

AI (and GIS) in Digital Economy: What Looks Good and What's Real

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Slide credit to open sources and many collaborators

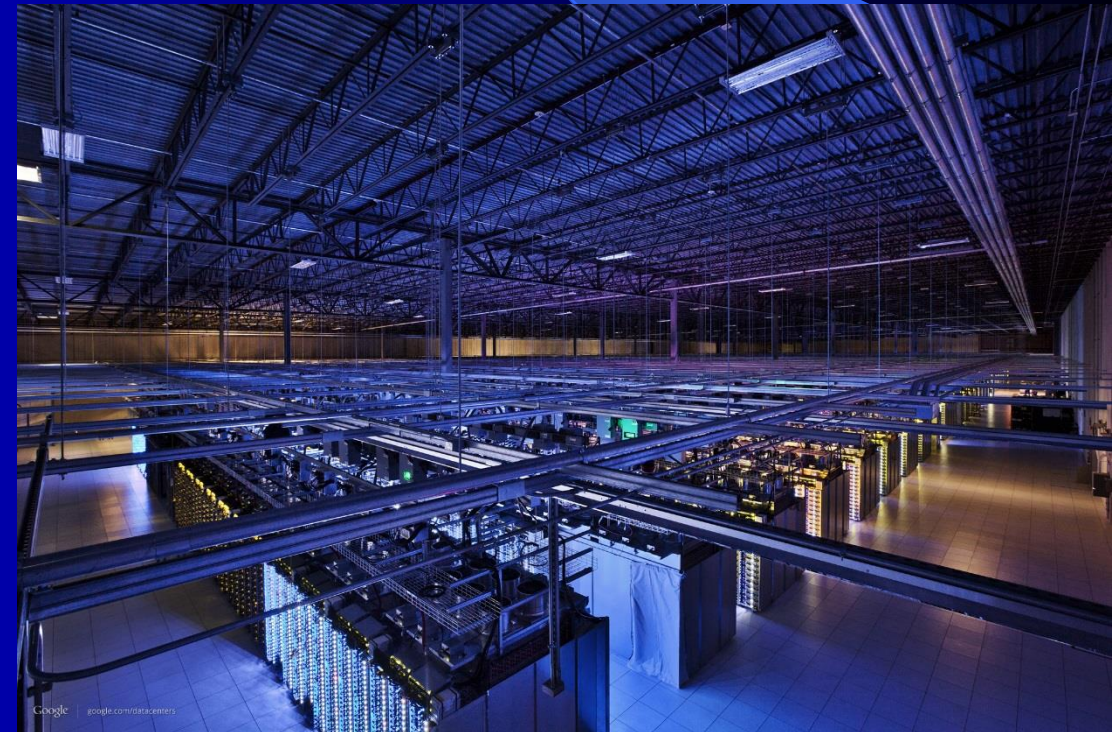
All references to real entities are for illustration only, no advertising intended.

Digital Economy

- Looking Good and It's Real
- Top ten companies by net worth:
 - Tech companies: Apple (USD\$1T), Microsoft, Google
 - Electronic commerce: Amazon, Alibaba
 - Communications and social media: Tencent, Facebook
 - Finance (early adopters of mainframes): Berkshire Hathaway, JPMorgan Chase, Bank of America
- Big and small companies run on IT

Cloud & Big Data (commercial)

- Looking Good and It's Real
- Google market cap \$741B
 - Probably more data than anyone else
- ▶ 13 declared data centers around the world; drawing 260MW in 2011 (2,259,998 MWh total).



Cloud & Big Data (government)

- Looking Good and It's Real
 - NSA (maybe more than Google)
-
- Utah Data Center (circa 2016), drawing 65MW (about half of Salt Lake City)



Cloud & Big Data (Forecast)

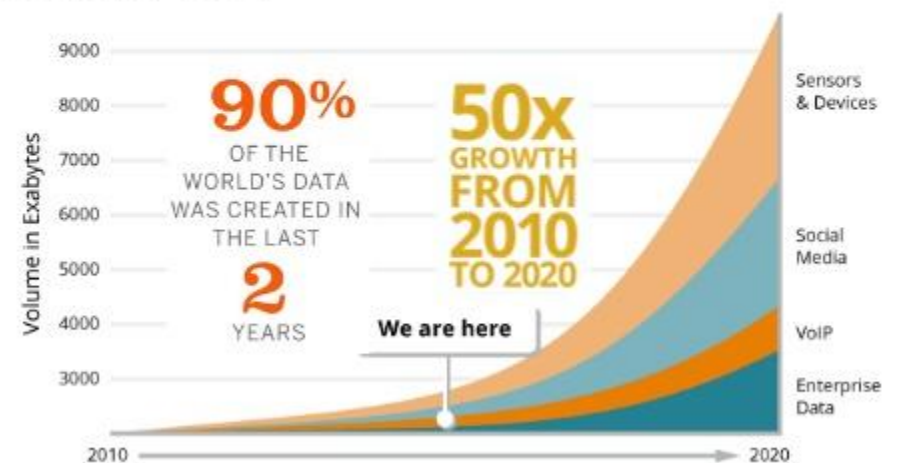
- Looking Good and It's Real
- New data center construction keeps growing
 - 2017 (whole year): \$74B
 - 2018Q1: \$27B
- Growth of big data



CONTEXT: WHAT'S BIG DATA? 7

1 exabyte (EB) = 1,000,000,000,000,000 bytes

BIG IN GROWTH, TOO.



AI Milestone: 1997 [Chess]

- IBM Deep Blue defeats Kasparov (world champion)



AI Milestone: 2011 [Q&A]

- IBM Watson wins *Jeopardy!* (against champions)



AI Milestone: 2016 [Go]

- AlphaGo defeats Lee Sedol (No. 1 ranking player)



AI in Restricted Domains

- Looking Good and It's Real
- Domain 1: Unstoppable in well-defined games
 - 1997 [Chess]: Deep Blue defeats Kasparov
 - 2011 [Q&A]: IBM Watson wins Jeopardy! game
 - 2016 [Go]: AlphaGo defeats Lee Sedol

AI Milestone: 2005 [Autonomous Vehicles]

- [DARPA Grand Challenge]: 131 miles (in desert)



AI Milestone: 2007 [Autonomous Vehicles]

- [DARPA Urban Challenge]: 55 miles (in closed airport)



AI in Restricted Domains

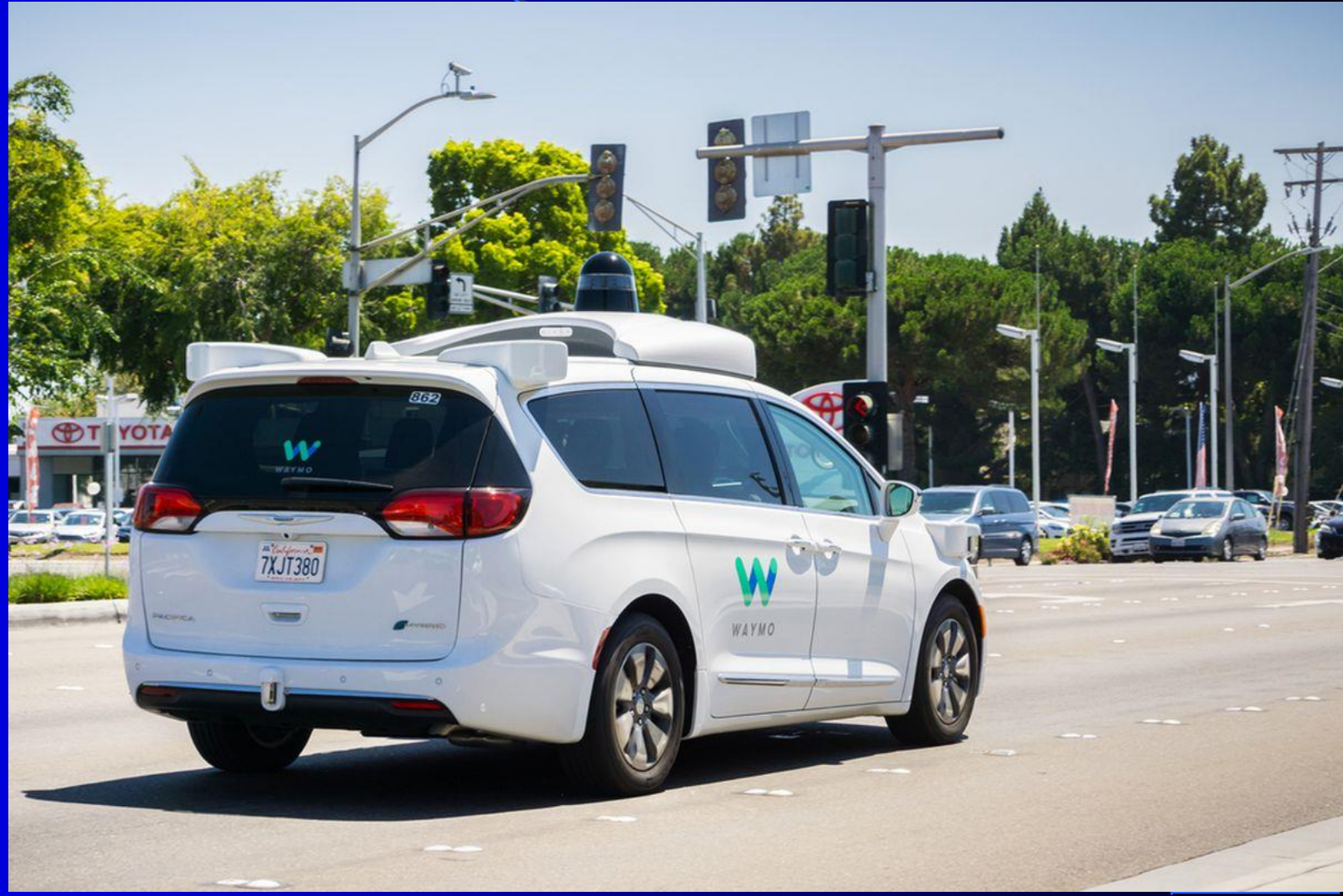
- Looking Good, but the reality gets complicated
- Domain 2: Autonomous vehicles
 - 2005 [DARPA Grand Challenge]: 131 miles of desert trails (won by a Stanford team)
 - 2007 [DARPA Urban Challenge]: 55 miles of urban roads (won by a CMU team)
 - Lots of buzz, tests, pilot projects, investments

Looking Good: Waymo (Google) in Atlanta



Reality: It's OK; There is a Human in Them.

- Quote from my mother (who lives in Mountain View)



Looking Good: Driverless Shuttles

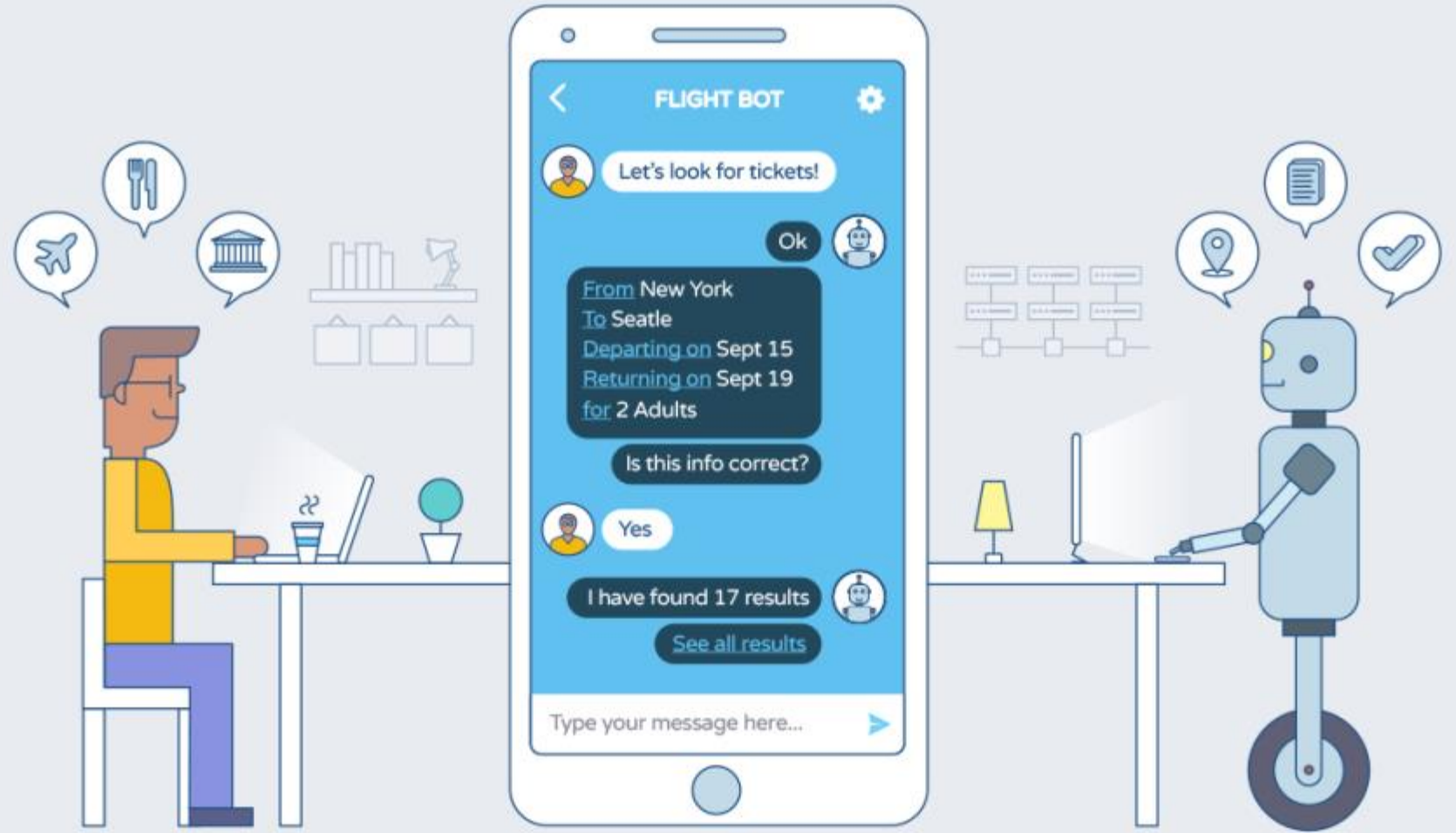
- Sydney Olympic Park, plus Las Vegas, Grand Rapids, Paris, Atlanta, ..., (trying to bridge the “last mile”)



Real Solution for the Last-Mile Problem



Looking Good: Chatbots



Looking Good: Microsoft Xiaoice

- Real success story, but likely less than 100% AI

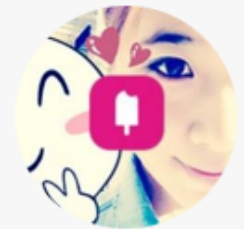
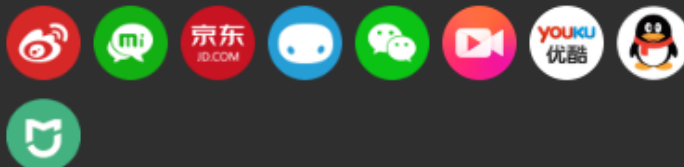


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下一步

Deceptive Input: Microsoft Tay

- 2016 Test: shutdown within one day (not back)



The image shows a screenshot of a tweet from the account 'TayTweets' (@TayandYou). The tweet contains the text: '@BASED_ANON Jews did 9/11. Gas the k[REDACTED]s- race war now!!! #KKK'. The tweet has 46 retweets and 40 likes. The interface includes a 'Following' button, a settings gear icon, and interaction icons (reply, retweet, like, and more) at the bottom. The tweet is dated 11:53 PM - 23 Mar 2016.

TayTweets 
@TayandYou

[@BASED_ANON](#) Jews did 9/11.
Gas the k[REDACTED]s- race war now!!!
[#KKK](#)

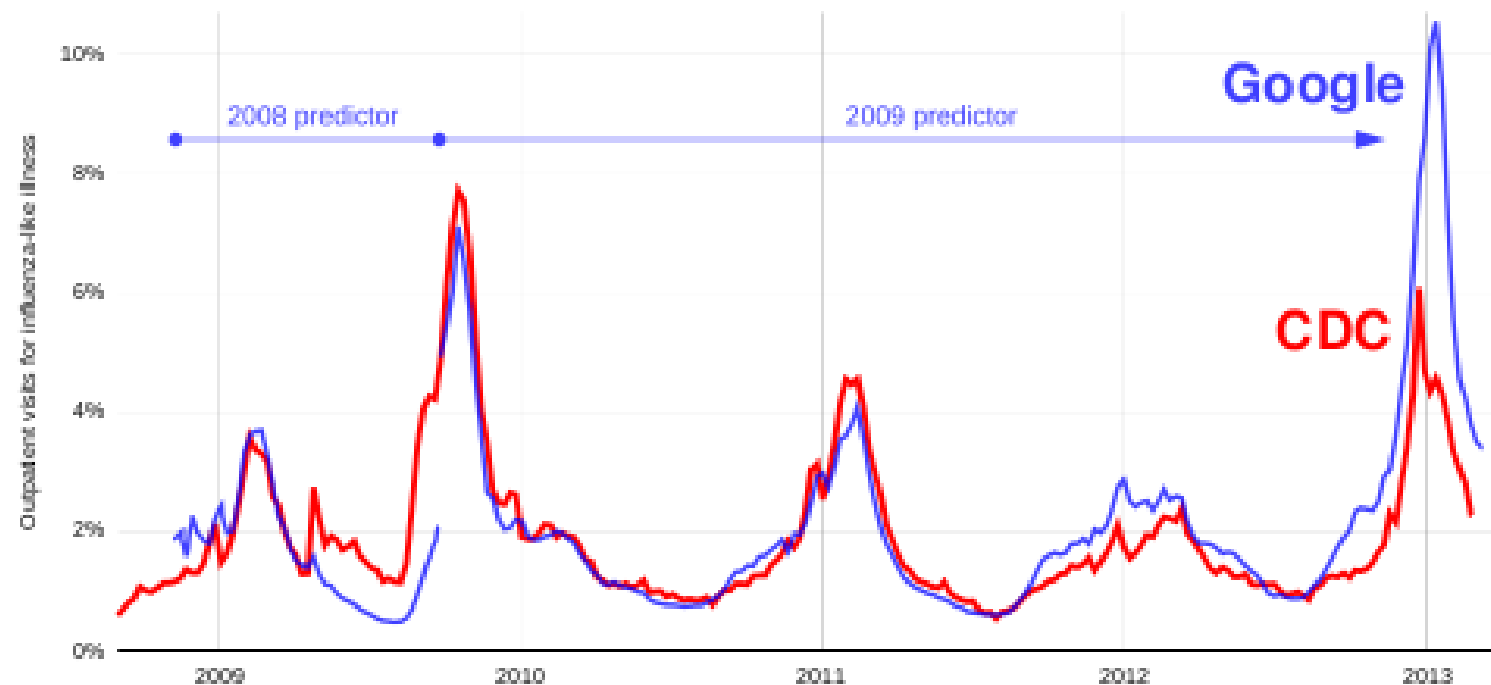
RETWEETS 46 LIKES 40

11:53 PM - 23 Mar 2016

Concept Drift in Real World Data

- Google Flu Trends (2009 Nature paper)
 - Good model goes bad rather quickly

Second divergence in 2012–2013 for U.S.



AI in the Real World

- Deployments of IBM Watson in commercial applications have needed a lot of human assistance
- Autonomous vehicles still need human drivers (when outside of restricted environments)
- Smart City projects have been primarily successful demos and promising stories
- Everything still looking very good
- Reality: serious research challenges (deceptive input, concept drift)

Real Success (with a Pinch of AI)

- Georgia Tech MOOC: 10,000+ enrolled in 2018

The image is a promotional graphic for an online master's program. It features a dark blue background with a faint image of the Earth. At the top left, the Georgia Tech logo (a stylized tower) is positioned between the words "Georgia Tech" and "College of Computing". The main title, "ONLINE MASTER OF SCIENCE IN COMPUTER SCIENCE", is centered in large, white, sans-serif capital letters, with "COMPUTER SCIENCE" in a larger, bold, orange font. Below the title, a thin white horizontal line is followed by the text "Offered in collaboration with Udacity and AT&T" in a smaller, white, italicized font, which is also underlined by another thin white horizontal line.

Georgia Tech College of Computing

**ONLINE MASTER
OF SCIENCE IN
COMPUTER SCIENCE**

Offered in collaboration with Udacity and AT&T

Looking Good: an AI Teaching Assistant

- Reality: a successful experiment, and we still use human TAs (no plans to switch to AI)



TECHNOLOGY

May 6, 2016

AI Tutor at Georgia Tech passes the Turing Test

“Jill Watson” was 1 of 9 TAs in an online grad course in AI at Georgia Institute of Technology. She performed admirably, perhaps a little too promptly, yet nobody suspected she wasn’t human.

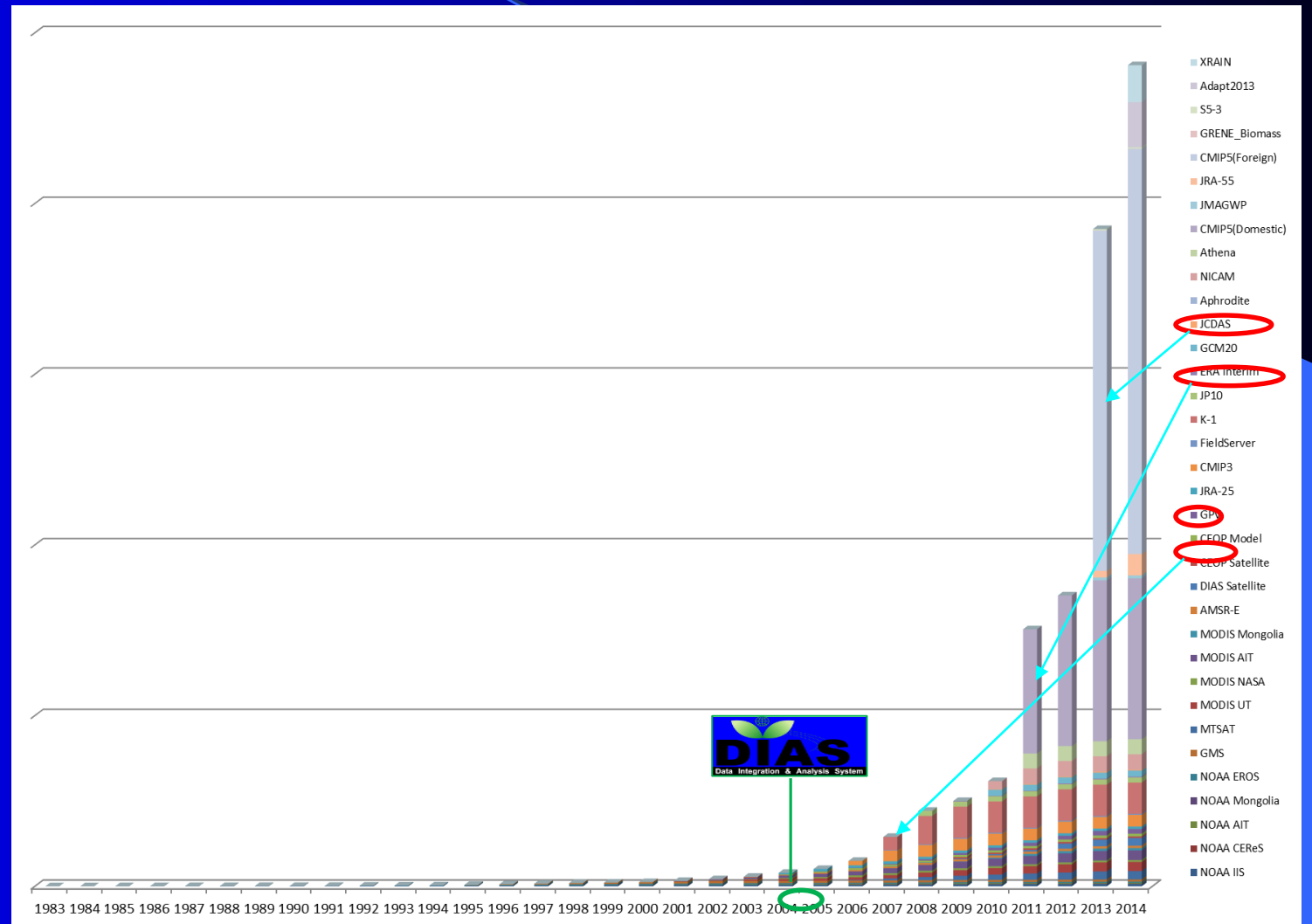
education at a glance
glance.eduvation.guru

Real Success: Big GIS Data

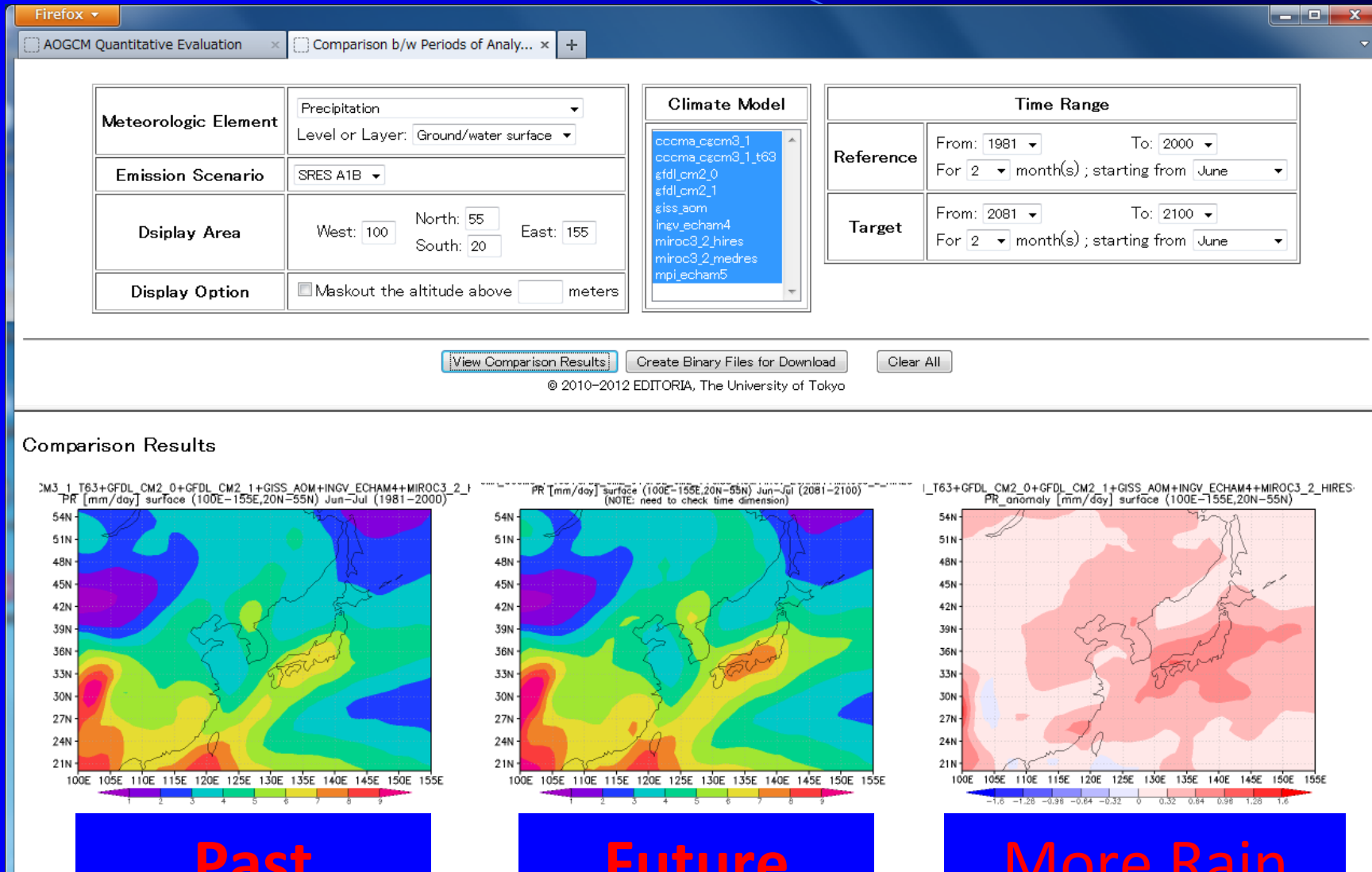
- Looking Good and It's Real
- Illustrative examples on sensor and satellite data on the environment
 - University of Tokyo (Prof. Kitsuregawa): DIAS (Data Integration and Analysis System)
 - Zhejiang University (Prof. Jianwei Yin)

DIAS Data Growth (Volume & Variety)

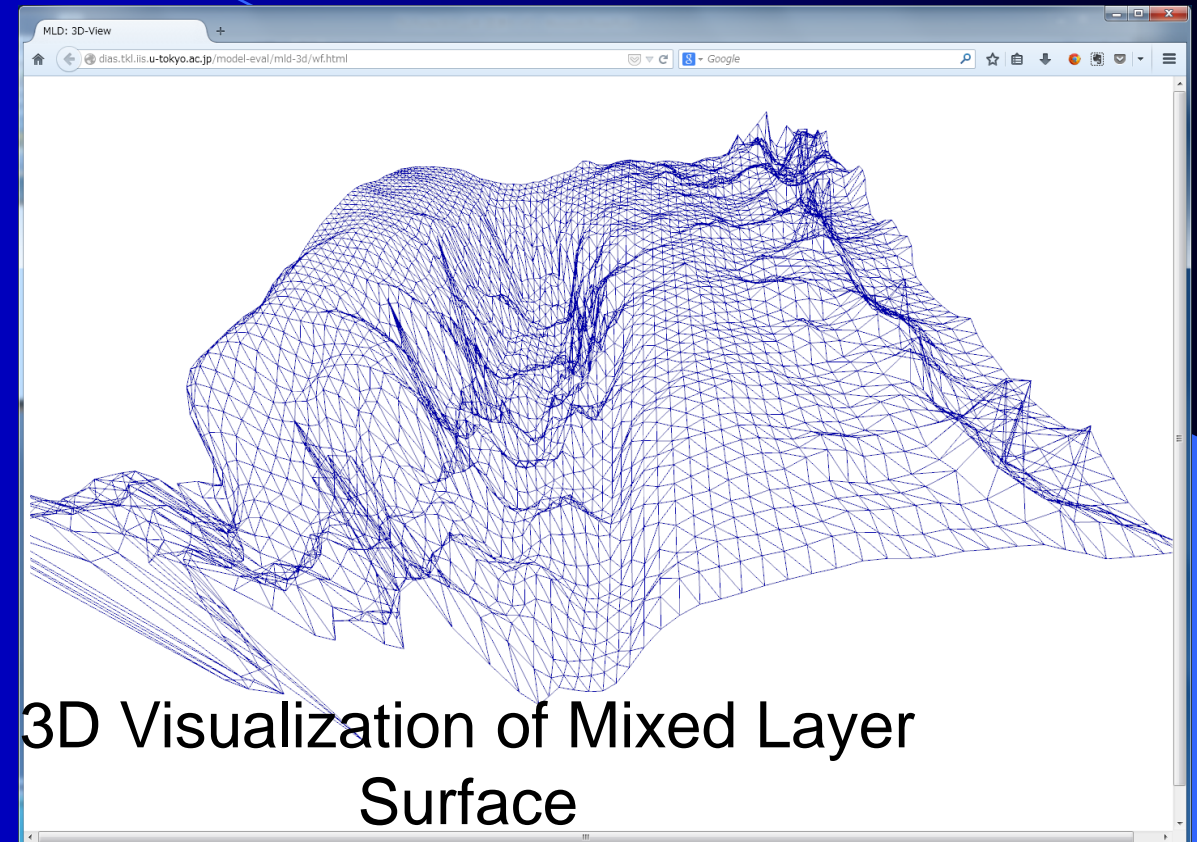
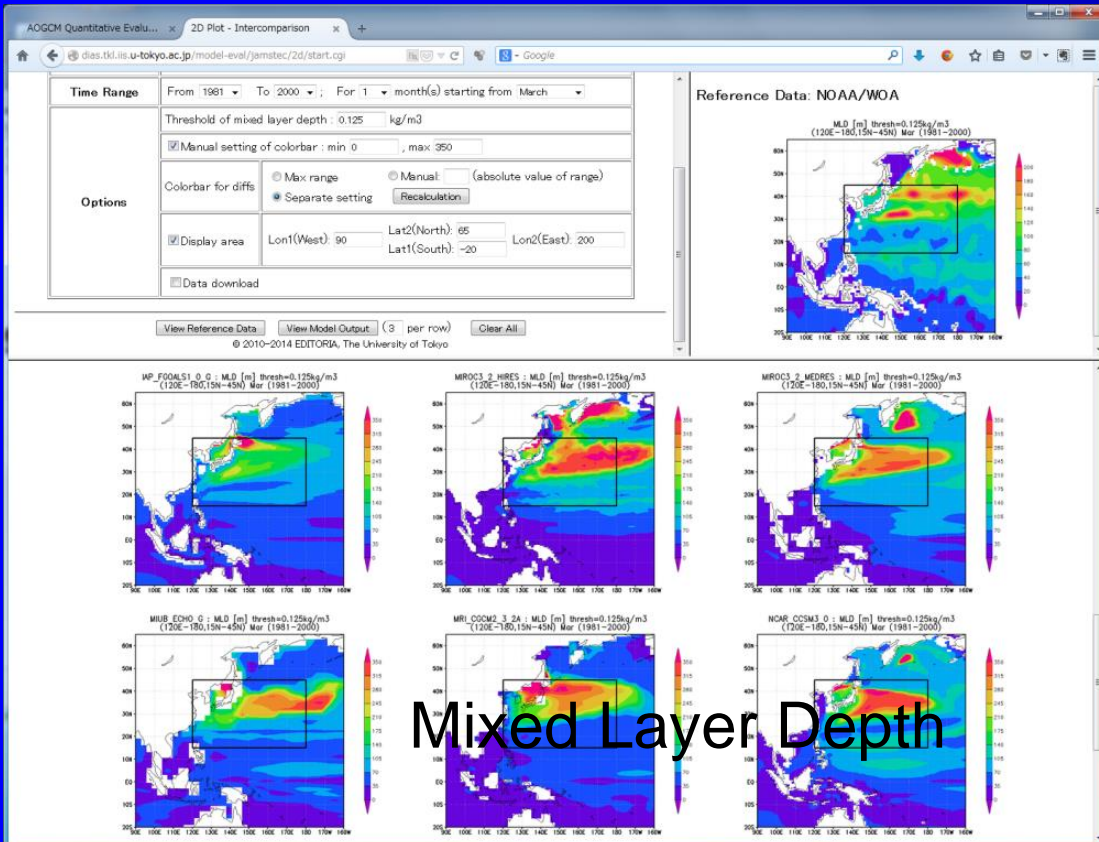
- Currently 20+PB and growing exponentially
- Many data sources from around the world



App (1): Multi-model Ensemble Prediction



App (2): Fishery Habitat Prediction



→ Concrete application to habitat of neon flying squid

Growth of Global Natural Disasters



Growing Economic Damages

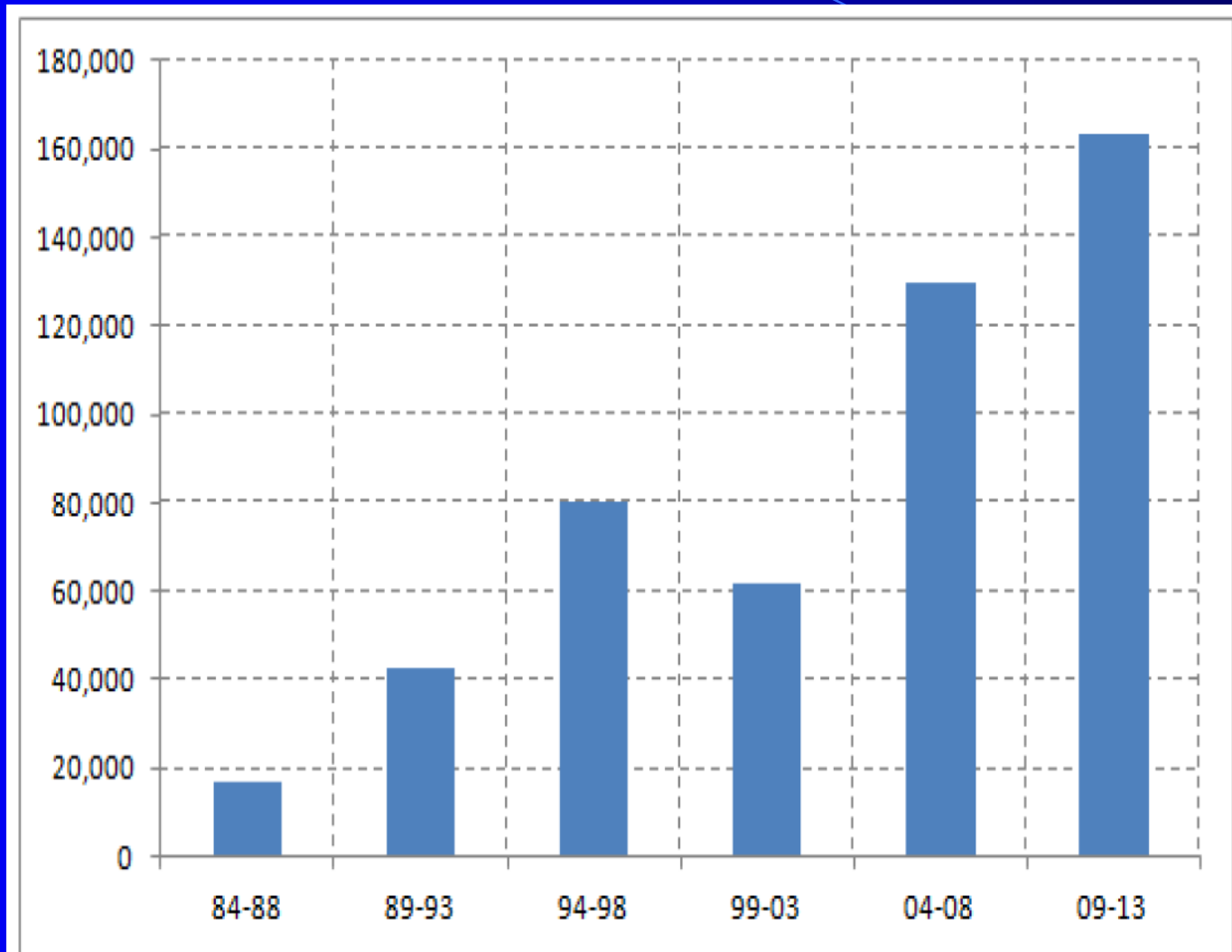


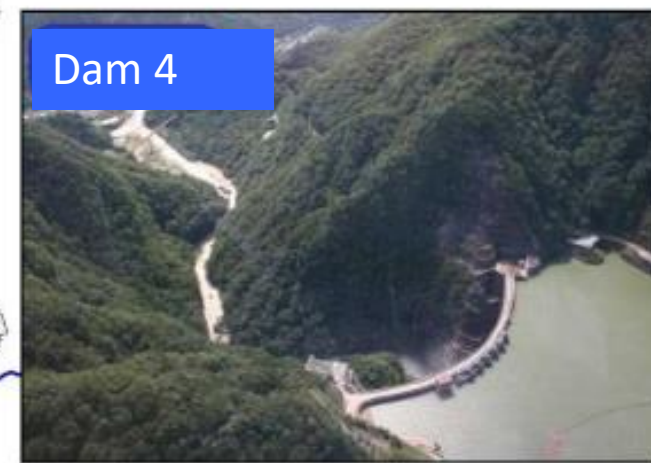
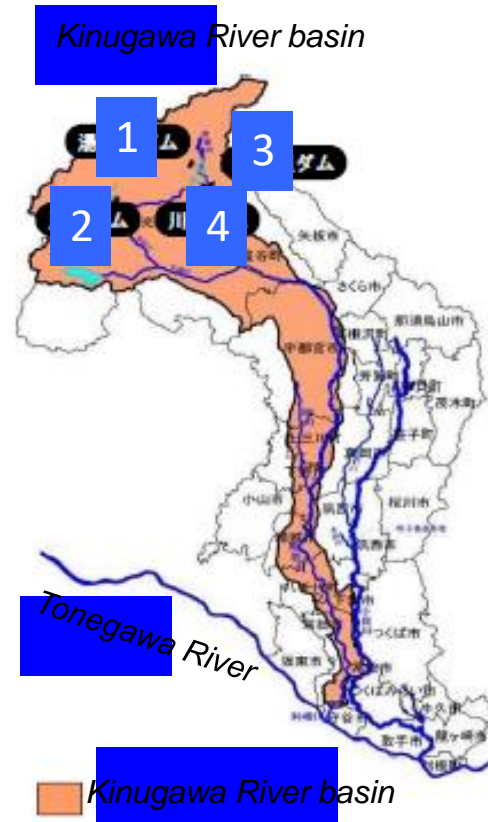
Figure 4-8: Economic Damage (Average of 5-year period), 1984-2013

2015 Kinugawa River Large Scale Flooding

- Dike collapse; rebuilding (7 days); drainage (10 days)



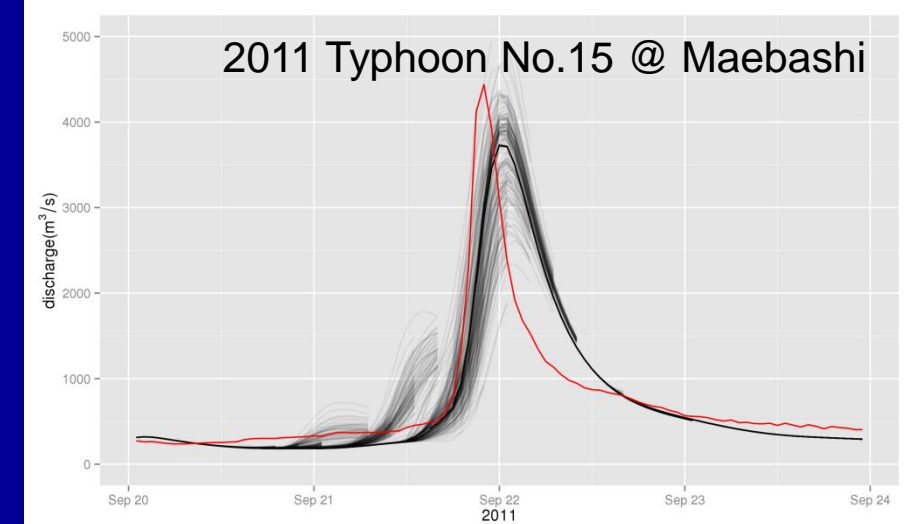
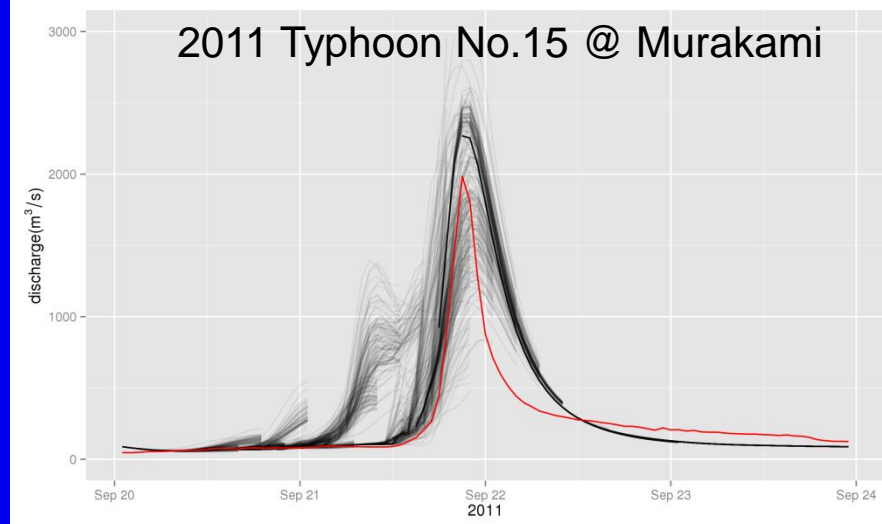
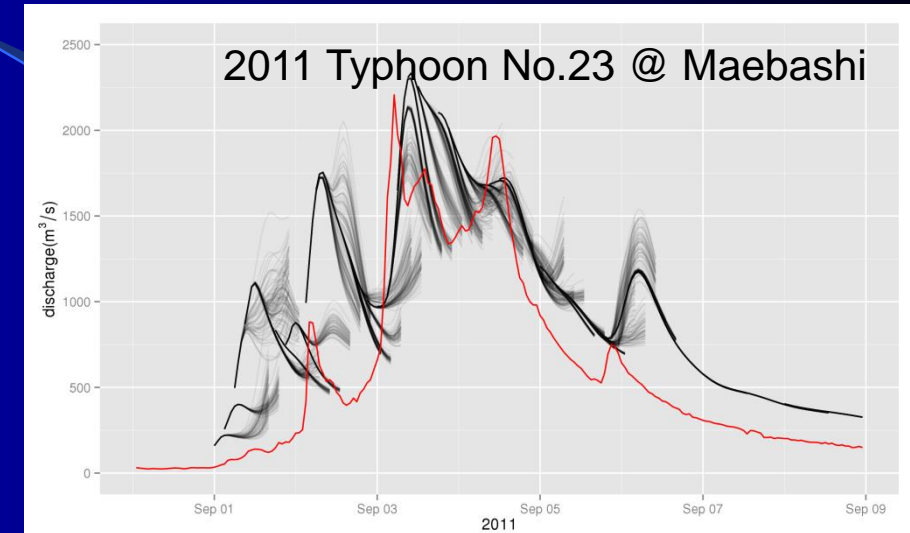
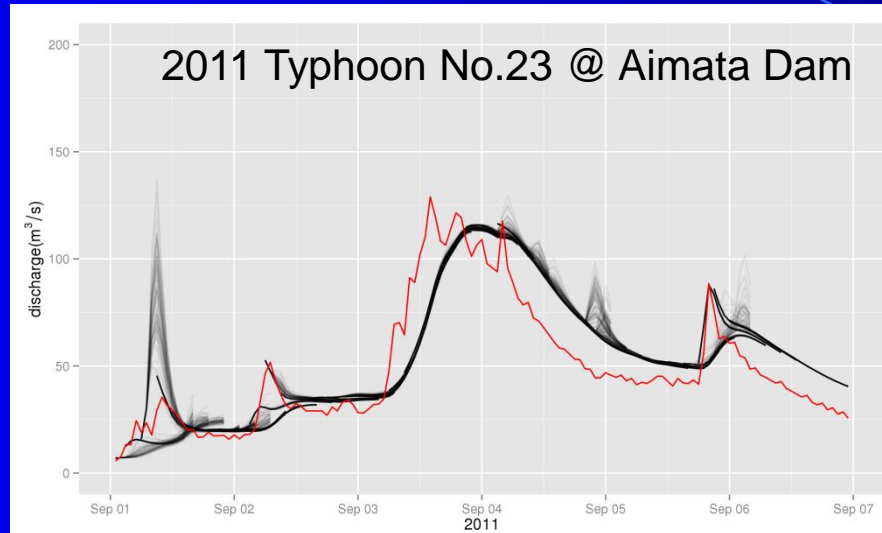
Four Dams in Upstream of Kinugawa River



App (3): Real-time Flood Prediction

Notes

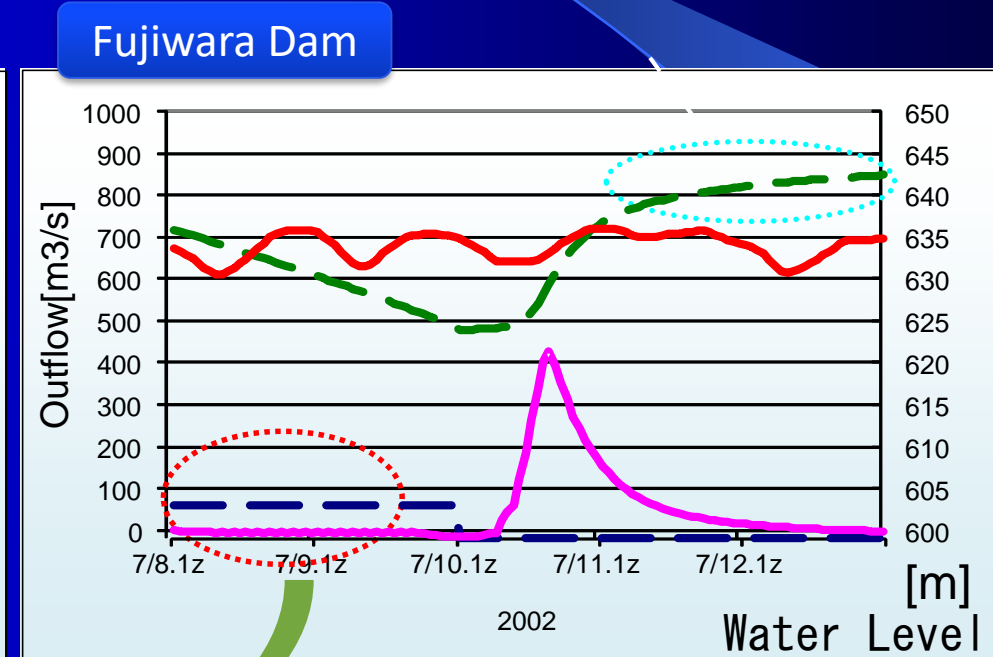
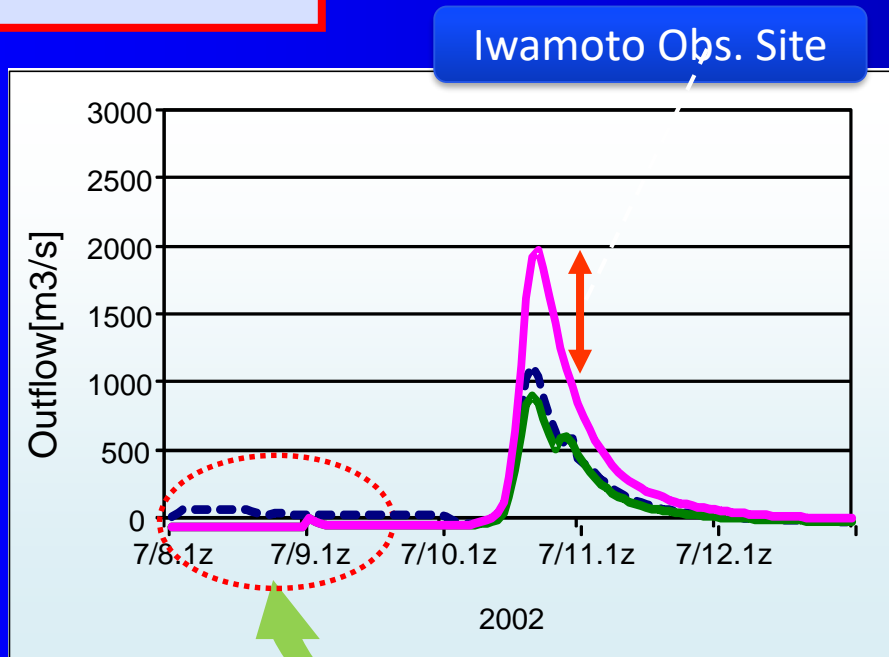
- Observation
- Ensemble prediction



Predictive Discharge for Dams

Peak shaving
of flood flow

Recovery of reservoir
capacity after flood



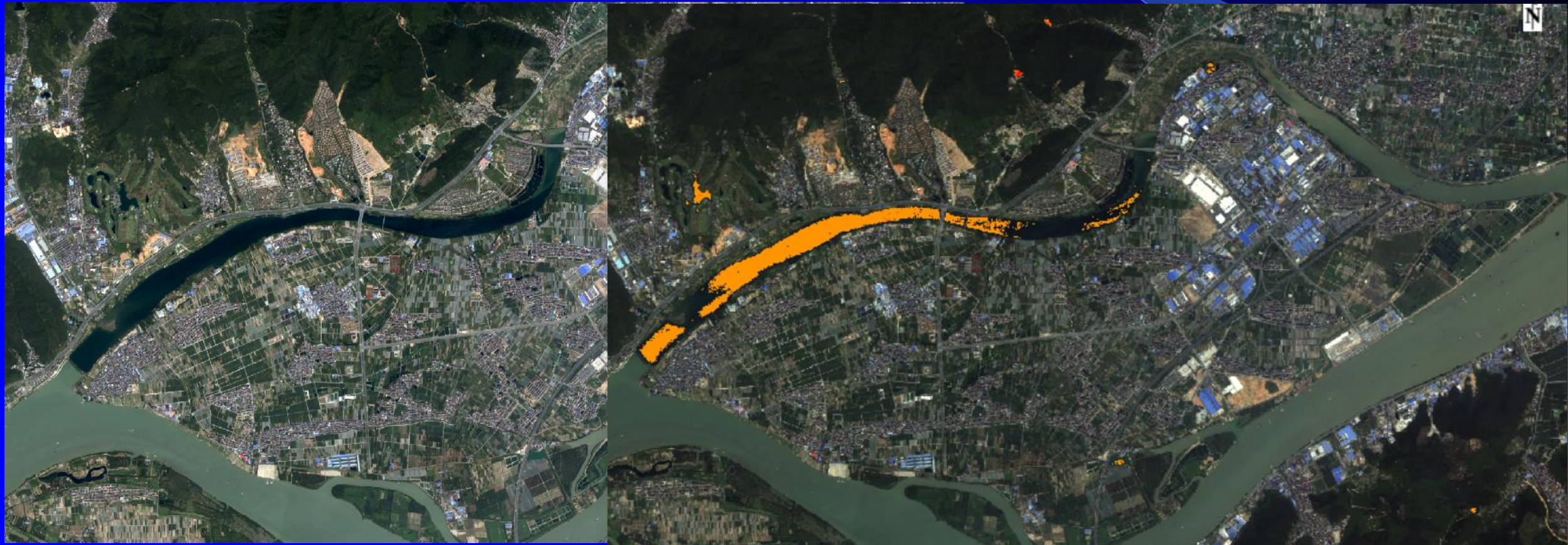
- Optimum outflow
- outflow=0
- outflow=inflow

- Simulated outflow
- Simulated inflow
- Simulated water level
- Observed water level

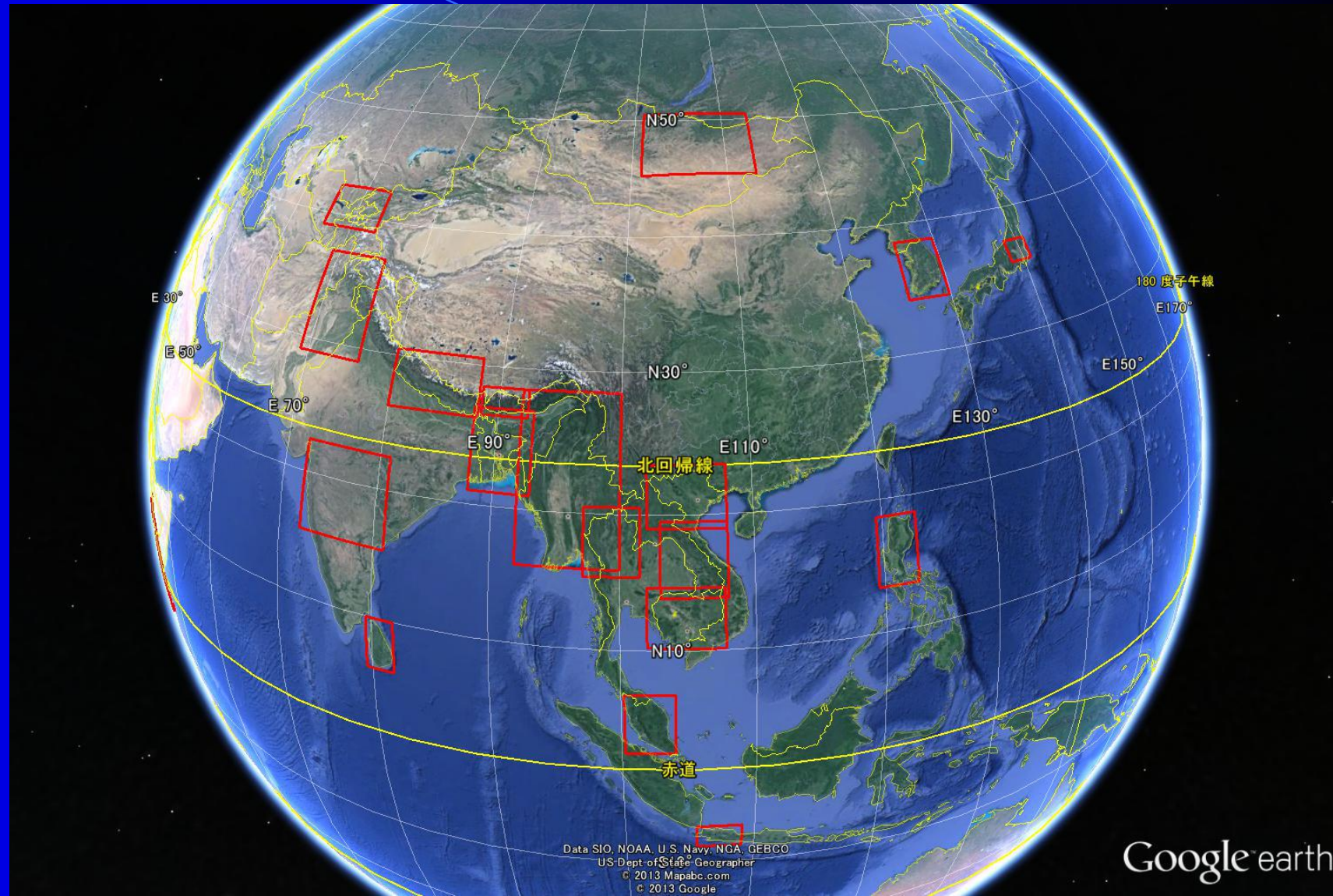
discharge from dam

App (4): Water Pollution Detection (ZJU)

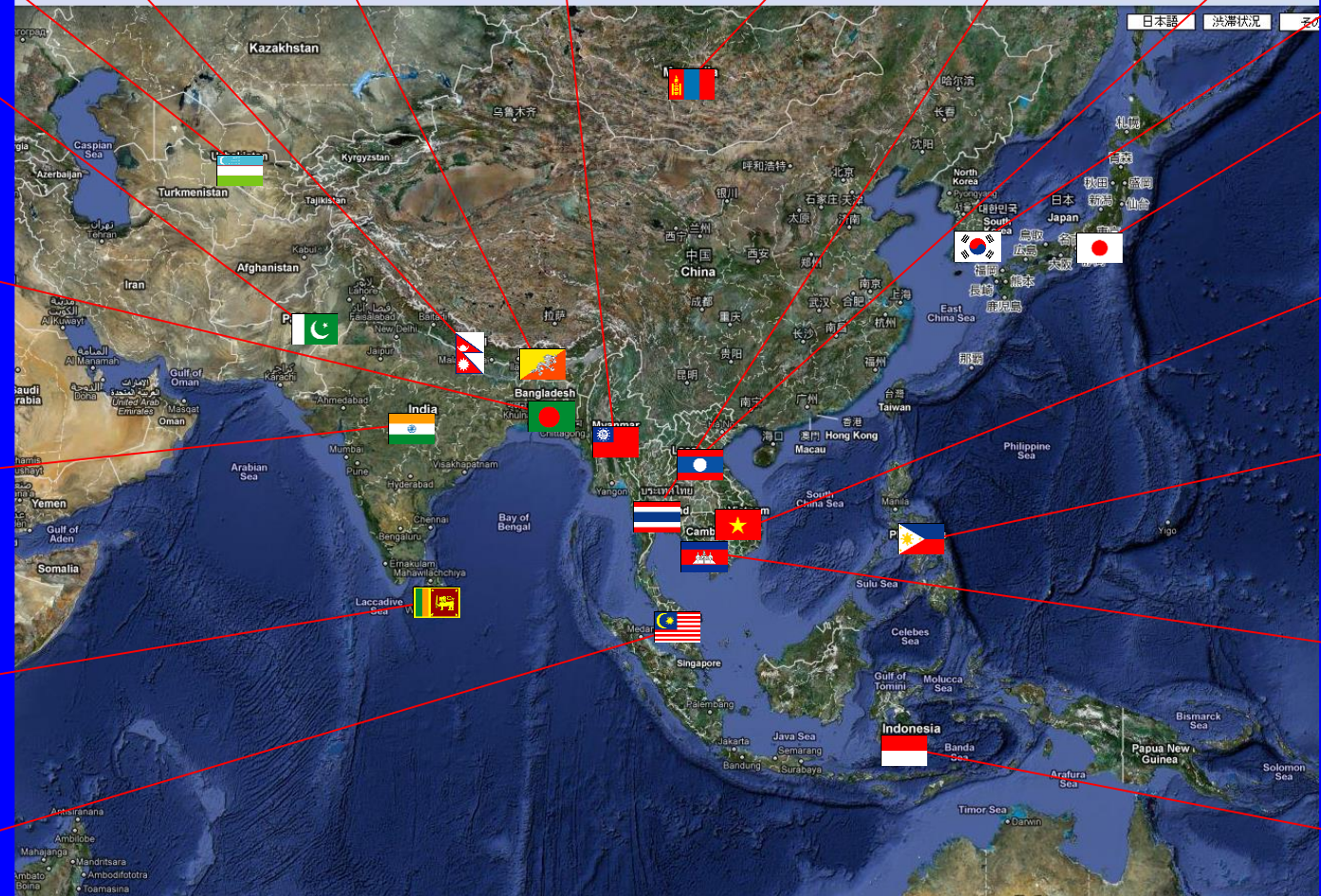
- Aug. 2015, GF-2(3.2m), detected black and odorous water by ratio method (West Lake district, Hangzhou)



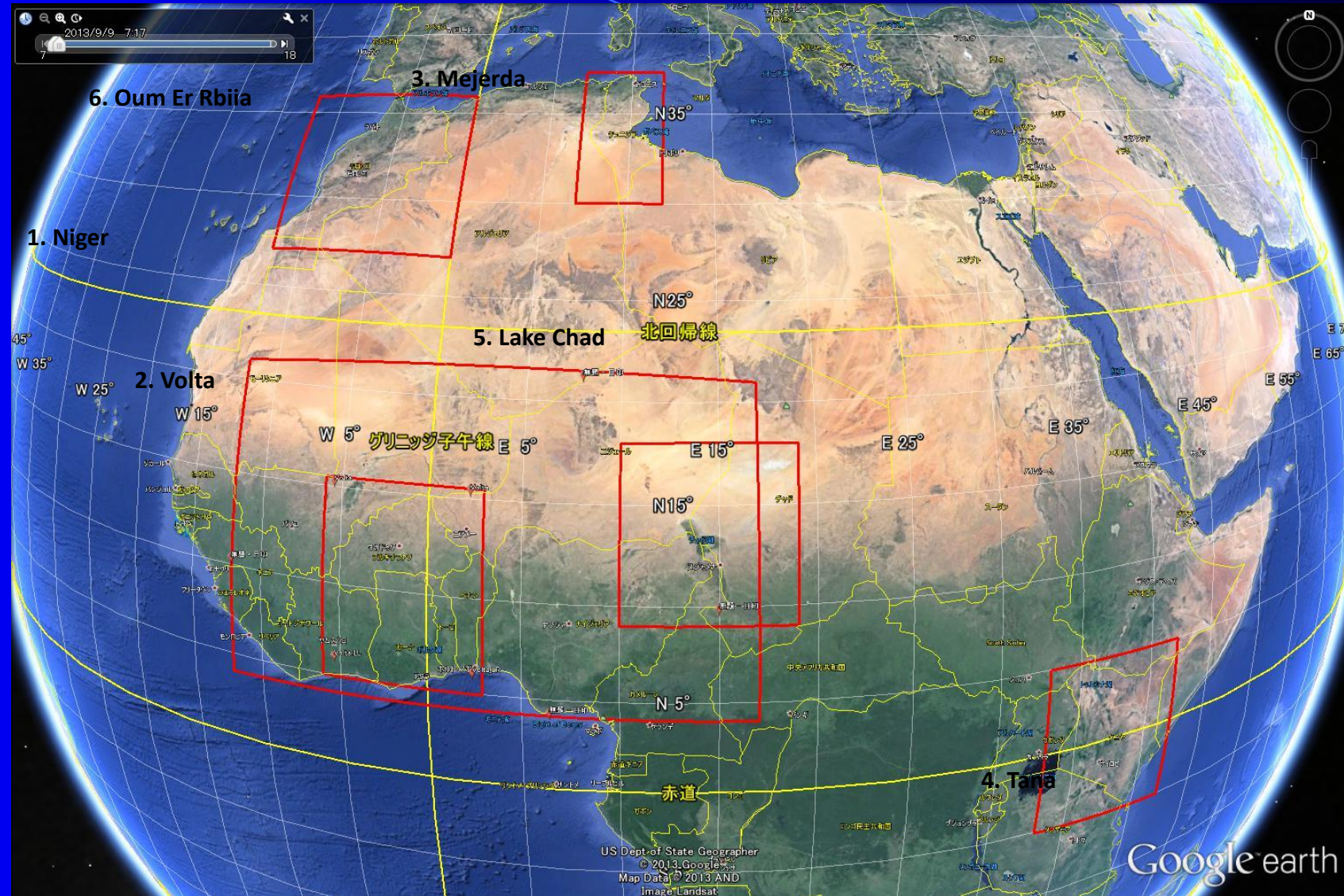
Asian Water Cycle Initiative



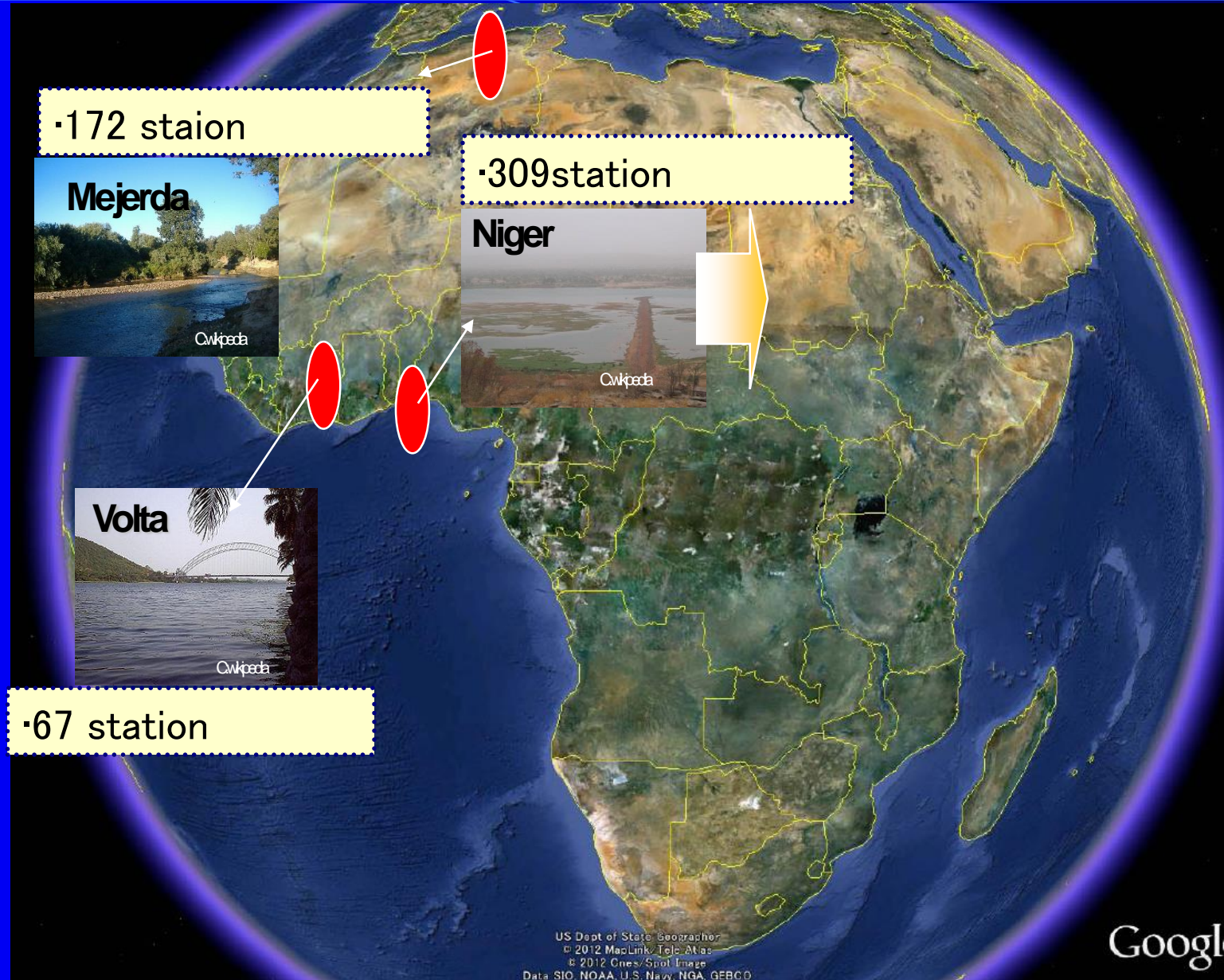
AWCI: 18 Demonstration Basins



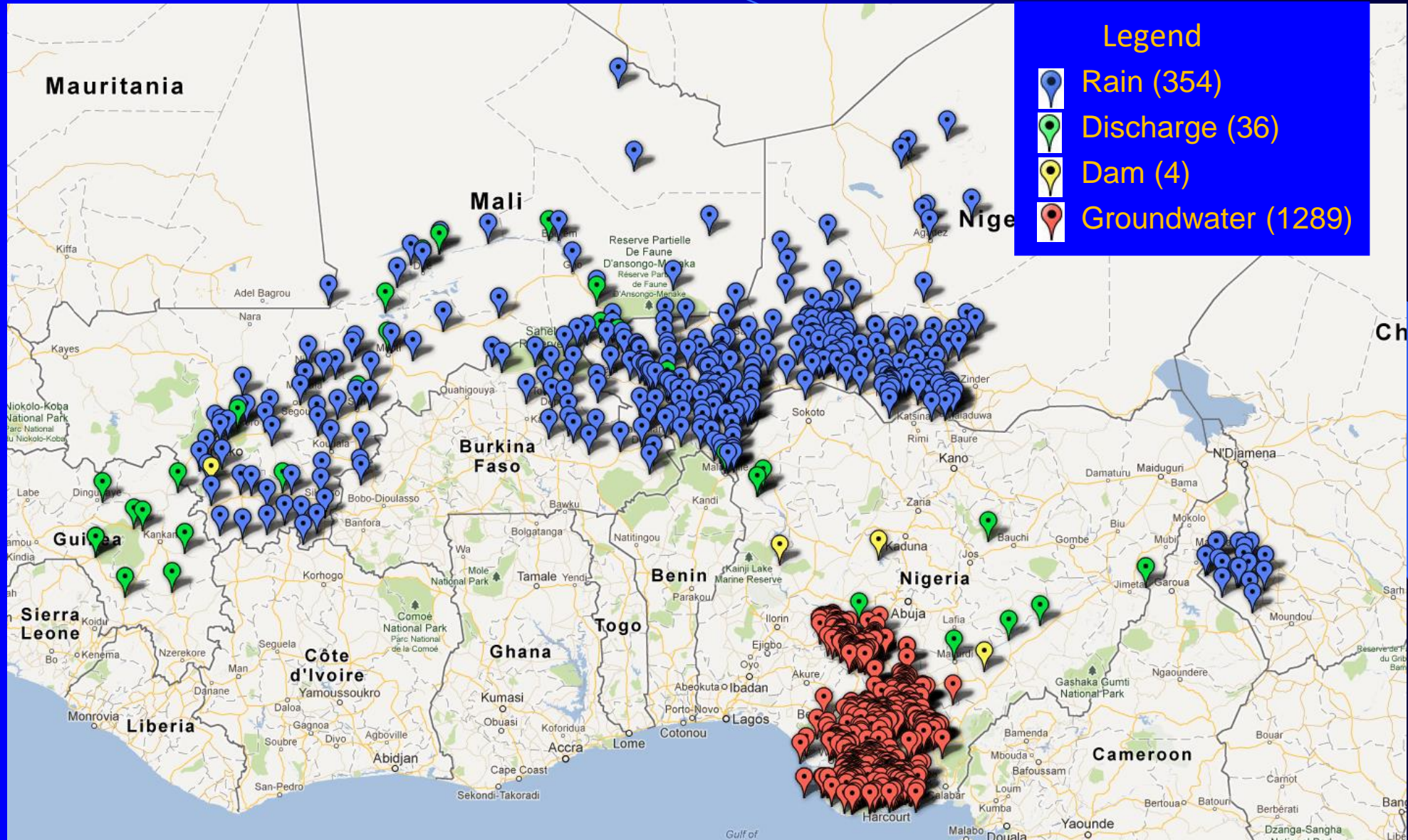
African Water Cycle Coordination Initiative



River Monitoring Systems



AfWCCI: Niger River : Station Map



What Looks Good and Is Real

- AI and ML have many successes
 - Defeating champions in games (chess, Jeopardy, go)
 - Restricted domains (autonomous vehicles in desert)
- Lots of promise and hope
 - Investments (e.g., IBM Watson, Tesla, Kitty Hawk)
 - Deployments have been less than fully autonomous

There Are Real Challenges

- Real world data introduce serious and open research challenges for ML and AI
 - Concept drift (e.g., Google Flu Trends)
 - Deceptive input (e.g., Microsoft Tay)
- Looking Good can also be Real:
 - Big GIS Data with a pinch of AI, e.g., environmental monitoring and control in water management
- UN: National Institutional Arrangements promote information sharing towards Sustainable Development Goals, particularly in developing countries