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Design and Assessment of water-energy-food-environment Mega-Systems

Rethinking Dams: Build, Re-operationalise, Remove?

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www.futuredams.org
www.gdi.manchester.ac.uk
www.waterstrategy.org
www.nexus-strategy.org

GCRF Global Challenges Research Fund

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Introduction

- Dams – major human modification of natural environments in the early Anthropocene
- Theoretical potential to improve human well-being – water supply, electricity, irrigation…
- Great potential to damage human well-being and the environment – resettlement, national debt, ecosystem services loss, methane release…
- Winners and losers…conflicts at local, national and international levels.

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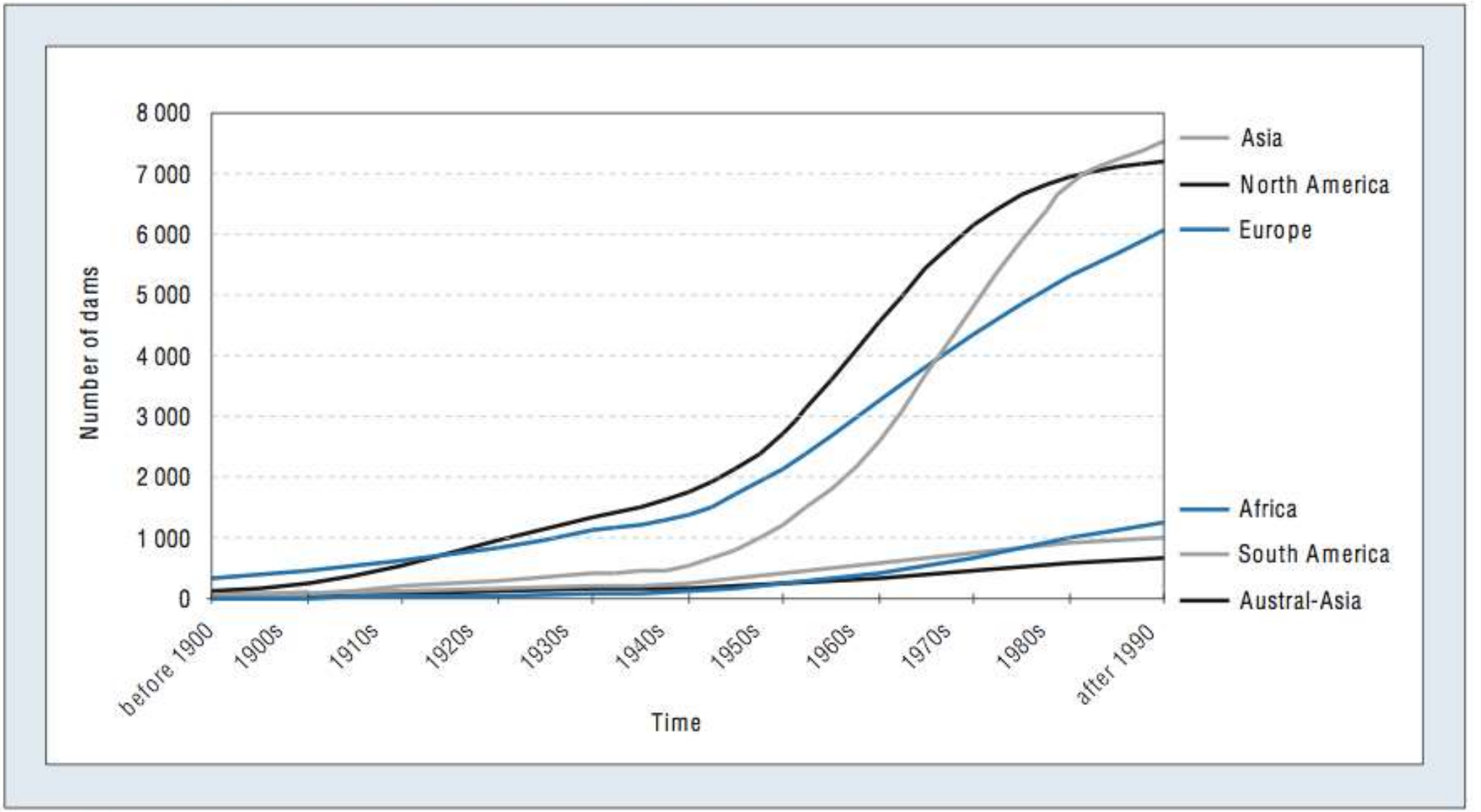
Figure 1.7: Dams constructed over time by region (1900-2000)



Source: ICOLD, 1998. Note: Information excludes the time-trend of dams in China.

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- Confession – Not an engineer or a dam expert
- Resettlement, social impacts of development projects …and help from colleagues, especially Bill Adams and Barnaby Dye
- **FutureDAMS** – crossdisciplinary team: systems engineers, hydrologists, climate scientists, economists, political scientists
- And I get fired up about dams – especially when rich Westerners celebrate stopping people in poorer countries from having dams- Nepal!

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FutureDAMS: Design and Assessment of resilient and sustainable interventions in water-energy-food-environment Mega-Systems

SUSTAINABLE DEVELOPMENT GOALS

- New dams have the potential to contribute to Sustainable Development Goals
- Poorly designed dams exacerbate social and political instability, environmental degradation, debt

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Future dams?

1. FutureDAMS questions
    - What's happening now?
    - What knowledge or techniques (models) would improve dams contribution to the SDGs?
    - How can these findings be taken to policy and practice?
2. Main options – dam decisions
    - New dams – build (better) dams, improve selection and planning
    - Focus on existing dams – re-operationalisation, sustainability
    - Remove existing dams (return rivers to 'natural flow')

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Eras of dam building

- Focus on large dams - 15m high and 3 million m3
- But small dams/canals are also important – informal irrigation
- Ancient civilizations – Mesopotamia, Egypt, India, Romans, Mexico, China - irrigation dams and canals
- Industrial revolution – water power and urban water
- Modern dam-building era – 20th Century. Europe, USA, Egypt… postWW2 colonial/independence dam boom
- 21st Century – what role in an age of climate crisis, energy insecurity and radical uncertainty?

Dams: good or bad idea?

- Preservation vs wise use debates in USA in early 1900s
- President Theodore Roosevelt and John Muir met in Yosemite National Park
- But a dam was built and massive dam building in USA in 20th century
- Alongside rise of US environmentalism…"anti-dams"

Dams: good or bad idea?

- Successful anti-dam campaign on the Colorado River in 1940s&1950s- Sierra Club, Wilderness Society & Readers Digest
- An international anti-dam movement develops, especially in USA
- Dam removals begin

Image: Airphonona.com

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Recent history

- Post WW2 dam boom created a strong anti-dam backlash in the 1980s and 1990s
- Especially in USA and in developing countries (the UN's G77) with foreign aid/World Bank financed dams
- Major questions over economic effectiveness
- Protests build up – indigenous people, host communities, economists, environmentalists(especially in Washington DC)
- The World Bank's Social and Environmental Assessment of Dams project discourages dam proposals – "**safeguards"**
- But governments and leaders in China, India, Turkey, Brazil and other G77 countries want to build dams
- What to do..?

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World Commission on Dams

- In 1997 International Union for Conservation of Nature and Natural Resources (IUCN) and World Bank high level workshop in Switzerland
- It recommends an international commission, World Commission on Dams (WCD)
- 12 commissioners and a technical secretariat based in Cape Town
- Very carefully 'balanced'

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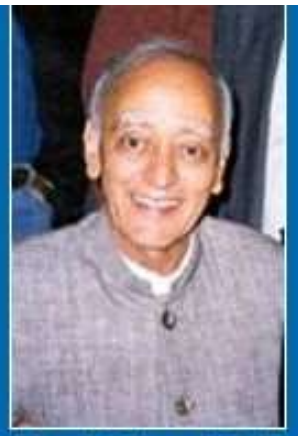
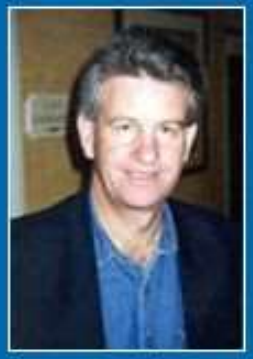
Who were the Commissioners ?

Kader Asmal
Government
South Africa



Lakshmi Chand Jain
Independent
India



Donald Blackmore
River Basin Agency
Australia

Joji Cariño
Indigenous Rights Activist
Philippines

Deborah Moore
Environmental NGO
USA

José Goldemberg
Academic/Government
Brazil

Judy Henderson
Development NGO
Australia

Jan Veltrop
Dam Engineers
USA/Netherlands

Thayer Scudder
Academia
USA

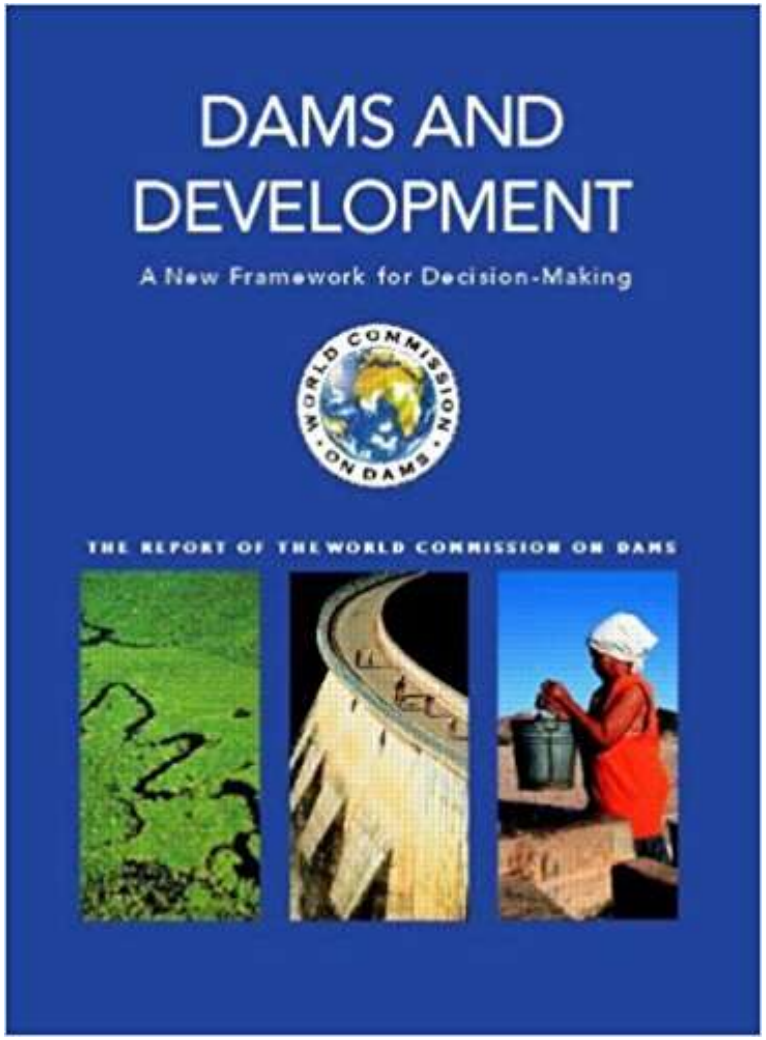
Medha Patkar
Affected People
India

Göran Lindahl
Corporate Sector
Sweden

Achim Steiner
Secretary-General
Germany

World commission on dams

- Final report *Dams and Development* launched by Nelson Mandela November 2000.
- 7 Strategic Priorities for dam construction
- 5 key criteria



The WCD's seven strategic priorities

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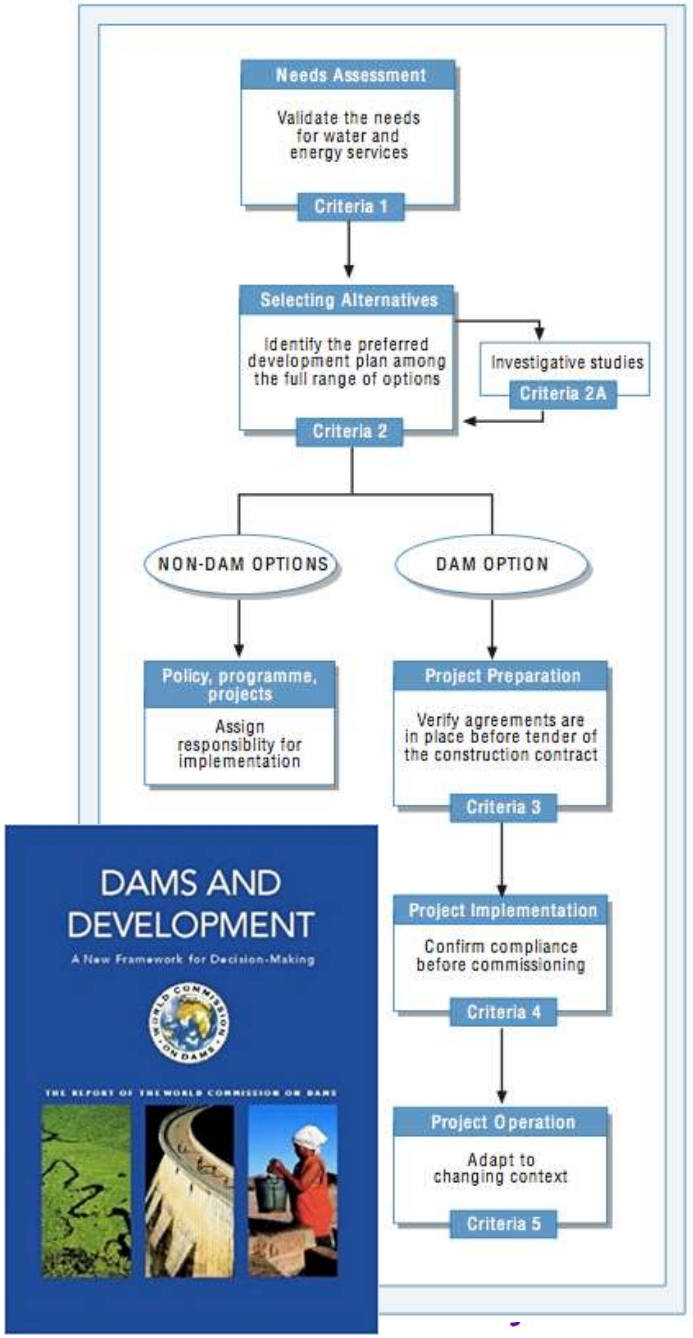
WCD's five key criteria

1. **Needs assessment**: validate needs for water and energy services
2. **Select alternatives**: full range of options – including "no dam"
3. **Project preparation**: all plans and agreements in place
4. **Project implementation**: full compliance
5. **Project operation**: adapt to changing context – continued participatory processes



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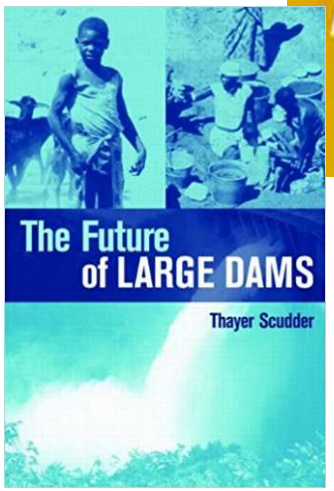
But the WCD did not fix the problem

- Report rejected by G77 governments
  - ‘all unanimously agreed that the WCD Report was biased and could not be accepted’ (Asik K. Biswas)
  - Brazil, China, Ethiopia, India, Lao PDR, Nepal, Pakistan, Philippines, Sri Lanka, Turkey, Vietnam
- Too negative about dams and ‘anti-growth’
- Too impractical: ‘multi-stage negotiated process too slow’
- Where are we now?
- Boom, protest, removal…conflicts



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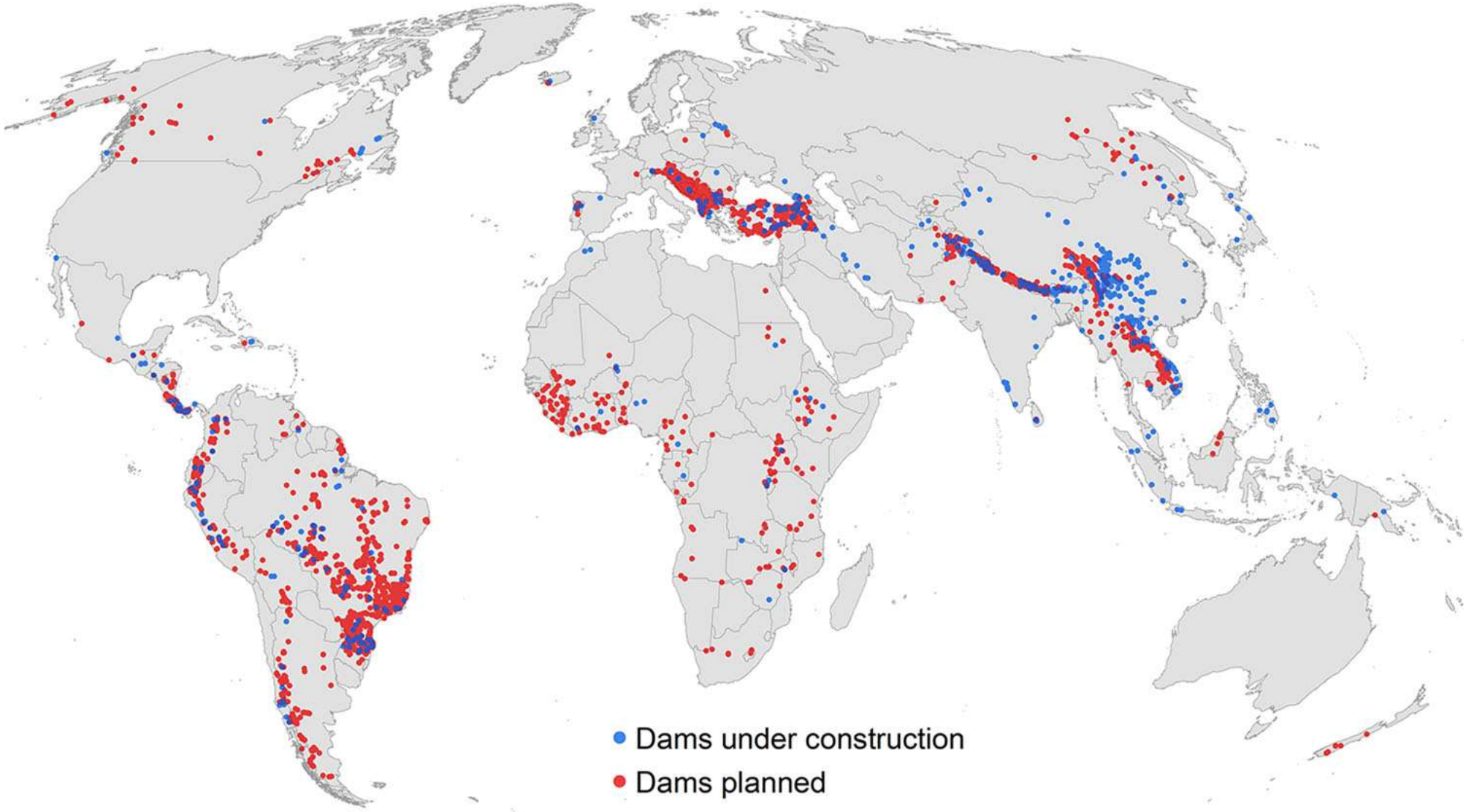
Now a global boom in dam construction-hydropower



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Boom in global protests

Save the Mekong
Our River Feeds Millions

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Knock down dams

- Dam removal has accelerated in the USA

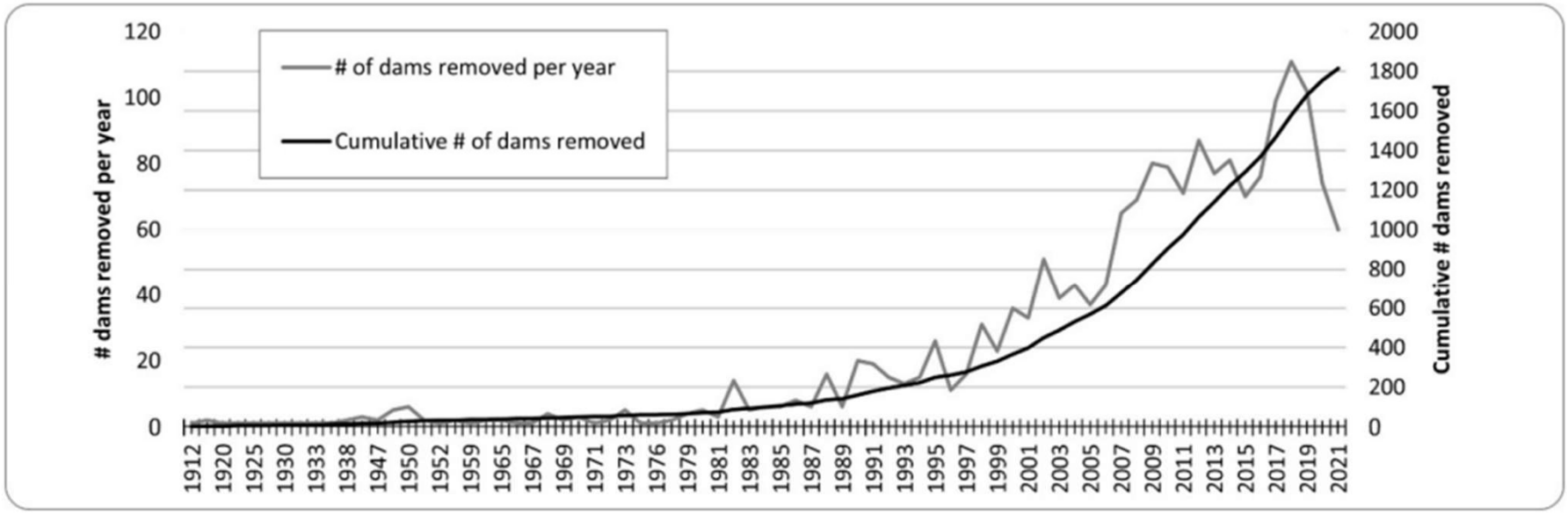

Figure 1. Cumulative number of dams removed versus the number of dams removed per year

Source: Free Rivers: The State of Dam Removal in the US. American Rivers. Feb 2022.

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Dam conflicts

- Conflict at multiple levels…often interlocking
- International
- National
- Local – displaced and host communities
- Economic – value of natural infrastructure
- Climate change – sustainability or emissions?

International conflicts

- Almost everywhere ‘dam’ tension/conflicts
- But no attributable wars-one of multiple factors
- Brahmaputra: Bangladesh and India. Teesta
- FutureDAMS examples
  - Nile: Ethiopia and Egypt. ‘GERD’ dam
  - Volta: Ghana and Burkina Faso. Bagre dam
  - Salween: Myanmar, ethnic ‘militias’…and China?

GERD – Ethiopia vs Egypt?

- Grand Ethiopian Renaissance Dam – GERD
- Historically Egypt controlled most Nile waters
- Ethiopia was catchment…but few rights to water
- All changed with GERD construction
- A sequenced cascade of 4 dams recommended
- President Zenawi went for one vast dam, 145-m tall
- Plan for 6 *GW* hydropower now downgraded to 2GW. Less water than was 'projected'

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GERD – Ethiopia vs Egypt?

- Ethiopia 'takes its share' of Nile waters
- Enormous tensions – threat of bombing, no bombs!
- No agreement yet on filling the dam
- Technical disputes about the consequences
- Heggy et al (2021): Egypt faces USD51 billion GDP loss, 4.74 million extra unemployed
- Wheeler et al (2022): Egypt faces '…minimal risk of additional water shortages during filling' (except in a severe drought year)

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Nile – Collaborative management

- FutureDAMS research
- Cooperative approach: an agreement Ethiopia, Sudan and Egypt could all benefit from GERD
- Ethiopia – hydropower
- Sudan – flood control and predictable irrigation
- Egypt – predictable irrigation and more water in drought years

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Our findings

ARTICLE

https://doi.org/10.1038/s41467-021-25877-w OPEN

Check for updates

Collaborative management of the Grand Ethiopian Renaissance Dam increases economic benefits and resilience

Mohammed Basheer[1], Victor Nechifor[2], Alvaro Calzadilla[2], Khalid Siddig[3,4], Mikiyas Etichia[1], Dale Whittington[5,6], David Hulme[5] & Julien J. Harou[1,7]✉

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Dams and national development

- Case for dam construction is usually based on national development
- Economic growth, jobs, “modernization”
- Promise of vast benefits-hydroelectricity, irrigation, flood control, urban water
- Argued costs are much smaller than benefits
- …proximate benefits and also multipliers

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The benefits of dams

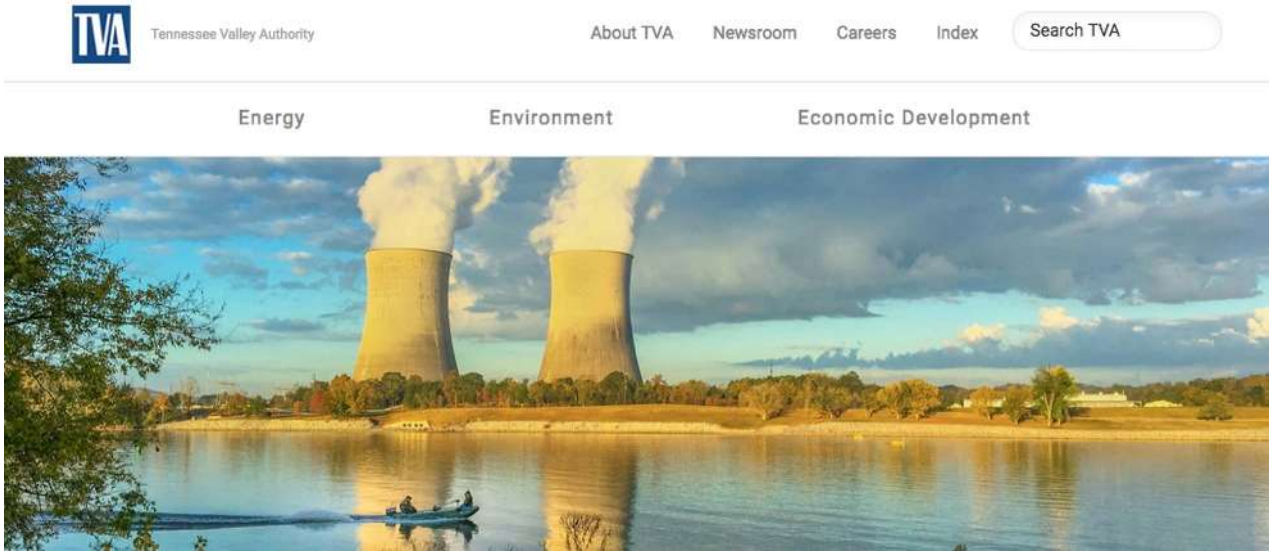
- Power generation
- Power storage-especially in the context of renewables
- Water supply
- Irrigation
- Flood control
- Pollution control
- Navigation, recreation, others
- ***Growth…jobs…modernisation***

The costs of dams

- Finance – construction: big loans, big debts?
- Finance - loss of national control of resources?
- Finance – compensation for negative impacts
- Economic impacts – loss of pre-existing natural infrastructure (agriculture, fishing, forestry, minerals)
- River delta erosion
- Displaced and host community…poverty, culture & identity
- Social impacts – resettlement, well-being, health…protests
- Environmental – upstream, downstream and lake ecology; biodiversity loss; methane emissions; concrete

US national development and river basin planning

- **Tennessee Valley Authority (TVA)**
  - 1930s Depression: Federal corporation created in 1933
  - '…to improve the navigability and to provide for the flood control of the Tennessee River; to provide for reforestation and the proper use of marginal lands in the Tennessee Valley; to provide for the agricultural and industrial development of said valley; to provide for the national defense …and for other purposes'.



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The TVA Model-Government led

- ***Land management***
  - Soil erosion control, reforestation, changed farming techniques
- ***River engineering***
  - Channelling the Tennessee River, dam construction
- ***Power generation***
  - Hydropower dams
- **Social Engineering**

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The export of the 'TVA Model'

- Mekong Committee 1957 to Mekong River Commission 1995 for Cambodia, Laos, Thailand, Vietnam (many dams)
- Volta River Authority, Ghana (Akosombo)
- Niger River Commission/Niger Basin Authority, 9 countries
- Zambezi River Authority, Zambia and Zimbabwe (Kariba)
- Rufiji Basin Development Agency, Tanzania
- ***Concrete Revolution*** (Christopher Sneddon)
- ***US Bureau of Reclamation*** – promoted TVA model in at least 36 countries
- ***National development…and Cold War Geopolitics***

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Good Dams?

- Akosombo in Ghana…?
- Initially very problematic, “modernization” without industry…very low demand
- Kaiser Aluminium – cheap electricity, tax-free production
- 80,000 displaced…still protesting. Livelihoods, poverty and health (malaria, bilharzia, others)
- Subsequently Ghana has prospered - Contribution of the dam to the economy and national electrification?

Bad….Dam problems! Bakolori Dam (Nigeria)

- Construction costs under-estimated
- Yields from irrigated land over-estimated
- Economic returns negative (tomato canning factory not built)
- Major negative downstream impacts
- Loss of riverside agricultural crops not recognised
- Public health problems – malaria, river blindness, bilharzia
- National debt, poverty, socio-political conflicts

Bad Dams

- Examples from FutureDAMS political analysis
- Pwalugu Dam, Ghana – very expensive irrigation and hydropower, delayed compensation and benefit sharing now happening (after project design)
- GERD, Ethiopia – centralised decision making key to overcoming international and domestic opposition, but bypassed technical expertise and oversizing dams whilst causing major socio-economic negative impacts
- Rwanda's electricity boom – Now having to buy electricity it cannot use at high price (Dye)

The ‘community’ – Local problems?

- Always very heated
- Displaced and hosts see themselves as ‘losers’
- Losing livelihoods, social services, culture, identity
- Unfortunately most research confirms…Kariba, Akosombo, Narmada
- China as the exception??

Image: thehigherlearning.com (photo Erin Conway-Smith)

Mitigating negative impacts?

- “Learning from experience” – politicians, planners, banks
- ‘NOT learning from experience’ – researcher findings
- Livelihoods – usually planned by outsiders
- Focussed on generic agriculture and business plans (‘firms’)
- Neglect locally-relevant opportunities (off-farm) and families… and women!
- IIED - from compensation to benefit-sharing
- Social services – some evidence of improved planning
- Beyond valuation – culture, identity, cemeteries, sacred groves
- Protest and resentment – for generations

Dams and Sustainability

- Great contention about dams and sustainability
- Dams are green…dams are not green
- Different banks/financiers with different criteria – the ‘ESG’ problem
- Why the confusion?
- Hydropower dams use a renewable resource (water) but construction requires vast amounts of concrete (CO2)
- Dam reservoirs emit methane - GHG ‘villain’
- Dams as the ‘white knight’ – Pumped storage hydropower
- Dam-created biodiversity losses (and gains) are rarely recorded…so far in the future

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Methane

- **Global reservoir Methane emissions are significant**

  - Perhaps as much as from global rice production or global biomass emissions

- **GHG fluxes from reservoirs in future IPCC budgets** and other inventories of anthropogenic emissions
- **Difficult to measure** – low intensity but vast area

Environmental sustainability Guardian development network

Hydroelectric dams emit a billion tonnes of greenhouse gases a year, study finds

Impact of dams on climate change has been underestimated, researchers warn, as rotting vegetation creates 25% more methane than previously thought

BioScience 66: 949–964.2016

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Pumped storage hydropower

- Potentially a major role for dams in grid stability
- When renewables are surplus use the excess electricity to pump water up to reservoirs
- When wind and sun 'fail' use the stored water for hydropower
- Australia – aiming for coal-free by 2040 – Snowy 2.0, Tasmania as 'Battery of the Nation'…pumped hydropower the key
- Great potential: for sustainability…or for green-washing dams?
- Will have fundamental, and currently unknown, downstream impacts. Sudden off/on of water releases
  - Requires strong policing of downstream rivers to avoid loss of life
  - Likely increases erosion
  - Undermines ecosystems and natural infrastructure (e.g. fertile sediment transport, dry/wet seasonal dynamics)

Technical Conflicts

- Professional analysts' disciplines - different assessments
- Modelers & growth economists – positive benefits:costs
- Anthropologists & political economists - negative benefits:costs
- Problem for modelers – 'All models are wrong, but some models are useful'. Complexity of WEFE systems and accuracy of data
- Many impacts are remote from the dam
- Many impacts are delayed and vary with mitigation actions
- Dam impacts interact
  - Complex and emergent outcomes(multi-purpose, generation or storage)
- Model assumptions – normative/best practice or historical ?

Political Conflicts

- Who has power? Elites or marginal groups, core or periphery
- Value-driven –public benefit or self-interest and corruption
- Competing coalitions - Political leaders, interest groups (business, identity, environmental NGOs etc), external influences
- Technical contestation about costs and benefits permits multiple narratives…'growth and jobs' vs 'debt and destruction'
- No dam…host communities, local and intn'l NGOs, anthropologists
- Yes dam…political leaders, intn'l corporations, engineers, bankers
- Often 'no dam' until powerful political actors, financiers and engineering corporations coalesce for 'build dam' decision
- Democratic (eg Ghana) and authoritarian (eg Ethiopia) contexts

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FutureDAMS Technical Outputs

WATER STRATEGY

WATERSTRATEGY.org

NEXUS STRATEGY

NEXUS-STRATEGY.org

FutureDAMS Economic Studies

- Economics of irrigation in Africa…no Green Revolution!
- Performance of large-scale irrigation projects in sub-Saharan Africa (Higginbottom et al, 2021)
- Beware bad data – even Nobel Prize winners!
- "What should we say of Dams who mainly 'metrics' mastered? The impact of 'Dams'" (Palmer-Jones, 2022)
- The continuing evolution of ex ante economic assessment of infrastructure
- "The ex-ante economic analysis of investments in large dams: a brief history" (Whittington and Smith, 2020)

FutureDAMS: Political Analysis Outputs

- Framework for political economic analysis of dam decisions
- Detailed studies of the politics of dam decisions in Ghana
- Detailed studies of the politics of dam decisions in Ethiopia
- Stakeholder Engagement Guide

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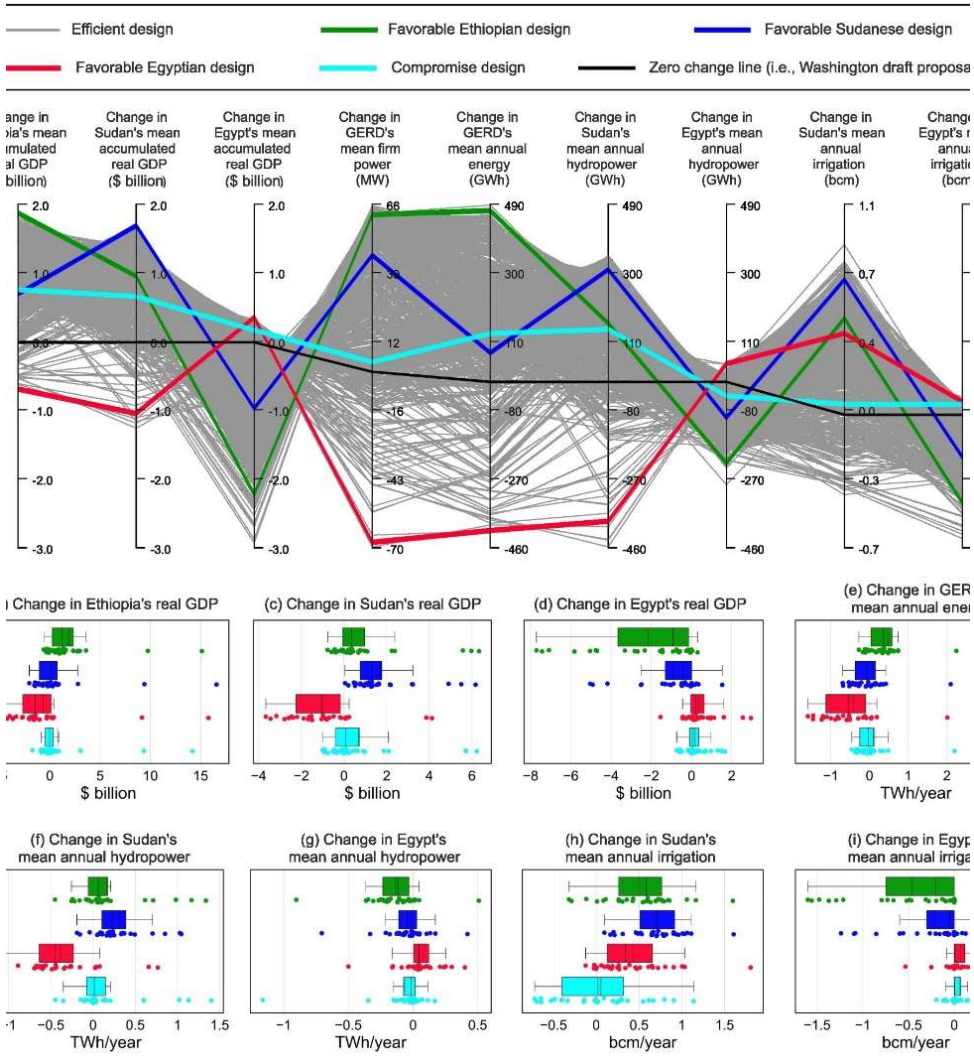
Overarching Conclusion 1

- From B/C to dashboard - Integrated, multi-criteria, iterative modelling to better inform dam decision-making
- But must be understood in a political context.
- Modelling can make SOME trade-offs much better understood. But they remain political judgements about what negatives and positives are worthwhile



Overarching Conclusion 2

- We therefore recommend a stakeholder driven, democratic approach informed by highest-quality technical analysis
- But an ideal? Our political economic analysis indicates that in the contemporary global political environment – populism, identity politics, big ‘men’, contested accountability and corruption, blended finance (multiple international and domestic sources and arrangements) the space for modelling and democratic decision-making to influence dam decisions is limited
- As Nelson Mandela warned many years ago

‘***…it is one thing to find fault with an existing system. It is another thing altogether, a more difficult task, to replace it with an approach that is better***’.

(Nelson Mandela, at the launch of *Dams and Development* in London,

16 November 2000)

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