


## How is water security conceptualized and practiced for rural livelihoods in the global South? A systematic scoping review

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### ABSTRACT

In the global South, rural and resource-based livelihoods increasingly face water-related risks. The conceptualization and application of the water security concept in relation to rural livelihoods has not been reviewed in this context. To fill this gap, a systematic scoping review of refereed journal articles (2000–2019) was conducted to examine how water security is defined, driven, and addressed for rural livelihoods in the global South. Publications ( $n = 99$ ) featured diverse methodologies and geographical contexts, and recognized simultaneous drivers of water insecurity and solution strategies for water security. Several shortcomings were evident. First, only 30.3% of publications defined the concept, mostly using frames of ‘adequate’, ‘sufficient’, and ‘acceptable’ water-related risks. Few definitions recognized the role of water security interventions in increasing capabilities and prosperity. Second, technical and managerial responses to proximate drivers of water-related risk – namely climate-related dynamics, water re-allocation, extraction, and mismanagement – outnumbered efforts to identify and transform the underlying social, economic, and political inequities that create and sustain water insecurity. Last, studies focused heavily on agriculture, while labour, transhumance pastoralism, and aquaculture were underrepresented. A research agenda that increases the synergies between the wider water security and rural livelihoods scholarship is advanced to address these shortcomings.

**Key words:** Global South, Livelihoods, Rural, Systematic scoping review, Water security

### HIGHLIGHTS

- A systematic scoping review clarifies how water security is framed and addressed for rural livelihoods.
- Water security focused on conditions of adequacy – not on advancing prosperity.
- Diverse rural livelihoods were underrepresented.
- Systemic processes that create and sustain water insecurity received less attention.
- A research agenda to better understand and address water-related risks for rural livelihoods is provided.

### INTRODUCTION

The concept of ‘water security’ is increasingly valued as a framework to advance coupled human and ecological needs associated with safe, sufficient, and sustainable water-use (Cook & Bakker, 2012; Gerlak *et al.*, 2018). The discourse of ‘security’ and ‘securitization’ emerged from international relations (Brauch *et al.*, 2008) as a set of actions designed to neutralize an existential threat to state interests (Buzan *et al.*, 1998). Early applications of the concept emphasized the need to secure water for intensifying land use for food and materials production

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(Geertsen, 1969; Bromley *et al.*, 1980), expanding regional settlement (Strong, 1956), and maintaining national security (Ohlsson, 1995; Shermer, 2005; Bogardi *et al.*, 2015). After the 1994 Human Development Report, water security was recognized as integral to advancing human security – lives free from fear, vulnerability, shame, conflict, and unmet wants (Cook & Bakker, 2012; Bogardi *et al.*, 2015). Thereafter, the Ministerial Declaration of The Hague (2000, unpag.) at the 2nd World Water Forum widened the concept to a set of conditions where:

*‘[F]reshwater, coastal and related ecosystems are protected and improved... sustainable development and political stability are promoted... every person has access to enough safe water at an affordable cost to lead a healthy and productive life and that the vulnerable are protected from the risks of water-related hazards.’*

This definition further recognized water’s multiple contributions to coupled human and ecological needs using an integrated social–ecological systems perspective (Falkenmark & Rockström, 2005; Vörösmarty *et al.*, 2010; Pahl-Wostl & Knüppe, 2015).

Since the 2nd World Water Forum, uses of the water security concept have exponentially increased in journal articles (Electronic Supplementary Material [ESM] – Panel A1). This is, in part, because water security approaches represent major steps beyond dominant scarcity-based frameworks in identifying, evaluating, and addressing growing concerns related to drinking water systems, economic growth and livelihoods, ecosystem resilience, and climate change (Bakker, 2012; Cook & Bakker, 2012). For one, security approaches measure multiple indicators of hydrological risk (e.g., availability, quality, sustainability) relative to context-specific water needs (Cook & Bakker, 2012; Hall & Borgomeo, 2013; Jepson, 2014; Wutich *et al.*, 2017; Gerlak *et al.*, 2018; Young *et al.*, 2019), instead of measuring how the volume of water available compares to standard and de-contextualized prescriptions over what constitutes need. Second, security approaches invite consideration to the multiple drivers of water insecurity, whereas scarcity frameworks often focus on biophysical and economic drivers affecting water availability. Third, security approaches recognize risk as a function of exposure and sensitivity to a water-related hazard (Garrick & Hall, 2014), indicating that interventions at multiple scales to reduce water-related risk exist. These include exposure reduction (Grey & Sadoff, 2007), incremental capacity-building initiatives that reduce sensitivity to water-related risks (Varady *et al.*, 2016; Venkataramanan *et al.*, 2020), adaptive planning premised on the interconnections between social–ecological systems and responsive to linked uncertainties and feedbacks (Scott *et al.*, 2013), and transformations in how water is governed, distributed, and used, which target the underlying causes of water insecurity (Loftus, 2014; Zeitoun *et al.*, 2016; Jepson *et al.*, 2017a; Wutich, 2019). These approaches contrast with scarcity-based approaches, where the solution space is often more limited, owing to the narrower conceptualization of factors driving water unavailability.

Recent efforts have been made to synthesize the definitions, metrics, and applications of water security (Cook & Bakker, 2012; Garrick & Hall, 2014; Zeitoun *et al.*, 2016; Jepson *et al.*, 2017b; Wutich *et al.*, 2017; Gerlak *et al.*, 2018; Hoekstra *et al.*, 2018), with specific contributions to water and social–ecological system governance (Bakker & Morinville, 2013; Medeiros *et al.*, 2016), household water security (Meehan *et al.*, 2020; Venkataramanan *et al.*, 2020), and human health and wellbeing (Rosinger & Young, 2020; Wutich *et al.*, 2020; Stoler *et al.*, 2021). Systematic knowledge syntheses concerning how water security is conceptualized and applied to rural livelihoods are, however, virtually non-existent. To the author’s knowledge, one study has systematically reviewed the water security concept for rural livelihoods, but compared different ontological and epistemological paradigms of agricultural water security (Malekian *et al.*, 2017). Conducting a systematic scoping review of refereed journal articles published between 2000 and 2019, I examine how water security is defined, driven, and addressed for rural livelihoods in the global South, inclusive of where responsibility rests for redressing insecurity, and which livelihoods

and geographical areas are explored. While systematic *scoping* reviews use a systematic review methodology, they often seek to ‘explore the breadth or extent of the literature, map and summarize the evidence, and inform future research’ (Peters *et al.*, 2020, p. 409), whereas conventional systematic reviews are commonly applied to answer precise, often disciplinary, questions (Aromataris & Munn, 2020).

Against the significant growth in the concept, this paper was motivated by the need to investigate where major water-related risks to rural livelihoods are located, identify responses to address insecurity, and propose avenues to further advance comprehensive water-related risk reduction. The review is further warranted because rural livelihoods in the global South are characterized by resource-dependence, high incidences of poverty, socially exclusive institutions, and insufficient policy support (Dasgupta *et al.*, 2014) – all of which re-produce and amplify the impacts of water-related risks, and necessitate actions to enhance water security.

## METHODOLOGY

### Search criteria

Search criteria were specified in relation to the question: ‘How is water security conceptualized and practiced to support rural livelihoods in the global South?’ The underlined terms represent components of the search criteria (listed in Supplementary Material, ESM – Panel B). Water security and insecurity refer to hydrological characteristics, and processes through which water is allocated and distributed. Livelihoods are defined as ‘the capabilities, assets (stores, resources, claims and access) and activities required for a means of living’ (Chambers & Conway, 1992, p. 6). This concept was operationalized by terms that reflect diverse occupations in the rural global South (Supplementary Material, ESM – Panel B). Articles with an explicit focus on urban livelihoods were excluded. The concept of the global South reflects sites where historical and active processes of colonialism and global capitalism have consolidated and sustained uneven distributions of power, resources, and inequality (Kloß, 2017; Mahler, 2017). I included search terms reflective of predecessor concepts (e.g., ‘developing’ country) and 124 low- and middle-income countries, per the World Bank.

In the social sciences, search criteria must be more exhaustive because of the relative absence of structured abstracts, standardized keywords, and descriptive methodologies (Petticrew & Roberts, 2006; Grey *et al.*, 2013). To meet this challenge, I first identified numerous search terms related to the main concepts in the research question. Second, to reduce selection bias and expand the range of search criteria (Berrang-Ford *et al.*, 2015), I generated multiple ‘Related Search Terms’ (RSTs) associated with the concepts of ‘water’ and ‘livelihoods’ using the available thesauri for each database searched (Supplementary Material, ESM – Panel B). Third, I incorporated the Boolean operators, ‘AND’, ‘OR’, ‘\*’, and ‘NEAR’, into the syntax to enable the databases to more comprehensively retrieve articles. The ‘\*’ truncator enabled different prefixes and suffixes for terms (e.g., ‘secur\*’ captures security, securitization, secured, secures, securing, etc.). The ‘NEAR’ operator established how key criteria were searched and maximized the retrieval of relevant articles. For example, ‘secur\* NEAR/5 water’ captured the ‘secur\*’ concept within five words of the term ‘water’ (e.g., water secure; security of water; securitization of water, etc.). This was replicated for each RST (e.g., ‘secur\* NEAR/5 suppl\* of water’, ‘secur\* NEAR/5 flow of water’, etc.). The entire process was replicated for the concept of ‘insecur\*’ as well. The criteria are provided in Supplementary Material, ESM – Panel C.

### Databases searched

I searched the Agricultural and Environmental Science Database, Aquatic Sciences & Fisheries Abstracts, Public Affairs Information Service, and the Web of Science Core Collection. Each database, with the exception of the generic Web of Science, specializes in thematic areas relevant to the research question (Shah, 2021, p. 36 for detail). I searched the title, abstract, author, keywords, and KeyWords Plus<sup>®</sup> (i.e.,

‘TOPIC’ operator) in the Web of Science Core Collection database<sup>1</sup> and everything but the full text (i.e., ‘NOFT’ operator) in the other three databases. I limited the scope of the analysis to English-language peer-reviewed journal articles published between January 2000 and mid-September 2019. Grey literature was not included because I aimed to understand how peer-reviewed research – an important repository of knowledge for shaping policy – defined, conceptualized, and studied water security. I seek to identify major shortcomings and establish a research agenda for future scholarship, which could directly inform policy-making.

### Processing and de-duplication

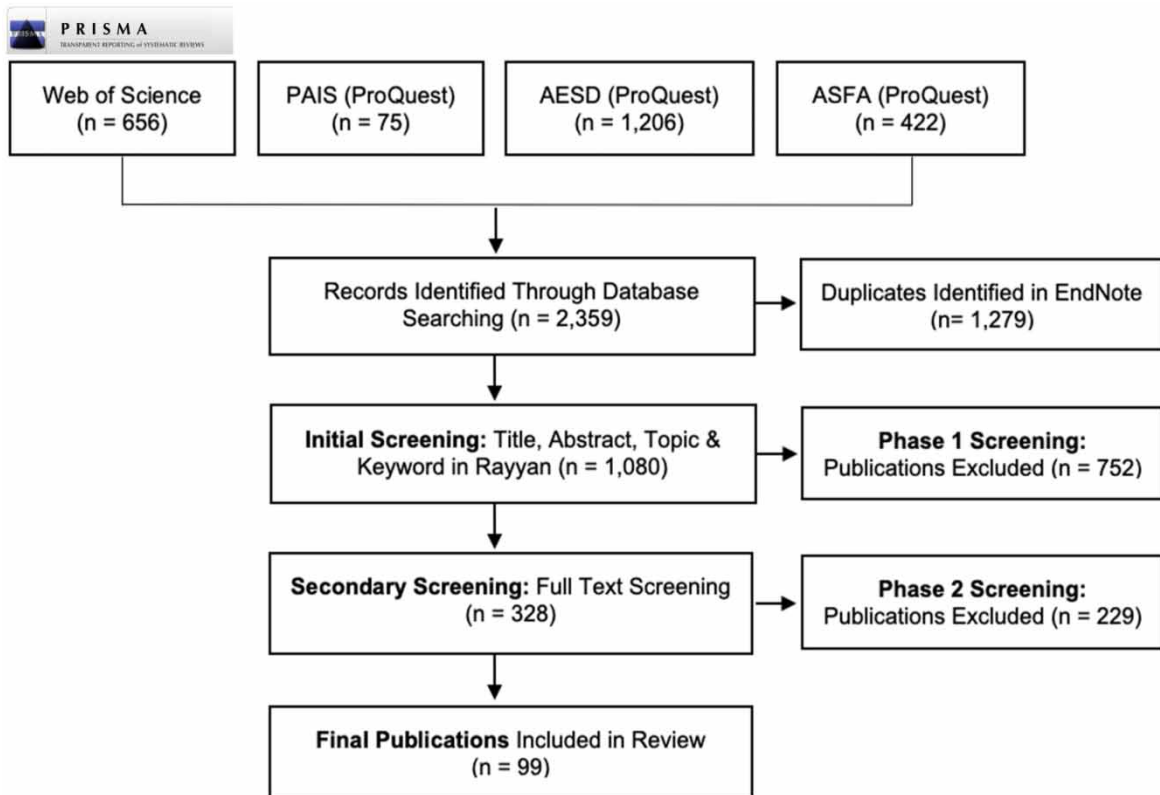
Publications retrieved from each database were exported into RefWorks Legacy Reference Management Software ( $n = 2,359$ ). These records were exported as RefWorks Tagged Format files into EndNote X9 (Clarivate, Philadelphia, PA) and de-duplicated using the seven-step methodology from [Bramer et al. \(2016\)](#). The de-duplicated records ( $n = 1,080$ ) were imported into Rayyan-QCRI (<http://rayyan.qcri.org>) – an open-source web-based application for systematic reviews ([Ouzzani et al., 2016](#)) and examined against novel multi-stage inclusion–exclusion criteria developed by the author.

### Inclusion/exclusion criteria

An initial screening process (‘Phase 1 screening’) excluded articles that did not meet the defined criteria for the review. Here, the articles’ title, abstract, and keywords ( $n = 1,080$ ) were screened and included for full-text review if the publication (i) was a peer-reviewed journal article, (ii) written in English, (iii) published on or after January 2000, (iv) had the concept of ‘in/security’ occurring in direct relation to a water-RST, (v) used the concept of water in/security (or security of an RST) to assess, evaluate, or improve a rural livelihood, and (vi) had a focus in at least one area defined to be the global South. The in/security concept must have been explicitly related to a water-related RST and referenced in the context of a rural livelihood.

Shown in [Figure 1](#), 752 publications were excluded in the initial screening and 328 peer-reviewed articles were designated for a second screening (‘Phase 2 screening’), where the full text was appraised to determine the extent to which articles *meaningfully engaged* with water in/security. I developed and applied explicit criteria, not subjective judgement, to ascertain a ‘meaningful’ focus. First, an article had a meaningful focus if water in/security (or security of an RST) was explicitly defined and consistently used in the context of rural livelihoods (‘Category 1’). 30.3% of the final included articles were coded as Category 1. Second, a substantial focus was present if in/security was explicitly defined but later rarely referred to as ‘in/security’ and instead as its constitutive elements (e.g., timing, amount, duration) (i.e., ‘Category 2’). No articles were coded as Category 2. Third, a meaningful focus occurred if the concept was undefined but used consistently ( $\geq 5$  times) in the context of rural livelihoods (i.e., ‘Category 3’). 69.7% of included articles were coded as Category 3. Articles were excluded (Category 4) if water in/security was inconsistent (e.g., mentioned a few times). This indicated that the concept was not a component of the publication’s analytical framework. Articles were further excluded if it was determined other criteria in the initial phase were not met upon full-text examination, or if deemed out-of-scope. The selection process was internally reviewed by a subject librarian at The University of British Columbia (Taylor, S. pers. comms., Sept. 24, 2019; Jan. 23, 2020). Articles designated for full inclusion ( $n = 99$ ) were thematically coded using a self-developed manual (Supplementary Material, ESM – Panel D). All articles were coded by the author (Supplementary Material, ESM – Panel E for included articles).

<sup>1</sup> KeyWords Plus<sup>®</sup> are terms generated from the title of the article; keywords are author-included terms.



**Fig. 1** | Process for identifying and excluding retrieved journal articles. PRISMA diagram adapted from [Moher et al. \(2009\)](#).

## RESULTS

### Metadata

The number of refereed articles on the subject has increased considerably since 2000 (Supplementary Material, ESM – Panel A2); however, this growth is recent as 85.9% of the articles were published after 2010. This pattern may be attributed to the heightened focus on the water–energy–food nexus, urban–industrial demands, and increasing research of climate impacts on water and food systems.

The lead author affiliation was examined under the assumption that the first author conducted the majority of the work. In half (50.5%,  $n = 50$ ) of the publications, the lead author held only a global North affiliation in at least one of the 14 countries<sup>2</sup>. 40.4% ( $n = 40$ ) of the publications had a lead author who was exclusively associated with an institution in the global South. In approximately 8.1% of publications, the lead author had a mixed South/North affiliation, and in one the affiliation's location was indeterminable. Nearly 40% of the publications examined had authors exclusively associated with organizations based in South Africa, United States, and/or England – representing key hotspots of knowledge production.

The majority of the research was produced by lead authors at academic institutions. Leads were exclusively affiliated with an academic institution in 64.7% of publications ( $n = 64$ ). In another 10.1% ( $n = 10$ ), the lead

<sup>2</sup> Australia, Canada, Denmark, England, Finland, France, Germany, Israel, Italy, Japan, Netherlands, Spain, Sweden, and the United States.

author had multiple affiliations of which one was an academic organization. Leads were exclusively associated with non-governmental (9.1%), inter-governmental (3%), private (3%), and government (2%) organizations<sup>3</sup> in fewer publications. The methodological and analytical approaches were multi-disciplinary in nature. Quantitative (35.4% of publications), qualitative (27.3%), mixed-methodological approaches (14.1%), and policy or concept notes based on secondary sources and available literature (23.2%) were well represented. This diversity is further reflected in the 56 different journals that articles were published in, including critical social science, interdisciplinary, review-based, and practitioner journals (Supplementary Material, ESM – Panel F). Five journals accounted for 26.3% of the publications and included the *Journal of Cleaner Production*, *International Journal of Water Resources Development*, *Natural Resources Forum*, *Water*, and *Water Resources Management*. The most common disciplines were water resources, environmental sciences and ecology, and engineering. Environmental sciences and ecology reflect environmental governance, natural resource management, and global and regional environmental change research (see Supplementary Material, ESM – Panel G).

### How is water security defined?

Only 30.3% of the publications explicitly defined water security or insecurity (or the in/security of a water-RST). Coding revealed definitions had procedural and/or outcome-oriented dimensions (Table 1). Procedural implies water security as a process (e.g., legal, managerial, and economic means to secure water) and outcome-oriented implies a set of hydrological characteristics relative to specific water-related requirements or risk thresholds.

Definitions that were entirely outcome-oriented were reflected in 43.3% ( $n = 13$ ) of the publications that provided a definition (e.g., Calow *et al.*, 2010; Agholor, 2013; Shah & Zerriffi, 2017). Most outcomes focused on an acceptable level of risk and sufficient hydrological characteristics (e.g., reliability, quantity, quality, timing, affordability) relative to particular water-related needs. This framing follows a key water security definition from Grey & Sadoff (2007) as ‘the availability of an *acceptable quantity and quality of water* for health, livelihoods, ecosystems and production, coupled with an *acceptable level of water-related risks* to people, environments and economies’ (p. 545, my italics). Only five definitions (16.7%) framed water security in relation to productivity, wellbeing, and prosperity. Even here, it was unclear whether wellbeing was associated with maintaining the existing needs, or whether it involved re-orienting water security initiatives towards building capabilities and meeting aspirations.

Procedural and outcome-oriented elements of water security were present in 50% ( $n = 15$ ) of the publications with a definition. These publications explicitly defined linkages between procedural (i.e., the means) and the outcomes of water security. Procedural elements enrolled different actors in mitigating and adapting to water-related risks. Mitigation strategies reduce the likelihood of experiencing water-related risks or inadequacies and included, within the definitions, broad language around water conservation, environmental protection, sustainable water-use, and coordinated management across scales (e.g., Wang *et al.*, 2012; Maleksaeidi *et al.*, 2015; Khalid, 2018; Nhamo *et al.*, 2018). Mitigation efforts further involved resisting changes in existing water rights in the context of policies that re-allocate water (Cremers *et al.*, 2005; Sinyolo *et al.*, 2014). Adaptation strategies reduce the impact of an existing or potential risk, and included livelihood capacities to deal with an ecohydrological change (Danie-laini *et al.*, 2018), and building resilient water systems through monitoring, redundant water sources, and water rights to manage and cope with water variability (Wegerich *et al.*, 2015). Overall, water security definitions were conservative because they often focused on processes and linked hydrological outcomes to *reduce* water-related risks or gaps in *sufficiency*. No definitions, in and of themselves, explicitly focused on transforming the existing social–ecological and institutional arrangements in water distribution and access to build human capabilities.

<sup>3</sup> The lead author affiliation was indeterminable in 7.1% of the publications. In 1%, the lead author had multiple non-academic affiliations.



**Table 1** | Illustrative definitions exemplifying procedural and substantive definitions.

Orientation <sup>a</sup>	Example definitions from included publications
Procedural ( $n = 2$ ; 6.7%)	<ul style="list-style-type: none"> <li>• ‘Security of access to water refers to the possibility of materializing water-use rights now and in the future, and to avoiding, or controlling the risks of, unsustainable water management’ (Cremers <i>et al.</i>, 2005, p. 40).</li> </ul>
Outcome-oriented ( $n = 13$ ; 43.3%)	<ul style="list-style-type: none"> <li>• ‘[The] availability of, and access to, water sufficient in quantity and quality to meet the livelihood needs of all households throughout the year, without prejudicing the needs of other users’ (Calow <i>et al.</i>, 2010, p. 248).</li> <li>• Secure surface irrigation service is ‘adequate in the amount, duration and timing of water supply that together satisfy agricultural needs... protect[s] against water-related hazards... and [is] predictable in [its] delivery’ (Shah &amp; Zerriffi, 2017, p. 3, citing Cook &amp; Bakker 2012; Grey &amp; Sadoff, 2007).</li> </ul>
Procedural and outcome-oriented ( $n = 15$ ; 50%)	<ul style="list-style-type: none"> <li>• ‘[I]nsufficient accessibility and capability of water sources and services to satisfy the household needs for health, livelihood, ecosystem, and production, coupled with inadequate acceptability and adaptive capacity of households to deal with the ecohydrological changes that impact liveability and sustainability’ (Danielaini <i>et al.</i>, 2018, p. 2).</li> <li>• ‘[D]etermined not just by absolute availabilities of water in their territories; most of all it is a function of historical and contemporary distribution patterns of resources and services (quantities and qualities), in a context of threats and encroachment practices. ... [W]ater insecurity is therefore a socio-political relationship that is felt hardest by socio-economically and politically less powerful societal groups’ (Hidalgo <i>et al.</i>, 2017, p. 68).</li> </ul>

<sup>a</sup>Not all definitions ( $n = 30$ ) shown.

## Drivers and solution pathways associated with water insecurity and water security

I used a combined deductive and inductive coding strategy to identify and synthesize drivers (Table 2) and solution strategies (Table 3) associated with water insecurity and water security. Each publication was assessed using the self-developed coding manual, which established via an earlier comprehensive literature review on agricultural water insecurity, five generic drivers associated with water insecurity and four solution pathways related to water security. An ‘indeterminate’ and ‘other’ category existed for both as well to allow flexibility. Furthermore, I listed each driver and solution from the author(s) text. To develop the inductive codes, each cause and solution was re-coded in multiple cycles to define themes. The inductive results are represented as the percentage of ‘causes’ listed (not the percentage of publications) because re-coded categories are a function of individual attributed causes, not the number of unique publications. Multiple drivers and solution pathways (ranging from 2 to 10 per publication) were present in 73.7 and 61.6% of publications, respectively. Thus, the references in the following two sections may cite one driver or solution strategy even where several were identified by the author(s).

### Drivers of water insecurity

First, the deductive and inductive coding results revealed that an environmental change was a prevalent driver related to water insecurity. Weather- and climate-related change and variation, discussed in 64.7% of publications (26.3% of listed causes), was the most prominent driver associated with livelihood water insecurity. Examples included the uneven spatial distribution of precipitation (e.g., Chegwin & Kumara, 2018), precipitation variability (e.g., Sinha *et al.*, 2018), extreme events such as flooding (e.g., Borgomeo *et al.*, 2017) and drought (Danielaini *et al.*, 2018), and climate-related changes in precipitation patterns, temperature, and aridity (e.g., Al-Bakri

**Table 2** | Inductive coding results for drivers associated with rural livelihood water insecurity.

Drivers <sup>a</sup>	Count	% Drivers
Biophysical		
• Land-related: sedimentation, land-use change, geological	12	4.9
• Weather and climatic-related change and variation	65	26.3
Inadequate infrastructure (e.g., availability of infrastructure, deterioration, lack of maintenance)	13	5.3
Inter-sectoral water competition	36	14.6
Water extraction and depletion	31	12.6
Other (e.g., adaptation barriers, violent conflict)	10	4.1
Socio-economic		
• Inability to acquire water, limited participation of underrepresented groups in decision-making, marginalization of water rights, and management systems	21	8.5
Water governance and water management		
• Structure and function: sectoral management, lack of integrative planning, ineffective transboundary cooperation, and cross-scalar planning	17	6.9
• Mechanisms: inadequate planning frameworks, vision, transparency, accountability	10	4.1
• Laws, regulations, monitoring, enforcement, regressive incentives, and inefficient use	14	5.7
• Economic and organizational resource scarcity for infrastructure and conservation promotion (e.g., decision-support, financial, extension resources)	11	4.5
• Poorly functioning institutions (e.g., unviable markets, lack of cooperation)	7	2.8

<sup>a</sup>Thirteen codes were removed because they were not drivers of water insecurity.

*et al.*, 2013; Falkenmark, 2013a). A second environmental driver associated with water insecurity was land-use processes and land-use change (4.9% of the listed causes). Land-use processes and characteristics associated with water insecurity included sedimentation and hydro-geological factors, invasive species (e.g., Bitterman *et al.*, 2016; Everard *et al.*, 2018), wetland drainage (Dixon & Wood, 2003), and land conversion (e.g., Qiu *et al.*, 2013; van Noordwijk *et al.*, 2016).

Second, the deductive results indicated that mismanagement and inadequate governance systems were associated with water insecurity in 48.5% of publications (23.9% of listed causes). The inductive codes revealed clearer sub-themes within this broad category related to (i) water governance – the organizational and administrative structures and functions around decision-making, distribution, and use (Bakker, 2003); and (ii) water management – the capacity to regulate and monitor water under particular governance arrangements (Bakker, 2003). The structure, function, and capacity of water governance – including sectoral management arrangements, and ineffective transboundary and cross-scalar planning within linked social-ecological systems – was associated with water insecurity. These included the inability to manage across boundaries and competing uses (e.g., Rasul, 2014; Bekchanov & Lamers, 2016; Sithirith *et al.*, 2016; Everard *et al.*, 2017), gaps in key planning frameworks, strategies, and mechanisms that may alleviate risks (e.g., Cremers *et al.*, 2005; Bichai *et al.*, 2016; Sen & Kansal, 2019), and inadequate economic and organizational resource support (e.g., decision-support, financial resources, extension) (e.g., Braune & Xu, 2009; Foster *et al.*, 2012; Williams, 2015; Nazari *et al.*, 2018). Inadequate water management included absent or the selective application of laws or regulations (e.g., Baleta & Winter, 2016; Ravnborg,



2016), perverse subsidies (e.g., Bitterman *et al.*, 2016; Rasul, 2016), and deficiencies in water-use and water-use rules (e.g., Sharaunga & Mudhara, 2016; Komakech & de Bont, 2018; McCord *et al.*, 2018).

Third, I found that inter-sectoral water competition – namely urban–industrial and environmental flows allocation (e.g., Rasul, 2014; Baleta & Winter, 2016; Shah & Zerriffi, 2017; Cetinkaya & Gunacti, 2018) – was associated with water insecurity in 36.4% of publications (14.6% of listed causes). Water extraction and depletion appeared in 32.3% of the publications (12.6% of listed causes), and included increasing irrigation demand associated with water-intensive cultivation systems, such as rubber plantations (Chiarelli *et al.*, 2017), groundwater extraction for transnational agri-businesses (e.g., Hidalgo *et al.*, 2017), and the potential for extensive water-use to contribute to linked socio-hydrological challenges, such as groundwater salinization (Wurl *et al.*, 2018).

Fourth, socio-economic standing (e.g., poverty, exclusion) clearly drove water insecurity in around 20.2% of publications (8.5% of listed causes), whereby endowment and entitlement bundles affected water access and management (e.g., Calow *et al.*, 2010; Komakech *et al.*, 2012; Bitterman *et al.*, 2016; Mollinga, 2016). Examples include neoliberal policy shifts and the prioritization of foreign entities (Kattelus *et al.*, 2013), exclusion from water services (Verzija & Dominguez, 2015), and the marginalization of rights and management systems (e.g., Cremers *et al.*, 2005; Hidalgo *et al.*, 2017; Klümper *et al.*, 2017). Further, few studies conceptualized, but did not report sufficient empirical evidence to support their hypotheses that factors such as gender, education, wealth, and access to institutional credit or extension, affected water insecurity (e.g., Sinyolo *et al.*, 2014; Sharaunga & Mudhara, 2016). Many publications, not reflected in the coding above, recognized poverty and inequality not as *drivers* but as *outcomes* of water insecurity, for which techno-managerial strategies were often discussed as key solutions.

### Solution pathways to water security

The deductive and inductive coding revealed multiple descriptive (i.e., describing how certain actors responded to insecurity) or normative (i.e., arguing for a course of action) solution pathways for water security.

First, strategies associated with increasing water supply or availability were represented in 45.5% of the publications and constituted nearly 20% of the listed strategies. Supply-oriented efforts existed at multiple geographical scales, and included regional large dams (e.g., Gohar *et al.*, 2013), inter-basin water transfer (e.g., Xia *et al.*, 2006; Rajsekhar & Gorelick, 2017), and decentralized village and household-scale water harvesting (e.g., Liu *et al.*, 2008; George *et al.*, 2010; Meyer & Solms, 2018). In the vast majority of publications (95.6%) where increasing water supply or availability was deductively coded as a solution, it was one of several strategies discussed. For example, Rajsekhar & Gorelick (2017) estimate that the recovery of Syrian-irrigated agriculture to its pre-conflict social–ecological state will produce twice the decline in transboundary inflow available for Jordanian agriculture as compared to that due to climate change. The authors recommend improved transboundary water-sharing agreements between Jordan and Syria as well as additional freshwater supplied through the multi-billion-dollar Red Sea–Dead Sea desalination project (Rajsekhar & Gorelick, 2017). A more indirect approach comes from George *et al.* (2010), who estimated significant improvements in agricultural water security, can be made by increasing urban water distribution efficiency, re-using urban runoff (90 million cubic meters [MCM]), recycling 120 MCM of wastewater, and implementing 500,000 household rainwater harvesting units in the city of Hyderabad (India). Overall, supply improvements were diverse and co-existed at multiple scales with other solution strategies.

Second, enhancing water efficiency and productivity were prominent responses (38.4% of publications; 17.1% of listed strategies). Examples included efficient irrigation technology (e.g., canal lining, drip irrigation), different crop variants, and land management practices (e.g., Falkenmark, 2013b; Chinnasamy & Agoramorthy, 2015; Seeliger *et al.*, 2018; Xu *et al.*, 2019). For example, Alcon *et al.* (2018) found that farmers in the Litani River Basin (Lebanon) were willing to pay higher water prices to support the installation of plot-level water-saving

measures (e.g., irrigation scheduling, drip irrigation) and farm-scale water-metering systems for the irrigation district to increase water security and reduce uncertainty. A handful of articles indicated behavioural changes (e.g., reducing water-intensive diets) (Perrone & Hornberger, 2013) and reducing demand in competing sectors as strategies (George *et al.*, 2010).

Third, solutions associated with water management and governance strategies featured prominently (75.8% of publications). The inductively coded strategies revealed four major sub-themes, including a focus on: (i) water management, and knowledge production and information dissemination (16.3% of coded solutions); (ii) new organizational structures and functions, particularly across social–ecological and jurisdictional scales (18.9% of coded solutions); (iii) new mechanisms for water security (e.g., conflict resolution, ecosystem-based management, market-based schemes) (4.8% of coded solutions); and (iv) strategic and sustainable planning of water and livelihoods (4.8% of coded solutions).

Water management approaches (16.3% of coded solutions) indicate regulatory, enforcement, data management, decision-making support, and monitoring processes without substantial shifts in governance frameworks (e.g., Wegerich *et al.*, 2015; Pousa *et al.*, 2019). For instance, in Western Bahia (Brazil), one of the most active agricultural frontiers globally, Pousa *et al.*, (2019) found that multi-decadal regional precipitation and streamflow had decreased in both seasons while irrigated area had increased 150-fold over a similar time period. They recommend avoiding irrigation during low-flow periods, halting the installation of new irrigation systems, and investing in hydro-climatic monitoring systems for regulating water licensing and use (Pousa *et al.*, 2019).

Water governance structure and function approaches included managing water across multiple social–ecological scales (18.9% of solutions) and on, relatedly, novel mechanisms (4.8% of solutions) for improving water security. Changes in the structure and function of water governance focused on developing cross-scalar arrangements between countries, and across and within basins (e.g., Sithirith *et al.*, 2016; Duan *et al.*, 2019); on integrative and multi-sectoral representation in water decision-making, particularly at the agriculture–water–energy nexus (e.g., Conway *et al.*, 2015; Rasul, 2016; Nhamo *et al.*, 2018; Mabhaudhi *et al.*, 2019); and on improved organizational characteristics (e.g., transparency, inclusion, openness, communication). Governance mechanisms or instruments included, but were not limited to, tradeable water rights (e.g., Bekchanov & Lamers, 2016; Matchaya *et al.*, 2019), conflict resolution mechanisms (Shah & Zerriffi, 2017), and ecosystem service conservation (e.g., Rasul, 2014; Bremer *et al.*, 2016; van Noordwijk *et al.*, 2016). For example, Rasul (2014) argues for cross-sectoral coordination between agriculture, energy, drinking water and environmental sectors, and regional integration between upstream–downstream areas for advancing food, water, and energy security in the Hindu Kush Himalayas. This includes both re-structuring governance to synchronize policies across different sectors and integrating water, energy, and land into basin planning, which can be advanced by incentives including ecosystem services and cost-benefit-sharing arrangements (Rasul, 2014, 2016). Sithirith *et al.* (2016) finds that the Mekong River Commission (MRC) Agreement, which focuses on the Mekong mainstream river flow, poorly regulates hydrological development on shared transboundary tributaries. The inability for the international agreement to regulate for dams on shared tributaries has affected the diverse relationships with water around the production and maintenance of livelihoods (e.g., rice farming, fishing) in linked social–ecological systems (Sithirith *et al.*, 2016). The authors argue that co-operative regulations and mechanisms must be strengthened (Sithirith *et al.*, 2016). These articles disassociate with management paradigms that assumed water to be predictable, static, and controllable over time and instead view risk to emerge from rigid, sectoral, and uncoordinated institutions<sup>4</sup>. Another subset of the codes focused on

<sup>4</sup> This is aligned with a broader scholarship, e.g., Folke (2003), Lankford & Beale (2007), Pahl-Wostl *et al.* (2011), and Bakker & Morinville (2013).

**Table 3** | Inductive coding results for solutions associated with rural livelihood water insecurity.

<b>Solutions</b>	<b>Count</b>	<b>% Solutions</b>
Water supply		
• Improve water supply or availability	44	19.4
• Improve water supply or availability (urban areas)	1	0.4
Water demand, productivity, and efficiency		
• Increase water productivity or efficiency	38	16.7
• Reducing demand of other sectors	1	0.4
Socio-economic standing		
• Build water-related entitlements (e.g., reduce poverty, enhance participation and representation of marginalized peoples)	7	3.1
• Assert rights or claims to water	4	1.8
• Distribute water for marginalized residents or communities	4	1.8
Water governance and management		
• Transboundary, cross-scalar planning, and multi-sectoral planning (e.g., institutional structures, mechanisms)	30	13.2
• Water management (e.g., monitoring, regulation, enforcement)	20	8.8
• New governance mechanisms for water security (e.g., markets, willingness-to-pay schemes, ecosystem-based management)	9	4.0
• Data acquisition and decision-support systems	9	4.0
• Formalizing strategic water management planning systems	7	3.1
• Water governance characteristics (e.g., transparency, inclusion, communication)	7	3.1
• New organizational structures (e.g., decentralized management, local participative institutions)	4	1.8
• Strategic national planning (e.g., de-linking livelihoods from water; re-considering the role of agriculture)	4	1.8
• Extension and training	3	1.3
• Mitigation of hazards (e.g., early warning)	3	1.3
• Improve water distribution and equitability	3	1.3
• Collective action and local co-operation	2	0.9
• Conflict resolution mechanisms	2	0.9
• Information dissemination and raise awareness	2	0.9
• Institutional change to recognize water rights	2	0.9
• Integrate land-use planning into water management	2	0.9
• General (governance and management)	2	0.9

*(Continued.)*

**Table 3** | Continued.

Solutions	Count	% Solutions
Other		
• Infrastructure rehabilitation and maintenance	7	3.1
• Indeterminate	3	1.3
• Context specificity in design and solution response	2	0.9
• Forestry and vegetation management	2	0.9
• Behavioural changes	1	0.4
• Livelihood diversification to manage water-related risks	1	0.4
• Stabilize conflict	1	0.4

formalizing sustainable water planning frameworks and on re-examining national planning in the context of water insecurity (4.8% of coded solutions). This included, for example, re-considering the role of agriculture, or certain agricultural products, in national planning (Bekchanov & Lamers, 2016; Nazari *et al.*, 2018).

Last, reducing socio-economic barriers or systems preventing water access was clear in approximately 14.1% of the publications (e.g., Cremers *et al.*, 2005; Hidalgo *et al.*, 2017; Klümper *et al.*, 2017; Danielaini *et al.*, 2018). Themes included asserting rights or claims to water (e.g., institutional pressure, forming alliances, or asserting management frameworks), building entitlements (e.g., poverty reduction, representation of marginalized peoples), and improving the distribution of water for marginalized groups. A focus on these systemic structures and processes is an area for significantly greater analysis.

The different solutions were well-distributed across scales. An individual or household scale (24.2% of publications) could include strategies, such as farmers' coping responses to inadequate irrigation (e.g., Liu *et al.*, 2008; Ferchichi *et al.*, 2017) or agreement to pay higher fees for improved water security (e.g., Alcon *et al.*, 2018). The community level (21.2%) could include strategies, such as local rules around water sharing (McCord *et al.*, 2018), communal management of groundwater resources (Foster *et al.*, 2012), or improved reliability and maintenance of water infrastructure (Borgomeo *et al.*, 2017). The watershed or river basin scale (37.4%) included strategies to revitalize irrigation systems (Lankford *et al.*, 2016) and manage water at the water–energy–food nexus (e.g., Wegerich *et al.*, 2015; Shah & Zerriffi, 2017; Colloff *et al.*, 2018). State or province (21.2%) and country (35.4%) scales could include many of these aforementioned strategies, or broader legal and regulatory changes. Last, the international scale (23.2%) often referenced transboundary water governance (e.g., Kibler *et al.*, 2014; Sithirith *et al.*, 2016; Rajsekhar & Gorelick, 2017; Mpandeli *et al.*, 2018). A handful of publications provided a general indication of multiple scales with unspecified units (6.1%). The scale of the solutions was indeterminate in two publications.

### Livelihood focus

The diversity of resource-based livelihoods in the global South was not well reflected in the studies examined. Nearly every article focused to some degree on agriculture, ranging from subsistence food production to commercial export-oriented commodities (e.g., flowers, rubber). Explicit focus on agricultural labour was not featured. Approximately 24.2% ( $n = 24$ ) of publications had some focus on livestock, animal husbandry, or pastoralism – but were most commonly studied as a secondary livelihood nested under agriculture. Global figures on

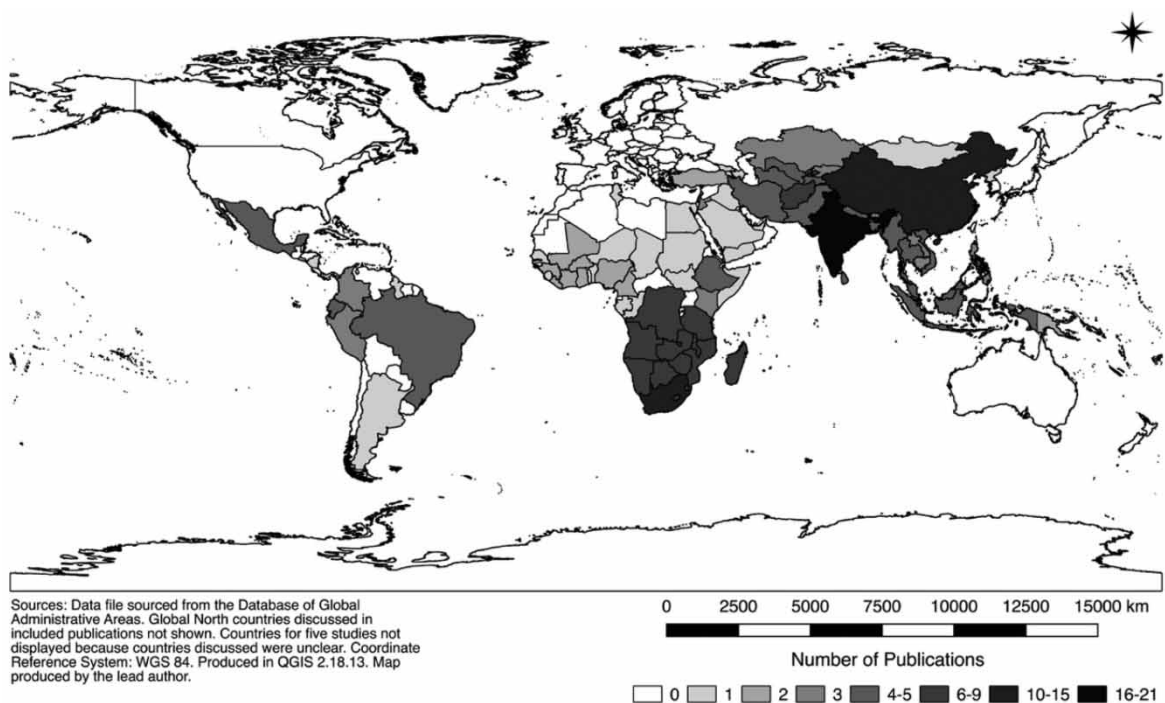
pastoralism are unclear but are estimated to support around 200 million households (Dong *et al.*, 2011; IUCN, 2020) with key regions experiencing growth (e.g., South America and Central Asia) and many areas experiencing decline from expanding agriculture (see FAO, 2001). A clear absence of transhumance pastoralism, in particular, is problematic. Last, a small subset of the articles focused on aquaculture and fishing (8.1%) and agro- or other industrial activities (7.1%), and an insignificant share focused on other resource-based livelihoods (e.g., hunting, artisan skills).

### Geographic focus

The geographical focus was wide-ranging. Eighty-six global South countries were studied across the 99 analyzed publications (Figure 2). Despite this diversity, three major country-specific clusters emerged in India ( $n = 21$  publications), South Africa ( $n = 15$ ), and China ( $n = 13$ ). Together, 42.4% of the publications examined contained at least one of these three countries<sup>5</sup>. One-third of the countries ( $n = 29$ ) examined were studied once (i.e., in one publication) with most in west and central Africa, and the greater Middle East. Notable absences included northern Africa and central areas of South America. Future research is warranted in these areas.

### Responsibility

A range of actors, including government bodies, river basin organizations, farmers, local communities, cooperative associations/agricultural associations, industrial water users, donors, non-governmental organizations, and consumers, were conveyed, directly or indirectly, as responsible for addressing water security. Government



**Fig. 2** | Articles' geographic focus. A publication can examine >1 country.

<sup>5</sup> This figure represents distinct publications, given in some >1 of the countries were examined.



bodies or officials were at least one entity responsible for contributing to livelihood water security in 81.8% of the publications. Examples included creating national, state, or regional planning frameworks, implementing regulations, or coordinating water across boundaries. Individuals and local communities were coded as at least one party responsible for improving water security in 21.2 and 20.2% of the publications, respectively. Examples included adoption of new technology, partaking in management decision-making, or developing community-based plans. Other actors, such as NGOs and donors, did not frequently appear as responsible co-entities.

## DISCUSSION

This section derives four insights from the results, reflecting shortcomings related to *what* the objectives of security interventions are, *who* and *what* is subject to intervention, *how* and *why* risks manifest, and *which* solutions are proposed. Within each insight, I present avenues for future research, reflecting on the wider water security and rural livelihoods scholarship and the potential synergies between these concepts.

**Insight #1:** *Water security focuses on conditions of adequacy – not on advancing prosperity.* The analyzed definitions of water security focused heavily on preventing unacceptable levels of risk or on ensuring ‘acceptable’ and ‘sufficient’ water – not explicitly on building capabilities or meeting self-determined aspirations. For instance, securing water to avoid crop failure (i.e., an ‘unacceptable’ risk) and securing water for enhancing yields, income, and socio-economic aspirations have different implications for how water security is advanced. The current focus on conditions of adequacy is an incomplete framing if the concept is to serve livelihoods. Scoones’ (1998) adaptation of Chambers & Conway’s (1992) sustainable livelihood definition posits, ‘[a] livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base’ (p. 5). Here, a ‘sustainable’ livelihood is not just one that maintains biophysical life-support systems but achieves ‘adequacy, security, well-being and capability’ (Scoones, 1998, p. 5). Capabilities represent what a person can be or do, which is linked to their freedoms to pursue self-determined aspirations and notions of wellbeing (Scoones, 1998; Bebbington, 1999; Sen, 1999). A pre-occupation with adequacy or unacceptable water-related risk is insufficient to increase livelihood capabilities for wellbeing and prosperity. Water security interventions have only recently emphasized the importance of building human capabilities (e.g., Lemos *et al.*, 2016; Jepson *et al.*, 2017a; Wutich *et al.*, 2017; Gimelli *et al.*, 2018). Pivoting from a short-term, risk reduction focus to an effort that builds capabilities – or, what people can be, do, and achieve (Sen, 1999) – should be a focus of research and practice, particularly in the context of social–ecological and hydrological change, that may increase livelihood water insecurity in the rural global South (Lemos *et al.*, 2016).

**Insight #2:** *‘Who’ and ‘what’ is made secure is narrow and limits livelihood support.* Key livelihood groups were disproportionately underrepresented – namely agricultural labourers, transhumance pastoralism, and aquaculture. Neglecting one livelihood is not necessarily limited to neglecting one distinct group of people; many resource-dependent households depend, either simultaneously or seasonally, on multiple livelihoods (Ellis, 2000). A narrow focus on agriculture will neglect the ‘complex bricolage or portfolio of [livelihood] activities’ (Scoones, 2009 p. 172) integral to rural household needs. Future research should explore water insecurity dynamics for multiple diverse livelihoods. Further, existing approaches to secure water for physical entities, such as crops or livestock, do not account for human needs to perform such livelihoods. This neglects how water for ‘domestic use’ is used for livelihood activities (Cleaver & Elson, 1995) and how water for irrigation (‘productive use’) is used in non-farm livelihoods, subsistence, and domestic use (e.g., van Koppen & Hussain, 2007; Mehta, 2014). Simply said, livelihoods are not independent of an individual’s physical health, thirst, and nutrition. Future research should further examine how water insecurity in ‘non-productive’ domains can affect the ability to perform and undertake a livelihood activity.



**Insight #3:** *The identification and transformation of systemic processes that create and sustain water insecurity is limited.* A limited focus on the relationship between water insecurity and socio-economic standing, power, and poverty exists. Mitigation and adaptation strategies related to proximate drivers of water-related risk exceeded efforts to identify and transform the underlying socio-economic dynamics sustaining water insecurity. This result is reflected in the wider water security scholarship (Loftus, 2014; Wutich & Brewis, 2014; Zeitoun *et al.*, 2016; Jepson *et al.*, 2017a) and is problematic because any understanding of risk related to the dominant drivers of change identified (e.g., climate change, water re-allocation, and increased water demand) cannot be understood, measured, or analyzed independently of systems of power and marginalization. In fact, a critical reason why water security programs, including in livelihood contexts, fail to achieve broadly distributed gains, is because technical and short-term ('practical') strategies often re-produce the inequitable planning, distribution, and use of water (Shah *et al.*, 2021; see Zeitoun *et al.*, 2016 on distinction between 'reductionist' and 'integrative' water security approaches). Livelihood frameworks have, in *theory*, centred structural and systemic interventions for building entitlement and endowment structures (Chambers & Conway, 1992; Scoones, 1998, 2009). Indeed, a critical component of the livelihood framework is the political-economic, class, and gender structures that mediate entitlement and endowment distribution, livelihood opportunities, and the social-ecological risks that accompany differentiated livelihood activities (Watts & Bohle, 1993; Scoones, 1998; Birkenholtz, 2012; Taylor, 2015). In this study, endowment and entitlement relations did not sufficiently factor into the causal structure of risk, nor in the solution pathways for reducing water insecurity, despite being foundational to the theoretical understanding of rural livelihoods. A stronger focus here will contribute back to the livelihoods scholarship – which despite integrating social and institutional systems into situated analyses of livelihoods (Chambers & Conway, 1992; Scoones, 1998) – has received criticism for ceding ground to technical, advisory, and extension-based efforts intended to mitigate 'external' hydrological risks that impact livelihood production systems (see Scoones, 2009; Taylor, 2015; Nightingale *et al.*, 2019; Carr, 2020). Given livelihoods exist at the interface of institutions and ecological change, I advocate for the use of coupled social-ecological (Adger, 2006), environmental livelihood security (Biggs *et al.*, 2015), or 'hydro-social' risk frameworks (Linton & Budds, 2014). Such frameworks recognize that the impacts of water-related stressors interact with, or depend on, social, economic, and political inequalities (Olsson *et al.*, 2014). For example, the effects of climate-related stressors, inter-sectoral water allocation, and demand-driven extraction could be analyzed using an equity-based approach to ascertain why certain households and their livelihood activities experience differentiated water insecurity. These efforts will support a focus on the underlying causes of water insecurity and are well-positioned to improve human prosperity beyond the scope of technical and management-based adaptations.

**Insight #4:** *Global dynamics and interactions are underrepresented.* The scale at which solutions were posited was well-distributed from household to international levels. However, the international scale was often limited to transboundary water-sharing agreements or integration at the water-energy-food nexus. Following Scoones (2009), livelihood approaches have not adequately examined how 'big shifts' associated with globalization, politics, and ecological change impinge on livelihood activities (p. 181). These 'big shifts' (Scoones, 2009) can emerge from social-ecological dynamics at smaller levels, which can, in an interconnected world, reverberate across larger spatial scales (Young *et al.*, 2006; Adger *et al.*, 2009). Relatedly, water managers have not adequately understood 'the interdependencies and dynamics of the global water system' (Hoff, 2009, p. 142). Here, the linkages between resilience, adaptive capacity, and water security at multiple scales are instructive (Scott *et al.*, 2013; Lemos *et al.*, 2016; Varady *et al.*, 2016). Notably, Scott *et al.*, (2013) stress that de-stabilization at one or more scales within interconnected social-ecological systems can create or exacerbate water (in)security. A socio-hydrological approach can support scholarship in this direction with a focus on understanding social and hydrological systems as coupled and generative of feedbacks across multiple scales (Scott *et al.*, 2013; Sivapalan *et al.*, 2012). This will widen

the scalar analysis of water security studies, advance the understanding of feedbacks between large-scale changes and local livelihood dynamics, and support interventions to enhance rural livelihood water security (*viz.* Scoones, 2009).

## LIMITATIONS

There are limitations to this scoping review that must be recognized. First, every effort was made to ensure the review was as comprehensive as possible; however, I do not claim to have captured the entirety of the existing literature, given the challenges in retrieving articles from an interdisciplinary literature without standardized language (Petticrew & Roberts, 2006; Grey *et al.*, 2013). Future reviews could use this study – both its methodology and empirical results – to compare whether new publications depart from the conventional framings of the water security concept, described herein. Second, the inability to include non-English-refereed scholarship is an unfortunate limitation that reinforces the English-language production and synthesis of knowledge. A more diverse set of scholarship could have yielded new or complementary insights, or be used to interrogate the water security concept as derived in the English-language scholarship. Third, I excluded grey literature for the reason detailed above. Fourth, I was the sole individual responsible for coding each article. To reduce concerns of coding bias, the drivers of water insecurity and strategies for addressing water security were both deductively and inductively coded for each article. The deductive and inductive codes were cross-checked for each article. This enabled redundancy to be built into the analysis for key questions. Further, the attribute data and codes for the substantive questions were double-checked.

## CONCLUSIONS

Despite a burgeoning scholarship on water security, the conceptualization and application of the concept to rural livelihoods has not been reviewed. To address this, I conducted a systematic scoping review of peer-reviewed journal articles (2000–2019,  $n = 99$ ) to investigate how water (in)security is defined, driven, and addressed for rural livelihoods in the global South. The review further contributes a transferable methodology for conducting systematic reviews on the water security concept across a multi-disciplinary scholarly literature.

I found that articles related to water security and rural livelihoods in global South contexts have increased since 2000; however, much of this growth is recent. A strength of the literature rests in the multiplicity of disciplines and methodologies, and in the diverse geographical contexts covered. Further, the majority of articles recognized multiple drivers (73.7%) of water insecurity and solution strategies (61.6%) for advancing water security, demonstrating a departure from single cause and solutions towards a complexity science approach, wherein multiple simultaneous drivers and solution options at different scales shape water security dynamics. The findings that water security research occurs in diverse contexts, uses varied methodological and analytical approaches, and frames social, economic, and ecological factors at multiple scales as affecting livelihood water security corroborate other reviews of the concept as applied to different objectives (see Cook & Bakker, 2012; Scott *et al.*, 2013; Wutich *et al.*, 2017; Gerlak *et al.*, 2018).

Nevertheless, four shortcomings were evident. First, under one-third of the included publications defined water security or insecurity. These definitions were conservatively centred on outcomes of ‘adequate’ water supplies or ‘acceptable’ water-related risks. Future research must re-orient water security interventions from a conservative focus on risk mitigation towards an approach that recognizes the role of water access and sustainability in building livelihood capabilities and human prosperity. Second, common livelihoods, such as agricultural labour, transhumance pastoralism, and aquaculture, were underrepresented. This is problematic because agricultural livelihoods (the dominant focus) often co-exist with complementary resource-based livelihoods. Further, included articles upheld a long-standing dualism between ‘productive’ (livelihood) and ‘unproductive’ (domestic/drinking)

water. Future water security research should focus on a greater diversity of livelihoods given their interconnected natures, and on how ‘non-productive’ domains can affect the ability to perform and undertake a livelihood activity. Third, mitigation and adaptation strategies related to proximate drivers of water-related risk outnumbered efforts to understand and transform the underlying dynamics that create and sustain water insecurity. Examined publications did not adequately analyze how entrenched inequalities affect the ability of the key water security responses described above to address risk for all people, nor sufficiently explore how equity concerns can enable interventions to be re-visited in pro-poor ways. Last, future research should examine how coupled land–water interactions at broader spatial scales impact local and regional livelihood production systems. These shortcomings corroborate findings from other reviews of the wider water security literature, which demonstrate that the concept is often insufficiently defined (Gerlak *et al.*, 2018), uses conservative framings around risk instead of capability-building (Jepson *et al.*, 2017a), and adopts technical approaches predicated on managing water as a physical property (Loftus, 2014; Zeitoun *et al.*, 2016; Jepson *et al.*, 2017a). Addressing these shortcomings will develop stronger synergies between the water security and livelihoods scholarship in ways that direct focus towards human prosperity, diverse and interconnected livelihoods, and global interactions across social–ecological systems.

## ACKNOWLEDGEMENTS

This article is part of the author’s unpublished doctoral dissertation. The research was financially supported by the Social Sciences and Humanities Research Council of Canada’s Canada Graduate Scholarship (#767-2016-2400), and The University of British Columbia’s Four-Year Fellowship (Award No. 6456, 6569) and Faculty of Science (Award No. 6444). I am grateful to Sally Taylor (subject librarian for Resources, Environment & Sustainability at The University of British Columbia), Lucy Rodina, and Graham McDowell for their support on the research design. I thank Leila Harris, Hannah Wittman, Mark Johnson, Trevor Birkenholtz, and the three anonymous reviewers for their feedback on earlier versions of this paper.

## DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

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First received 16 February 2021; accepted in revised form 28 July 2021. Available online 16 August 2021