

Global Questions: An Interdisciplinary Review
INTERDISCIPLINARY REVIEW | COMMISSIONED SYNTHESIS

Water Security Under Compound Climate and Institutional Risk

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Abstract

This interdisciplinary review examines water security under compound climate and institutional risk. The organizing question is how infrastructure, ecosystems, finance, and public institutions jointly shape reliable and fair water access. Ten related scholarly sources are synthesized through a decision-centered framework spanning problem definition, mechanism, measurement, evaluation, implementation, and governance. The review does not invent experiments, pooled estimates, or unreported quantitative results. It instead evaluates the strength and transferability of the available evidence, with particular attention to treating physical scarcity as independent of institutions and distribution. The resulting framework links technical or empirical performance to explicit use conditions and identifies tests that should precede wider adoption in regional water planning under climatic and political uncertainty.

Keywords: water security, compound risk, climate adaptation, institutions, equity

Synthesis lens	Principal question
Mechanism	the interactions among hydroclimatic hazards, demand, storage, quality, ecosystems, and administrative capacity
Evaluation	compound-event stress tests, service continuity, affordability, ecological thresholds, and deep uncertainty
Primary risk	treating physical scarcity as independent of institutions and distribution

1. Introduction

Research on water security under compound climate and institutional risk sits at the boundary between a promising component and a consequential decision. The core question is how infrastructure, ecosystems, finance, and public institutions jointly shape reliable and fair water access. Answering it requires more than assembling favorable results. It requires a chain of evidence that makes the problem boundary, mechanism, measurement, comparator, uncertainty, and accountable decision visible to the reader.

This article presents a structured narrative review of ten related publications. Sources were selected for topical relevance, traceable publication metadata, and complementary coverage of technical, empirical, and governance questions. No meta-analytic pooling is attempted because the included studies differ in designs, populations, system boundaries, and outcomes. The purpose is decision-oriented synthesis: to identify what each source can support, where transfer remains uncertain, and which evidence would justify the next stage of use.

The central risk is treating physical scarcity as independent of institutions and distribution. A top-line metric or broad policy label can appear decisive while concealing the conditions that produced it. Accordingly, the synthesis separates observation from interpretation and implementation from validation. This separation is especially important when the same system creates benefits for one user or institution while transferring cost, risk, or administrative burden to another.

2. Evidence Base and Problem Boundary

A defensible review begins by defining the unit of analysis. For the present topic, the relevant boundary includes inputs, institutional or technical context, the mechanism producing an output, the person or system acting on that output, and the downstream outcome. Evidence falls outside the boundary when it measures only an intermediate proxy yet is used to claim an end-to-end benefit.

Borrelli et al. (2020) addresses "Land use and climate change impacts on global soil erosion by water (2015-2070)." In this synthesis, that work is used as a source on problem definition within water security under compound climate and institutional risk. The connection is deliberately bounded: the cited study informs the evidence map, but it does not by itself establish readiness for regional water planning under climatic and political uncertainty. That distinction keeps the review close to the published record and prevents an adjacent result from being converted into a broader causal claim.

Stringer et al. (2021) addresses "Climate change impacts on water security in global drylands." In this synthesis, that work is used as a source on conceptual boundary within water security under compound climate and institutional risk. The connection is deliberately bounded: the cited study informs the evidence map, but it does not by itself establish readiness for regional water planning under climatic and political uncertainty. That distinction keeps the review close to the published record and prevents an adjacent result from being converted into a broader causal claim.

Koop and Leeuwen (2016) addresses "The challenges of water, waste and climate change in cities." In this synthesis, that work is used as a source on measurement within water security under compound climate and institutional risk. The connection is deliberately bounded: the cited study informs the evidence map, but it does not by itself establish readiness for regional water planning under climatic and political uncertainty. That distinction keeps the review close to the published record and prevents an adjacent result from being converted into a broader causal claim.

Together, these works provide complementary entry points, but their conclusions should not be flattened into a single ranking. Differences in data generation, setting, temporal horizon, and outcome definition may be substantively meaningful. A review should therefore preserve those differences and state where analogy, rather than direct replication, connects one domain to another.

3. Mechanism and System Design

The operative mechanism is the interactions among hydroclimatic hazards, demand, storage, quality, ecosystems, and administrative capacity. This formulation discourages component-only reasoning. A model, platform, policy, assay, or infrastructure service acquires practical meaning only when its interfaces and use conditions are specified. The evidence chain should describe what information is available, what transformation occurs, which assumptions make that transformation credible, and who is authorized to act.

Mishra et al. (2021) addresses "Water Security in a Changing Environment: Concept, Challenges and Solutions." In this synthesis, that work is used as a source on system mechanism within water security under compound climate and institutional risk. The connection is deliberately bounded: the cited study informs the evidence map, but it does not by itself establish readiness for regional water planning under climatic and political uncertainty. That distinction keeps the review close to the published record and prevents an adjacent result from being converted into a broader causal claim.

Hoekstra et al. (2018) addresses "Urban water security: A review." In this synthesis, that work is used as a source on representation choice within water security under compound climate and institutional risk. The connection is deliberately bounded: the cited study informs the evidence map, but it does not by itself establish readiness for regional water planning under climatic and political uncertainty. That distinction keeps the review close to the published record and prevents an adjacent result from being converted into a broader causal claim.

DeNicola et al. (2015) addresses "Climate Change and Water Scarcity: The Case of Saudi Arabia." In this synthesis, that work is used as a source on failure analysis within water security under compound climate and institutional risk. The connection is deliberately bounded: the cited study informs the evidence map, but it does not by itself establish readiness for regional water planning under climatic and political uncertainty. That distinction keeps the review close to the published record and prevents an adjacent result from being converted into a broader causal claim.

These studies also show why modular claims require interface tests. A component may perform well while the complete pathway fails because inputs drift, users interpret outputs differently, recovery semantics are ambiguous, or institutional incentives change. Design documentation should therefore include not only the intended pathway but also foreseeable deviations, degraded modes, and conditions under which the system should stop or defer.

4. Evaluation and Uncertainty

Evaluation should center on compound-event stress tests, service continuity, affordability, ecological thresholds, and deep uncertainty. Average performance remains useful, but it should be accompanied by distributions, error categories, relevant subgroups or operating regimes, and uncertainty at the point where a decision changes. Comparators must isolate the value of the proposed addition rather than compare a mature intervention with an intentionally weak baseline.

Woodhouse and Muller (2017) addresses "Water Governance—An Historical Perspective on Current Debates." In this synthesis, that work is used as a source on comparative evaluation within water security under compound climate and institutional risk. The

connection is deliberately bounded: the cited study informs the evidence map, but it does not by itself establish readiness for regional water planning under climatic and political uncertainty. That distinction keeps the review close to the published record and prevents an adjacent result from being converted into a broader causal claim.

Abedin et al. (2018) addresses "Climate Change, Water Scarcity, and Health Adaptation in Southwestern Coastal Bangladesh." In this synthesis, that work is used as a source on uncertainty within water security under compound climate and institutional risk. The connection is deliberately bounded: the cited study informs the evidence map, but it does not by itself establish readiness for regional water planning under climatic and political uncertainty. That distinction keeps the review close to the published record and prevents an adjacent result from being converted into a broader causal claim.

External validation should introduce meaningful shifts in setting, time, population, workload, market structure, or environmental conditions. A nominally independent sample can still be too similar to test transfer. Conversely, a failed transfer is scientifically informative when the changed conditions are measured and the mechanism of failure is examined rather than hidden in an aggregate score.

5. Translation and Governance

Translation to regional water planning under climatic and political uncertainty depends on more than technical readiness. Decision rights, documentation, maintenance, monitoring, appeal, and recovery are part of the intervention. The governance requirement is adaptive pathways, polycentric coordination, transparent allocation rules, and protection of vulnerable users. Each control should be connected to a named failure mode and should identify an owner, evidence source, review interval, and escalation path.

Simpson and Jewitt (2019) addresses "The Development of the Water-Energy-Food Nexus as a Framework for Achieving Resource Security: A Review." In this synthesis, that work is used as a source on implementation within water security under compound climate and institutional risk. The connection is deliberately bounded: the cited study informs the evidence map, but it does not by itself establish readiness for regional water planning under climatic and political uncertainty. That distinction keeps the review close to the published record and prevents an adjacent result from being converted into a broader causal claim.

Mpandeli et al. (2018) addresses "Climate Change Adaptation through the Water-Energy-Food Nexus in Southern Africa." In this synthesis, that work is used as a source on governance within water security under compound climate and institutional risk. The connection is deliberately bounded: the cited study informs the evidence map, but it does not by itself establish readiness for regional water planning under climatic and political uncertainty. That distinction keeps the review close to the published record and prevents an adjacent result from being converted into a broader causal claim.

A credible implementation plan also defines sunset and revalidation conditions. New data, software updates, institutional restructuring, population change, or shifts in incentives can invalidate previously reasonable assumptions. Monitoring should therefore test the validity of the evidence chain, not merely whether a service remains online or a headline metric remains stable.

6. Research Agenda

Future studies should preregister or otherwise predefine the intended decision, principal outcomes, exclusions, and analysis plan when feasible. They should report missingness, sensitivity analyses, negative or null findings, and the cost of errors to differently situated stakeholders. Reproducible artifacts should include sufficient metadata to reconstruct data provenance, model or analytical versions, parameter choices, and the sequence from evidence to conclusion.

Cross-disciplinary work needs a shared object of explanation rather than a collection of adjacent vocabularies. For water security under compound climate and institutional risk, that shared object is the complete decision pathway. Technical, clinical, social, environmental, or economic expertise should each change the design or interpretation of the study. When evidence remains incomplete, the useful output is a bounded hypothesis, a transparent uncertainty statement, or a request for additional measurement.

7. Conclusion

The literature supports a disciplined approach to water security under compound climate and institutional risk: define the decision, preserve system boundaries, test consequential failure modes, connect uncertainty to action, and assign accountable control. The strongest conclusion is not that one method is universally superior. It is that credible use in regional water planning under climatic and political uncertainty requires an auditable link from source evidence to design choice, evaluation result, and governed decision.

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