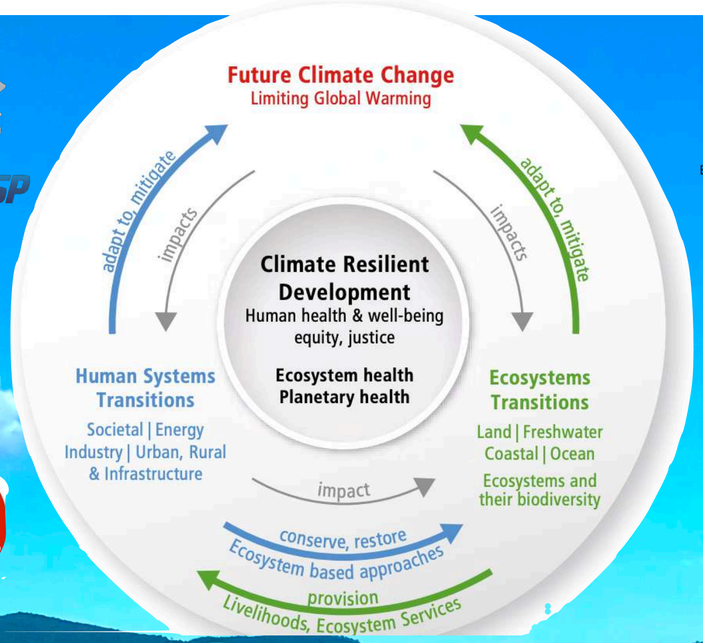
Missão de Pesquisa FAPESP, Fortaleza-CE, 3 de fevereiro de 2023

Conferência · Workshop · Visita Experimental

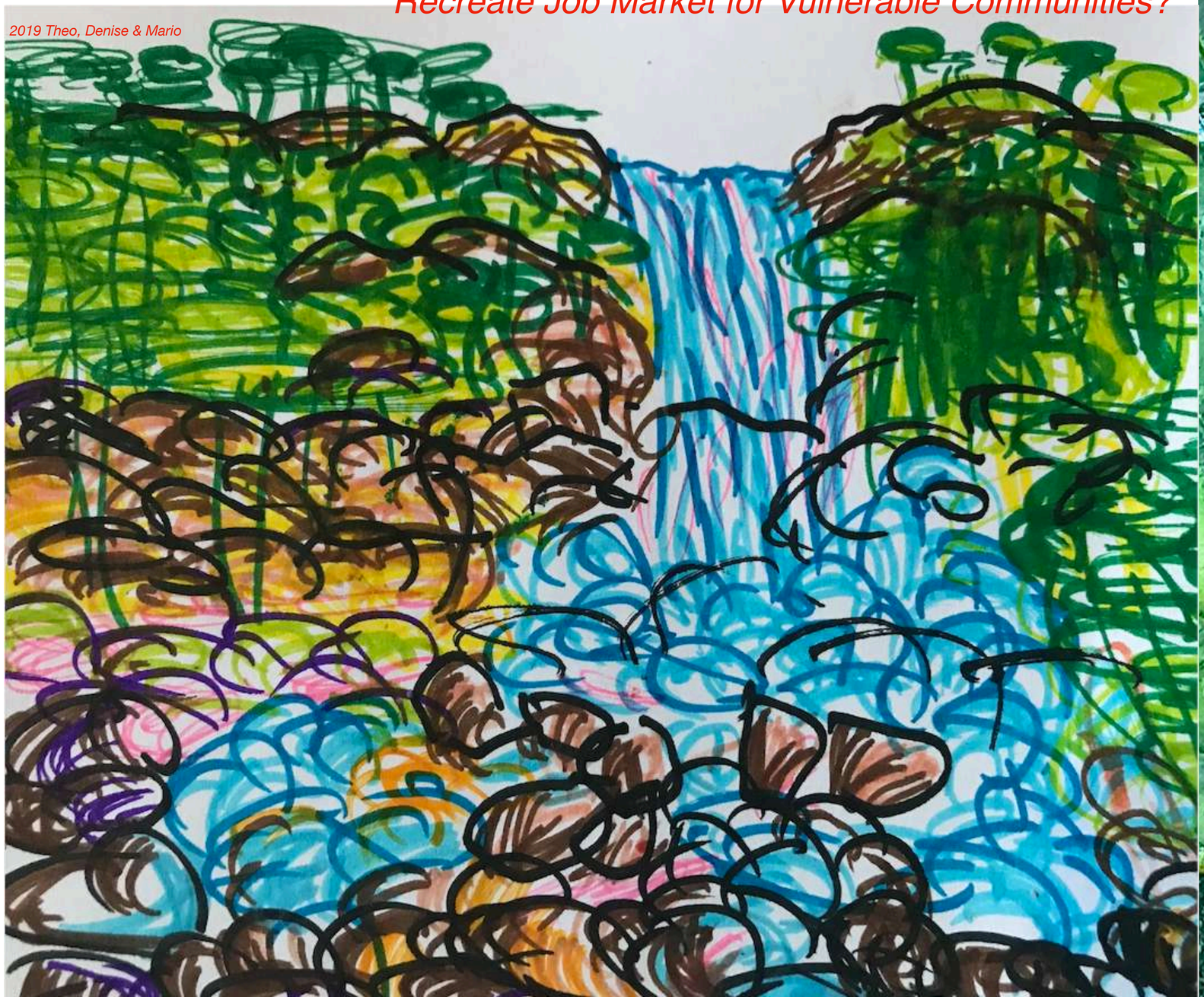


Prof Dr Eduardo Mario Mendiondo
Depto Hidráulica e Saneamento
Escola de Engenharia de São Carlos, USP
emm@sc.usp.br

Photo: Atibainha Reservoir, Cantareira System, Sao Paulo / 2021 E.M.M.

Apoios: FAPESP # 2022/07521-5 "Mudanças globais e adaptações sustentáveis com viabilidade hídrica e energética e solvência econômica"
FAPESP # 2022/08468-0 "Características de secas rápidas e mecanismos de respostas à mudança climática considerando correlação espacial"

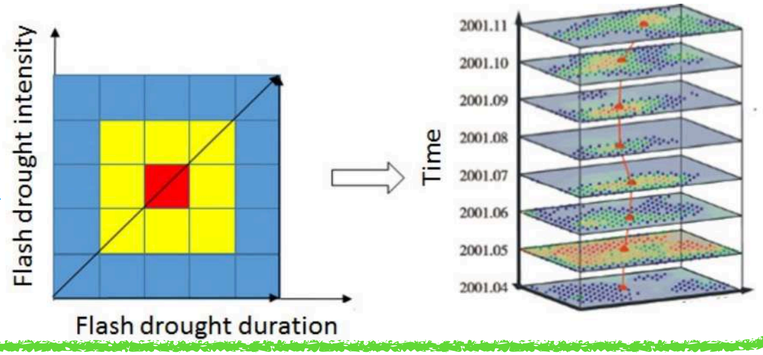
How Can Applied Solutions on Water Security from Climate Services Help Reimagine Habitats, Restore Landscapes, Revive Risk Management and Recreate Job Market for Vulnerable Communities?

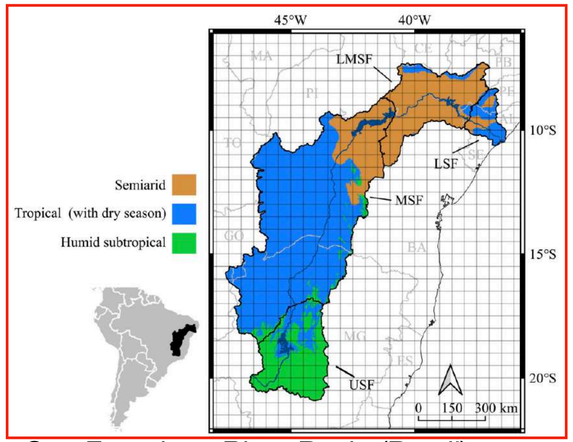


Motivation

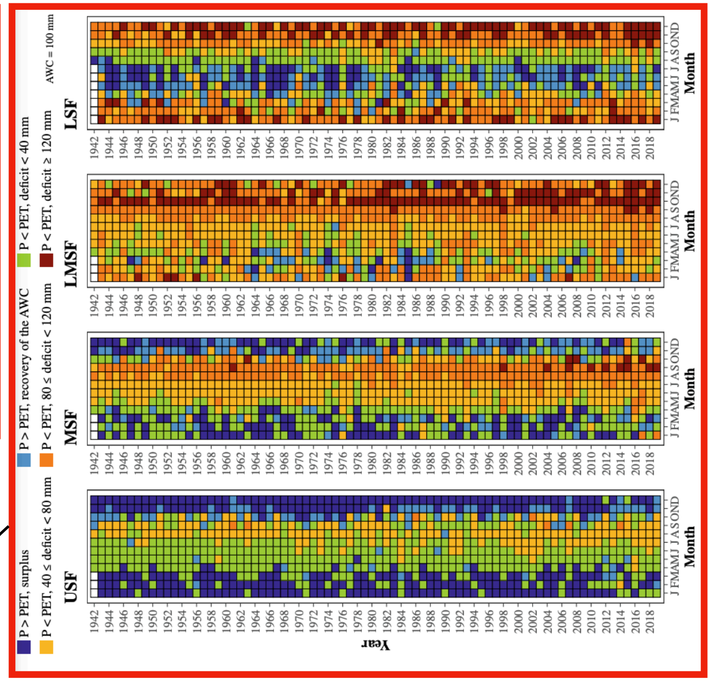
Mendiondo (2023) Missão de Pesquisa FAPESP, Fortaleza-CE, 6/2/2023

NFSC(China)-FAPESP (#2022/08468-0)
Flash drought event evolution characteristics and the response mechanism to climate change considering the spatial correlation in the Yangtze & Sao Francisco river basins

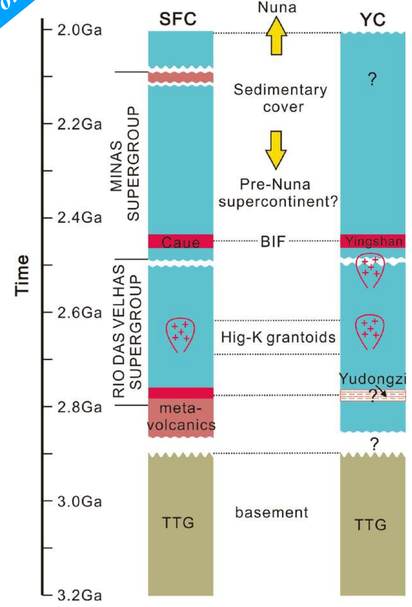




Sao Francisco River Basin (Brazil)

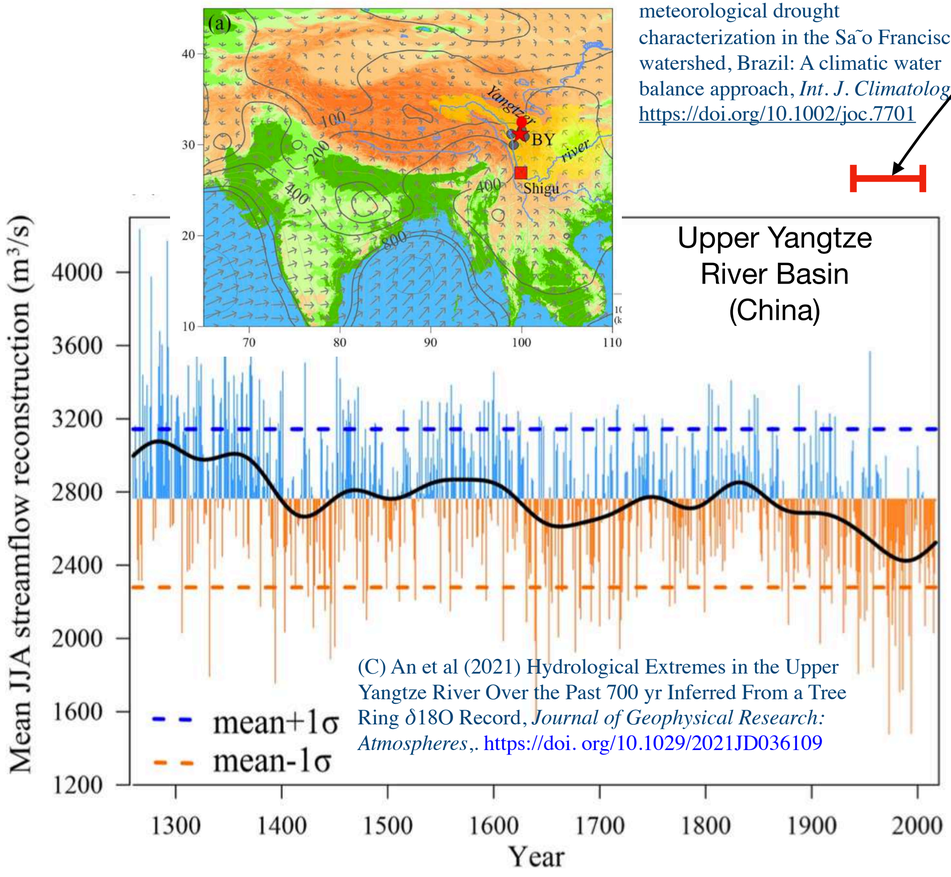


(C) Mutti et al (2022) Long-term meteorological drought characterization in the Sa˜o Francisco watershed, Brazil: A climatic water balance approach, *Int. J. Climatology*, https://doi.org/10.1002/joc.7701

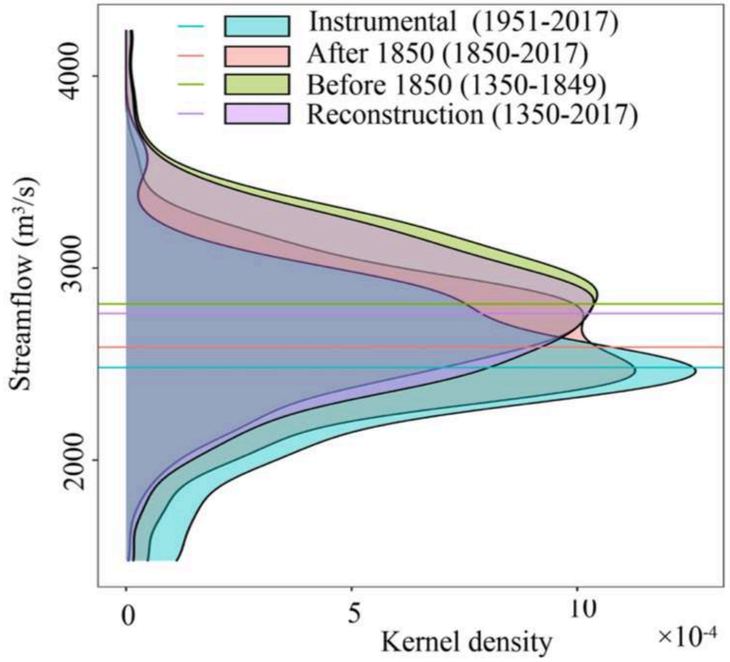


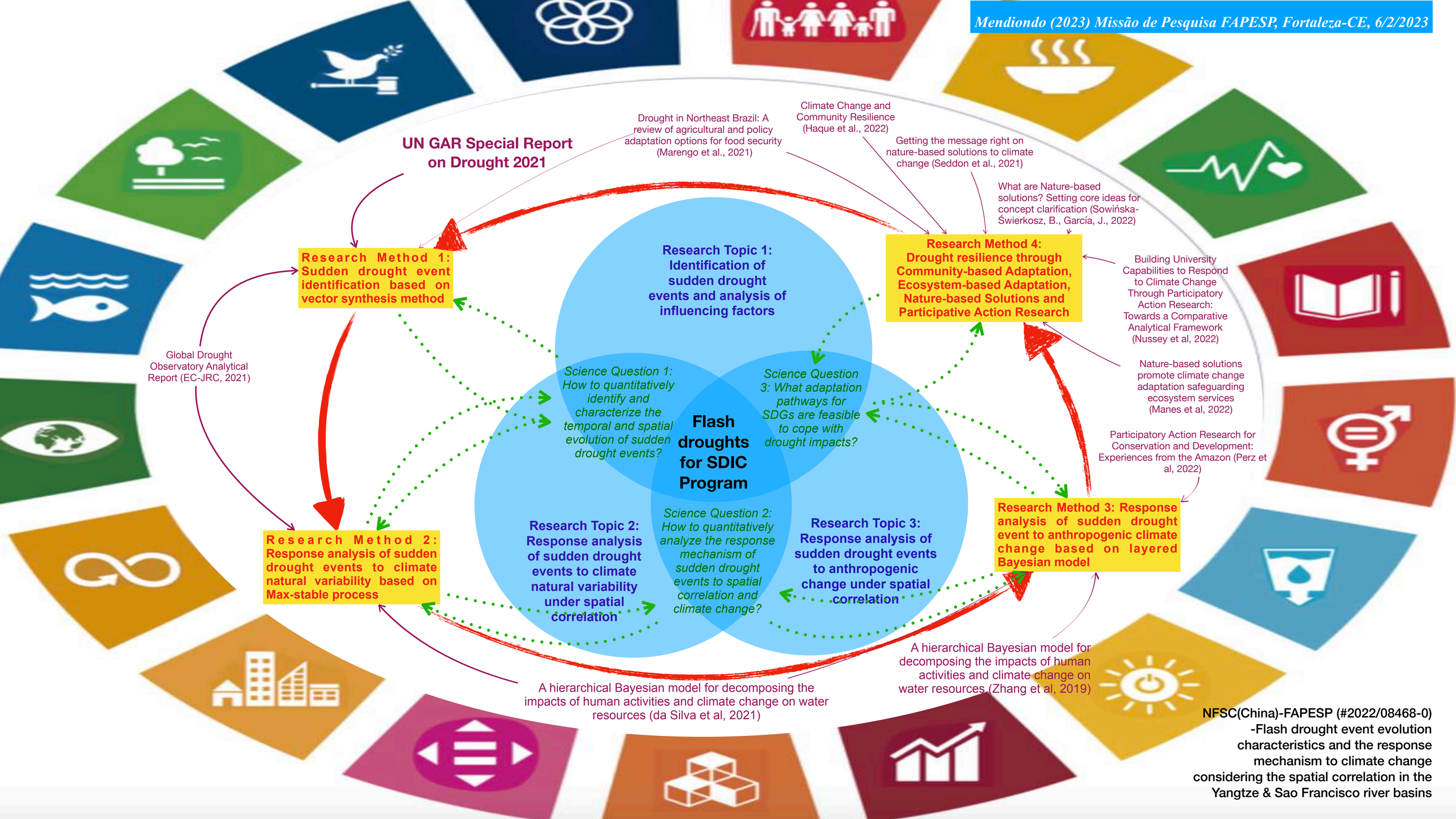
Comparison of stratigraphic-tectonic histories between the Southern Sao Francisco Craton (SF) and the Yangtze Craton (YC)

(C) Ye, H., Wu, CZ., Yang, T. *et al.* Updating the Geologic Barcodes for South China: Discovery of Late Archean Banded Iron Formations in the Yangtze Craton. *Sci Rep* **7**, 15082 (2017). https://doi.org/10.1038/s41598-017-15013-4



(C) An et al (2021) Hydrological Extremes in the Upper Yangtze River Over the Past 700 yr Inferred From a Tree Ring δ18O Record, *Journal of Geophysical Research: Atmospheres*,. https://doi. org/10.1029/2021JD036109





NFSC(China)-FAPESP (#2022/08468-0) -Flash drought event evolution characteristics and the response mechanism to climate change considering the spatial correlation in the Yangtze & Sao Francisco river basins

Tópicos

- “Contextos”:
  - IPCC/AR6
  - UNESCO-IHP IX
  - IAHS PUB, Panta Rhei, …
- “Transformadores”:
  - INCT-Mudança Climática
  - INCT-Combate à Fome
  - INCT-Observatório Segurança Hídrica e Gestão Adaptativa
- “Aceleradores":
  - Belmont Forum Mgmt Disaster Risk & Societal Resilience
  - Centro de Matemática Aplicada à Indústria
  - Centro de Inteligência Artificial
- “Atores”
  - Centro de Estudos e Pesquisas em Desastres
  - Mudanças Climáticas
  - Cátedra UNESCO / Water Family
  - @TheWadiLab

CEPED-SP / USP

Centro de Estudos e Pesquisas sobre Desastres no Estado de São Paulo

Popularização Científica - Academia - Comunidade

www.ceped.eesc.usp.br

COVID-19

Popularização Científica para Professores de Escola da Rede Pública

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PROSFE – Panta Rhei Open Science for a Future Earth – Envisioning a Post Pandemic Resilient Society

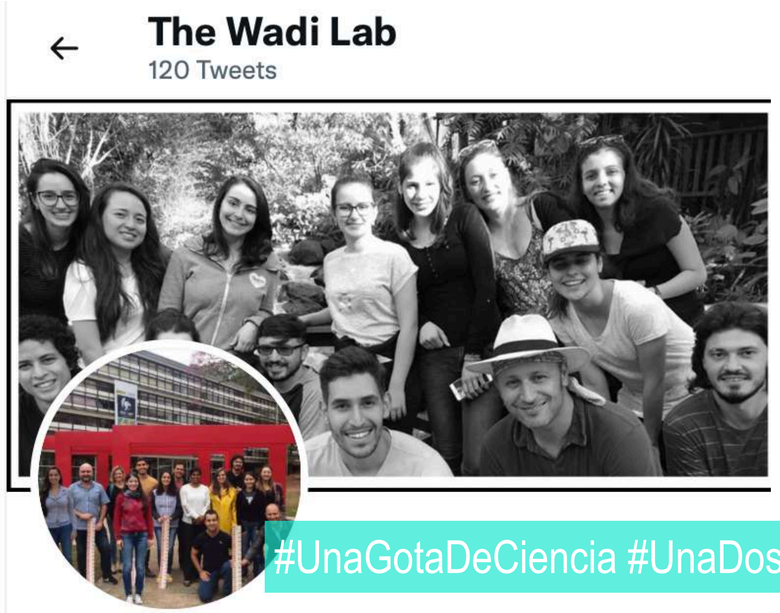
#UmaGotaDeCiencia

#UmaDoseDeResiliencia

Jan. 2020 | Jul. 2020 | Dez. 2020 | Jul. 2021 | Dez. 2021 | Jul. 2022

Ciencia Abierta y Ciudana

Eje Planeta



LIBRO GRATUITO: http://www.usp.br/ceped/sites/default/files/LIVROriscosdesastres.pdf

Panta Rhei IAHS AISH Everything Flows Change in Hydrology and Society

EESC • USP

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The wadi lab water-adaptive design & innovation

United Nations Educational, Scientific and Cultural Organization

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University of São Paulo, Brazil

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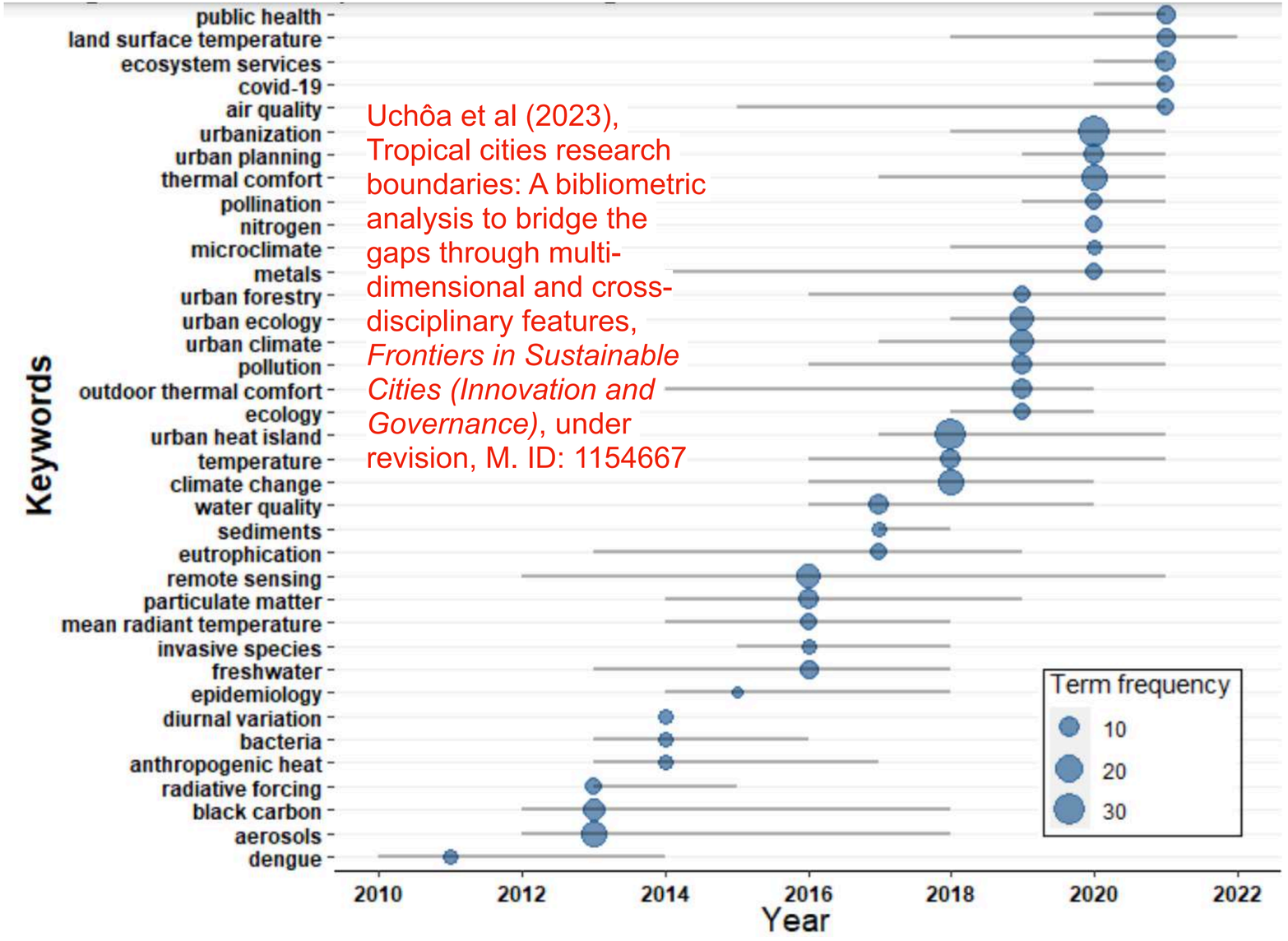
Intergovernmental Hydrological Programme

"ReWASH"



Uchôa et al (2023), Tropical cities research boundaries: A bibliometric analysis to bridge the gaps through multi-dimensional and cross-disciplinary features, *Frontiers in Sustainable Cities (Innovation and Governance)*, under revision, M. ID: 1154667

Recycling Water Assets for Sustainable Habitats

Cátedra UNESCO de Aguas Urbanas - Calidad, Gestión, Recuperación y Reutilización
Universidade de São Paulo, Escola de Engenharia de São Carlos

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Notes and Comments

Urban waters

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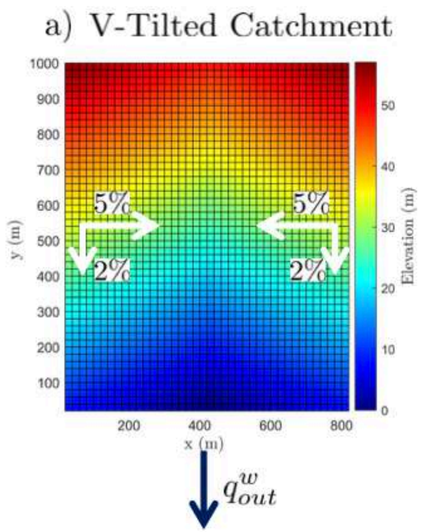
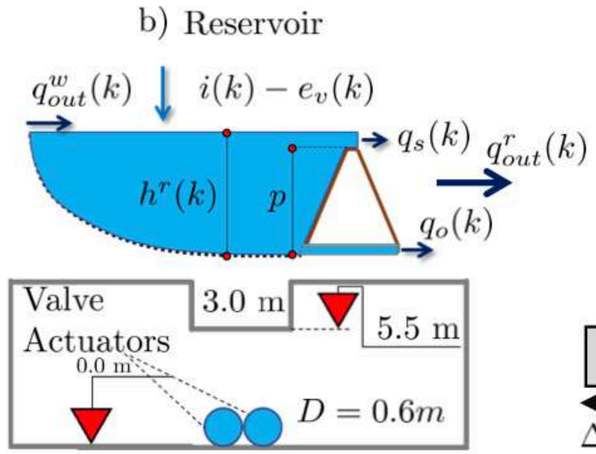
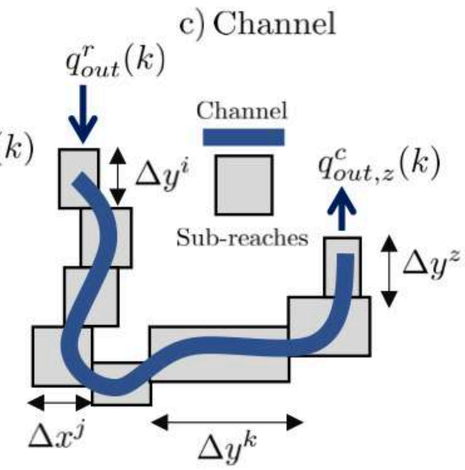
Received: July 5, 2021 – Accepted: July 22, 2021

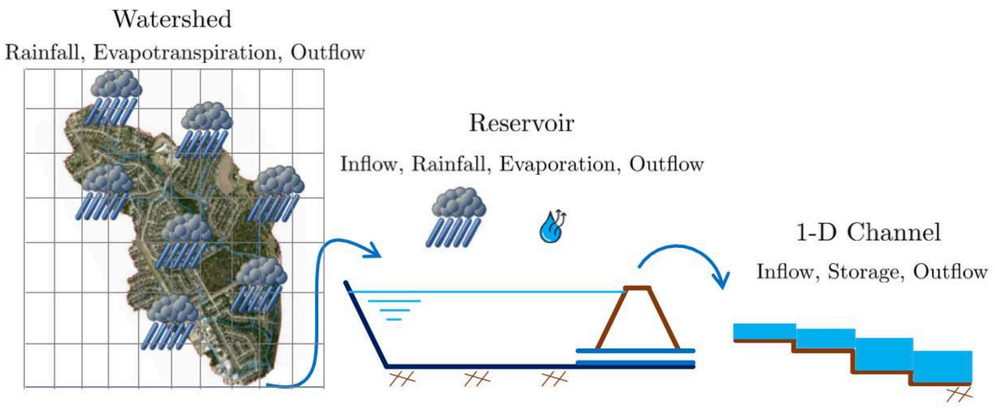
Mendiondo (2023) Missão de Pesquisa FAPESP, Fortaleza-CE, 6/2/2023

Case Study on water security: stormwater system optimization

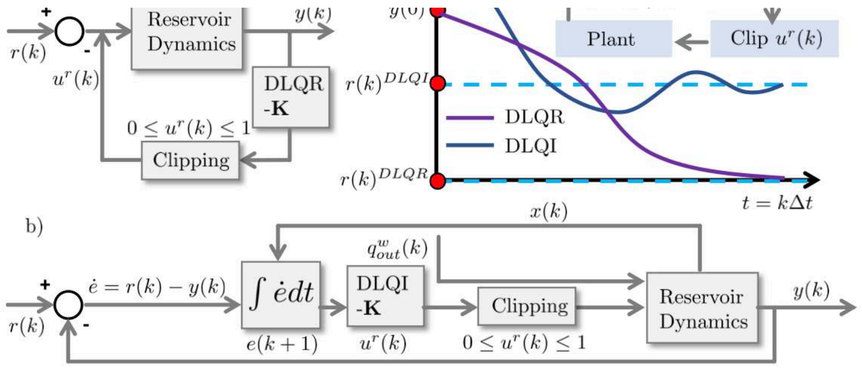








Community of Practice of NbS related to:
Real-time control,
Smart urban drainage systems,
Control theory,
Model predictive control,
Linear quadratic regulator,
Ruled-based control.



https://doi.org/10.1061/(ASCE)WR.1943-5452.0001588

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How can 1m2 of Amazon rainforest + 1m2 of Atlantic Forest help diluting Grey Water Footprint of Urban Waters in South American Megacities?

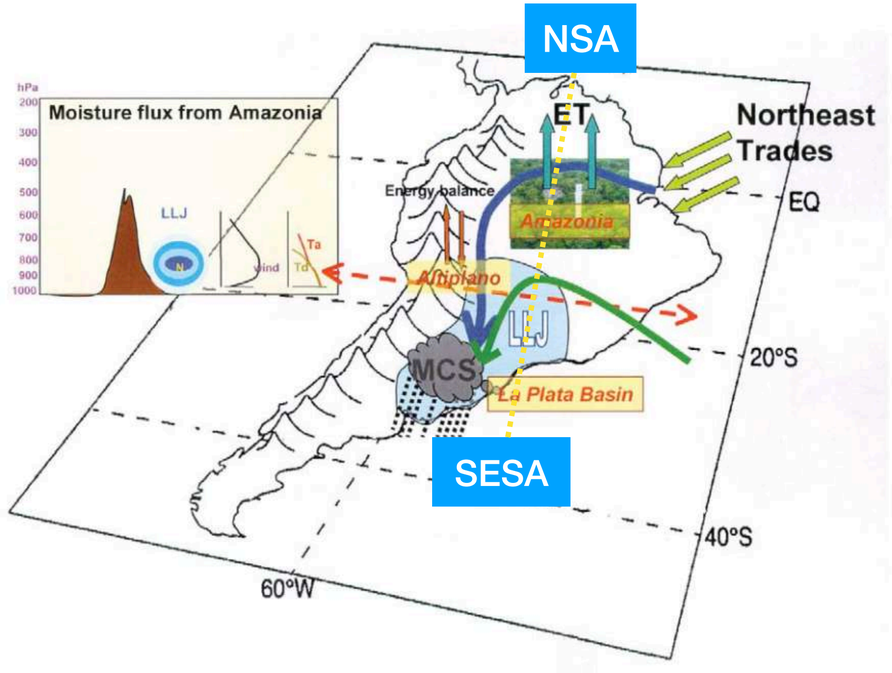
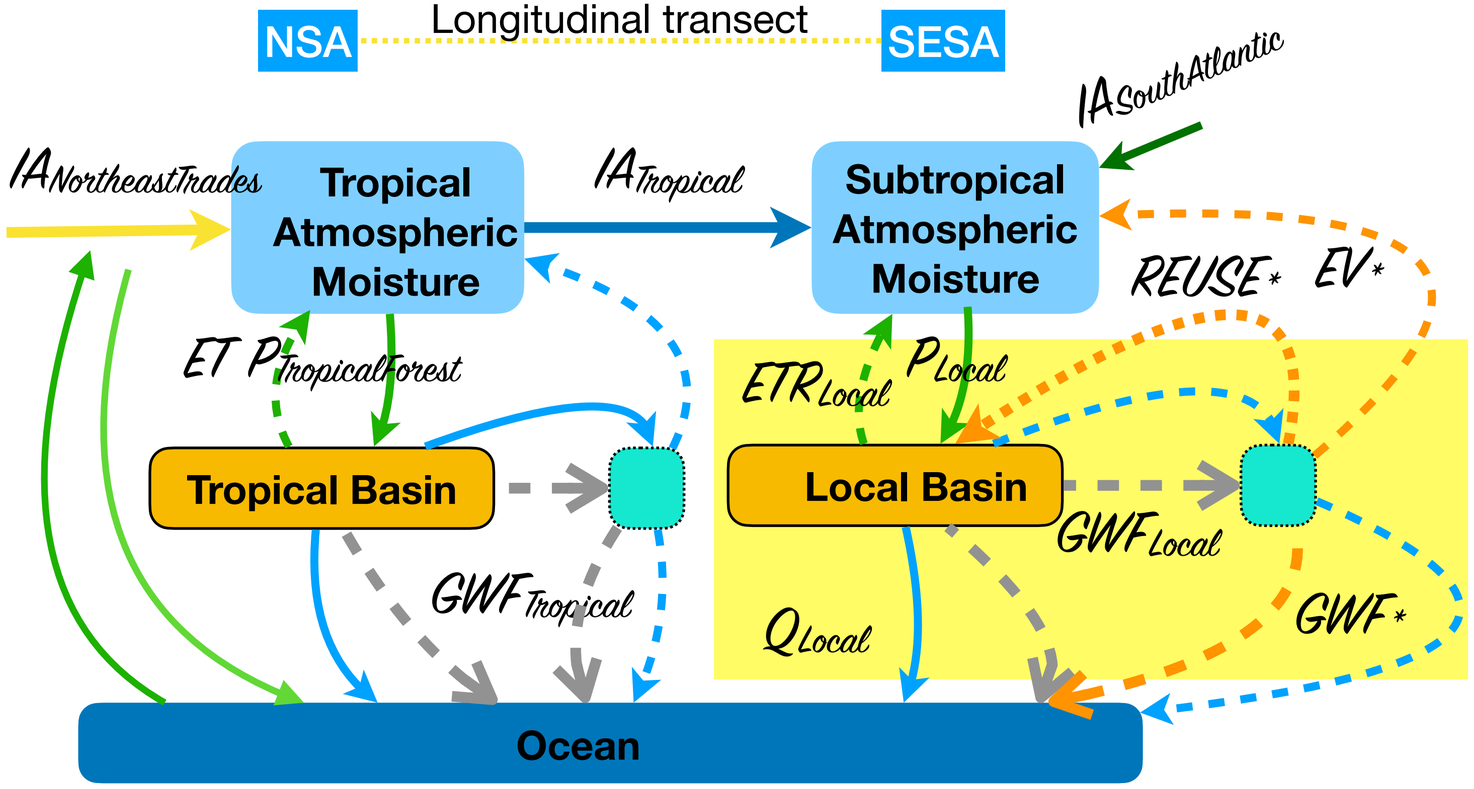
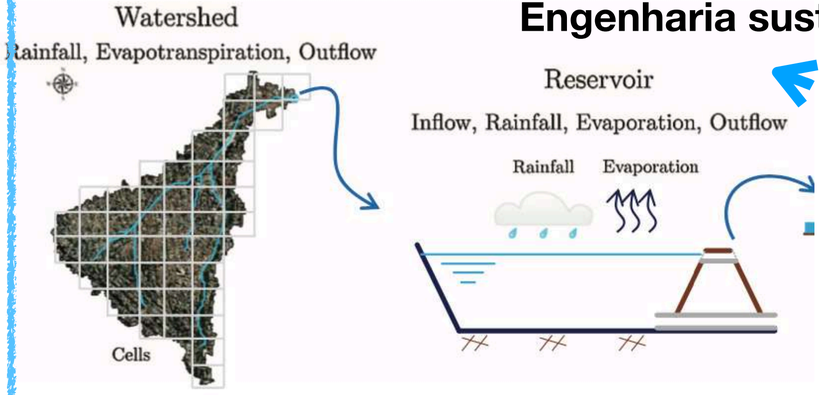


Fig. 1. Schematic diagram of elements relevant to poleward moisture transport over South America. Blue and green arrows depict the moisture transport into the continent from the tropical and South Atlantic Ocean, respectively. The inset represents a vertical cross section of the northerly flow along the red dashed line displayed in the diagram, including wind and temperature profiles representative of the LLJ core.





"ReWASH"
Recycling Water Assets for Sustainable Habitats

https://doi.org/10.1061/(ASCE)WR.1943-5452.0001588

Contextos

Mendiondo (2023) Missão de Pesquisa FAPESP, Fortaleza-CE, 6/2/2023

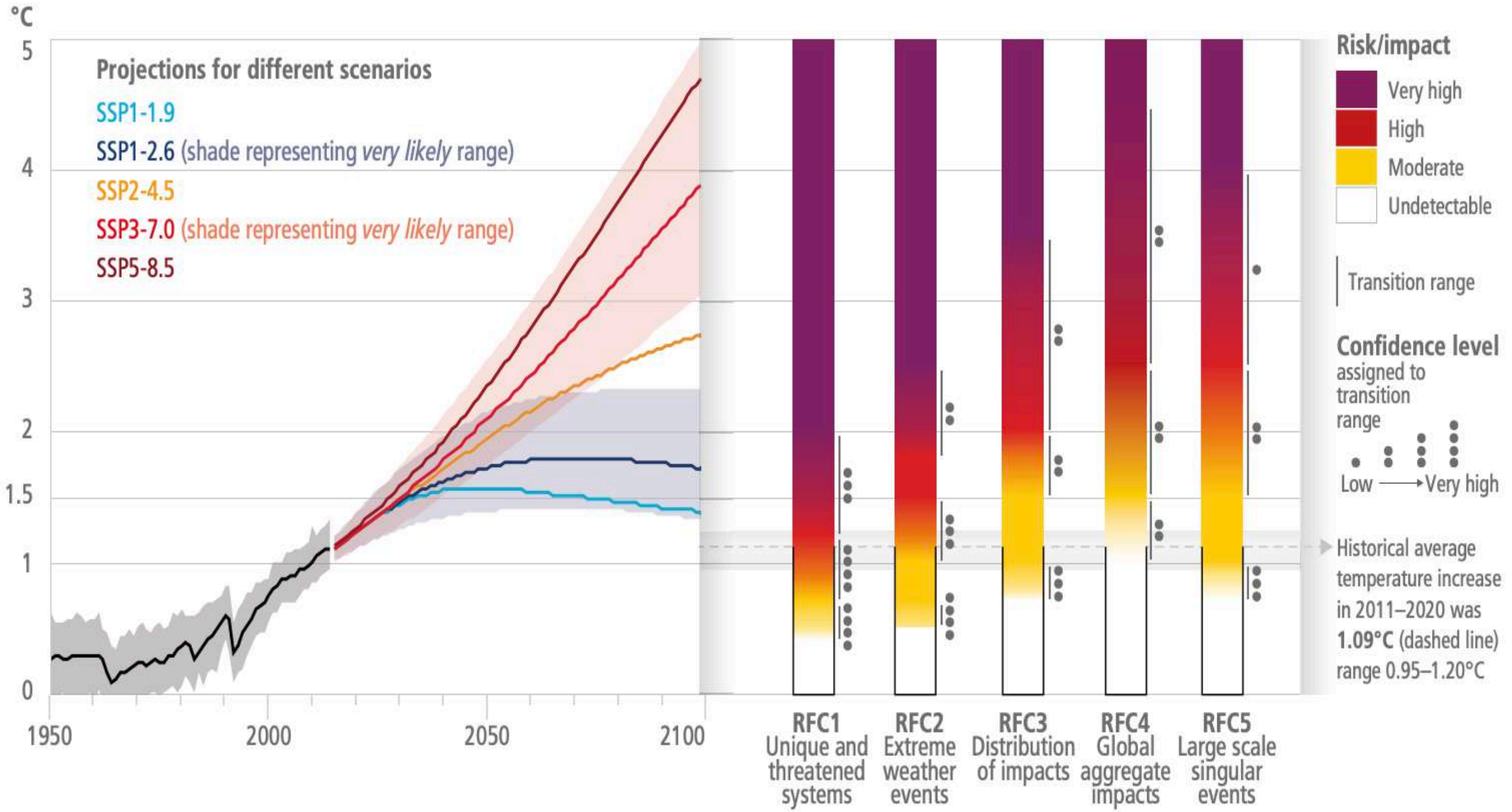
Synthetic diagrams of global assessments and examples of key risks.

How can Water-Adaptive Design & Innovation with Hydroinformatics incentive adaptation and mitigation of climate change impacts?

Global and regional risks for increasing levels of global warming

(a) Global surface temperature change
Increase relative to the period 1850–1900

(b) Reasons for Concern (RFC)
Impact and risk assessments assuming low to no adaptation

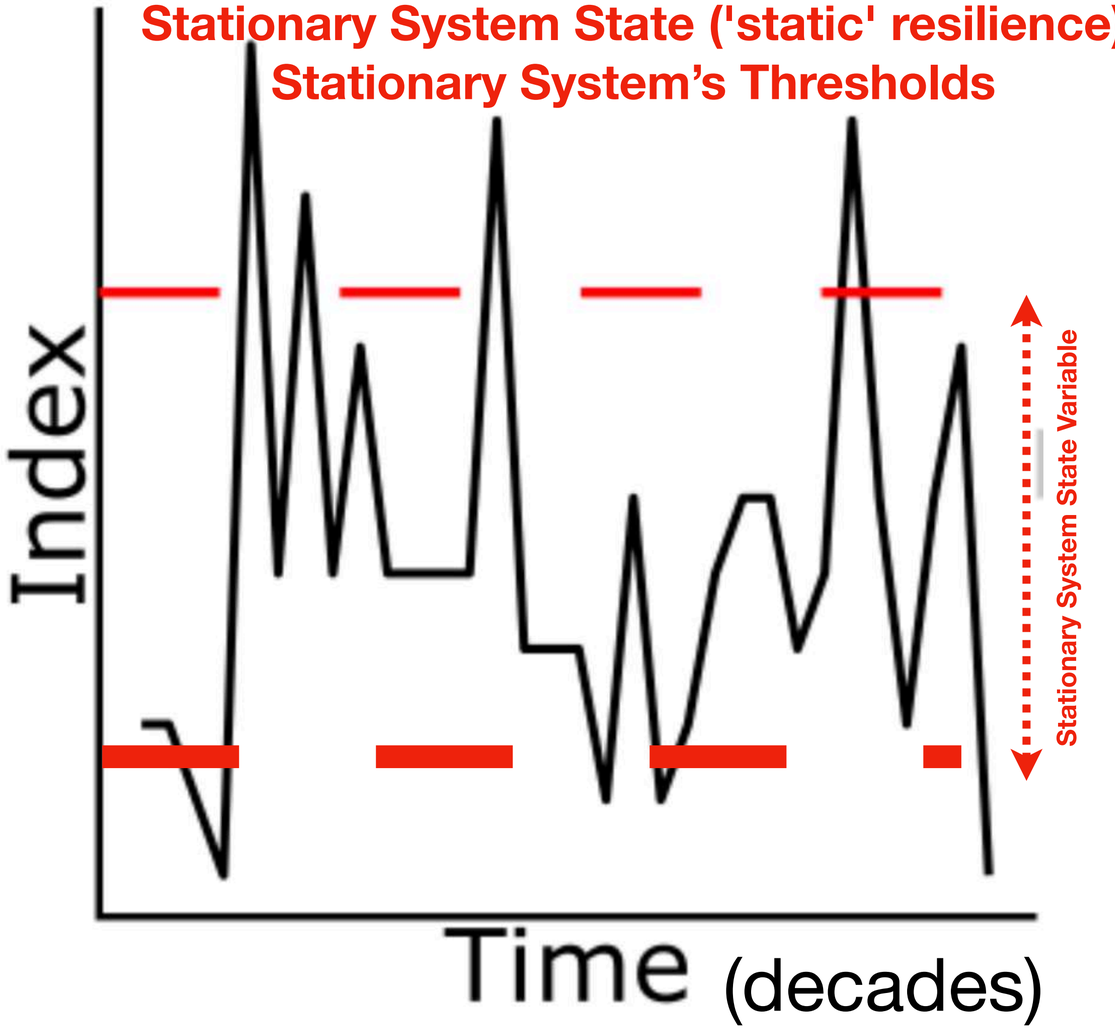


https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

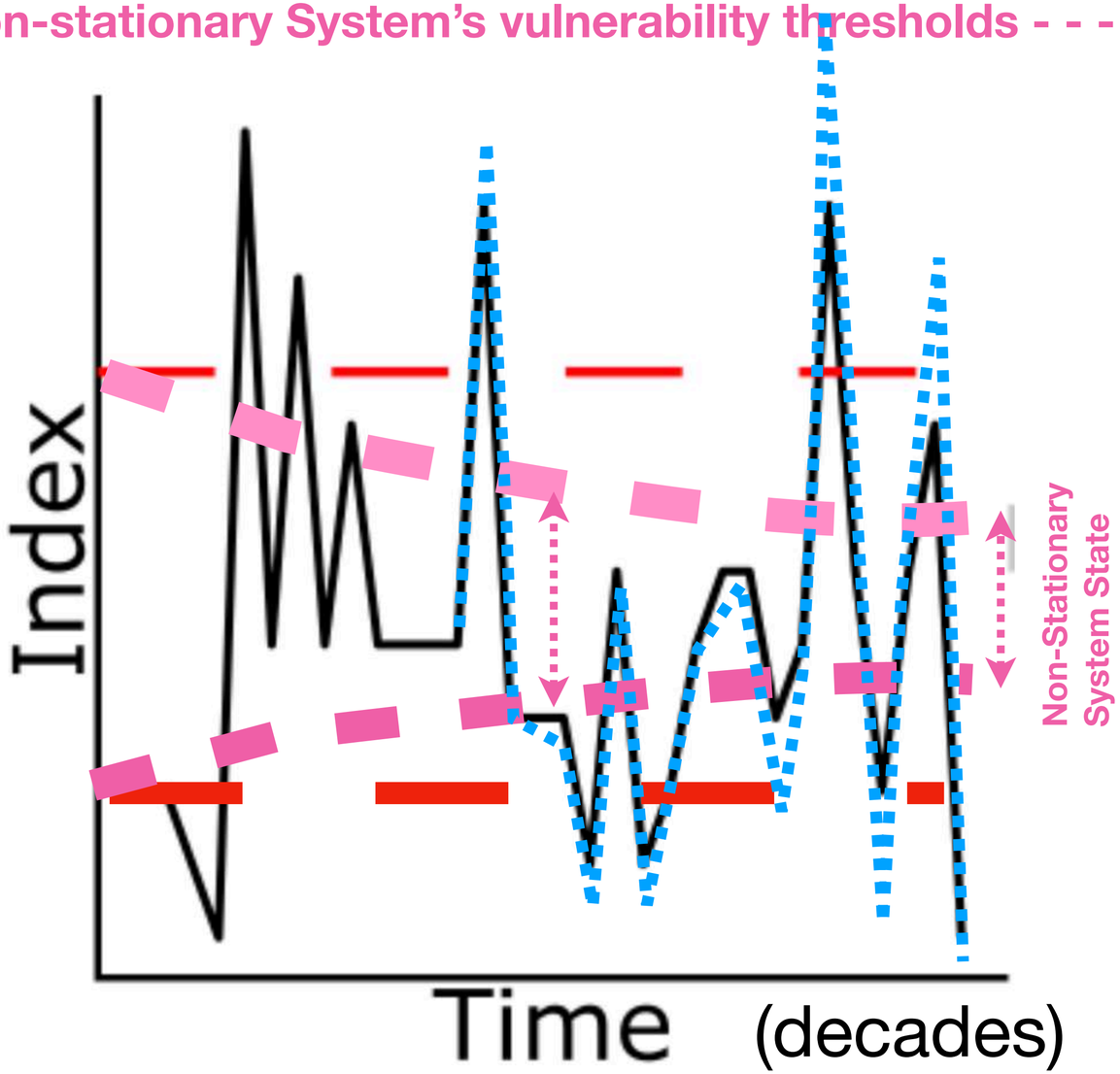
Mendiondo (2023) Missão de Pesquisa FAPESP, Fortaleza-CE, 6/2/2023

Management of Disaster Risk and Societal Resilience
"how to contextualize the concepts about resilience"?

Stationary System State ('static' resilience)
Stationary System's Thresholds



Non-Stationary System State ('dynamic' resilience):
Non-stationary hazards - - - - -
Non-stationary System's vulnerability thresholds - - -



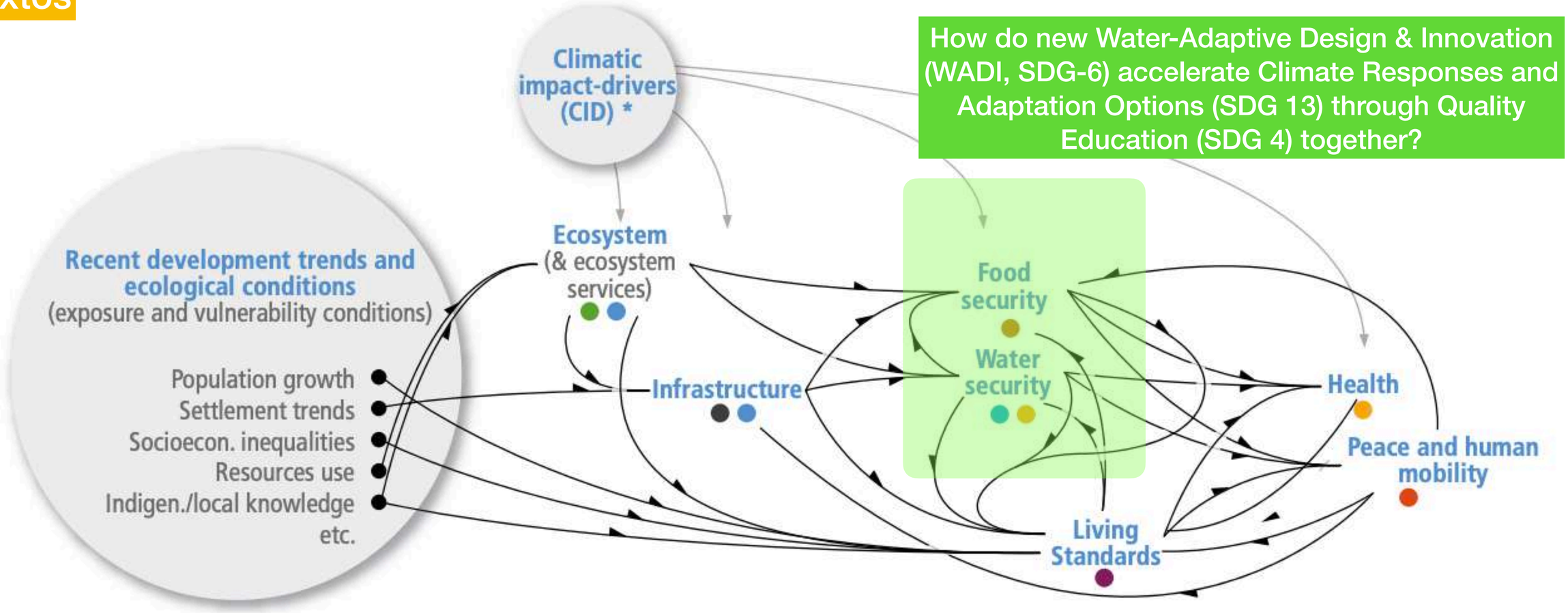
https://egusphere.copernicus.org/preprints/2022/egusphere-2022-498/

(a) Interactions across the eight Representative Key Risk level

Contextos

Illustration of some connections across key risks

How do new Water-Adaptive Design & Innovation (WADI, SDG-6) accelerate Climate Responses and Adaptation Options (SDG 13) through Quality Education (SDG 4) together?



* CIDs are physical climate system conditions (e.g., means, events, extremes) that affect an element of society or ecosystems. Indiced changes are system-dependent and can be detrimenlal, beneficial, neutral, or a mixture of each. {WGI AR6 SPM}

Risk cascades **

- Across key risks
- Climate-driven

Representative Key Risks

- A (Low-lying coasts)
- B (Ecosystems)
- C (Infrastructure)
- D (Living standards)
- E (Human health)
- F (Food security)
- G (Water security)
- H (Peace and human mobility)

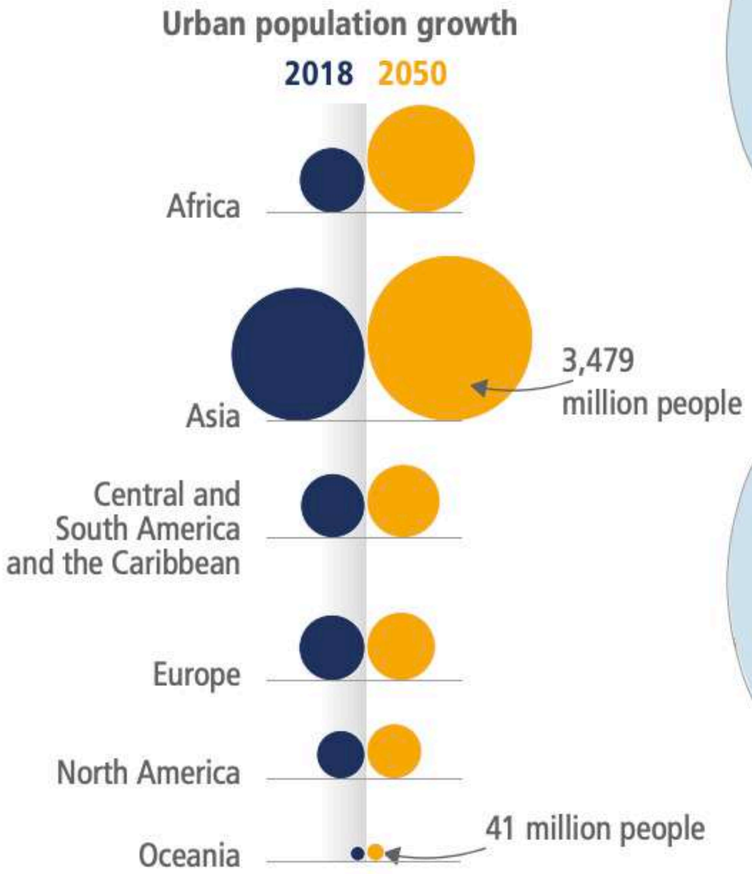
** As illustrative suggested rather across than RKR comprehensive, assessments; and qualitative rather than quantitative

https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

(b) Global distribution of population exposed to potentially deadly conditions from extreme temperatures and relative humidity.

Map data without accounting for heatwaves.

Named cities are the largest 15 urban areas by population size.



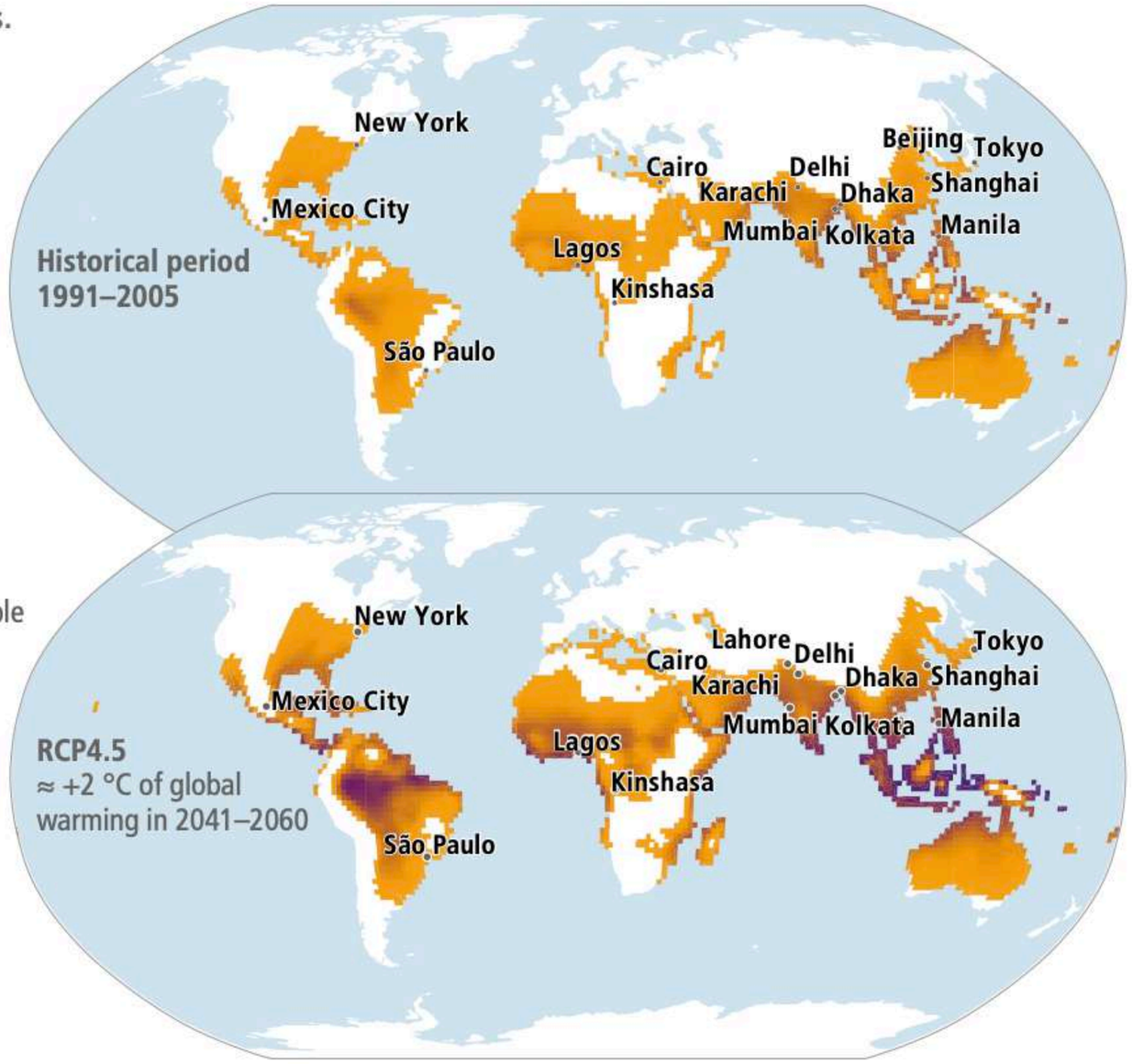


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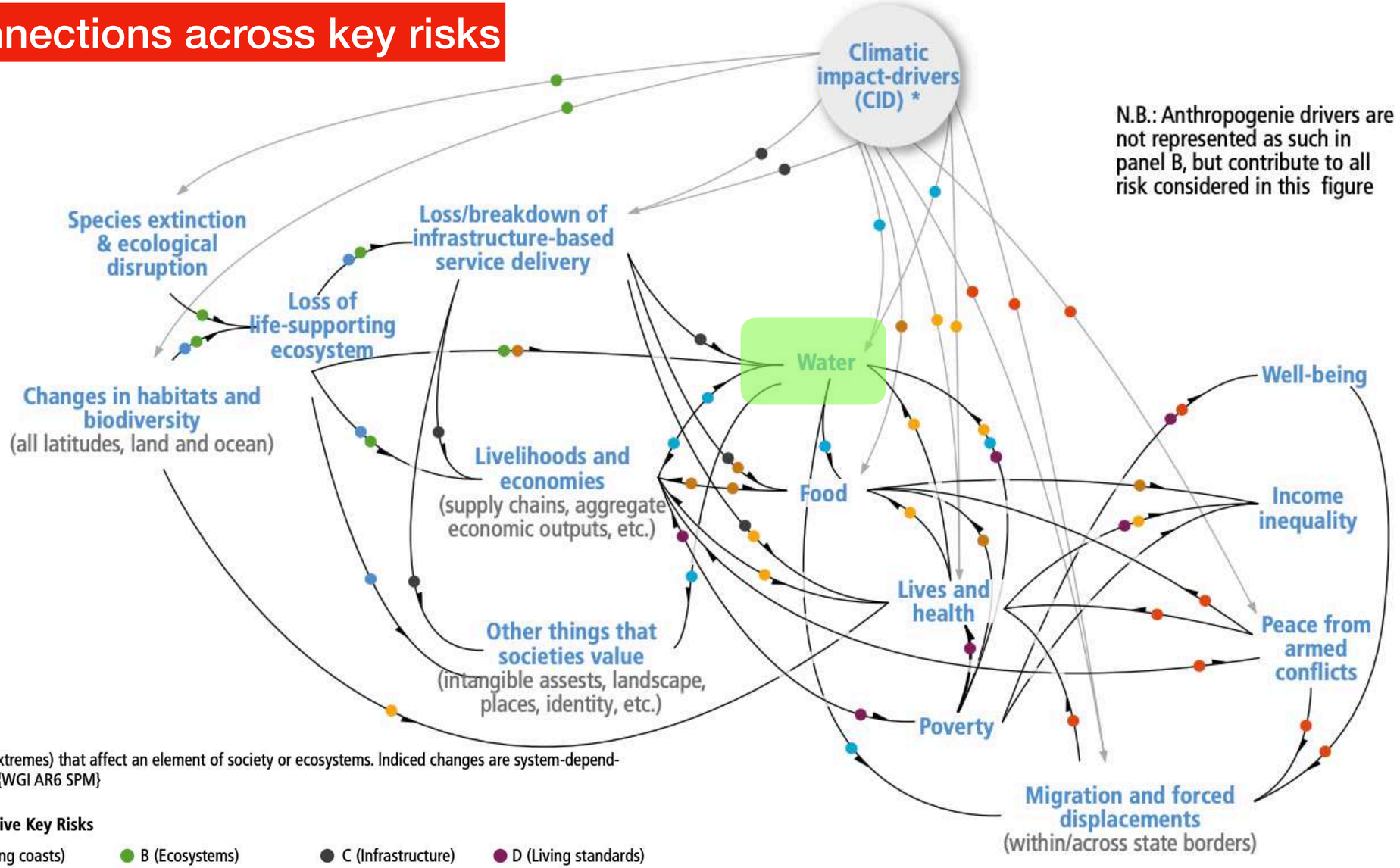
Illustration of some connections across key risks

How do new Water-Adaptive Design & Innovation (WADI, SDG-6) with HYDROINFORMATICS accelerate Climate Responses and Adaptation Options (SDG 13) through Quality Education (SDG 4)?

https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

(b) Illustration of interactions at the Key Risk level (e.g. from ecological risk to key dimensions for human societies)



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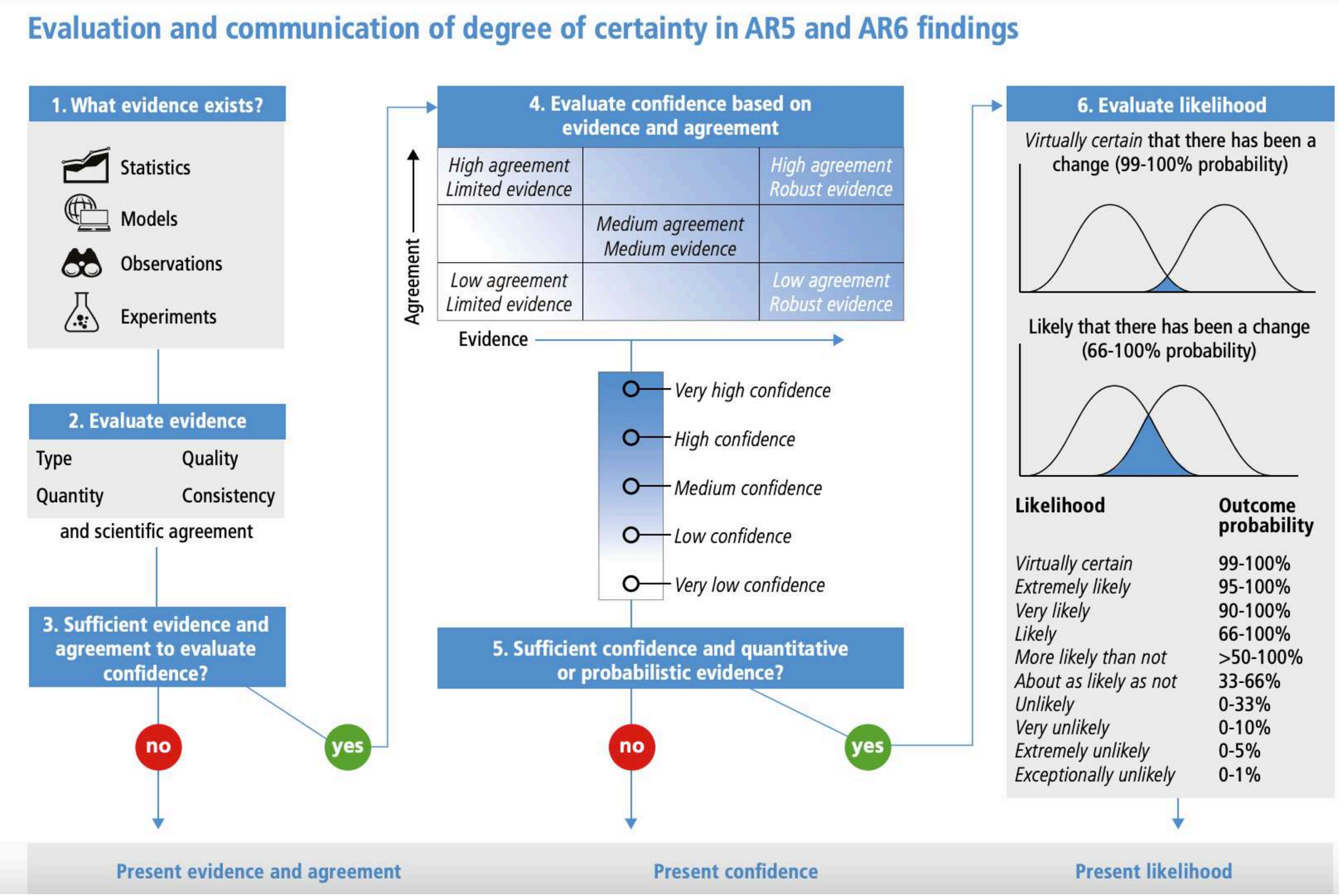
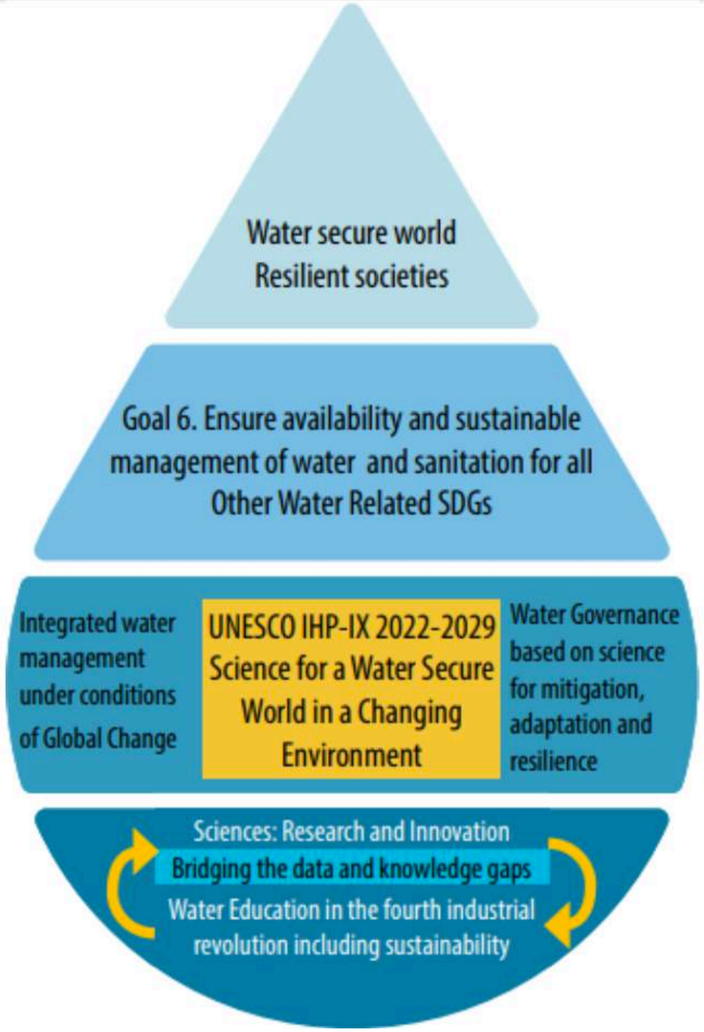


Climate Services, Water Security and Adaptation (formal, global approach)

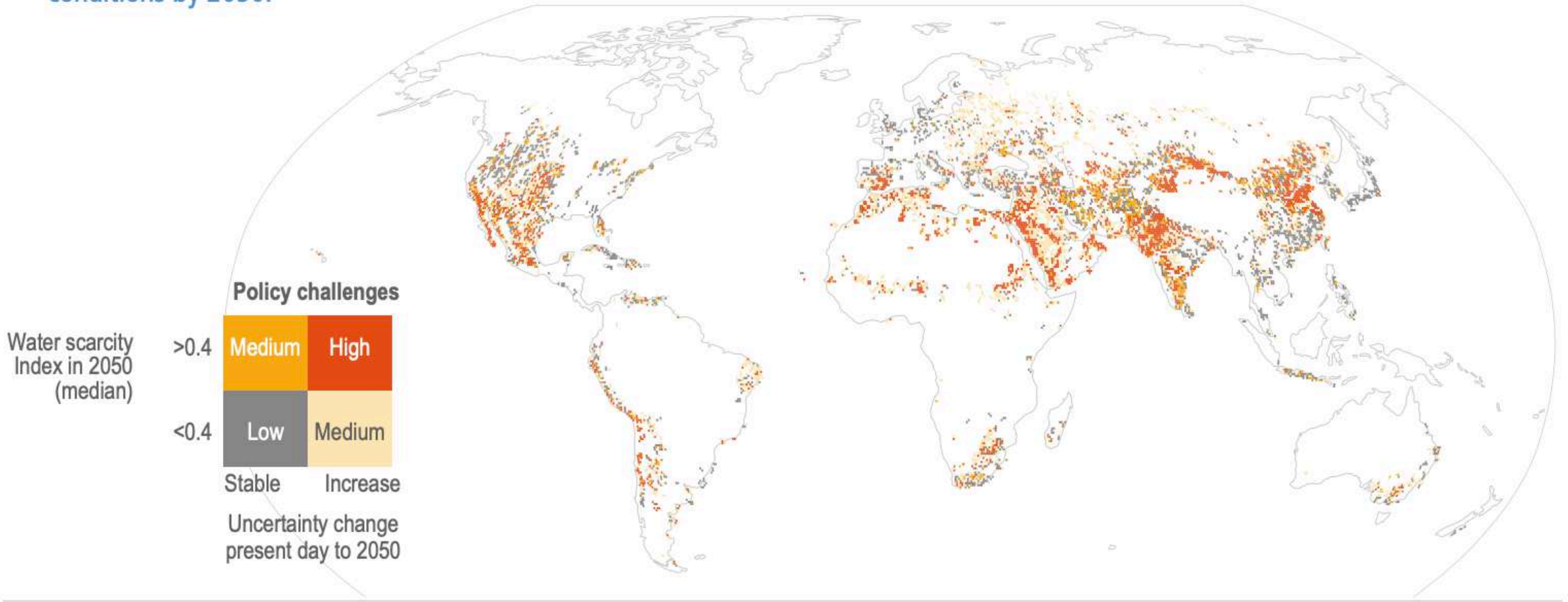
Intergovernmental Hydrological Programme (9th Phase of IHP 2022-2029)



- **5** Priority Areas
  1. Scientific research and innovation
  2. Water Education in the Fourth Industrial Revolution including Sustainability
  3. Bridging the data-knowledge gap
  4. Integrated water resources management under conditions of global change
  5. Water Governance based on science for mitigation, adaptation and resilience
- **34** expected outputs
  - The Strategic Plan has been approved with its 5 priority areas and 34 expected outputs by the IHP Council in its 24th Session last June
- **150** Key activities
  - Operational Implementation Plan endorsed at the 25th Session of the IHP Council 26-29 April 2022

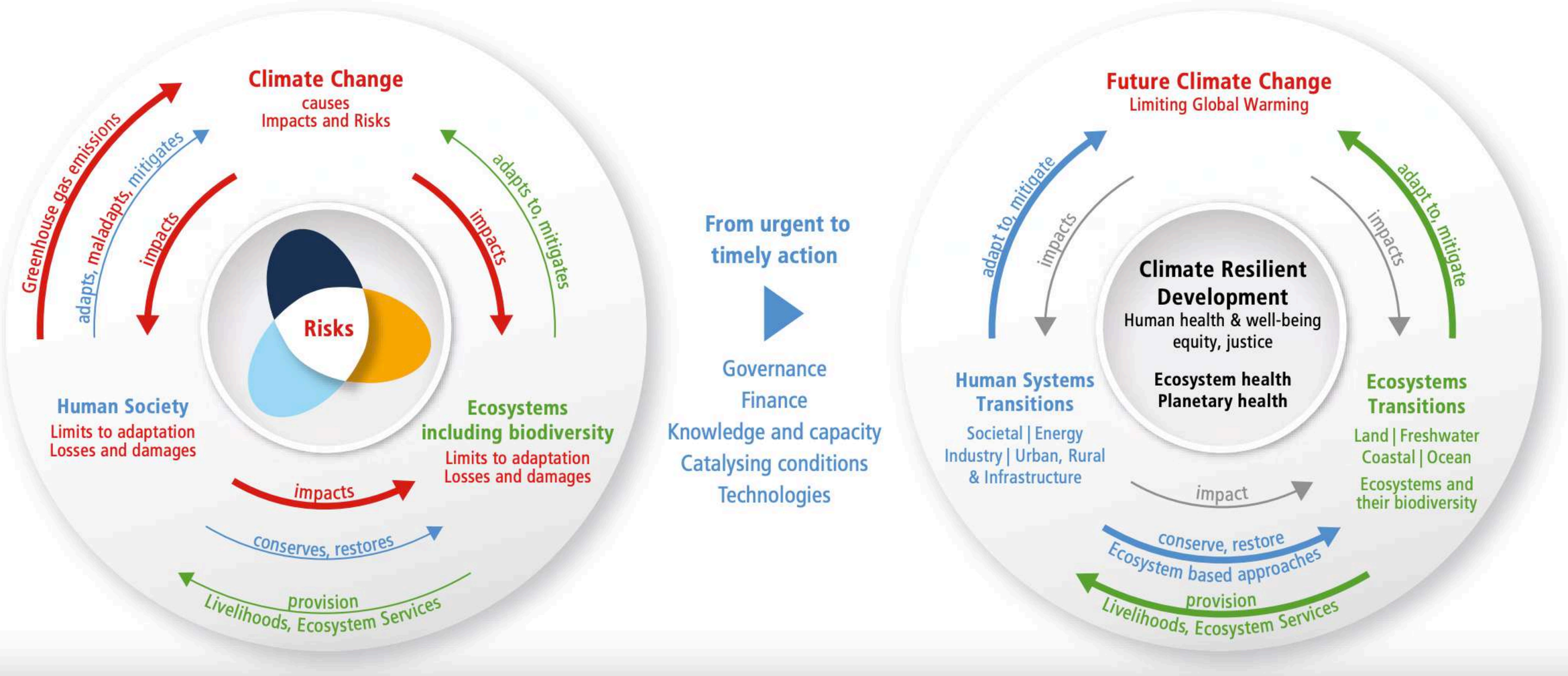
https://unesdoc.unesco.org/ark:/48223/pf0000381318

(d) Drought is exacerbating water management challenges which vary across regions with respect to anticipated water scarcity conditions by 2050.



https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

From climate risk to climate resilient development: climate, ecosystems (including biodiversity) and human society as coupled systems



https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

Observed global and regional impacts on ecosystems and human systems attributed to climate change.

Global South's regions Challenges for Water-Adaptive Design & Innovation (WADI) on SuDS+NbS under Climate Change

New WADI's Job Markets on SuDS+NbS for Climate Change's impacts?

Impacts of climate change are observed in many ecosystems and human systems worldwide

(a) Observed impacts of climate change on ecosystems

Ecosystems	Changes in ecosystem structure: Terrestrial	Changes in ecosystem structure: Freshwater	Changes in ecosystem structure: Ocean	Species range shifts: Terrestrial	Species range shifts: Freshwater	Species range shifts: Ocean	Changes in timing (phenology): Terrestrial	Changes in timing (phenology): Freshwater	Changes in timing (phenology): Ocean
Global	●	●	●	●	●	●	●	●	●
Africa	●	●	●	●	○	●	○	◌	◌
Asia	●	◉	●	◌	◉	○	◌	◌	◉
Australasia	●	○	●	●	○	●	●	○	◌
Central and South America	●	●	●	●	●	●	○	○	◌
Europe	●	●	●	●	●	●	●	●	●
North America	●	●	●	●	●	●	●	●	●
Small Islands	●	●	●	●	●	●	●	○	◉
Arctic	●	◉	●	●	●	●	●	◉	●
Antarctic	◉	○	◉	◉	○	◉	◉	○	○
Mediterranean region	●	○	●	●	◉	●	●	○	◉
Tropical forests	●	○	na	◉	○	na	○	○	na
Mountain regions	●	◉	na	●	◉	na	●	◌	na
Deserts	●	na	na	●	na	na	○	na	na
Biodiversity hotspots	●	○	●	●	○	●	●	○	not assessed

Confidence in attribution to climate change
- ● High or very high
- ◉ Medium
- ◌ Low
- ○ Evidence limited, insufficient
- na Not applicable

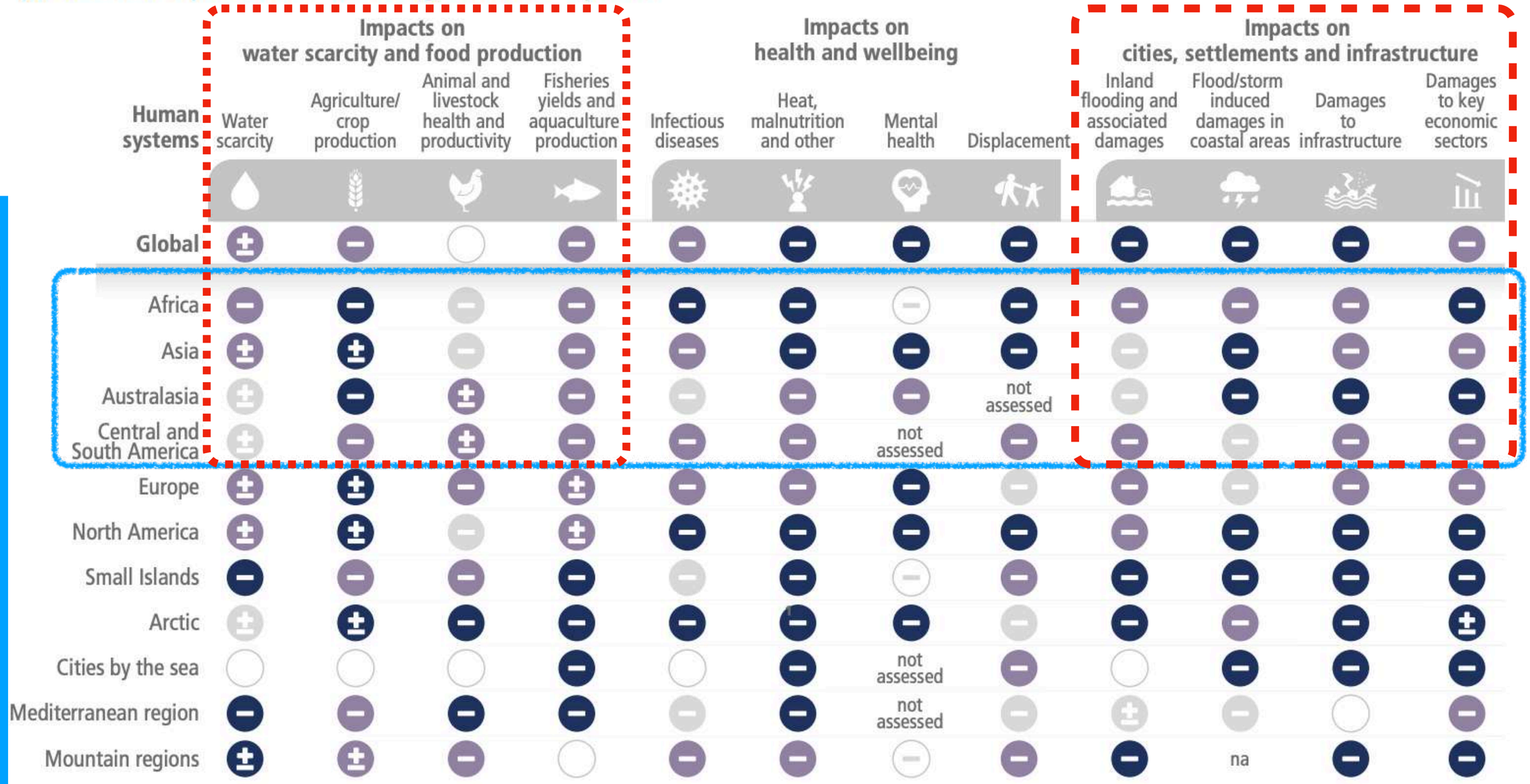
Impacts to human systems in panel (b)
- − Increasing adverse impacts
- ± Increasing adverse and positive impacts

https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

Observed global and regional impacts on ecosystems and human systems attributed to climate change.

"Confidence levels reflect uncertainty in attribution of the observed impact to climate change. Global assessments focus on large studies, multi-species, meta-analyses and large reviews. For that reason they can be assessed with higher confidence than regional studies, which may often rely on smaller studies that have more limited data. Regional assessments consider evidence on impacts across an entire region and do not focus on any country in particular", IPCC (2022)

(b) Observed impacts of climate change on human systems



https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

Some actions facilitate sustainable use but also increase space for nature.

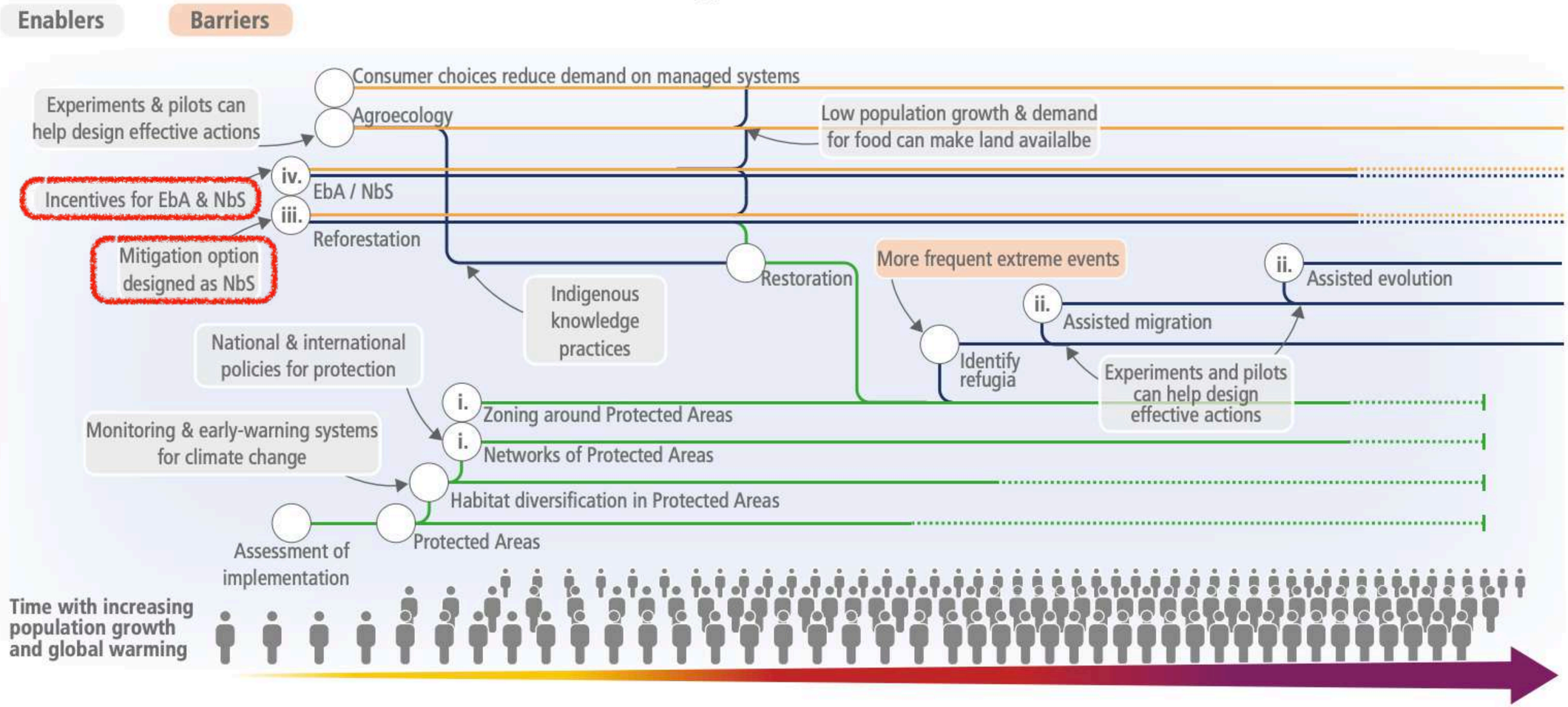
How can WADI's on NbS incentive daptation and mitigation of climate change impacts?

(d) Adaptation pathways for ecosystems.

Adaptation options can be facilitated by actions which increase the solution space such as consideration of local knowledge, new regulations and incentives but also decrease due to climatic and non-climatic stressors and maladaptation.

Strategies
- Protect
- Restore/migrate
- Sustainable use
- ..... Uncertainty in effectiveness with increasing pressures

Examples for actions
i. Networks of Protected Areas combined with zoning increase resilience.
ii. Assisted migration and evolution might reduce extirpation and extinction.
iii. Adaptation and mitigation increase space for nature and benefit society.
iv. Ecosystem-based Adaptation (EbA) and Nature-based Solutions (NbS).



https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

(c) Observed and projected impacts from climate change in the water cycle for human managed systems and crop yield productivity.

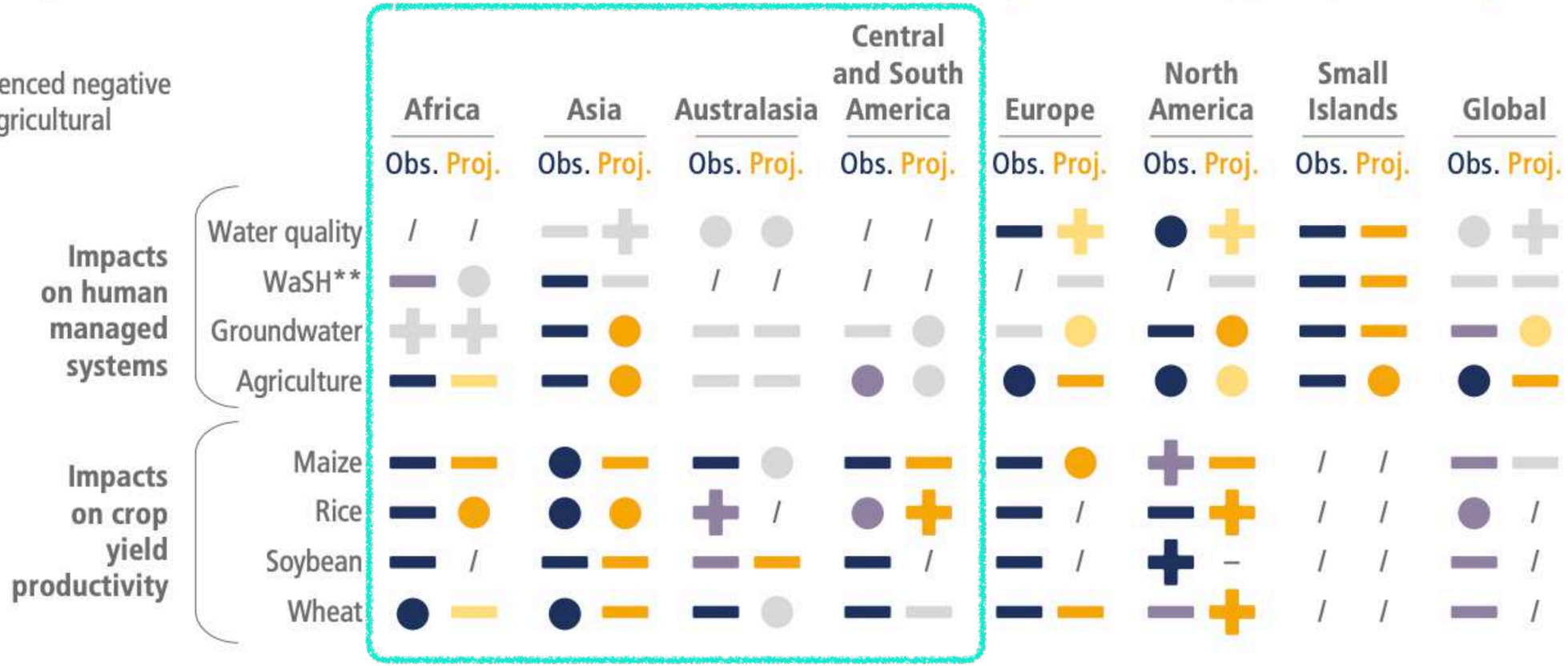
Most regions have already experienced negative impacts on the water cycle and agricultural productivity.

Direction of impact

Positive Negative Mixed

Confidence in attribution to climate change
Observed / **Projected***

Low Medium High



*Mid-century at RCP4.5 (~2°C Global Warming Level)

** = Water, sanitation and hygiene

/ = Not observed or insufficient evidence

https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

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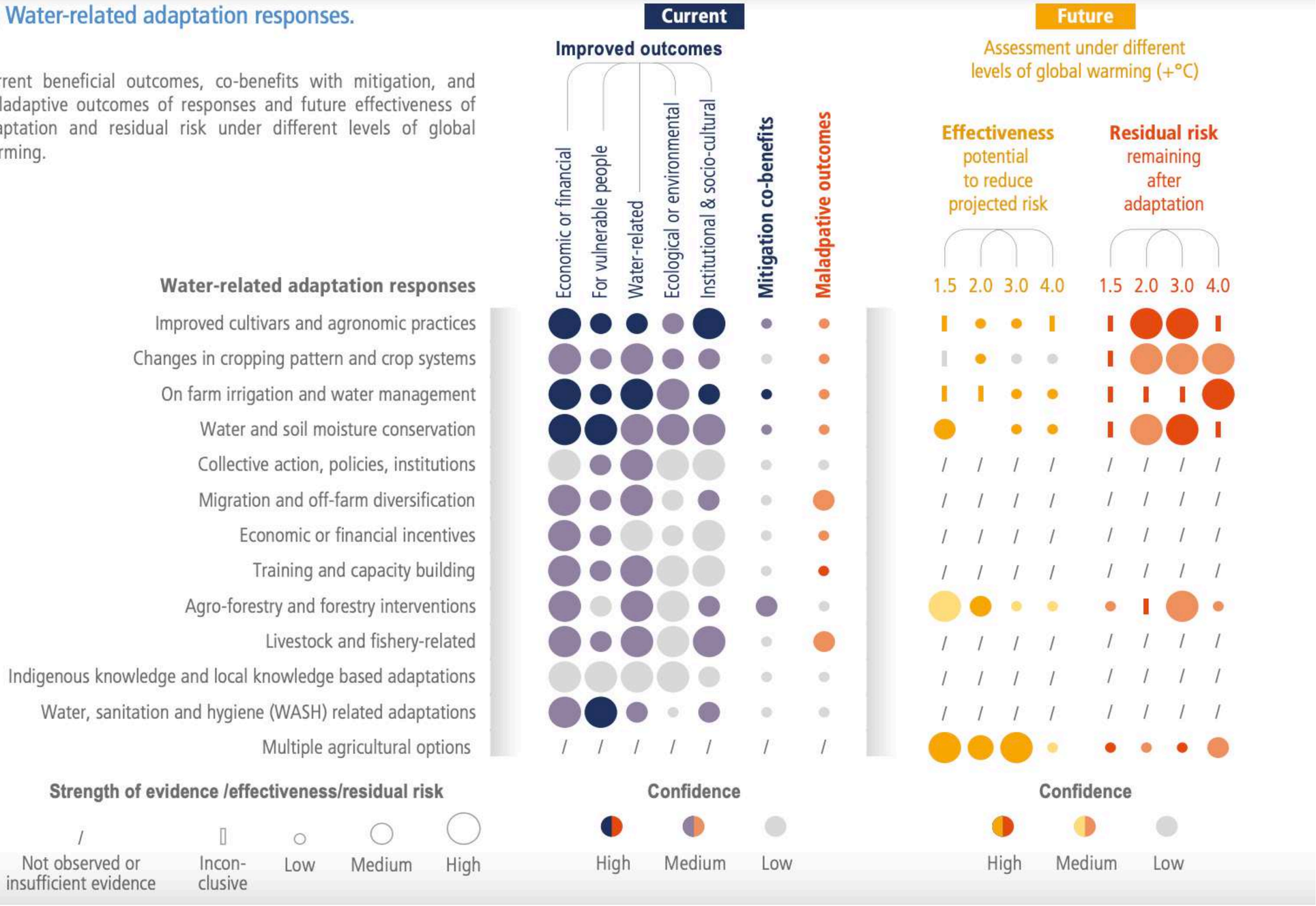
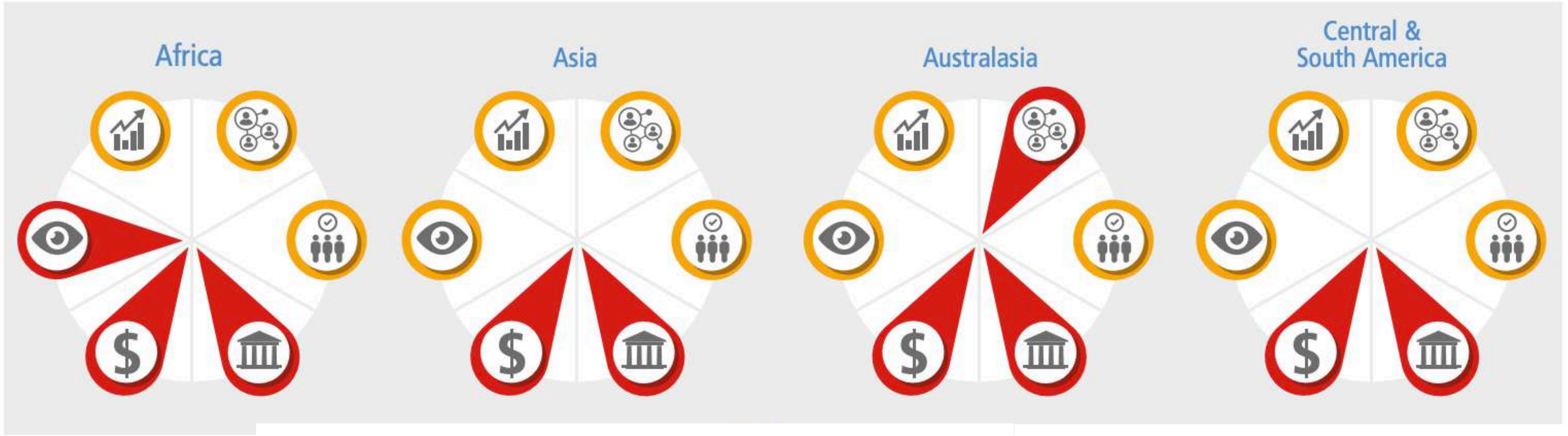
https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

(e) Water-related adaptation responses.

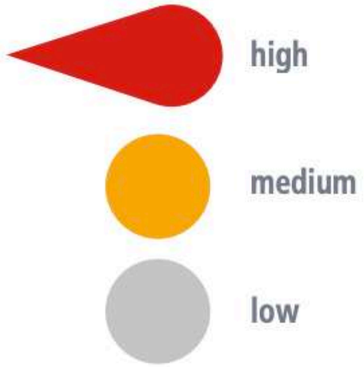
Current beneficial outcomes, co-benefits with mitigation, and maladaptive outcomes of responses and future effectiveness of adaptation and residual risk under different levels of global warming.



(d) Constraints that make it harder to plan and implement human adaptation



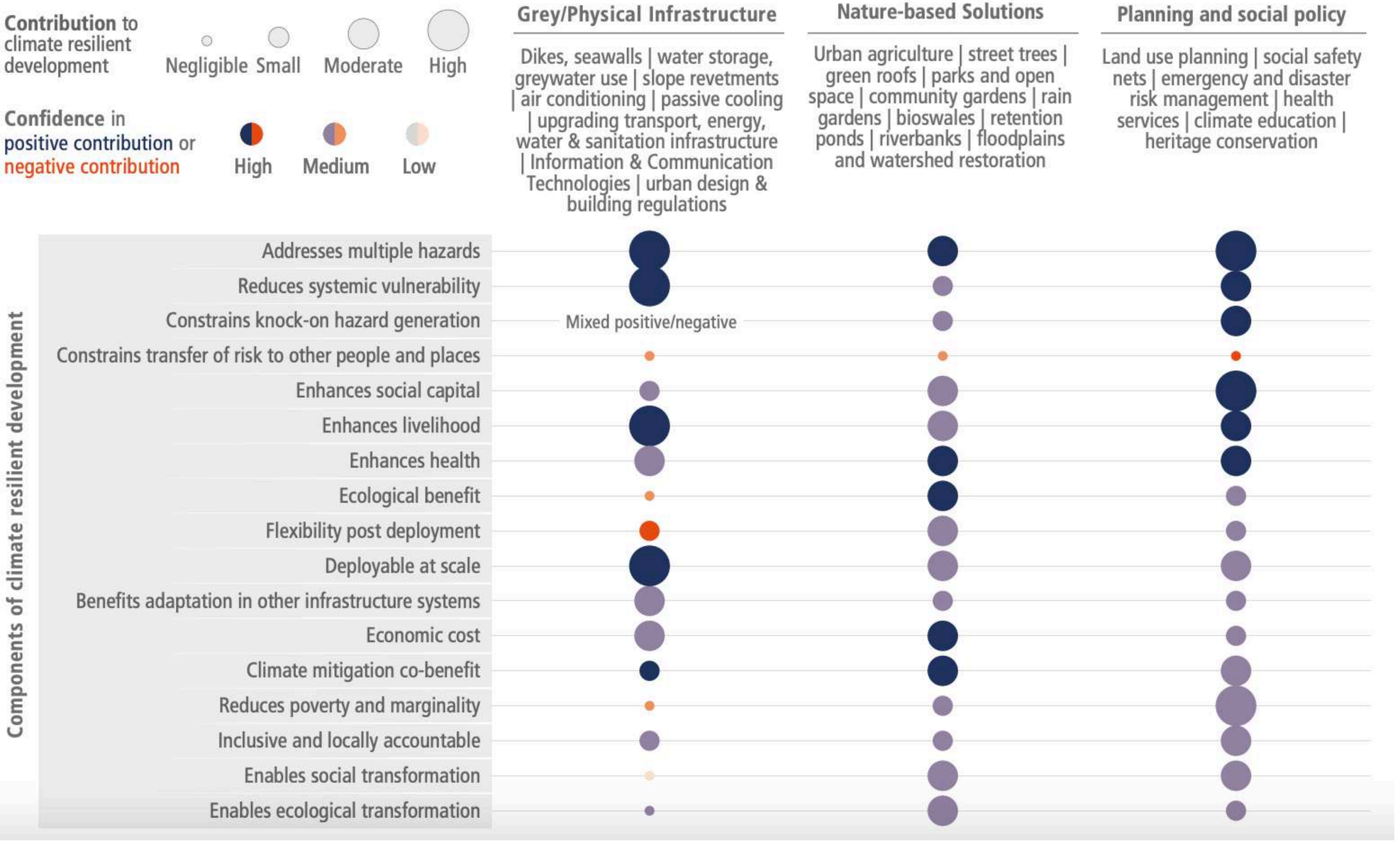
Constraints associated with limits to adaptation for regions across all sectors:



https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

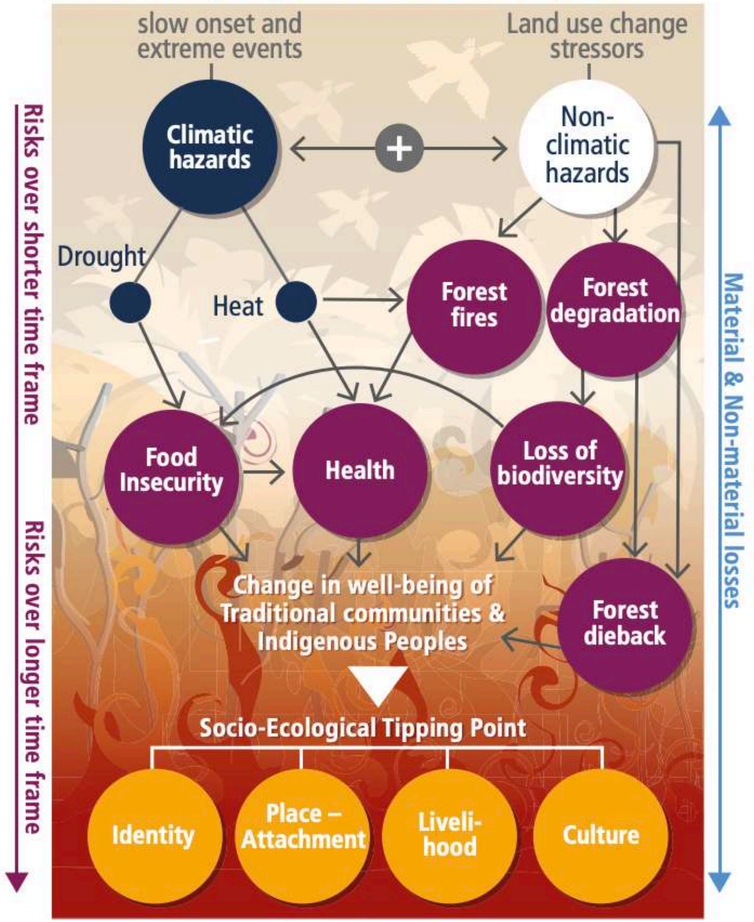
(d) Contributions of urban adaptation options to climate resilient development.

Nature-based solutions and social policy as innovative domains of adaptation show how some of the limitations of grey infrastructure can be mediated. A mixture of the three categories has considerable future scope in adaptation strategies and building climate resilience in cities and settlements.

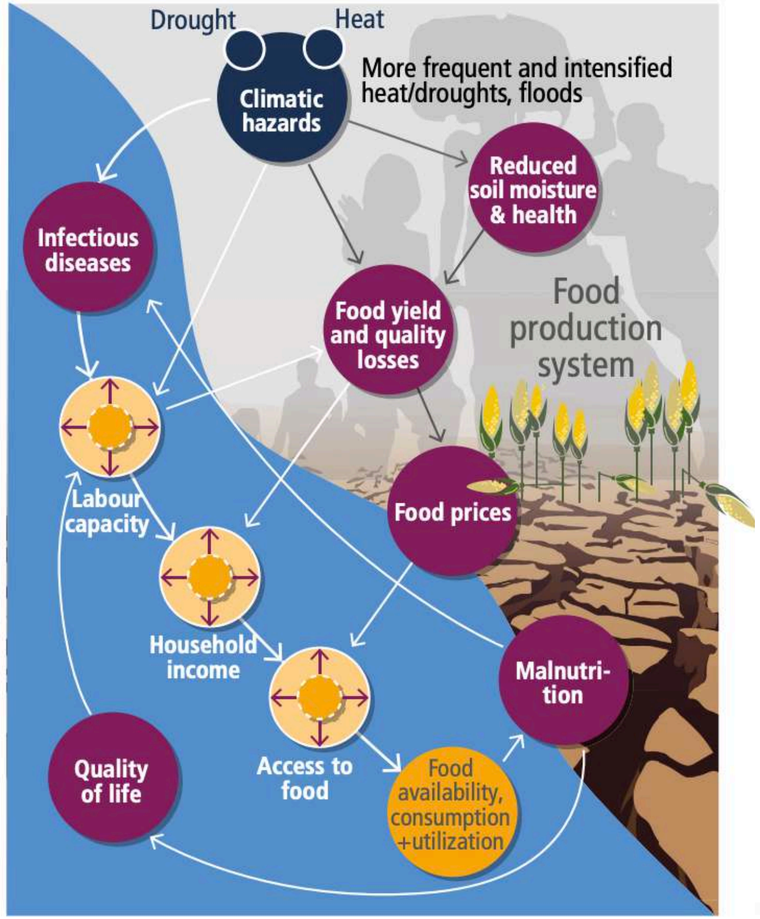


https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

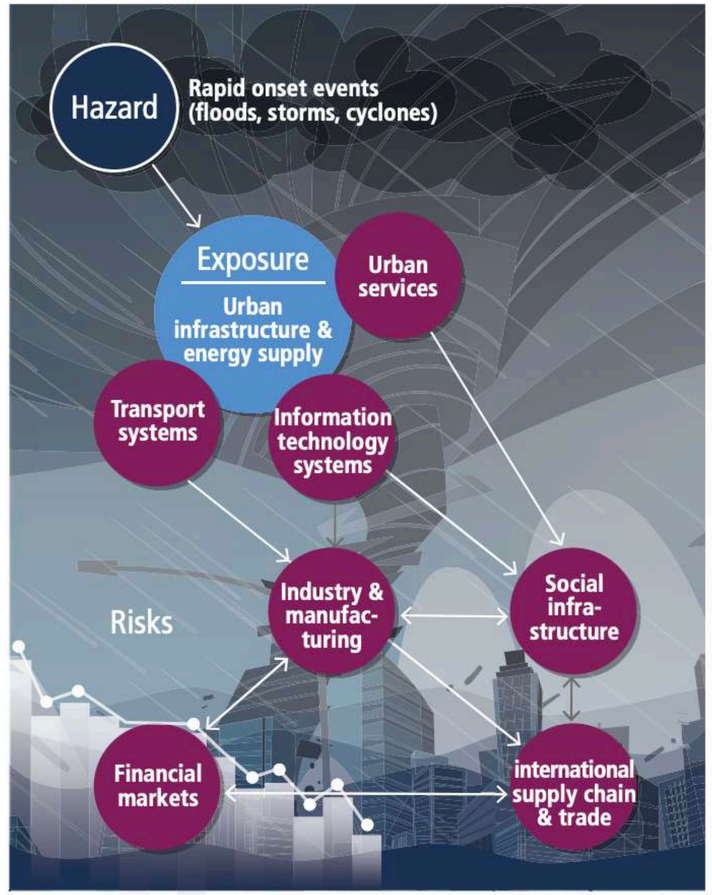
(b) Socio-ecological risks to the Amazonia ecosystem



(c) Cascading impacts of climate hazards on food and nutrition



(e) Urban infrastructure failures cascade risk and loss across and beyond the city



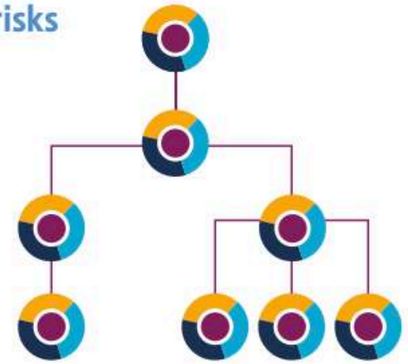
https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

Compound risks

undirectional

bidirectional

Cascading risks



Vulnerability

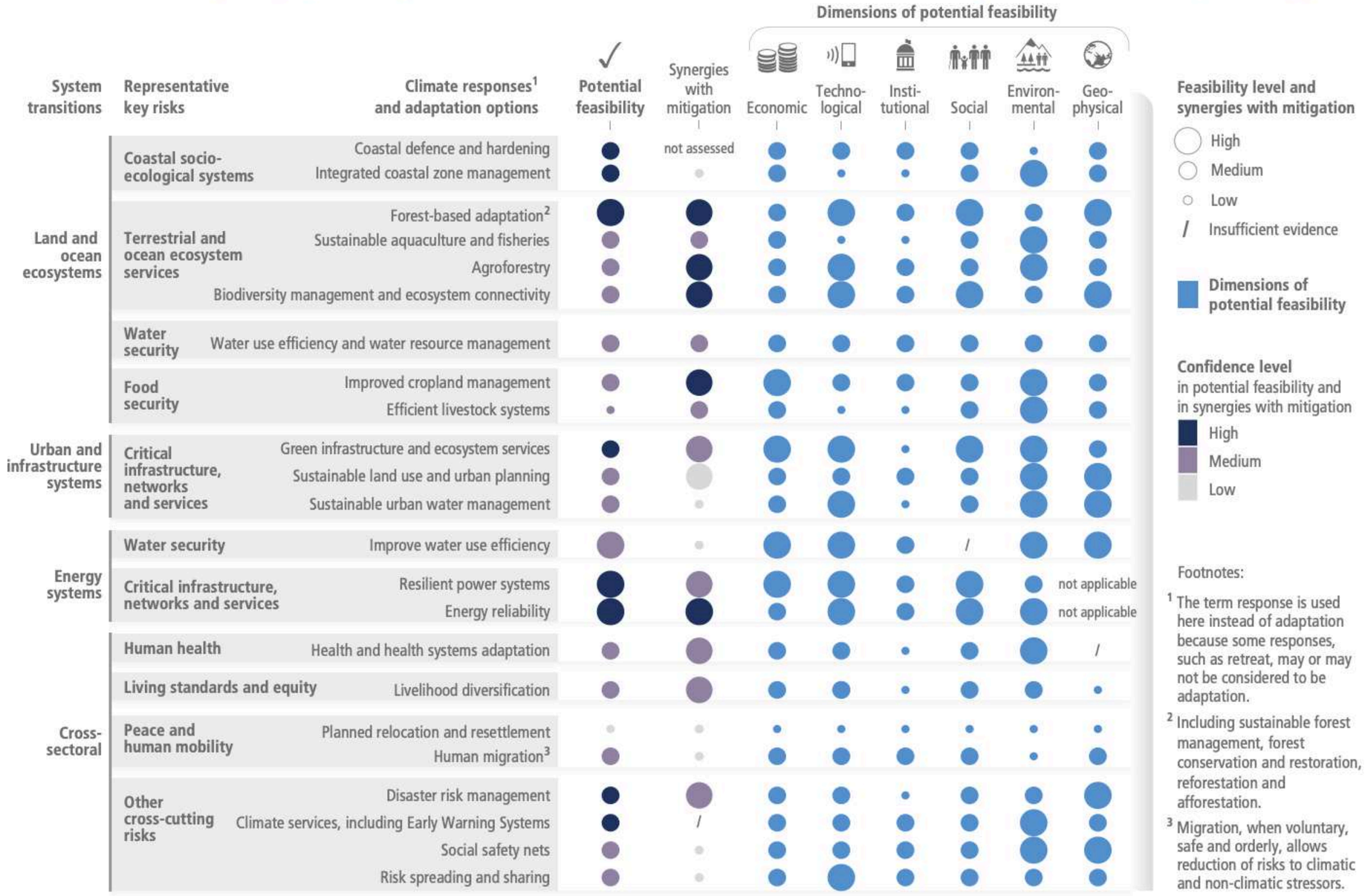
Exposure

Hazard

Risk

(a) Diverse feasible climate responses and adaptation options exist to respond to Representative Key Risks of climate change, with varying synergies with mitigation

Multidimensional feasibility and synergies with mitigation of climate responses and adaptation options relevant in the near-term, at global scale and up to 1.5°C of global warming



https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

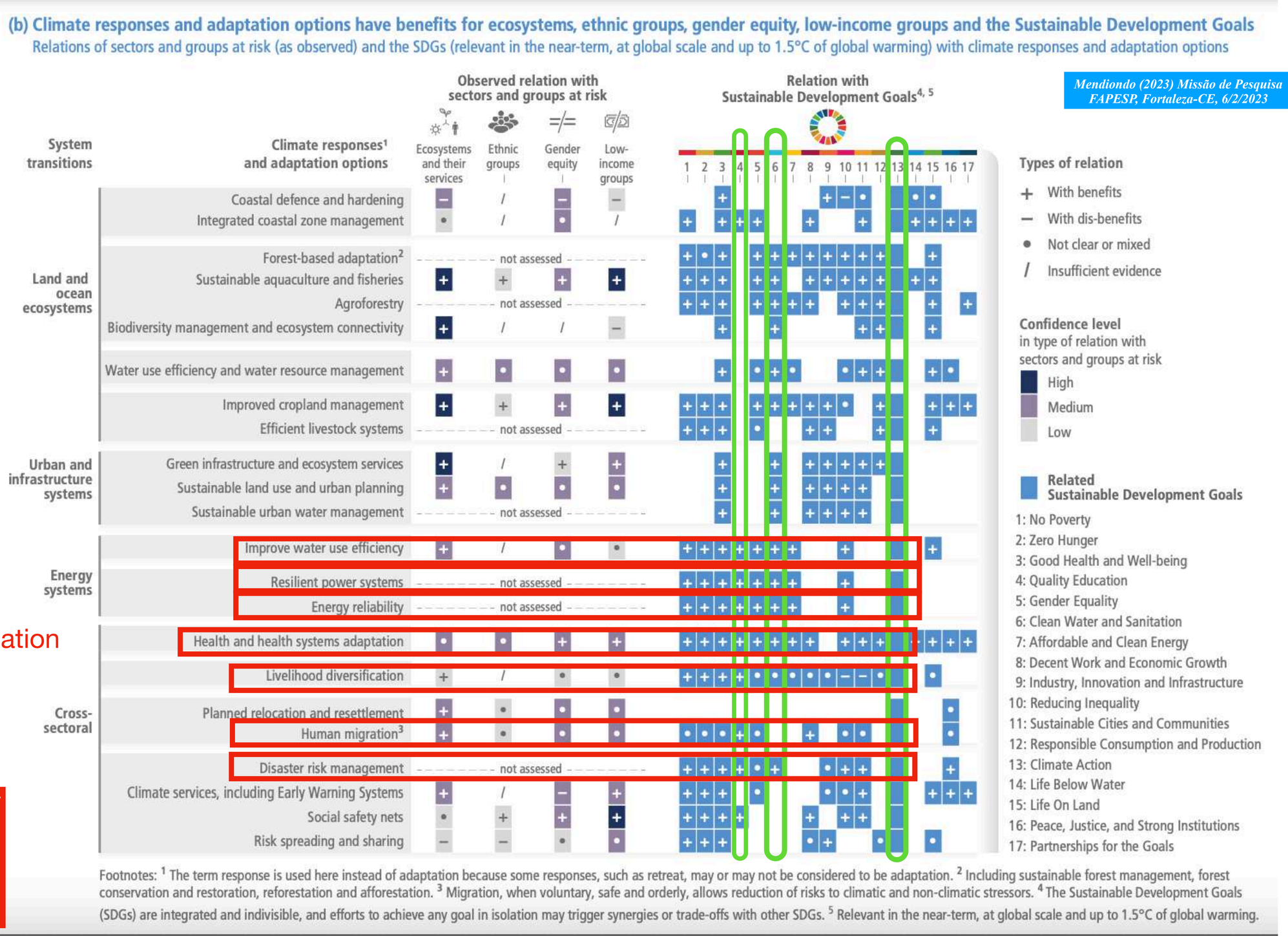
How do new Water-Adaptive Design & Innovation (WADI, SDG-6) Job Markets on SuDS+NbS accelerate Climate Responses and Adaptation Options (SDG 13) through Quality Education (SDG 4) together)?

Improve water use efficiency
Resilient power systems
Energy reliability
Health & health systems adaptation
Livelihood diversification

Human migration

Disaster risk management

https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf



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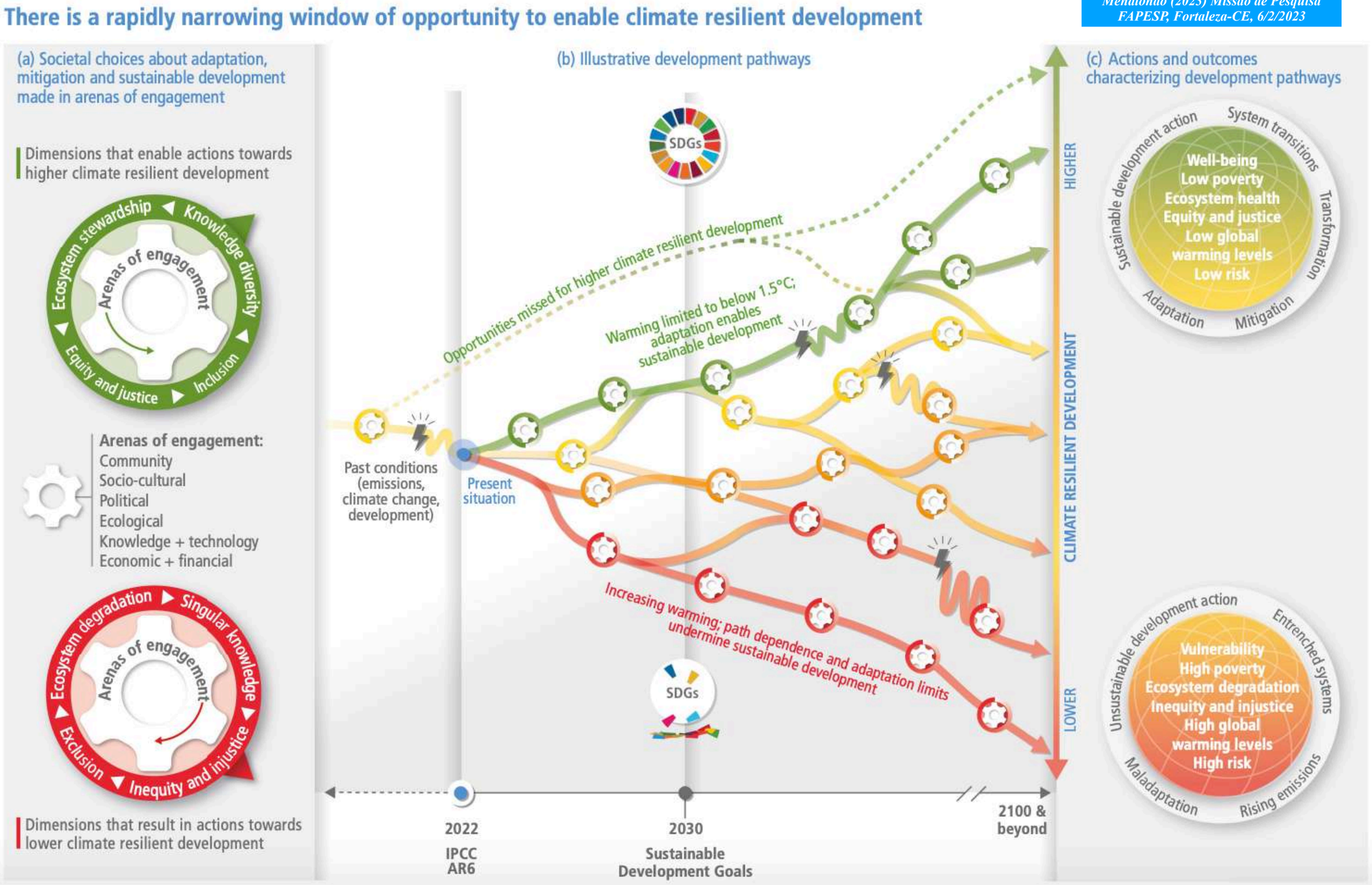
How do new Water-Adaptive Design & Innovation (WADI, SDG-6) Job Markets on SuDS+NbS accelerate Climate Responses and Adaptation Options (SDG 13) through Quality Education (SDG 4) together)?

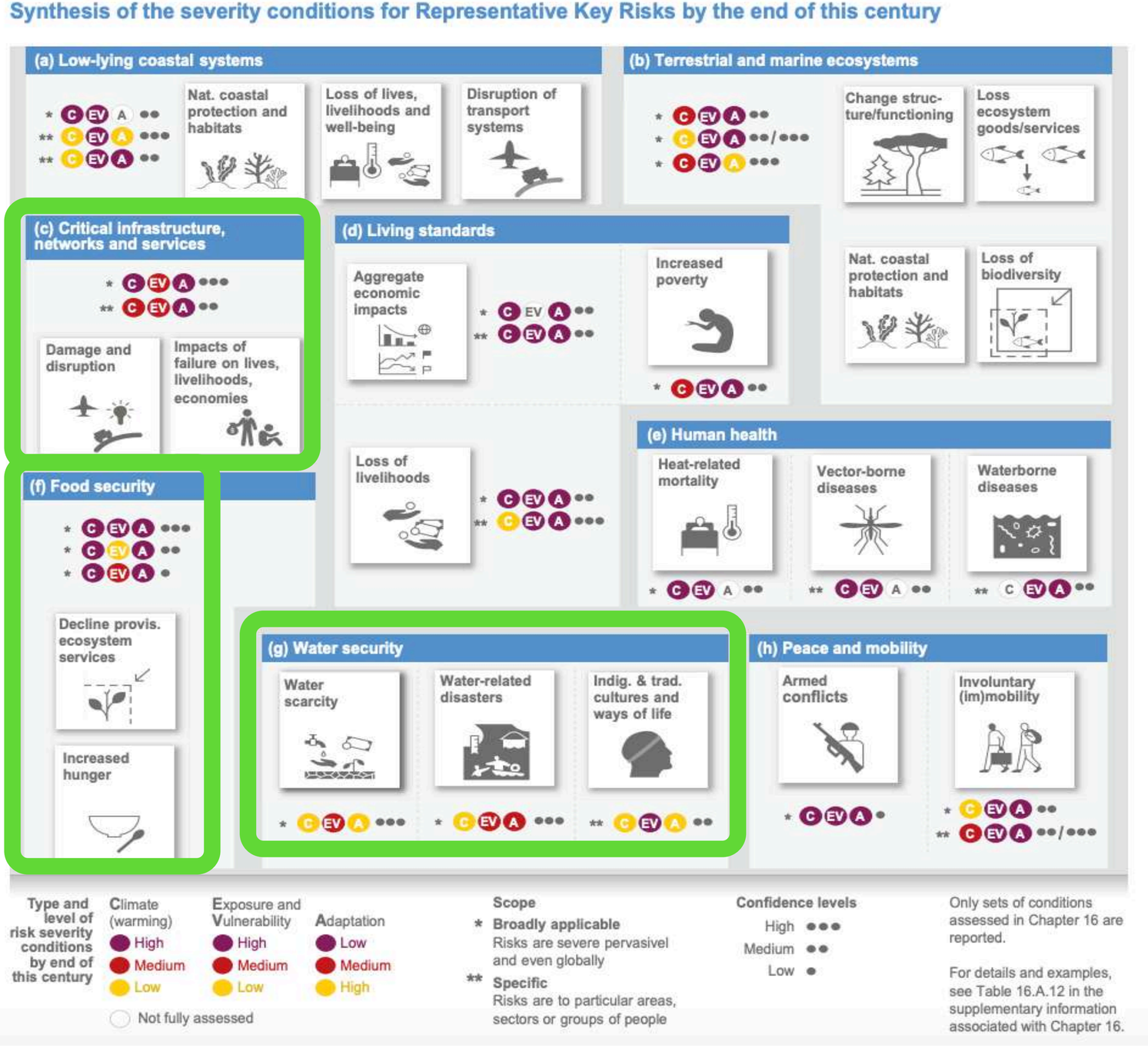
https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf



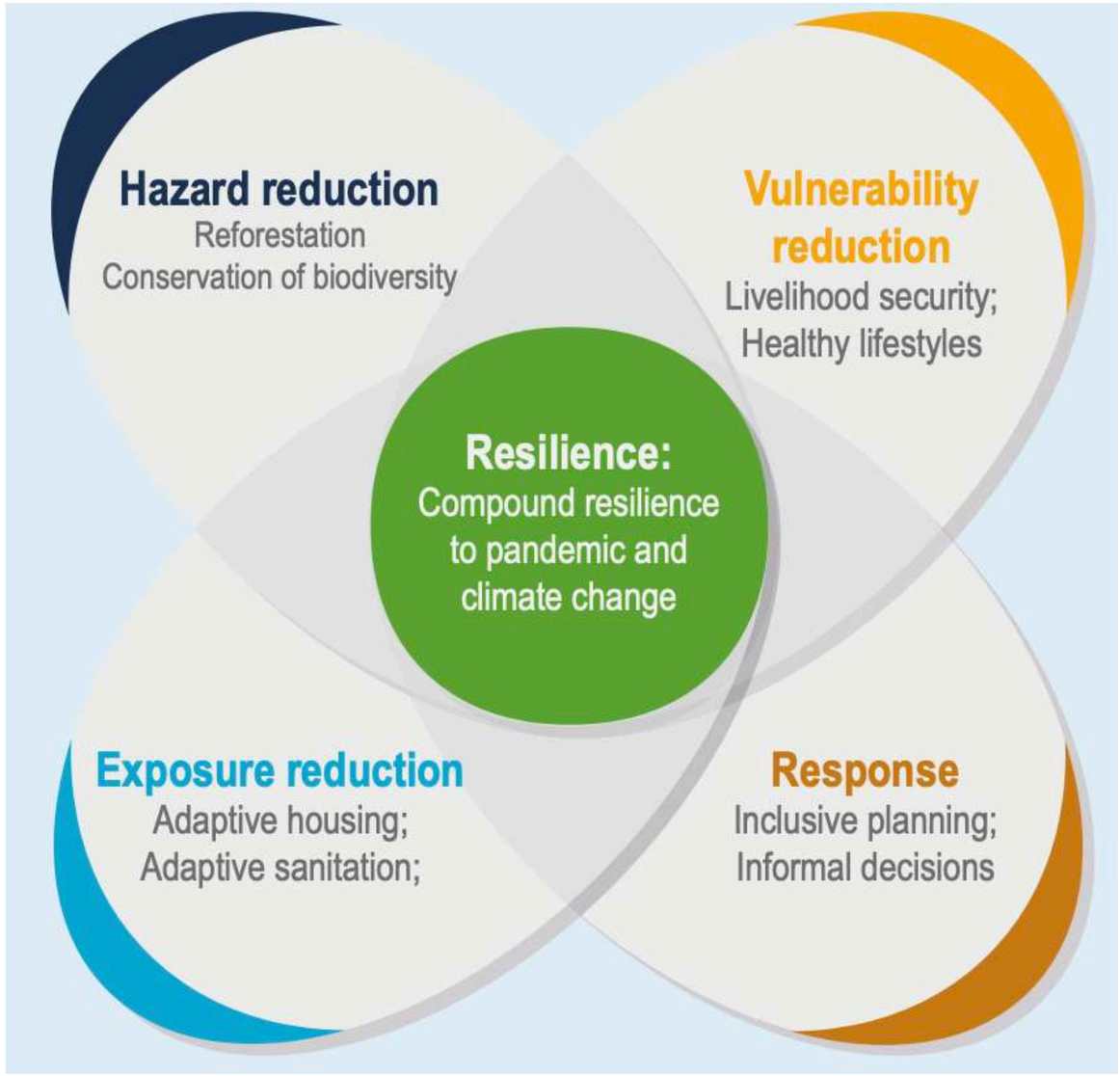
How do new Water-Adaptive Design & Innovation (WADI, SDG-6) Job Markets on SuDS+NbS accelerate Climate Responses and Adaptation Options (SDG 13) through Quality Education (SDG 4) together)?

Example:
How will future WADI-NbS (SDG-6) be accelerated as Climate Action (SDG 13) by todays' Quality Education (SDG 4), i.e. towards:
1. adapting critical infrastructure, networks and services,
2. achieving food security and
3. transforming water security?

https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf



Compound risk and compound resilience to pandemic and climate change. Source: Pelling et al. (2021)



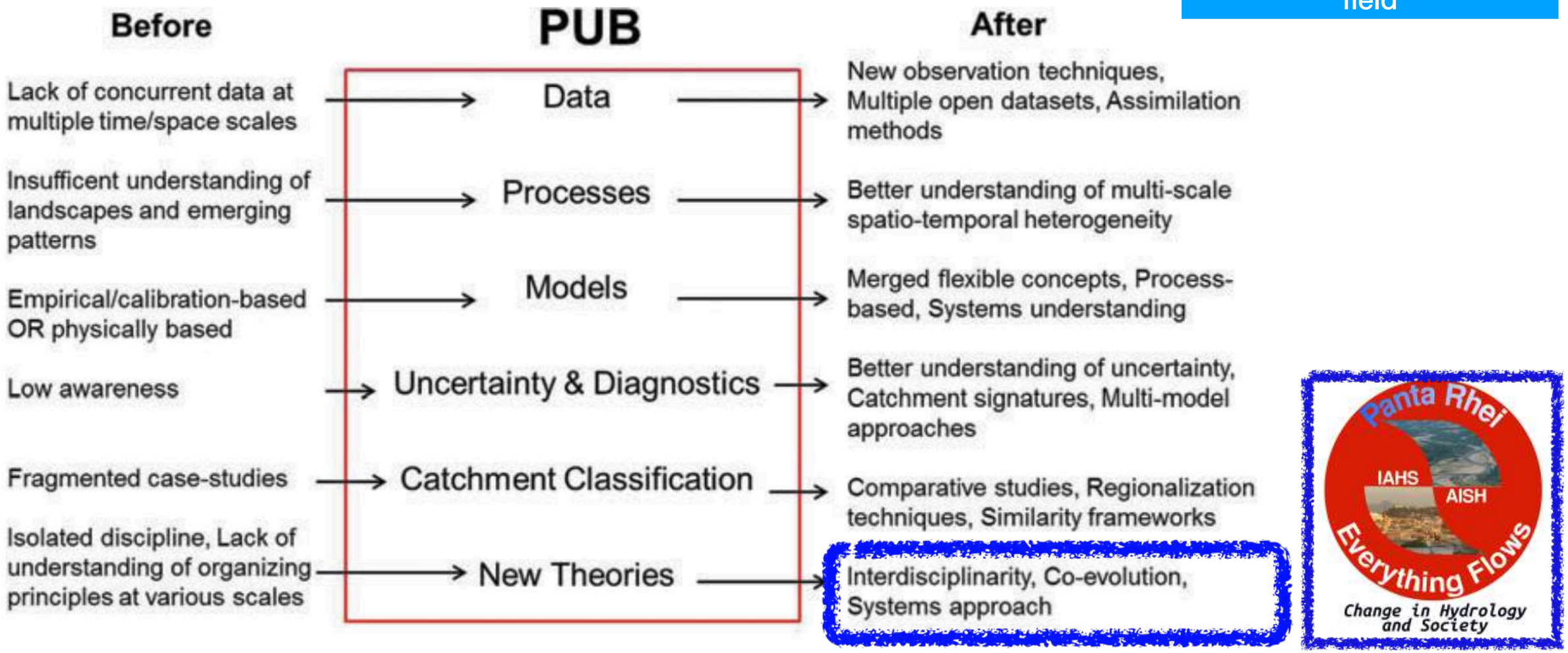
Cissé, G., R. McLeman, H. Adams, P. Aldunce, K. Bowen, D. Campbell-Lendrum, S. Clayton, K.L. Ebi, J. Hess, C. Huang, Q. Liu, G. McGregor, J. Semenza, and M.C. Tirado, 2022: Health, Wellbeing, and the Changing Structure of Communities. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1041–1170, doi:10.1017/9781009325844.009.

https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Chapter07.pdf

Last 20 years of Hydrology….

Outline of how scientific understanding evolved and the way of thinking shifted towards new questions during the PUB Decade…

…and how it has evolved into a more interdisciplinary field



Panta Rhei
IAHS
AISH
Everything Flows
Change in Hydrology and Society

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Panta Rhei Decade: Everything Flows (Society & Hydrology Under Change)

FOLHA DE S.PAULO

ambiente › planeta em transe amazônia sob bols

Agência FAPESP • UNIVERSIDADE •
MUDANÇA CLIMÁTICA

Políticas de gestão de risco ainda são insuficientes para limitar impacto de efeitos climáticos extremos

Cientistas dizem que campanhas permanentes de políticas educacionais que incentivem o uso racional e o reaproveitamento de água são primordiais para evitar crises

20.out.2022 às 4h00

EDIÇÃO IMPRESSA

Principal Edição Folha Minha Folha Seções

FOLHA DE S.PAULO

saúde › coronavírus saúde responde ciência

CORONAVÍRUS

Nascidos no dia 1 da pandemia completam mil dias; entenda impacto na primeira infância

Especialistas cobram políticas públicas para reverter possíveis danos no desenvolvimento de crianças

5.dez.2022 às 23h15

Ouvir o texto A- A+

Anna Virginia Balloussier

Principal Edição Folha Minha Folha Seções

Contextos, Aceleradores, Atores

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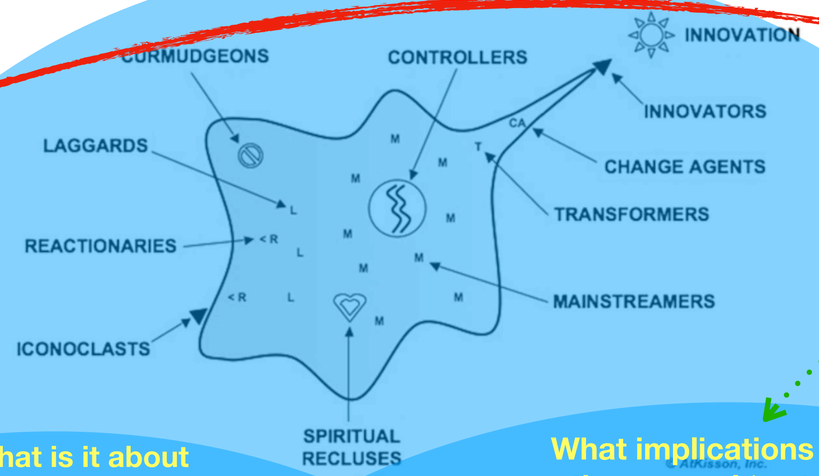
Community of Practice of * : 1st-iteration roadmap

"WBSRC" (*)
Water, Biodiversity, ecosystem Services for society, Resilience to climate change, and Cultural heritage

How can we scale solutions and decision-making using 'water security'?

How Can We Boost Community of Practice on 'Water Security' Under Risks of the Food-Energy-Health Nexus?



What is it about developing countries that demands a different approach to 'water security' from developing countries?

What implications do these novel 'water security' have for strategic actions / governance?

Community of Practice on 'WATER SECURITY'

What new/different approaches have been proven to address the challenge of 'water security' in developing countries?

Contributory citizen science
(Majority of early online citizen science projects)

Co-creation & participatory approaches
(Citizen social sciences, AR, science shops)

Scientist as project designer | Participatory technology or strategy | Citizens as data gatherers

Citizens' & CSOs' real-world problems | Scientist as co-designer and facilitator | Shared, open, reflexive research process

How can we accelerate communication using 'Water Security' Under Risks of the Food-Energy-Health Nexus?

How Can 'Water Security' Reimagine Habitats, Restore Landscapes and Recreate Job Market for Vulnerable Communities?

Suggested topics of Applied Solutions on Water Security from Climate Services

- Water resources and water security
- Nature-based Solutions
- People Centered Early Warning Systems
- Climate change mitigation: net zero carbon emissions, water/ energy/food nexus
- Climate change adaptation: risk & resilience, flood management
- Circular economy, treatment technologies, reuse and recycling
- Modelling & control of water+wastewater systems, digital twins
- Sensors and sensor data analysis
- Water management in urban, peri-urban and rural areas, WASH
- Sustainable Insurance of WaterMulti-Risk, Multi-Hazards

Water Wise Cities (C) 2019 I.W.A.

Change in Hydrology and Society

"Panta Rhei" (C) 2019 I.A.H.S.

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INCT MC2
INCT para Mudanças Climáticas · Fase 2

COVID-induced interdisciplinary communication among INCTMC2's partners & pos-IPCC/AR6 intersectorial dialogue with international stakeholders under new regulation frameworkd of the Brazilian Water Security Plan (PNSH, 2019-2035), the New Brazilian Water Security Act (#14026/2020) and the Payment for Ecosystem Service Act (#14.114)

"Absorptive"-Resilience

"Adaptive" Resilience

Science

Technology

INCTM- C2 water security alliances with other FAPESP interdisciplinary projects (C4AI #2019/07665-4, MADIS #2019/23393-4, CeMEAI #2013/07375-0) through: NbS efficiency under LULC (SSP) & climate (RCP), EbA valuation & water risk management

HYDROINFORMATICS

INCTMC2 water security alliances with international initiatives of: UNESCO-IHP IX Phase (2022-2029), UNEP WWQA/GEMS, WMO Strategic Plan, #Act4SDGs, IBPES & COP27 to accelerate science-for-policy adaptation with disruptive open innovation for climate-resilient startups and jobs for a low-carbon economy under SDGs (2022-2030)

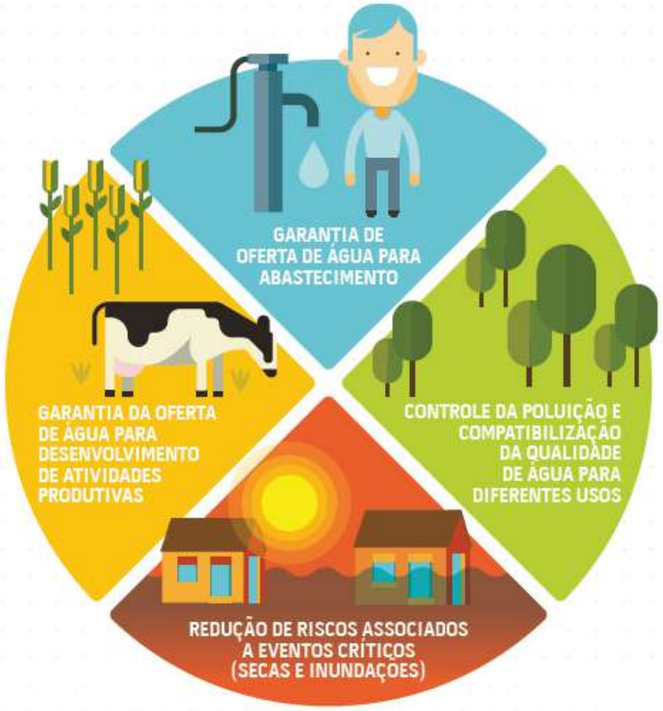
Innovation

"Transformative" Resilience

Community of Practice in the Context of Water security

Human dimension

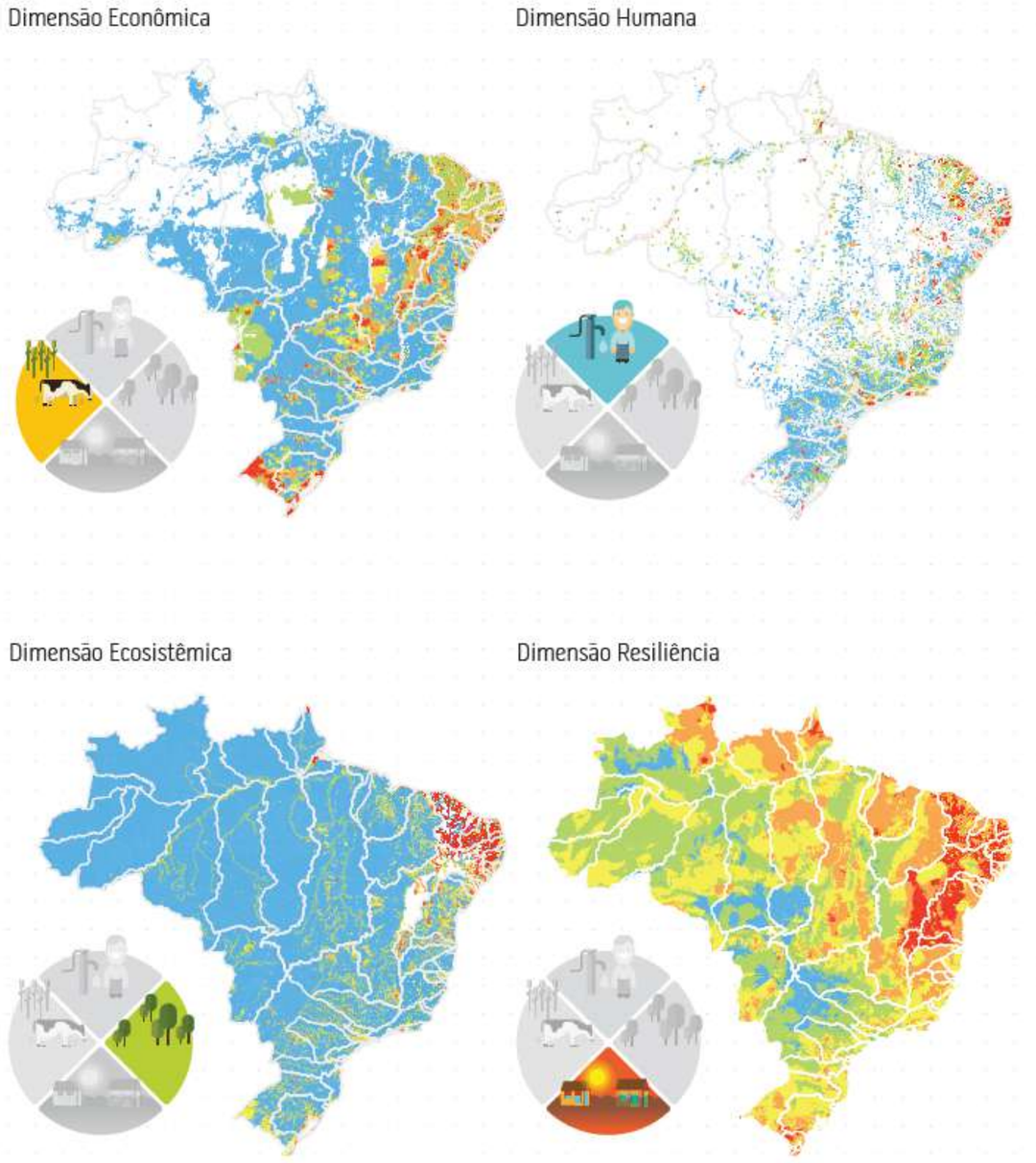
Economic dimension



Ecossystem dimension

Resilience dimension

(C) Agencia Nacional de Águas - ANA



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nature

Article | Open Access | Published: 03 August 2022

The challenge of unprecedented floods and droughts in risk management

Heidi Kreibich ✉, Anne F. Van Loon, ... Giuliano Di Baldassarre + Show authors

Nature **608**, 80–86 (2022) | Cite this article

https://www.nature.com/articles/s41586-022-04917-5

Mendiondo (2023) Missão de Pesquisa FAPESP, Fortaleza-CE, 6/2/2023

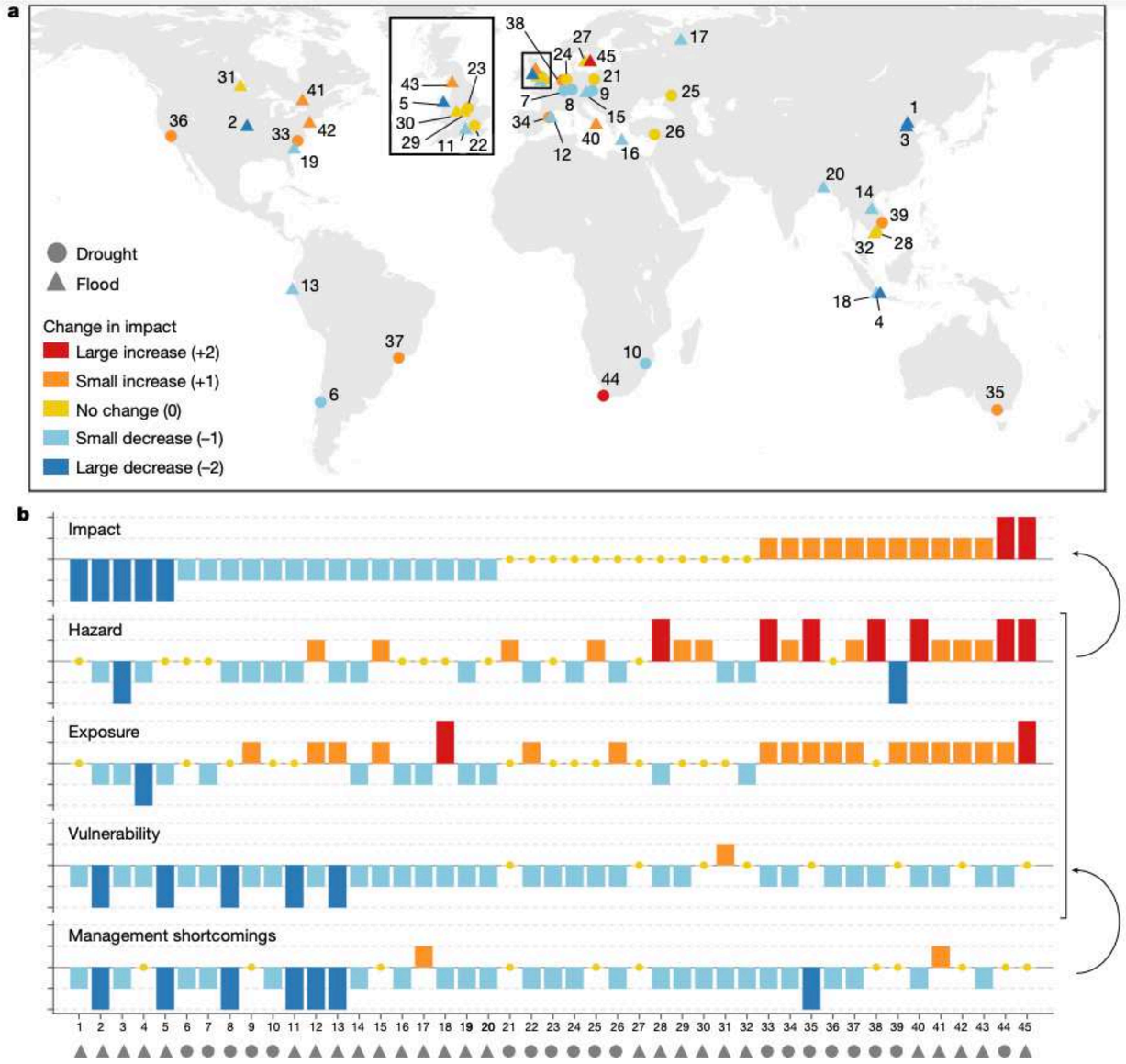
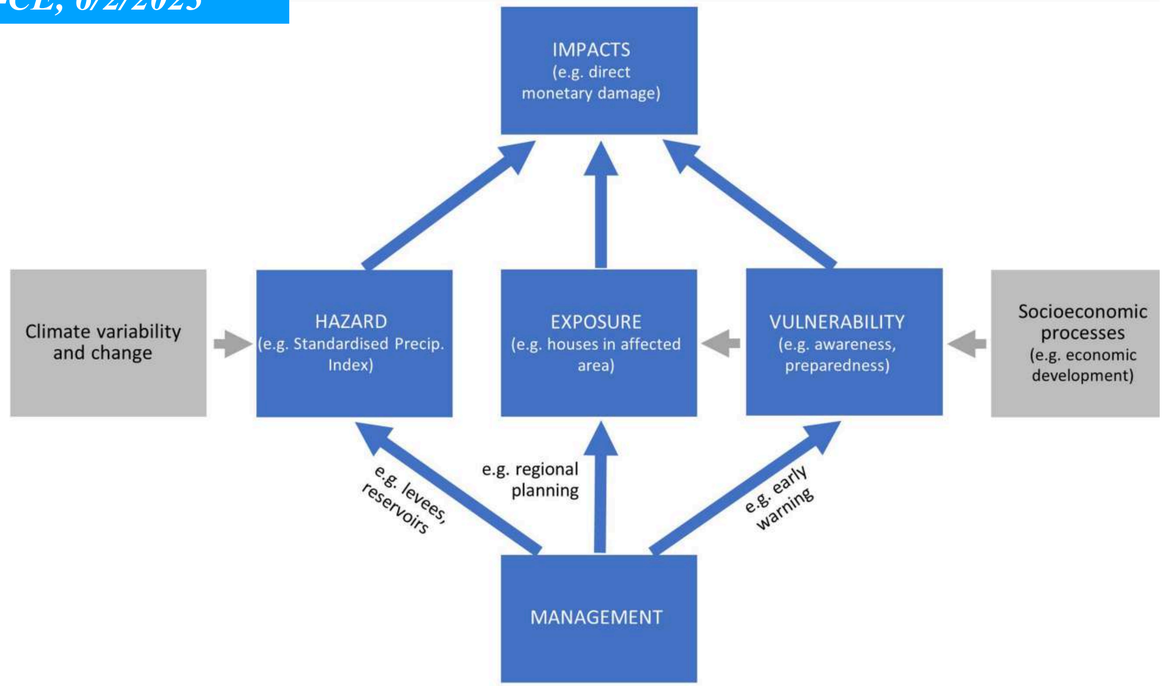


Fig. 1 | Location of flood and drought paired events coloured according to changes in impact and their indicators of change. a, Location of flood and drought paired events ($n = 45$). Numbers are paired-event IDs. **b**, Indicators of change, sorted by impact change. Impact is considered to be controlled by hazard, exposure and vulnerability, which are exacerbated by risk management shortcomings. Maps of the paired events coloured according to drivers and management shortcomings are shown in Extended Data Fig. 1.



Extended Data Fig. 4 | Theoretical framework used in this study (adapted from IPCC[3]). This theoretical risk framework considers impact as a result of thre risk components or drivers: hazard, exposure and vulnerability, which in turn are modified by management.

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The challenge of unprecedented floods and droughts in risk management

Heidi Kreibich, Anne F. Van Loon, ... Giuliano Di Baldassarre + Show authors

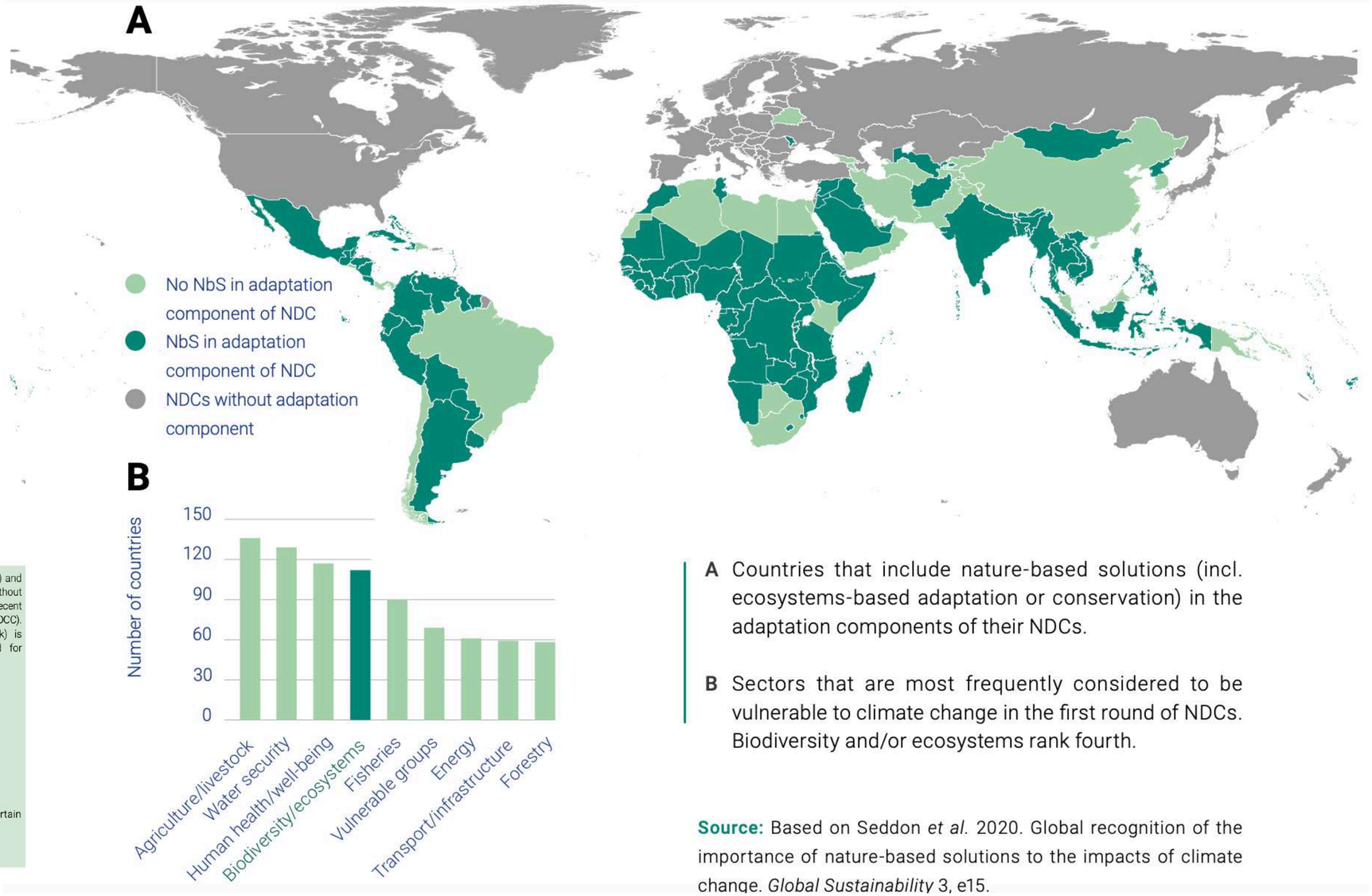
Nature **608**, 80–86 (2022) | Cite this article

17k Accesses | **350** Altmetric | Metrics

NbS' in Developing Countries: Global Adaptation Needs

United Nations Environment Programme (2021). Adaptation Gap Report 2020. Nairobi (UNEP, UNEP DTU Partnership (UDP) & the World Adaptation Science Programme (WASP). https://www.unep.org/adaptation-gap-report-2020

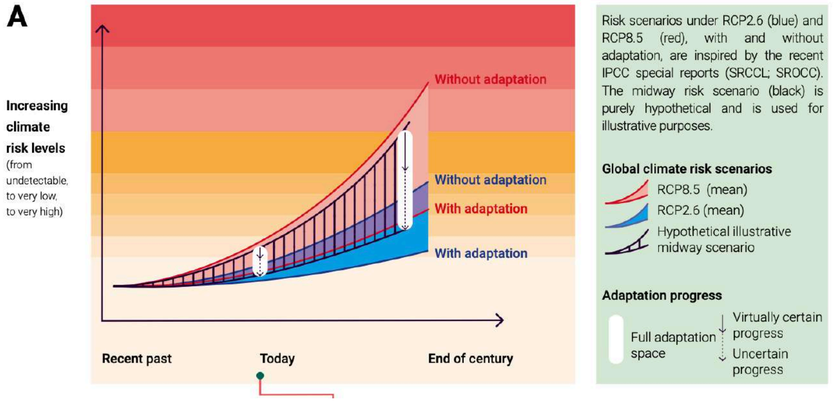
- NAPs: : https://www4.unfccc.int/sites/NAPC/News/Pages/national_adaptation_plans.aspx.
- NDCs: https://www4.unfccc.int/sites/ndcstaging/Pages/Home.aspx.
- Database available here: https://climate-laws.org.



A Countries that include nature-based solutions (incl. ecosystems-based adaptation or conservation) in the adaptation components of their NDCs.

B Sectors that are most frequently considered to be vulnerable to climate change in the first round of NDCs. Biodiversity and/or ecosystems rank fourth.

Source: Based on Seddon *et al.* 2020. Global recognition of the importance of nature-based solutions to the impacts of climate change. *Global Sustainability* 3, e15.



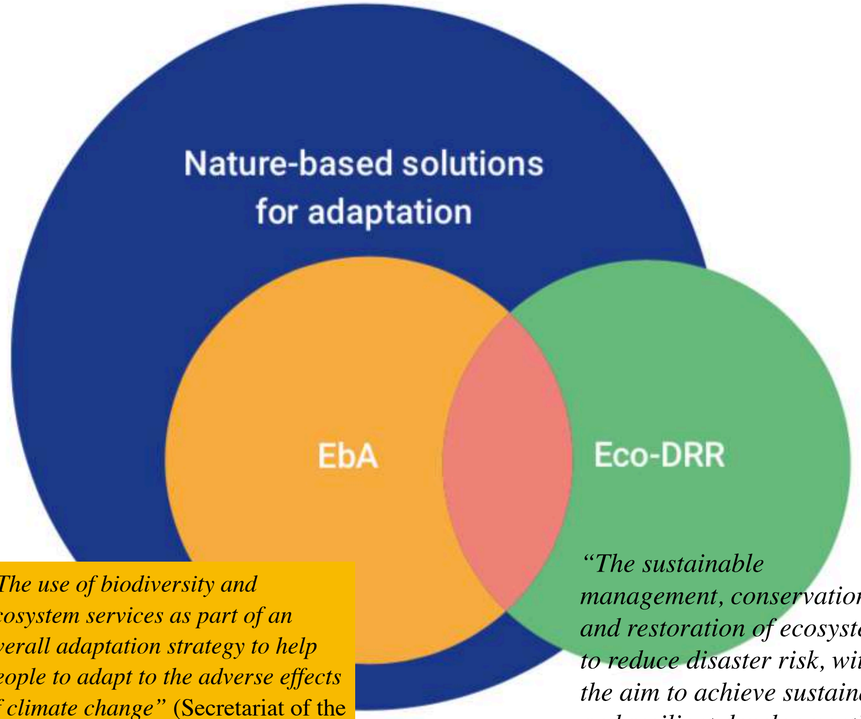
NbS in Developing Countries: Definitions & Concepts to Apply in Demonstrative Projects

Seddon et al (2021)

Glob Change Biol.

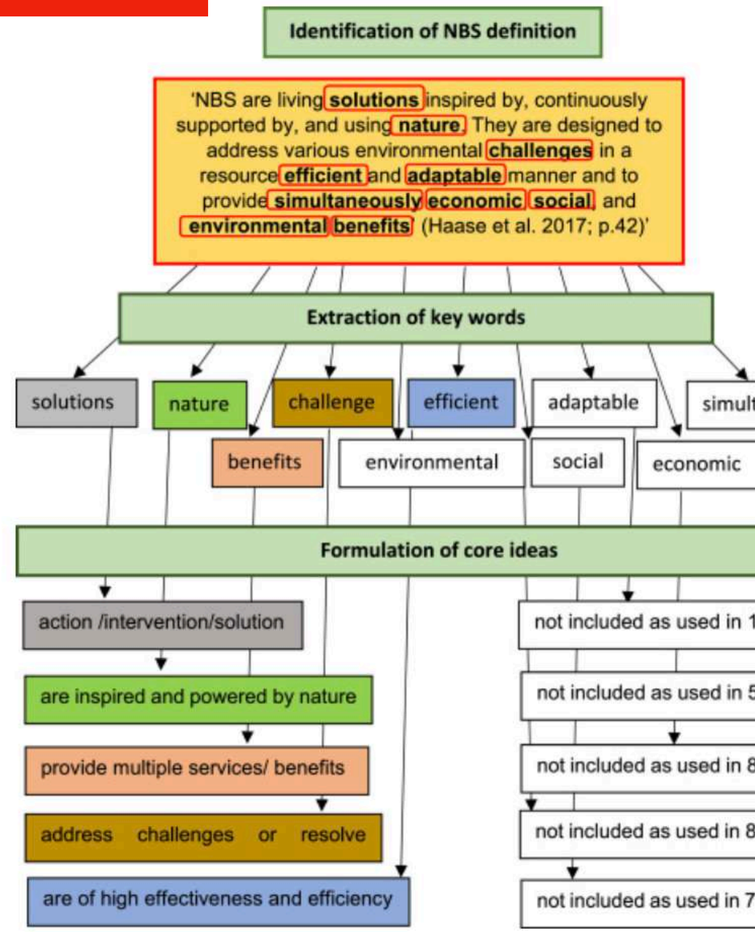
DOI: 10.1111/gcb.15513

United Nations Environment Programme (2021). Adaptation Gap Report 2020. Nairobi (UNEP, UNEP DTU Partnership (UDP) & the World Adaptation Science Programme (WASP). https://www.unep.org/adaptation-gap-report-2020



"The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change" (Secretariat of the Convention on Biological Diversity [CBD] 2009).

"The sustainable management, conservation and restoration of ecosystems to reduce disaster risk, with the aim to achieve sustainable and resilient development" (Estrella and Saalismaa 2013).



Sowińska-Świerkosz & García (2022) What are Nature-based solutions (NBS)? Setting core ideas for concept clarification, Nature-based Solutions

Nature-Based Solutions and Climate Change – Four Shades of Green

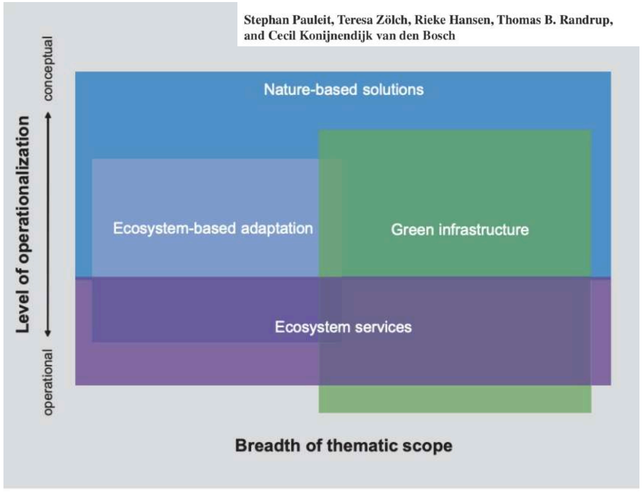


Fig. 3.1 Illustration of thematic scope and current level of operationalization of the four concepts

Eco-DRR is depicted as being only partially within the term **NbS** for adaptation as **Eco-DRR** can also refer to activities and approaches that address non-climatic disaster risk, such as tsunamis and earthquakes. As **EbA** refers to ecosystem-based approaches to climate change adaptation, it is situated entirely within the scope of **NbS** for adaptation.

Mendiondo et al (2022) How Can We Boost Community of Practice on Nature-based Solutions Under Risks of the Food-Energy-Health Nexus?

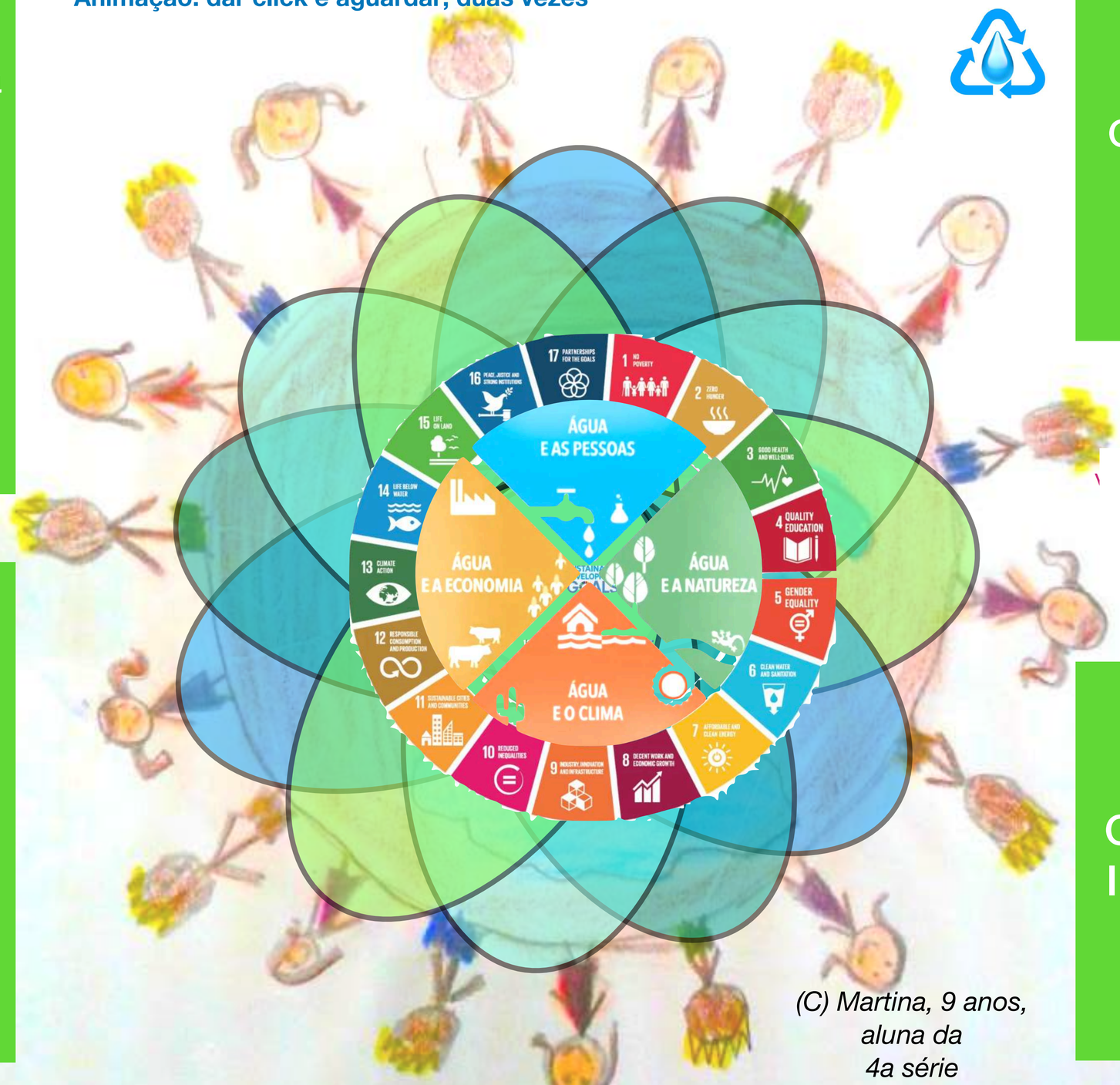
Animação: dar click e aguardar; duas vezes

1

Modelo de Governança recomendado via Subcomponente de Segurança Hídrica do INCTMC2 (diferentes níveis concêntricos e dinâmicos que “giram” entre si)

2

Centro: Índice de Segurança Hídrica (ANASBPNSH-2035) que ao girar exige comunicação interdisciplinar com ODSs e INCTMC2-SegurançaHídrica



(C) Martina, 9 anos, aluna da 4a série

3

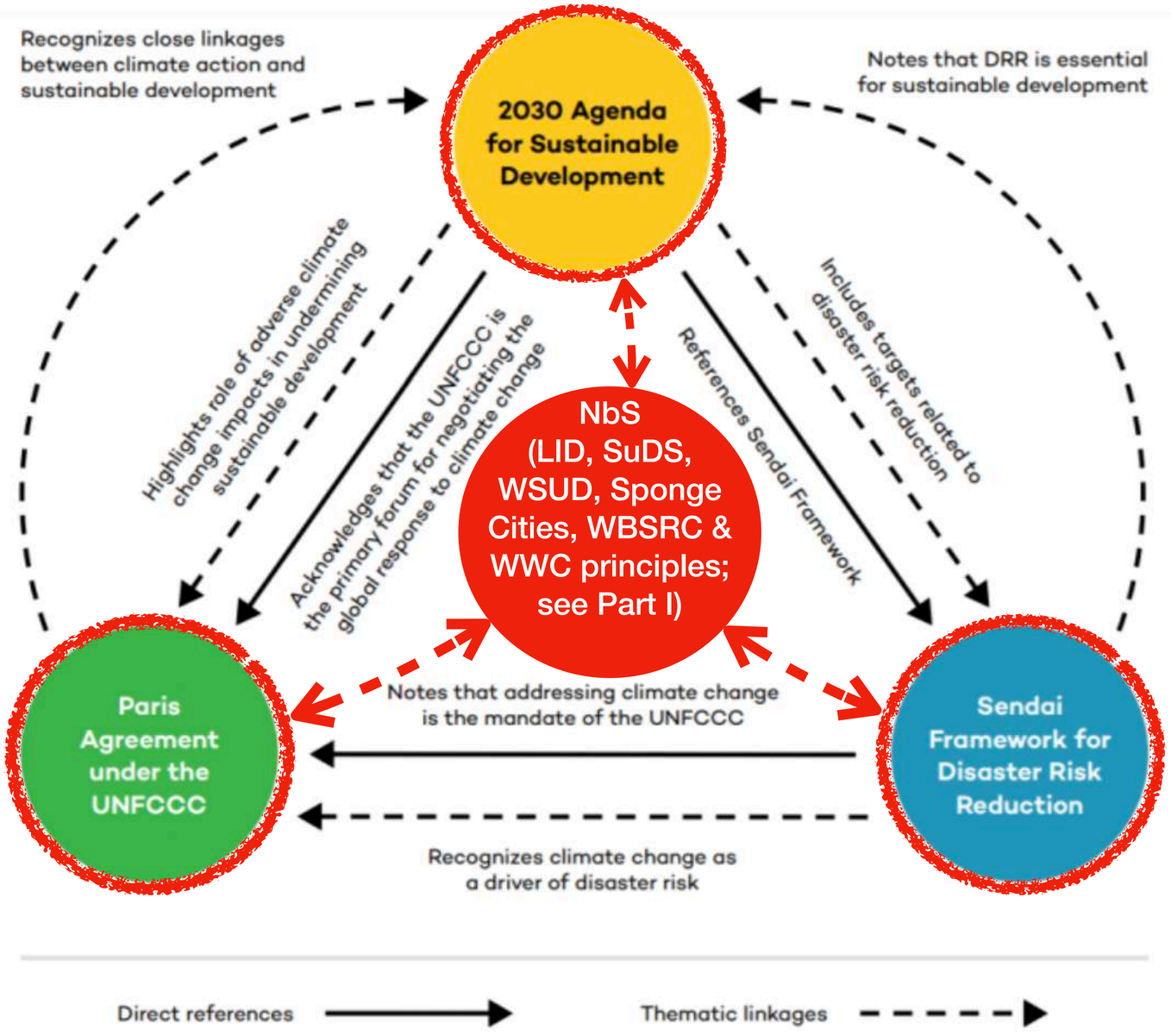
Ciclo Intermediário: ODS (Agenda 2030), ao girar tem atuação interdisciplinar com INCTMC2-SegurançaHídrica

INCT MC2
INCT para Mudanças Climáticas · Fase 2

4

Ciclo Exterior: Objetivos e Metas do INCTMC2 Segurança Hídrica focada em Pessoas e Usuários (cidadãos)

NbS as a ACCELERATOR from Global Programs to Local Demonstrative Sites using WWC principles (IWA, 2019) + WBSRC principles (Zalewski et al, 2019)



"WBSRC" : Water, Biodiversity, ecosystem Services for society, Resilience to climate change, and Cultural heritage

Ecohydrology & Hydrobiology
Volume 18, Issue 4, December 2018, Pages 309-310
ELSEVIER

Low cost, nature-based solutions for managing aquatic resources: integrating the principles of Ecohydrology and the Circular Economy

Maciej Zalewski [1, 2], Giuseppe Arduino [3], Giovanni Bidoglio [4], Wolfgang Junk [5], Johannes Cullmann [6], Stefan Uhlenbrook [7], Jun Xia [8], Carlos Garcia de Leaniz [9], Pawel M. Rowinski [10], Charles J. Vörösmarty [11, 12], Luis Chicharo [13]

"WWC" - Water Wise Cities

17 Principles for Water-Wise Cities

4 Levels of Action

1 Regenerative Water Services
- Replenish Waterbodies and their Ecosystems
- Reduce the Amount of Water and Energy Used
- Reuse, Recover, Recycle
- Use a Systemic Approach Integrated with Other Services
- Increase the Modularity of Systems and Ensure Multiple Options

2 Water Sensitive Urban Design
- Enable Regenerative Water Services
- Design Urban Spaces to Reduce Flood Risks
- Enhance Liveability with Visible Water
- Modify and Adapt Urban Materials to Minimise Environmental Impact

3 Basin Connected Cities
- Plan to Secure Water Resources and Mitigate Drought
- Protect the Ecological Health of Water Resources
- Prepare for Extreme Events

4 Water-Wise Communities
- Empowered Citizens
- Professionals Aware of Water Co-benefits
- Transdisciplinary Planning Teams
- Policy Makers Enabling Water-Wise Action
- Leaders that Engage and Engender Trust

5 Building Blocks

Vision | Governance | Knowledge & Capacity | Planning Tools | Implementation Tools

Figure 1: The "Principles for Water-Wise Cities" Framework: four Levels of Action and five Building Blocks for urban stakeholders to deliver "Sustainable Urban Water" in their cities

“Absorptive” Resilience

Icebreking topic:
How can we scale NbS in vulnerable community under risks of Agenda 2030’s SDGs?

Question 2: What new/ different approaches have been proven to address the challenge of NBS in developing countries?

Icebreking topic:
How can we communicate nature-based solutions (NbS) for decision-makers ?

Question 1: What is it about developing countries that demands a different approach to NbS-digital water from developed countries?

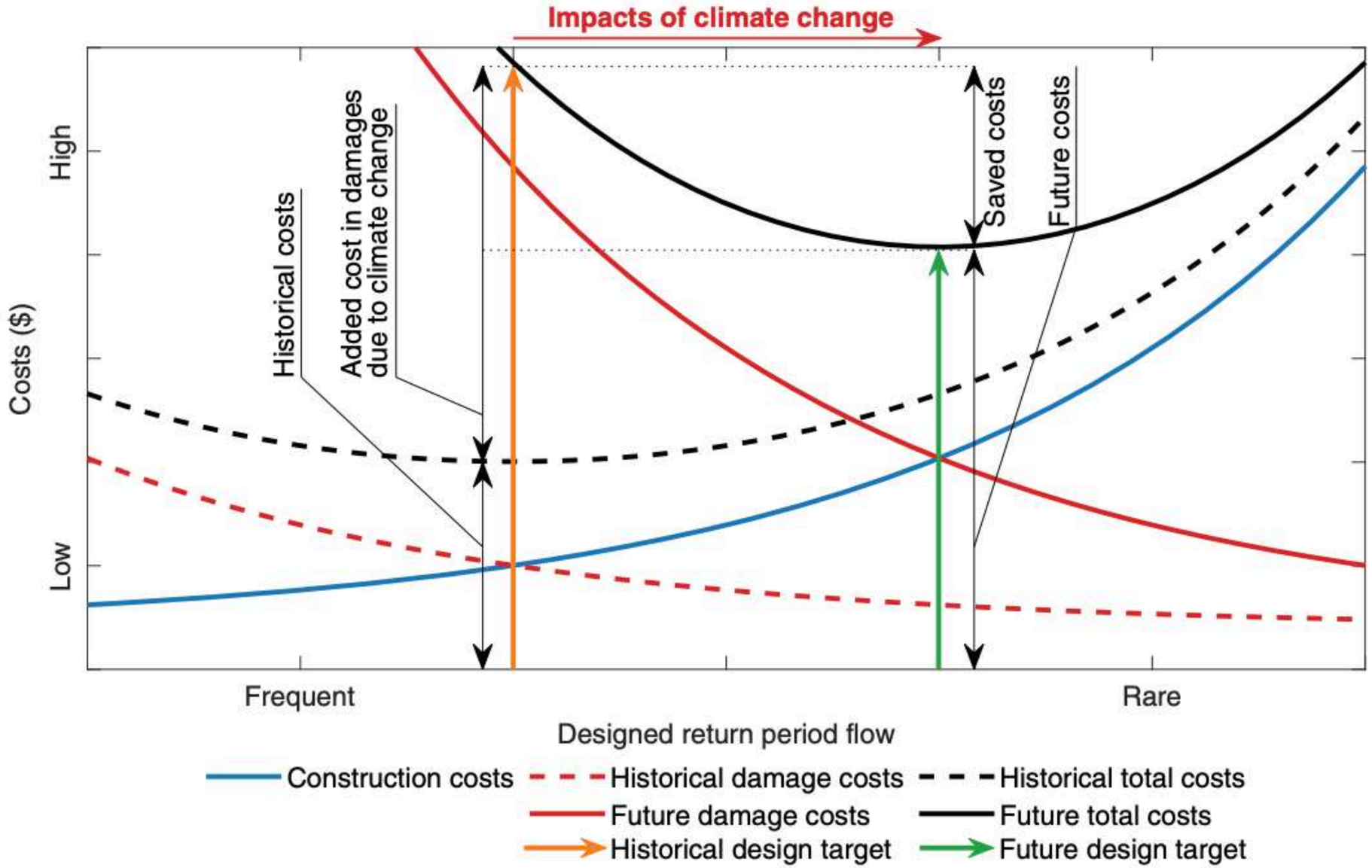
“Adaptive Resilience

Icebreaking topic: How can we boost a wider ‘Community of Practice on NbS’ through Open Science ?

Question 3: What implications do these have for strategic actions / governance?

Icebreaking topic:
How can NbS help reimagining new habitats, restoring landscapes and recreating the water job market for vulnerable communities?

“Transformative Resilience

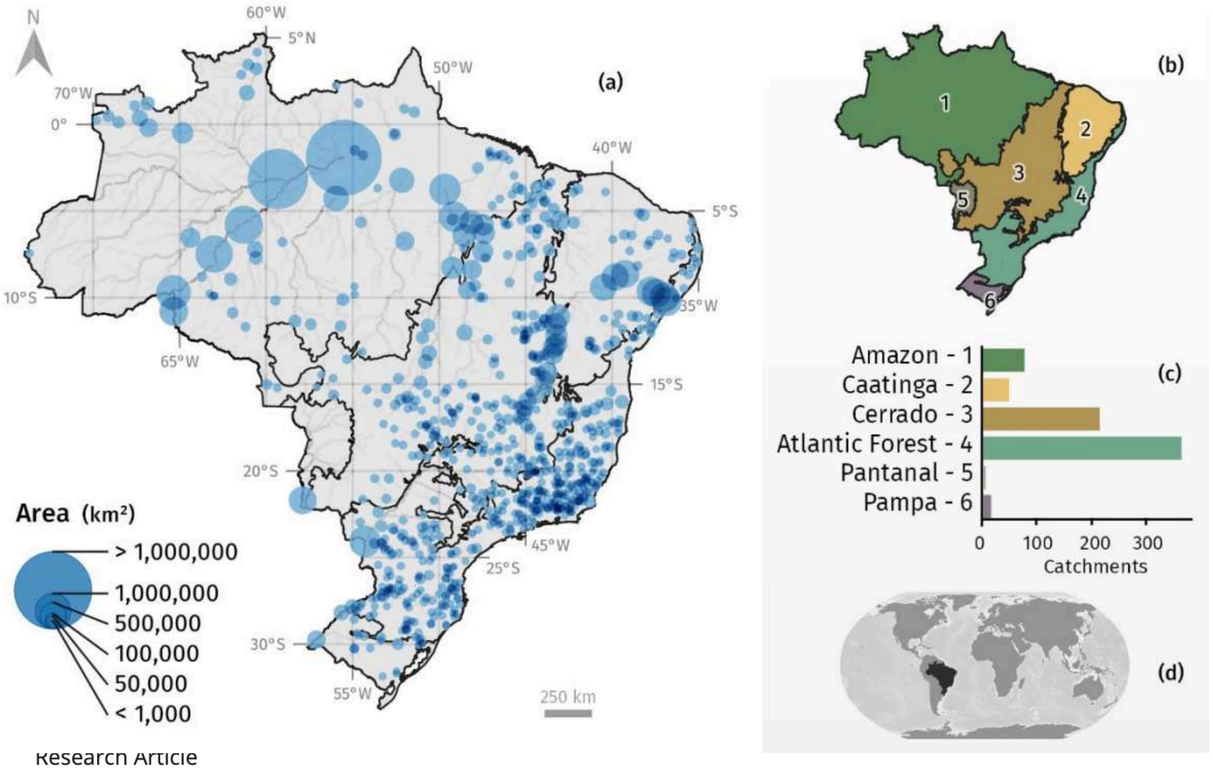


(Color) Conceptualization of climate change impacts on the theoretical design compromise for typical urban infrastructure.

Martel et al 2021, Climate Change and Rainfall Intensity–Duration–Frequency Curves: Overview of Science and Guidelines for Adaptation (https://ascelibrary.org/doi/full/10.1061/%28ASCE%29HE.1943-5584.0002122)

Brazilian cases, i.e. with impacts of open water balance for controlling long-term streamflow

Mendiondo (2023) Missão de Pesquisa FAPESP, Fortaleza-CE, 6/2/2023



Research Article

The Impact of an Open Water Balance Assumption on Understanding the Factors Controlling the Long-Term Streamflow Components

André S. Ballarin ✉, Paulo Tarso S. Oliveira, Bruno K. Marchezepe, Raquel F. Godoi, Aline M. Campos, Fabrizio S. Campos, André Almagro, Antônio A. Meira Neto

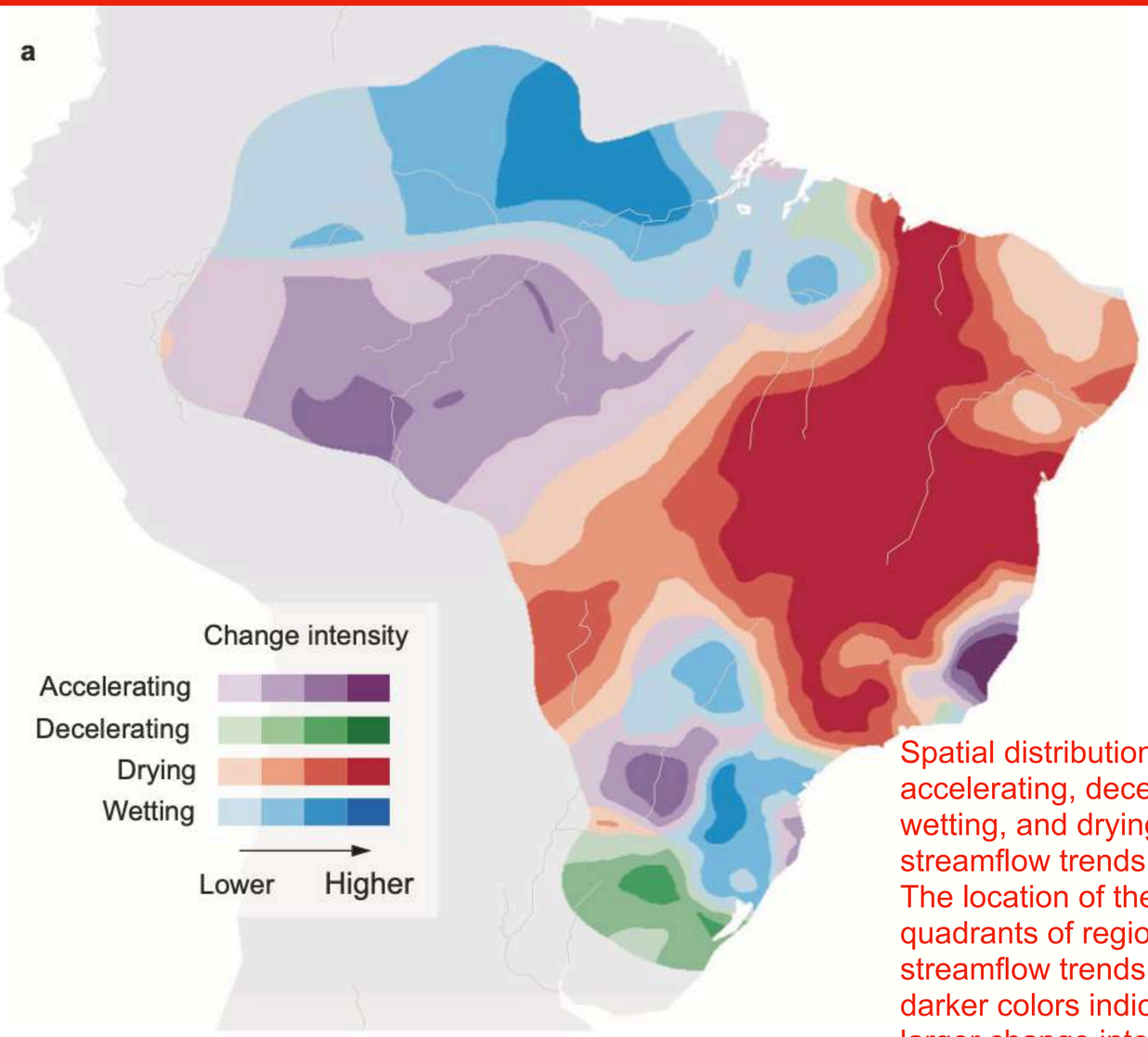
First published: 23 September 2022 | https://doi.org/10.1029/2022WR032413

Key Points:

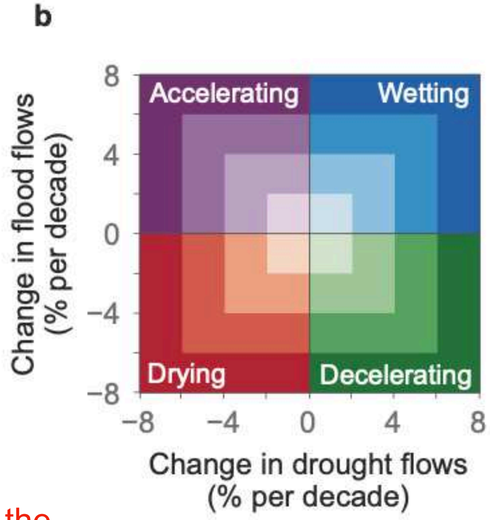
- assessed the controls on long-term streamflow components under an open water balance assumption,
- inclusion of inter-catchment groundwater flow improves the performance of aridity-based formulations to describe long-term streamflow,
- Partitioning streamflow into baseflow and quickflow improves the understanding of the water balance control mechanisms

https://doi.org/10.1029/2022WR032413

Brazilian cases, i.e. climate and land management accelerating the water cycle



Spatial distribution of the accelerating, decelerating, wetting, and drying streamflow trends in Brazil. The location of the four quadrants of regional streamflow trends, with darker colors indicating larger change intensities



https://doi.org/10.1038/s41467-022-32580-x

Explanation of the color code for water cycle:

"Accelerating": 29% (2.7 m km^2);

"Decelerating": 4% (0.4 m km^2);

"Drying": 42% (3.9 m. km^2)

"Wetting": 25% (2.4 m km^2).

nature communications

Article

https://doi.org/10.1038/s41467-022-32580-x

Climate and land management accelerate the Brazilian water cycle

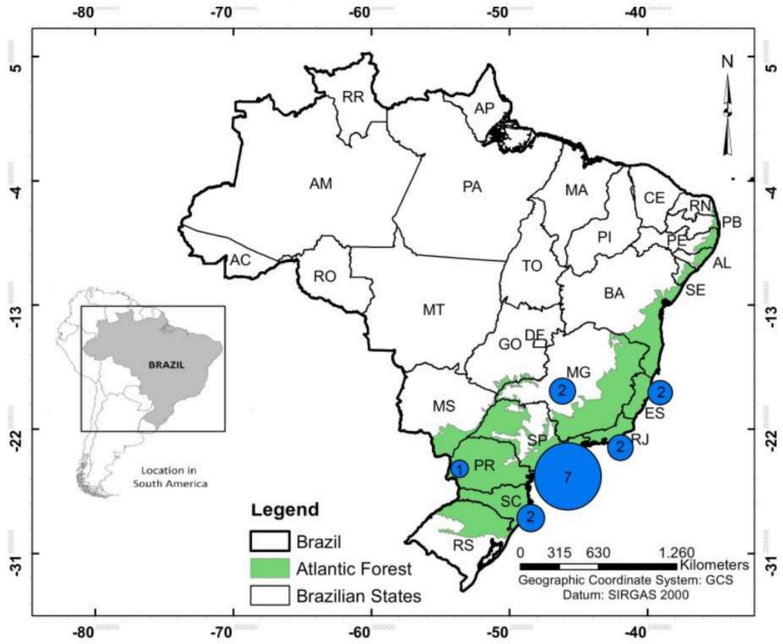
Received: 2 August 2021

Accepted: 4 August 2022

Vinícius B. P. Chagas[1], Pedro L. B. Chaffe[2] & Günter Blöschl[3]

Example I:

climate services, water security and circular framework with feedbacks, scales and stakeholders [c]



Brazilian States

WATER-PES PROJECTS BY STATE IN THE ATLANTIC FOREST

ELSEVIER

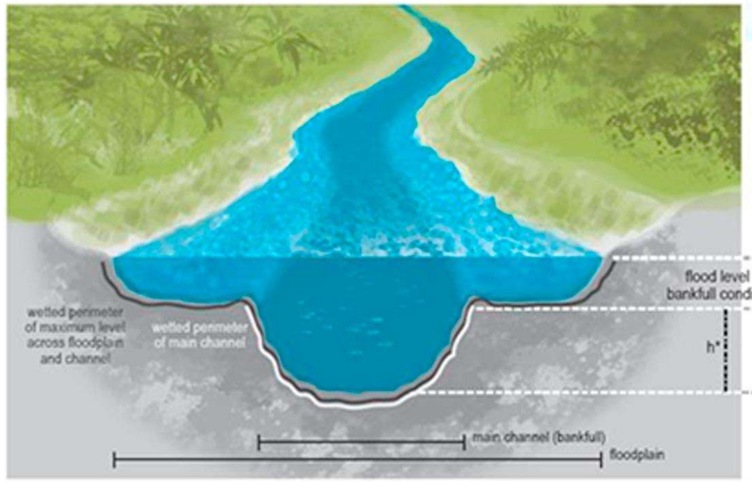
Climate Services

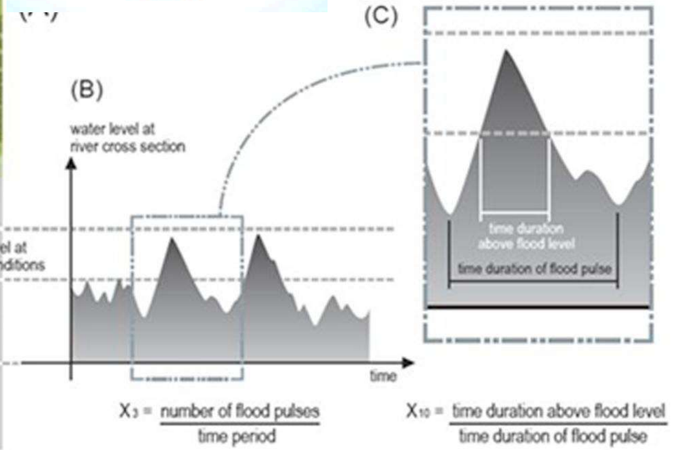
Volume 8, December 2017, Pages 1-16

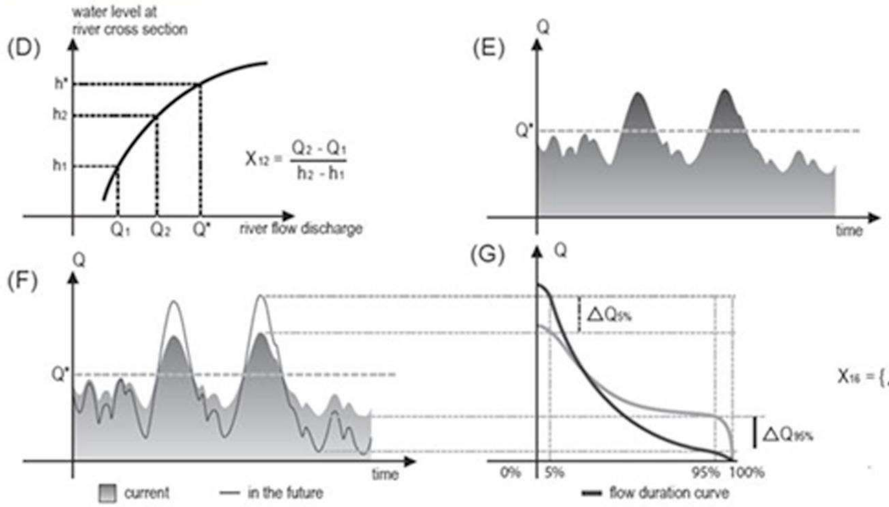
Hydrological services in the Atlantic Forest, Brazil: An ecosystem-based adaptation using ecohydrological monitoring

Denise Taffarello [a], Maria do Carmo Calijuri [a], Ricardo A. Gorne Viani [b], José A. Marengo [c], Eduardo Mario Mendiondo [a]

Community of Practice NbS related to:
River pulse patterns in biomes
Flood rating curves
Flow-duration Curves
Payment of Ecosystem Services
Stakeholders' risk aversion







[c]: https://doi.org/10.1016/j.cliser.2017.10.005

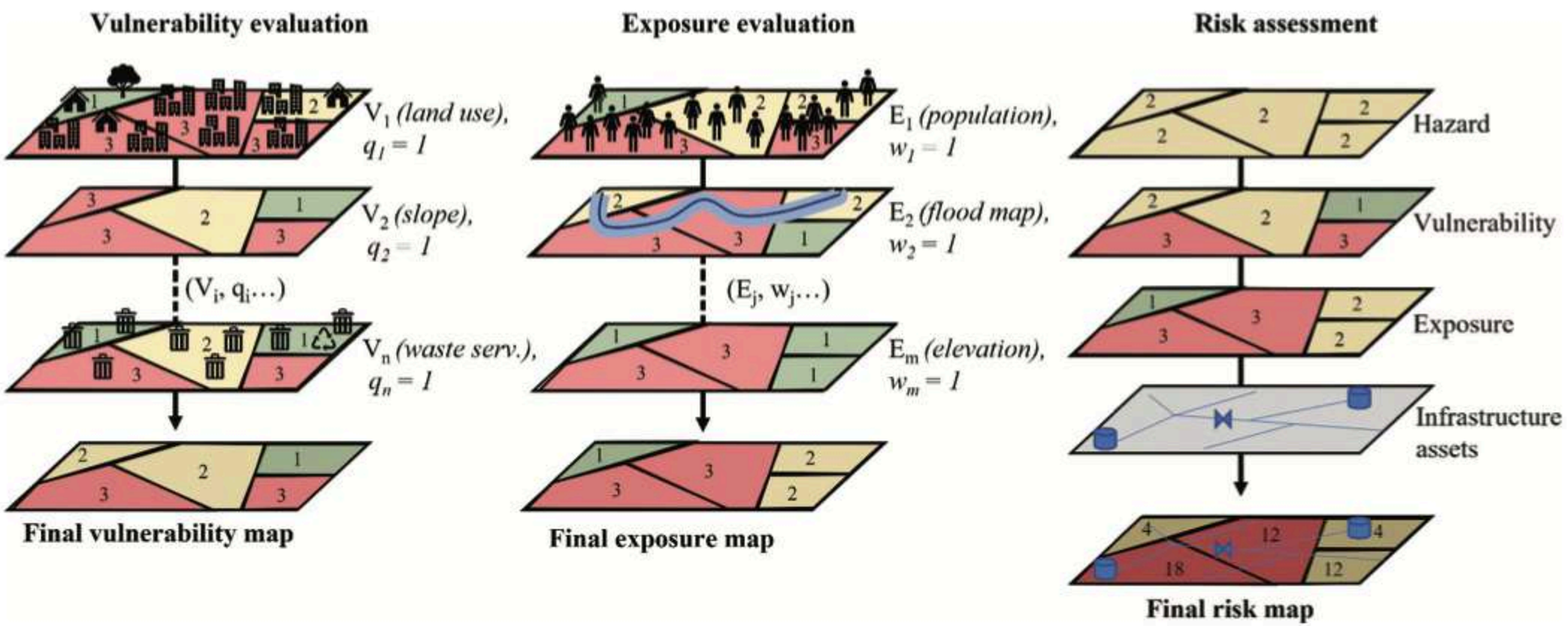


Figure 3. Spatial risk estimation model for sanitation infrastructure through geospatial integration of its components.

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URBAN WATER JOURNAL
https://doi.org/10.1080/1573062X.2022.2047737
Taylor & Francis
Taylor & Francis Group
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RESEARCH ARTICLE

Multi-stage resilience analysis of the nexus flood-sanitation-public health in urban environments: a theoretical framework

Marina Batalini de Macedo[a], Eduardo Mario Mendiondo[b], Maria Tereza Pepe Razzolini[a], N. K. Goel[c], Dhyan S. Arya[c], Mathew Kurian[d]* and Adelaide Cassia Nardocci[a]*

[a]School of Public Health, University of Sao Paulo, São Paulo – SP, Brazil; [b]Sao Carlos Engineering School, Department of Hydraulics and Sanitation, University of Sao Paulo, São Paulo – SP, Brazil; [c]Department of Hydrology, Indian Institute of Technology Roorkee, Roorkee, India; [d]Water-Energy-Food Nexus, Pennsylvania State University, State College, PA, USA

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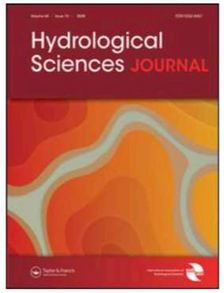


Hydrological Sciences Journal

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/thsj20

Unveiling water security in Brazil: current challenges and future perspectives

Gabriela Chiquito Gesualdo, Jullian Souza Sone, Carlos de Oliveira Galvão, Eduardo Sávio Martins, Suzana Maria Gico Lima Montenegro, Javier Tomasella & Eduardo Mario Mendiondo

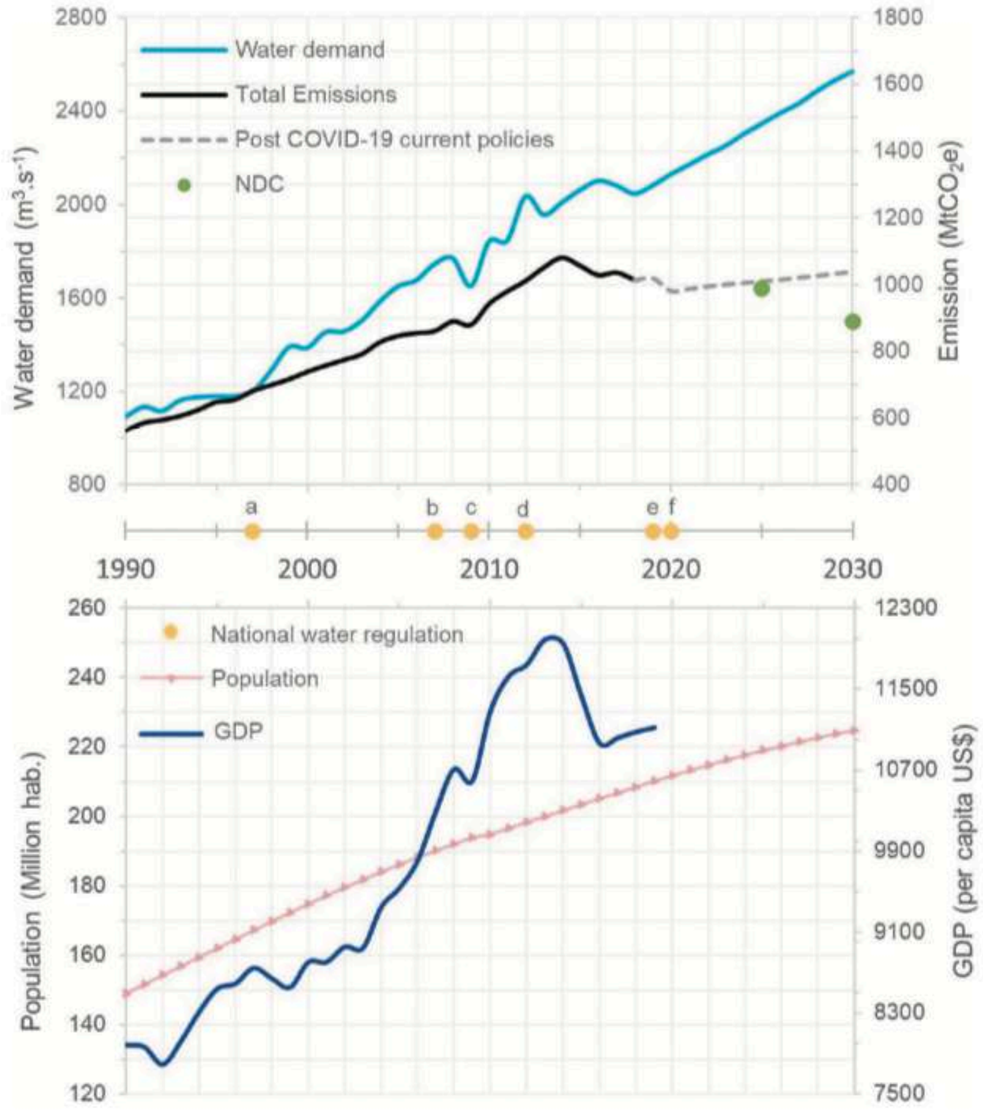


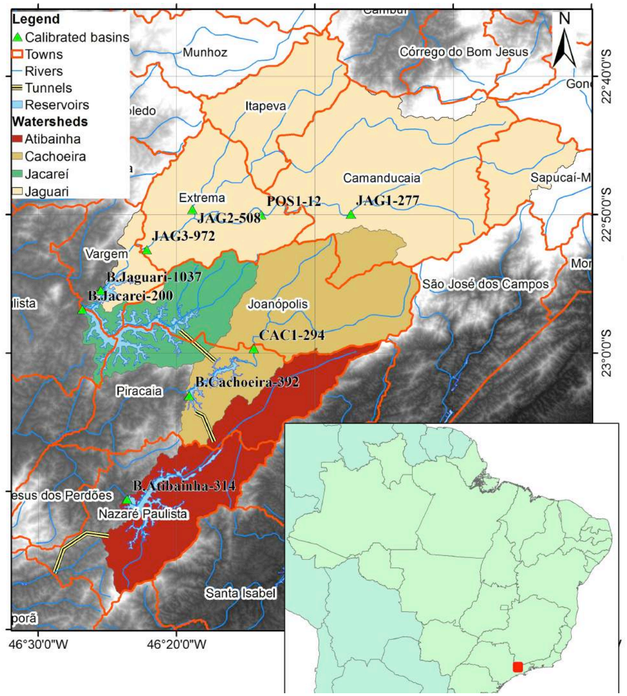
Figure 3. Correlation of data on water demand, CO_2 emissions, population growth, gross domestic product (GDP), Nationally Determined Contributions (NDCs), and national water regulations from 1990 to 2030. National water regulations: (a) Act 9433/1997: National Water Resources Policy; (b) Act 11445/2007: National Guidelines for Basic Sanitation; (c) Act 12187/2009: National Policy on Climate Change; (d) Act 12608/2012: National Policy for Civil Protection and Defense; (e) Water Security National Plan; (f) Act 14026/2020: Update of the Basic Sanitation Act. *Data are in constant 2010 US dollars (1USD = 1.76 Brazilian Real - BRL). Sources: CAT (2020), IBGE (2020), World Bank (2020).

Mendiondo (2023) Missão de Pesquisa FAPESP, Fortaleza-CE, 6/2/2023

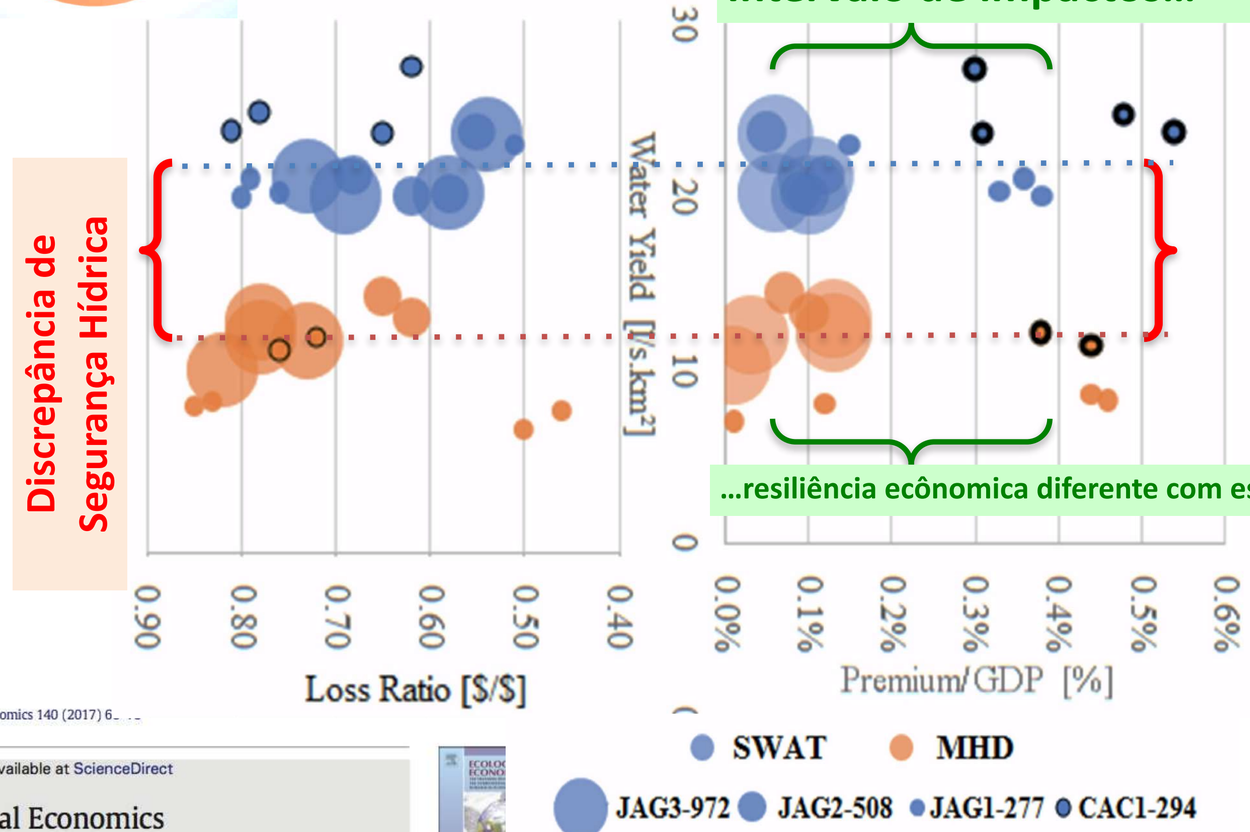
"ÁGUA E A NATUREZA": Resiliência depende do tamanho de bacias doadoras

INCT MC2 INCT para Mudanças Climáticas · Fase 2

Incertezas de Segurança Hídrica: exemplo de cenários 2010-2099 com modelos hidrológicos diferentes(p.ex. SWAT/TAMU MHD/INPE)….



Intervalo de impactos…



…resiliência ecônomica diferente com escala de bacias

Ecological Economics 140 (2017) 6…

Contents lists available at ScienceDirect

Ecological Economics

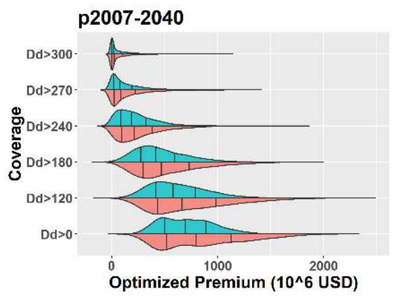
journal homepage: www.elsevier.com/locate/ecolecon

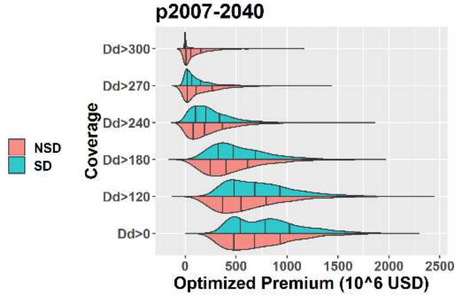
Economic indicators of hydrologic drought insurance under water demand and climate change scenarios in a Brazilian context

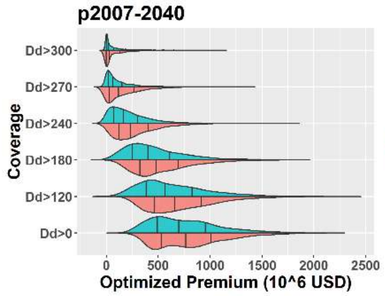
Guilherme Samprogna Mohor *, Eduardo Mario Mendiondo

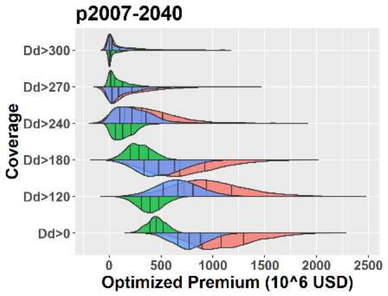
Department of Hydraulic Engineering and Sanitation, Sao Carlos Engineering School, University of Sao Paulo, Sao Carlos, SP, Brazil
National Center for Monitoring and Early Warning of Natural Disasters, Sao Jose dos Campos, SP, Brazil

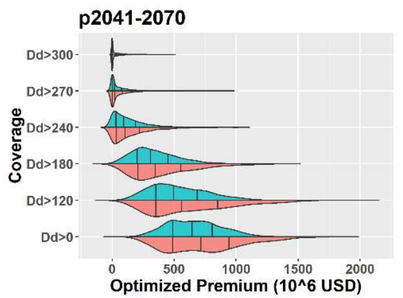
…mas **mecanismos de resiliência financeira** (p.ex. seguros) mostram evidências de forte dependência espacial* (áreas de drenagem de: 294, 277, 508 e 972 km²)

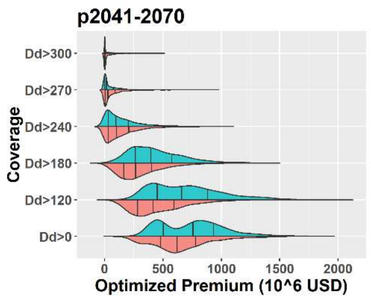


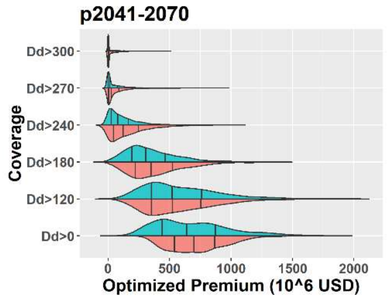


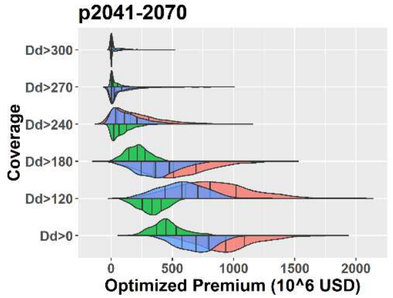


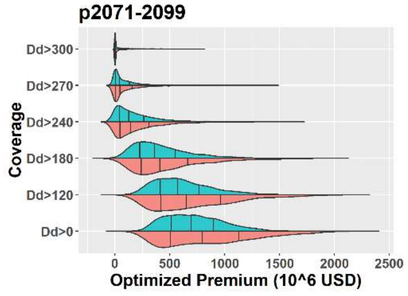


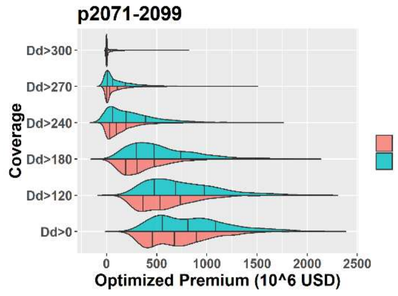


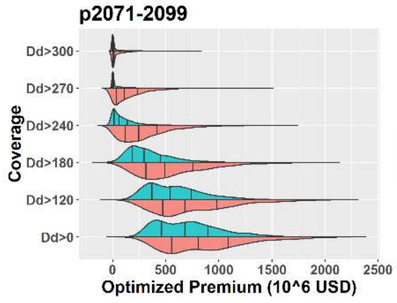


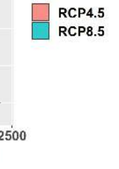


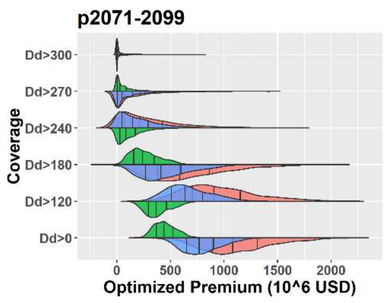












Simulated outputs of climate-driven insurance premiums for Brazilian Megacity's Water Utility from one water supply system under climate change scenarios for different coverage (%) considering the DURATION of water spell and for different future time horizons depending on:

1s column: Stationary Demand (SD) or Non-Stationary Demand (NSD), 2nd. column: climate models; 3rd-column: levels of climate perturbation (RCPs), and 4th column: return period (Tr, = 2 yrs, Tr= 20 yrs, Tr = 100 yrs)

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ÁGUA E AS PESSOAS
ÁGUA E A NATUREZA
ÁGUA E O CLIMA
ÁGUA E A ECONOMIA

Open Access Article

Multi-Year Index-Based Insurance for Adapting Water Utility Companies to Hydrological Drought: Case Study of a Water Supply System of the Sao Paulo Metropolitan Region, Brazil

by Diego A. Guzmán [1,*], Guilherme S. Mohor [2] and Eduardo M. Mendiondo [3]

Contents lists available at ScienceDirect
Ecological Economics
journal homepage: www.elsevier.com/locate/ecolecon

Economic indicators of hydrologic drought insurance under water demand and climate change scenarios in a Brazilian context

Guilherme Samprogna Mohor *, Eduardo Mario Mendiondo

URBAN WATER JOURNAL
https://doi.org/10.1080/1573062X.2022.2058564

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RESEARCH ARTICLE

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Multi-driver ensemble to evaluate the water utility business interruption cost induced by hydrological drought risk scenarios in Brazil

Diego A. Guzmán [a], Guilherme S. Mohor [b] and Eduardo M. Mendiondo [c]

Mendiondo (2023) Missão de Pesquisa FAPESP, Fortaleza-CE, 6/2/2023

Ecohydrology & Hydrobiology
Volume 21, Issue 3, July 2021, Pages 443-453

A novel multistage risk management applied to water-related disaster using diversity of measures: A theoretical approach

Fabricio Alonso Richmond Navarro, Gabriela Chiquito Gesualdo, Renan Gon Ferreira, Luis Miguel Castillo Rápalo, Marcos Roberto Benso, Marina Batalini de Macedo, Eduardo Mario Mendiondo

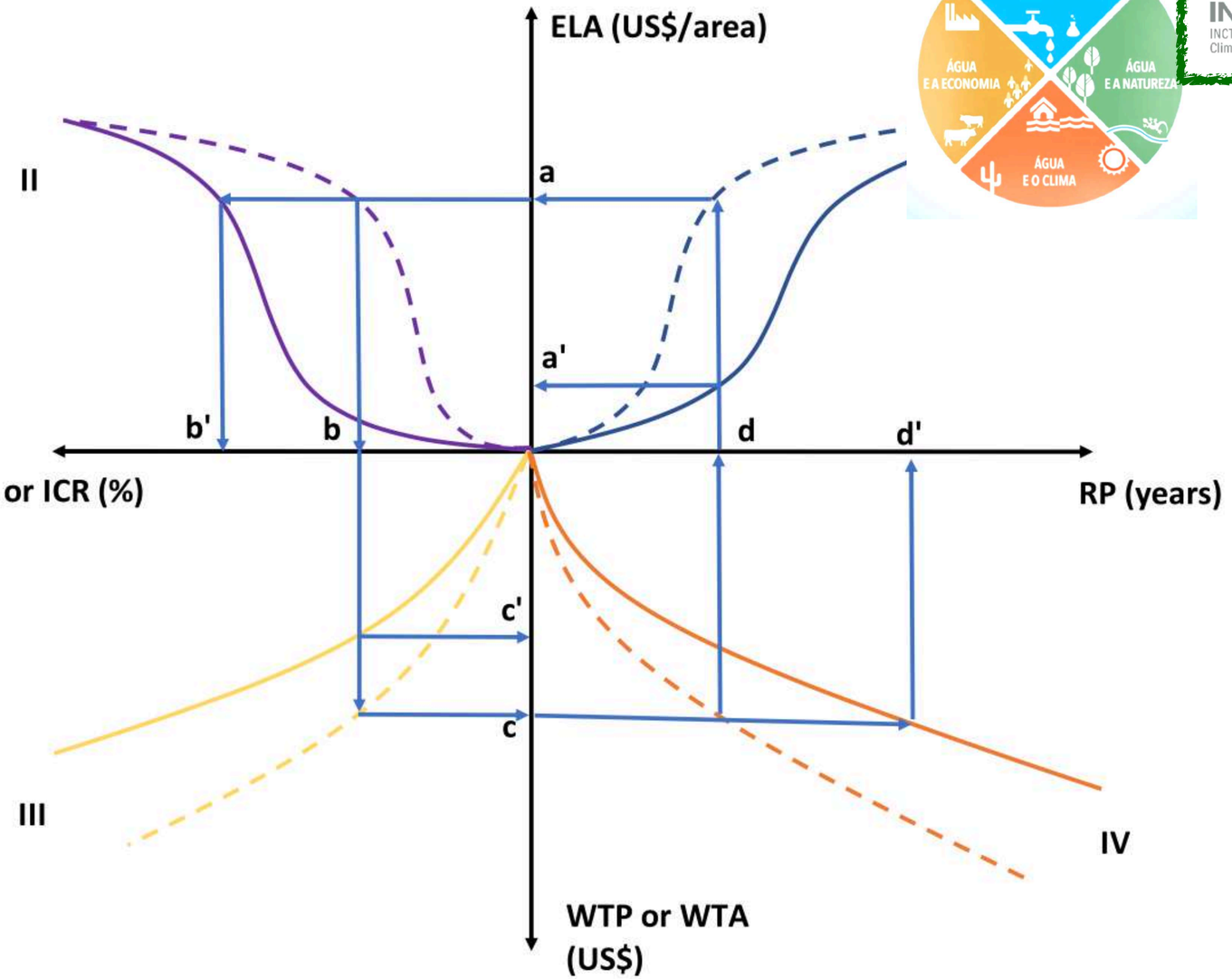
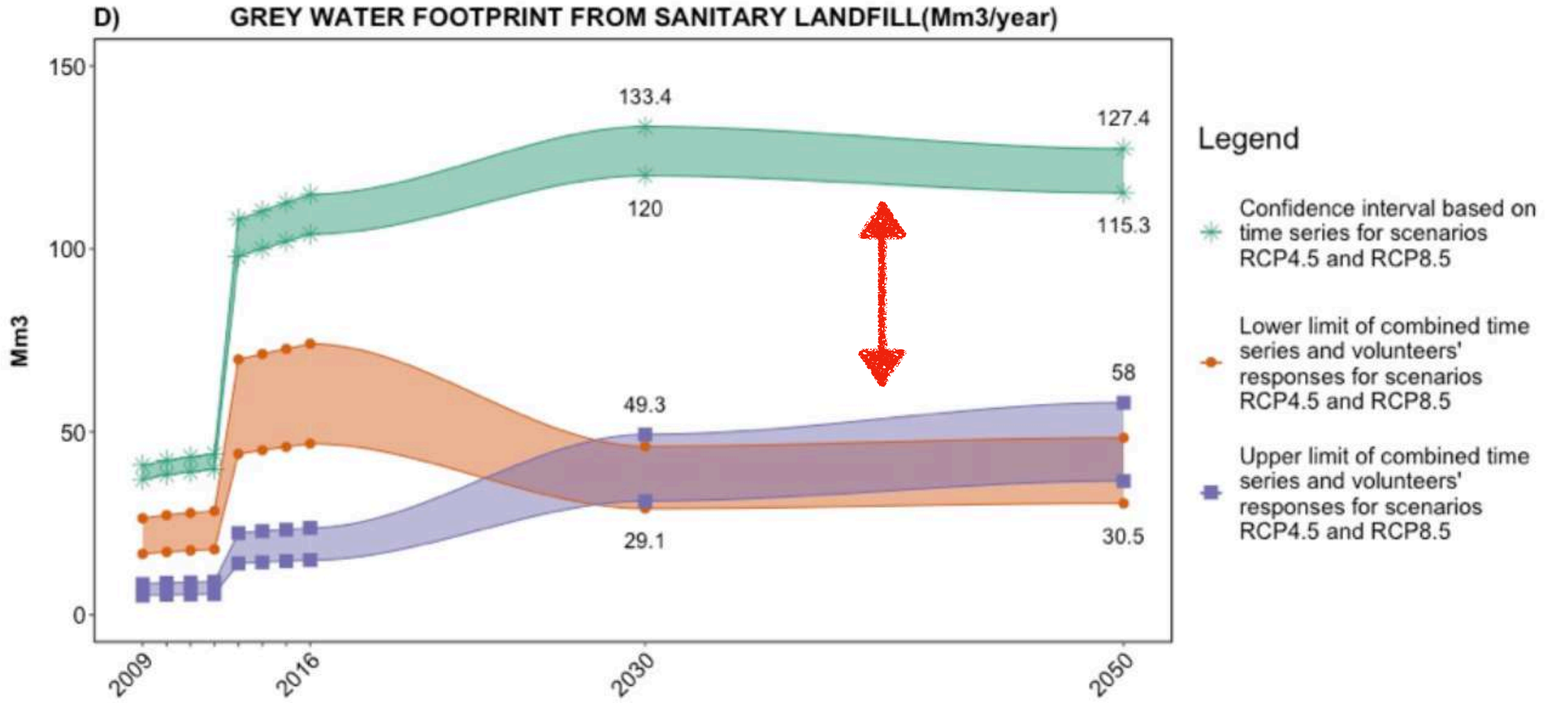


Figure 2. Risk management approach composed for a four-quadrant graph. **Description:** The solid lines represent the first moment, when only is considered a stationary event (I quadrant), grey infrastructure (II quadrant) and people and government are not awake about the necessity to adapt (III and IV quadrant). The dashed line represents our novel approach to improve resilience, considering non-stationary events (I quadrant), NbS combined with grey infrastructure (II quadrant), and the use of multidimensional indices (III and IV quadrant).

Mendiondo (2023) Missão de Pesquisa
FAPESP, Fortaleza-CE, 6/2/2023

Climate Services, Water Security and Citizen Science Awareness



Citizen-science awareness discrepancy about of landfill solid waste *WFGrey* accounting in a Brazilian mid-size municipality throughout the aggregated 2009-2050 period. The 2009-2016 $WFGrey_{SolidWaste}$ time series is aggregated with the 2020-2050 RCP 4.5 & RCP 8.5 climate change scenarios and volunteer participatory perceptions. Source: Souza et al (2020).

Differences between citizen awareness and climate change predictions about grey water footprint from urban cities

HYDROLOGICAL SCIENCES JOURNAL
https://doi.org/10.1080/02626667.2021.1879388

SPECIAL ISSUE: ADVANCING SOCIO-HYDROLOGY

Blue and grey urban water footprints through citizens' perception and time series analysis of Brazilian dynamics

Felipe Augusto Arguello Souza[a], Namrata Bhattacharya-Mis[b], Camilo Restrepo-Estrada[a,c], Patricia Gober[d], Denise Taffarello[a], José Galizia Tundisi[e,f] and Eduardo Mario Mendiondo[a]

[a]Department of Hydraulics and Sanitation, São Carlos School of Engineering, University of São Paulo, São Carlos, Brazil; [b]Geography and International Development, University of Chester, Chester, UK; [c]Economic Sciences/Department of Statistics and Mathematics, University of Antioquia, Medellin, Colombia; [d]School of Geographical Sciences and Urban Planning, Arizona State University, Tempe, Arizona, USA; [e]International Institute of Ecology, São Carlos, Brazil; [f]São Carlos Municipality, Secretary of Environment, Science and Technology, São Carlos, Brazil

Mendiondo (2023) Missão de Pesquisa
FAPESP, Fortaleza-CE, 6/2/2023

How can we communicate Climate Services and Water Security using nature-based solutions (NbS)[a] under risks of F-E-H nexus?

Estrada Municipal de Payol Grande, Sao Bento do Sapucaí-SP, Brazil / E.M.M. 2020

Mendiondo et al (2022) How Can We Boost Community of Practice on Nature-based Solutions Under Risks of the Food-Energy-Health Nexus?

Example III:

climate services, water security and ecosystem-based valuation using water footprint[e]

Community of Practice of NbS related to:
Grey Water Footprint
Flow-Duration Curves
Valuation Methods
Conservation Effects
Restoration Impacts

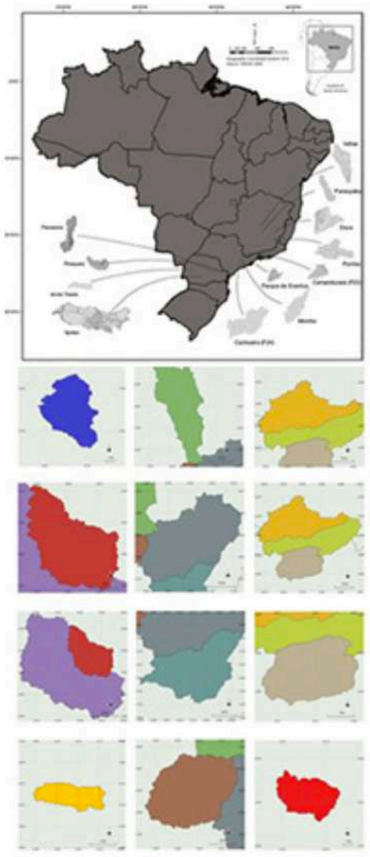
ELSEVIER

Science of The Total Environment

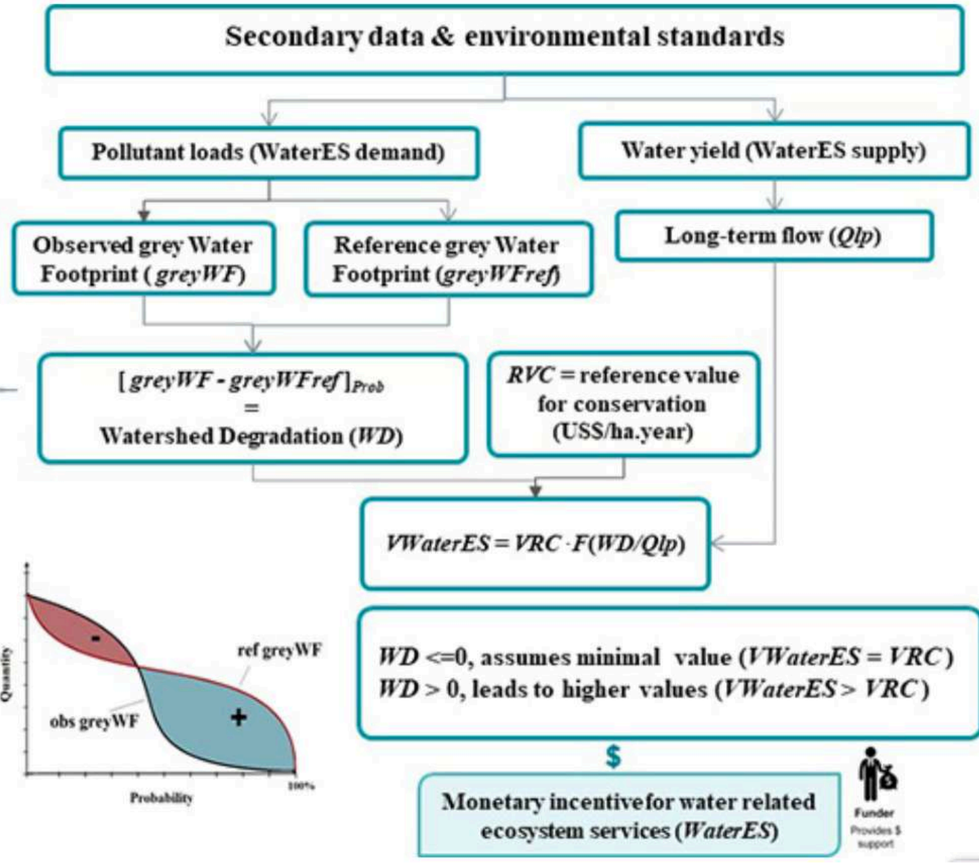
Volume 738, 10 October 2020, 139408

Ecosystem service valuation method through grey water footprint in partially-monitored subtropical watersheds

D. Taffarello [a, b], M.S. Bittar [a, c], K.S. Sass [d], M.C. Calijuri [a], D.G.F. Cunha [a], E.M. Mendiondo [a]



Diversity of Brazilian basins under different climates, drainage areas, land uses and river regimes (water quantity and quality).



[e]: https://doi.org/10.1016/j.scitotenv.2020.139408

Mendiondo (2023) Missão de Pesquisa FAPESP, Fortaleza-CE, 6/2/2023

"Water & Nature"

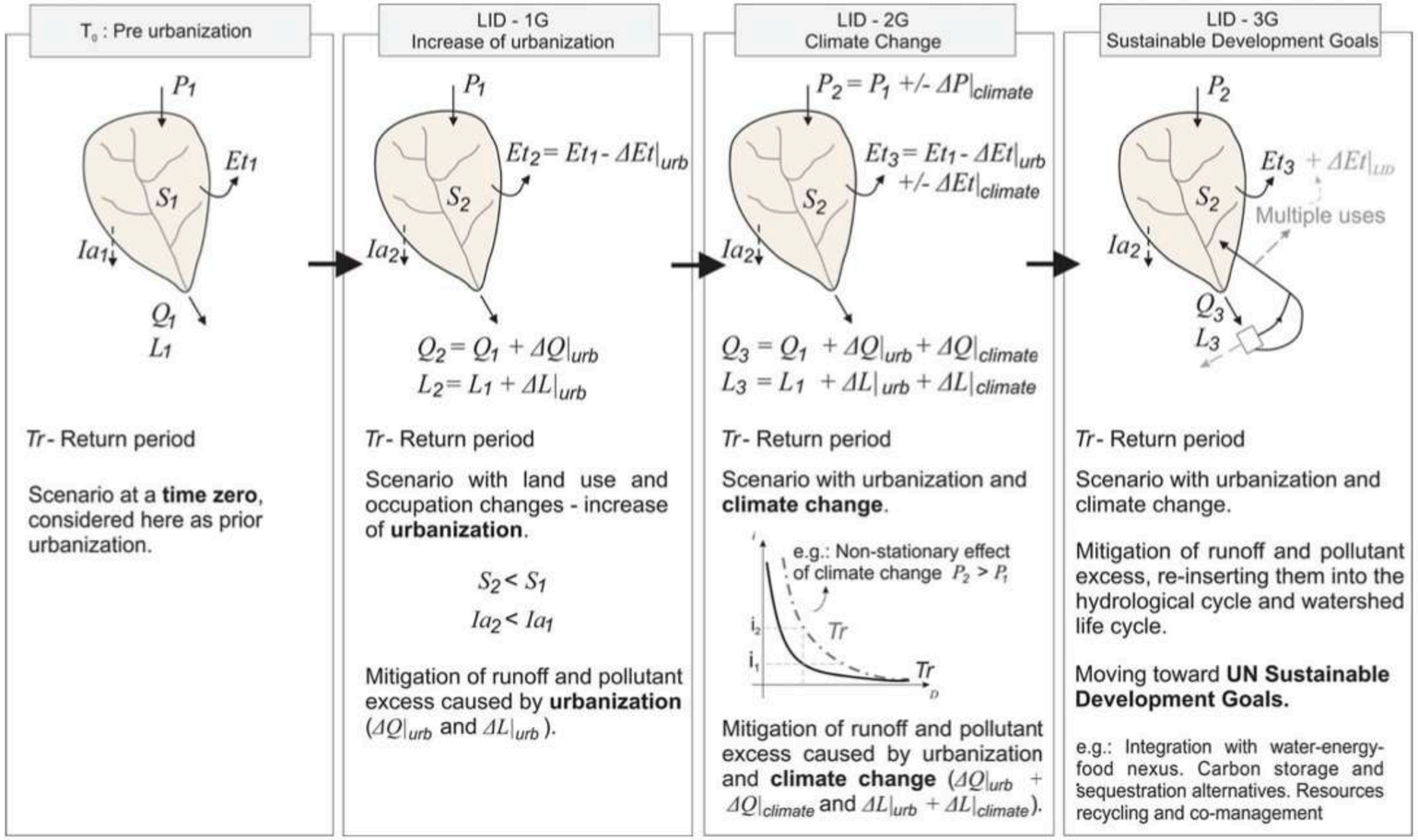


Figure 1. Concept and evolution of LID practices generations in terms of water balance variables and mitigation purpose. In the figure, P_1, Et_1, Q_1, L_1, S_1, Ia_1 and Tr represent, respectively, rainfall, evapotranspiration, runoff, pollutant load, soil storage capacity, infiltration and return period to base scenario of preurbanization (adapted from Macedo et al. (2017)).

INCT MC2
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New oportunities from climate services to envisioning water security and life cycle analysis

CRITICAL REVIEWS IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY
https://doi.org/10.1080/10643389.2021.1886889
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Low Impact Development practices in the context of United Nations Sustainable Development Goals: A new concept, lessons learned and challenges

Marina Batalini de Macedo[a], Marcus Nóbrega Gomes Júnior[a,b], Thalita Raquel Pereira de Oliveira[a], Marcio H. Giacomoni[b], Maryam Imani[c], Kefeng Zhang[d], César Ambrogi Ferreira do Lago[a,b], and Eduardo Mario Mendiondo[a]

[a]WADILab, Deparment of Hydraulics and Sanitation, Escola de Engenharia de Sao Carlos, University of Sao Paulo, São Carlos, SP, Brazil; [b]Department of Civil and Environmental Engineering, University of Texas at San Antonio, San Antonio, Texas, USA; [c]Water Systems Engineering (Civil Engineering), School of Engineering and the Built Environment, Anglia Ruskin University, Chelmsford, Essex, UK; [d]Water Research Centre (WRC), School of Civil and Environmental Engineering, UNSW Sydney, NSW, Australia

Example IV: climate services, water security and water-quality scenarios of ecosystem-based adaptation [f]

"ÁGUA E O CLIMA": Serviços Climáticos afetam os Serviços Ecossistêmicos e as formas de adaptação basedas na Natureza

INCT MC2
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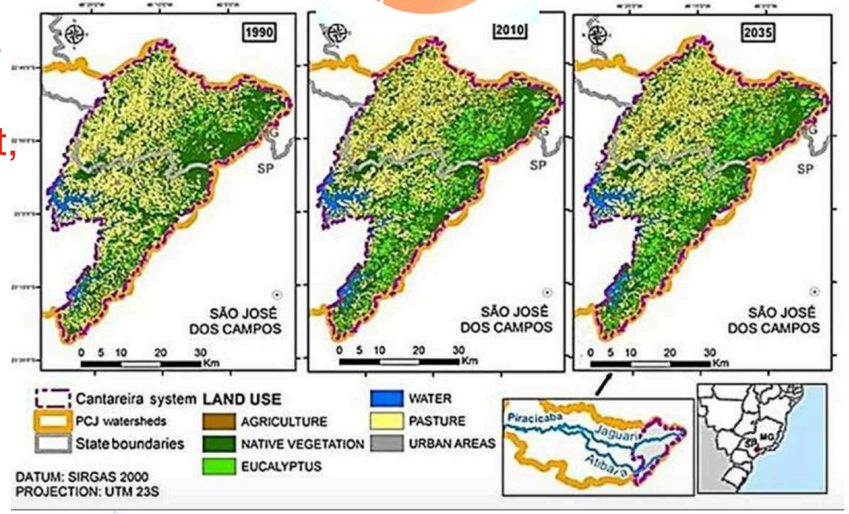
Hydrol. Earth Syst. Sci., 22, 4699–4723, 2018
https://doi.org/10.5194/hess-22-4699-2018

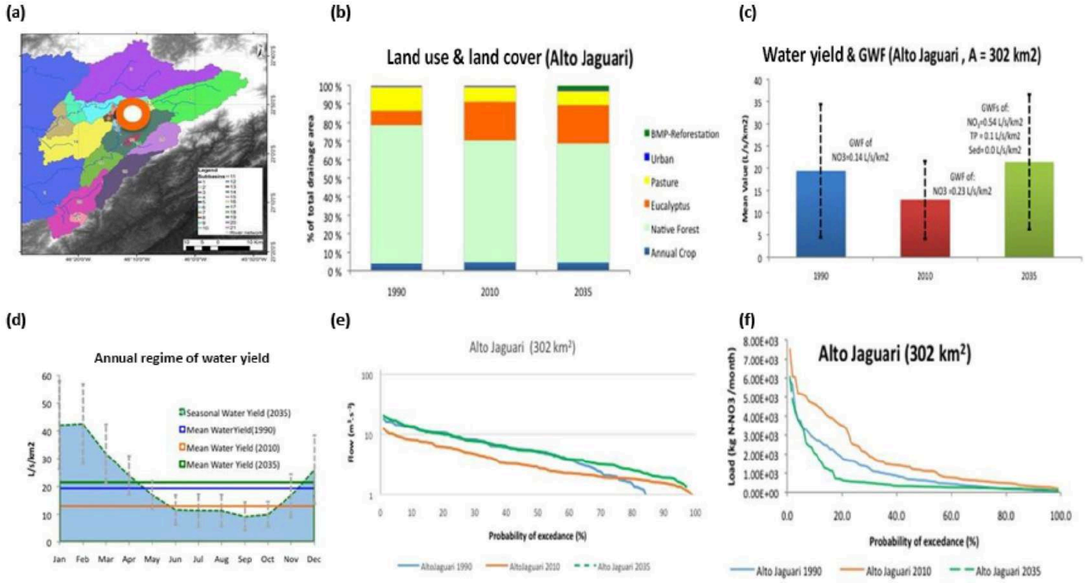
Hydrology and Earth System Sciences — Open Access — EGU

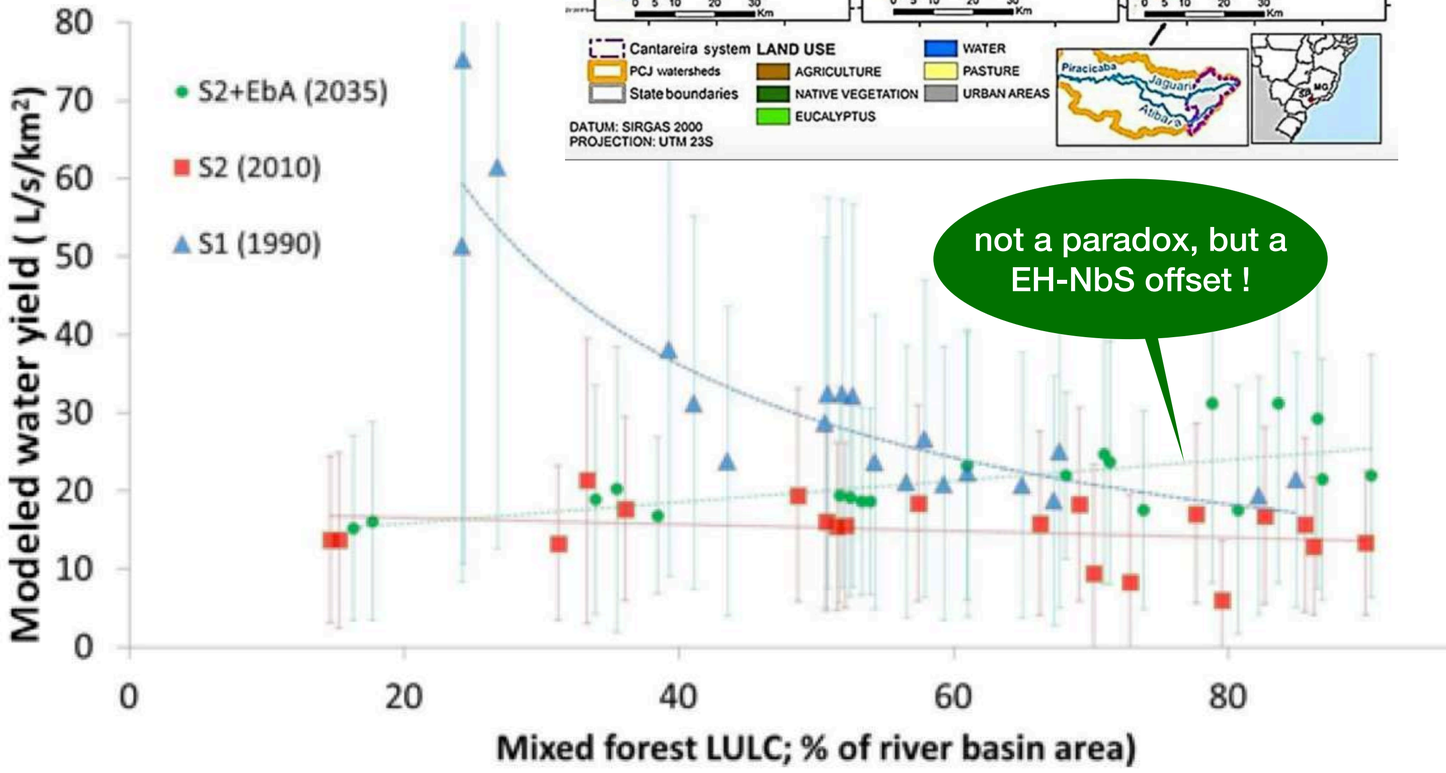
Modeling freshwater quality scenarios with ecosystem-based adaptation in the headwaters of the Cantareira system, Brazil

Denise Taffarello[1], Raghavan Srinivasan[2], Guilherme Samprogna Mohor[1,3], João Luis Bittencourt Guimarães[4], Maria do Carmo Calijuri[1], and Eduardo Mario Mendiondo[1]

Community of Practice ofNbS related to: Field observations, Scenario Criteria+Assessment, Scaling Problems, Water Cycle Changes, Ecophysiological Patterns



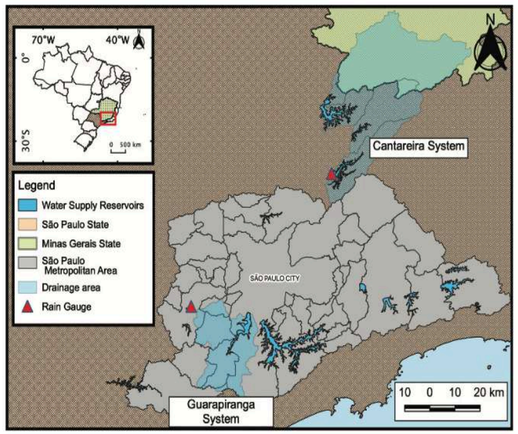


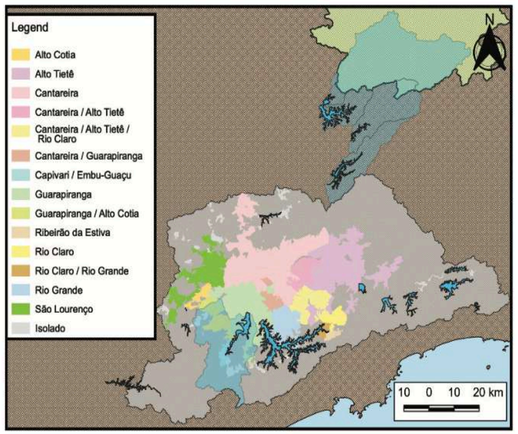


[f]: https://doi.org/10.5194/hess-22-4699-2018

Example XI: stormwater reuse in Sao Paulo Megacity [m].

Community of Practice of NbS related to: Historial trends, Level of Rainwater Harvesting, Concurrent water-allocation, Decentralized Water Consumption. Socio-Hydrological Values, Beliefs & Norms





URBAN WATER JOURNAL
https://doi.org/10.1080/1573062X.2022.2047735

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RESEARCH ARTICLE

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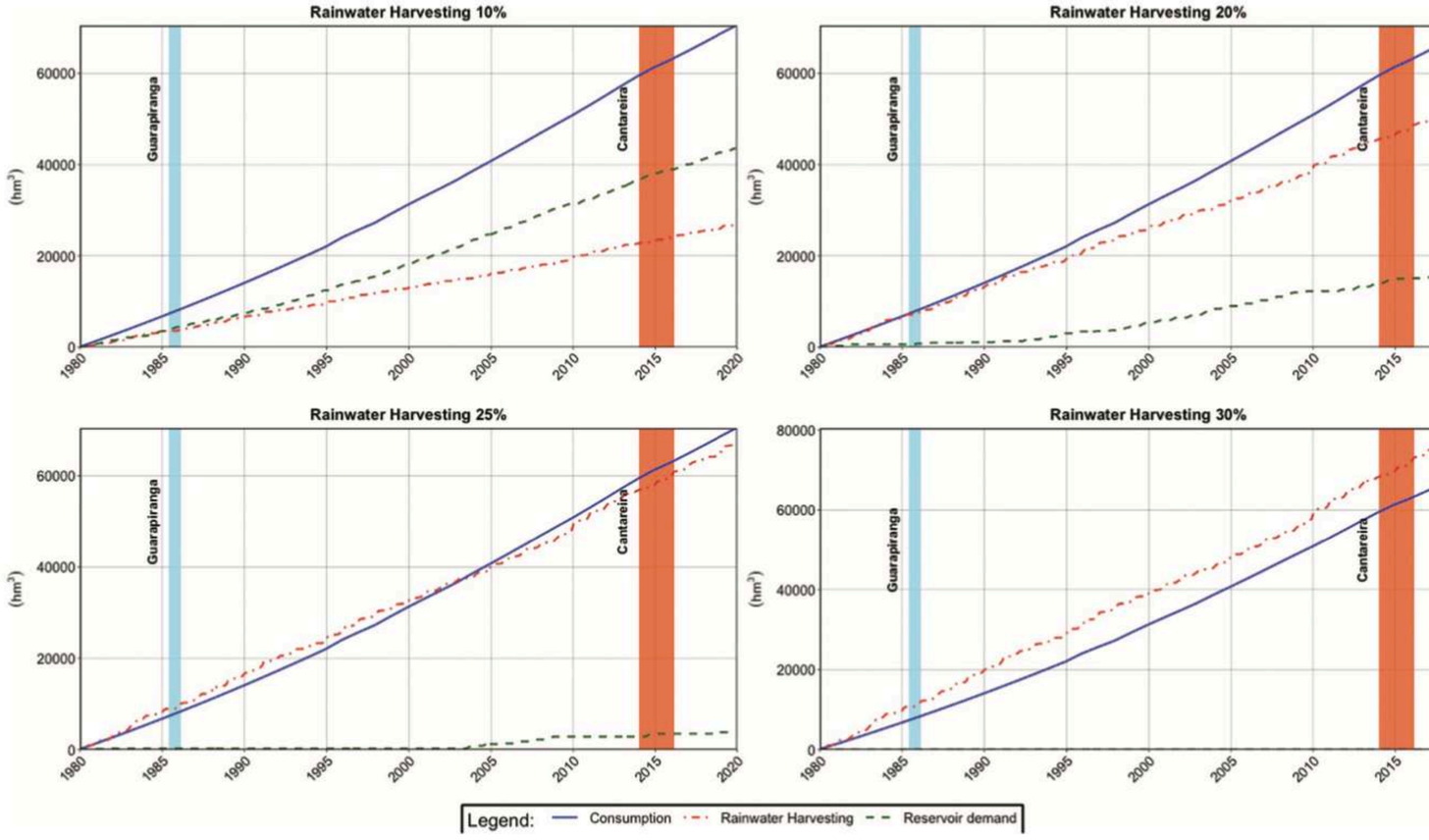
Droughts in São Paulo: challenges and lessons for a water-adaptive society

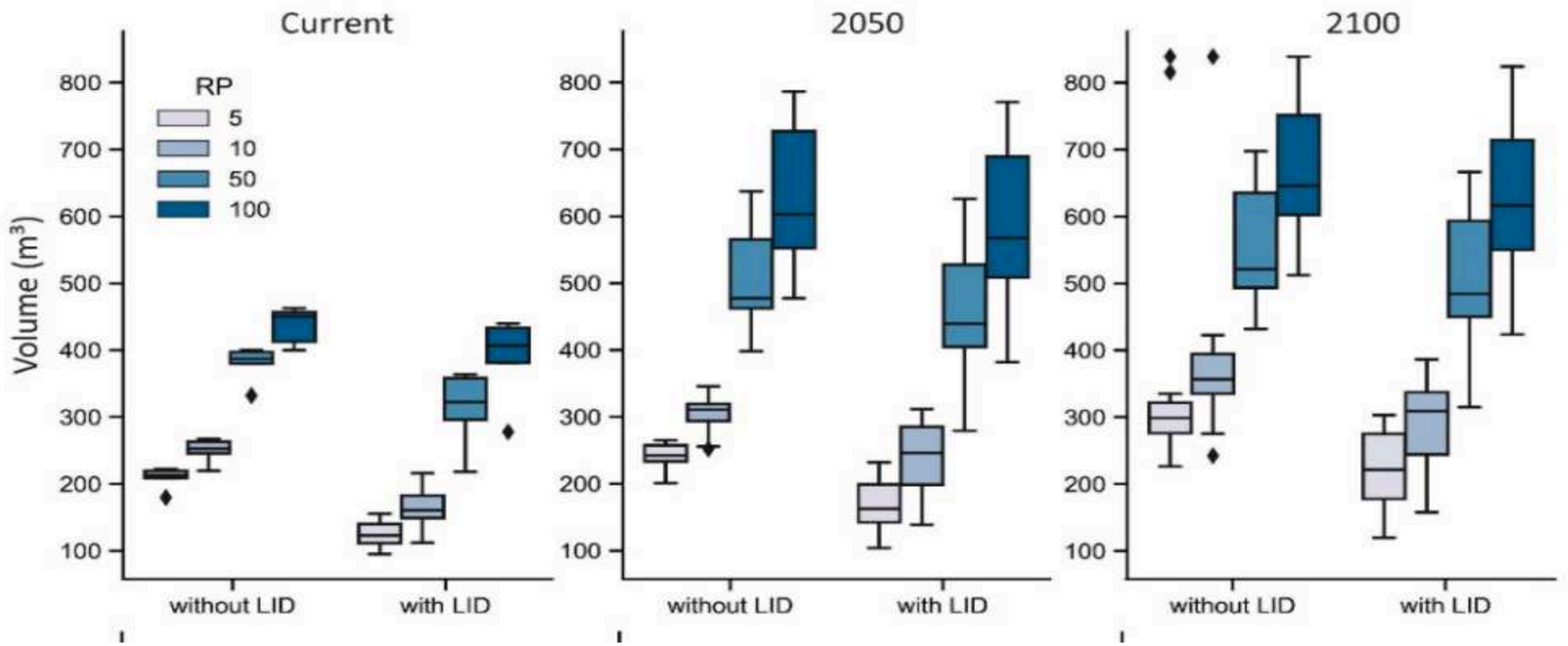
Felipe Augusto Arguello Souza [a], Guilherme Samprogna Mohor [b], Diego Alejandro Guzmán Arias [c], Ana Carolina Sarmento Buarque [a], Denise Taffarello [a] and Eduardo Mario Mendiondo [a,d]

[m]: https://doi.org/10.1080/1573062X.2022.2047735



Example VIII:

climate services, water security and citizen science and low impact development [j]



Cooperative EH-NbS related to:
Low Impact Development (LID),
Citizen Science Data,
Flood Observation,
Climate Change Scenarios,
Corrected IDF,
Historical-Future changes.

water

MDPI

Article

Linking Urban Floods to Citizen Science and Low Impact Development in Poorly Gauged Basins under Climate Changes for Dynamic Resilience Evaluation

Maria Clara Fava [1,*], Marina Batalini de Macedo [2], Ana Carolina Sarmento Buarque [3], Antonio Mauro Saraiva [4], Alexandre Cláudio Botazzo Delbem [5] and Eduardo Mario Mendiondo [3]

[j]: https://doi.org/10.3390/w14091467

How can we scale Governance & Community of Practice of Applied Solutions on Water Security from Climate Services?

Urban Park "Bosque das Paineiras", Sao Carlos-SP, Brazil / E.M.M. 2022

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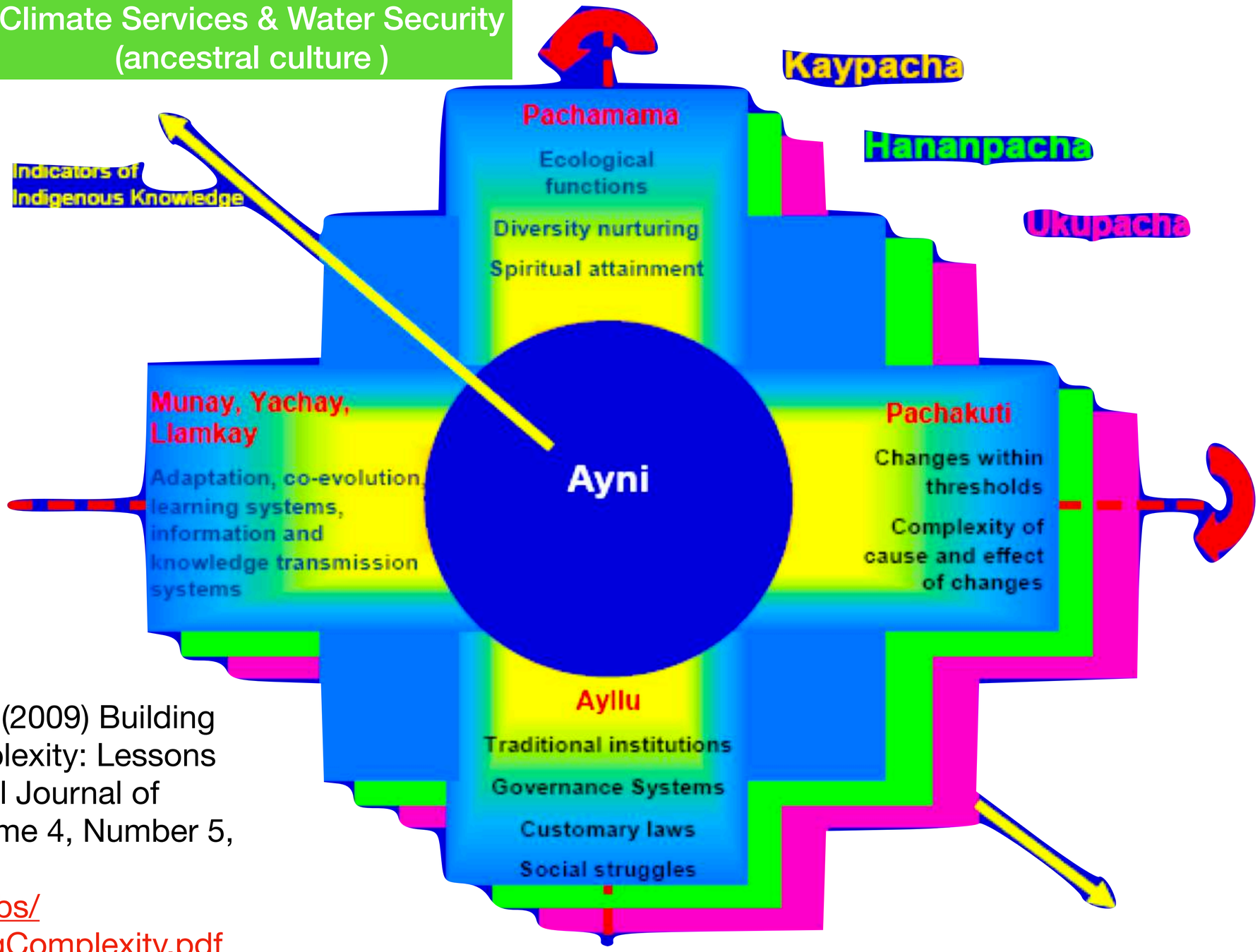
Causal Multicriteria Decision Making in Food Production Networks

Developing causal multicriteria AI models for decision making under uncertainty in food production networks.

Mendiondo (2023) Missão de Pesquisa FAPESP, Fortaleza-CE, 6/2/2023

Polycentric Governance for Climate Services & Water Security (ancestral culture)



Apgar, J.M., Argumedo, A. & Allen, W. (2009) Building Transdisciplinarity for Managing Complexity: Lessons from Indigenous Practice. International Journal of Interdisciplinary Social Sciences. Volume 4, Number 5, pp.255-270.
https://learningforsustainability.net/pubs/BuildingTransdisciplinarityforManagingComplexity.pdf

Oportunidades

- IUGG / IAHS Symposia (Berlin, July 2023), Deadline: 14 Feb., 2023 (https://www.iugg2023berlin.org/iahs/)
- IAHS Working Group on History of Hydrology: https://iahs.info/Initiatives/History-of-Hydrology.do
- Frontiers in Sustainable Cities, International Day of Tropics, Deadline 22 March, 2023; https://www.frontiersin.org/research-topics/42680/international-day-of-the-tropics-2022-urban-sustainability-in-tropical-cities)
- FAPESP TT-4, 24 months, FAPESP # 2022/07521-5 (https://fapesp.br/oportunidades/)
- FAPESP TT-5, 24 months, FAPESP # 2022/08468-0 (https://fapesp.br/oportunidades/)
- Contact: emm@sc.usp.br, @MendiondoMario

United Nations
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- UNESCO Chair on Urban Water - Quality, Management, Recovery and Reuse
- University of São Paulo, Brazil

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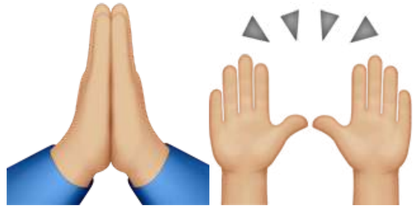

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谢谢 *obrigado* Спасибо

gracias **Chaltu** شكرا

yuum bo'otik *merci*

thank you aguyje

Añay!, sullpay!, pachi!

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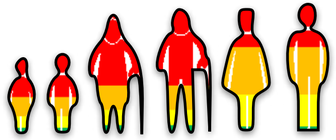

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