Water politics & climate adaptation – path dependency and the challenge of environmental extremes

SWAN International Workshop
Open Knowledge: Bridging Perspectives to Address Water Challenges

David L. Feldman
Department of Planning, Policy and Design and Water UCI,
University of California, Irvine
feldmand@uci.edu

February 17, 2016

Water UCI

UCIRVINE | SCHOOL OF SOCIAL ECOLOGY

Path dependence, water policy, climate

- **Societies long preoccupied by climate extremes & water management.**
  - **Adjusting to impacts of drought and flooding, averting calamitous consequences are principal drivers of water politics.**
  - **Traditional response: alter rivers/groundwater basins through public works to protect built-environment assets, irrigate farms, slake thirsty cities.**
- **Result? Politics shaped by *path dependency*:**
  - **Long-established policies and practices that constrain capacity for change.**
  - **Policies and practices based on hard-power: centralized and hierarchical control of information & decisions.**

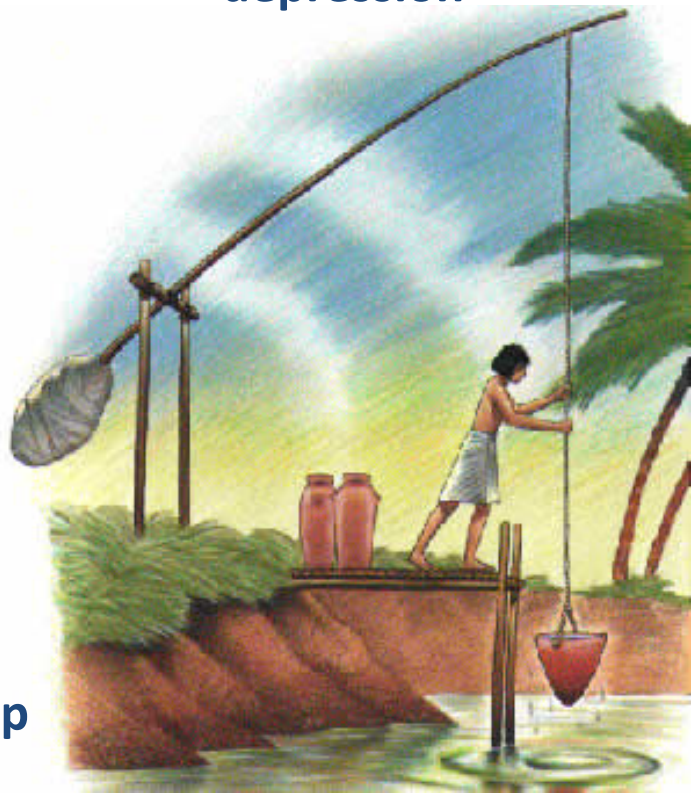
Overview

- **Review** ***hard power, path-dependent approaches and their failures.***
- **Assess** ***how climate change reveals path dependency's vulnerability*****.**
- **Describe** ***emerging paradigm*** **– water-sensitive politics.**
- **Discuss** ***conflicts between path-dependent & water-sensitive paradigms*****.**
- **Conclude** **–** ***contending water futures in light of climate issues.***

Hard power and water – Ancient Egypt

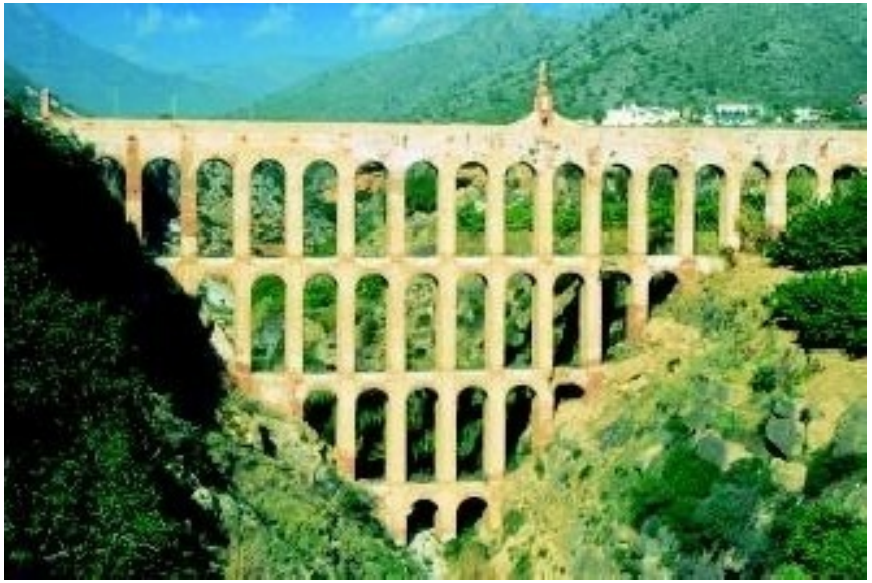
Mural from Nile Valley (c. 2000 B.C.)

Bahr Yousuf canal – Faiyum depression



Shaduf and sweep

Roman aqueducts – ‘threads of empire’



El Acueducto del Aguila – from Nerja to Maro

Segovia Acueducto – built 1st Century A.D

By 3rd century AD, Rome had eleven aqueducts for a population of over 1 million – mostly for public baths. Cities and towns throughout the empire emulated this model; ***funded aqueducts as objects of public interest and civic pride***, "an expensive yet necessary luxury to which all could, and did, aspire."

To Romans, as for us – similar concerns

Public latrines – Ostia

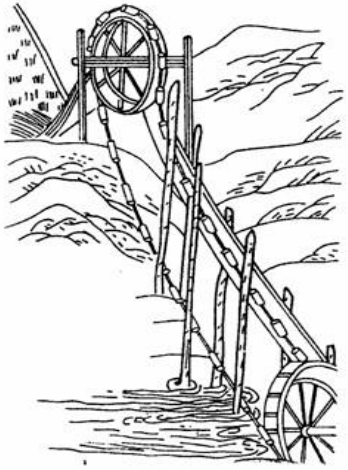
Public baths – Pompeii

"It is plain . . . how much more our forefathers cared for the general good rather than private luxury, inasmuch as even the water which private parties used was made to serve the public interest." – Sextus Julius Frontinus, Supervisor of Water Supply, City of Rome (A.D. 97).

China – diversion and water banking

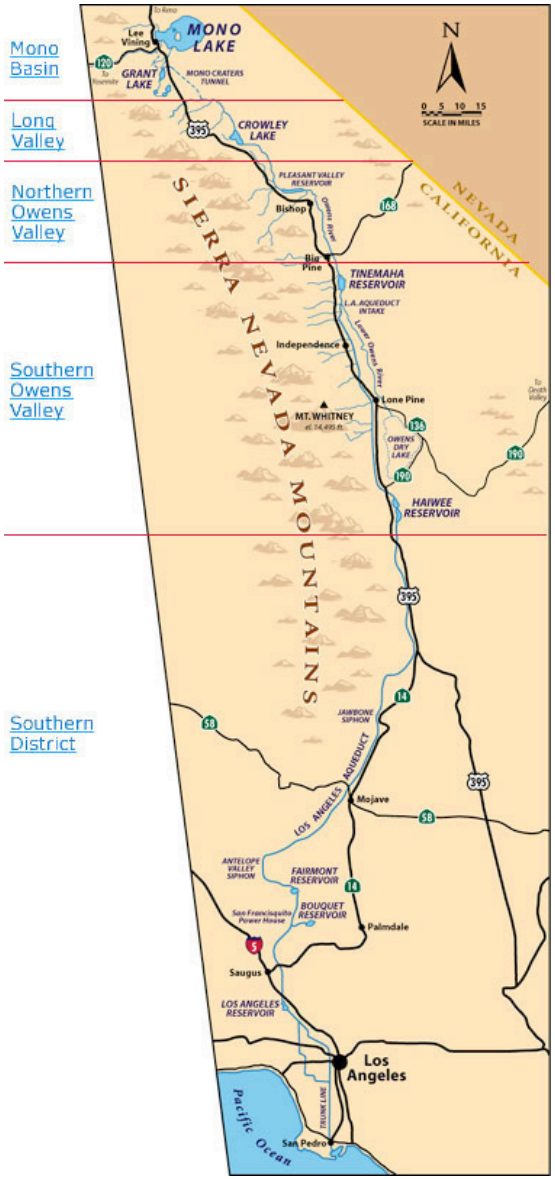
Dujiang Irrigation Project – Min River, Sichuan province (*Qin dynasty, 256 BC)*

图 4-85　水转翻车
（引自（明）宋应星《天工开物》）



Tiangong Kaiwu Chain Pumps – (Ming dynasty , c. 1300 AD)

California – hard politics and hydraulic empire



- **In early 20th century, LA's population doubled every 10 years.**
- **Civic leaders sought reliable sources. Owens Valley surveyed, land and water rights <u>secretly acquired by a business syndicate</u>. Legacies?**
  - ***Environmental degradation of Owens and Mono Lakes.***
  - ***Economic decline of Eastern Sierra.***
  - ***Litigation over air quality and riparian protections.***
  - ***Phenomenal growth of Los Angeles region***

JP Lippincott, Fred Eaton, William Mulholland – c. 1910

Los Angeles Aqueduct dynamited - 1927

Climate change – vulnerability of path dependency

- **Droughts are recurring events that may become more frequent.**
- **Supply-side solutions unviable – there's less water to harvest.**
- **How we manage available water key to adaptation.**
- ***Sustainable management* = meeting society's needs & protecting environment:**
  - ***Reduce demand & profligate uses.***
  - ***Become more efficient.***
  - ***Re-use every drop.***
  - ***Harvest new sources.***

Left: More than 12 million trees have died from California's drought. Right: Irrigation manager Rick Gilmore inspects dried grape vines in Byron, California.

LEFT: LUCY NICHOLSON/REUTERS, RIGHT: DAVID PAUL MORRIS/BLOOMBERG/GETTY

Regional adjustments to reduced precipitation or snow pack are needed, even if overall precipitation does not change. Demand management, conservation, public outreach, technological innovation for water conservation and more-flexible market-based solutions and infrastructure adaptation are fundamental to responding to increased demands and climate-change stress in the future.

For example, Australia's 1997–2009 Millennium Drought triggered changes in public perception and policy reforms, water demand and other environmental management strategies[10]. City dwellers reduced their water use. Incentives for using water-conservation technologies slashed long-term water demand.

Breakthroughs in drought management, adaptation, mitigation, resilience assessment and prediction demand the close collaboration of scientists, policymakers and decision-makers. Federal and state agencies should develop long-term research programmes to address key science challenges and the realization of innovative technologies.

Explorations of drought must go beyond supply issues to encompass water demands (including environmental needs), water-storage infrastructure, adaptability, policy and feedback between human actions and climate as a complex system. This requires embracing a broader definition of socio-economic drought — a condition in which water demands exceed available supply.

A key element is investing in drought-monitoring and -prediction systems. Over the past decades, drought monitoring has evolved to include satellite observations and advanced analysis software. But drought prediction at seasonal scales remains a challenge. Climate and hydrological scientists should prioritize such research to support better water management and explore the causes, local impacts and management of droughts across many scales. The social consequences of downsizing agriculture during water-scarce periods require deeper research and planning.

Decision-makers should update drought-preparation strategies given that combined demand growth and reduced water supplies make it more difficult to recover after droughts. This will entail prioritizing water needs under extreme conditions in a way that minimizes long-term impacts on both humans and ecosystems. A range of behavioural and technological options (such as conservation and water reuse) must be considered. Water-policy reforms and the establishment of water entitlements for environmental protection during the Millennium Drought are examples of successful adaptation plans.

Policymakers should establish environmental water entitlements and drought plans, based on understanding water needs for ecosystems and trade-offs between endangered species and crucial water uses. This should include emergency actions for key river segments and refuge habitats, including evacuation and captive breeding to avoid extinction of endangered species.

Water and environment managers must reconcile environmental water supplies with economic water uses, and develop adaptive plans for future conditions. Long-term impacts of policy reforms should be considered to avoid further socio-economic impacts. Industry and the agricultural sector should prepare for a warmer climate and lessen their water use by increasing water recycling and efficiency and forgoing low-value water uses.

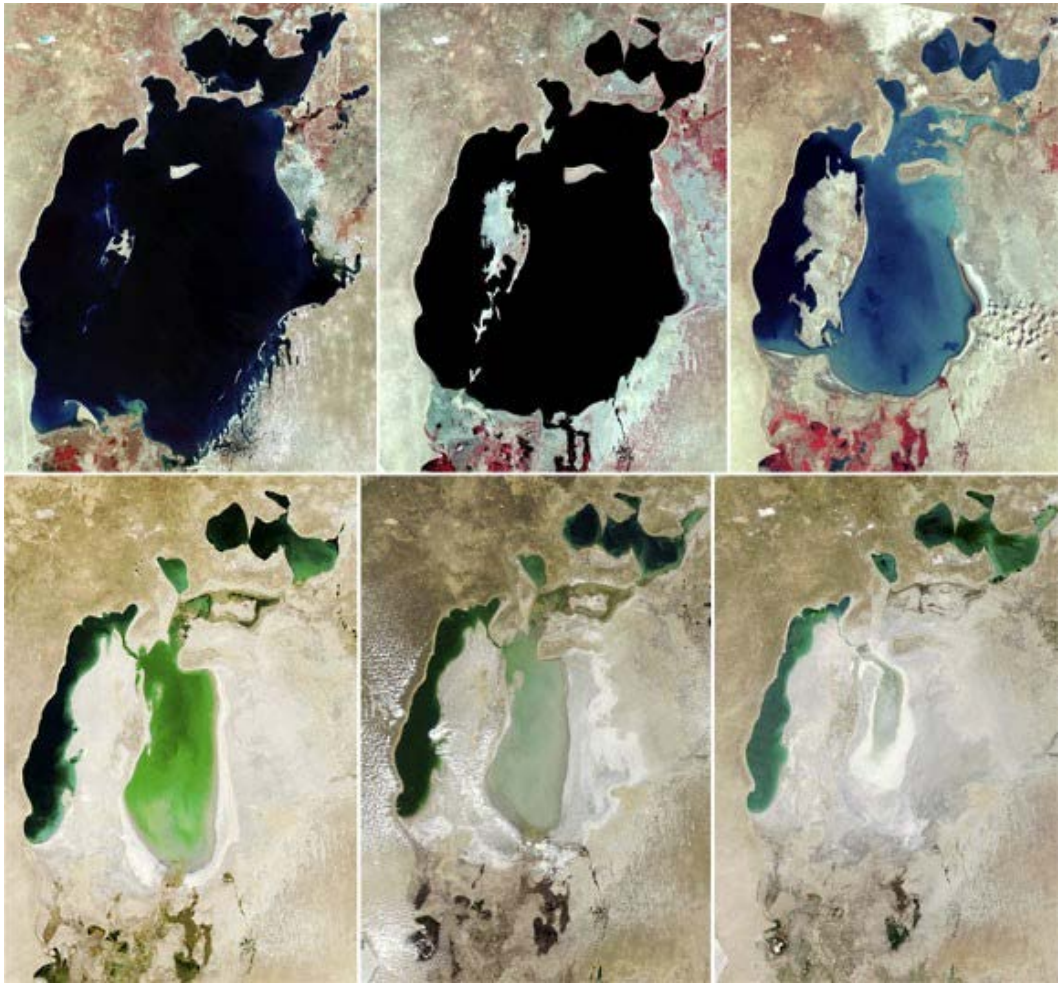
California's current extreme drought must be a lesson for managing water in a warmer future climate with increased demands. ■

Amir AghaKouchak *is an assistant professor in the Center for Hydrology and Remote Sensing, University of California, Irvine, USA.* **David Feldman** *is a professor in the Department of Planning, Policy and Design, University of California, Irvine, USA.* **Martin Hoerling** *is a meteorologist at the National Oceanic and Atmospheric Administration, Earth System Research Laboratory, Boulder, Colorado, USA.* **Travis Huxman** *is a professor in the Department of Ecology and Evolutionary Biology, University of California, Irvine, USA.* **Jay Lund** *is a professor in the Department of Civil and Environmental Engineering, University of California, Davis, USA.*
e-mail: amir.a@uci.edu

1. Shukla, S., Safeeq, M., AghaKouchak, A., Guan, K. & Funk, C. *Geophys. Res. Lett.* **42**, 4384–4393 (2015).
2. Howitt, R. E., Medellin-Azuara, J., MacEwan, D., Lund, J. R. & Sumner, D. A. *Economic Analysis of the 2014 Drought for California Agriculture* (University of California, Davis, 2014).
3. Adams, H. D. *et al. Proc. Natl Acad. Sci. USA* **106**, 7063–7066 (2009).
4. Herring, S. C., Hoerling, M. P., Peterson, T. C. & Stott, P. A. (eds) *Bull. Am. Meteor. Soc.* **95**, S1–S96 (2014).
5. Lund, J. R. & Medellin-Azuara, J. in *Proc. World Environmental and Water Resources Congr.* 2073–2080 (American Society of Civil Engineers, 2015).
6. Power, M. E., Bouma-Gregson, K., Higgins, P. & Carlson, S. M. *Copeia* **103**, 200–211 (2015).
7. Hwan, J. I. & Carlson, S. M. *River Res. Applic.* http://dx.doi.org/10.1002/rra.2907 (2015).
8. Barnett, T. P. *et al. Science* **319**, 1080–1083 (2008).
9. Diaz, H. F. & Wahl, E. R. *J. Climate* **28**, 4637–4652 (2015).
10. AghaKouchak, A. *et al. Science* **343**, 1430–1431 (2014).

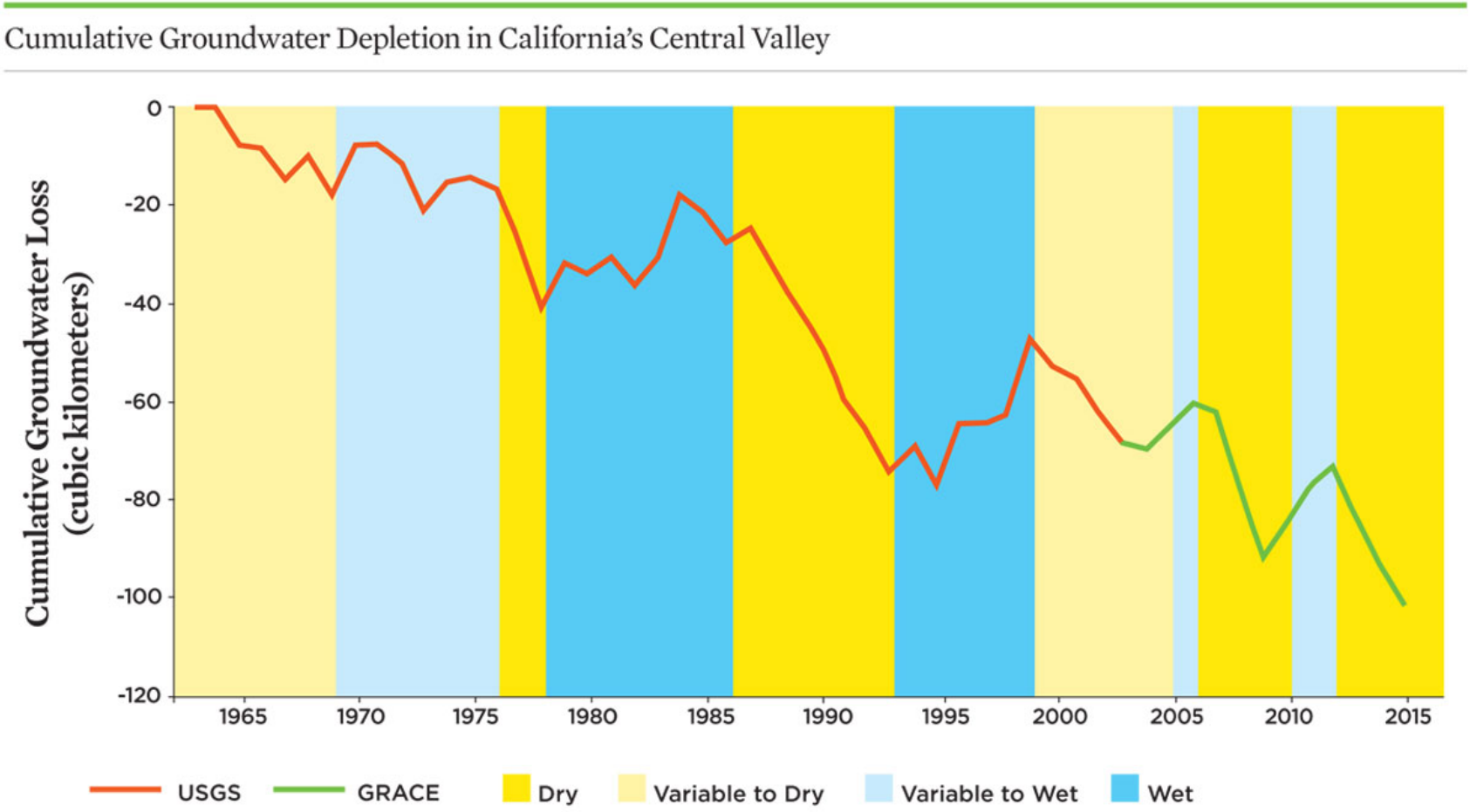
A. Aghakouchak, D. Feldman, M. Hoerling, T. Huxman, J. Lund (2015) "Recognize Anthropocentric Drought," Nature 524: 409-11.

Aral Sea – diversion, depletion, aridity (2014)



- **Once world's 4th largest saline lake.**
- **In 1960s, Soviet Union diverted Syr Darya and Amu Darya for irrigation.**
- **Return flow/evaporation rate imbalanced.**
- **Salt, dust laden air, seepage of pesticide severe impacts region.**

And . . . profound effects on groundwater



Cumulative groundwater losses in California's Central Valley aquifer since 1962. The red line shows data from groundwater model simulations calibrated by the U.S. Geological Service (USGS) from 1962 to 2003. The green line shows Gravity Recovery and Climate Experiment (GRACE) satellite-based estimates of groundwater storage losses. Background colors represent different water years.

SOURCE: ADAPTED FROM FAMIGLIETTI ET AL. 2014.

New paradigm – water-sensitive-politics

- **Integrated water management**:
  - *Wastewater reuse*
  - *Stormwater harvesting*
  - *Innovative floodplain management*
- **Broader public participation** – *socially-inclusive decisional processes.*
- **Reliance on climate-knowledge networks:**
  - *More effective science-policy partnerships*
  - *Link local & expert knowledge to adapt to change*

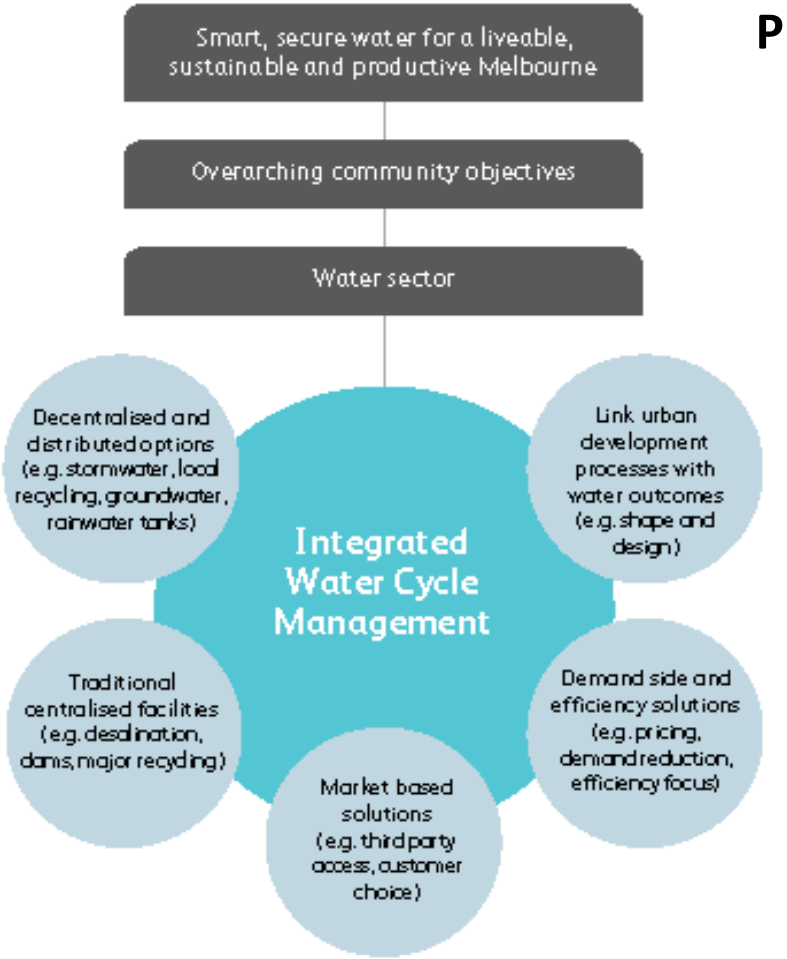
Australia – exemplar of new paradigm

- **World's driest inhabited continent – 90% of 23 million inhabitants live in cities.**
- **Millennium Drought (1996-2010) diverse effects on SE region:**
  - **Reservoirs fell to 26% capacity, bush fires erupted.**
  - ***Dramatically altered public attitudes toward climate change, drought, water***

Figure 3: Map of Greater Melbourne by Local Government Area[11]

Integrated management & public engagement

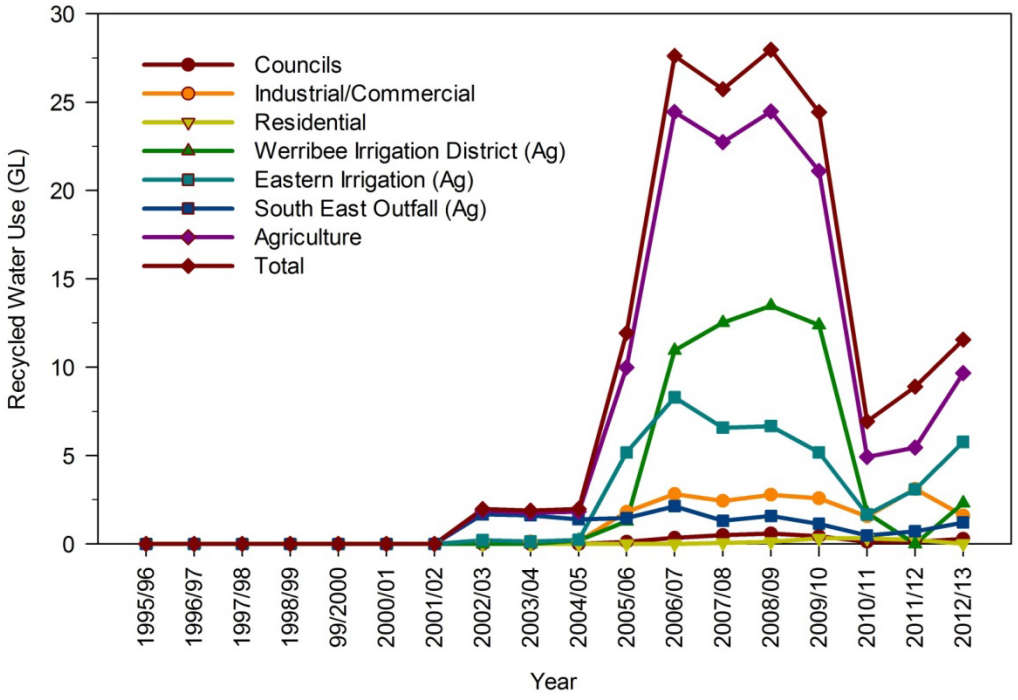
Figure 1: Integrated Water Cycle Management[5]

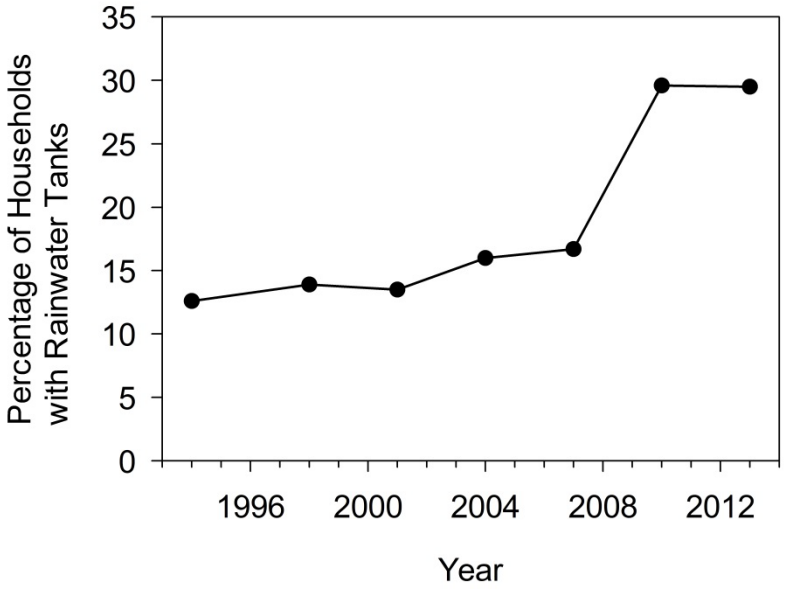


Process of public engagement undertaken to:

- ***Create and sustain a culture of community involvement & innovation.***
- ***Energize officials to adopt a wide-range of options to augment water supply.***
- ***Encourage inter-agency cooperation.***
- ***Emphasize low-impact development alternatives.***

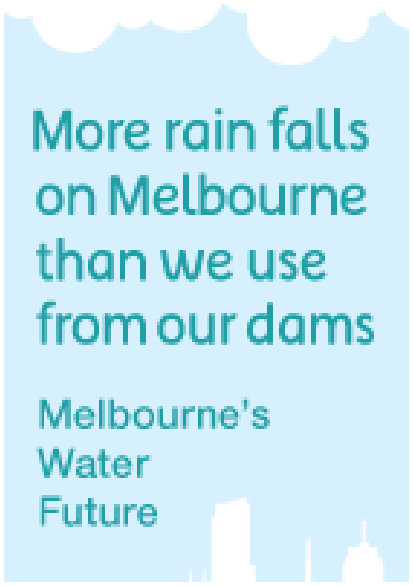
Wastewater re-use, rainwater harvesting – Melbourne





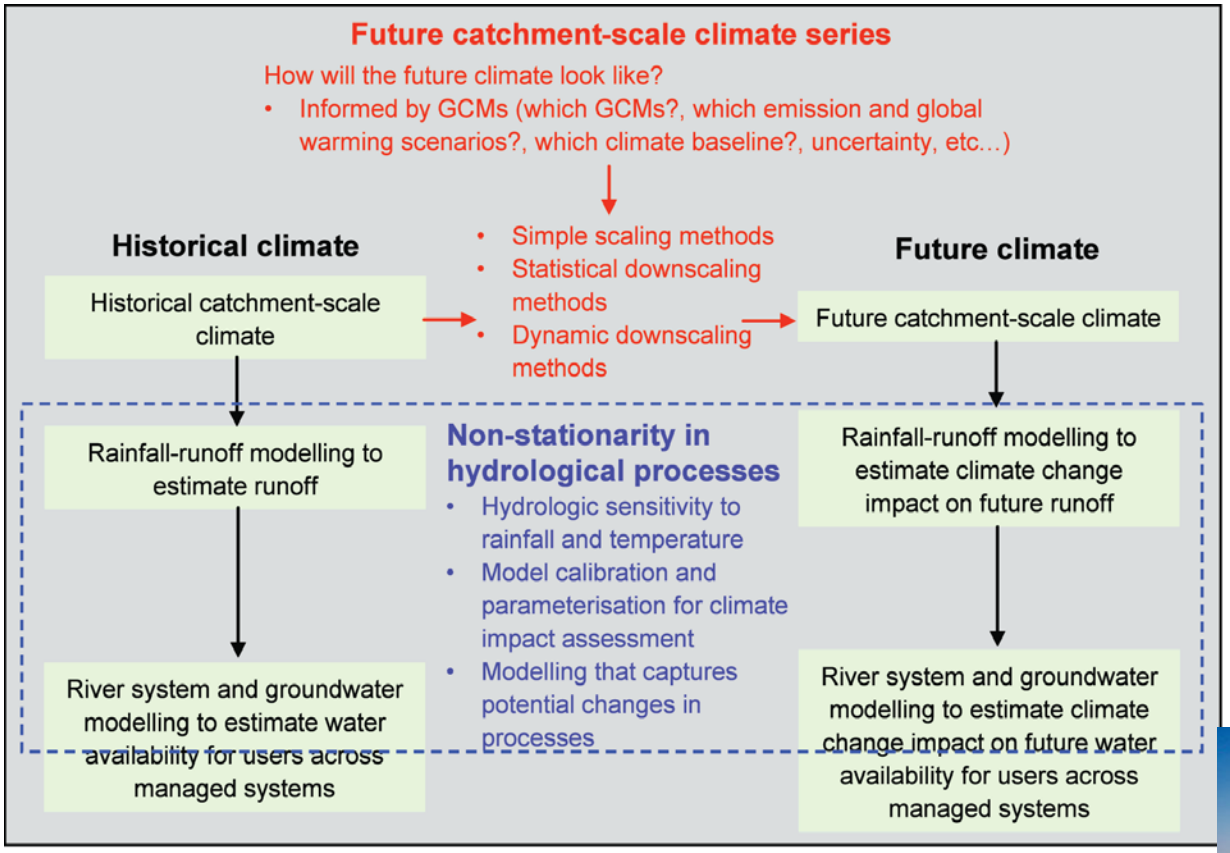
Stormwater management – Victoria

- **Innovations adopted during millennium drought include –**
  - **Local government *development consents* encourage rainwater tanks connected to roofs that provide for gardens, toilets, clothes & car washing.**
  - **Above- & under-ground storage/on-site detention – incentives for developers and home owners include *rebates* on water and sewer charges for rain gardens, biofilters.**



Constructed wetland - Melbourne

Climate-knowledge networks and basin management

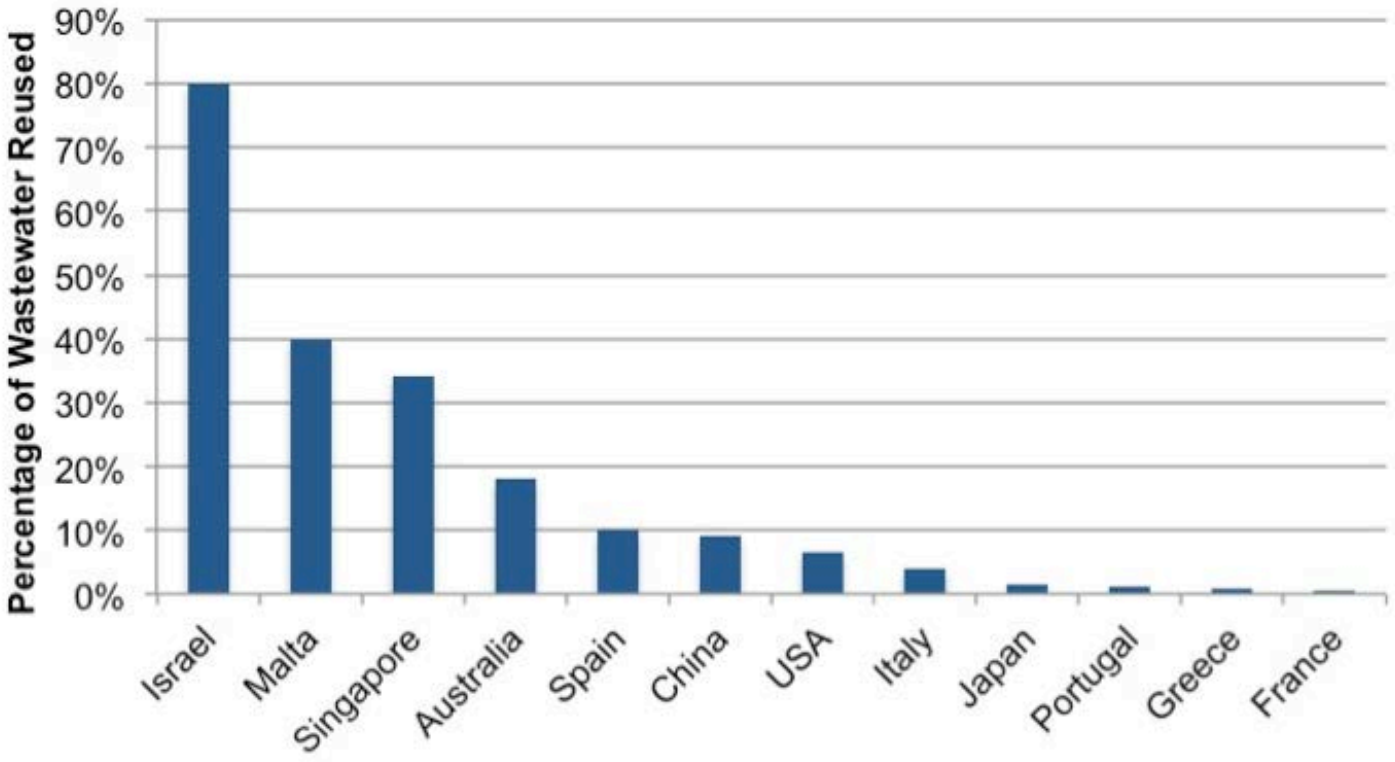


Murray-Darling basin

Conflict: path dependence v. innovation – California

- **OC Water District Groundwater Replenishment system – <u>indirect potable reuse</u> (100 MGD or 60% of region's needs), recharges aquifer/provides seawater barrier.**
  - **Not yet widely duplicated in either Los Angeles or San Diego – why? EJ issues revolving around trust, confidence, and environmental legacies.**
  - **Viewed by some as incentive for additional residential & commercial growth.**
- **Public needs to be given information on all available options; permitted to evaluate and compare them; continual outreach needed to address long-term consequences.**

Governance matters for overcoming path-dependence



Percentage of Wastewater Reuse in Select Countries*

- ***Reuse is greatest where there is:***
  - **National government encouragement through regulation & subsidy.**
  - **Wide latitude for local adoption.**
  - **Other options are found less feasible via open-ended life-cycle assessment.**

***Source: Adapted from BlueTech Insight Report – Municipal Wastewater Reuse http://www.watertapontario.com/asset-map/global-water-challenge/environmental-water-issues#sthash.cRZ81QBM.dpuf**

Boundary organizations are needed for climate networks

Cooperative Extension Services: land-grant universities in U.S.; provide large networks of people who interact with local stakeholders and decision makers within certain sectors (not limited to agriculture) on regular basis. Elsewhere, agricultural extension work is often done by local government (e.g., Queensland, Australia).

***Watershed Councils*: in some U.S. states, watershed councils and other local planning groups have developed, and many are focused on resolving environmental conflicts and improved land and water management (e.g., Oregon).**

Natural Resource Conservation Districts: within the U.S. Department of Agriculture, these districts are highly networked within agriculture, land management, and rural communities.

Non-governmental organizations (NGOs) and public interest groups: focus on information dissemination and environmental management within particular communities. They are good contacts for identifying potential stakeholders, and may be in a position to collaborate on projects. Internationally, many NGOs have stepped forward and are actively engaged in working with stakeholders to advance use of climate information in decision making (e.g., Asian Disaster Preparedness Center, in Bangkok, Thailand).

Federal agency and university research activities: expanding types of research conducted within management institutions and local and state governments is an option to be considered—the stakeholders can then have greater influence on ensuring that the research is relevant to their particular concerns. Regional Integrated Science Assessments are an example.

Low-impact development and political hurdles

- **Pollution & flooding caused by stormwater huge challenge.**
- **2011: *LA City Council's* Low Impact Development Ordinance:**
  - **Established by city in collaboration with neighborhoods, NGOs, business groups, building industry.**
  - **Redevelopment projects capture rainwater at its source; utilize rain barrels, permeable pavement, storage tanks, infiltration swales to contain water.**
  - **Other benefits: water conservation, groundwater recharge, green neighborhoods.**
  - **Maintenance by neighborhood a continuing challenge.**

Some contending water futures – Nigeria

***Watershed management "game" – farmers role-play solutions to local problems (e.g., how preserve* floodplains for farming, grazing, fishing) without large dams.**

Break-out discussions – comparing solutions and reaching accord – JWL Hadejia office, Dauchi, Nigeria.

Joint Wetlands Livelihood

Session 1 – brainstorm methods to maintain income & production with less water.
Session 2 – prioritize methods by voting – results become basis for by-laws to be followed by farmers.
Session 3 – discuss what additional information is needed to support agreements.
Session 4 – review, reflect, conduct evaluation and specify actions.

Flood resilience in Bangladesh – another future?

- **NGOs & villagers are introducing local-scale, low-tech adaptation measures in opposition to World Bank plans:**
  - **Raised & amphibious dwellings – more flood-proof.**
  - ***Re-introduce innovative farming*; e.g., floating gardens; salt-tolerant rice; convert paddies to shrimp ponds.**
- **Incorporating voices of those impacted by flooding may produce better innovations.**

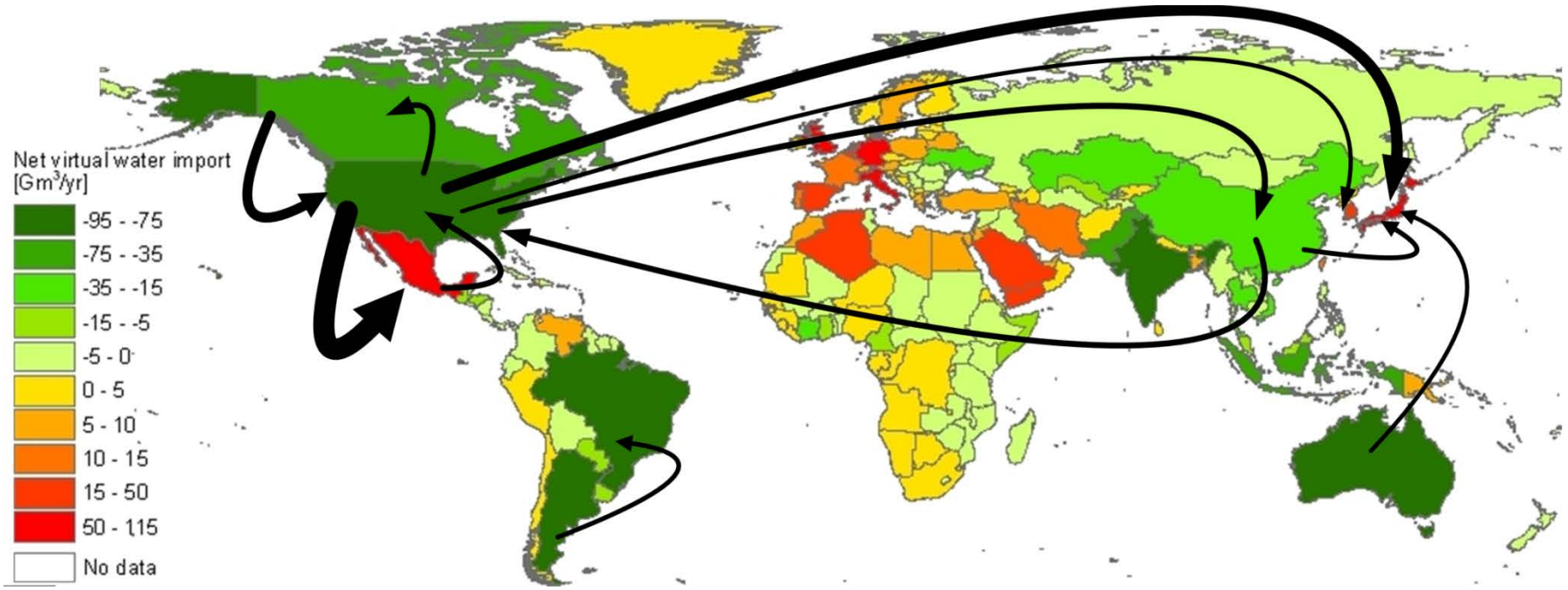
Contending futures – global-scale challenges

Global Water Security

INTELLIGENCE COMMUNITY ASSESSMENT
ICA 2012-08, 2 February 2012
This is an IC-coordinated paper.

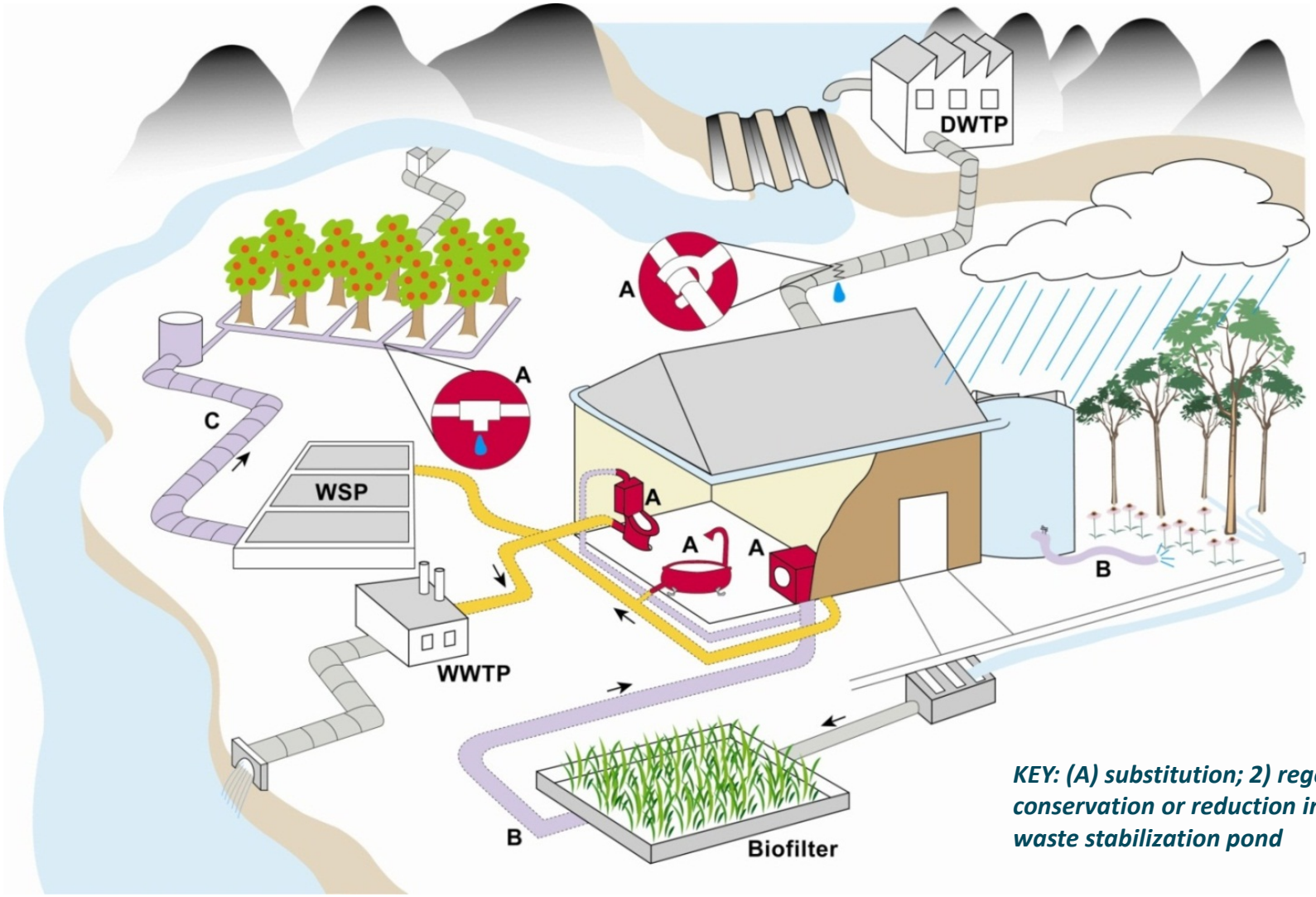
- **By 2040, flooding, drought, pollution will create instability and regional tension; hinder ability to grow food, produce energy.**
- **Conservation and re-use can help, but will not be sufficient.**
- **Massive aid transfers required.**

“Virtual” water flows may complicate paradigm shifts



- **Countries in green = negative balance, are virtual water exporters for food and industrial production.**
- **Countries in yellow to red = net virtual water importers.**
- **GOOD NEWS: may encourage efficient water use by ensuring water rich countries produce products water short countries need.**
- **BAD NEWS: water short countries are dependent on water rich ones; to end dependency, may build more large water projects.**

Long-term ideal – water sensitive development



KEY: (A) substitution; 2) regeneration; (c) conservation or reduction in use. WSP = waste stabilization pond

From: S.B. Grant, J.D. Saphores, D.L. Feldman, Taking the "waste" out of "wastewater" for human water security and ecosystem sustainability. *Science, 337*, (2012): 681-686.

Capture water before it's contaminated; use natural biofilters to remove contaminants; and treat water only to extent necessary for use.

Conclusion

- **Persistence of path-dependent views will continue – ensuring that climate change responses remain problematical.**

- **Will complicate political consensus and make more difficult the identification of long-term policy solutions.**

- ***To adopt the new paradigm, polities will have to:***

  - ***Acknowledge*** **that no group has a monopoly of knowledge about water; groups define legitimate needs differently.**

  - ***Emphasize*** **adaptive management: *solutions that are small-scale, incremental, reversible if they fail.***

  - ***Understand*** **that control over water must be tempered by *fairness and accountability*: if groups are excluded they'll resist.**

OLD PARADIGM: "The American West can best be described as a . . . social order based on the intensive, large-scale manipulation of water and its products in an arid setting. (It is) increasingly a coercive, monolithic, and hierarchical system, ruled by a power elite based on the ownership of capital and expertise." - Donald Worster (1985)

NEW PARADIGM: "The root of our predicament lies in the simple fact that, though we remain a flawed and unstable species, plagued now as in the past by a thousand weaknesses, we have insisted on both unlimited freedom and unlimited power. It would now seem clear that, if we want to stop the devastation of the earth, the growing threats to our food, water, air, and fellow creatures, we must find some way to limit both." - Donald Worster (1994)