

Disruptive Technology Innovations for Water Management

Nagaraja Rao Harshadeep (Harsh)

Global Lead (Disruptive Technology) Sustainable Development Practice Group



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Session: The Bigger Picture: The Relevance of Data for Water Management and Sustainable Service Provision First Danube Water Forum: The Importance of Water Sector Data in the Digital Age Multiple sectors, multiple institutions, linked by water and natural resources... A Typical Watershed/Basin...





- **Data Collection**: Monitoring/Surveys (in-situ sensors/IoT/Biometrics, earth observation (satellite, aerial, UAVs), crowdsourcing, digitization...
- Data Management: Telemetry, 5G, cloud services, open data, Blockchain, ...
- **Data Analysis:** Big data, Geospatial, AI/Machine Learning, modeling/ scenario analysis, script repositories, quantum computing...
- **Data Access:** Open data APIs, data visualization, gamification, mixed reality-AR/VR, ...
- Outreach: Platforms/Social Media/Portals/Apps/ebooks/Competitions...

"DISRUPT" DATA VALUE CHAINS



"DISRUPT" PRODUCTION VALUE CHAINS



- 3D/4D printing/additive manufacturing...
- Automation/SCADA...
- Robotics/ Autonomous transport...
- Advanced materials/nanotech/ biotech/genomics/energy tech/ green tech, ag tech...







"DISRUPT" STAKEHOLDER VALUE CHAINS



- Virtual social networks/ Digital Platforms...
- Sharing economy...
- Crowdsourcing, gamification, competitions (e.g. *hackathons, appathons...*)
- Mobile money, fintech, cryptocurrency...
- Maker movement/DIY/Tech Incubators...
- Virtual learning/re-skilling...



A new world of "Disruptive Technology"



"Disrupt" data value chains

- Data Collection: Monitoring/Surveys (in-situ sensors/IoT/Biometrics, earth observation (satellite, aerial, UAVs), crowdsourcing, digitization...
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"Disrupt" production value chains

- 3D/4D printing/additive manufacturing...
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"Disrupt" stakeholder value chains

- Virtual social networks/ Digital Platforms...
- Sharing economy...
- Crowdsourcing, gamification, competitions (e.g. hackathons, appathons...)
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http://www.appsolutelydigital.com/dt/

Reimagining Development

Making "smart development" wrt climate, water and natural resources, energy, food, waste, mobility, knowledge, services, networks.







Online Services



Broadband & Smartphone Access





Access to a new world of Data, Information, **Knowledge and Services**







Planning



3D Printed Infrastructure







Sensors/IoT (e.g. for soil moisture)



Drones/UAVs (e.g. for monitoring, seeding, delivery)



We have NO data...



Of course we have data...



Data, data everywhere...



Information & Analysis Trends

What's In?

What's Out?



Paper Records/Publications Desktop Databases

- Static, Infrequent data
- Data Secrecy
- Unclear data pricing
- Sectoral approaches
- **Fragmented** activities
- Desktop Modeling "Retail" Supply-side inputs "Come to my website &
- see my bit of data..."

Digital Data/Portals/Apps/e-books... "Analysis Ready" Cloud Data Services/APIs **Real-time data services & visualizations Open, Public-Domain, Available** Free open basic data services Multi-sectoral/ spatial approaches **Shared vision partnerships; Interoperability Cloud Analytics – "Wholesale" AI Platforms Demand-driven to support decisions Integrative, Collaborative Data Services & Customized Platforms/Dashboards/Apps**

The "Old" Ways...

Are YOU part of the problem?

- "But all you need is to fill a form ... "
- "Please write a letter to us why you want the data..."
- "That department does not share data with us..."
- "I know someone who knows someone with some of the data..."
- "Its on the website somewhere all you need is a password that you can get when you register for free..."
- "All the data is accessible in pdf format..."
- "I remember seeing some of that on some website somewhere..."
- "We can download and install a model to analyze the data..."
- "I'm waiting to publish a few papers and then I will release the data..."



The "New" Ways:

Can YOU be part of the solution to reduce the barriers?

Online Analysis-Ready Interoperable Open Data Services

- Open Data APIs (Application Programming Interfaces)
- Use common standards e.g. Open Geospatial Consortium (OGC) formats for spatial data

Online Analytical Services

- Cloud analytics
- Modeling services using open APIs and drawing upon online data services
- Open collaboration script repositories



"Bottom-up" Monitoring Systems











Doppler Radar





Shore-mounted Radar **Bridge-mounted Radar**



Groundwater Monitoring

Water Quality Monitoring



Non-Contact Measurement of Stage &

Discharge





Laboratories

ADCE

Automatic Cableway

System





Crowdsourcing Monitoring





Training Communities/Citizen Science







	2009	2010	2011	2012	Total
itaff	3132	11812	12409	6522	33875
urbidity	3131	12069	12469	6624	34293
tain	3116	>12777	>15000	>15000	>47000
low					>500
ed samples	1425	4176	3139	1216	9956

Sediment Concentration Analyses











Secchi Jug for turbidity





Disasters



"Space-based Stream Gauge"

"Top-down" Monitoring Systems

Weather Products





Land Cover Monitoring







"Space-based Reservoir Levels"



+ Snowcover, Glaciers, Soil Moisture, Temperature, Evapo-transporation, Landcover, Soil Moisture, Water Quality, and much more...

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in CDR 20hz altime

"Space-based Groundwater monitoring" e.g. GRACE











The Data Value Chain Example: Deciding on Coping with Floods



Key Elements of a Water Information System Ecosystem

- Collect Data: In-situ (gauges, Apps/Logs) and Earth Observation
- Quality Management: Proprietary/open systems for data integration and quality management - traditionally desktop systems but heading towards low-cost cloud-based online systems for data storage and quality management.
- Serve Data: Use free/open OGC standard services and open APIs for making national/sub-national data accessible (including provisional real-time data) so that multiple customized systems can be created to access them. Create Data Services Catalog with public and restricted services.
- Access Data: Use free/open systems for creating dashboards/portals/Apps using these national/sub-national services with other global data services and free cloud analytics (e.g. online GIS, analysis scripts tools e.g. <u>CUAHASI</u>, <u>Tethys</u> that use Python, R, etc., Google Earth Engine, etc.), open scripting repositories (e.g. <u>GitHub</u>, <u>Bitbucket</u>, etc.) and interactive data visualization libraries e.g. <u>https://d3js.org/</u>).
- USE Data: Trends, Benchmarking, Modeling; Decision Support; Interactive Dashboards, E-Books; Hackathons



Interactive Dashboards: Illustrative Data & Functionality

Historical Trends and Future Projections:

- *Climate* (historical climate, ET, climate change scenarios temp, precipitation, etc. and hydrological implications)
- *Water Resources* (surface and ground water resources, snow, glaciers, rivers, lakes, bathymetry)
- *Disasters* (floods, droughts, storms hazard/exposure/risk, forecasts)
- Land (detailed elevation, soil characteristics, lithology, geology, landcover, agriculture incl. rainfed and irrigation, erosion/sedimentation; satellite imagery especially free)
- *Environment* (surface and groundwater pollution sources, water quality incl. sedimentation and salinity, land degradation, forests, ecotourism, fisheries/aquaculture)
- *Social* (demography/census, settlements, occupations, poverty)
- *Economic* (gridded gdp, transport, administrative, crop/transport prices)
- *Water Investments* (incl. storage, headworks, embankments, diversions, irrigation, pumps, water supply and wastewater treatment infrastructure, etc.) with appropriate attribute data

Functionality:

- Open Access (additionally a secure version if necessary) responsive-design web portal and mobile App (Android and iOS) to visualize and interact with data –accessible on computers, tablets, smartphones and touchscreens/touchtables
- Updatable data and analytical services catalog with appropriate metadata
- Interactive knowledge base (relevant articles, reports, videos, websites)
- Spatial and temporal data visualization (interactive maps and graphs, swipe tools, animations)
- Spatial analytics (e.g. for selected area, pre-defined admin or hydrological or other areas, selected shapefiles) – incl. use of free cloud analytics
- Ability to export catalog data services and visualizations as images, spreadsheets/CSV where possible, deep URL links and embeds in other portals, mobile Apps, e-books, storymaps or blogs
- Scenario visualization using the data and existing model outputs
- Help tools (e.g. interactive documentation, screen-capture videos)









Technology-Enhanced Community Discussions















Illustrative Interactive Dashboards

Example for Dam Operation

Decisions to be Supported: When to release? How much to release?







Climate

- Rainfall in upstream watershed (GPM, in-situ gauges/radar, CHIRPS, ...) – current & historical
- Weather forecasts (short-term, seasonal); Storm tracks

Downstream

Irrigation status (crops, crop

stage from earth observation

moisture, groundwater (from

earth observation and in-situ)...

Soil and sub-surface soil

• Snowmelt estimates (if relevant)...

and in-situ)

Flows

- Current and historical flows (from in-situ observations, satellite estimates where possible)
- Dam inflow forecasts (e.g. from GEOGLOWS Global Streamflow Forecasting, local forecasts)...

System Levels

Current and historical levels of this dam's reservoir as well as other storages in system (e.g. from satellite, in-situ gauges)...

. . .





Other Data & Analytics

- Inundation forecasts
- Systems water infrastructure needs
- Systems model to explore implications of alternative dam operations
- Hi-resolution Satellite data
- Crowdsourced data



Need to draw upon global and other accessible data and analytic services to make interactive maps, graphs, and analytics for such decision support dashboards that are accessible on portals, apps, e-books, touchscreens, etc.





Spatial Agent App

A new world of data and analytics at your fingertips!



Showcase

Sub-National

Country-Level

Great interactive maps and charts.

Check out global data from WDI, MIT Atlas on Trade, etc.

Check out great showcase data on Mekong Delta, Poverty, Forecasts, etc. for selected areas and specialized themes





http://spatialagent.org/KIDS/

https://maps.worldbank.org/



Download free from: http://apps.worldbank.org OLC Resource Page and Blog ioS (iPad and iPhone): search "Spatial Agent" on Appstore or from http://apple.co/2eVu5xJ Android Draft version **Contact: Nagaraja Rao Harshadeep**



Interactive Dashboards

S Hydro Informatics Data Portal × +

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Population



Population - Facebook

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Analytics upstream of selected location (e.g. Elevation – Danube Watershed)



Land Cover



Rainfall Analytics



Historical Climate Records



Disclaimer. Country borders or names do not necessarily reflect the World Bank Group's official position. This map is for illustrative purposes and does not imply the expression of any opinion on the part of the World Bank, concerning the legal status of any country or territory or concerning the delimitation of frontiers or boundaries.



Leaflet | Powered by Esri | World Bank, This IMERG dataset is provided by the NASA/Goddard Space Flight Center's GPM Team and Precipitation Processing System (PPS), which develop and compute IMERG as a contribution to GPM, and archived at the NASA GES DISC

Real-time Weather Visualization



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→ C A earth.nullschool.net/#current/wind/surface/level/orthographic=92.04,13.17,275





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Recent & Forecast Weather Visualization





About the Map Data





Soil Moisture



Vegetation Index – Pleven, Bulgaria

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Water Consumption (Evapotranspiration)





Climate Engine Water Consumption (Evapotranspiration) Cloud Computing of Climate and Remote Sensing Data https://app.climateengine.org/cli × + Mean NDV app.climateengine.org/climateEngine C \rightarrow \leftarrow * MENU Figure Region: (?) I I I Polygon ~1 Mapping Tour Statistics -Graph-University of Idaho **ORI** Google Add another region Actual Evapotranspiration (SSEBop) Download Available Data from 2003-01-01 to 2020-10-11 60 -O- Polygon 1 Variable 1 (?) Type: 50 Remote Sensing V Actual Evapotranspiration (mm) **Processing Request** Dataset: ?? USGS MODIS ET - SSEBop Dekadal V This computation requires a large amount Variable: ?? of daily data and may take a couple of 40 Evapotranspiration (ETa) minutes. Y Units: millimeters V Computation Resolution (Scale): (?) 1000 m (1/96-deg) V Cancel Request Time Period (?) 20 Period of Record: 2003-01-01 to 2020-10-11 Entire Period of Record of Dataset V 10 Start Date: 2003-01-01 End Date: 2020-10-11 Jan 2004 Jan 2006 Jan 2008 Jan 2010 Jan 2012 Jan 2014 Jan 2016 Jan 2018 Jan 2020 Generated by ClimateEngine.org

World Bank Group Geospatial Pla × +

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Water Levels from Satellite

10 Water Monitor Lakes and Reserver 🗙 🕂

Important-Read me

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Project Information Project Background 10-day Resolution Product Table Monthly Resolution Product Table Satellite Radar Altimetry Frequently asked Questions References Contact Us **Funding Sources** Data Acknowledgement Disclaimer Missions Topex/Poseidon Jason-1 Jason-2/OSTM Jason-3 ERS-1 and ERS-2 **ENVISAT**







Climate Change

G Homepage | World Bank Climate ★ +

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Climate Change Knowledge Portal For Development Practitioners and Policy Makers - 0 X

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GLOSSARY METADATA CONTACT US

Climate Change Knowledge Portal

The Climate Change Knowledge Portal (CCKP) provides global data on historical and future climate, vulnerabilities, and impacts. Explore them via **Country**, **Region**, and **Watershed** views. Access synthesized **Country Profiles** to gain deeper insights into climate risks and adaptation actions. **Disclaimer**

NEW! Please check out the introductory video for the CCKP here

REGION

WATERSHED

DOWNLOAD DATA

COUNTRY PROFILES

AGRICULTURE PROFILES

ABOUT













New ways of Interactive Analytics



Tangible Landscape https://tangible-landscape.github.io/



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🚱 Congo Basin Forests Water E-Bo 🗙 🕂

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E-Packaging of Knowledge (e.g. Interactive E-books/ Storymaps)

Outreach (e.g. virtual/online learning, hackathons, Expos)



Virtual Seminars on Key Topics from Global Experts Virtual Desktop

Participation; e-learning



Spatial COVID-19 Recovery Stimulus Planning







Illustrative Data

Location: Peri-Urban Centroid Coordinates: 46°46′51″N 61°39′00″E Basin: Syr Darya Type of Intervention: Degraded Land Rehabilitation Number of person-days: 200 (60% women) Cost: USD 3000 Potential Implementer: Agency xxx Potential Associated Project: Pxxxxx + Associated Pictures/Video Narrative/Documents



Looking Ahead: AI/Machine Learning





AI-Enabled Text and Data Mining of documents, news & social media

AI-Enabled Chatbots Natural Language Processing



 Training Data for Machine Learning Classification
 Land Cover Classification using Training Data

 Machine-Learning Image Classification – Earth Observation
 CNN, ANN, Deep Learning...

In Summary

- A new world of HydroInformatics is emerging with the help of Modern "Disruptive" Technologies
- Great potential to leverage (and contribute to) global, regional, and national data and analytics for local benefit

- An enabling environment can help development of applications at scale
 - Improving awareness of new technologies and their benefits/risks
 - Develop an ecosystem of "analysis ready" open data services
 - Enhanced **collaboration** across sectors and countries

Disrupt or Be Disrupted! Thanks!

Dr. Nagaraja Rao Harshadeep (Harsh)

Global Lead (Disruptive Technology) Environment, Natural Resources & Blue Economy Global Practice The World Bank 1818 H St NW Washington DC 20433 harsh@worldbank.org



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