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

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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

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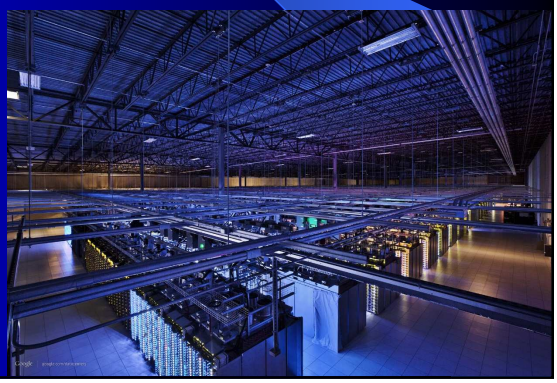
Cloud & Big Data (commercial)

- 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).



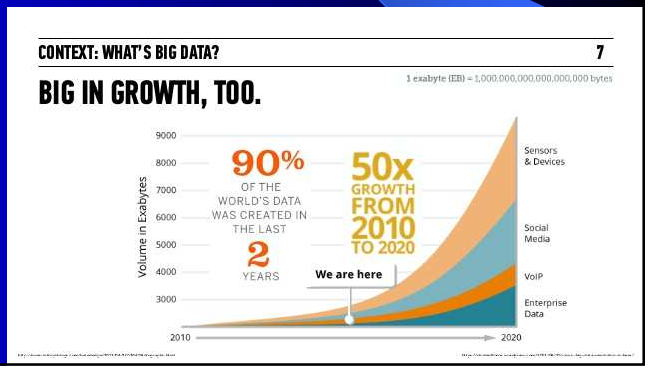
Cloud & Big Data (government)

- 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



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

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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

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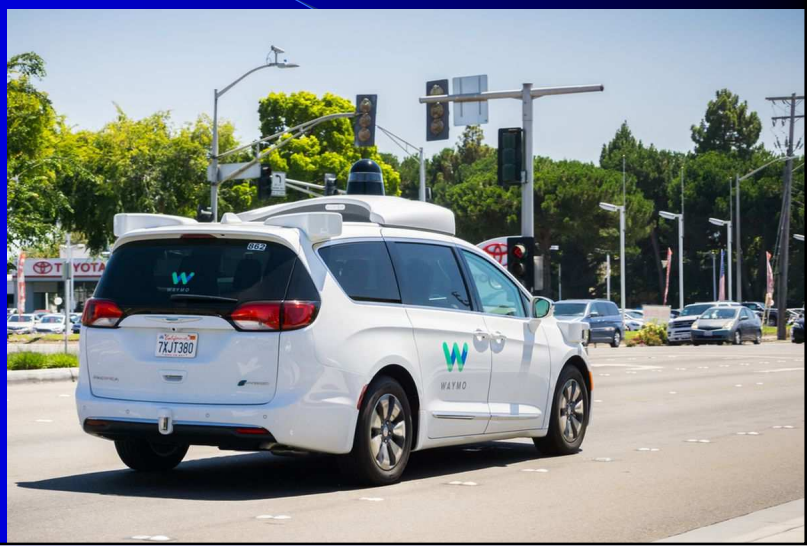
Looking Good: Waymo (Google) in Atlanta

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

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

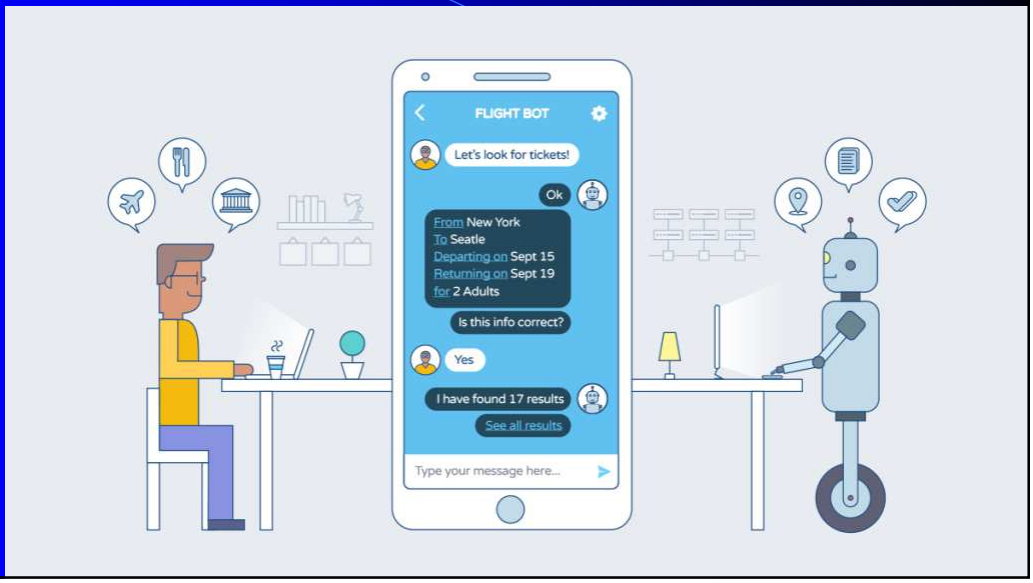


Looking Good: Driverless Shuttles

- 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

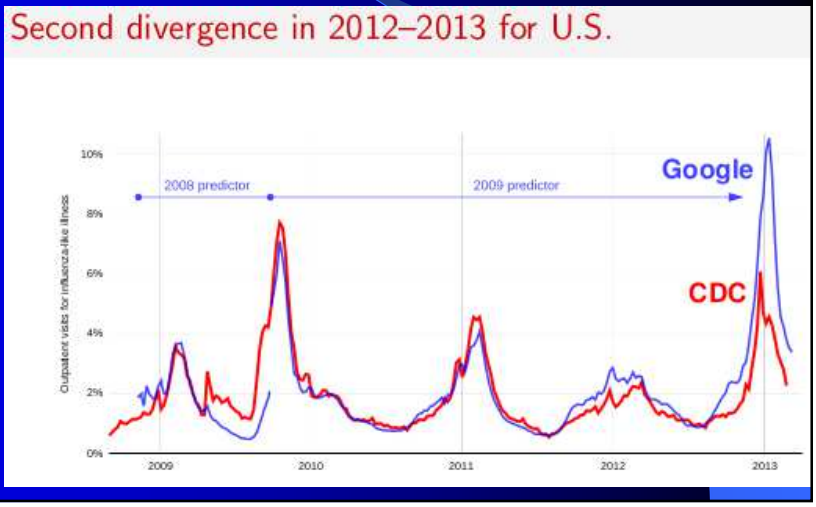
- Real success story, but likely less than 100% AI

Deceptive Input: Microsoft Tay

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

Concept Drift in Real World Data

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



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)

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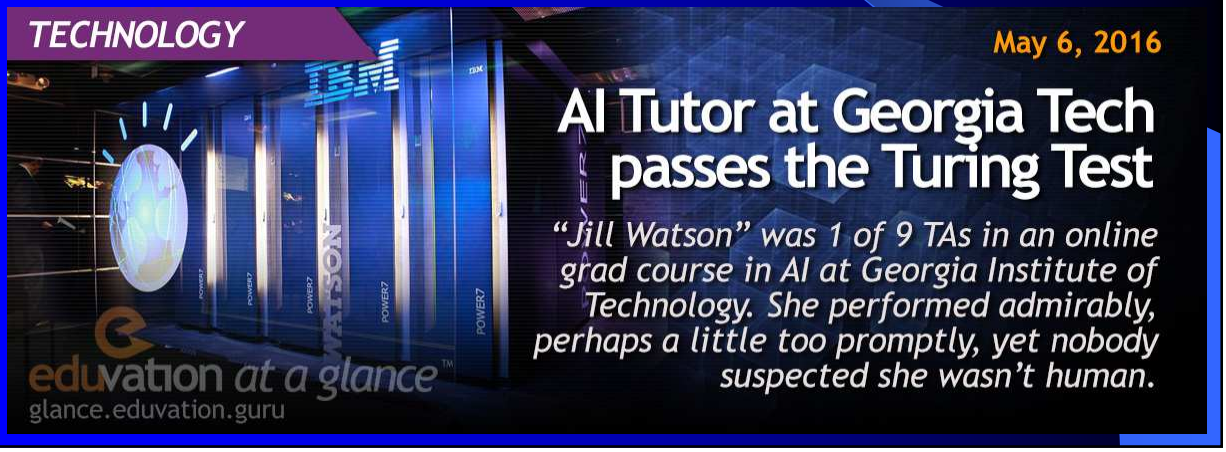
Real Success (with a Pinch of AI)

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

Looking Good: an AI Teaching Assistant

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



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)

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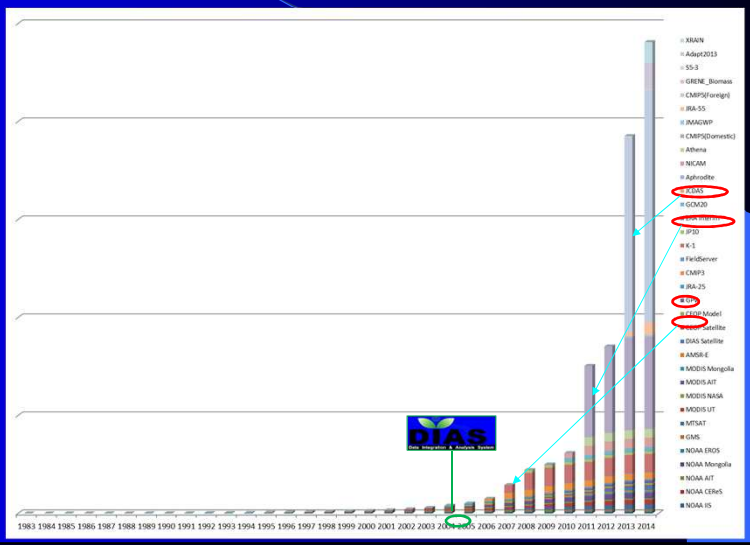
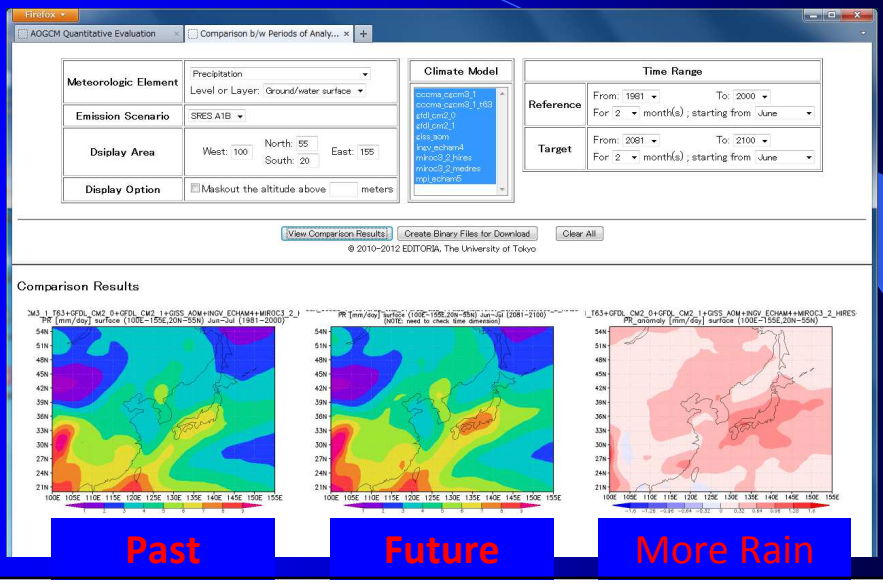
DIAS Data Growth (Volume & Variety)

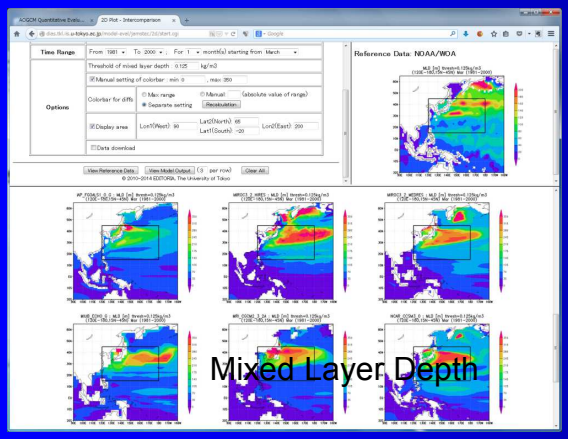
- Currently 20+PB and growing exponentially
- Many data sources from around the world



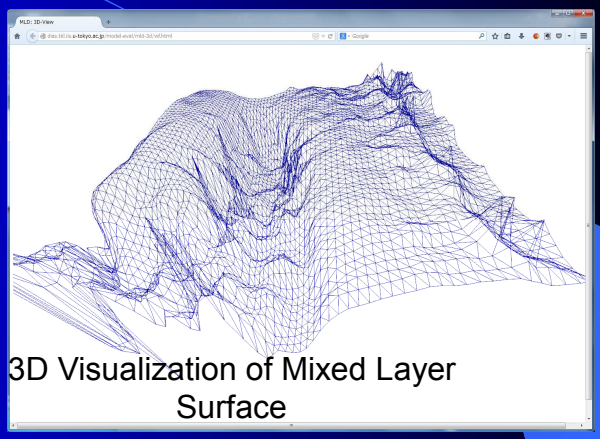
App (1): Multi-model Ensemble Prediction



App (2): Fishery Habitat Prediction



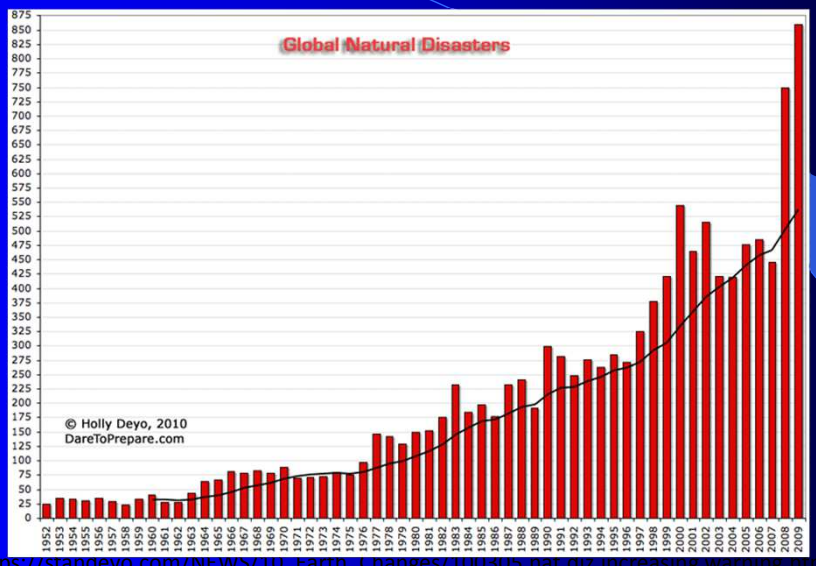
Mixed Layer Depth



3D Visualization of Mixed Layer Surface

→ Concrete application to habitat of neon flying squid

Growth of Global Natural Disasters



https://standeyo.com/NEWS/10_Earth_Changes/100305.nat.diz.increasing.warning.html

Growing Economic Damages

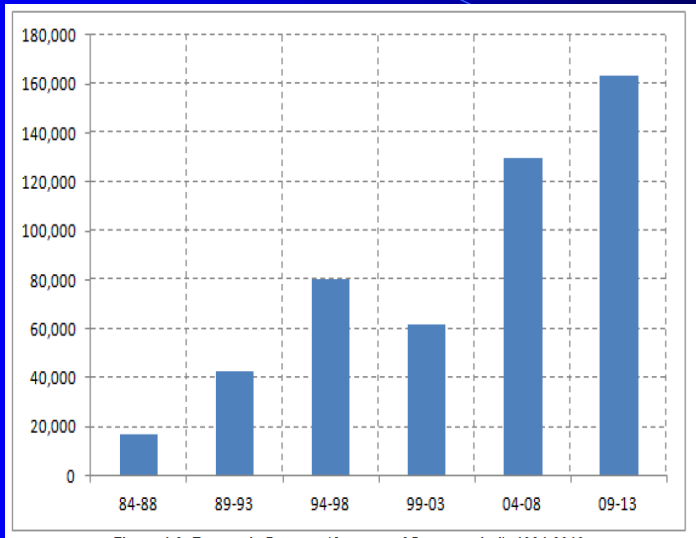
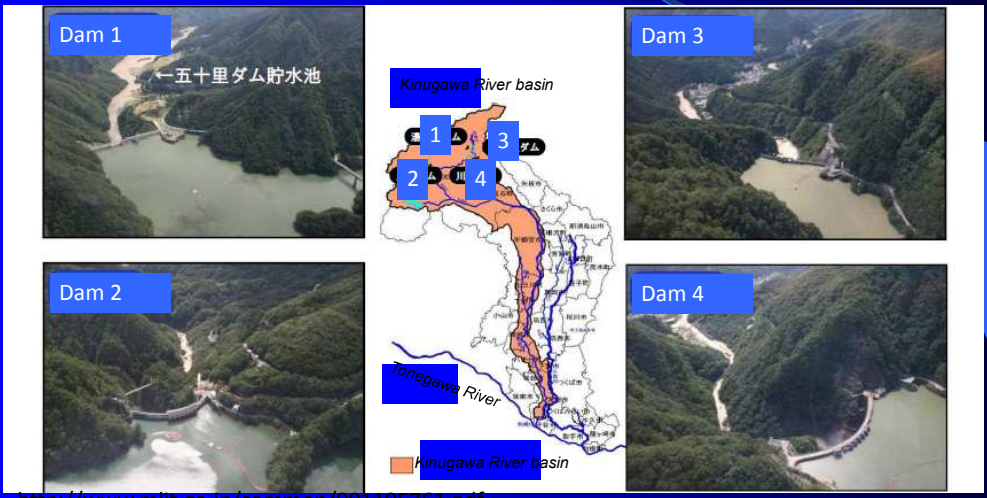


Figure 4-8: Economic Damage (Average of 5-year period), 1984-2013

2015 Kinugawa River Large Scale Flooding

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

Four Dams in Upstream of Kinugawa River

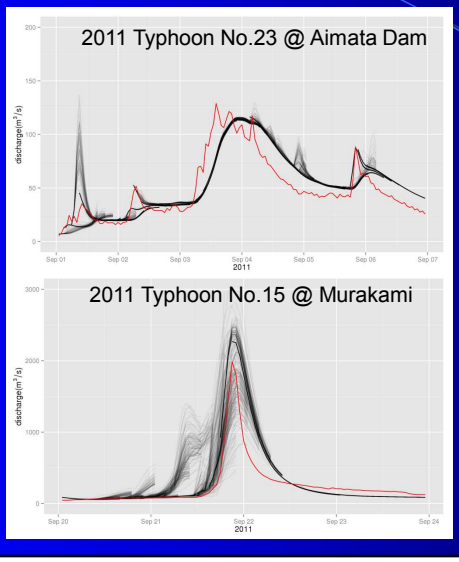


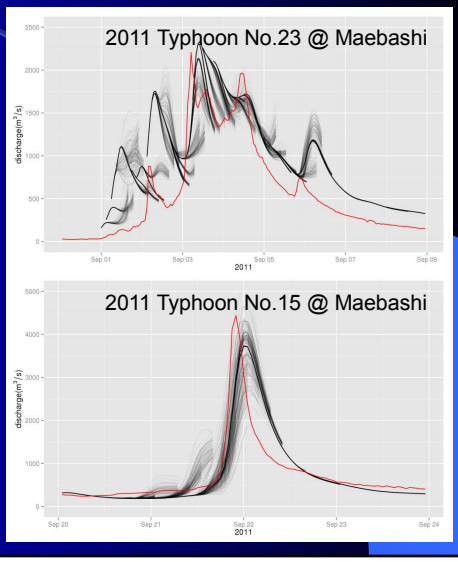
http://www.mlit.go.jp/common/001105761.pdf

App (3): Real-time Flood Prediction

DIAS
Data Integration & Analysis System

Notes
Observation
Ensemble prediction

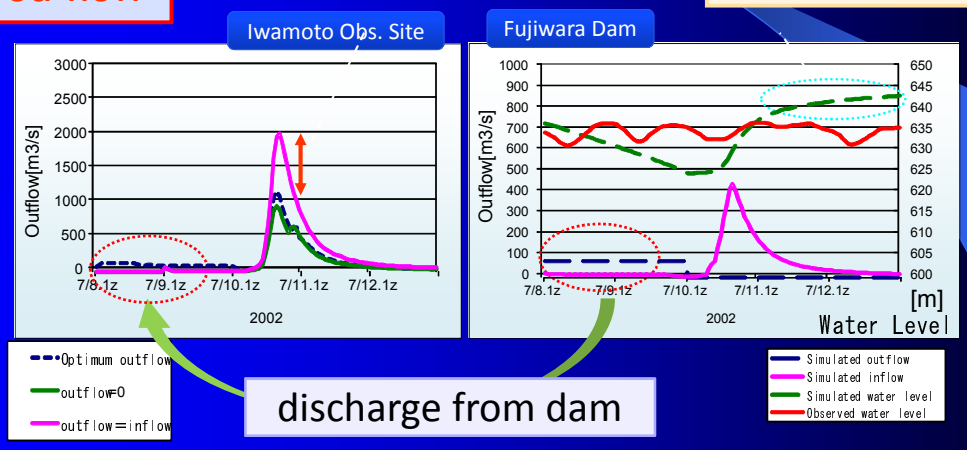




Predictive Discharge for Dams

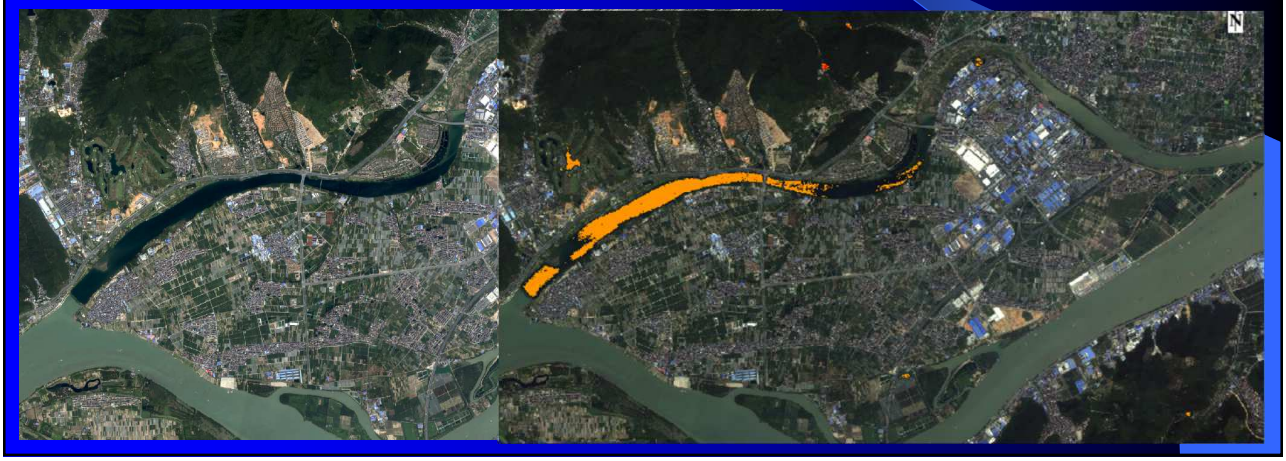
Peak shaving of flood flow

Recovery of reservoir capacity after flood

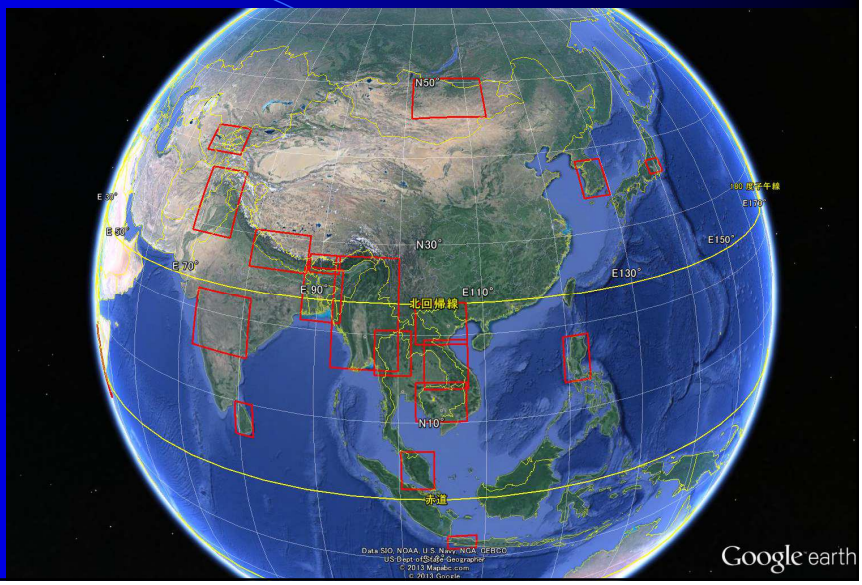


App (4): Water Pollution Detection (ZJU)

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

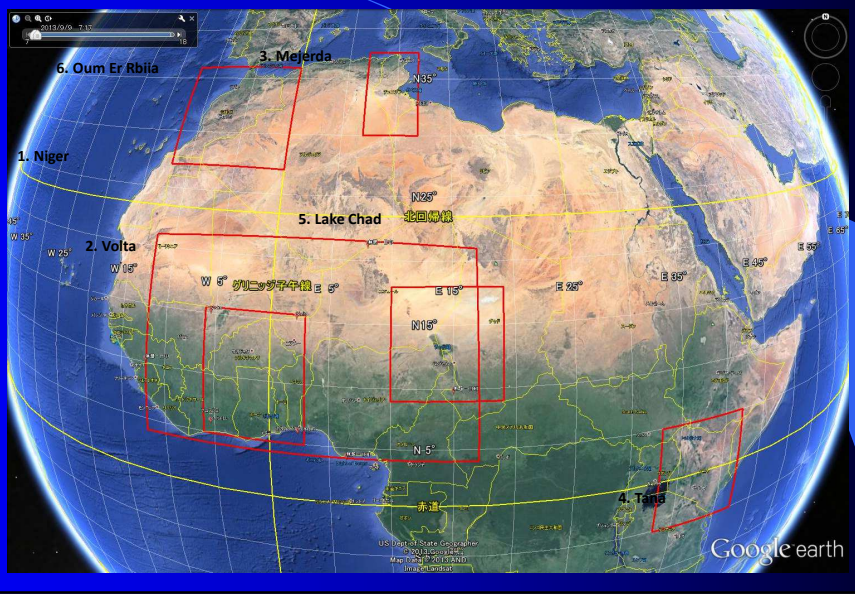


Asian Water Cycle Initiative

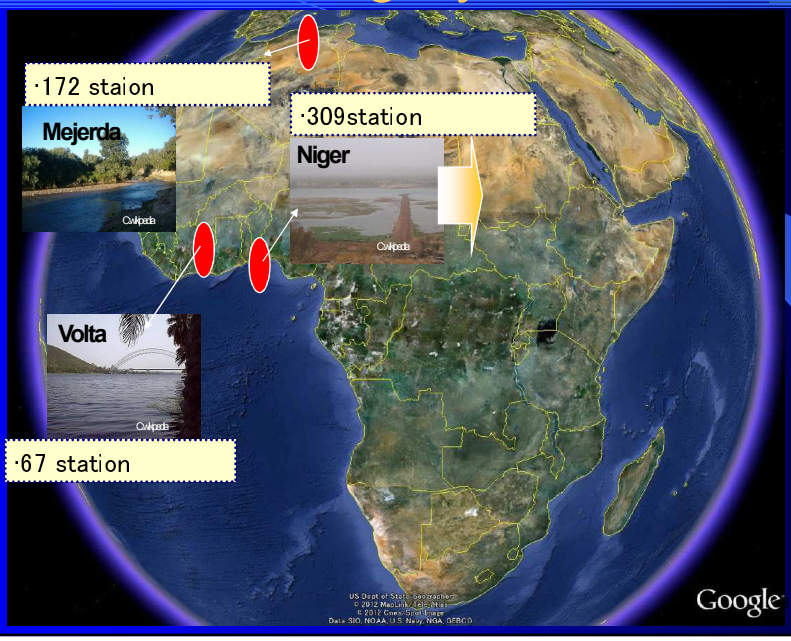


AWCI: 18 Demonstration Basins

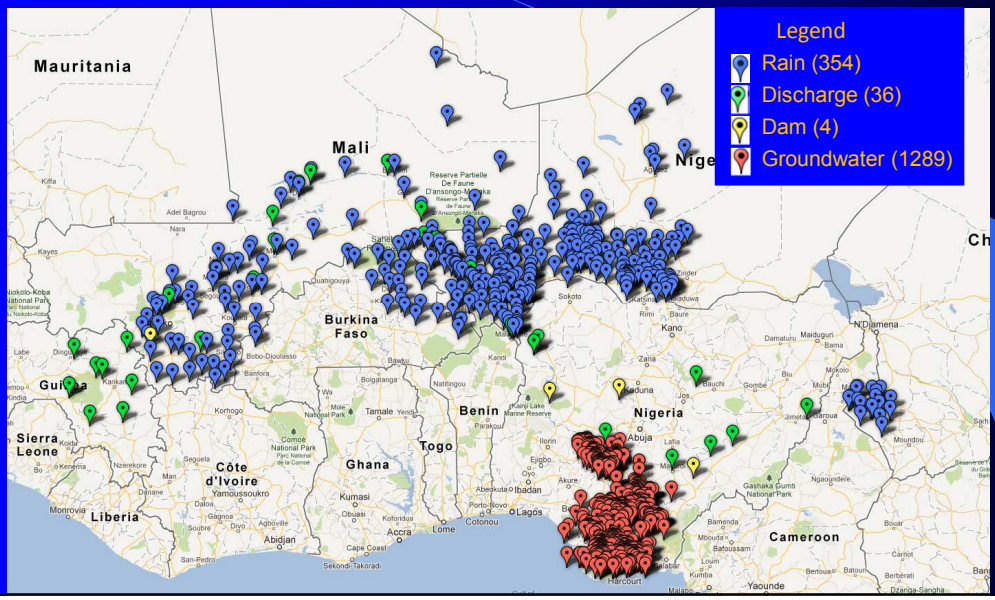
African Water Cycle Coordination Initiative



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

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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

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