Water @ Wilson: 50 Years of Water, Conflict, and Cooperation

November 28, 2018

Panel | Raging Waters: The New Face of Water Conflicts

Richard Matthew, UC Irvine

Our Research

- Using big data and local knowledge to develop versatile, high resolution tools (maps, models, simulations) for understanding, predicting and managing the increasing risk associated with extreme events (flood, drought, fire)
- Special (but not exclusive) focus on high vulnerability/low resource communities (e.g. Malawi, Nepal)
- Tools are co-developed with a wide range of stakeholders (refugees, residents, emergency response, conservationists, planners, policymakers)

Our Research

- Linking our tools to humanitarian crises (war, epidemic disease, forced displacement)
- Integrating our technology with other technologies (e.g. humanitarian response technology at York University; rapid field based diagnostic tools at Berkeley)

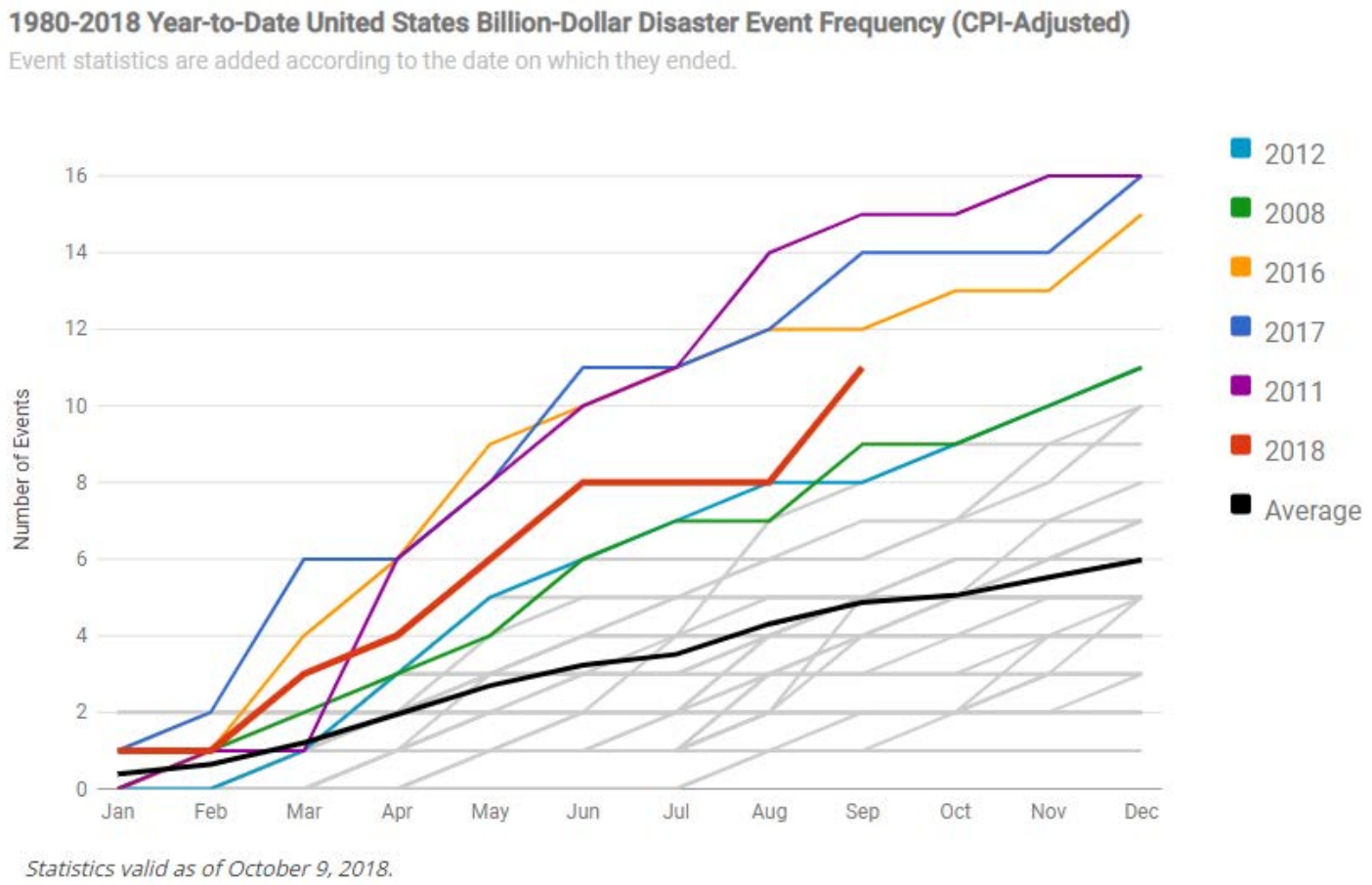
- *Gratefully acknowledge NSF, NOAA, the LP Foundation, the Blum Foundation, the Gates Foundation, UCOP and many private donors for funding this work.*

UCI Team

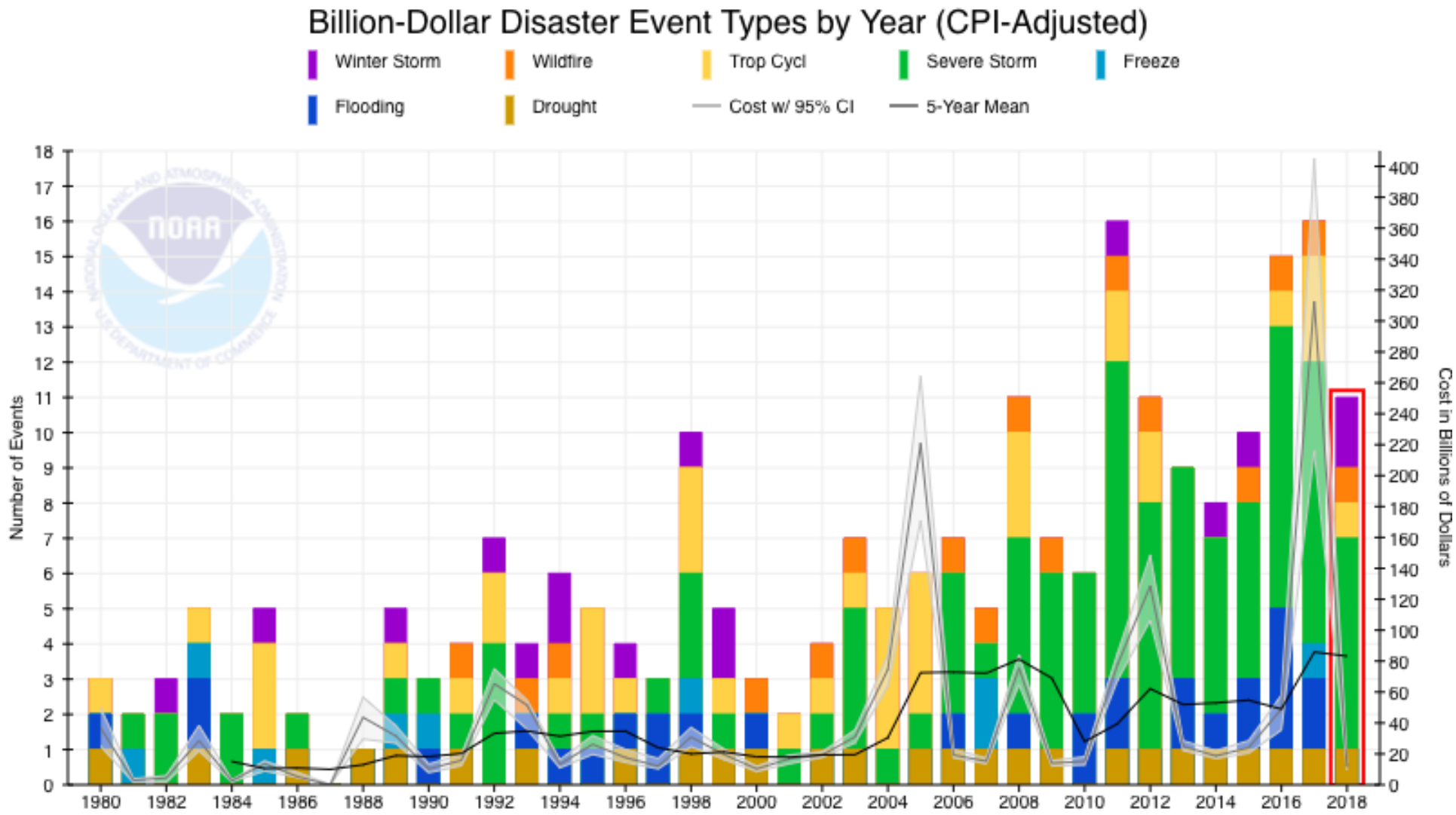
- **FACULTY**
- Amir AghaKouchak
- Maura Allaire
- Victoria Basolo
- David Feldman
- Doug Houston
- Richard Matthew
- Brett Sanders
- Nicola Ulibarri

- **ALUMNI**
- Wing Cheung
- Adam Luke
- Hamed Moftakhari
- **RESEARCH SPECIALIST**
- Jochen Schubert
- **GRADUATE STUDENTS**
- Matthew Brand
- Kristen Goodrich
- Paroma Wagle

Steady Increase in Costs of Disasters



National Centers for Environmental Information


Billion-Dollar Disaster Event Types by Year (CPI-Adjusted)
Winter Storm
Wildfire
Trop Cycl
Severe Storm
Freeze
Flooding
Drought
Cost w/ 95% CI
5-Year Mean
Number of Events
Cost in Billions of Dollars
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018

Rising Humanitarian Need

- In 2017, a humanitarian crisis emerged in Nepal, Bangladesh and India where more than 1,000 people died and at least 41 million were affected by monsoon flooding and landslides (Gettleman, 2017).

- Flood fatalities have increased dramatically over the past half-century and floods today pose unacceptable levels of health risk (Few et al. 2004, Di Baldassarre et al. 2010, Watts et al. 2015, UNISDR & CRED 2015).

Argatala, India (Getty Images, 2017)

- In 2018, 200,000 Rohingya refugees in Bangladesh have been threatened by flooding, landslides and waterborne disease.

Rohingya Refugee Camp near Cox's Bazar, Bangladesh (Medium, 2018)

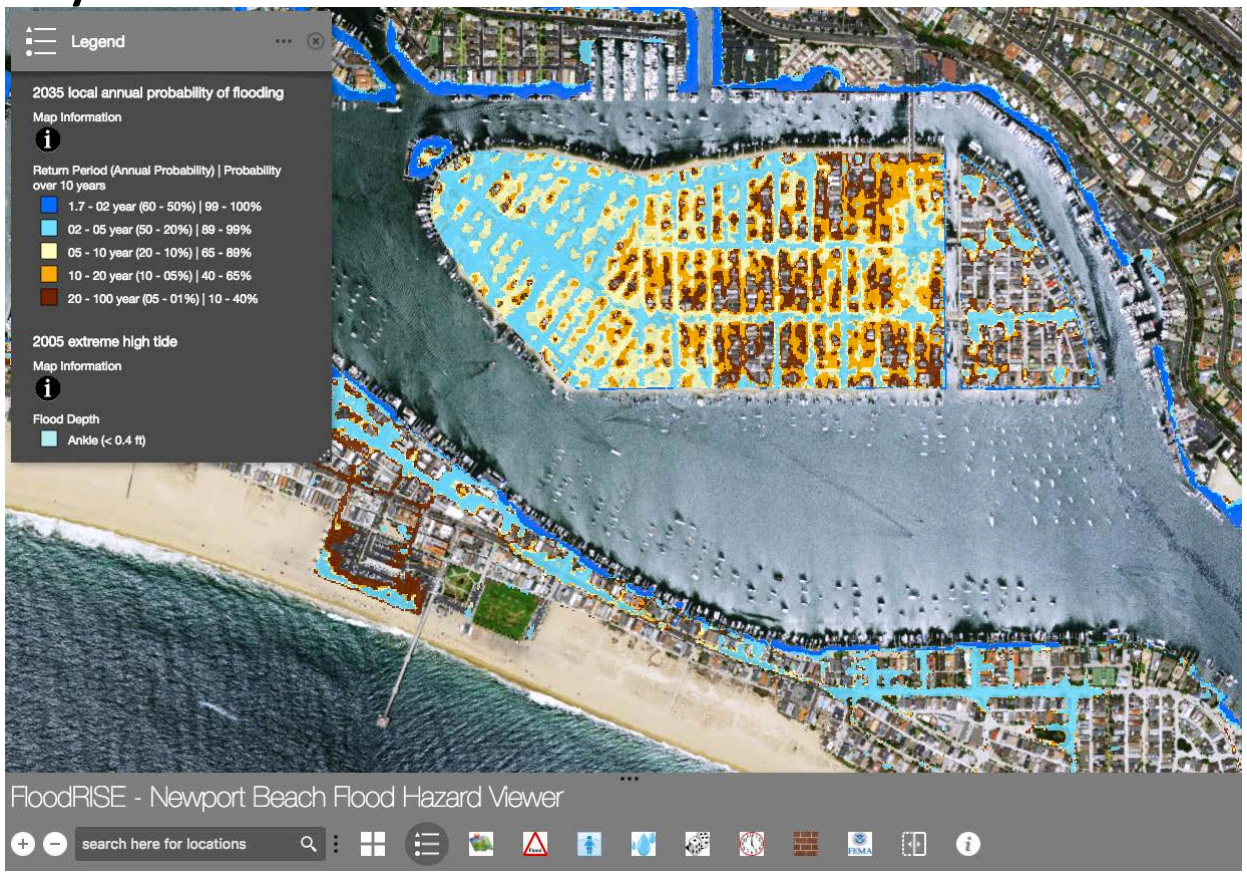
The Modeling Challenge

- A combination of factors are increasing the risk of both nuisance and major weather events but make prediction difficult:
  - Land change especially deforestation
  - Coastal settlement and development
  - Aging infrastructure
  - Poverty and inequality
  - Climate change

World Population in 1900 **1.6 billion**	**World Product in 1900** **$1.1 trillion**
World Population in 2018 7.7 billion	World Product in 2018 $87 trillion
Increase: 4.8X	Increase: 79X
Wealth of Bottom 70% 2.7%	Wealth of Top 1% 50.1%

The Modeling Challenge

Land change is altering the dynamics of extreme events



- Defense systems are failing

The Modeling Challenge

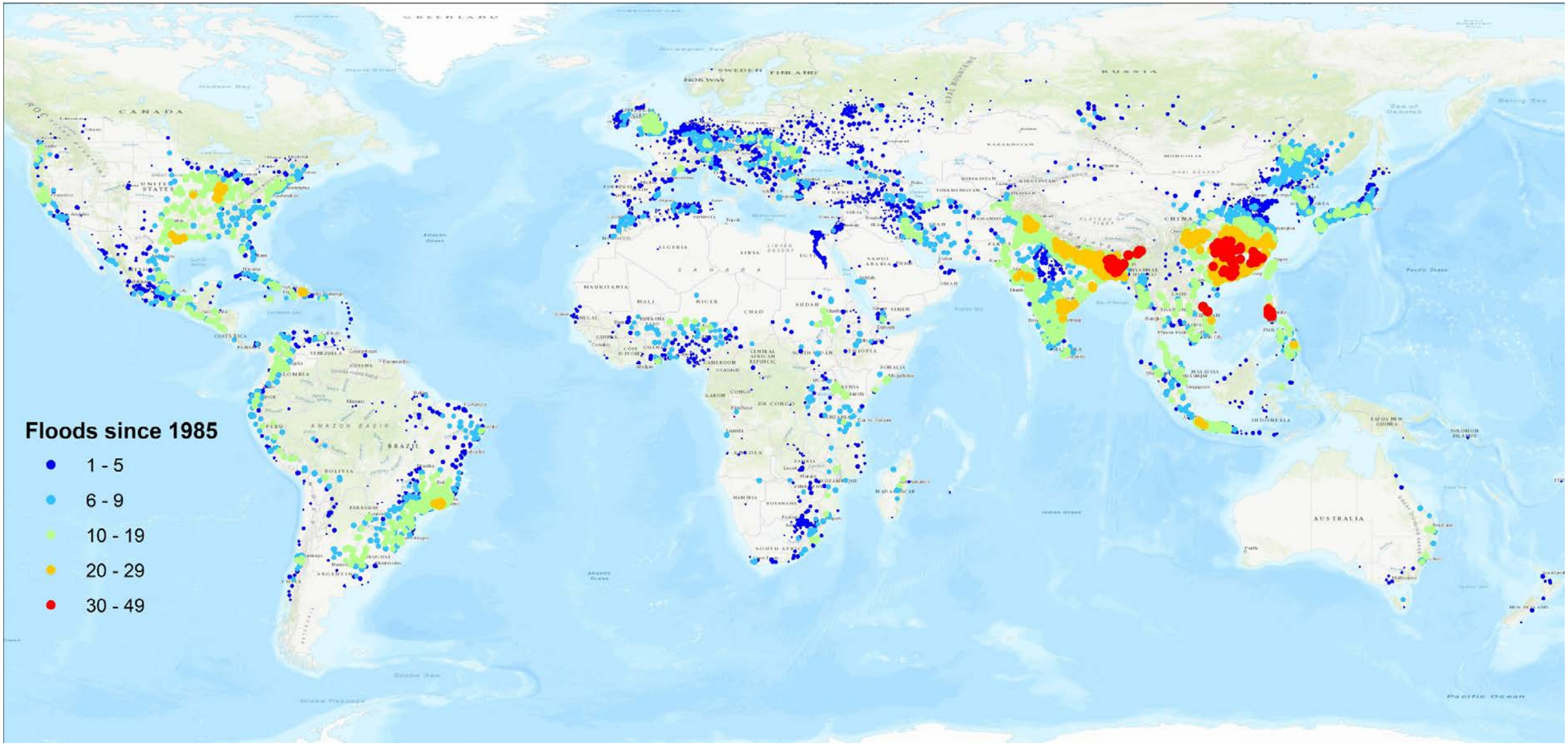
- Climate change impacts:
  - Fire (e.g. climate change has doubled the extent of the burn area in the Western US between 1984-2015)
  - SLR (e.g. 80% of California beaches and slat marshes may disappear this century)
  - Drought (e.g. since 2000 Lake Mead has dropped 130 feet and lost 60% of its volume)
  - Heatwaves (e.g. heat stress affecting humans and crops)

The Modeling Challenge

To be useful tools have to provide the right information in the right resolution

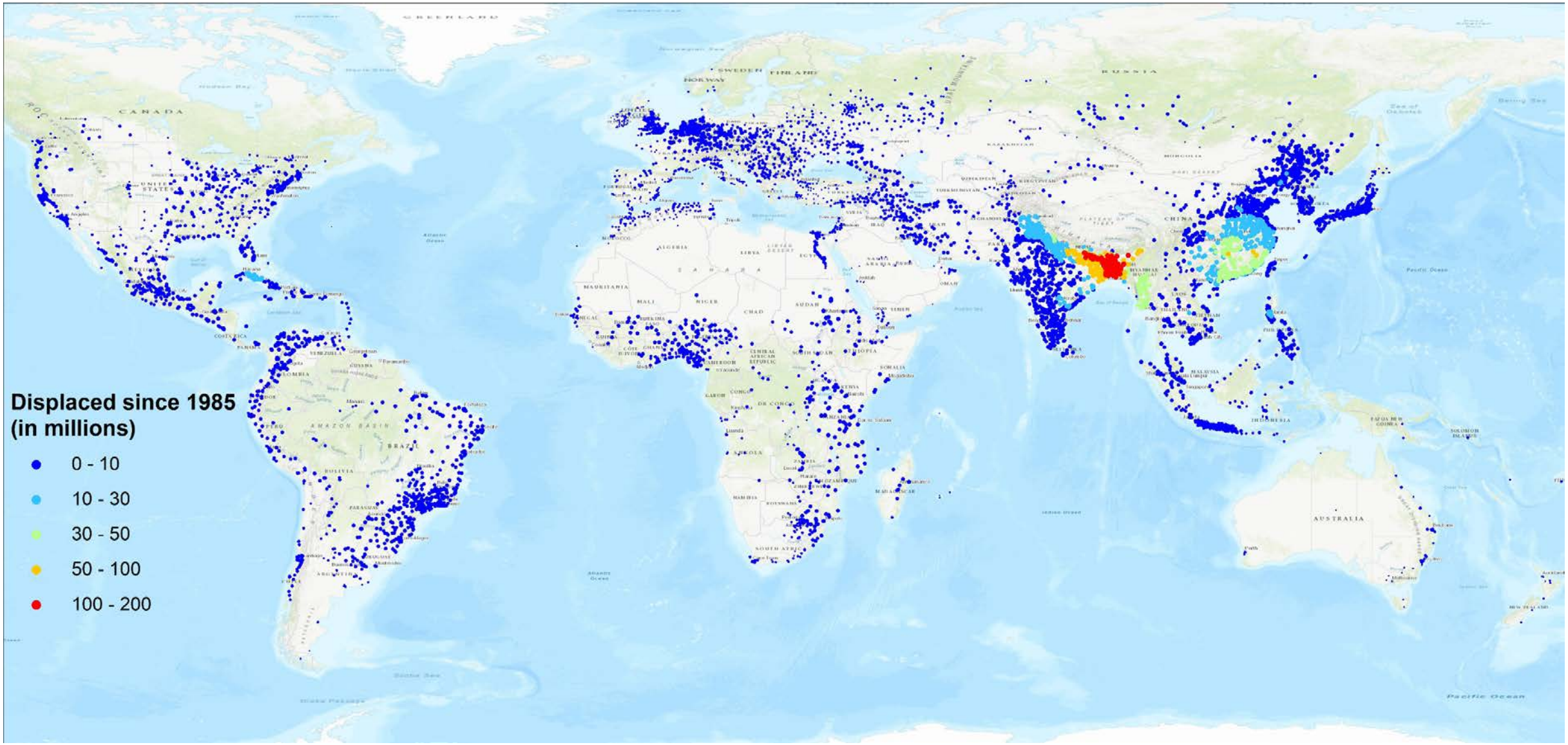
Examples of Visualization Tools

Frequency of Flooding since 1985



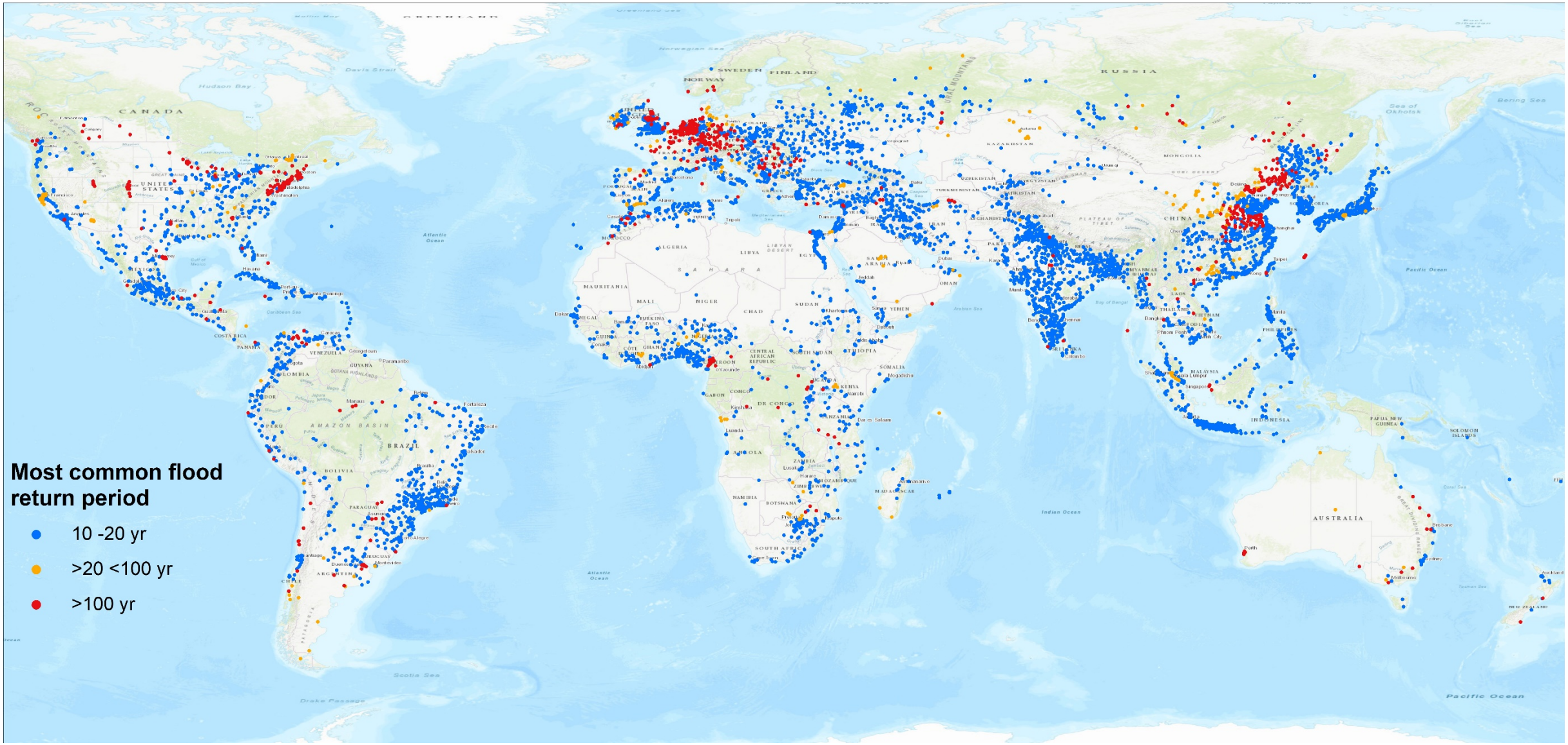
Source: Dartmouth Flood Observatory

Displaced by Flooding since 1985



Source: Dartmouth Flood Observatory

Most Common Flood Return Period since 1985



Source: Dartmouth Flood Observatory

UNIVERSITY of CALIFORNIA · IRVINE

The Global Integrated Drought Monitoring and Prediction System (GIDMaPS)

Global Integrated Drought Monitoring and Prediction System (GIDMaPS)

Map | Layers | Advance

Drought Monitoring

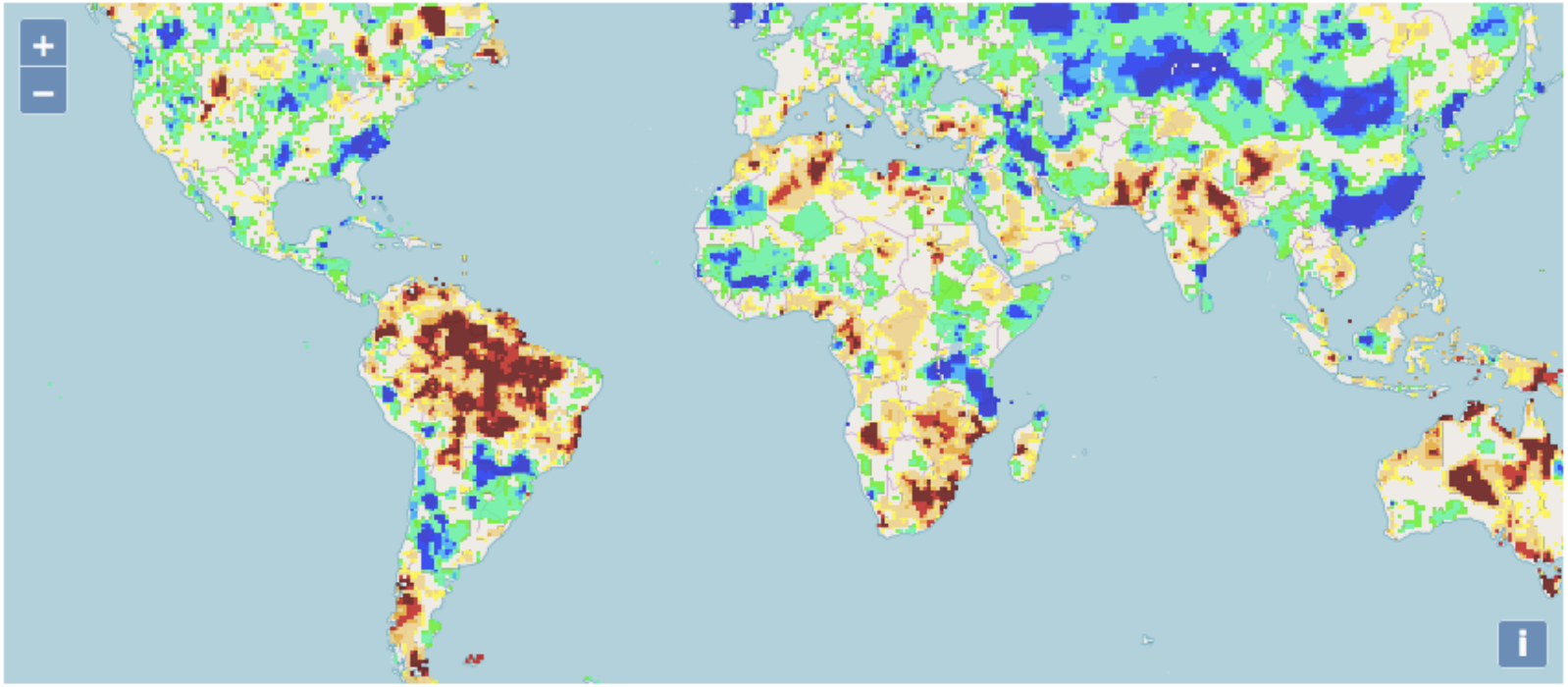
Data Set: MERRA

Year: 2016

Month: February

Index: SPI

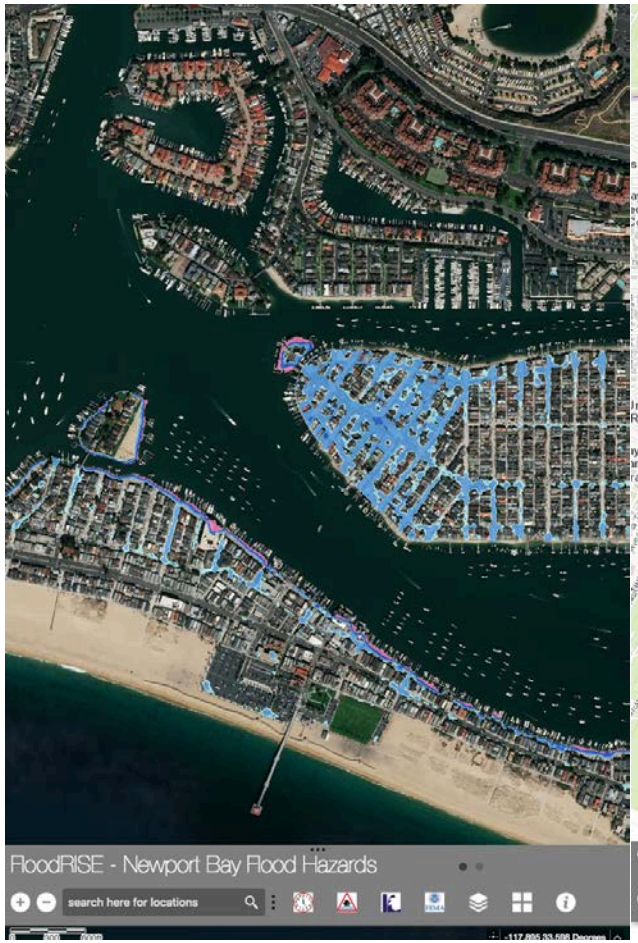
Load | Download Map



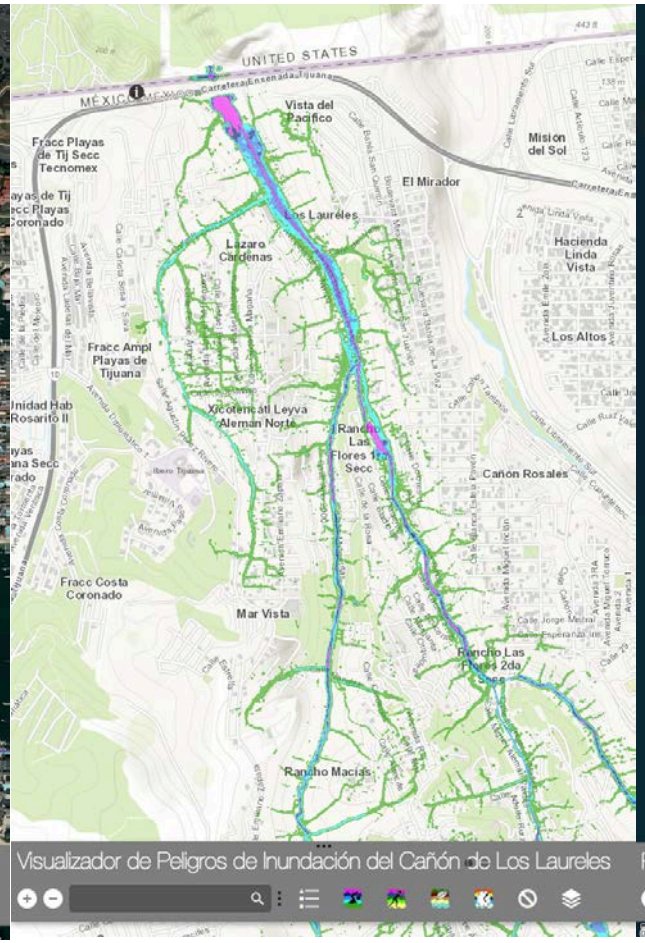
Monitoring

D4 D3 D2 D1 D0 W0 W1 W2 W3 W4

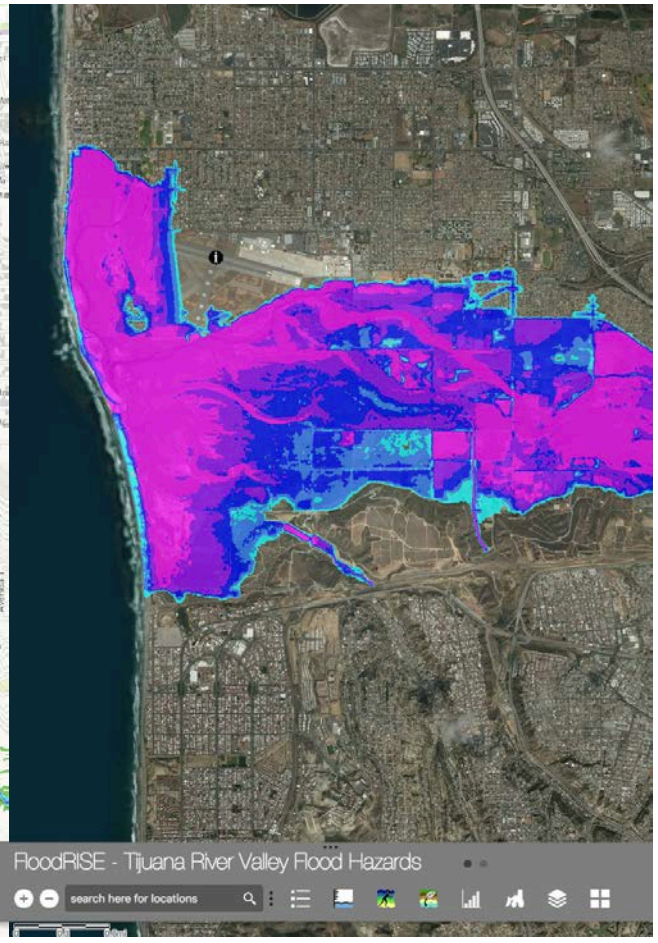
Online Flood Hazard Viewers



Newport Beach
http://bit.ly/floodrisenb

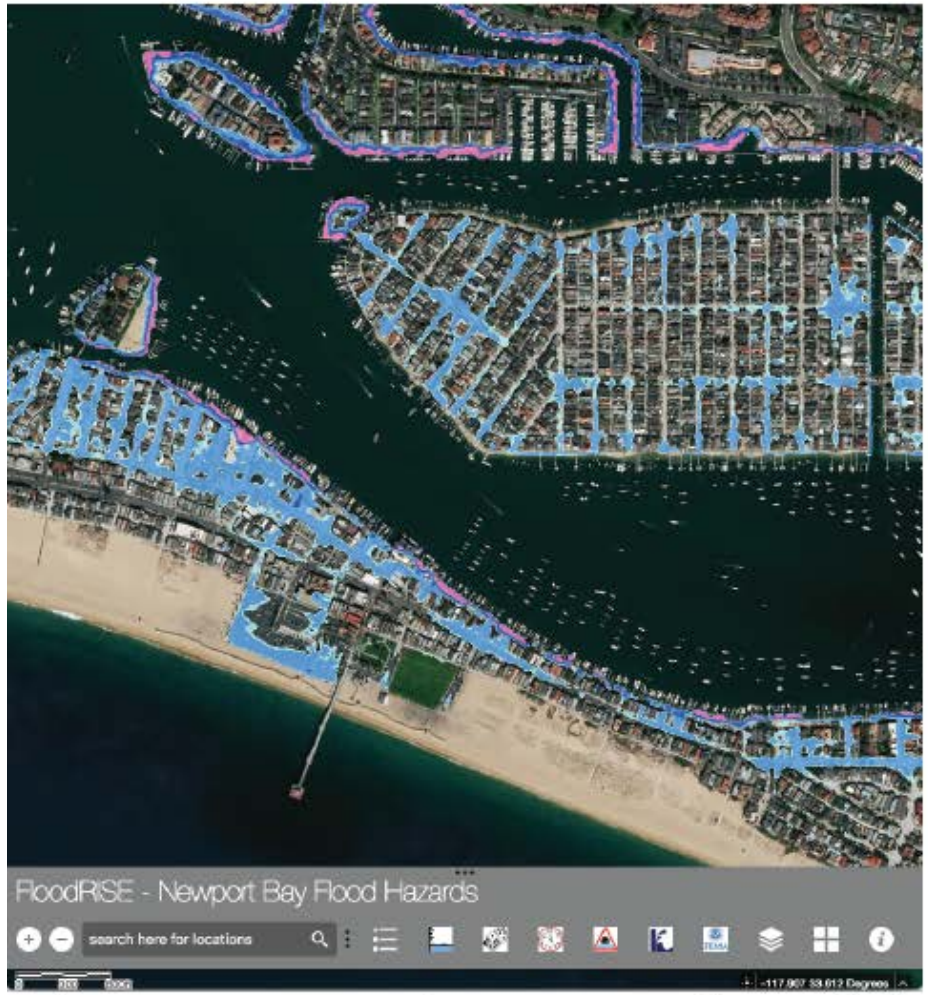


Los Laureles
http://bit.ly/floodrisell

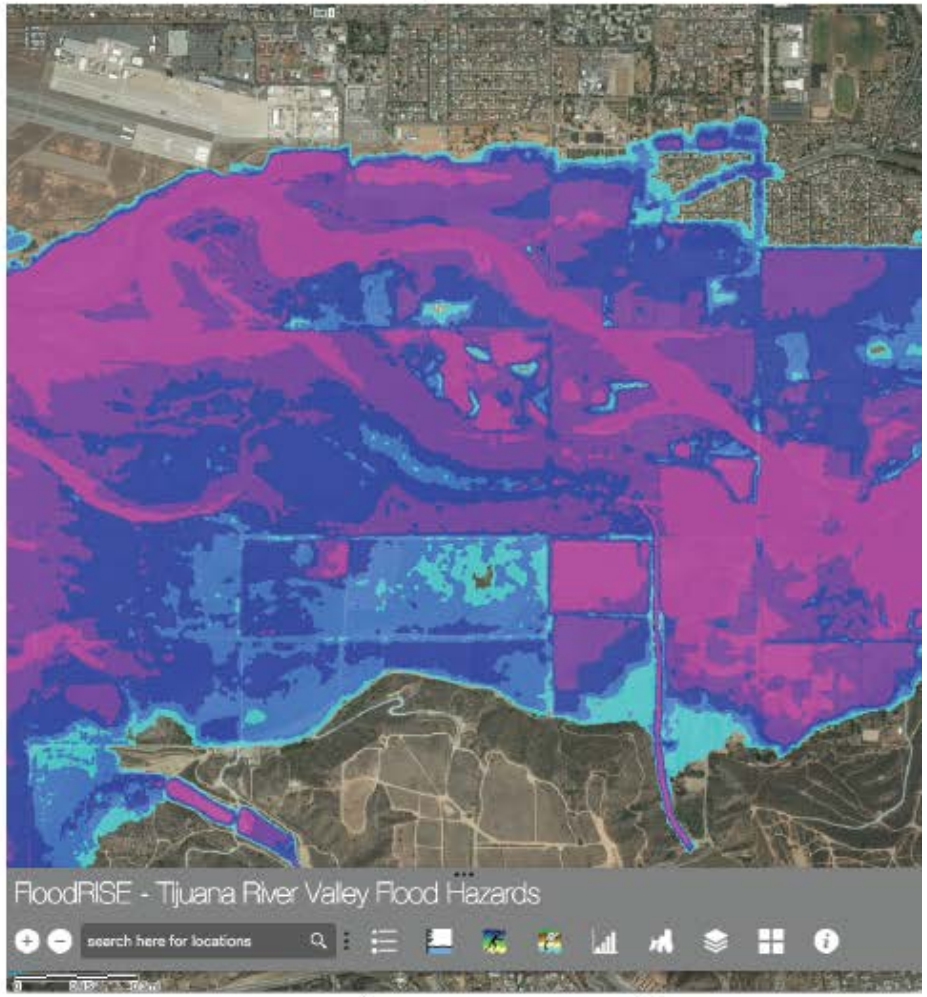


Tijuana River Valley
http://bit.ly/floodrise_TRV

(A) Newport Bay Flood Hazard Viewer



(B) Tijuana River Valley Flood Hazard Viewer



Zoom In and Out

Search by Address

Select Flood Hazard Layer

Add Contextual Information

Change Base Map

Activate Legend

Review Management Plans

Access Technical Documentation

(C) Viewer Toolbar Features

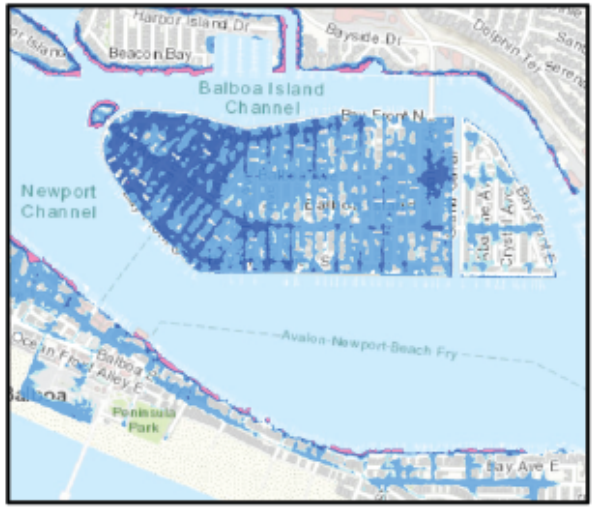
(A) Historical Event (Jan 2005)

Flood Depth

- Ankle (< 0.4 ft)
- Ankle - Knee (0.4 - 1.5 ft)
- Knee - Waist (1.5 - 3.3 ft)
- Over Waist (> 3.3 ft)

2005 Flood Photos

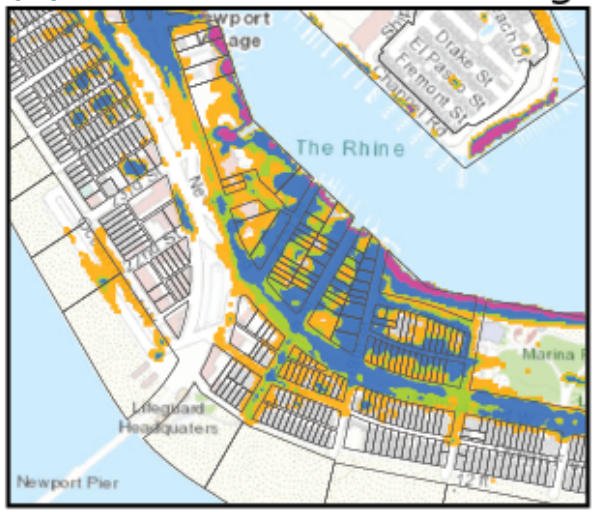
(B) 2035 1% Annual Chance



Flood Depth

- Ankle (< 0.4 ft)
- Ankle - Knee (0.4 - 1.5 ft)
- Knee - Waist (1.5 - 3.3 ft)
- Over Waist (> 3.3 ft)

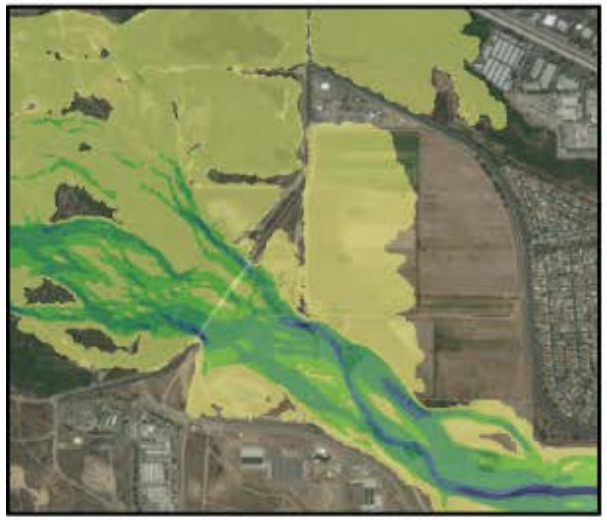
(C) 2015 Chance of Flooding



Annual Chance	Return Period	Chance over 10 years
40 - 60%	1.7 - 2.5 year	99 - 100%
20 - 40%	2.5 - 5.0 year	89 - 99%
10 - 20%	05 - 10 year	65 - 89%
01 - 10%	10 - 100 year	10 - 65%

Land Parcels

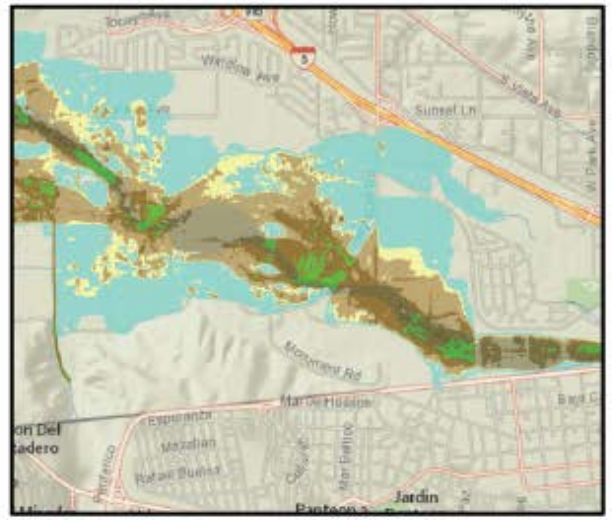
(A) Flood Force



Flood Force

- People Likely Stable (< 4.3 ft²/s)
- People Toppled (4.3 - 8.1 ft²/s)
- Cars Displaced (8.1 - 16.1 ft²/s)
- Structural Home Damage (16.1 - 27.0 ft²/s)
- Homes Washed Away (> 27.0 ft²/s)

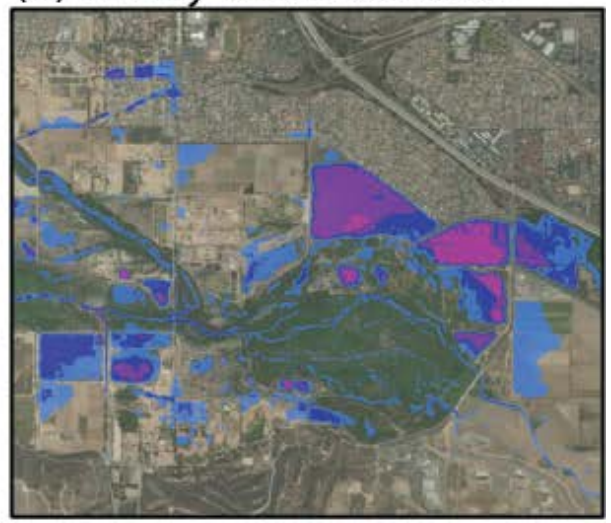
(B) Shear Stress



Erodible Materials (Shear Stress)

- Erosion Unlikely (< 0.02 lbs/ft²)
- Sandy Soils (0.02 - 0.045 lbs/ft²)
- Silty Loams (0.045 - 0.26 lbs/ft²)
- Alluvial Silt (0.26 - 0.7 lbs/ft²)
- Vegetated Surfaces (> 0.7 lbs/ft²)

(C) Poorly Drained Areas



Standing Water Depth (After Flood)

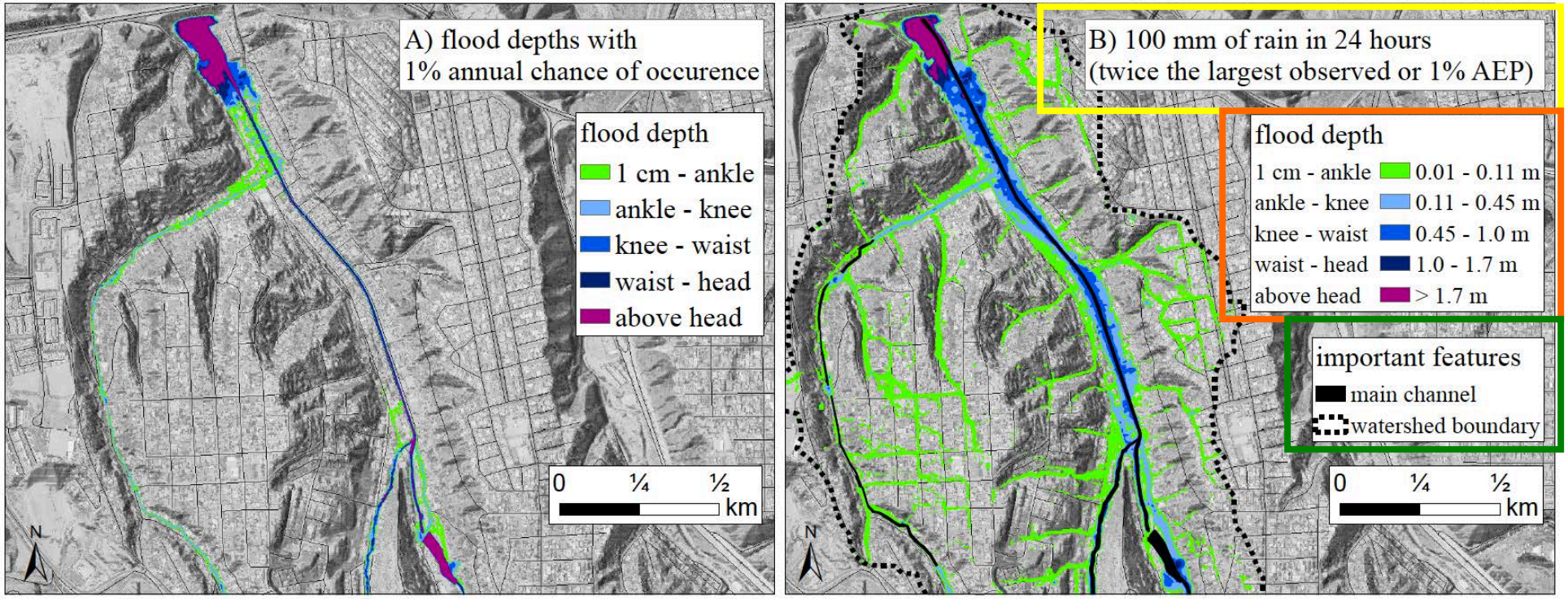
- Ankle - Knee (0.4 - 1.5 ft)
- Knee - Waist (1.5 - 3.3 ft)
- Waist - Head (3.3 - 5.5 ft)
- Above Head (> 5.5 ft)

A Case of Improving Flood Model Structure

V1 Map: Hydrologic Model (Rainfall-Runoff) Forcing Hydrodynamic Model (Streamflow routing)

V3 Map: "Rain on Grid" Hydrodynamic Model

Luke et al., NHESS, 2017



How Are the Maps Being Used?

- Planning and policies
  - NB: AB 691, TRV: Updating Coastal Plan, LL: informing land use plans
- Project scoping and design
  - NB: channel structures affected by SLR, TRV: trash traps and sediment basins, marsh restoration
- Maintenance/funding of flood control systems
  - Helps to justify resource expenditures.
  - Tool for public communication of risks.
  - Tool for communication with decision-makers
- Leveraging other modeling and research
  - TRV: value for sediment management studies
- Community awareness and outreach
  - Support targeted communications to increase awareness about flooding and erosion

On the Horizon

- Some 4 million people live in camps managed by UNHCR—as witnessed in Bangladesh, these camps can be highly vulnerable to flooding, water ponding and erosion—and we now can rapidly develop models to inform siting decisions and to inform flood risk management
- Extreme events medium term forecasting (6 months) tool
- Linking our flood models (predictive and dynamics to the work of Dan Fletcher's lab at Berkeley that has developed smart phone based tools for rapid assessment of parasitic worms (river blindness, loa loa, elephantiasis) in blood samples—now want to see what can be done with water
- A study of the implications of using big data for humanitarian crises in terms of individual privacy
- Exploring the linkages among environmental change and migration e.g. to what extent do the movements of climate refugees intersect with the migration of other species, and certain forms of trafficking (human, exotic species, drugs, arms, ivory)

Linking to Violent Conflict

- Analysts consider many factors to understand violent conflict including:
  - Root or structural causes
  - Perceptions and motivations
  - Catalyzing factors
  - Triggering events
  - Sustaining factors

- Hydrological events are broadly relevant and their weight is likely to increase because risk management is failing and the costs of cyclones, floods, droughts and fires are growing. E.g.:
  - Poverty and inequality contribute to violent conflict
  - Poverty and inequality are increasing
  - Extreme weather events deepen poverty and inequality
  - Extreme weather events are increasing

UNIVERSITY of CALIFORNIA · IRVINE

The Global Integrated Drought Monitoring and Prediction System (GIDMaPS)

Global Integrated Drought Monitoring and Prediction System (GIDMaPS)

Map | Layers | Advance

Drought Monitoring

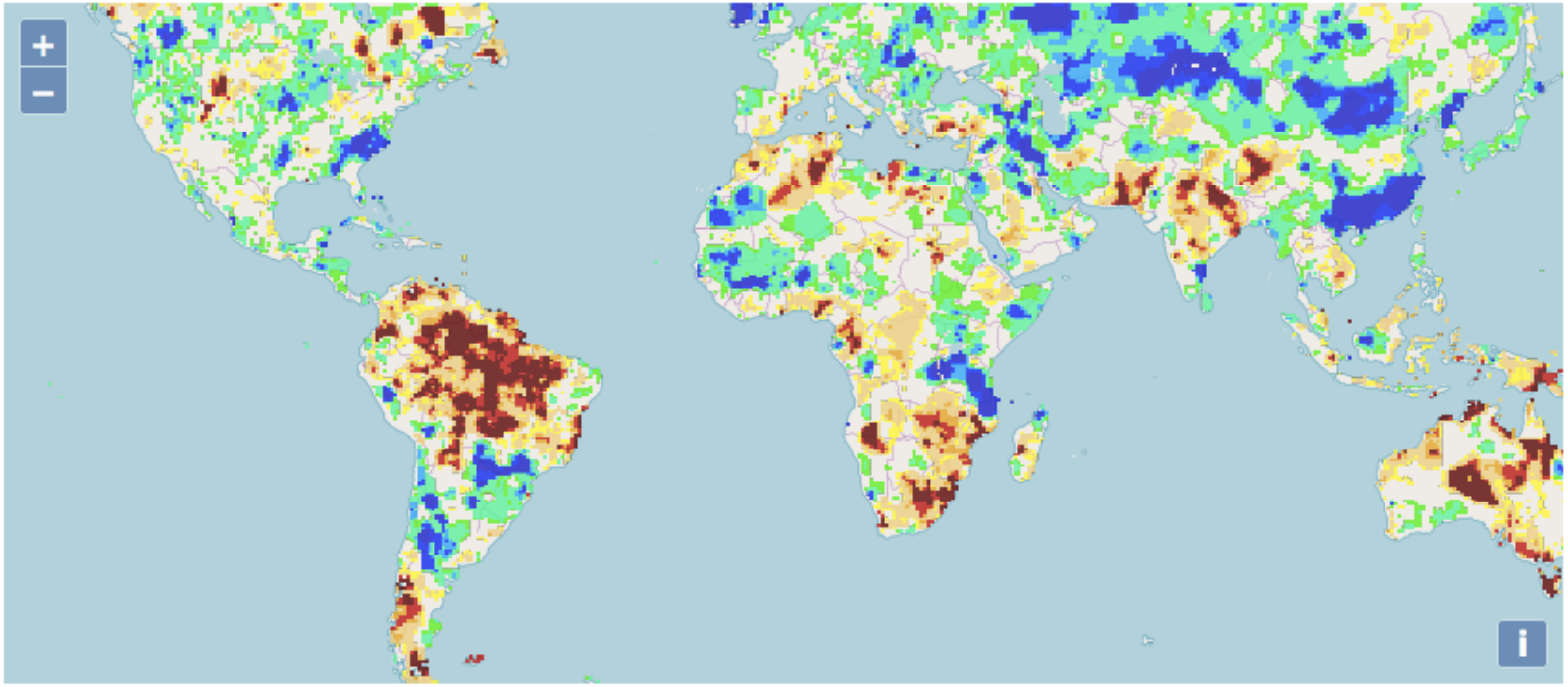
Data Set: MERRA

Year: 2016

Month: February

Index: SPI

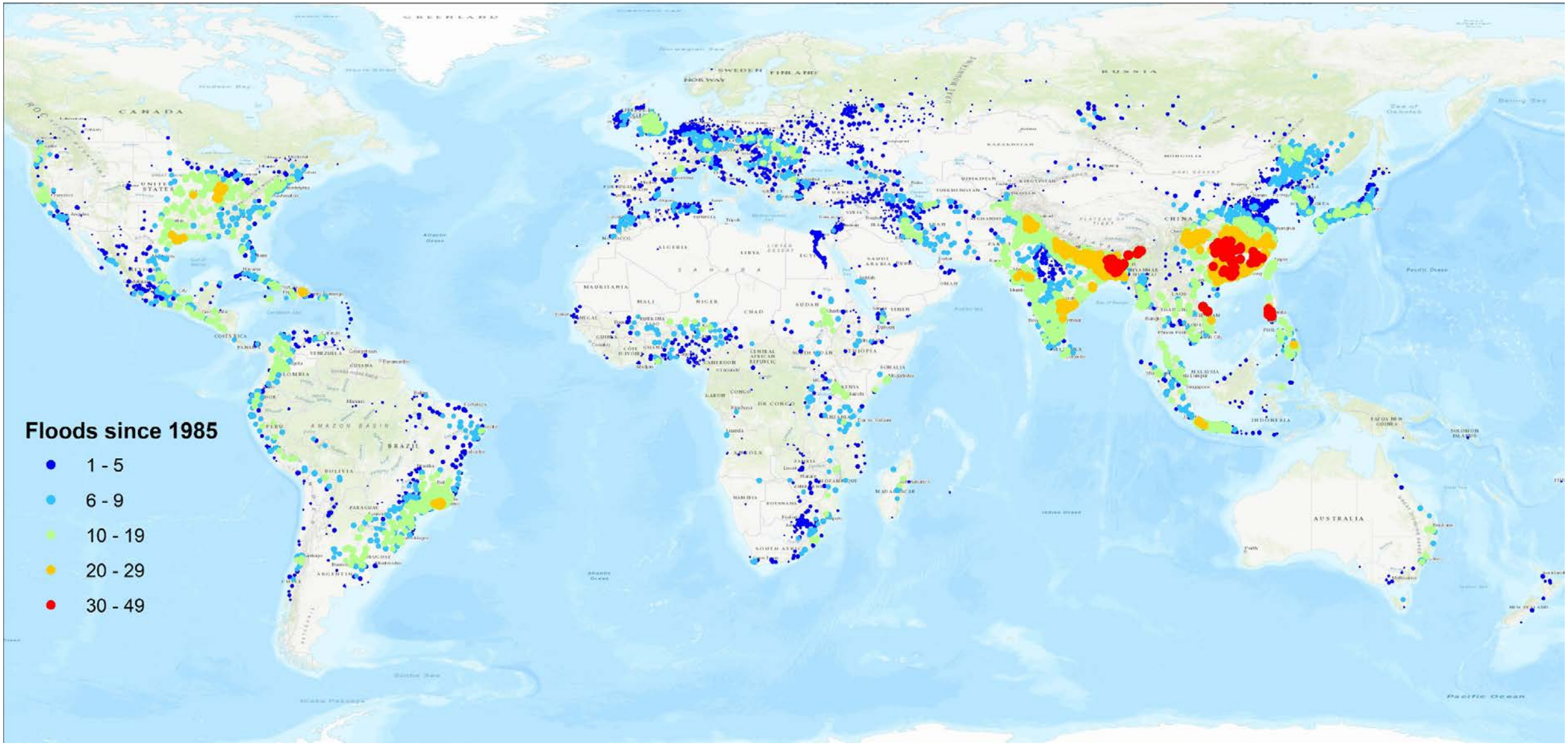
Load | Download Map



Monitoring

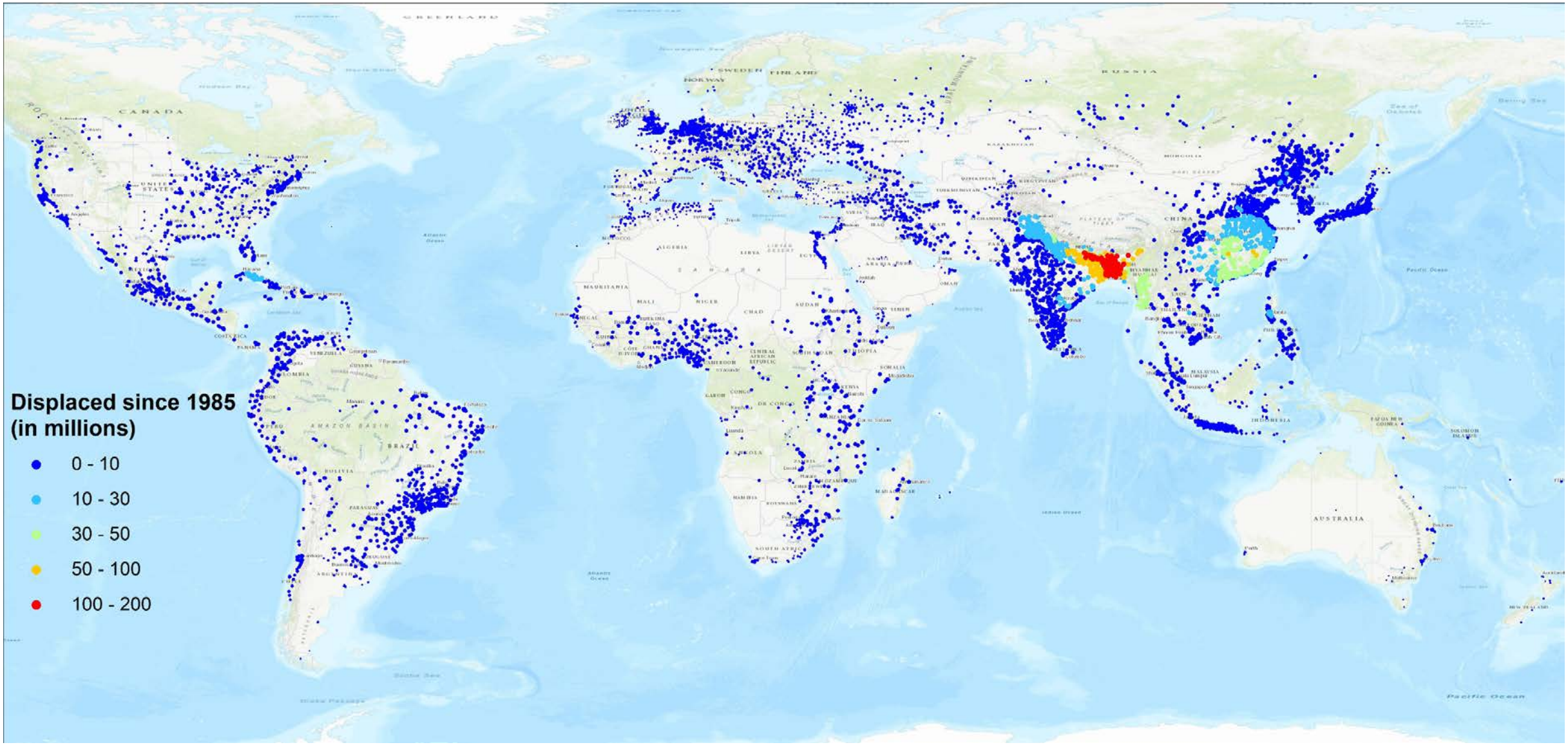
D4 D3 D2 D1 D0 W0 W1 W2 W3 W4

Frequency of flooding since 1985



Source: Dartmouth Flood Observatory

Displaced by flooding since 1985



Source: Dartmouth Flood Observatory

Potential of Actionable Visual Information

Development Decisions

Mobilizing Social Capital

Flood Resilient Design

Staging Resources

Optimizing Interventions

Flood Risk Awareness and Early Warning

Contact

- Richard Matthew
- Director, Blum Center for Poverty Alleviation
- Professor, Urban Planning and Public Policy
- University of California Irvine
- rmatthew@uci.edu
- http://blumcenter.uci.edu/