Integrated climate, environmental and socio-economic storylines

to support adaptation in the Euphrates-Tigris Basin

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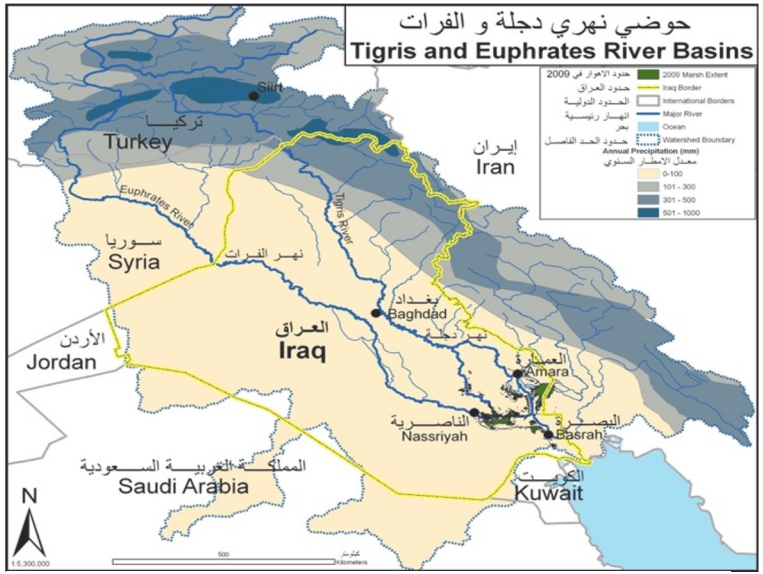
1. INTRODUCTION

Overview of the Euphrates-Tigris basin (ETB) region

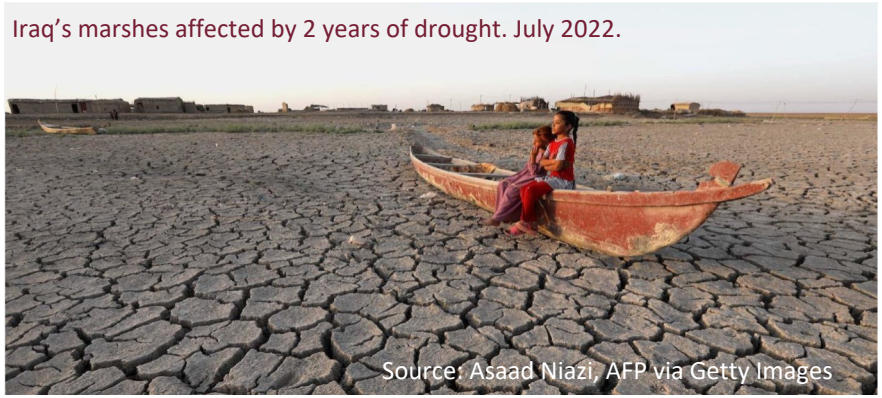
Euphrates and Tigris rivers main freshwater resource for 60m people in ETB region. High **cross-country water dependency** (40-90% rivers recharge from Türkiye) in a **highly engineered** water system (>70 dams since 1970s).

Highly **economically and socially vulnerable** region (conflicts).



ETB annual precipitation. UN Assistance Mission for Iraq (2010).

Iraq's marshes affected by 2 years of drought. July 2022.



Climate change impacting already (extreme heat, prolonged droughts, more sand and dust storms) **with transboundary impacts.**

Water scarcity is a worsening issue, especially in south, due to climate but **also human pressures:**

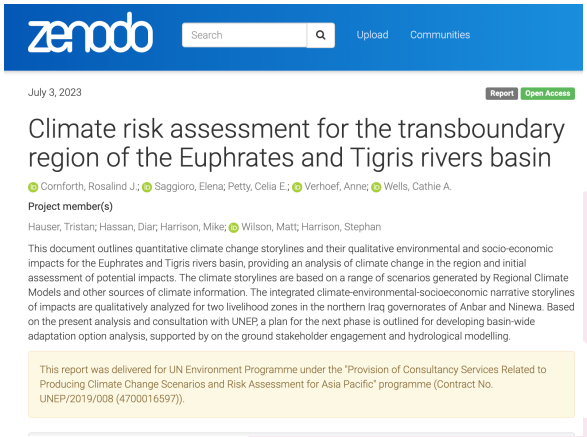
- inefficient **irrigation** techniques and old/damaged **water infrastructures**
- water **pollution**
- **no transboundary water coordination**: dams main cause of the 30-40% decline in river flow in South Iraq since 1970s.

Supporting UNEP with analysis of transboundary climate risk

- **UN Environment Programme (UNEP)** is working in the West Asia region to **translate best available climate, environmental and socio-economic science** into strategies and action to reduce climate-related risks. UNEP is supporting Iraq with its National Adaptation Plan, and more countries will be supported too.

- **UNEP recognizes risk and adaptation have transboundary dimensions**, hence the decision to do this piece of research on the ETB region to understand better the risk to Iraq and other ETB countries.

- The Walker Institute led the development of a **Climate Change Risk Assessment for the ETB region**, with focus on water resources. In partnership with WSP and CCRM consultancies.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Climate risk assessment for the transboundary region of the Euphrates and Tigris rivers basin

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Project member(s)

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This document outlines quantitative climate change storylines and their qualitative environmental and socio-economic impacts for the Euphrates and Tigris rivers basin, providing an analysis of climate change in the region and initial assessment of potential impacts. The climate storylines are based on a range of scenarios generated by Regional Climate Models and other sources of climate information. The integrated climate-environmental-socioeconomic narrative storylines of impacts are qualitatively analyzed for two livelihood zones in the northern Iraq governorates of Anbar and Ninewa. Based on the present analysis and consultation with UNEP, a plan for the next phase is outlined for developing basin-wide adaptation option analysis, supported by on the ground stakeholder engagement and hydrological modelling.

This report was delivered for UN Environment Programme under the "Provision of Consultancy Services Related to Producing Climate Change Scenarios and Risk Assessment for Asia Pacific" programme (Contract No. UNEP/2019/008 (4700016597)).

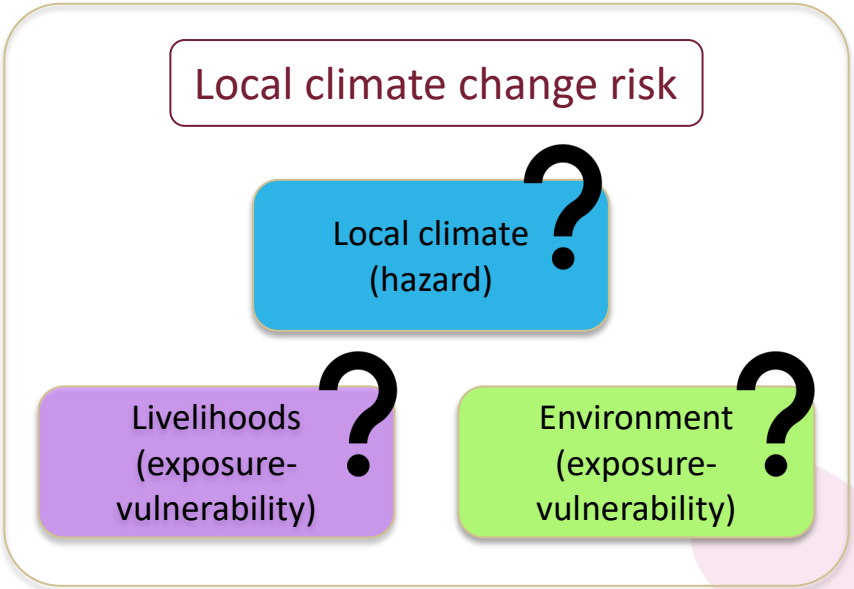
2. METHODS AND DATA

Improving synthesis and communication of climate change risk

- Climate Change Risk Assessments (CCRA) often remain words on a page. Motivation of WCRP My Climate Risk WCR Lighthouse Activity.

- A barrier to uptake of CCRAs is **the representation and communication of local climate risk**
  - **climate uncertainty not communicated effectively** (Shepherd 2019)
  - **limited environmental and socio-economic contextualization** (Wells et al. 2023, Adger et al. 2018)

- **Inclusive Consultative Integrated Climate, Livelihoods and Environment Storylines (ICICLES)** were proposed to UNEP as framework to overcome these limitations.



Inclusive Consultative Integrated Climate, Livelihoods and Environment Storylines (ICICLES)

What

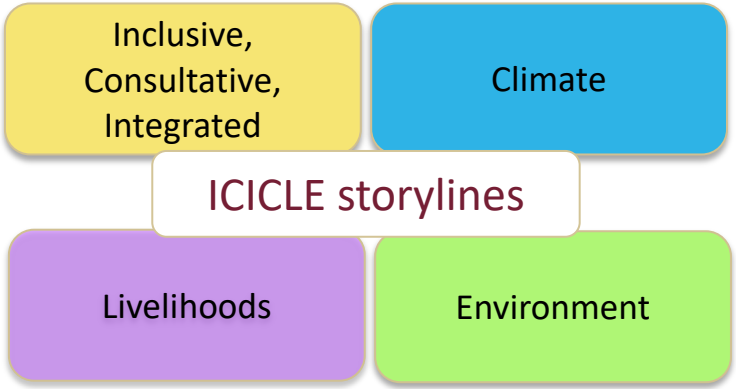
- **Climate Storylines**: local climate uncertainty summarized in few plausible futures (Shepherd et al, 2018)
- **Livelihood and Environmental** vulnerabilities stated explicitly to derive risk with
  - impact models (e.g. hydro, crop modelling)
  - qualitative analysis (e.g. Driver-Pressure-State-Impact-Response).

How

- **Inclusive and Integrated**: incorporate both quantitative and qualitative information from a range of sources, integrates across the three domains above.
- **Consultative**: requires broad stakeholders' consultations from the outset to ensure context is captured properly. Requires iterations.

Communication

- **Infographics and narratives** for communication and facilitate iterative development with stakeholders (Jack et al, 2020).



ICICLES methodology recently published as part of the Implementation Centric Evolving Climate Change Adaptation Process (ICECCAP) framework. Wells C.A., Saggioro E., Petty, C., Cornforth, R (2023), Frontiers in Climate, 10.3389/fclim.2023.1197.

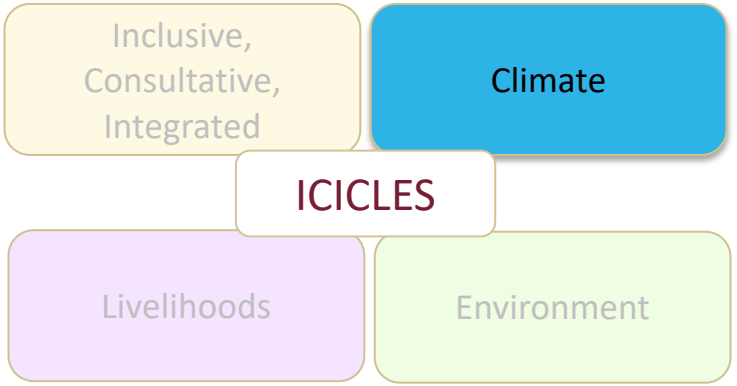
Data

Climate

- **CORDEX Regional Climate Models (RCMs):** set of models selected to span most of CMIP5 uncertainty in temperature and precipitation change in the region
- **RCP2.6 (5 RCMs), RCP 4.5 (3 RCMs) and RCP8.5 (5 RCMs)**
- Baseline: 1985-2005; Future: 2040-2060; 2080-2100

Environment and livelihoods

- **Mostly grey and peer-reviewed literature** due to lack of data
- **Focus on North-west Iraq Livelihood Zones** (Oxfam 2019)
- 6 impact sectors: **land resources, water resources, agriculture, livelihood, health, human mobility**



3. CLIMATE STORYLINES

Identify key climate variables for ETB and source of uncertainty

Results from literature.

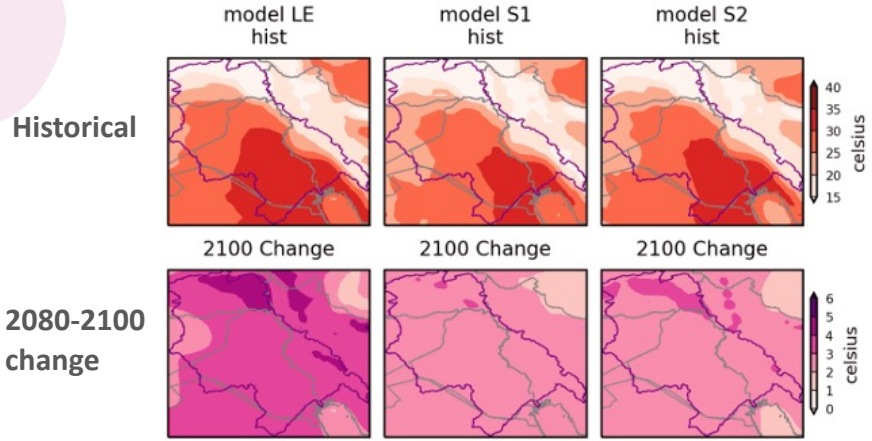
	Confidence in direction of change	Magnitude of change depends mostly on
Higher temperatures (inc. extreme and heat stress)	high	emission scenario
More droughts and desertification, leading to more SDS	high	emission scenario
More erratic and strong rainfall events (flash floods)	high	emission scenario
Less precipitation in the northern ETB (Mediterranean drying)	high	emission scenario and choice of models
More precipitation in southern ETB? (south Asian monsoon? ITCZ?)	low	choice of models
Decline in Tigris and Euphrates rivers' flow.	high	emission scenario and choice of models

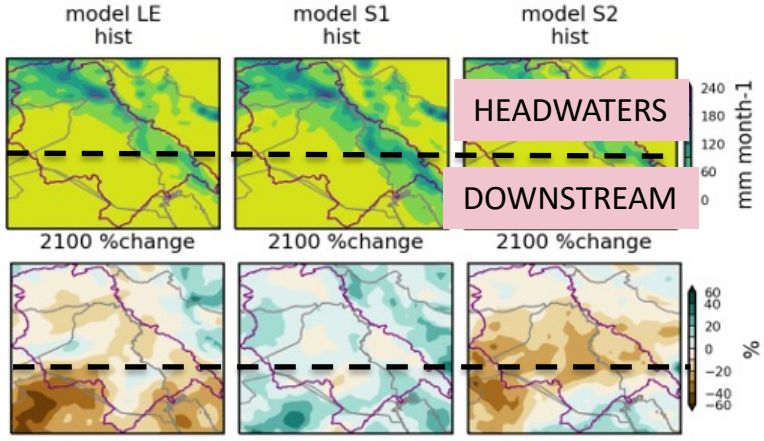
Focus on Temp and Precip for climate storylines

Focus on Temperature and Precipitation uncertainty

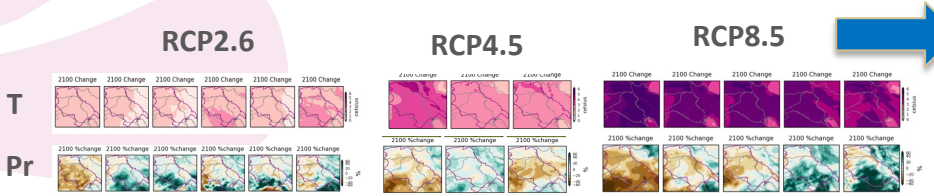
Our RCM analysis of model uncertainty in agreement with literature.
Below results from RCP4.5, similar to RCP2.6-8.5.

- **Temperature**: RCMs with different magnitude
- **Wet season Precipitation**: RCMs with different trend sign!





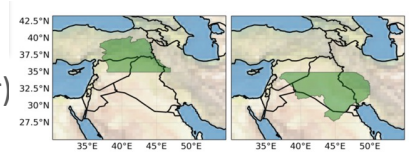
Building climate storylines for ETB



Compute:

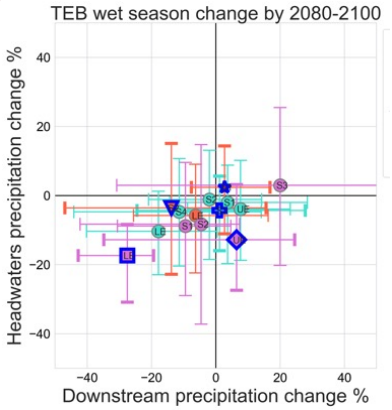
- Mean temperature change ETB (T)
- Wet season precipitation change headwaters (H-Pr)
- Wet season precipitation change downstream (D-Pr)

Headwaters -- Downstream

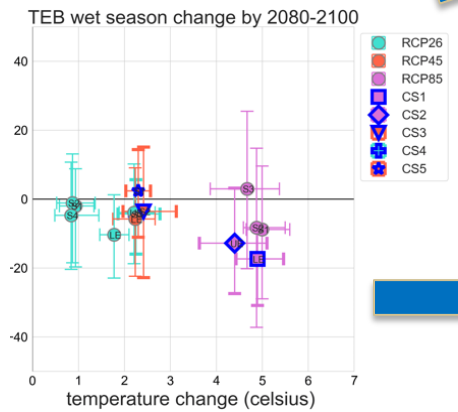


Inspect joint change

H-Pr vs D-Pr



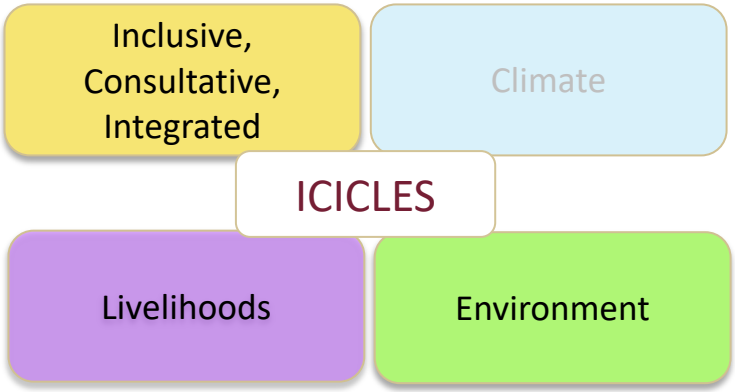
H-Pr vs T



5 climate storylines

Climate storyline	Winter and summer temperature change	Wet season (winter) headwaters precipitation change	Wet season (winter) southern-Iraq precipitation change	Model
1	↑↑↑	↓↓↓	↓↓	RCP8.5 LE
2	↑↑↑	↓↓	↑	RCP8.5 UE
3	↑↑	↓	↓↓	RCP4.5 S2
4	↑	↓	no change	RCP2.6 S3
5	↑↑	↑	↑	RCP4.5 S1

Select individual models that span most of the joint uncertainty range.



4. ICICLE STORYLINES

Two livelihood zones in North-West Iraq

"Rainfed High Wheat and Barley Producing LZ"

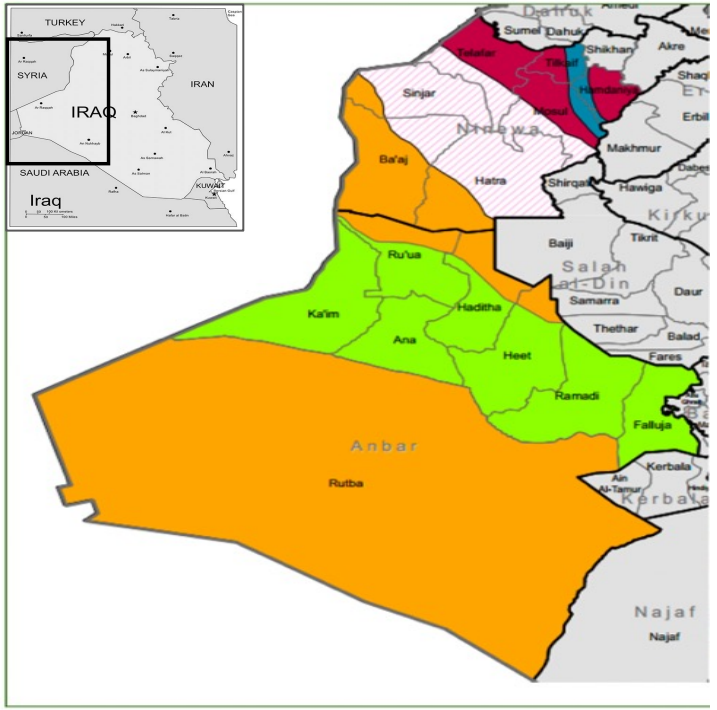
- Mild-Wet winters (600 mm), Hot-dry summers.
- Rain and Tigris river source of freshwater
- Green plains, shrubs and short grass
- Wealth determined by access to land

"Irrigated mixed crops and livestock LZ"

- Mild-dry winters (150 mm), very hot-dry summers.
- Euphrates main river source of freshwater, and use of groundwater.
- Shrubs and grass along river
- Wealth determined by access to land and means for irrigation

Climate storylines relevant to north Iraq:

- Drier and hotter, to varying degrees (most likely)
- Wetter and hotter (very unlikely)



Irrigated mixed crops and livestock (Anbar)

Rainfed High Wheat and Barley Producing (Ninewa)

Source: Oxfam (2019), Household Economy Analysis Baseline Assessment for Building Resilience – Ninewa and Anbar Governorates.

Building ICICLES for North Iraq

- **Environmental and socio-economic scenarios** combined with the climate storylines to develop ICICLES.
- Expressed as “pressures” and chosen to reflect BAU and without adaptation.

	..On water resources	.. On Land resources
Environmental and climate change pressures (natural)	• *higher temperatures* • *reduced precipitation* • *Increased (potential) evapotranspiration* • *increased precipitation variability* • *floods* • *droughts* • *heatwaves*	• *desertification* • *droughts* • *frequent sand and dust storms* • *soil salinization* • ***land degradation***
Socio-economic pressures (human)	• *increased water demand for households and agriculture* • *groundwater over-exploitation* • *water pollution from waste, agriculture, oil and gas production* • ***unmitigated competition with upstream countries***	• ***population growth*** • *internal displacement* • ***urbanization*** • ***consequences of past conflicts*** • *mismanagement and/or abandonment of agricultural and natural land*

Natural and human pressures on water and land resources considered for ICICLES. Cornforth et al. (2023)

ICICLES for the Ninewa Livelihood Zone

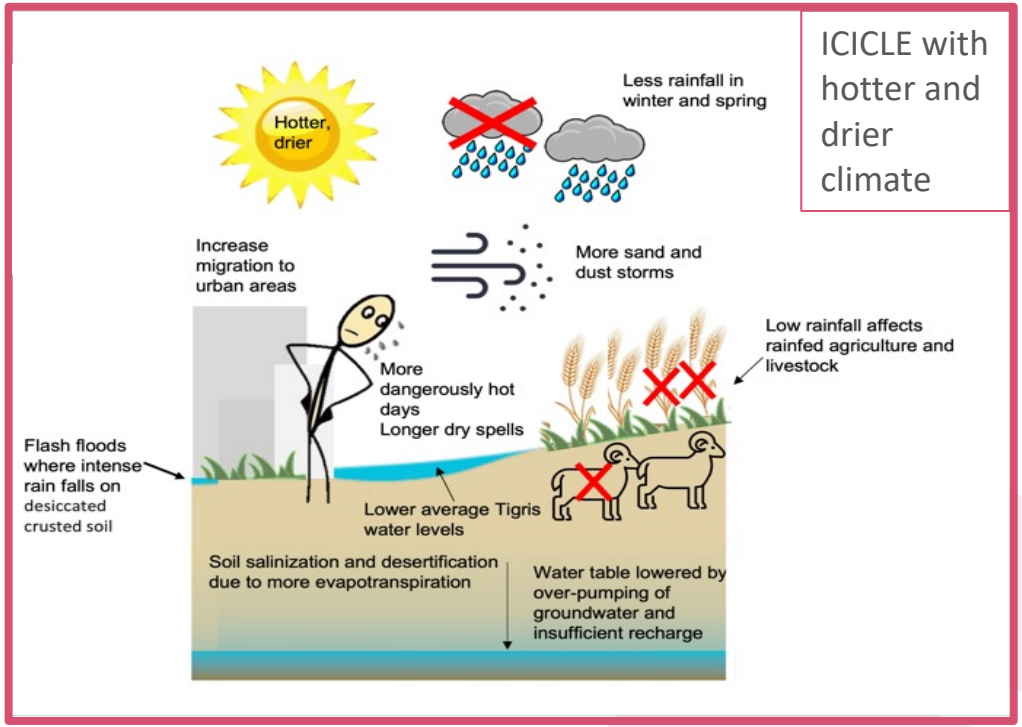
Analysis of impacts across environment and socio-economic sectors. Qualitative, done with DPSIR framework

- **Decline in agricultural production,** both rainfed and irrigated
- **More migration to urban** areas
- **Increased water competition** with countries upstream
- **impacts on health** (women, displaced people, children, elderly) due to heat and poor water quality

Type of pressure	Ninewa LZ Rainfed high producing wheat and barley		CS3: Hotter and drier/CS4: Warmer and slightly drier		
	Unmitigated environmental impacts (pressures)		Unmitigated social and economic impacts (pressures)		
	Land impacts	Water and air impacts	Human mobility and livelihoods	Health	Agriculture and Energy
Natural pressures (including climate change)	Desertification (prolonged temperature and evaporation increase)	Tigris river discharge decreases (-20% CS3 and -10% CS4) (evaporation, reduced precipitation and snowfall) [estimate based on literature]	Rural to urban migration increases towards Mosul or towns across the LZ (loss of agricultural productivity due to environmental degradation)	Respiratory and eye diseases (air pollution due to sand and dust storm)	Decline in rainfed wheat and barley yield (-20% CS3 and -15% CS4) (increased temperature; heat extremes and evapotranspiration) [estimate based on literature]
	Cropland loss (increased soil aridity)	Groundwater decrease (-20% CS3; -10% CS4) (reduced precipitation, increased evapotranspiration) [estimate based on literature]	Increased poverty levels in rural areas (loss of agricultural employment)	Heat stress days (40-35ºC) increase by +400%in CS3 and + 150 % in CS4 (high temperatures; urban heat island (UHI) effect)	Further decline in wheat, barley due to water stress. (-10% CS3 and -5% CS4 rainfall; SDS; occasional flooding)
	Increased sand and dust storms (bare soil exposure, erosion, drought; evaporation)	Water salinization and quality decrease (evaporation)	Loss of rural employment and wealth (loss of agricultural productivity due to environmental degradation; labour heat stress)	Waterborne diseases (water pollution; stagnant water due to reduced water in Tigris)	Decline in productivity of livestock (meat and milk) (increased temperature and heat stress; reduced fodder; SDS, occasional floodings)
	Erosion (topsoil removal, loss of vegetation cover)	Flooding (erratic excess rain, early spring snow melting)	Infrastructure abandonment in rural areas (loss of jobs, occasional high-risk flooding)	Re-emergence of diseases (change in water temperature, ecosystems changes)	Increased demand for energy in summer (extreme temperatures)
	Soil salinization (evaporation)	Blackwater event (inundation following extended drought)	Reduced season for construction work and cement production (heat stress)		Reduced demand for energy in winter (warmer winters)
	Vegetation species change (increased alkalinity e.g. due to drought,	Air quality decrease (sand and dust storms)			

Table of impacts in Ninewa.

Impacts translated into infographic and narrative



ICICLE with hotter and drier climate

Cornforth et al (2023).

Adaptation options valid *across storylines*

Water resources: more efficient use of water for agricultural irrigation; fix leakages; ensure provision of environmental flows for biodiversity and ecosystem services (helps with SDS too); water pollution regulation and monitoring.

Land resources: planting species more resilient to heat/drought/salinity and new technologies (e.g. liquid nanoclay).

Agriculture: drought tolerant wheat and fodder; better sowing techniques; pest and disease control; date palms rehabilitation.

Health: shift working hours to avoid heat stress; prevention of water-borne diseases; education

Livelihoods and human mobility: vocational skills in agriculture and construction; diversification of economic activities in rural areas.

Transboundary cooperation: dialogue on basin-wide water challenges and co-benefits of coordinated management (e.g. water and energy), share data and water management techniques.

Note on method: Options based on literature reviewed and limited national level engagement in Iraq. Adaptation analysis will be expanded in the next phase of work.

5. CONCLUSIONS

Reflection on ICICLES for transboundary climate risk assessment and dialogue

Limitations in ICICLES development

- Impossibility to carry out stakeholder engagement at the time meant ICICLES lacked the “consultative” aspect.
- Lack of modelling resources for the impact analysis.

Positive response to the risk assessment

- Report presented to UNEP Resident Coordinators: ICICLES were remarked as very helpful is conveying contextual risk and suggested as tool for communication with local, non-technical stakeholders.

Next steps

- UNEP and UN system colleagues are exploring options for adaptation planning based on the science reviewed in this report.

Cornforth, R.J., Saggioro, E. , Petty, C., Verhoef A., Wells, C.A. (2023). Climate Risk Assessment for the Transboundary region of the Tigris and Euphrates rivers basin, https://doi.org/10.5281/zenodo.8100921

THANK YOU!

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