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Water security in the polycrisis: between negative and positive tipping points

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Water security is facing multiple stressors in the emerging polycrisis of the Anthropocene, with a great acceleration challenging planetary boundaries and human livelihoods. In a framework of interactions the hydrological cycle is connected to the Earth's ecological and social systems, becoming a potential crisis multiplier through pathways in the water-food-energy nexus and the water-climate-conflict nexus. Water security balances protection of natural water resources and societal efforts to meet human needs, identify nexus tradeoffs and synergies, and facilitate transitions from negative to positive tipping points. Beyond simple narratives of water wars, various conflict types are considered, from water scarcity and abundance as conflict drivers to water as a weapon, target and casualty of conflict. To contain water-related tensions and strengthen cooperation in water distribution and control, investments and institutional mechanisms preserve the natural resource base, support technical and social innovations for efficient, sufficient, resilient, fair, peaceful and sustainable water use, and collaborate on integrated water sharing and trust building in environmental cooperation, conflict transformation and peacebuilding. Assessments and solutions are illustrated for local water systems and regional hot spots in Africa, Middle East, South, East and Central Asia.

KEYWORDS

water-climate-conflict nexus, water-energy-food nexus, tipping points, polycrisis, water cooperation and environmental peacebuilding, water security

1 Introduction

Growing agriculture, industry, consumption, population, environmental and climate change challenge and exceed planetary boundaries and other limits in the Anthropocene (Steffen et al., 2015; Scheffran et al., 2023; Scheffran, 2023). This results in multiple interrelated and disrupting crisis events (environmental, economic, social, health, geopolitical), compounding into a global polycrisis with diverse consequences (Lawrence et al., 2024; Jørgensen et al., 2023). Being vital for life and an essential part of the earth system, the water cycle is affected by and contributing to the polcycrisis. In many regions people are facing a water crisis with too much or too little water (UNESCO, 2024; Dewitz et al., 2025), raising concerns of water scarcity, pollution and competition, destabilizing water systems and triggering tipping points.

This perspective investigates the complex interactions and pathways of the water-security nexus, within a conceptual framing of nature-society interaction. Section 2 introduces systemic processes and feedbacks of the natural water cycle in the Earth system, including interactions of the water-energy-food (WEF) nexus and the water-climate-conflict (WCC) nexus, possibly triggering tipping points in the polycrisis. Section 3 focuses on the availability and use of water resources to satisfy human needs and reduce water stress and risk that could undermine water security. Socio-economic mechanisms and interactions in water use are discussed in Section 4 as conditions for tipping processes between water conflict and cooperation. Water-related

conflict transformation and environmental peacebuilding are highlighted in Section 5 as a contribution to a sustainable and peaceful balance between water resources and human needs. Connections between natural and social dimensions of water availability and risk, conflict and cooperation, tipping and polycrisis are explored in Section 6 for selected regional cases of the water-security nexus. Systemic factors are essential for hydrological cycles and water availability, including climatic and environmental conditions. By addressing the complexities, societies can better navigate the risks and opportunities inherent in the evolving dynamics and stability of water security in the double nexus of water-energy-food and water-climate-conflict.

2 Systemic processes and feedbacks of the water cycle

2.1 Conceptual framework of water cycles and security in polycrisis and tipping point

The water cycle is a core component of the Earth System, connecting atmosphere, clouds and rainfall; rivers, lakes and oceans; life and ecosystems; human society and economy. Due to these connections in a nexus framework of nature-society interactions (Figure 1), the hydrological cycle is becoming a potential crisis multiplier through pathways in the WEF nexus and the WCC nexus. Water security conceptions balance protection of natural water resources and societal efforts to meet human needs, identify nexus tradeoffs and synergies, and facilitate transitions from negative to positive tipping points. Key factors of water security are the risks to environmental and climate change, depending on hazard, exposure and vulnerability which can be influenced by mitigation and adaptation strategies to strengthen resilience and sustainability as well as governance and peacebuilding mechanisms to prevent conflict and strengthen cooperation.

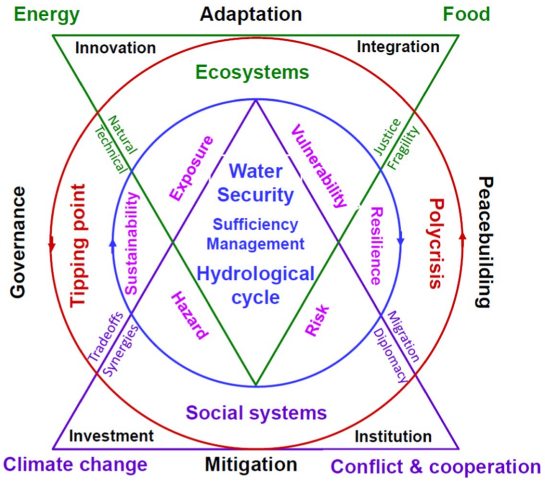

FIGURE 1
Conceptual framework of interactions between the hydrological cycle, water security and the polycrisis through pathways in the overlapping water-energy-food nexus and water-climate-conflict nexus, connecting human water needs and risks, tradeoffs and synergies, negative and positive tipping points, governance and peacebuilding.

An emerging water crisis contributes to the global polycrisis and is affected by it through multiple pathways of the hydrological cycle with changes in atmosphere, biosphere and sociosphere, making water a potential multiplier of crises and synergies (Figure 1). For instance, rising temperature of the ocean increases evaporation and cloud formation which increases rainfall on land and water levels in rivers, changing regional water distribution and availability for ecosystems, agriculture, industry, households and hydropower. In turn, multiple stressors, risks and instabilities in the water sector influence local land cover and climate patterns, ecological and social stability, interacting with the polycrisis and tipping points (Jaramillo, 2020; Berglund et al., 2024; van Thienen et al., 2025).

To prevent a collapse of human-water systems, technical and social innovations offer solutions for efficient, sufficient, fair and sustainable water use, but require a willingness for system change and adaptive behavior. The discussion highlights the role of complex nature-society interactions in water security and synergies for sustainable, fair and peaceful water use. A related question is to understand the drivers that avoid negative tipping points and induce positive tipping points in water systems, integrating the natural dynamics of water resources and social mechanisms.

2.2 Climate change and water tipping points

Combined with the impacts of climate change, population and economic growth are rapidly increasing water demand, exposing a growing number of people to critical water stress. Climatic impacts are spreading through complex pathways in the nature-society interaction framework (Figure 1), including compounding effects, tipping points, cascading events, polycrisis and vicious circles (Buhaug and von Uexkull, 2021; Lenton et al., 2023). Shifts in climate patterns are altering the regional water distribution with water excess in some areas and shortages in others, causing water stress of too much or too little water. Extreme weather events such as floods, droughts or wildfires, exacerbated by climate change are closely connected to the water cycles, threatening human life, damage to ecosystems, destruction of property and financial loss, thus making the water cycle a critical component of the polycrisis. A "tipping point" has been defined as a threshold at which the future state of a system is qualitatively altered in a self-enforcing, rapid and possibly irreversible way (Lenton et al., 2023). Passing water tipping points could aggravate water scarcity or abundance, both with disastrous consequences (Lenton et al., 2023). Tipping points regionally accelerating/decelerating the hydrological cycle under climate and environmental change, have been listed as the first of 23 Unsolved Problems in Hydrology by the International Association of Hydrological Sciences (Blöschl et al., 2019; Jaramillo, 2020). With increasing climate-related weather extremes, in many regions water systems can move closer to a tipping point where impacts can significantly increase. At 3°C global warming over 1 billion people could face increased water scarcity, rising to 1.16 billion at 4°C and even more once tipping points are exceeded (Gosling and Arnell, 2016; Wang et al., 2023) and expose millions of more people to water scarcity.

According to the Global Tipping Point Report (Lenton et al., 2023), a collapse of the Atlantic Meridional Overturning Circulation (AMOC) would disrupt global precipitation patterns, water availability and security (Jackson et al., 2015), decreasing annual mean precipitation in Europe, northern South America, central Africa, and southern Asia, while precipitation could increase in southern North America, northeastern South America, southern Africa, and western Australia. Ice sheet collapse accelerates sea level rise, coastal flooding and groundwater salinization, with far-reaching consequences for freshwater availability, and agricultural water use (Mazhar et al., 2022; IPCC, 2021). Atoll island nations may become uninhabitable (Bailey et al., 2016), and in delta regions like Bangladesh salinization together with water abstraction and variable rainfall threatens both water, food and human security (Chen and Mueller, 2018; Barbour et al., 2022; Khanom, 2016; Sultana et al., 2024), displacing hundreds of thousands (Hauer et al., 2019). In the Arctic, water quality in rivers and lakes is declining due to thawing permafrost which also damages pipelines and other infrastructures, reducing access to freshwater (Hjort et al., 2022). Amazon rainforest dieback decreases river flows und increases water scarcity (Lapola et al., 2023; Lenton et al., 2023).

Global water tipping points interact with local ones. Lakes are examples of social-ecological systems with alternative stable states adaptively responding to changes in conditions at ecosystem level (Martin et al., 2020). Freshwaters are vulnerable to pressures such as nutrient pollution and climate change, triggering tipping points with societal impacts on water, food, health and other infrastructures. Forest cover loss is rapidly increasing, affecting hydrologic systems and yield beyond critical thresholds of major freshwater-producing regions that experienced extensive drought, fire, or flooding (Domínguez-Tuda and Gutiérrez-Jurado, 2024). In urban systems population growth and a drying climate can push water supply across a tipping point into a new regime of water deficits which requires preventive management approaches and resilience building (Berglund et al., 2024). Compared to rapid tipping processes, water infrastructures are slow-moving over decades and thus difficult to adapt (van Thienen et al., 2025). Leveraging innovations in technology, governance and finance can reduce or manage the potential of tipping points to exacerbate water scarcity and flooding risks.

2.3 The water-energy-food nexus

The water-energy-food (WEF) nexus (sometimes expanded by "ecosystems" to the WEFE nexus) provides a framework for the interconnections of water use with food and energy as critical resources which are essential for human societies. Change in each resource can negatively or positively effect another, creating mutually reinforcing and cascading impacts and crises. WEF insecurities in the polycrisis could have negative effects on famine, premature death and civil unrest, violence, war, terrorism, and migration. Water-related issues directly impact and are impacted by food and energy supplies, each of which interact with ecosystems and environmental quality as well as social systems. A holistic approach addresses tradeoffs (which may trigger conflicts) and synergies (which foster cooperation) in the WEF nexus (Haji et al., 2024). By internalizing social and environmental impacts, the nexus approach guides cross-sectoral policies to address complex resource and development challenges (Albrecht et al., 2018). In the global polycrisis new systemic risks emerge to the availability and access of key resources for human survival and well-being. Require a paradigm shift by reducing vulnerability and strengthening resilience, turning the vicious into a virtuous circle (Quagliarotti, 2023). Local strategies align with global sustainability goals where each of the resources is represented. Synergies between food production, water use, and CO_2 emissions in agriculture highlight the need for integrated solutions that balance competing demands.

3 Multiple stressors, risks and sufficiency in water security

Freshwater ecosystems are fundamental to support global biodiversity, human health and livelihoods, expressed in ecosystem stability and resilience as well as contributing to ecosystem services. The systemic dimensions of water interact with human agency and behavior, shaped by human perceptions and values of security (motivations and risks) as well as actions and policies (capabilities and costs). Water security relies on access to sufficient, safe, and reliable water, which requires the supply of a sufficient quantity and quality of freshwater (Link et al., 2016), balancing water supply (renewal) and demand (withdrawal) to guarantee sufficient water availability (Kattel, 2019), which is a function of the quantity of accessible water resources, their benefits and risks, distribution and pollution to meet human needs in social interaction and participation processes (such as markets, elections, conflict and cooperation). Water security and securitization discourses vary across human, national, and international security levels and multiple dimensions (physical, environmental, human, economic, social, political, institutional, legal) (Zeitoun, 2011; Floyd and Matthew, 2012; Fischhendler, 2015). In this context, water-related security challenges and stresses encompass two major pathways: dissatisfaction of human needs and water risks.

Imbalances between water demand and supply can drive water scarcity and competition, through increasing water demand and excessive water withdrawal or declining water supplies, inefficient water use and low renewal rates. Insufficient water availability is causing and exacerbating water stress and hampers development, particularly in regions where large populations lack access to safe and affordable water for basic needs. Water resources face supply shortages for human, industry or ecosystem use, manifesting as food and water insecurity at local, regional or global level from human exploitation and mismanagement of water, climate change, and a lack of suitable infrastructure (GRR, 2025). This puts pressure on the 313 transboundary surface waters, more than 600 groundwater bodies and more than 300 wetlands that need to be managed by several states despite different security, economic, social, political, environmental and other interests (McCracken and Wolf, 2019; UNESCO-IHP and IGRAC, 2021; Rosenblum and Schmeier, 2022).

Water resources are facing numerous stressors, pressures, drivers and threats which are often not clearly separated in the literature, despite attempts to clarify differences (Spiller et al., 2025). Related to polycrisis is the concept of "multiple stressors" in freshwater systems, e.g., between nutrient loadings, pollution, climate change, increased water temperatures, biological invasions etc., which together erode freshwater resilience. Human proximity to and dependence on freshwater has caused a degradation of freshwater ecosystems and services, which face a "double

jeopardy" of threats on river channels, such as flow modification and dams, as well as land use change and climate change. Insufficient water availability and pollution can lead to value losses and risks that affect water security for communities vulnerable to water scarcity and conflict, irrespective of the causal relationships between both.

Risk is the expected harm of events combined with their probability which in the context of climate change result from hazard, exposure and vulnerability of the affected system (IPCC, 2022) as well as associated perceptions of risk, power and capability of the respective actors which drive human decisions and discourses. Water risks include natural hazards such as weather and climate extremes, as well as human-induced pressures by population growth, forced migration, urbanization, violence, and geopolitics. Vulnerable communities, particularly in less developed regions, are particularly exposed to these risks (de Amorim et al., 2018; Haji et al., 2024). Water quality is undermined by pollution from human activity of households and industry, environmental accidents such as oil spills, and radioactive contamination. Harmful materials in freshwater and oceans, such as pharmaceuticals, pesticides and fertilizers, Per- and Polyfluoroalkyl substances (PFAS), micro- and nanoplastics, result in severe impacts on ecosystems, biodiversity and human health, loss of life and finance. Water pollution is also substantially aggravated by military activities, such as warfare, weapons testing and arms buildup which absorb a relevant part of water resources and infrastructure. According to the Global Risks Report (GRR, 2025), pollution of air, water and soil ranks high among global risks, in particular among lower income and densely populated countries such as Bangladesh and India. In the European Union, only around 40 percent of surface waters have good ecological status, in Germany only 8 percent of rivers and 25 percent of lakes (Dewitz et al., 2025, p. 9).

Whether water dissatisfaction and risk escalate into broader security concerns depends on perceptions and power dynamics of actors as well as capabilities to respond. Climate change can both reduce water availability and act as a risk multiplier. Understanding pathways of water (in)security is important for effective and cooperative water management to mitigate conflict and promote resilience in face of water security challenges, disproportionately affecting vulnerable communities. Around 4 billion people or 50% of the world population live under highly water-stressed conditions for at least 1 month of the year (Kuzma et al., 2023).

4 Water conflict pathways

In the water-climate-conflict nexus a wide range of pathways can occur between conflict and cooperation (e.g., Link et al., 2016; Gleick and Shimabuku, 2023). In a conflict social actors pursue incompatible interests and actions which range from war and hostility (mutual harm) to cooperation and peacebuilding (mutual benefit). Water conflicts could possibly include the use of violence and terror attacks, geopolitical rivalry and power struggles over water access and control, local protests and resistance against water projects, social disruptions and disputes over fair water distribution. The manifestation of conflict depends on context conditions, influenced by poverty and fragility, injustice, hydro-hegemony and securitization which are shaped by political and institutional mechanisms of stakeholders that both influence and are influenced by water use.

Data on transboundary water conflict and cooperation are assembled in the Transboundary Freshwater Dispute Database (TFDD), the International Freshwater Treaties Database (IFTD) and other databases at Oregon State University (McCracken and Wolf, 2019). ETH Zürich established the International Water Cooperation and Conflict (IRCC) database (Kalbhenn and Bernauer, 2012); and the regional Water-Related Intrastate Conflict and Cooperation (WARICC) dataset using the Water Events Scale (Bernauer et al., 2012). A different approach of data collection and coding is used in the Water Conflict Chronology of the Pacific Institute which distinguishes pathways of water as a cause, weapon or casualty of conflict (Gleick and Shimabuku, 2023).

4.1 Water scarcity and abundance as conflict drivers

Research has paid attention to water as a potential cause, multiplier, catalyzer or trigger of conflicts, including disputes over water scarcity, access and control, with mixed findings. Some studies suggest that water availability below critical thresholds of water scarcity could trigger tensions and increase conflict risk within and between states (largely at local/sub-national level), interpersonal disputes and community-level disagreements (Gleick and Shimabuku, 2023). Insufficient access to and control over water resources may initiate and amplify emotions such as anger, fear, greed, or hostility, mobilizing hostile actions between social groups such as farmers and herders over shared water resources. Other studies question direct causal links and suggest that rarely does water scarcity increase the risk of violent conflict but rather is mitigated by cooperation, institutions and treaties (Link et al., 2016; Bernauer et al., 2012; de Bruin et al., 2023). Accordingly, reports of water wars are largely rejected (Swain, 2016), and between war and peace over water there is a broad spectrum of possibilities (Biswas and Tortajada, 2019). Conflicts over water are only 28 percent of all interactions between states, which are rarely violent. Water is one of many different conflict factors that contribute to escalation of conflict which is mediated by socioeconomic and political conditions. Climate change imposes pressure on fragile and conflict-prone regions under water stress (IPCC, 2021: 4.5.6), influencing conflict patterns and behavior (Scheffran et al., 2012; Mach et al., 2019). Intermediate water-conflict linkages and pathways play a role, such as the degradation of the WEF nexus affecting environmental migration and development which can be an indirect driver of and driven by conflict between states. If a country receives its fresh water supply from outside its own territory (rivers or groundwater flows), it is dependent on the relationship with other countries which may be conflictive or cooperative.

Beyond conflicts over water scarcity, societies can be destabilized by extreme water abundance increasing with climate change, such as heavy rainfall and river flooding, with disastrous consequences for communities, infrastructures and landscapes. Recent examples include the catastrophic flooding of the Indus River in Pakistan (2023), which displaced millions; the severe floods in Western Germany (2021) and Eastern Spain (2024), which destroyed numerous buildings and each claimed around 200 lives; and a dam collapse in Libya (2023) with thousands of casualties. Such events demonstrate the vulnerability of water infrastructures for sanitation, drinking water, and irrigation, contributing to societal instability and protests.

Low-income countries, particularly in Africa, are at higher risk for flood-induced displacement (Kakinuma et al., 2020), possibly resulting in millions of internally displaced by 2050 in sub-Saharan Africa, South Asia and Latin America (Rigaud et al., 2018). While too much water can be a conflict driver, it can promote cooperative measures for adaptation, disaster management, prevention, early warning and nature-based solutions for stormwater management (Ide, 2023; Muwafu et al., 2024).

4.2 Water as a weapon, target and casualty of conflict

Water resources and critical infrastructures may become collateral damages and deliberate targets as well as weapon-like tools in conflicts, weakening populations and forces of an opponent dependent on or affected by water. This issue has become more urgent with escalating geopolitical tensions and conflicts in Iraq, Syria, Ukraine, Gaza and elsewhere. The compounding and cascading impacts of armed conflict are demonstrated by the Russia-Ukraine war which had far-reaching implications for water and the environment. Other parts of the world are also affected through supply chains and the WEF nexus, for instance food imports in the Mediterranean region from Russia and Ukraine (Quagliarotti, 2023). Water was also affected locally, for instance, by the destruction of the Kakhovka dam on the Dnipro river in Ukraine (Naddaf, 2023). Water resources and infrastructures (irrigation channels, desalination plants, dams) have also been targeted in terrorist attacks (Veilleux and Dinar, 2019). Such events spurred the debate over ecocide due to significant environmental destruction and emissions. Water development and engineering projects can also provoke protests and tensions due to hydropolitical costs and risks. Local populations are concerned about conflict-related displacement and environmental degradation, which increase inequitable access to water. Similarly, resistance can emerge against climate and water politics, involving development, mitigation, adaptation, and disaster management, as well as tensions between current and future generations, or struggles to balance human needs with the planetary boundaries and the Sustainable Development Goals (SDGs) in which water plays a key role, in particular in SDG6 (clean water and sanitation) (Zipper et al., 2020). Tipping between escalation or containment of water conflicts depends on motivational factors, as well as actors' capabilities, political power and resource access. Water's low economic value and lack of a global market reduces incentives for costly wars compared to cooperative water management strategies (Biswas and Tortajada, 2019).

5 Water cooperation, conflict transformation and environmental peacebuilding

More frequent than conflict is cooperation over shared water resources, particularly when supported by treaties and institutions (Dinar et al., 2015; Turgul et al., 2024). While water scarcity poses significant challenges, it also presents opportunities for collaboration and innovation to address shared vulnerabilities and ensure sustainable water management. Water stress can incentivize management strategies to increase resilience, preventing negative tipping points and inducing positive ones, towards efficient water use, advanced technology, alternative water sources and recycling, new infrastructures, demand constraints, and equitable water-sharing (Link et al., 2016; Berglund et al., 2024; Eker et al., 2024).Water management, governance and participation are important in a social-ecological transformation to contain water crisis and achieve a sustainable and peaceful water balance, strengthening justice, fairness, and equity in water access and distribution (David and Hughes, 2024; Schubert-Zunker and Knappe, 2024). Water cooperation and hydro-diplomacy bring long-term benefits and sustainable peace, transcending borders, sectors, and scales.

Collaboration among stakeholders across levels can transform water from a source of conflict into a catalyst for environmental peacebuilding (Dresse et al., 2019). Transformative analysis identifies harmful practices, barriers and opportunities to integrate social-ecological thinking and environmental peacebuilding into conflict transformation (Daoudy, 2007; Wolf, 2012; Zeitoun et al., 2019; Cascão et al., 2020; Froese et al., 2024). A framework of water conflict transformation distinguishes four negotiation stages (adversarial, reflexive, integrative, action) which are classified according to common water claims, collaborative skills and geographic scope (Wolf, 2010). International agreements and institutions can help to reduce conflict and promote cooperation in water crises (Cooley and Gleick, 2011; Petersen-Perlman et al., 2017). Legal and institutional mechanisms mediate disputes, build collaboration and organize peaceful water distribution (Tir and Stinnett, 2012; Kittikhoun and Schmeier, 2020; Yetim, 2023; Turgul et al., 2024). Water agreements set legal standards and guiding frameworks for cooperative actions (Kattel, 2019). More than 800 international agreements in the IFTD regulate water rights and needs, allocation and equity, pollution and flood control, hydropower and fisheries, among others (IFTD, 2023). The International Court of Justice and the Permanent Court of Arbitration in The Hague marginally contribute to escalation prevention and arbitration, as documented in the International Water Law Cases (Devlaeminck, 2018), for instance the conflict between Hungary and Czechoslovakia over the Gabcikovo-Nagymaros dam in 1997, or the conflict between India and Pakistan over a dam on the Kinshenganga river in 2013 (ICJ, n.d.).

6 Regional cases of the water-security nexus

Interactions in the water-security nexus vary significantly across regions, as water availability depends on geographic conditions and characteristics of water sources. In hotspots, climate change interferes with local environmental and socio-economic factors, resulting in complex and compounding interactions which contribute to the polycrisis. To maintain water security depends on both physical availability and societal pressure influencing conflict and cooperation. A few cases illustrate some of the general statements in the framework without aiming for a comprehensive comparative assessment.

Particularly vulnerable are Africa, the Middle East, Central Asia and South Asia. In shared river basins like Jordan, Nile, Indus, Ganges-Brahmaputra, and Syr Darya-Amu Darya, cooperation is weakened by mistrust, inequalities, power asymmetries, and ongoing conflicts (Link et al., 2016). Most vulnerable are regions which depend on water-sensitive resources exposed to climate hazards. If water risks

cannot be limited, tipping cascades to instability and conflict may more likely propagate through systemic networks like a domino chain.

In Africa the water-security nexus is intricately engrained in the continent's conflicts. Herders and farmers compete for water, which is becoming less available due to the climate crisis (Bukari et al., 2018; Brottem, 2021; Adams et al., 2023). In West and Central Africa farmer-herder violence has increased over the past decade, due to population pressure and growing social inequalities, changes in land use and resource access, rendering traditional dispute resolution less effective. Potential tipping cascades in the Lake Chad Basin (LCB) are the collapse of fisheries leading to a loss of income and food security for local populations or increased desertification, land degradation and soil erosion, loss of biodiversity, and reduced carbon sequestration (Okpara et al., 2017; Kamta et al., 2021; Lenton et al., 2023: Ch. 2.4). Escalating cycles of violence combine water scarcity with climate extremes, ethnic-religious tensions, forced displacement and arms transfers, exacerbated by extremist groups recruiting dissatisfied people. Possible solutions include sustainable water management, irrigation and agricultural practices, conservation of ecosystems, economic development and regional cooperation, partly supported by the LCB Commission and the United Nations (Nagabhatla et al., 2021).

Africa is home to several large transboundary river systems, including the Nile, Congo, Zambezi, Senegal, Niger and Orange Rivers, where water availability is largely adequate for daily sustenance of significant portions of the population with low baseline water stress. Several river basins are jointly managed by the riparians, in particular water-regulation schemes in the Volta River Basin or the Okavango River Basin, preventing or mediating conflicts between riparians and addressing issues of equity, and sustainability. Along the Senegal River countries have cooperated since the 1970s on joint construction of two dams enabling irrigation, supply electricity to neighbors and facilitate shipping (Manikowski and Strapasson, 2016).

Higher water stress is found in downstream areas of the Nile River Basin which is under pressure since Ethiopia is building a dam on the Blue Nile to generate hydropower and supply its population with electricity. This is seen as an existential threat to water supply by downstream Egypt which is highly dependent on the Nile and claiming water rights since colonial times (Pemunta et al., 2021; Matthews and Vivoda, 2023). This has led to diplomatic tensions between Egypt, Ethiopia and Sudan but no tipping to violent actions yet while international water negotiations remained unsuccessful (Helal and Bekhit, 2023; Ranjan, 2024).

Often cited as a water-security hotspot with tipping elements is the Middle East, which is characterized by arid or semi-arid climate, a mismatch between water demand and supply, and already tense interstate relations, in particular in the Jordan river basin (Rodriguez Lopez et al., 2019). Severe water-related inequalities and conflicting narratives drive the Israeli-Palestinian water conflict (Ide and Fröhlich, 2015), occurring alongside cooperation patterns. Disputes over the Jordan River also exist between Israel and Lebanon and between Israel and Syria, while water interactions between Israel and Jordan were largely cooperative. Increased water availability due to Israeli desalination and wastewater recycling could reduce international tensions over water resources, but significant de-securitization has not yet occurred. Facing environmental degradation and escalating violence, conflict transformation and environmental peacebuilding through water cooperation are supported by advocacy projects such as EcoPeace, encompassing stakeholder engagement from grassroots movements to political negotiations of governments and United Nations. The Green Blue Deal for the Middle East proposes synergies in water reallocation and management, rehabilitation of the Jordan River, a Peace Triangle in the water-energy interaction between Jordan, Palestine and Israel, as well as public awareness and education programs (Majdalani and Scheffran, 2024).

In the larger MENA region pre-existing cleavages and either autocratic political systems or cuts of public water supply are relevant predictors of nonviolent, water-related conflict during droughts (Ide et al., 2020), especially in the absence of proper political institutions. Drought–conflict links are highly context-dependent even for nonviolent, local conflicts, challenging determinist narratives that claim direct interlinkages between climate change, hydro-meteorological disasters and conflict (Ide et al., 2020). The Arabic Spring of 2011 has been associated with the sharp rise in food prices following extreme weather events such as droughts in Russia and China exerting pressure on international food markets, together with other factors magnifying public dissatisfaction and political protest. A tipping cascade of consequences and stressors contributed to a polycrisis, including climate-related food and water problems, unemployment and poverty, regime changes and violent conflicts, refugee movements and terrorism, affecting the stability of the Mediterranean and Europe (Johnstone and Mazo, 2011; Lenton et al., 2023: Ch. 2.4). One of the most striking cases has been the Syrian civil war, raising controversy whether and how the severe drought before in the Fertile Crescent potentially contributed (Ide, 2018). Water and climate change were suggested among multiple overlapping stressors.

Central and Southern Asia are sensitive to both climate-conflict risks and connecting pathways in between, such as water resources, crop yield and income (Xie et al., 2022). A large population is dependent on water from monsoon rainfall, rivers and mountain glaciers, affecting large rivers and deltas, including Indus, Ganges-Brahmaputra and Mekong as well as Syr Darya and Amu Darya. Water-related concerns also affect East Asia, such as the Yangtze, Yellow and Pearl rivers, deltas and coastal zones exposed to ocean storms, floods and sea-level rise (Petzold and Scheffran, 2024; Dewitz et al., 2025). In Afghanistan, when the former government was unable to operate outdated water infrastructures and maintain a fair water distribution, the Taliban took over local water management, which contributed to its power acquisition in 2021 (Shams and Muhammad, 2022).

7 Discussion

While water security is a cornerstone of human livelihoods worldwide, the current global polycrisis and the related water crisis pose multiple challenges to water security. Agriculture, industrialization, overconsumption, population growth and climate change impose stress on planetary boundaries and risk negative tipping points. To contain the crisis, new opportunities need to be mobilized to avoid tradeoffs and develop synergies for efficient, sufficient, fair, peaceful and sustainable water use. To prevent negative tipping points and induce positive tipping points in water systems, new water security conceptions would balance the natural dynamics of water resources and social mechanisms to meet human needs.

A conceptual framework captures the role of the hydrological cycle in nature-society interactions in the Earth system, involving

multiple pathways in the WEF nexus and the WCC nexus. Water is a potential crisis multiplier, connecting climate change and risk, low human development and inequality, exceeding adaptive capacities and pushing water stress to critical levels of instability and conflict. Moving beyond simple narratives of water wars, this study highlights the complexity of water-security-conflict interactions and connects the water crisis to the polycrisis and tipping points that can be further elaborated in future research. Whether water dissatisfaction and risk escalate into broader security concerns depends on perceptions and power dynamics of actors as well as capabilities to respond. A variety of conflict types need to be considered, from water scarcity and abundance as conflict drivers to water as a weapon, target and casualty of conflict.

Sufficient water availability is essential to satisfy human needs as a condition for human security, conflict prevention and cooperation, moving from negative to positive tipping points. To contain water-related tensions and strengthen agreement over water use, distribution, and control, institutional mechanisms can help to preserve the natural resource base, collaborate on water sharing and trust building, find technical and social innovations among riparian states in environmental cooperation and peacebuilding, in water crises. Various problem assessments and solutions need to be adapted to and embedded into the respective hot spot regions and local water systems, providing incentives even for hostile states to cooperate, in particular in the Middle East, North and Central Africa, Southern, Eastern and Central Asia.

Consulting diverse perspectives and knowledge systems helps in most water disputes to understand and resolve them effectively, increasing the likelihood of successful participation and mediation among stakeholders to improve mutual understanding of each other's positions. This as a precondition for joint management and governance, leveraging synergies in the WEF nexus and the WCC nexus, both in pairwise and triangular interaction. For instance, water is essential for hydropower and food production (including desalination plants for growing crops in coastal desert areas) while energy is needed for water pumps and agriculture. Water projects can help to adapt to climate change and strengthen cooperation, conflict resolution and peacebuilding, which in turn have positive effects on water management and governance. How water-related positive pathways and related tipping points can help to resolve the polycrisis is a subject for future research (Scheffran, 2025), including mutual support between social-ecological transformation and conflict transformation in long-term water cooperation for building sustainable peace.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

JS: Writing – original draft, Writing – review & editing.

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