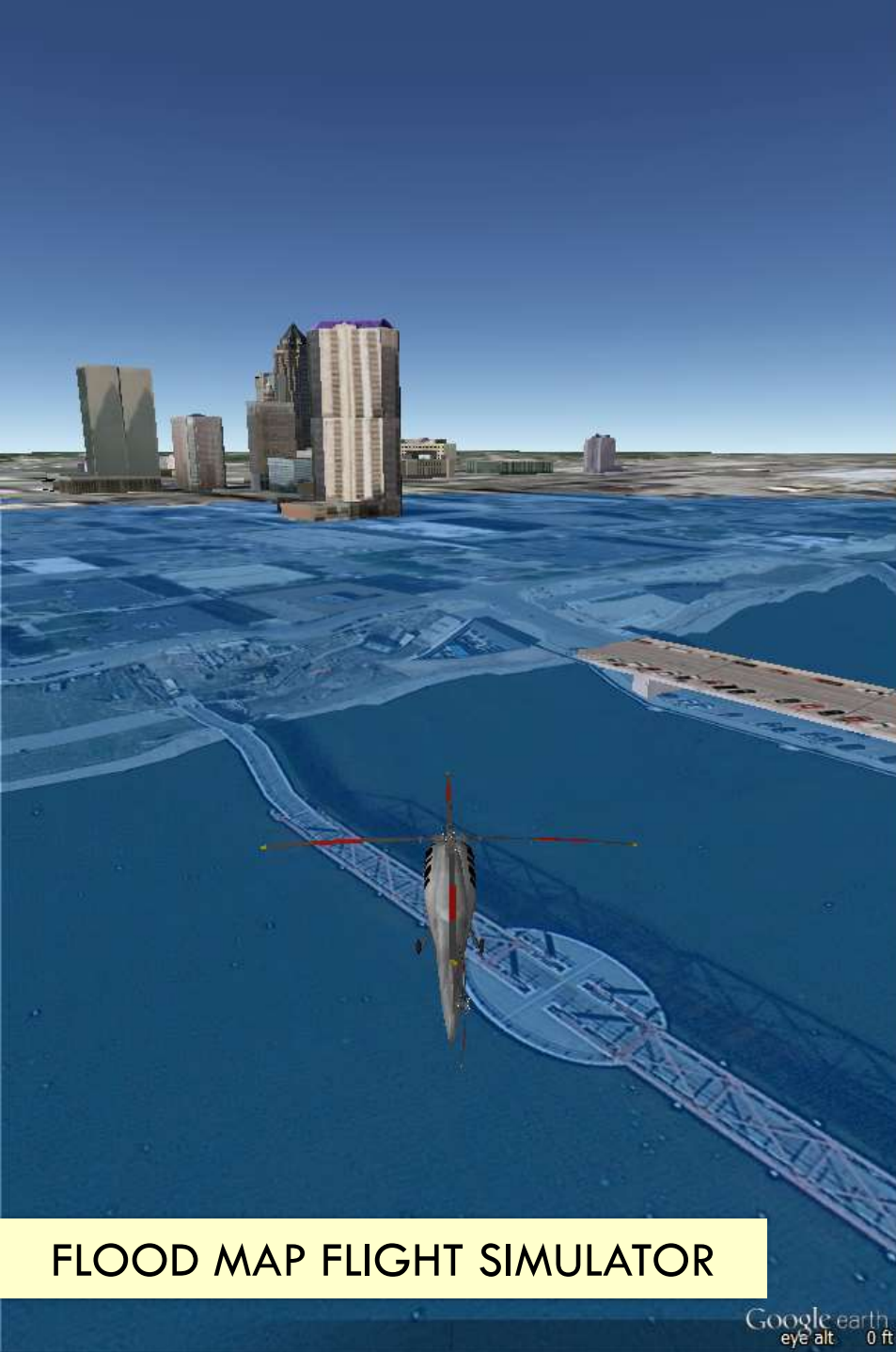
EDUCATION



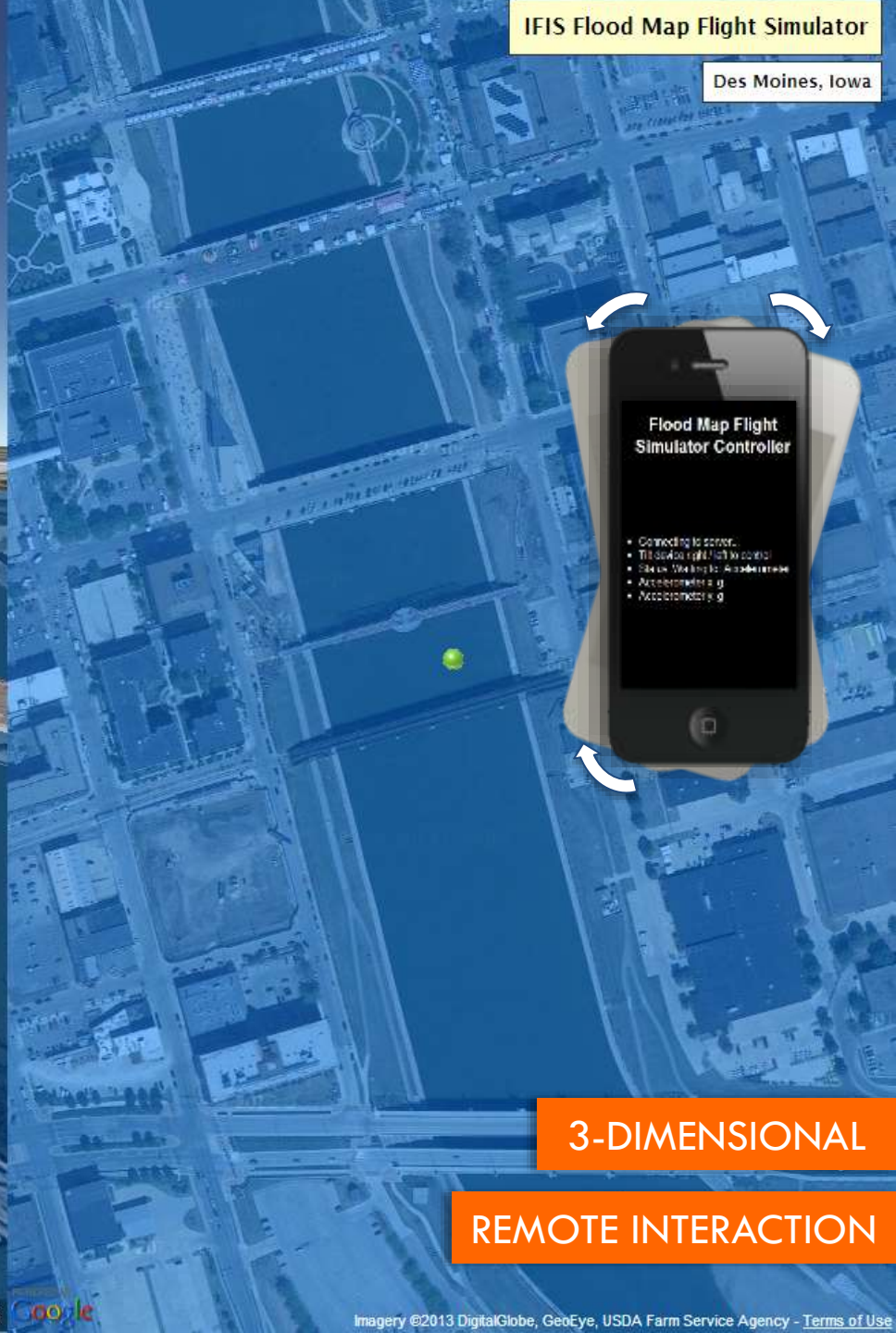
2D FLOOD SIMULATOR GAME

ANIMATION

GAMIFICATION



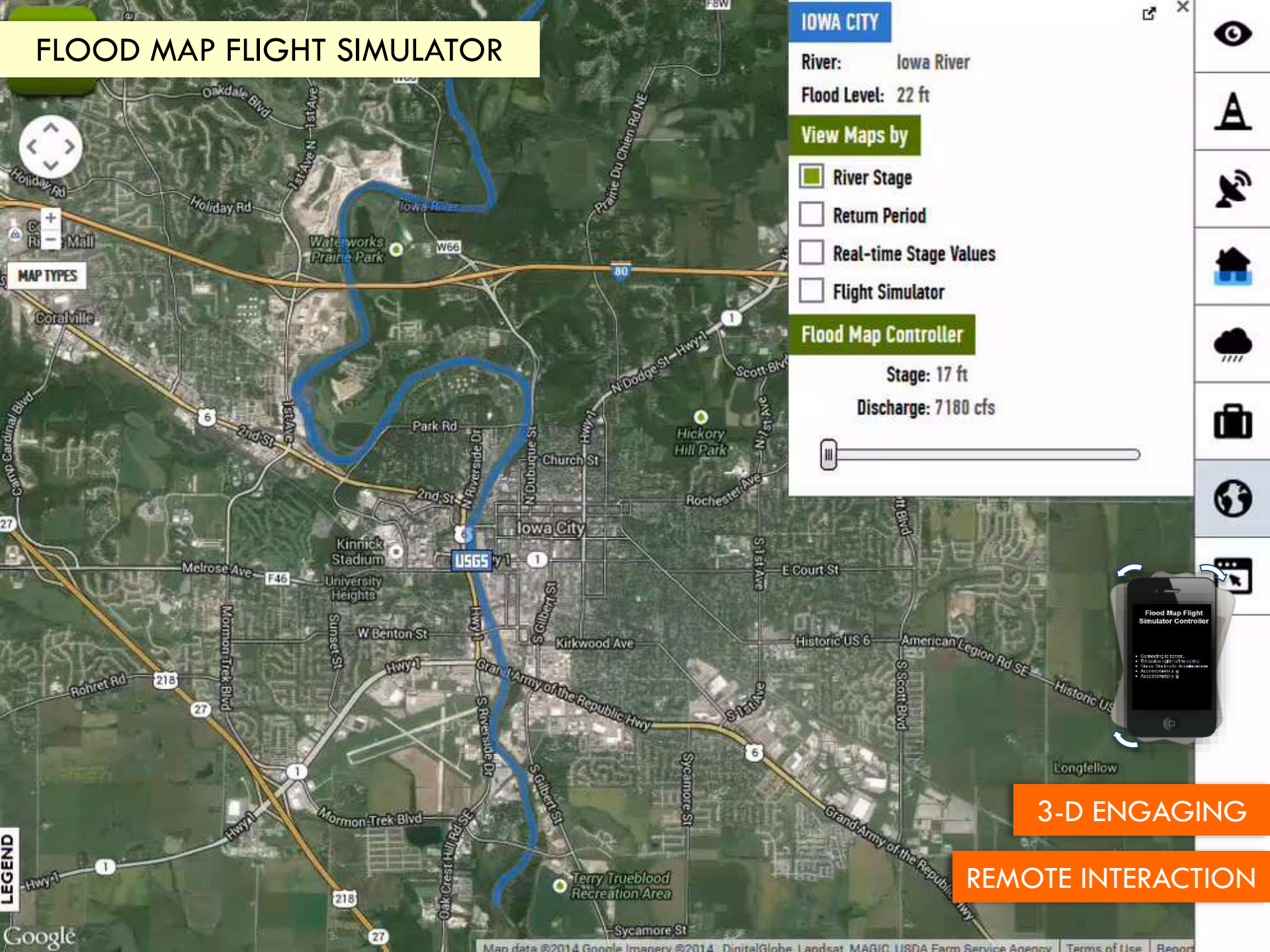
FLOOD MAP FLIGHT SIMULATOR



3-DIMENSIONAL

REMOTE INTERACTION

FLOOD MAP FLIGHT SIMULATOR

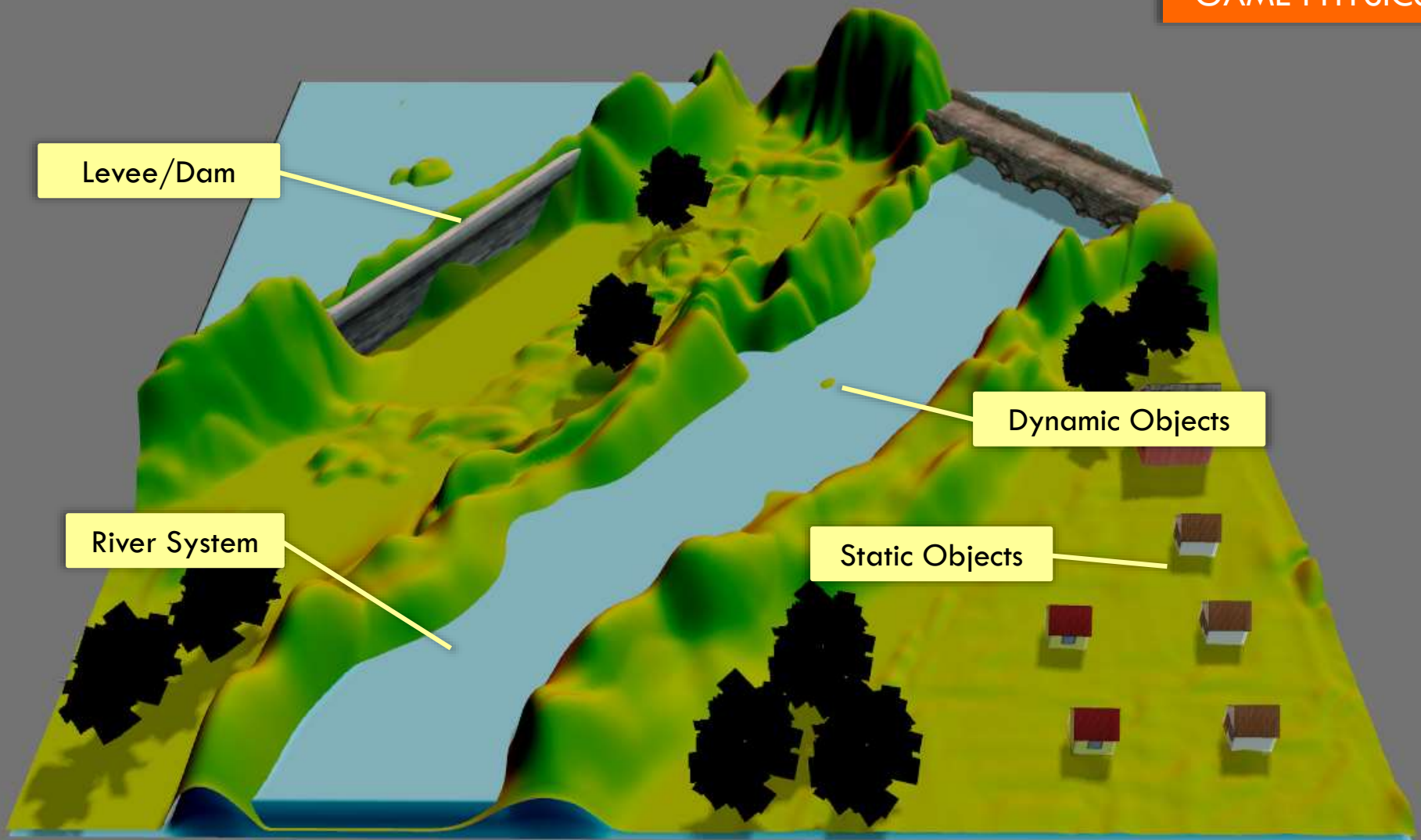


3-D ENGAGING

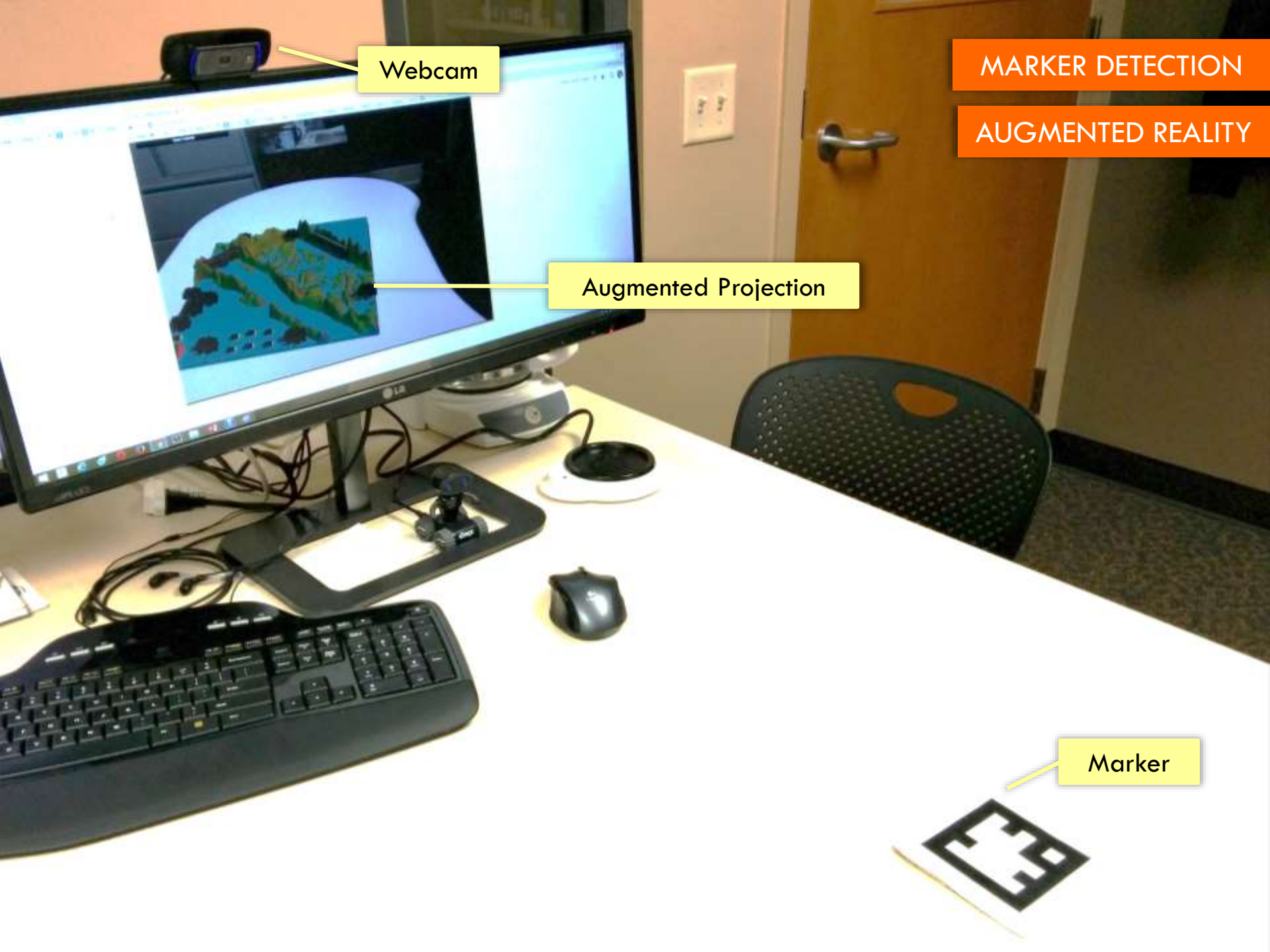
REMOTE INTERACTION

VIRTUAL REALITY

GAME PHYSICS







Webcam

MARKER DETECTION

AUGMENTED REALITY

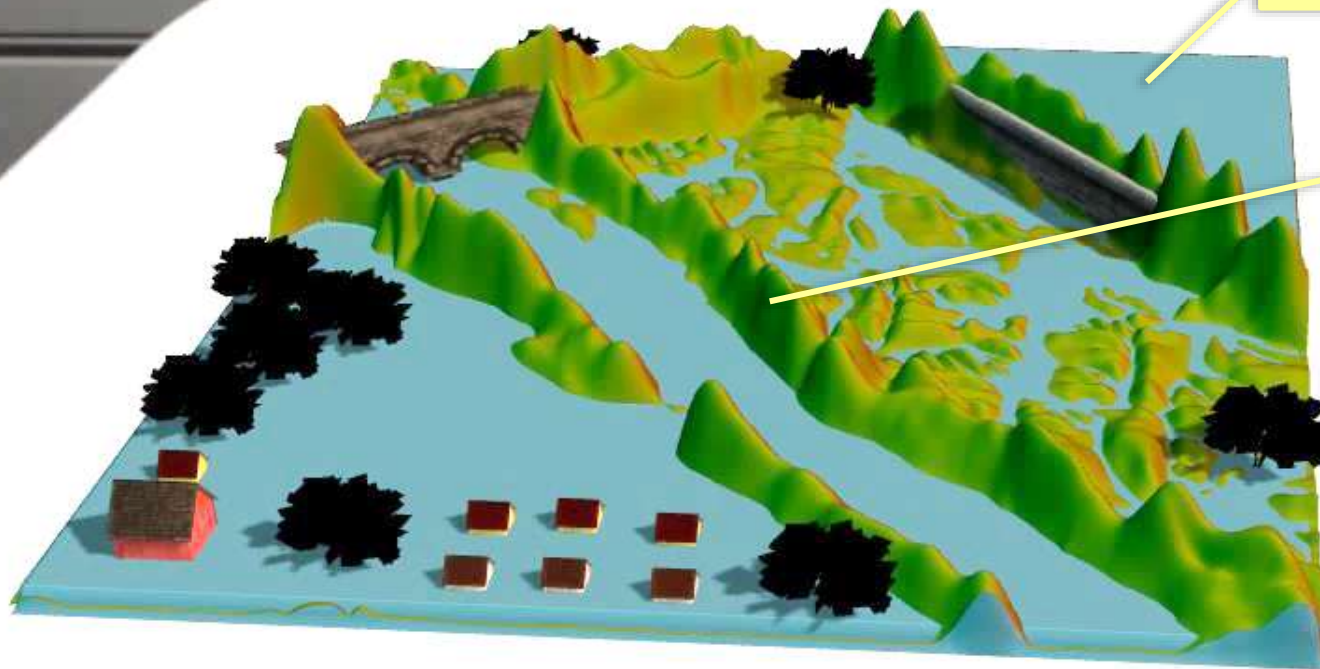
Augmented Projection

Marker

Table

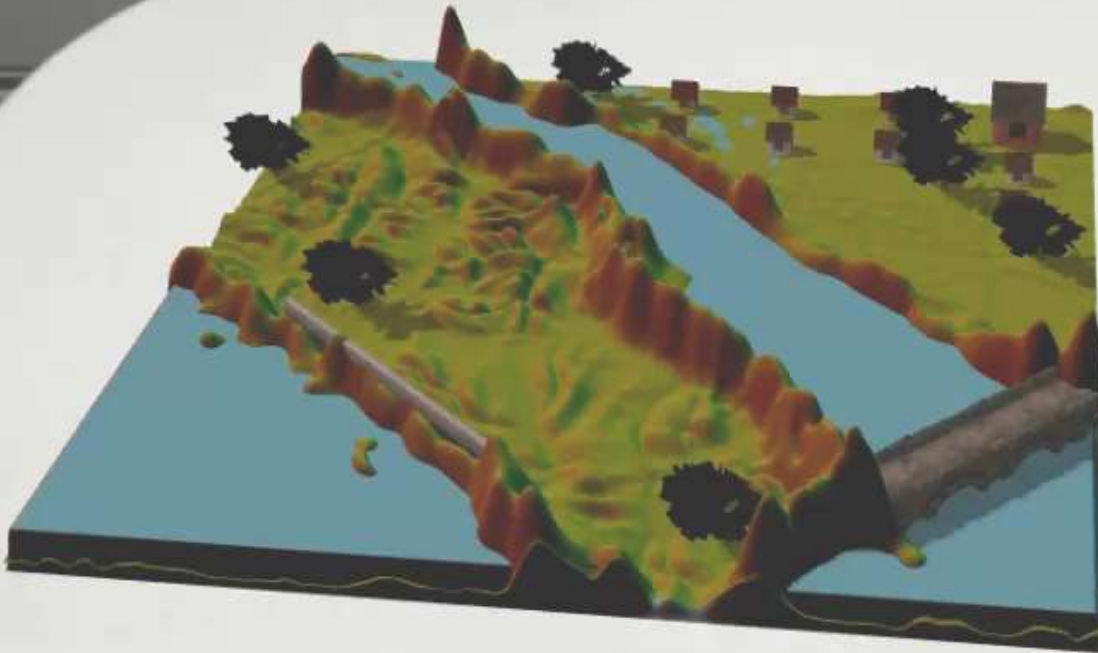
Augmented Projection

Marker



MARKER DETECTION

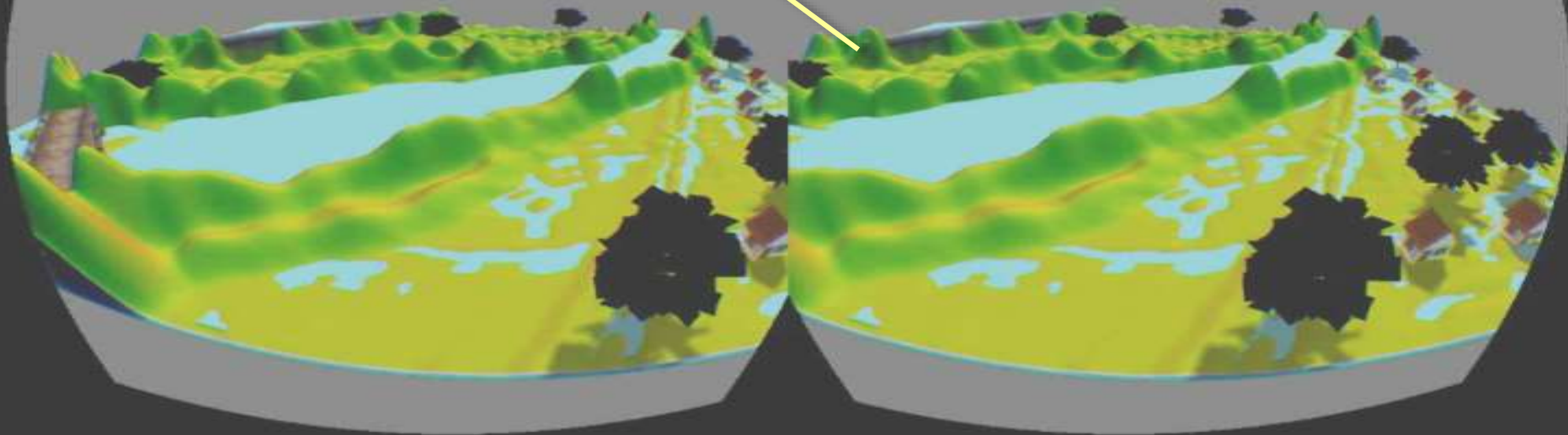
AUGMENTED REALITY



Distorted Projection of Scene

HEADS-UP DISPLAY

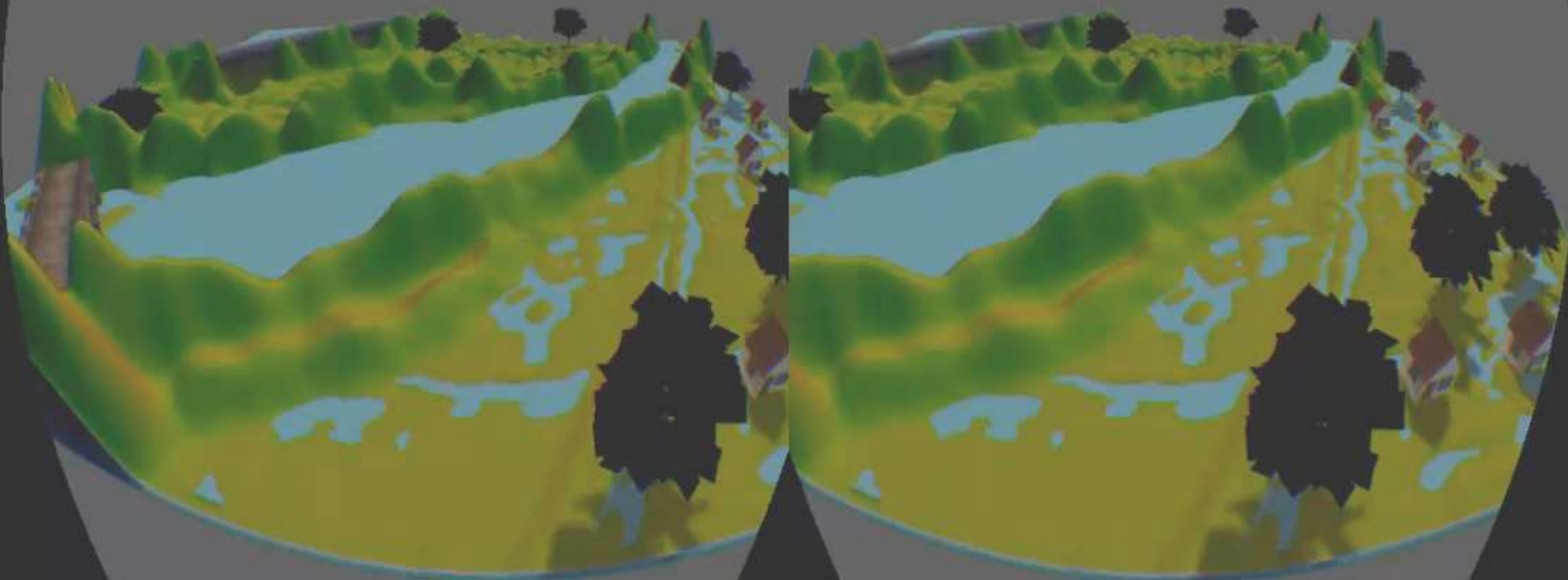
IMMERSIVE REALITY



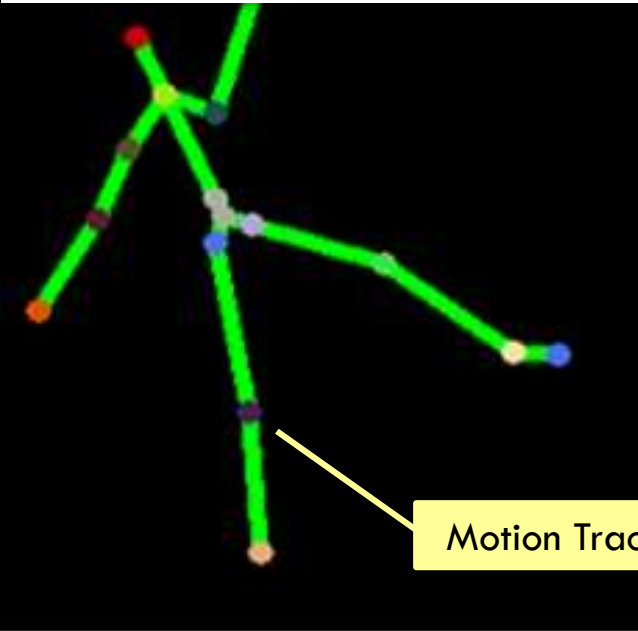
Heads-up Display



IMMERSIVE REALITY



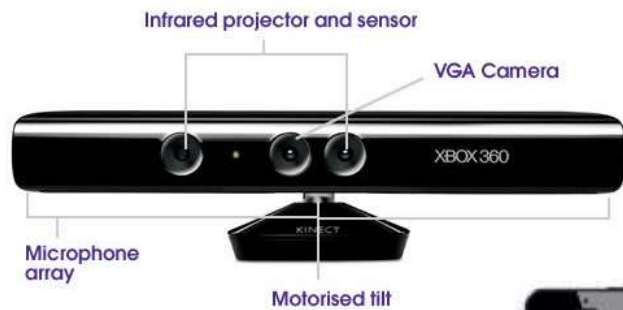
Controls and Interaction



Motion Tracking



Gesture Tracking

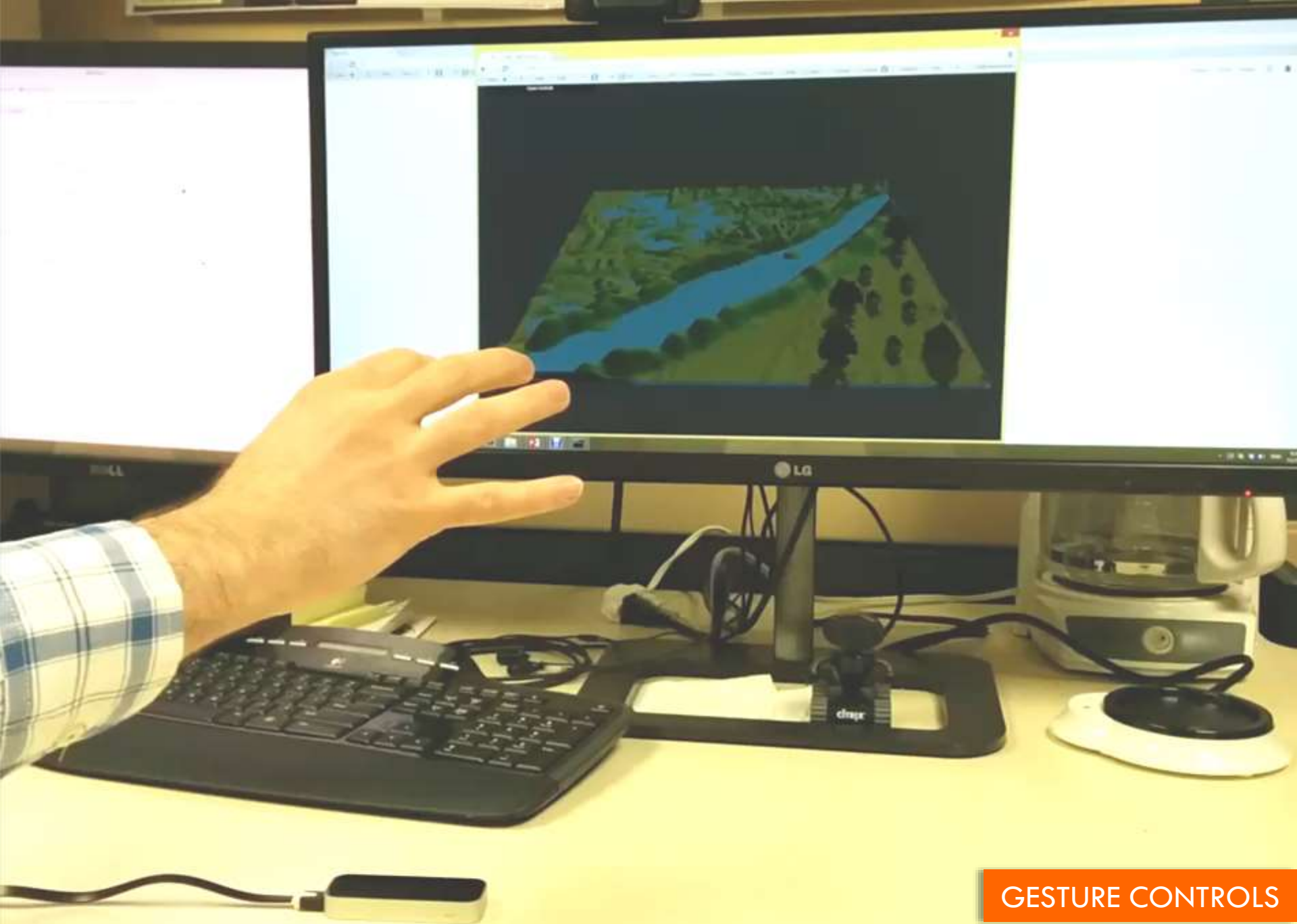


Remote Interaction

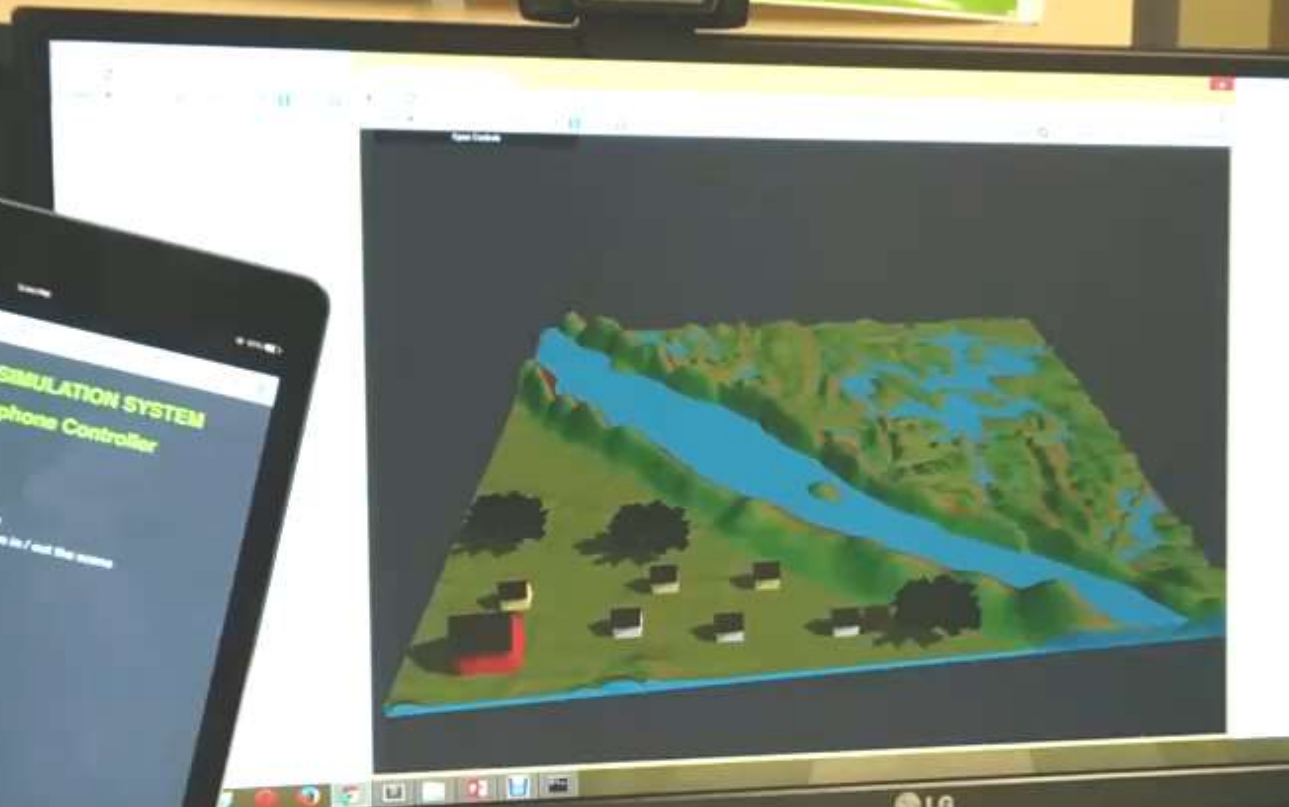
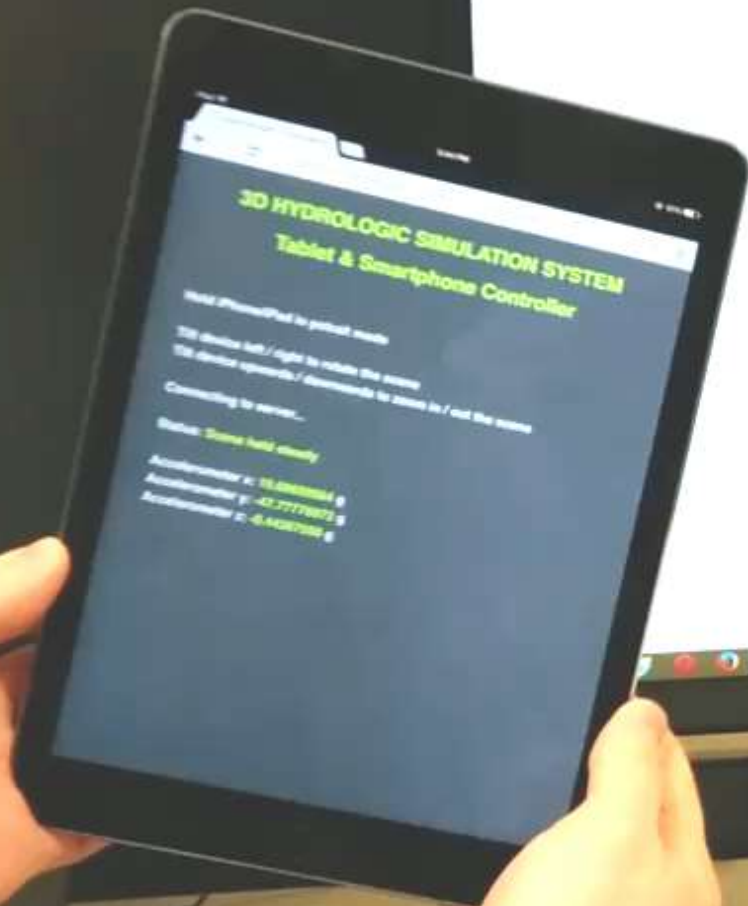


MOTION TRACKING

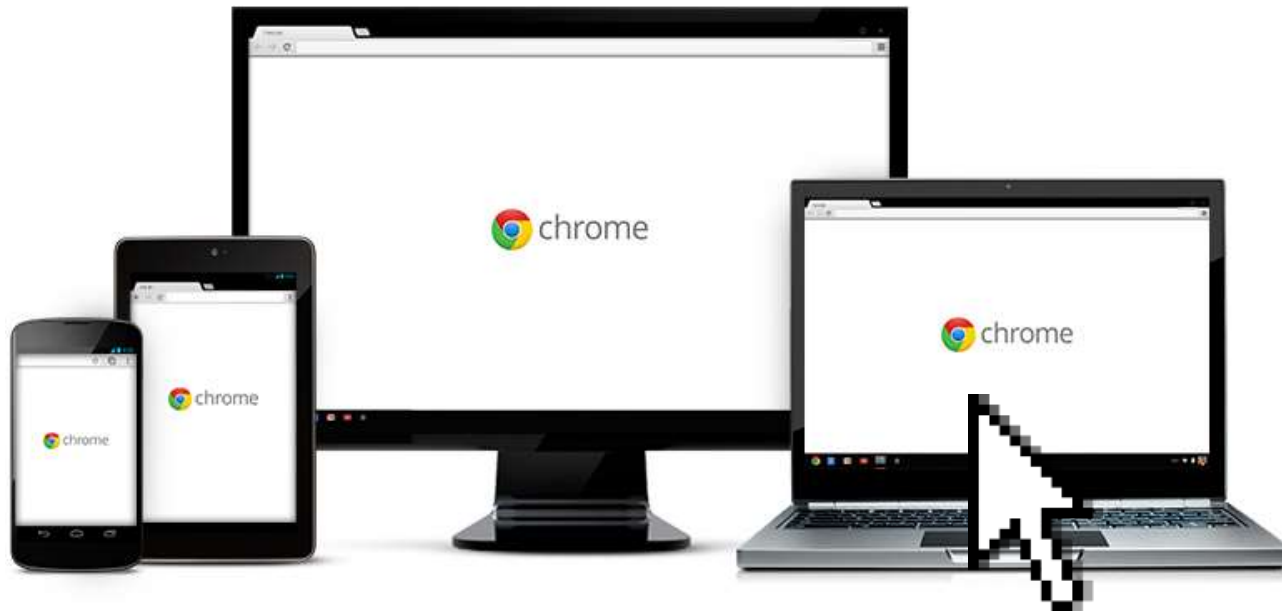
GESTURE CONTROLS



GESTURE CONTROLS



REMOTE INTERACTION



<http://ifis.iowafloodcenter.org>

Thank you

Questions

Ibrahim Demir

ibrahim-demir @ uiowa.edu

<http://myweb.uiowa.edu/demir/>