

From Land-Cover Transitions to Water Conflict: A Systematic Review of Hydrological Variability, Resource Competition and Governance Responses in Intermittent River Catchments

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Abstract

Intermittent river catchments are increasingly exposed to interacting pressures from land-use and land-cover transitions, hydrological variability, resource competition, and weak governance systems. Yet, evidence on how these processes jointly shape water-related conflict remains fragmented across hydrology, environmental science, geography, and political ecology. This systematic review synthesised peer-reviewed evidence on the linkages between land-cover transitions, hydrological variability, resource competition, and governance responses in intermittent river catchments. Following PRISMA 2021 guidelines, a systematic search of selected academic databases and platforms identified 376 records, of which 104 studies met the inclusion criteria and were included in the final synthesis. The evidence base was geographically concentrated in Africa and Asia, which accounted for 46.2% and 33.7% of included studies, respectively. Agricultural expansion was the most frequently reported land-cover transition, appearing in 59.6% of studies, followed by urban and built-up expansion, riparian and wetland degradation, and deforestation. These transitions were associated with increased surface runoff and flood risk, reduced groundwater recharge and baseflow, intensified dry-season flow intermittency, sediment yield, and drought-related water stress. Hydrological variability contributed to resource competition through reduced dry-season flows, intersectoral water demand, farmer–herder tensions, and upstream–downstream conflicts. Governance responses were dominated by Integrated Water Resources Management, land-use planning, ecological restoration, zoning, participatory approaches, and adaptive management. The review concludes that water-related conflict in intermittent river systems is not driven by physical scarcity alone, but by coupled socio-hydrological processes shaped by land-cover change, hydrological disruption, livelihood dependence, and institutional capacity.

1. Introduction

Intermittent river are landforms that flow periodically. They include temporary, ephemeral, seasonal and episodic rivers and streams. Although several disciplines has identified these classes of streams and river, they are commonly referred to as Intermittent rivers and Ephemeral streams (IRES) (Fovet et al., 2021). They constitute a major but historically underrepresented component of global freshwater systems particularly across arid, semi-arid, and Mediterranean-climate regions where hydrological regimes are strongly governed by seasonal precipitation variability and high evapotranspiration demand (Acuña et al., 2020). Unlike perennial river systems, intermittent rivers are characterized by episodic flow, spatial discontinuity, and recurrent dry phases, which fundamentally shape their ecological functioning and water availability dynamics (Datry et al., 2014; Larned et al., 2010). Recent global syntheses indicate that such non-perennial systems may represent more than half of the world's river networks, yet they remain under-monitored and under-theorized in mainstream hydrological science (Messenger et al., 2021). Under accelerating global environmental change, intermittent rivers are increasingly expanding in both spatial extent and temporal duration of flow cessation, driven by interacting climatic and anthropogenic pressures (Acuña et al., 2014).

Among the dominant anthropogenic pressures shaping catchment hydrology, land-cover and land-use transitions play a central role. Processes such as deforestation, agricultural intensification, urban expansion, wetland drainage, and rangeland degradation fundamentally alter biophysical properties of catchments, including soil infiltration capacity, evapotranspiration rates, and runoff generation mechanisms (Veloso et al., 2024; Foley et al., 2005; Scanlon et al., 2007; Haile et al., 2026). These alterations modify the partitioning of rainfall into surface and subsurface flows, often intensifying peak discharge while reducing baseflow contributions during dry periods. Consequently, land-cover transitions are widely recognized as key drivers of hydrological non-stationarity, particularly in water-limited environments where small shifts in land surface characteristics can produce disproportionate effects on flow intermittency (Buytaert et al., 2006; Bogaart et al., 2003).

Hydrological variability induced by land-cover change is particularly consequential in intermittent river catchments, where water availability is already temporally constrained and highly sensitive to external forcing. Empirical evidence demonstrates that vegetation removal and land degradation can significantly reduce groundwater recharge and dry-season streamflow persistence, thereby increasing the frequency and duration of zero-flow conditions (Zimmermann et al., 2006). Water balance in an ecosystem is influence by these transitions and agricultural activities are mostly affected in the scenario (Jiang et al., 2023). Conversely, land restoration and afforestation may enhance infiltration and stabilize hydrological regimes, although

such outcomes are strongly contingent on climatic context, soil structure, and land management practices (Ellison et al., 2017). These hydrological shifts directly influence ecosystem resilience, water security, and the sustainability of dependent livelihoods.

Beyond biophysical impacts, changes in hydrological regimes have profound socio-political implications, particularly in regions where water demand exceeds seasonal supply. In intermittent river systems, water scarcity is not merely a physical phenomenon but a socially mediated condition shaped by allocation rules, institutional capacity, and power asymmetries among users (Molle, 2009). Competition over limited water resources intensifies during dry phases, often generating tensions among agricultural users, pastoral communities, urban consumers, and ecological water requirements. These dynamics are further complicated by upstream–downstream dependencies, transboundary governance challenges, and unequal access to infrastructure and institutional representation ((Zeitoun & Warner, 2006; Dell’Angelo et al., 2018).

Water-related conflict in intermittent catchments is increasingly conceptualized within broader socio-hydrological and political ecology frameworks that emphasize feedbacks between environmental change and social responses. Rather than being driven solely by absolute scarcity, water conflict emerges from the interaction between hydrological variability and governance arrangements that determine allocation, access, and enforcement (Sivapalan et al., 2012; (Mirumachi & Allan, 2007). In many dryland regions, conflicts are often latent or institutional rather than violent, manifesting as allocation disputes, contested water rights, or breakdowns in collective management systems. These patterns underscore the importance of integrating hydrological science with socio-political analysis to fully understand water conflict dynamics.

Governance systems play a central role in mediating these interactions by shaping how water is allocated, managed, and contested. Integrated Water Resources Management (IWRM) has been widely promoted as a framework for coordinating land and water governance across scales, emphasizing basin-wide planning, stakeholder participation, and adaptive management (Agarwal, 2000; Pahl-Wostl et al., 2007). However, empirical evaluations reveal mixed outcomes, particularly in contexts characterized by weak institutions, fragmented data systems, and rapidly changing land-use regimes. Adaptive water governance approaches have therefore gained prominence, emphasizing flexibility, learning, and cross-scale institutional coordination in response to uncertainty and change (Pahl-Wostl et al., 2013).

Despite significant advances across hydrology, remote sensing, and governance studies, the integration of land-cover change, hydrological variability, and socio-political dynamics remains fragmented across disciplinary boundaries. Hydrological research often emphasizes process-based modelling without adequately capturing governance and conflict dimensions, while social science research on water conflict frequently lacks explicit representation of hydrological mechanisms. This disciplinary divide limits the development of integrated understanding of how environmental change translates into socio-political outcomes in intermittent river catchments. As a result, there is no comprehensive synthesis that systematically connects land-cover transitions, hydrological intermittency, resource competition, water conflict, and governance responses within a unified analytical framework.

This systematic review addresses this gap by synthesizing global peer-reviewed evidence on the coupled relationships between land-cover transitions, hydrological variability, resource competition, water conflict, and governance responses in intermittent river catchments. Specifically, the review aims to (i) identify dominant land-cover transition patterns reported in intermittent systems, (ii) examine their impacts on hydrological variability and flow intermittency, (iii) analyse how hydrological change shapes resource competition and water-related conflict, and (iv) evaluate governance and institutional responses designed to manage water scarcity and reduce conflict risks. The relevance of this synthesis lies in its capacity to integrate fragmented knowledge across hydrology, environmental science, geography, and political ecology into a coherent socio-hydrological framework. The justification for the study is grounded in the accelerating expansion of intermittent river systems under combined pressures of climate variability and land-use transformation, which necessitates integrated analytical approaches to support sustainable water governance. From a policy perspective, the findings directly contribute to Sustainable Development Goal 6 (Clean Water and Sanitation), the implementation of Integrated Water Resources Management, and emerging adaptive water governance frameworks under the United Nations Water agenda and climate adaptation strategies under the Paris Agreement.

2. Methodology

2.1 Review protocol

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2021) guidelines to ensure transparency, reproducibility, and methodological rigor. A priori, a detailed protocol was developed to define the research objectives, eligibility criteria, information sources, search strategy, study selection procedures, quality appraisal framework, and evidence synthesis approach, thereby ensuring methodological consistency across all stages of the review. Although the protocol was not formally registered in a public repository, all methodological decisions were predefined and strictly implemented without deviation during the conduct of the review. The study specifically focused on synthesizing and critically integrating evidence on the linkages between land-cover transitions, hydrological variability, resource competition, water-related conflict, and governance responses within intermittent river catchments, with the aim of generating a coherent understanding of coupled socio-hydrological and socio-political dynamics across diverse environmental and geographic contexts.

2.2 Planning stage

During the planning stage, the research questions were refined to integrate socio-hydrological and socio-ecological systems perspectives within intermittent river catchments, positing that land-cover transitions alter hydrological regimes, which in turn drive resource competition and water-related conflicts, ultimately eliciting governance responses across multiple scales. To operationalize this framework, a conceptual review structure was developed to guide the systematic identification of relevant studies spanning hydrology, environmental science, geography, political ecology, and water governance, with key concepts consolidated into four analytical domains: land-cover change, hydrological variability, resource competition/conflict, and governance responses. An iterative scoping exercise was conducted across major bibliographic databases to test and refine keyword combinations, ensuring both sensitivity and specificity in the retrieval of relevant literature.

2.3 Research questions

The review was guided by a set of clearly defined research questions designed to systematically structure the synthesis of evidence on the linkages between land-cover transitions, hydrological variability, resource competition, water conflict, and governance responses in intermittent river catchments. These questions ensured analytical coherence across biophysical and socio-political dimensions of the reviewed literature.

The research questions are:

1. Which types of land-cover transitions are most frequently reported in intermittent river catchments, and how are they spatially and temporally distributed?
2. How do land-cover transitions influence hydrological variability, including streamflow intermittency, runoff, groundwater recharge, and drought dynamics?
3. Through what mechanisms does hydrological variability drive resource competition and water-related conflict in intermittent river systems?
4. What governance and institutional responses are used to manage hydrological variability, resource competition, and water conflict in these catchments?

2.4 Conducting stage

2.4.1 Literature search

A systematic literature search was conducted across major multidisciplinary scientific databases, including Scopus, Web of Science, ScienceDirect, SpringerLink, Wiley Online Library, PubMed, and Google Scholar and research gate. However, the eligible studies were retrieved from Science Direct, Research Gate and MDPI. These were selected for their comprehensive coverage of hydrology, environmental sciences, remote sensing, water governance, and socio-ecological systems literature.

The search strategy employed structured keyword combinations and Boolean operators across four core conceptual domains, namely land-cover change ("land cover change" OR "land use change" OR deforestation OR urbanization OR "catchment degradation"), hydrological variability ("hydrological variability" OR "streamflow intermittency" OR drought OR runoff OR "water scarcity"), water conflict and governance ("water conflict" OR "resource competition" OR "water governance" OR "water allocation" OR dispute), and intermittent river systems ("intermittent river" OR "ephemeral river" OR "seasonal river" OR "non-perennial river" OR catchment OR basin). Search strings were iteratively adapted to database-specific syntax to ensure optimal retrieval sensitivity and consistency across platforms. All retrieved records were exported into reference management software for systematic de-duplication and screening. In addition, supplementary searches were conducted in Google Scholar to capture relevant interdisciplinary and potentially under-indexed peer-reviewed studies, while backward and forward citation tracking was applied to all eligible articles to ensure comprehensive coverage of the evidence base.

2.4.2 Screening process

Study selection followed a structured two-stage screening procedure conducted in accordance with PRISMA 2021 guidelines to ensure transparency and reproducibility. In the first stage, all retrieved records were independently screened by reviewers based on titles and abstracts against predefined eligibility criteria aligned with the review objectives. In the second stage, full-text articles were assessed for methodological relevance, analytical adequacy, and explicit or implicit inclusion of linkages between land-cover change, hydrological variability, and water-related socio-political outcomes including resource competition, conflict, and governance responses. Screening was conducted using a dual-reviewer approach to minimize selection bias, with disagreements resolved through discussion and consensus; where consensus could not be reached, a third reviewer was consulted to adjudicate. All exclusion decisions at the full-text stage were systematically documented, with reasons for exclusion recorded and subsequently reported in the PRISMA flow diagram to ensure full auditability of the study selection process.

2.5 Eligibility criteria

Studies were included if they met all predefined eligibility criteria, namely: (i) focused on intermittent, ephemeral, seasonal, or non-perennial river catchments; (ii) explicitly examined land-cover or land-use transitions as a core explanatory or contextual variable; (iii) incorporated hydrological variability indicators such as streamflow dynamics, runoff, groundwater fluctuations, or drought-related processes; (iv) addressed water-related resource competition, conflict, or governance responses within the study system; (v) were empirical, modelling-based, or review studies published in peer-reviewed journals; and (vi) were published in English between 1985 and 2026. Studies were excluded where they focused exclusively on perennial river systems without intermittency characteristics, lacked hydrological analysis, omitted land-cover transition components, or did not engage with socio-political dimensions of water use and allocation. In addition, non-peer-reviewed materials, including editorials, commentaries, policy briefs without methodological detail, and other grey literature sources, were excluded to maintain analytical rigor and comparability across the evidence base.

2.6 Quality assessment

Methodological quality of included studies was assessed using a structured appraisal framework adapted from established environmental systematic review standards and socio-hydrological literature. Each study was evaluated across four core domains: (i) clarity of research objectives and conceptual framing, (ii) robustness and transparency of land-cover and hydrological data sources, (iii) appropriateness and rigor of analytical or modelling methods employed, and (iv) strength of linkage between hydrological variability, resource competition, and governance or conflict outcomes. Each domain was scored using a three-point ordinal scale (0 = weak, 1 = moderate, 2 = strong), yielding a maximum possible score of 8 per study. Studies scoring below a predefined methodological threshold were classified as low robustness and either excluded from the final synthesis or retained only for contextual interpretation where relevant. Overall quality assessment outcomes were used to inform the interpretative weight of findings rather than to apply formal statistical weighting within the synthesis process.

2.7 Data extraction

A standardized data extraction framework was developed and piloted prior to full-scale extraction to ensure consistency, completeness, and comparability across heterogeneous study designs. For each included study, key variables were systematically extracted, including author(s), year of publication, geographic location, river or catchment system, study design, type of land-cover transition, hydrological variables assessed, data sources, analytical or modelling methods, identified resource users, forms of water competition or conflict, governance responses, and principal findings. Additional contextual variables were also recorded, including spatial scale of analysis (local, catchment, basin, or regional), temporal coverage of the study, and whether climate variability was explicitly considered as a confounding or interacting factor. Data extraction was conducted in a structured and iterative manner to ensure methodological consistency and reduce interpretative bias across diverse disciplinary approaches and analytical frameworks.

2.8 Data synthesis and analysis

A mixed-methods synthesis approach was employed, integrating narrative synthesis, thematic analysis, and descriptive quantitative summarisation to systematically synthesise evidence across heterogeneous study designs. The narrative synthesis was structured around five interrelated analytical domains: (i) land-cover transition patterns in intermittent river catchments, (ii) hydrological variability responses, (iii) resource competition mechanisms, (iv) water conflict pathways, and (v) governance and institutional responses. Thematic coding was conducted using a dual approach, combining deductive coding guided by the predefined conceptual framework with inductive coding derived from emergent patterns in the literature, thereby enabling both theory-driven and data-driven synthesis. Cross-study comparative analysis was undertaken to identify recurrent causal and associative pathways linking land-cover transitions to hydrological disruption and subsequent socio-political outcomes. Where data availability permitted, descriptive frequency analyses were applied to quantify the distribution of key variables, including land-cover transition types, hydrological indicators, conflict categories, and governance interventions. A formal meta-analysis was not conducted due to substantial heterogeneity in study designs, variable definitions, analytical methods, and outcome measures across the included literature.

2.9 Reporting

The review was reported in accordance with PRISMA 2021 guidelines. A PRISMA flow diagram was used to document the number of records identified, screened, excluded, and included. Findings were presented through a combination of thematic narratives, summary tables, and conceptual synthesis frameworks illustrating linkages between land-cover transitions, hydrological variability, resource competition, conflict formation, and governance responses.

3. Results

3.1 Distribution of Research Papers

The systematic search across selected academic databases and platforms yielded a total of 376 records. After removing duplicates and conducting title, abstract, and full-text screening in accordance with the PRISMA 2021 guidelines, a final total of 104 studies met the inclusion criteria and were included in the synthesis, representing approximately 27.7% of all initially retrieved records. The largest share of eligible studies was retrieved from ScienceDirect, which contributed 74 studies, accounting for 71.2% of the final evidence base, followed by ResearchGate with 25 studies (24.0%) and MDPI with 5 studies (4.8%). This distribution indicates that the review was dominated by peer-reviewed journal literature indexed through major scientific publishing platforms, with ScienceDirect serving as the principal source of relevant studies on land-cover transitions, hydrological variability, resource competition, and governance responses in intermittent river catchments (Table 1; Fig. 1).

Table 1
Selection of papers based on the databases

Database	Retrieved	Relevant	% of Included Studies
Science Direct	114	74	71.2%
ResearchGate	250	25	24.0%
MDPI	12	5	4.8%
Total	376	104	100%

3.2 Temporal Distribution and Growth of the Evidence Base

The annual distribution of included studies revealed a clear upward trajectory in research output, with limited publication activity before 2022 and a marked increase from 2022 onwards. The strongest concentration of studies occurred between 2022 and 2026, indicating that integrated research on land-use/land-cover transitions, hydrological variability, water-related competition, and governance responses in intermittent river catchments has expanded substantially in recent years. The highest publication output was recorded in 2025, followed by 2024 and 2026, suggesting that this field has become increasingly important in response to intensifying climate variability, land-use pressures, water scarcity, and conflict risks in semi-arid and water-stressed regions (Fig. 2).

3.3 Geographic Distribution of Included Studies

The included studies covered a broad range of geographic contexts, although the evidence base was unevenly distributed across countries and regions. At the country level, China contributed the largest number of single-country studies, with 22 papers representing 21.2% of the included literature, followed by Ethiopia with 8 studies (7.7%), India with 7 studies (6.7%), Kenya with 6 studies (5.8%), and Nigeria with 5 studies (4.8%). Global or multi-country analyses accounted for 12 studies (11.5%), while other African countries collectively contributed 12 studies (11.5%). Tanzania, Brazil, and Iran each contributed 4 studies (3.8%), and the remaining 20 studies (19.2%) were distributed across other country contexts. This pattern demonstrates both the global relevance of intermittent river catchments and the strong concentration of research in countries experiencing rapid land-cover change, water stress, and intensifying competition over land and water resources (Table 2; Fig. 2).

Table 2
Research Papers by Country / Region

Country / Region	Number of Papers	Percentage (%)
Ethiopia	8	7.7
China	22	21.2
Nigeria	5	4.8
Kenya	6	5.8
India	7	6.7
Global / Multi-country	12	11.5
Tanzania	4	3.8
Brazil	4	3.8
Iran	4	3.8
Other African countries	12	11.5
Other countries	20	19.2
Total	104	100

3.4 Continental Distribution of the Evidence Base

When grouped by continent, Africa contributed the largest share of the reviewed evidence, accounting for 48 studies or 46.2% of the total included literature, followed by Asia with 35 studies (33.7%). Global or multi-continental studies represented 9 studies (8.7%), while South America contributed 6 studies (5.8%), and Europe and North America each contributed 3 studies (2.9%). Together, Africa and Asia accounted for nearly four-fifths of the included studies, underscoring the prominence of intermittent river catchments in regions where semi-arid climates, agricultural expansion, urban growth, livelihood dependence on natural resources, and institutional constraints frequently intersect. The dominance of African evidence is particularly important because many studies from the region addressed farmer–herder tensions, drought-related water scarcity, and governance challenges in catchments undergoing rapid socio-environmental transformation (Table 3).

Table 3
Research Papers by Continent

Continent	Number of Papers	Percentage (%)
Africa	48	46.2
Asia	35	33.7
Global / Multi-continental	9	8.7
South America	6	5.8
Europe	3	2.9
North America	3	2.9
Total	104	100

3.5 Characteristics of the Included Studies

The final synthesis included 104 studies that collectively examined the relationships among land-cover transitions, hydrological variability, resource competition, water-related conflict, and governance responses in intermittent river catchments. The studies varied considerably in geographic scope, methodological design, spatial scale, and thematic

emphasis, but most applied remote sensing approaches, particularly Landsat and Sentinel imagery, often combined with hydrological or ecosystem-service modelling tools such as SWAT, WEAP, MIKE SHE, InVEST, GRACE-based analysis, and machine-learning classification techniques. The dominant analytical focus was on agricultural expansion, urban growth, deforestation, wetland degradation, riparian vegetation loss, and rangeland conversion, with many studies linking these transitions to increased runoff, reduced groundwater recharge, declining dry-season flows, flood risk, and sediment yield. A substantial proportion of the literature also connected hydrological variability to socio-political outcomes, including farmer–herder conflicts, upstream–downstream tensions, intersectoral water competition, and governance responses such as Integrated Water Resources Management, land-use planning, ecological restoration, zoning, and participatory management (Table 4).

Table 4
Final studies included in the Systematic Review

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
ResearchGate	Kandel <i>et al</i> (2025)	Impact of land cover change on water regulation services in the Ratuwa River Basin, Churia Region, Nepal	Forest & wetland decline, agricultural increase; SWAT	Ecological/economic losses	Integrated watershed management
ResearchGate	Soita <i>et al</i> (2024)	Assessment of the Land Use/Land Cover Change in Koitobos River Catchment, Trans Nzoia County, Kenya	Agricultural expansion	Population pressure on land	Integrated watershed management, law enforcement
ResearchGate	David <i>et al</i> (2024)	Climate change, water scarcity, and farmer–herder relations: a hydro conflict perspective in the benue river basin	Surface water & riparian vegetation decline	Farmer-herder hydro-conflicts	Benue Basin Resilience Compact
ResearchGate	Stosch <i>et al</i> (2022)	Catchment-Scale Participatory Mapping Identifies Stakeholder Perceptions of Land and Water Management Conflicts	Spatial land-cover/conflict correlation	Perceived land/water-use conflicts	Participatory stakeholder mapping
ResearchGate	Besnier <i>et al</i> (2026)	Crossing the Threshold: Land Cover Change Triggers Hydrological Regime Shift in Brazil's Itaipu Hydropower Region	Cropland-savanna-wetland thresholds; GRACE gravimetry	Water security risks	Three-zone adaptive management
ResearchGate	Yao <i>et al</i> (2024)	Effects of climate variability and/or land use dynamics on the hydrological balance of the Cavally river catchment at Toulepleu, West Africa	Topographic land cover variation, streamflow intermittency	Seasonal watercourse shifts	SWBM decision-support tool
ResearchGate	Ismaila <i>et al</i> (2026)	Geospatial Analysis of Climate-Induced Farmer-Herder Conflicts in the	Urban/cropland increase, riparian forest decline	Farmer-herder conflicts	Sustainable land-use & IWRM

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
		BAY States of Nigeria			
ResearchGate	Kah <i>et al</i> (2025)	Hydroclimatic Trends and Land Use Changes in the Continental Part of the Gambia River Basin: Implications for Water Resources	Forest/shrubland decline, urban & barren land increase	Farmer-herder conflict awareness	Grazing corridors & zoning
ResearchGate	Ayalew <i>et al</i> (2024)	Hydrological responses to historical and predicted land use/land cover changes in the Welmel watershed, Genale Dawa Basin, Ethiopia	Forest/savanna decline, agricultural expansion	Water scarcity & flooding risk	IWRM, reforestation
ResearchGate	Tena <i>et al</i> (2019)	Impact of Land Use/Land Cover Change on Hydrological Components in Chongwe River Catchment	Built-up & agricultural expansion	Reduced water availability	Water conservation & stakeholder engagement
ResearchGate	Sertel <i>et al</i> (2019)	Impacts of Land Cover/Use Changes on Hydrological Processes in a Rapidly Urbanizing Mid-latitude Water Supply Catchment	Urban & irrigated agriculture expansion	Increased abstraction pressure	Integrated catchment management
ResearchGate	Teshome <i>et al</i> (2026)	Impacts of land use and land cover changes on streamflow and sediment yield in the Gidabo River Catchment, Ethiopia	Urbanization	Erosion & runoff increase	Environmentally sound land-use plans
ResearchGate	Heo <i>et al</i> (2024)	Integrating Machine Learning, Land Cover, and Hydrological Modeling to Contribute Parameters for Climate Impacts on Water Resource Management	LULC transitions in South Korea rivers	Flood potential	Climate-resilience project prioritization

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
ResearchGate	Chinbat <i>et al</i> (2026)	Land Use Change and Hydrological Transformation in a Cold Semi-Arid Catchment: A SUWMBA-Based Case Study of the Selbe River, Ulaanbaatar	Urban densification	Stormwater runoff increase	Water-Sensitive Urban Design
ResearchGate	Kinyaiya <i>et al</i> (2025)	Land use/land cover change impacts on streamflow of Mkomazi River Catchment in Pangani River Basin, Tanzania	Built-up increase, forest decline	Baseflow depletion	Effective land use management strategies
ResearchGate	Werede <i>et al</i> (2025)	Modeling streamflow dynamics under climate and land use shifts using MIKE SHE in the upper Omo Gibe catchment, Ethiopia	Settlement & forest/shrub reduction	Flooding & groundwater depletion	Collaborative policy efforts
ResearchGate	Naz <i>et al</i> (2020)	Modeling hydrological response to land use/cover change: case study of Chirah Watershed (Soan River), Pakistan	Deforestation & LULC change	Flash floods & shrinking resources	SWAT-informed planning
ResearchGate	Ogbonna <i>et al</i> (2025)	Impact of Land use Land cover Change on Water Quality of Athi River Basin, Kenya	Bare land decrease, built-up & farmland increase	Water quality deterioration	Effective land management practices
ResearchGate	Yono <i>et al</i> (2025)	Remote sensing of land cover change dynamics in mountainous catchments and semi-arid environments: a review	Deforestation, agricultural/urban expansion (review)	Land degradation	Multidisciplinary research agenda
ResearchGate	Hari <i>et al</i> (2021)	Impact of change in land use land cover on water resources in gundlakamma sub basin	Agricultural with seasonal river	Intersectoral water competition	SWAT for scarcity management

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
ResearchGate	Bhat <i>et al</i> (2026)	Six decades of land-use and land-cover change in Jammu and Kashmir: socio-economic drivers and implications for water resources	Built-up expansion, forest & pasture decline	Waterbody contraction	Forest-buffer mapping in EIAs
ResearchGate	Nomvar <i>et al</i> (2016)	Status qua and future conflicts in transboundary river catchments water resources in the zeravshan river basin (tajikistan-uzbekistan)	Unsustainable land use	Upstream-downstream tension	IWRM approach
ResearchGate	Annan <i>et al</i> (2025)	Assessing the Hydrological Impacts of Land Use/Cover Change in the Ouémé River Basin, West Africa	Forest & savanna decline, agricultural expansion	Increased flood risk & limited availability	Sustainable land management
ResearchGate	Copeland <i>et al</i> (2025)	Understanding Hydrological Responses to Land Use and Land Cover Change in the Belize River Watershed	Agricultural expansion & forest loss	Reduced recharge	Protected area maintenance
ResearchGate	Tena <i>et al</i> (2019)	Impact of Land Use/Land Cover Change on Hydrological Components in Chongwe River Catchment	Repeated entry - agricultural/settlement increase	Runoff increase	Stakeholder engagement
MDPI	Zhou <i>et al</i> (2025)	Chain-Spectrum Analysis of Land Use/Cover Change Based on Vector Tracing Method in Northern Oman	Sand → cropland/built-up	Water scarcity	Coordinated land-use planning

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
MDPI	Traoré <i>et al</i> (2019)	Using Multi-Temporal Landsat Images and Support Vector Machine to Assess the Changes in Agricultural Irrigated Areas in the Mogteto Region, Burkina Faso	Rainfed to irrigated agriculture	Competition among water users	Sustainable irrigation governance
MDPI	Xing <i>et al</i> (2023)	Ecological Restoration in the Loess Plateau, China Necessitates Targeted Management Strategy: Evidence from the Beiluo River Basin	Cultivated land → grassland/forest	Restoration vs livelihood competition	Precision restoration & compensation
MDPI	Yin <i>et al</i> (2026)	Spatiotemporal Evolution and Synergy–Tradeoff Relationships of Ecosystem Services in Typical Karst Mountain Areas, China	Land-use/land-cover changes 2000–2020	Water yield vs other services	Land-use planning for balance
MDPI	Ramachandra <i>et al</i> (2023)	Ecohydrological Footprint and Climate Trends in Lotic Ecosystems of Central Western Ghats	Forest loss	Streamflow intermittency	Sustainable watershed management
Science Direct	Maharjan <i>et al</i> (2025)	Advancing geospatial insights in Afghanistan: Annual land cover mapping and landscape metrics analysis for rural landscape planning and restoration	Climate & anthropogenic pressures	Competition among users	Stormwater management, IWRM
Science Direct	Wang <i>et al</i> (2025)	A framework for land use conflicts identification and zoning based on “scale-function-pattern”: Theory and application	Rangeland, built-up, sand expansion	Desertification & degradation	Landscape restoration strategies

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
Science Direct	Wang <i>et al</i> (2026)	A modeling framework for disentangling the impacts of changing climate and land uses on terrestrial water-carbon balance under SSP-RCP scenarios	Land-use conflict evolution	Competing land functions	Conflict zoning
Science Direct	Wang <i>et al</i> (2025)	A multi-level spatial assessment framework for identifying land use conflict zones	Agricultural to construction land	Resource competition	Multi-level spatial planning
Science Direct	Cao <i>et al</i> 2026	A multi-objective optimization for coordinating water-land resources considering crop suitability and drought effects	Drought effects on water allocation	Competition intensified by drought	Grid-scale optimization
Science Direct	Nabikandi <i>et al</i> (2025)	An integrated scenario-based approach for evaluating water yield responses to land use and climate change	Forest decline, cropland & urban expansion	Conflicts between development & protection	Ecological conservation scenarios
Science Direct	Keyser <i>et al</i> (2025)	A review of hydropower in Central Asia: Past, present, and future	Climate & glacier retreat	Irrigation vs hydropower, transboundary conflicts	Basin-wide governance
Science Direct	Jin <i>et al</i> (2025)	A novel integrated modelling framework to uncover spatial and temporal evolutionary patterns and influence mechanisms of land use conflicts	Agricultural, ecological & construction land changes	Competing stakeholder interests	PLE spatial planning
Science Direct	Schweikart <i>et al</i> (2026)	Balancing growth and conservation: Land-use policy scenarios for Uruguay's grasslands	Historical transitions & future scenarios	Production vs conservation	Policy scenarios (BAU, conservation)
Science Direct	Gerçek <i>et al</i> (2026)	Between panels and pastures: Socio-economic impacts of large-	Solar development on grazing/agricultural land	Land-use competition	ESMS & participatory planning

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
		scale solar development on land use and rural livelihoods			
Science Direct	Ramesh <i>et al</i> (2026)	Bio-invasion and decadal changes in the trophic dynamics of a temporarily closed estuary: An Ecopath model from Veli-Akkulam Estuary, Kerala, India	Estuarine hydrological changes	Invasive species & overexploitation	Ecosystem-based management
Science Direct	Drew <i>et al</i> (2025)	Boundary-making, tenure insecurity, and conflict: regional dynamics of land tenure change and commodification in East Africa's pastoralist rangelands	Rangeland fragmentation	Land & grazing conflicts	Community land legislation
Science Direct	Medeiros <i>et al</i> (2026)	Agricultural human-water systems	Forest/grassland to irrigated agriculture	Agriculture vs ecosystems & downstream users	Collective water governance
Science Direct	Castro <i>et al</i> (2026)	The widening world of Panta Rhei case studies	Floodplain land-use dynamics	Competition under water scarcity	Community irrigation governance
Science Direct	Zou <i>et al</i> (2024)	Characterizing land use transition in China by accounting for the conflicts underlying land use structure and function	Urban, cropland, afforestation transitions	Competing land functions	Integrated land-use planning
Science Direct	Puga <i>et al</i> (2026)	Connecting Mediterranean forests: a framework for conservation corridor planning	Deforestation & fragmentation	Sectoral competition	Conservation corridors & EU policies
Science Direct	Langhu <i>et al</i> (2026)	Coupling demography and crop dynamics under monsoon floods: A socio-hydrological case study of Dhubri, Assam, India	Floodplain agricultural dynamics	Competition for floodplain resources	Adaptive management & resilience planning
Science Direct	Li <i>et al</i> (2025)	Coupling response	Urban expansion & ecological conversion	Production-living-ecological conflicts	Spatial governance

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
		mechanisms of land use conflicts and ecosystem health using the GWRf-SHAP model			
Science Direct	Wang <i>et al</i> (2026)	Deciphering runoff-sediment-nutrient dynamics in agricultural watersheds supplied by large feeder Rivers	Agricultural activities	Mechanisms underpinning resource competition	Adaptive water-nutrient management
Science Direct	Fernandes-Tavares <i>et al</i> (2024)	Dispossessed lands and land-use change in the Colombian armed conflict	Traditional to agro-industrial uses	Land dispossession conflicts	Land Restitution Law
Science Direct	Sabut <i>et al</i> (2026)	Distinguishing drought and flash drought: definitions, processes, and consequences	Vegetation & soil moisture responses	Competition for scarce water	Drought monitoring & early warning
Science Direct	Zheng <i>et al</i> (2025)	Dynamic mechanisms of land use spatial conflicts in mining cities	Agricultural/forest to mining & construction	Mining-related conflicts	Coordinated land-use governance
Science Direct	Weng <i>et al</i> (2026)	Dynamics and trade-off/synergy of ecosystem services in China's First Batch national Parks	Forest expansion, cropland decline	Ecosystem service trade-offs	Ecological Protection scenarios
Science Direct	Yadav <i>et al</i> (2024)	Ecosystem health assessment of East Kolkata Wetlands, India	Wetland loss, urban & agricultural expansion	Ecosystem degradation	Wetland restoration & monitoring
Science Direct	Zakari <i>et al</i> (2025)	Effects of land use and land cover changes on ecosystem services and functions in the Kulpawn River Basin of Ghana	Agricultural & built-up expansion, water body decline	Reduced water availability	Sustainable land-use planning
Science Direct	Ketabchi <i>et al</i> (2025)	Emergent archetype patterns of coupled land use/land cover and hydrogeologic	Irrigated cropland to residential	Groundwater depletion	Artificial recharge & water-efficient agriculture

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
		responses on a regional scale			
Science Direct	Jin <i>et al</i> (2026)	Evaluating ecological security pattern responses to land use optimization	Farmland, forest, built-up transitions	Ecological resilience	Ecological security planning
Science Direct	Ashournejad <i>et al</i> (2026)	Exploring land cover change patterns in Hyrcanian forests	Forest → agriculture & impervious surfaces	Ecosystem degradation	Forest Rest Plan & UNESCO governance
Science Direct	Zhou <i>et al</i> (2025)	Harmonizing land management strategies with dust transport and water conservation	Degraded land & vegetation restoration	Pressure on natural resources	Integrated land restoration
Science Direct	Qin <i>et al</i> (2024)	Identification of conflict and its evolution between land use and land suitability during urban expansion	Agricultural/ecological to built-up	Development vs agriculture/ecology	Land suitability evaluation
Science Direct	Wang <i>et al</i> (2025)	Impact of land-use change on ecosystem services in Africa's Great Green Wall	Grasslands decline, cropland expansion	Competition for productive land	Ecosystem restoration
Science Direct	Makwati <i>et al</i> (2026)	Impacts of land use and land cover change on habitat connectivity	Agricultural expansion & fragmentation	Human activities vs conservation	Corridor protection
Science Direct	Ayele <i>et al</i> (2025)	Impacts of land use/land cover changes on spatio-temporal variation of groundwater recharge	Agricultural & urban expansion	Pressure on groundwater	Sustainable land-use planning
Science Direct	Thomsen <i>et al</i> (2026)	Improving spatial land-use and land-cover change simulations with machine learning	Future land-cover transitions	N/A	Tool for land-use planning

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
Science Direct	Xie <i>et al</i> (2026)	Incorporating water-energy-carbon constraints into the optimization of urban refined land use	Urban & ecological land changes	Water-resource sustainability	Integrated planning
Science Direct	Kioko <i>et al</i> (2025)	Infrastructure-driven land appropriation, institutional change and conflict in a communal conservancy in Kenya	Agricultural & community land changes	Land & resource conflicts	Stronger land governance
Science Direct	Kavhu <i>et al</i> (2025)	Integrating socio-economic zones into water resource analysis under land use change and climate variability in the Okavango basin	LULC changes across socio-economic zones	Hydropolitical tensions	Socio-economic zoning
Science Direct	Katonge <i>et al</i> (2025)	Lake Babati ecosystem, Tanzania: biodiversity status, anthropogenic threats, and land use implications a review	Agricultural & urban expansion	Competition among fishing, farming, communities	Sustainable land-use planning
Science Direct	Zhao <i>et al</i> (2025)	Land and water resource effects of power structure transformation in China	Renewable energy land requirements	Land–water trade-offs	Ecological zoning
Science Direct	Nardotto Júnior <i>et al</i> (2026)	Land conservation based on land use potential and erosion risk in an Atlantic Forest watershed (Brazil)	Agricultural expansion into unsuitable areas	Soil & water-use conflicts	Land suitability planning
Science Direct	Kassun <i>et al</i> (2024)	Land use and land cover change, trade-offs, and synergies between ecosystem services in a dry Afromontane Forest	Open forest increase, farmland decline	Livelihoods vs conservation	Sustainable forest management

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
Science Direct	Ji <i>et al</i> (2026)	Land use change analysis for sustainable development in arid oases	Cropland & built-up changes	Agricultural, ecological & urban competition	Adaptive land-use planning
Science Direct	Chai <i>et al</i> (2026)	Long-term spatiotemporal dynamics of urban land and surface water bodies in Shanghai	Urban expansion & surface water changes	Urban water demand pressure	Sustainable urban planning
Science Direct	Li <i>et al</i> (2025)	Mining-induced land use change and ecological restoration	Mining expansion replacing vegetation	Mining vs agriculture & communities	Adaptive governance
Science Direct	Wu <i>et al</i> (2026)	Multiscale synergistic evolution of China's water-land-energy-food-carbon system	Sectoral interactions	Structural trade-offs	Nexus-based planning
Science Direct	Wang <i>et al</i> (2025)	Multiscale territorial spatial conflict evolution and driving mechanism in China's land border	Urban expansion, ecological decline	Territorial conflicts	Comprehensive spatial planning
Science Direct	Marco <i>et al</i> (2025)	Network-based assessment of multi-scale resilience in the water-energy-land-food nexus	Deforestation & agricultural expansion	Competing demands	WELF nexus planning
Science Direct	Kalies <i>et al</i> (2026)	Not all mining is equal: The impact of lithium production technology on land, water, and emissions footprints through 2040	Lithium mining land-use footprints	Mining vs ecosystems & other uses	Direct Lithium Extraction (DLE) adoption
Science Direct	Latella <i>et al</i> (2026)	On the calculation of the land cover and management factor in soil erosion assessments	Vegetation cover & land management	Pressure on soil & water	Conservation farming
Science Direct	Abou-Soufianou <i>et al</i> (2026)	Participatory land-Use planning for climate-resilient governance in	Rainfed agriculture expansion	Competition among farmers, pastoralists	Participatory land-use planning (PLUP)

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
		the sahelian drylands			
Science Direct	Mallesh <i>et al</i> (2026)	Persistent organic pollutants in India	Urbanization & agricultural expansion	Pollution-related competition	National monitoring & regulation
Science Direct	Li <i>et al</i> (2025)	Prediction of land use and optimization of water environmental carrying capacity on Xiamen Island	Future land-use scenarios	Economic vs ecological water resources	WECC-based planning
Science Direct	Shafizadeh-Moghadam <i>et al</i> (2025)	Pronounced decline in Iran's terrestrial water storage from GRACE and GRACE-FO	Cropland expansion, urbanization, deforestation	National water scarcity	Sustainable land management
Science Direct	Bogale <i>et al</i> (2026)	Quantifying ecosystem services and analyzing trade-offs under a rapid land cover change	Plantation forest expansion	Agricultural production vs regulating services	Balanced land allocation
Science Direct	Herano <i>et al</i> (2025)	Quantifying the land use land cover change and its effect on sediment yield in upper watersheds of Bilate River, Ethiopia	Agriculture & settlements expansion	Competition over wetlands & forests	Wetland conservation
Science Direct	Krueger <i>et al</i> (2019)	Quantifying urban water supply security under global change	Climate variability & infrastructure	Urban vs agriculture competition	Capital Portfolio Approach
Science Direct	Tabetando <i>et al</i> (2025)	Rainfall shocks and land conflicts	Rainfall variability	Land & water conflicts	Irrigation & climate adaptation
Science Direct	Vuille <i>et al</i> (2018)	Rapid decline of snow and ice in the tropical Andes	Glacier retreat	Competition among sectors	Integrated water governance
Science Direct	Phy <i>et al</i> (2025)	Recent streamflow variability linked to climate, dam operations and land cover change in the Irrawaddy River	Basin-wide land-cover change	Competition among water users	Integrated basin-scale management

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
Science Direct	Su <i>et al</i> (2026)	Regional water and land resource equilibrium optimization under climate change	Alternative land-use patterns	Sectoral competition	Equilibrium optimization framework
Science Direct	Zhang <i>et al</i> (2026)	Rethinking and reconciling the land–energy conflicts from centralized photovoltaics in China	PV development on cropland/grassland	Energy vs agriculture & conservation	Optimized site selection
Science Direct	Ogweno <i>et al</i> (2026)	Semi-supervised machine learning for montane vegetation mapping	Vegetation transitions in Mount Kenya	Pressure on mountain ecosystems	High-resolution monitoring
Science Direct	Anticoli <i>et al</i> (2025)	Spatial land conflict typologies in the Atlantic Forest of South America	Deforestation & agricultural expansion	Agribusiness vs indigenous & small farmers	Just territorial planning
Science Direct	Bihon <i>et al</i> (2025)	Spatiotemporal analysis of land use and land cover using random forest in Google Earth engine	Agricultural & built-up increase	Competition for land & water	Integrated watershed management
Science Direct	Yang <i>et al</i> (2026)	Studying the impact of historical land use/land cover change on land–atmosphere interactions in the Dongting Lake region	Cropland expansion at expense of lakes & forests	Competition among agricultural, urban & ecological uses	Sustainable lake conservation
Science Direct	Shibo <i>et al</i> (2026)	The cost of ecological protection and restoration	Land-cover types & soil interaction	Trade-offs between agriculture & conservation	Soil-type informed spatial planning
Science Direct	Katusiime <i>et al</i> (2023)	The relationship of land tenure, land use and land cover changes in Lake Victoria basin	Land tenure influence	Competition among agriculture, cities, industry	Integrated water management
Science Direct	Neesham-McTiernan <i>et al</i> (2025)	The spatial potential for agrivoltaics to address energy-agriculture land use conflicts in Great Britain	Solar on agricultural land	Energy vs agriculture	Agrioltaic systems

Source	Author	Title	Key Focus / Model (RQ1–RQ2)	Resource Competition / Conflict (RQ3)	Governance Responses (RQ4)
Science Direct	Rafael Pucci <i>et al</i> (2025)	Toburnaslum: Urban land conflicts and the use of arson against Favelas	Urban land conflicts	Land conflicts in favelas	(Implied urban planning)
Science Direct	Benitez <i>et al</i> (2026)	Trajectories of farming systems reshape land use/land cover dynamics in the agricultural zones of the Galapagos Islands	Annual vs perennial crops, invasive species	Pressures on agricultural land	Adaptive land management
Science Direct	Filho <i>et al</i> (2022)	Understanding responses to climate-related water scarcity in Africa	Climate-induced drought	Livelihood insecurity & conflict	Stronger institutions & IWRM
Science Direct	Zhang <i>et al</i> (2024)	Understanding the “conflict-coordination” theoretical model of regional land use transitions	Cropland ↔ rural settlements	Urban development vs cropland protection	Coordinated land-use policies
Science Direct	Ebaju <i>et al</i> (2026)	Urban expansion and its effects on land surface temperature and vegetation in three east African cities	Urban expansion replacing vegetation	Pressure on green spaces	Sustainable urban planning
Science Direct	Khan <i>et al</i> (2025)	Wide range of potential spillover effects under net-zero emissions pathways for Australia’s land sector	Land-use changes for net-zero	Conflicts among carbon, agriculture, biodiversity, water	Integrated policy portfolios

3.6 Dominant Land-Cover Transition Patterns in Intermittent River Catchments (RQ1)

Agricultural expansion emerged as the most frequently reported land-cover transition in intermittent river catchments, appearing in 62 studies and representing 59.6% of the reviewed evidence. This transition commonly involved the conversion of forests, savannas, wetlands, and rangelands into cropland or irrigated agricultural land, particularly in Africa and Asia. Urbanization and built-up area expansion were also prominent, reported in 48 studies (46.2%), often associated with the replacement of agricultural land, vegetation cover, or riparian zones by settlements, roads, and impervious surfaces. Other frequently documented transitions included riparian and wetland degradation in 31 studies (29.8%), deforestation or forest loss in 29 studies (27.9%), rangeland or grassland conversion in 18 studies (17.3%), and sand encroachment or desertification in 9 studies (8.7%). Spatially, these transitions were concentrated in rapidly developing and water-stressed regions, especially sub-Saharan Africa and Asia, while temporally most studies assessed land-cover changes from approximately 1990 to 2025, with many reporting accelerated transitions after 2000 and particularly after 2010 (Table 5).

Table 1
Most Frequently Documented Land-Cover Transitions

Land-Cover Transition	Number of Studies	Percentage of Included Studies
Agricultural expansion (forest/savanna → cropland)	62	59.6%
Urbanization / Built-up expansion	48	46.2%
Riparian / Wetland degradation	31	29.8%
Deforestation / Forest loss	29	27.9%
Rangeland / Grassland conversion	18	17.3%
Sand encroachment / Desertification	9	8.7%

3.7 Hydrological Responses to Land-Cover Transitions (RQ2)

The reviewed literature showed consistent evidence that land-cover transitions alter hydrological regimes in intermittent river catchments, especially through increased runoff, reduced infiltration, declining groundwater recharge, and intensified seasonal flow variability. Increased surface runoff and flood risk were the most frequently reported hydrological outcomes, documented in 68 studies (65.4%), largely in association with agricultural expansion, urbanization, vegetation removal, and wetland loss. Reduced groundwater recharge and baseflow were reported in 55 studies (52.9%), while streamflow intermittency and dry-season flow decline were documented in 42 studies (40.4%), indicating that land-cover change often reduces the capacity of catchments to sustain flow during dry periods. Additional impacts included increased sediment yield and erosion in 31 studies (29.8%), altered evapotranspiration and water yield in 28 studies (26.9%), and amplified drought effects in 19 studies (18.3%). Across the evidence base, hydrological modelling studies consistently suggested that land-cover change interacts with climate variability, thereby compounding water scarcity, flood exposure, and dry-season hydrological instability (Table 6).

Table 6
Most Common Hydrological Impacts Reported

Hydrological Impact	Number of Studies	Percentage of Included Studies
Increased surface runoff / flood risk	68	65.4%
Reduced groundwater recharge / baseflow	55	52.9%
Streamflow intermittency / dry-season decline	42	40.4%
Increased sediment yield / erosion	31	29.8%
Altered evapotranspiration & water yield	28	26.9%
Amplified drought effects	19	18.3%

3.8 Mechanisms Linking Hydrological Variability to Resource Competition and Water-Related Conflict (RQ 3)

The synthesis identified multiple pathways through which hydrological variability contributes to resource competition and water-related conflict in intermittent river systems. The most frequently reported mechanism was reduced dry-season flow and streamflow intermittency, documented in 31 studies (29.8%), which limited water availability during periods of peak livelihood dependence and intensified competition among users. Intersectoral competition between agriculture, domestic supply, hydropower, livestock, urban development, and ecological water needs was reported in 24 studies (23.1%), while land-cover change intensifying water scarcity was identified in 22 studies (21.2%). Broader land-and-water resource competition appeared in 19 studies (18.3%), and farmer–herder conflicts driven by water scarcity were reported in 18 studies (17.3%), particularly across sub-Saharan African contexts. Upstream–downstream competition was also prominent, appearing in 15 studies (14.4%), especially in basins where water abstraction, land-use change, and seasonal flow reduction affected downstream access. These findings indicate that water-related conflict in intermittent catchments is rarely caused by

hydrological scarcity alone; rather, it emerges through the interaction of variable water availability, unequal access, livelihood dependence, institutional weaknesses, and competing land-use priorities (Table 7).

Table 7
Mechanisms Driving Resource Competition and Conflict

Mechanism	Number of Studies	Percentage of Included Studies
Farmer-herder conflicts due to water scarcity	18	17.3%
Upstream–downstream competition	15	14.4%
Intersectoral competition (agriculture vs others)	24	23.1%
Reduced dry-season flows / intermittency as trigger	31	29.8%
Land-cover change intensifying scarcity	22	21.2%
Broader resource competition (land + water)	19	18.3%

3.9 Governance and Institutional Responses to Hydrological Variability and Conflict

The reviewed studies identified a range of governance and institutional responses designed to manage hydrological variability, resource competition, and water-related conflict in intermittent river catchments. Integrated Water Resources Management and watershed management were the most frequently reported approaches, often recommended as mechanisms for coordinating water allocation, catchment protection, stakeholder participation, and cross-sectoral planning. Land-use planning and zoning also featured prominently, including grazing corridors, protected areas, conflict zoning, land-suitability planning, and spatial regulation of agricultural, urban, and conservation activities. Ecological restoration, particularly reforestation, wetland restoration, riparian rehabilitation, and catchment conservation, was frequently proposed to improve infiltration, stabilize runoff, and reduce degradation-related water stress. Adaptive and scenario-based frameworks, participatory and community-based management, and transboundary or nexus-oriented approaches were also reported, especially in contexts requiring flexible planning under climate uncertainty, stakeholder conflict, or upstream–downstream water dependencies. Overall, the evidence suggests that effective governance in intermittent catchments requires integrated land–water planning, locally grounded participation, hydrological evidence for decision-making, and stronger institutional capacity to mediate competing resource claims (Table 8).

Table 8
Major Governance and Institutional Responses

Response Type	Most Common Approaches	Frequency
Integrated Management	IWRM, watershed management	High
Land-Use Planning & Zoning	Grazing corridors, conflict zoning, protected areas	High
Ecological Restoration	Reforestation, wetland restoration	High
Adaptive & Scenario-Based Frameworks	Three-zone risk management, future scenarios	Medium
Participatory & Community-Based	Stakeholder engagement, participatory mapping	Medium
Transboundary & Nexus Approaches	Basin-wide governance, water-energy-food nexus	Medium

4. Discussion

This systematic review demonstrates that research on land-cover transitions, hydrological variability, resource competition, and governance responses in intermittent river catchments has expanded rapidly, particularly after 2022. This temporal pattern suggests that intermittent river systems are increasingly being recognized as critical socio-hydrological landscapes

rather than marginal or secondary hydrological units. This is consistent with (Messenger et al. (2021), who showed that non-perennial rivers and streams constitute approximately 51–60% of global river length, indicating that flow intermittence is a widespread global condition rather than an exception. Similarly, Fovet et al. (2021) argued that intermittent rivers and ephemeral streams provide important ecosystem services but remain insufficiently incorporated into mainstream hydrological and governance frameworks. The strong concentration of studies in Africa and Asia in the present review therefore reflects not only the geographic prevalence of intermittent catchments in semi-arid and monsoonal regions, but also the growing policy urgency around water insecurity, land-use pressure, and livelihood vulnerability in these regions. However, this distribution should also be interpreted cautiously, because it may reflect research visibility, database coverage, and recent donor or policy interest rather than the full global distribution of intermittent river challenges.

The dominance of agricultural expansion as the most frequently reported land-cover transition is a central finding of this review. Agricultural expansion was reported in 59.6% of the included studies, followed by urban and built-up expansion in 46.2%, riparian or wetland degradation in 29.8%, and deforestation in 27.9%. These results indicate that the transformation of forests, savannas, wetlands, and rangelands into cropland and settlements is the principal pathway through which human activity restructures intermittent catchments. This finding aligns with recent catchment-scale studies showing that agricultural intensification and urbanisation alter runoff generation, infiltration, evapotranspiration, and groundwater recharge. For example, Zhang et al. (2025) demonstrated that land-use/land-cover data characteristics significantly influence SWAT-based streamflow projections, while Kiflay et al. (2025), in a rapidly urbanising Tanzanian catchment, showed that urban expansion altered recharge and runoff dynamics in complex and spatially variable ways. The implication is that land-cover change should not be treated simply as a background driver in hydrological assessments; rather, it is a direct determinant of catchment function, particularly in systems where dry-season flows are already fragile.

The hydrological responses reported in this review confirm that intermittent catchments are highly sensitive to landscape transformation. Increased surface runoff and flood risk were reported in 65.4% of the studies, reduced groundwater recharge and baseflow in 52.9%, and dry-season flow decline or streamflow intermittency in 40.4%. These findings are consistent with the broader hydrological literature, which shows that vegetation removal, soil compaction, impervious surface expansion, and wetland degradation reduce catchment storage capacity and accelerate the movement of water from hillslopes to channels. Nevertheless, the relationship is not always linear. For instance Kiflay et al. (2025), found that urbanisation in Arusha increased simulated recharge partly because of leakage and altered urban water pathways, despite increased runoff. This suggests that hydrological outcomes depend on local soil properties, infrastructure conditions, groundwater connectivity, and water-use practices. Therefore, while the reviewed studies strongly support the conclusion that land-cover transitions intensify hydrological variability, future research should move beyond generalized assumptions and evaluate context-specific mechanisms, especially in data-scarce semi-arid catchments.

The findings further show that hydrological variability becomes socially consequential when it intersects with livelihood dependence, unequal access, and weak allocation systems. Reduced dry-season flows and streamflow intermittency were the most frequently reported triggers of resource competition, followed by intersectoral competition among agriculture, domestic supply, livestock, hydropower, and ecological water needs. Farmer–herder conflict was particularly prominent in African studies, confirming that water conflict is rarely caused by scarcity alone; rather, it emerges when scarcity interacts with mobility, land tenure change, crop expansion, blocked grazing routes, and fragmented institutions. This interpretation is supported by Unfried et al. (2022), who found empirical evidence linking local water mass decline to increased social conflict in Africa and Central America, and by Kåresdotter et al. (2025), whose review concluded that climate-related water conflicts are shaped by multiple interacting social, institutional, and environmental factors. The present review therefore contributes to the literature by showing that land-cover transitions act as a bridge between biophysical hydrological change and socio-political conflict formation.

Governance responses identified in the reviewed studies were dominated by Integrated Water Resources Management, watershed management, land-use planning, ecological restoration, zoning, participatory approaches, and adaptive management. This reflects the widespread acceptance of integrated land–water governance as the preferred response to coupled hydrological and socio-political risks. However, the prominence of IWRM in the literature should not be interpreted as

evidence of consistent effectiveness. Lukat et al. (2023) argue that IWRM depends on strong vertical and horizontal coordination across government levels and policy sectors, yet many water governance systems remain fragmented. This is particularly relevant to intermittent catchments, where decisions made in agriculture, settlement planning, conservation, livestock management, and infrastructure development often determine hydrological outcomes more directly than water-sector policies alone. The review therefore suggests that governance effectiveness depends less on adopting IWRM as a label and more on whether institutions can coordinate land-use regulation, protect recharge and riparian zones, resolve competing claims, and use hydrological evidence in allocation decisions. Recent work on catchment-scale flood and drought mitigation similarly emphasises the need to restore water retention, infiltration, and storage functions across the landscape rather than relying only on downstream water management interventions.

Overall, this review advances current understanding by integrating four bodies of literature that are often treated separately: land-cover change, hydrological variability, resource competition, and water governance. The results indicate a clear socio-hydrological pathway: land-cover transitions reduce catchment buffering capacity, altered hydrological regimes intensify seasonal water scarcity, and scarcity becomes conflictual where governance institutions are unable to regulate access equitably. This synthesis supports calls by Datry et al., (2023) for greater attention to the interactive effects of drying, land-use pressure, and other anthropogenic stressors in river systems. It also strengthens the argument that intermittent river catchments require governance models that are adaptive, spatially explicit, and sensitive to both ecological thresholds and livelihood realities. For policy, the key implication is that reducing water-related conflict in intermittent catchments requires upstream action on land-use planning, wetland and riparian restoration, groundwater recharge protection, and negotiated access arrangements among farmers, pastoralists, domestic users, and ecological water needs.

Despite the contribution of this review, the interpretation of the findings should be considered in relation to its methodological and evidentiary limitations. The synthesis was restricted to studies retrieved from selected academic databases and platforms, which may have limited the inclusion of relevant evidence published in local journals, non-English sources, institutional repositories, or grey literature. In addition, the reviewed studies varied considerably in design, spatial scale, analytical methods, and outcome measures, ranging from remote sensing and hydrological modelling to governance-oriented and conflict-focused analyses; as a result, formal meta-analysis was not appropriate. Another important limitation is that many included studies reported associations between land-cover transitions, hydrological variability, and water-related conflict, but did not empirically test the full causal pathway linking land-use change to hydrological response and subsequent socio-political outcomes. The strong concentration of evidence from Africa and Asia improves the relevance of the findings for water-stressed and rapidly transforming catchments, although it may reduce direct generalisability to less represented regions such as Europe, North America, and temperate intermittent river systems. These limitations highlight the need for future research that uses longitudinal designs, comparable hydrological indicators, mixed-methods conflict analysis, and cross-regional datasets to better explain how land-cover change translates into hydrological variability, resource competition, and governance outcomes in intermittent river catchments.

5. Conclusion and recommendations

This systematic review demonstrates that land-cover transitions, hydrological variability, resource competition, and governance responses are closely interconnected in intermittent river catchments. The evidence shows that agricultural expansion was the dominant land-cover transition, reported in 59.6% of the reviewed studies, followed by urban and built-up expansion, riparian and wetland degradation, and deforestation. These transitions were strongly associated with increased surface runoff and flood risk, reduced groundwater recharge and baseflow, intensified dry-season flow intermittency, sediment yield, and drought-related water stress. The findings further indicate that hydrological variability becomes a source of conflict when declining water availability intersects with competing livelihood demands, weak institutional coordination, unequal access to water, and fragmented land-use governance. Africa and Asia accounted for the largest share of the evidence, highlighting the particular vulnerability of semi-arid, rapidly transforming, and livelihood-dependent catchments. Overall, the review confirms that water-related conflict in intermittent river systems should not be understood as a simple outcome of

physical scarcity alone, but as a socio-hydrological process shaped by land-use change, hydrological disruption, resource dependence, and governance capacity.

Building on these findings, effective responses require practical, integrated, and catchment-sensitive interventions that connect land-use planning with water governance. Governments, basin authorities, and local institutions should prioritise the protection and restoration of forests, wetlands, riparian buffers, groundwater recharge zones, and grazing corridors, while regulating agricultural expansion, settlement growth, and water abstraction in hydrologically sensitive areas. Remote sensing, hydrological modelling, participatory mapping, and early-warning systems should be routinely applied to monitor land-cover transitions, identify emerging water-conflict hotspots, and support evidence-based allocation decisions. Integrated Water Resources Management should therefore move beyond broad policy commitments and be implemented through enforceable land-use zoning, inclusive stakeholder platforms, drought preparedness plans, and negotiated access arrangements among farmers, pastoralists, domestic users, industries, and ecosystem needs. Further research should prioritise longitudinal and comparative studies that directly test causal pathways linking land-cover change, hydrological variability, and conflict outcomes, especially in data-scarce intermittent catchments. Future studies should also evaluate the effectiveness of governance interventions, integrate local ecological knowledge with hydrological data, and develop cross-regional datasets that allow stronger comparison across Africa, Asia, South America, Europe, North America, and other underrepresented regions.

Declarations

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Ethics Approval

Not applicable. This study is a systematic review based exclusively on published peer-reviewed literature and did not involve human participants, animals, field experiments, or the collection of any identifiable personal data.

Consent to Participate

Not applicable.

Consent to Publish

Not applicable. This manuscript does not contain any individual person's identifiable data, images, or personal information.

Ethics and Trial Registration

Not applicable. No protocol registration or trial registration was required for this systematic review.

Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability Statement.

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Figures

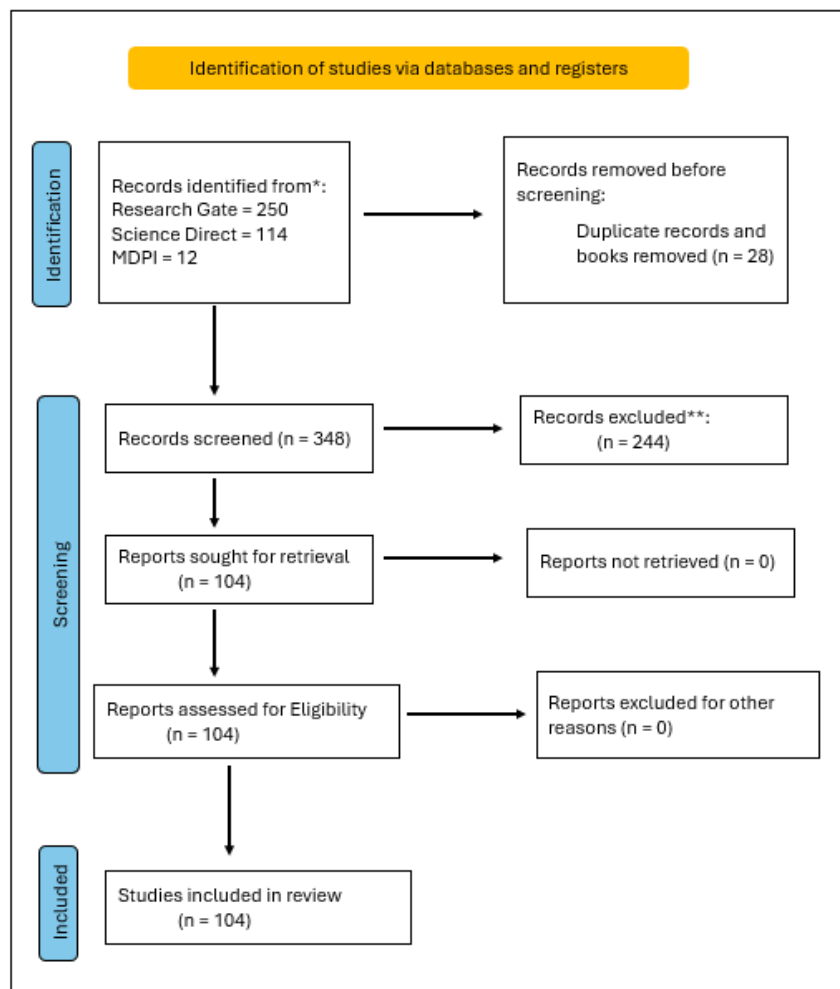


Figure 1

PRISMA flow diagram utilized in the study.



Figure 2

Research paper collection at Country level