



DANIEL K. INOUE ASIA-PACIFIC CENTER FOR SECURITY STUDIES

Water Security in the Indo-Pacific: Perspectives & Technologies

National Geospatial-Intelligence Agency

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Educate Connect Empower



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Water Security in the Indo-Pacific: Perspectives & Technologies

- **Overview of the problem**
- **Local scale, Pacific Island viewpoint**
- **Broad issues across Asia**
- **Science/Technology Contributions**



Key Ideas

- Availability of freshwater resources impacts the security of all – from individuals to international relationships
- Evolving scientific and technological advances offer approaches to strengthening water security

Take Away

Evidence-based policies emphasizing conservation, stewardship, and collaborative/equitable distribution of freshwater resources can increase water security for all



Water Insecurity is a global concern:

- >10% of the world's population (780 million people) lack access to an improved water source
- >35% of the world's population (2.5 billion people) lack access to improved sanitation
- 11% of the 7.6 million annual deaths of children under the age of five die from diarrhea each day (2,200 children)
- Unsafe drinking water, inadequate availability of water for hygiene, and lack of access to sanitation together contribute to about 88% of deaths from diarrheal diseases



**“The wars of the twenty-first century
will be fought over water.”**

Ismail Serageldin

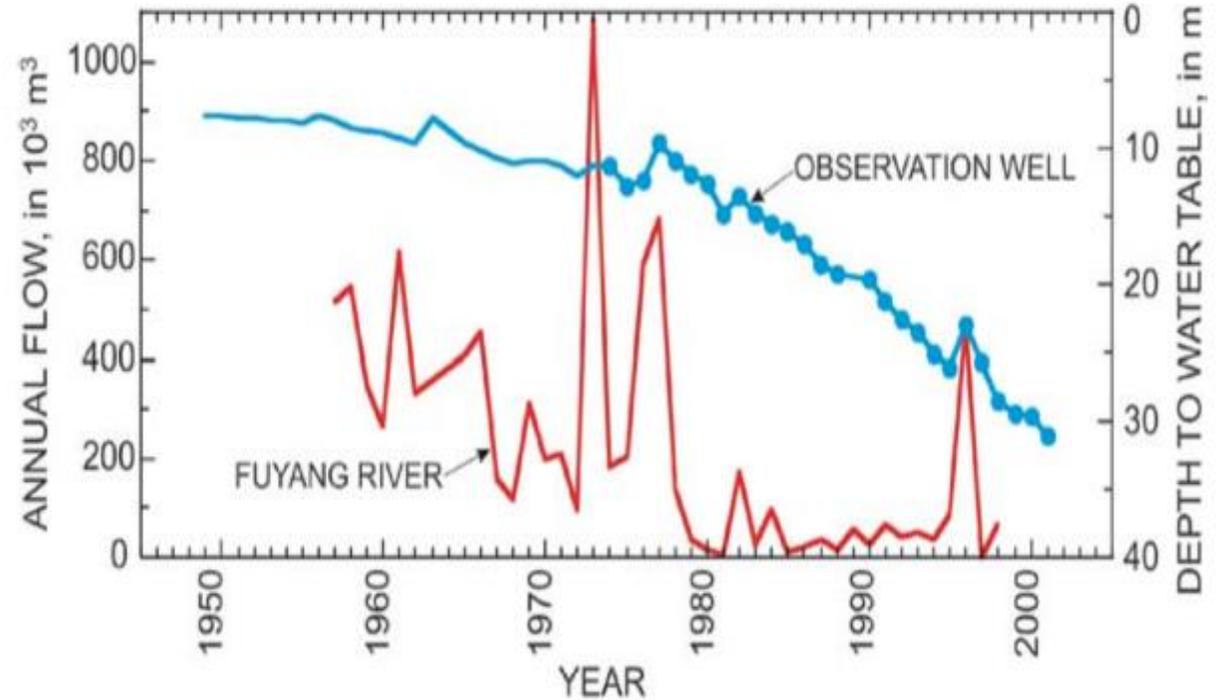
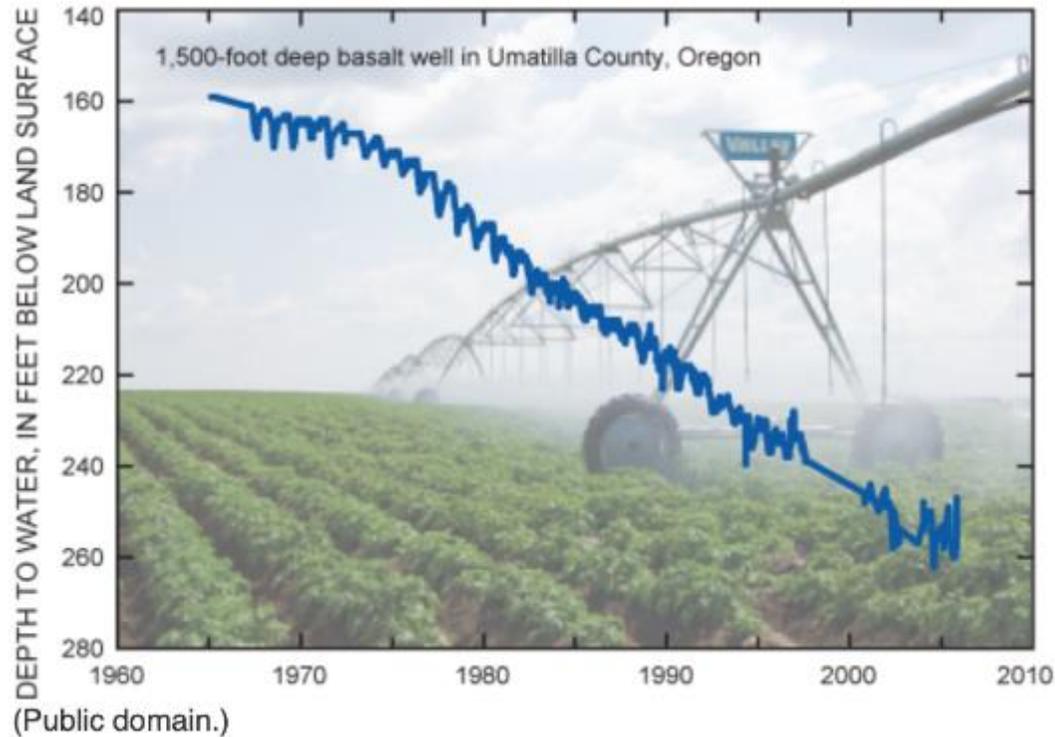
**Founding Director, Bibliotheca Alexandrina
(the new Library of Alexandria); member,
Advisory Committee, World Social Science
Reports, 2013 & 2016, and UNESCO-
supported World Water Scenarios**



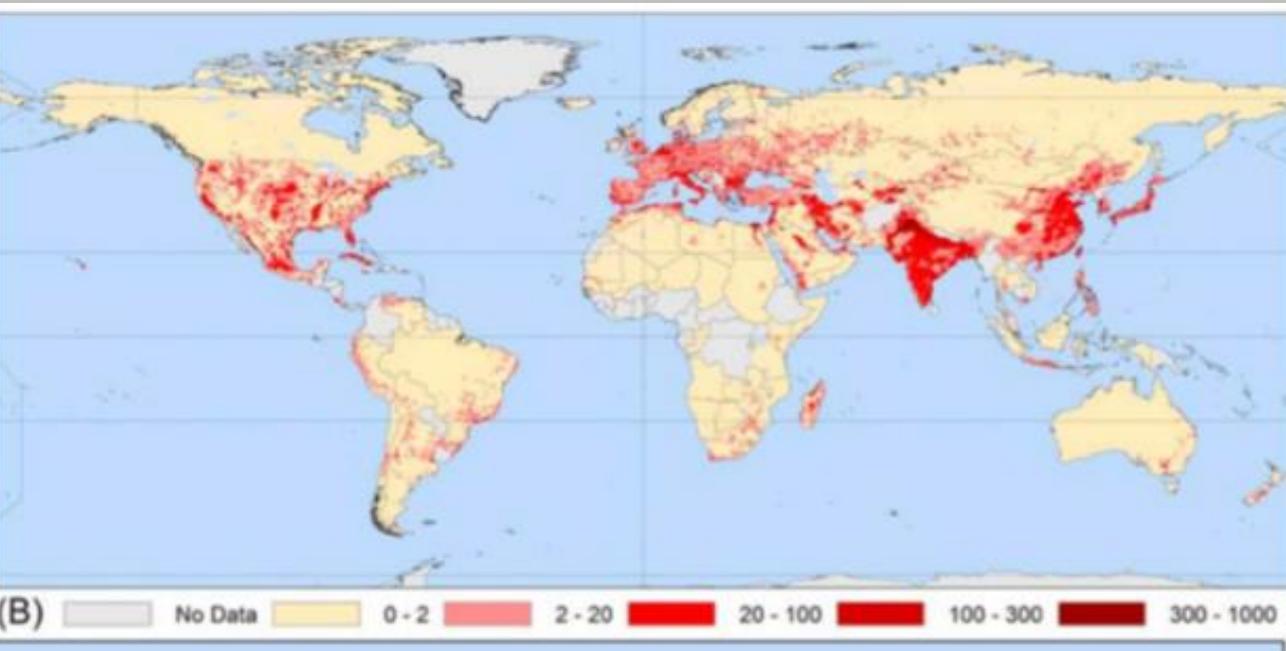
Aquifer Depletion

In western USA

In northern China

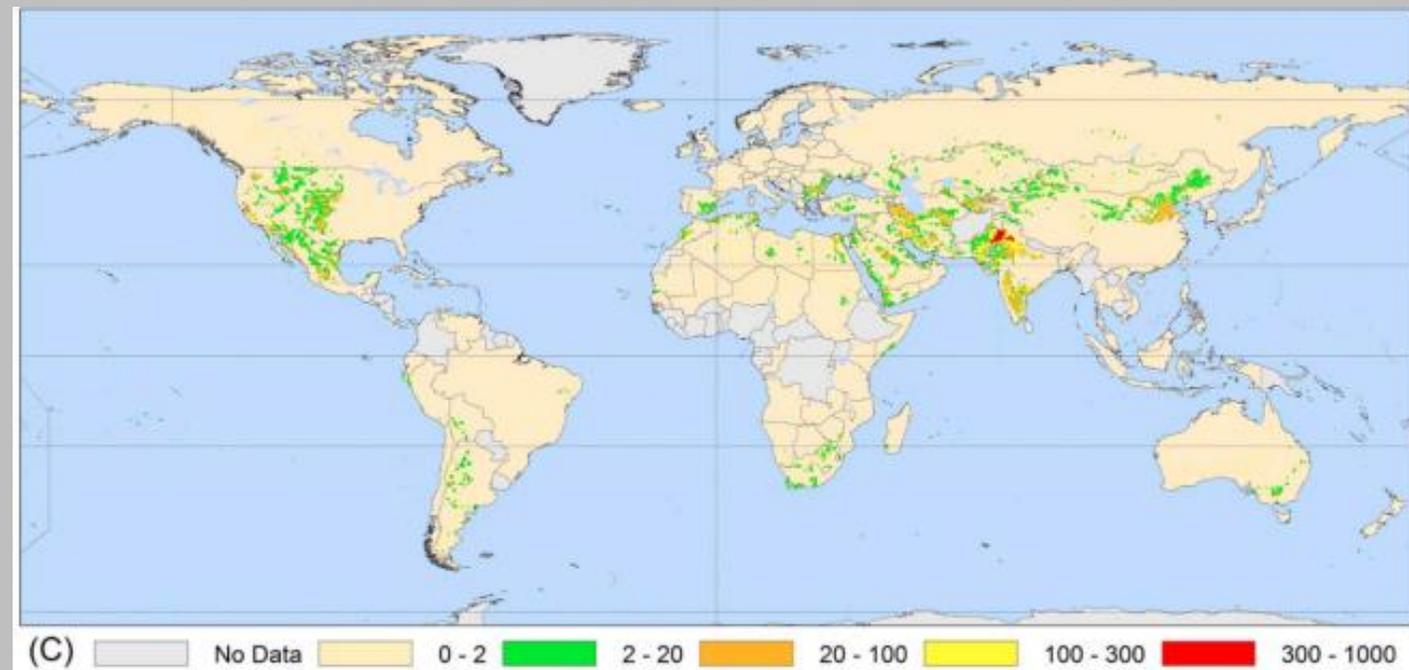


Global Aquifer Depletion (mm/yr)



Global Aquifer Recharge (mm/yr)

Wada, et al., GEOPHYSICAL
RESEARCH LETTERS,
VOL. 37, L20402, 2010





Population & Per Capita Water Use

- **7.4 billion currently**
- **8.5 billion by 2030**
- **>9 billion by 2040**

As more of this growing population adopts an urbanized, industrialized lifestyle, *per capita* water use will increase.





Contrasting Perspectives on Water Security

Local

Small island scale

Local (Micronesia)

Immediate to near-term

Few political issues

Little chance of cascading crises

Continental

Broader trans-Asia scale

Regional / transboundary

Mid- to long-term

Many political issues

Great chance of cascading crises



Local Scale: *Water for Life*



**Informal science learning in Yap, Chuuk, Palau, & Marshall Islands
Funded by the National Science Foundation: \$2.9M over 2012 – 2017**





Goals of *Water for Life*

- **Foster community-based, informal science education, using water as a meaningful theme**
- **Help meet growing regional needs for potable water**



Building water security in communities across Micronesia



Process: Core Teams

Leveraged Resources

At each site, representatives from key stakeholder communities learned together about water science and local water issues:

- Education
- Environmental/NGO
- Water systems infrastructure



Identified community needs and assets; recruited supporters
Built local commitment: Worked with youth and broader communities on water-related service-learning projects: rainwater catchment, water quality monitoring, conservation, etc.



Site-based Examples

- ***RMI***: School-based RWCSs & WQMTs; public education & monitoring systems
- ***Chuuk***: Enhancing public access to higher quality water from groundwater springs
- ***Yap***: Installing first-flush diverters in community RWCSs
- ***Palau***: Creating out-door lessons; restoring traditional surface water sources

Locally-driven

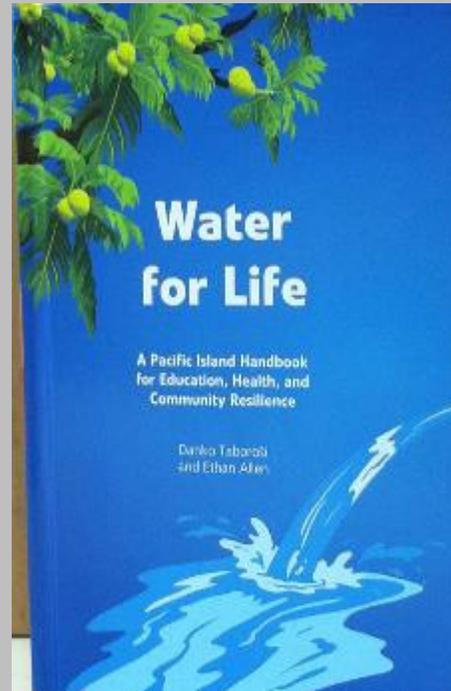




Impacts from partnerships

- Improved RWCSs in all 12 public schools on Majuro; school-based teams maintain, monitor monthly, and send data to RMI EPA; self-sustaining model that has now been replicated and adapted In other sites.

- Created and distributed 3,000 copies of the 280-page *Pacific Island Handbook for Education, Health, and Community Resilience*





Introduced Solar Distillation Technologies

Students from Majuro's Life Skills Academy adapted and built solar stills from locally available and affordable materials

[Funded from a \$300,000 supplementary grant from NSF's Food, Energy, & Water (FEW) initiative]





Introduced MadiDrops (see Madidrop.com)

Appropriate
technology

Simple, inexpensive - \$15 @: 1 year, point-of-use water microbial decontamination system for 10-20 L/day

Silver-infused porous ceramic tablets – release silver ions into water

Toxic to microbes; harmless, at these levels, to humans

Requires no electrical power, batteries or replacement parts

No aftertaste or smell

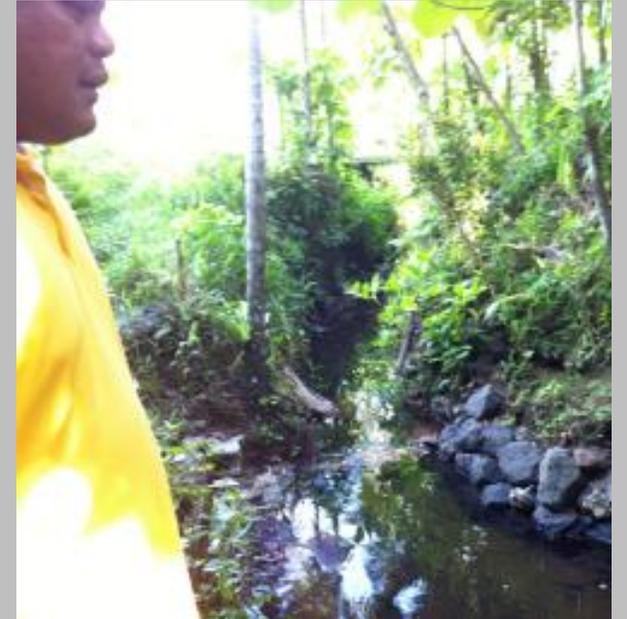




Project Outcomes

Greater Drinking Water Security

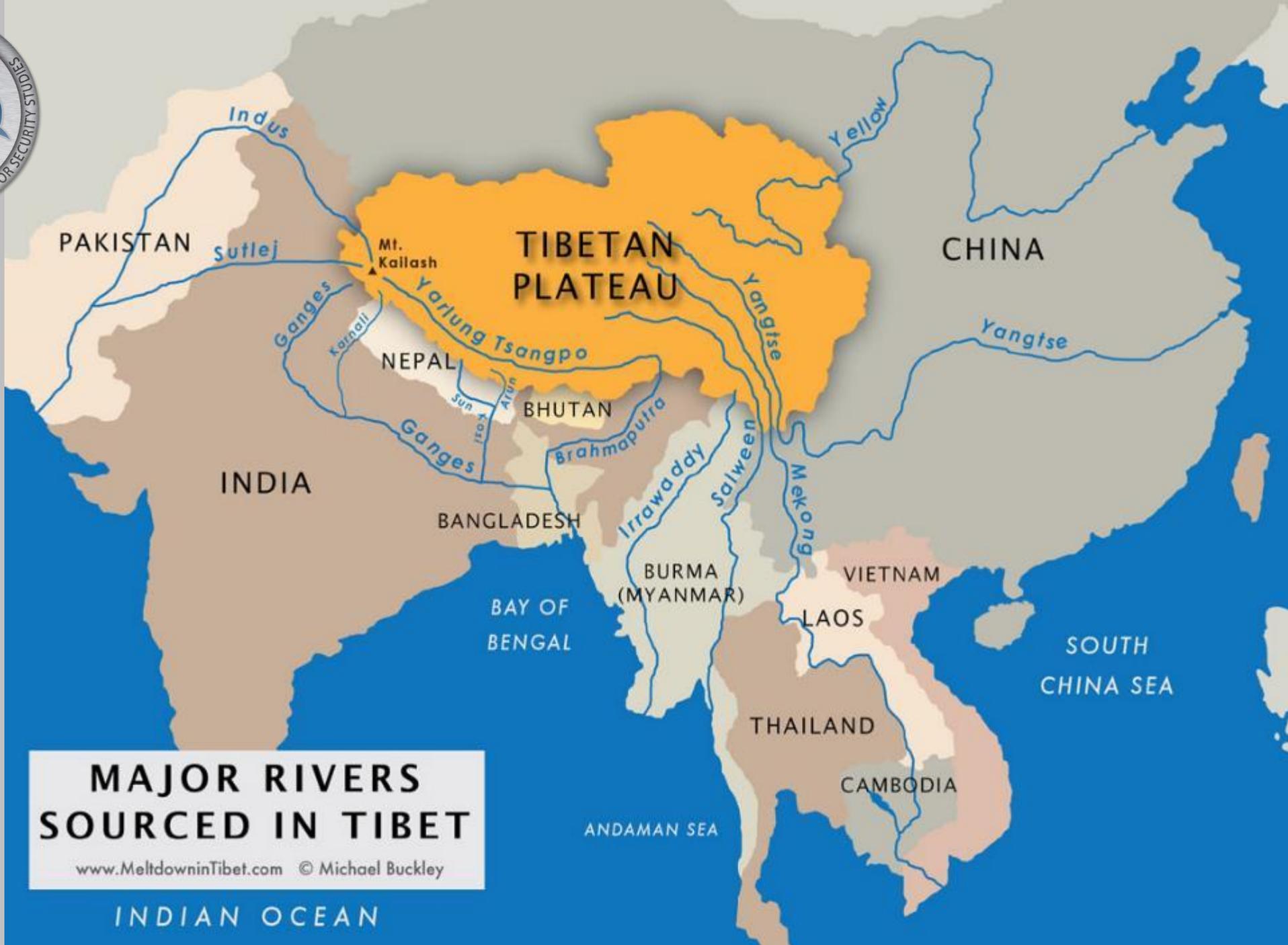
- Improved local community leadership on water issues
 - Enhanced formal and informal science education
 - Created infrastructure for water resiliency
 - Prevented and mitigated water crises





Broad Asian Continental Perspective:

- ~4 billion people - > half Earth's population
- Through its presence in Tibet, China controls 10/11 major rivers of Asia
 - Building hydroelectric dams - further control of downstream water:
 - ✓ Brahmaputra River damming causing friction with India
 - ✓ Mekong damming impacting livelihoods of residents of Myanmar, Cambodia, Laos, Thailand, & Vietnam
 - Water as 'soft power,' but moving into gray zone



**MAJOR RIVERS
SOURCED IN TIBET**
www.MeltdowninTibet.com © Michael Buckley

INDIAN OCEAN

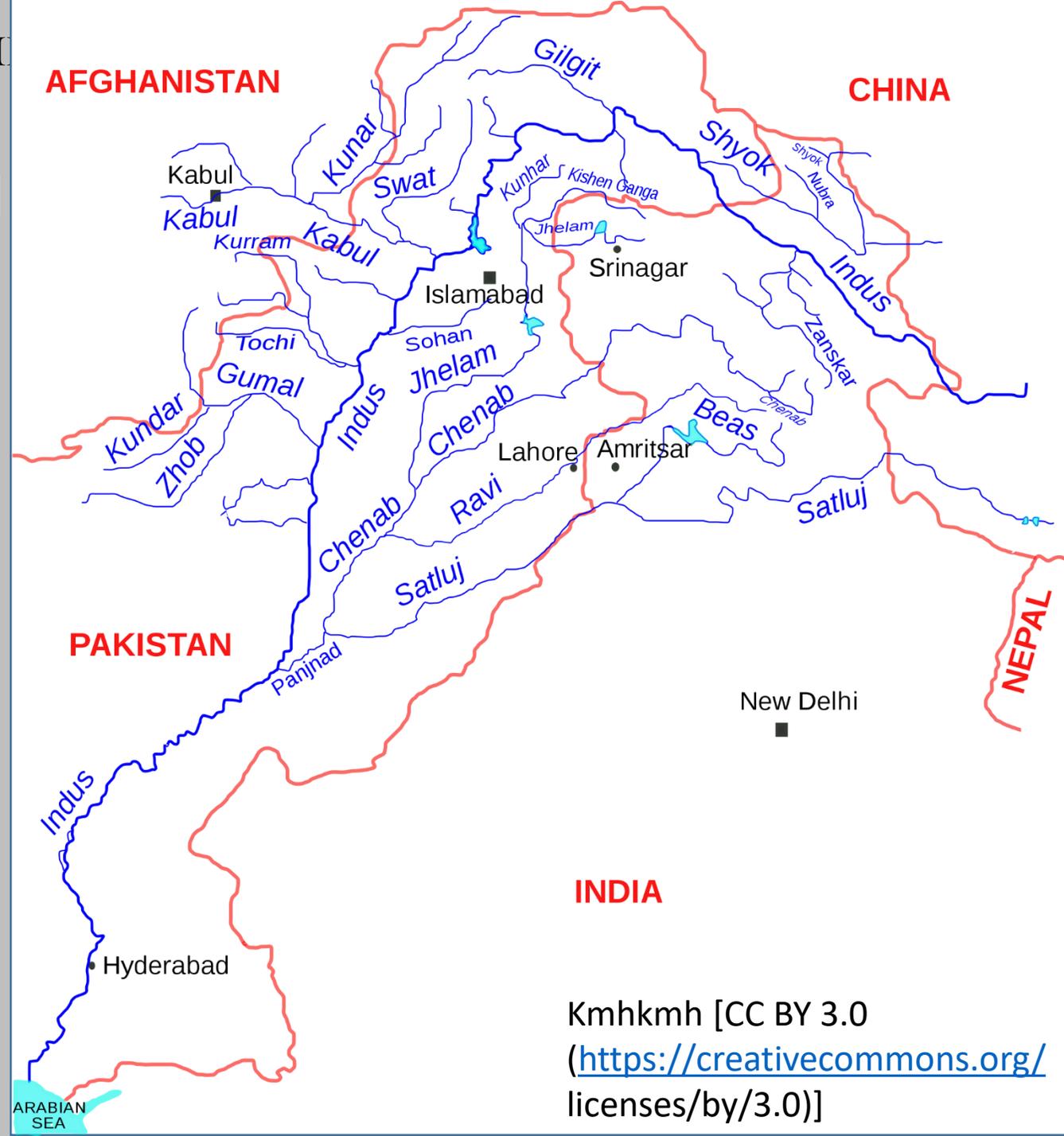


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If efficiently managed,
likely enough water for all

Indus Water Treaty

- Impacts ~250 million people
- Simple, physical division of watershed
- No provisions or incentives for collaboration or data sharing
- Violation of treaty considered 'act of war'



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(<https://creativecommons.org/licenses/by/3.0/>)]



"Consider what will happen in water-distressed, nuclear-armed, terrorist-besieged, overpopulated, heavily irrigation dependent and already politically unstable Pakistan when its single water lifeline, the Indus river, loses a third of its flow from the disappearance from its glacial water source."

Steven Solomon

Water: The Epic Struggle for Wealth, Power and Civilization



Further Asian Water Security Issues

- **India & China together make up 1/3 of world population, have access to only 1/10 of world water reserves, & are not cooperating on water issues**
- **22/32 major Indian cities are projected to be “water-stressed” by 2025 and “water scarce” by 2030**
- **China has an annual shortfall of usable water resources of 2.3%**
- **Pakistan’s water storage capacity is ~30 day supply (vs. 1,000 day recommended)**



Floods & Droughts: Security Implications

80% of the land in Bangladesh is flood plain – 75% is located less than 10 meters above sea level

Floods are the most common natural disasters within South East Asia

Aeolian desertification is occurring in Northern China

Over 29% of India's total geographical area is under desertification; in eight Indian states, the figure is around 40-70%



Summary: Asian Water Issues



- **Insecure supplies of clean water exacerbate economic disruption, social tension, and conflict**
- **Pace and scale of Asian urbanization are increasing demands on already stressed resources.**
- **Climate change is further raising these risks, increasing episodes of extreme weather, reducing predictability of water supplies, and changing traditional geographic distribution of water resources.**
- **Large-scale water projects to date have not emphasized water stewardship, conservation, and efficiencies.**
- **Improved inter-government cooperation is needed to reduce these risks.**



Science & Technology Improve Water Security

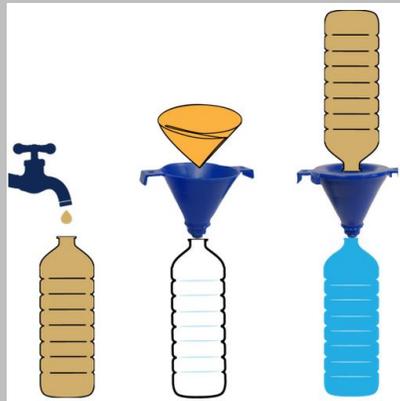
Satellite surveillance: Sophisticated algorithms, better modeling, and machine-based learning are leading to better weather predictions, with longer lead times and more accurate localization (e.g., El Nino/La Nina)





Decontamination: Kill &/or filter out microbes

MadiDrops: silver-infused porous ceramic tablet; disinfects 5 gallons of water per day for a year (<https://www.madidrop.com>)



Folia Water: coffee filter infused with silver nanoparticles; comes with a screw-on filter holder; cleans a half-gallon of water in about 10 minutes (<https://www.foliawater.com>)



Aqus filters: multi-layered filter based on progressively finer and finer nanofibers; filter >300 gallons per day and remove bacteria, fungi, and most microbes (except viruses)
[\(http://www.aquswater.com/\)](http://www.aquswater.com/)

Life Straw: containing filters, iodine crystals, and carbon [\(https://www.lifestraw.com/\)](https://www.lifestraw.com/)



Other novel decontamination systems are under development.



Distillation: Evaporate/re-condense water

- Sunny Clean Water

<https://www.sunnycleanwater.com/>

- Desolenator

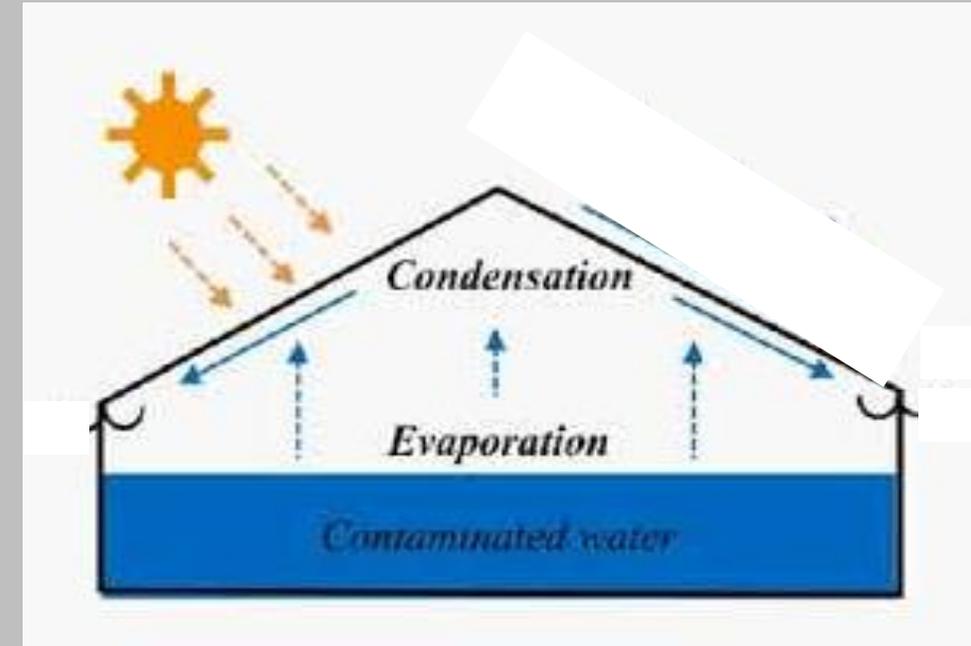
<http://desolenator.com/#contact-off>

- F Cubed

<http://www.fcubed.com.au/aspx/home.aspx>

- Innovative Water Technologies

<http://www.innovativeh2o.com/#!emergency-response/xufcd>



<https://www.youtube.com/watch?v=UiBCxavgMVY>



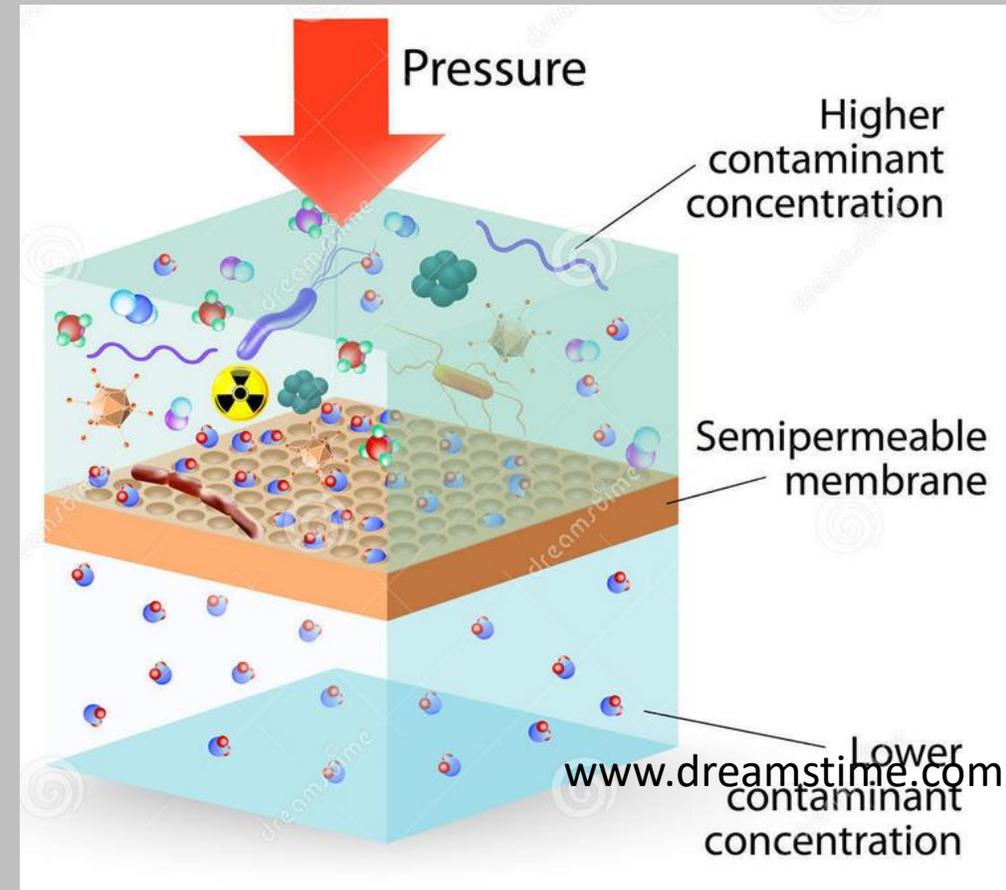
Reverse Osmosis (RO)

Filtering to remove salt and other chemical contaminants

New technologies for smoother and thinner membranes: using graphene

- e.g., perforene

<https://www.lockheedmartin.com/en-us/products/perforene-graphene-membrane.html>





Extracting Water from Air

- Fog fences – old technology – works only in limited circumstances
- Zero Mass Water - nano-structured materials together with a solar panel to extract and condense water vapor even from dry desert air.

(<https://zeromasswater.com/>)

- Metal organic frameworks
- Penn State’s “slippery rough surface” - prototype nano-scale textured surface condenses 30 gal/day/m² of water vapor from air.





Take Away:

Evidence-based policies emphasizing conservation, stewardship, and collaborative/equitable distribution of freshwater resources can increase water security for all



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Mahalo

Let's talk story