

Article

Designing Tomorrow's Food Systems Through Integrative Ethical Water Governance

Dilek Olcay *  and Serap Ulusam Seçkiner 

Industrial Engineering Department, Gaziantep University, 15 Temmuz Mah., Üniversite Bulvarı, Gaziantep 27310, Türkiye; seckiner@gantep.edu.tr

* Correspondence: do02982@student.gaziantep.edu.tr or dolcay@gmail.com

Abstract

Integrative Ethical Water Governance (IEWG) offers a structured pathway to enhance the resilience and sustainability of food systems under intensifying water scarcity, climate change, and rising demand. This article develops and applies a scoring-based comparative framework to evaluate how four governance contexts—Türkiye's Southeastern Anatolia Project (GAP), China's Yangtze River Basin management, India's watershed development programs, and California's groundwater sustainability initiatives—perform across dual IEWG dimensions: ethical principles (rights-based approaches, justice, intergenerational equity, ecological integrity) and governance frameworks (stakeholder participation, environmental focus, equity approach, institutional integration, economic mechanisms). The analysis assigns explicit scores to each dimension, revealing distinct patterns of ethical integration, strengths and gaps in governance design, and context-specific trade-offs between agricultural production and ecosystem protection. Results show that higher aggregate IEWG scores are associated with more robust participatory structures, clearer allocation of responsibilities across scales, and better alignment of economic instruments with stewardship objectives. The study's scoring-based comparative method provides a transparent, replicable tool for diagnosing governance performance and identifying priority areas for institutional innovation, offering a novel evaluative lens for future research and policy on ethical water–food governance.

Keywords: ethical stewardship; agricultural sustainability; water–food nexus; participatory management; institutional innovation



Academic Editors: Carla Cavallo, Maura Sannino, Chiara Amtrano, Francesco Serrapica and Christophe El-Nakhel

Received: 5 December 2025

Revised: 14 January 2026

Accepted: 21 January 2026

Published: 9 February 2026

Copyright: © 2026 by the authors.

Licensee MDPI, Basel, Switzerland.

This article is an open access article distributed under the terms and conditions of the [Creative Commons Attribution \(CC BY\)](https://creativecommons.org/licenses/by/4.0/) license.

1. Introduction

Water scarcity, climate change, and depletion of natural resources—magnified by population growth—threaten global food systems. Resource scarcity conflicts disrupt agricultural productivity, ecological balance, and social welfare. Intensifying climate variability and demographic pressures place unprecedented strain on water resources and food production systems [1].

Ethical water governance matters critically in food systems due to the fundamental interdependence between water and food production. Water serves as a critical input for agriculture while food systems simultaneously affect water quality and availability. This nexus creates complex ethical dimensions involving competing interests, access inequities, ecosystem impacts, and intergenerational concerns that require robust frameworks for water allocation decisions. An integrative approach combining rights-based frameworks,

justice principles, long-term sustainability, and ecological integrity can create more resilient food and water systems.

Conventional water management models cannot assure food system sustainability because they overlook complex, interdependent pressures. Developing new frameworks that treat water as both a resource and a pillar of ethical stewardship is essential for food, agriculture, and broader society.

The primary objective of this paper is to establish that Integrative Ethical Water Governance (IEWG) is essential for sustainable food system resilience. It investigates the transition from conventional scarcity-based water management toward IEWG models, where ethical principles and stewardship-based frameworks guide the design and governance of food systems.

The study examines how four diverse water governance cases approach the dual pillars of IEWG: ethical principles and governance frameworks. These pillars are explored through the Türkiye Southeastern Anatolia Project (GAP), Chinese Yangtze River management, Indian community watershed programs, and California's Sustainable Groundwater Management Act (SGMA). These cases represent distinct geographical, institutional, and socio-economic contexts, yet each demonstrates varying degrees of integration across the four ethical principles that underpin IEWG: Rights-Based Integration, Justice Integration, Intergenerational Equity, and Ecological Integrity. Through this comparative analysis, the research evaluates how these diverse governance systems operationalize five key governance frameworks (Stakeholder Participation, Environmental Focus, Equity Approach, Institutional Integration, and Economic Mechanisms) to translate ethical principles into practice.

This comparative approach illuminates not only the universal applicability of the dual pillar structure of IEWG but also the contextual adaptations required across varying scales of water governance, from large river basin management to local watershed interventions, as these systems attempt to balance agricultural water demands with conservation imperatives while embedding ethical stewardship into their governance structures. Understanding how these cases apply, or fail to apply, the dual pillars of IEWG provides essential insights for designing the food systems of tomorrow.

1.1. Integrative Ethical Water Governance (IEWG)

Integrative Ethical Water Governance embeds ethical principles into water resource management. It is crucial to balance economic, social, ecological, and institutional dimensions for sustainability and equity. It protects human rights, public health, ecological integrity, and social cohesion by coordinating stakeholders at every scale. The approach fosters responsible stewardship and inclusive governance through a values-based, multi-disciplinary, and participatory model [2,3].

Ethical principles are primarily based on rights, justice integration, ecology, and intergenerational equity, supporting integrative ethical water governance. It is a fundamental ethical principle rooted in the recognition of water as a human right and the integration of justice frameworks to ensure equitable access to water for all stakeholders [4]. Furthermore, it encompasses eco-integrity, which preserves the centrality of ecosystems and promotes environmental sustainability, alongside intergenerational equity, which conserves water resources for future generations [5].

Governance frameworks include the policies, procedures, and structures that shape decision-making, risk management, and accountability. They align strategies with ethical standards, regulations, and stakeholder expectations, improving performance [6]. Resource governance frameworks are key to effective resource management. Their main elements are stakeholder participation, environmental focus, equity, integration, and economic

mechanisms [2]. Each pillar ensures the integrity, security, and usability of resources. Figure 1 illustrates the primary pillars of IEWG.

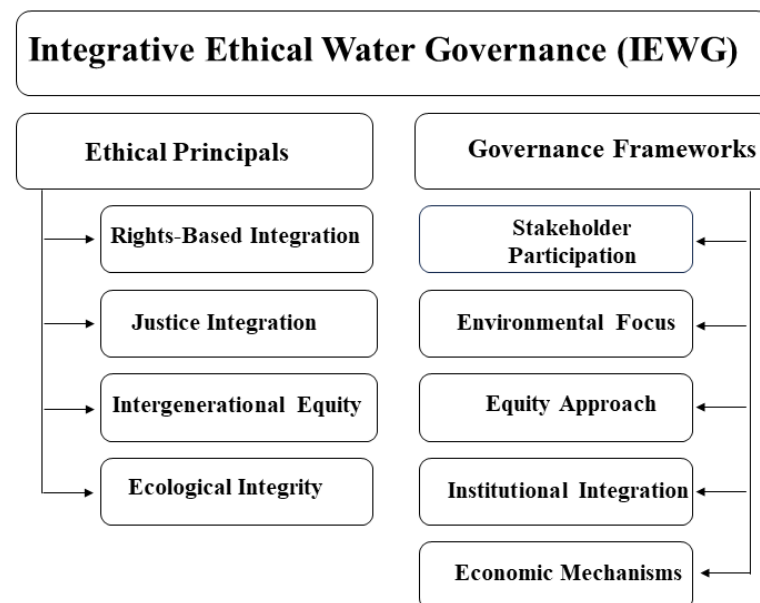


Figure 1. Two primary and nine subsidiary dimensions of Integrative Ethical Water Governance (IEWG): Ethical Principles and Governance Frameworks.

1.2. Ethical Principles

1.2.1. Rights-Based Water Governance

The human right to water is a relatively new addition to the catalogue of internationally recognized human rights. At the international level, access to water was recognized as a human right at least since 2010, when both the Human Rights Council and the General Assembly of the United Nations affirmed its existence [7].

Since then, the understanding of this right, and the obligations flowing from it, have deepened and become more sophisticated [8]. This approach ensures that water management prioritizes human dignity and basic needs while addressing inequalities in access.

1.2.2. Justice and Equity Principles

In order to create effective governance, power imbalances must be addressed, participation in decision-making must be enabled, and conflicting values must be reconciled. The OECD water governance principles have been critiqued for needing stronger integration of Indigenous rights and water justice perspectives, highlighting the importance of incorporating diverse ethical frameworks [7,9].

1.2.3. Intergenerational Equity

Recent scholarship emphasizes that water resource management must explicitly incorporate intergenerational considerations, using adapted Bentham–Rawls criteria and overlapping generation structures to balance current economic benefits with long-term sustainability. This principle has gained recognition in international environmental law and climate jurisprudence as customary practice [5].

1.2.4. Ecological Integrity

Modern water governance increasingly recognizes ecosystem centrality as a core ethical principle, moving beyond viewing water solely as a resource toward understanding

water as integral to ecological systems. This includes protecting freshwater ecosystems, maintaining biodiversity, and ensuring sustainable water flows [2].

These four ethical dimensions are most effective when operationalized together through comprehensive water governance frameworks. Values-based approaches to water governance help adjudicate competing priorities while maintaining ethical commitments to sustainability, equity, and environmental protection [4].

1.3. Governance Frameworks

1.3.1. Stakeholder Participation

Stakeholder engagement is an integral part of water governance to provide long-term sustainable water services (e.g., water storage, distribution, treatment). Yet, evidence-based studies documenting how community engagement contributes to water governance objectives are scarce [10].

Increasing demands for long-term benefits, including sustainability and resilience, have made stakeholder engagement a central component of water-related projects in various contexts. Intangible assets, such as trust, ownership, and acceptability, are fragile yet powerful [11].

1.3.2. Environmental Focus

Environmental focus in water governance emphasizes the health, value, and integrity of aquatic ecosystems, recognizing water's role in supporting biodiversity and ecosystem services. Strong connections between water systems and broader ecosystems must be maintained, natural flows must be protected, and water quality must be maintained [12]. For long-term sustainability, water governance must balance human needs with ecosystem demands, apply precautionary principles, and integrate environmental protections into legal and regulatory frameworks [13].

1.3.3. Equity Approach

Assuring equitable distribution of water among communities, social groups, and economic sectors at the national and transboundary levels. Water resources are shared equitably across communities, reducing spatial and socioeconomic disparities. All individuals, regardless of gender, should have opportunities to enhance or maintain their well-being. Equity between and among the various interest groups, stakeholders, and consumer-voters needs to be carefully monitored throughout the process of policy development and implementation [14].

The equity approach ensures that all members of society have equitable access to, management of, and decision-making about water resources, with special consideration for the most vulnerable and marginalized members of society. In addition to equal distribution, this pillar addresses diversity, historical inequalities, and power imbalances, recognizing that water governance requires identifying who benefits, who participates in making water decisions, and how costs and benefits are distributed [15]. It is essential that equitable water governance involves transparent, accountable, and nondiscriminatory frameworks that respect water as a human right, promote social justice, and address the disproportionate impact on disadvantaged groups [16].

1.3.4. Institutional Integration

Institutional integration entails coordination and cohesion among water governance structures at various governmental levels (local, regional, national, transboundary) and across multiple policy sectors, including agriculture, energy, environment, health, and industry, which influence water resources both vertically and horizontally [2]. Addressing fragmentation requires defining clear roles and responsibilities, promoting cross-sectoral

collaboration, and establishing coordination mechanisms, such as river basin organizations. Additionally, fostering synergistic interactions among hierarchical, market-based, and network governance mechanisms is essential. Effective institutional integration depends on flexible and sustainable arrangements that support information flow, stakeholder engagement, legal coherence, and adaptive capacity to manage conflicts and trade-offs [17,18].

1.3.5. Economic Mechanisms

Water governance reduces confusion by defining clear roles, fostering cooperation, and creating coordination groups such as river basin organizations. Effective governance relies on the sharing of accessible information, stakeholder participation, legal alignment, and robust conflict resolution.

Institutional integration in water governance involves aligning structures across government levels, from local to transboundary, and across various sectors, including agriculture, energy, and the environment. This alignment addresses fragmentation by clarifying roles, encouraging collaboration, and establishing coordination mechanisms such as river basin organizations. Success depends on flexible information sharing, stakeholder engagement, legal coherence, and adaptive conflict management [19].

1.3.6. Conceptual Distinctions Between Dimensions

This governance framework distinguishes governance dimensions to support systematic analysis. Institutional integration involves mechanisms that enable integrated governance, such as interagency bodies, unified legal frameworks, and cross-sectoral arrangements. Economic mechanisms use financial tools to influence behavior, including water pricing, subsidies, cost recovery, and payment schemes. Although these dimensions interact, each serves a distinct function. Integrated institutions address coordination by clarifying responsibilities and processes, while economic mechanisms establish incentives through financial tools. The scoring process maintains this distinction by evaluating organizational and legal evidence separately from pricing and financial evidence.

1.4. As a Complementary Dimension of IEWG: Stewardship

The term stewardship refers to the collaborative planning and responsible management of the environment through natural resource management practices that take into account ecosystem functions. The concept of stewardship has gained considerable traction in recent years, yet it is used loosely in the literature of land management and rarely defined. It has the potential to be a valuable concept in modern management philosophies. There is currently a lack of connection between this practical usage and stewardship ethics. Environmental stewardship, as an area of research, has gained prominence relatively recently, emerging only in the past four decades. It is now recognized as a notable confluence of sociocultural norms and ecological sustainability which is crystallized into practice and conservation strategy [20]. There is no doubt that stewardship is a crucial technical term in the sustainability discourse. However, it carries a deeper meaning than many alternatives, such as Management, Governance, Conservation, Sustainability, Care or Guardianship. It is essential that stewardship combines moral responsibility, future orientation, active management, collaboration, and humility [21].

Stewardship provides an operational framework that synthesizes ethical principles through integrated management practices [20]. Unlike traditional resource management focused on extraction and control, stewardship emphasizes care, responsibility, and regeneration [22,23].

Regenerative stewardship extends beyond the traditional sustainability approach of maintaining current conditions by actively improving system capacity. Such stewardship

involves practices that improve soil health, increase water retention, promote biodiversity, and strengthen social cohesion.

Regenerative agriculture broadly encompasses both conservation agriculture and more sustainable agroforestry techniques. These practices increase crop productivity, enhance soil fertility, improve water retention, and create other ecosystem services, resulting in significant economic, mitigation, adaptation, and social benefits [24]. Regenerative Agriculture describes farming and grazing practices that, among other benefits, reverse climate change by rebuilding soil organic matter and restoring degraded soil biodiversity, resulting in both carbon drawdown and improved water cycle. Research continues to reveal the damaging effects on soil from tillage, the application of agricultural chemicals and salt-based fertilizers, and carbon mining. Regenerative agriculture seeks to reverse this paradigm by fostering long-term ecological and agricultural sustainability [25].

Collaborative stewardship is a critical aspect of stewardship capacity and social innovation among individuals and groups [26]. Collaborative partnerships are being used around the world to address complex water problems and integrate diverse government and non-government perspectives. This approach views decision-making as a dialog and negotiation involving stakeholders from government, nonprofit and private sectors, and deliberation with the general public [27].

Adaptive stewardship utilizes learning and adjustment to facilitate the evolution of governance systems. These systems adapt based on experience, changing conditions, and new knowledge. Adaptability is the capacity of actors in a system to influence resilience. In a Social–Ecological System (SES), humans manage resilience. Complex adaptive systems often self-organize without intent. In SESs, individual human actors show intent, but the system as a whole does not, as seen in a market. This approach treats uncertainty as an opportunity for innovation rather than a barrier to action [28].

2. Methods

2.1. Four International Cases Selected

Our study demonstrates how ethical water governance serves as a cornerstone of resilient food systems by examining innovative frameworks from Türkiye's Southeastern Anatolia Project (GAP), China's Yangtze River Basin management, India's watershed development programs, and California's groundwater sustainability initiatives. Türkiye was selected as a case study due to its integration of regional development with a sustainable human development philosophy. China and India, the world's most populous countries, were included to compare differing development contexts: India remains a developing country, while China is relatively advanced.

2.1.1. Türkiye's Southeastern Anatolia Project (GAP): Integrated Regional Development

The Southeastern Anatolia Project represents one of the world's most comprehensive attempts to integrate water resource development with regional socioeconomic transformation while addressing transboundary governance challenges [29]. Initiated in 1977 and encompassing 22 dams, 19 hydroelectric power plants, and irrigation infrastructure for 1.8 million hectares, GAP operates across multiple scales from local villages to international diplomacy [30]. Figure 2 presents the dams constructed as part of Türkiye's Southeastern Anatolia Project (GAP).

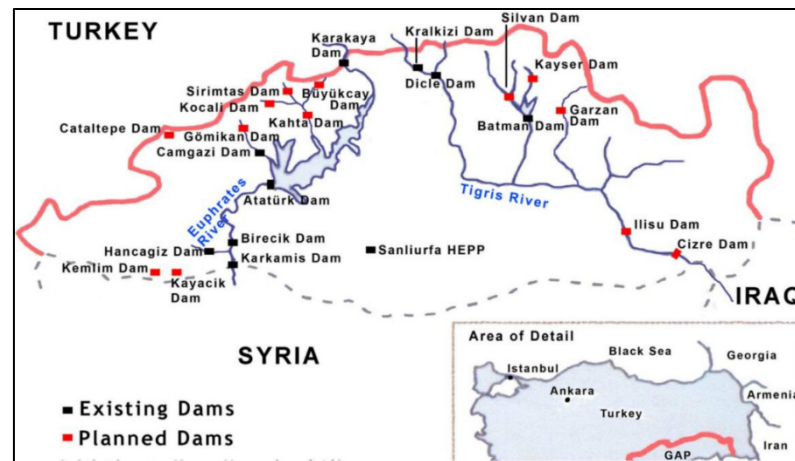


Figure 2. Türkiye's Southeastern Anatolia Project (GAP) region with the existing and planned dams and hydroelectric power plant projects [31].

2.1.2. China's Yangtze River Basin: Ecological Civilization Integration

China's Yangtze River Basin management exemplifies large-scale transformation from economic development focus to "ecological civilization" principles that integrate environmental protection with sustainable development [32]. The 2021 Yangtze River Protection Law requires that the ecosystems of the Yangtze River Basin be managed mainly through natural restoration, but also with combinations of natural restoration and artificial restoration [33]. Our analysis focuses on institutional integration through the Yangtze River Basin Authority, which coordinates previously fragmented provincial governance and unifies ecological standards. Economic instruments such as payment for ecosystem services, large-scale land-use change programs (e.g., "grain-for-green"), and technological measures in agriculture are considered as key governance mechanisms in the IEWG framework.

Figure 3 presents a map of the Yangtze River basin in China, highlighting its major tributaries.

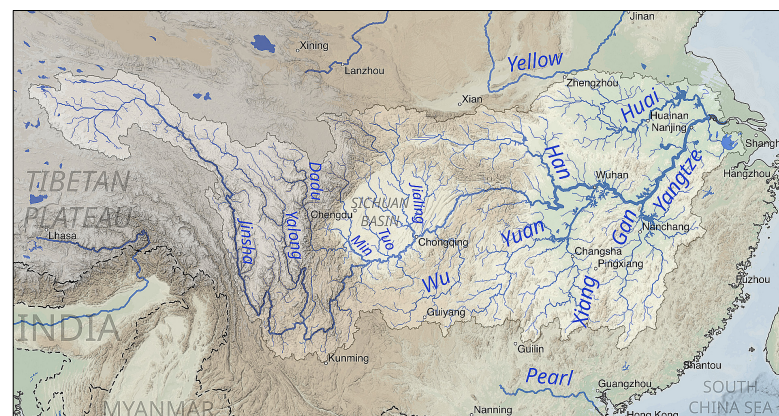


Figure 3. Map of the Yangtze River basin with major tributaries. Data from GTOPO30, HYDRO1k, and Natural Earth (all public domain), adapted from a map by Keenan Pepper, licensed under CC BY-SA 4.0 [34].

2.1.3. India's Watershed Development: Community-Based Stewardship

India's watershed development programs, particularly in semi-arid regions, demonstrate how participatory governance can integrate water conservation, agricultural development, and social equity [35]. Implemented across millions of hectares since the 1990s, these programs combine traditional water harvesting techniques with contemporary development approaches [36]. Figure 4 presents a map illustrating basins (A) and sub-basins (B) in India, adapted from the Central Ground Water Board of India.

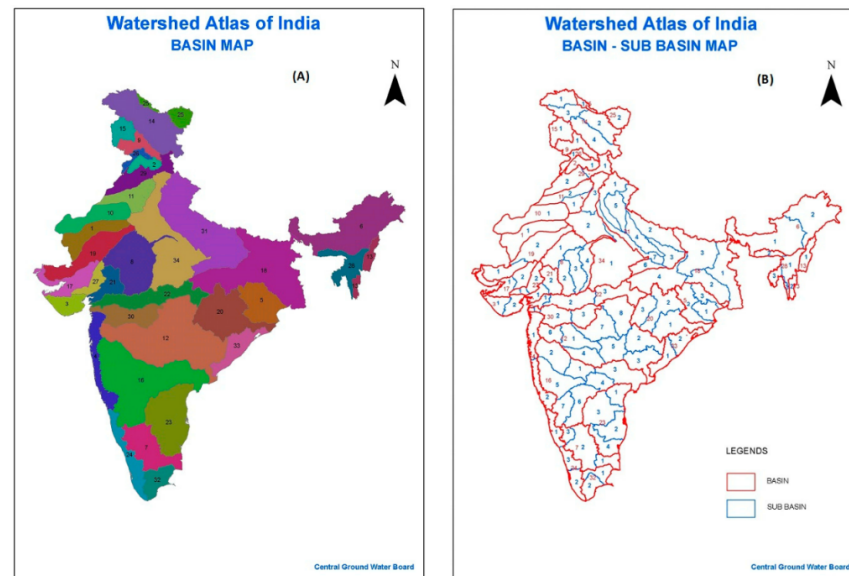


Figure 4. Map of basins (A) and sub-basins (B) in India, adopted from the Central Ground Water Board of India [37].

For IEWG scoring, we emphasize participatory institutions (watershed committees, panchayat-based structures), livelihood diversification, and attention to marginalized groups, including women and lower castes. Technical measures and scaling strategies via farmer-to-farmer learning and policy support are treated as part of the governance framework rather than as engineering results.

2.1.4. California's Groundwater Sustainability: Rights-Based Governance

California's 2014 Sustainable Groundwater Management Act (SGMA) exemplifies how developed economies can transition to ethical governance while addressing historical over-allocation and climate adaptation [38,39]. SGMA represents a fundamental shift from unregulated groundwater pumping to community-based sustainability planning across the state's overdrafted basins [40]. Figure 5 presents a map depicting the locations of Integrated Regional Water Management Plans in California.



Figure 5. Location of Integrated Regional Water Management Plans in California [41].

In our comparative framework, SGMA is evaluated through its participatory planning arrangements, rebalancing of existing water rights with sustainability and environmental protections, and use of monitoring, modeling, and economic instruments such as managed aquifer recharge and water trading. Its adaptive provisions for periodic review and adjustment are treated as indicators of learning-oriented, ethically informed governance.

2.2. Scoring of Four International Cases

Comparative Case Study Selection was used for this study. Türkiye, China, India, and California were selected as representative sites for intermediating water governance in food systems because they each embody significant diversity in water challenges and governance related to food systems. To analyze these contexts, we apply a total of nine evaluation dimensions, which are classified into two main pillars: Ethical Principles and Governance Frameworks. Specifically, Ethical Principles include Justice Integration, Rights-based Integration, Ecological Integrity, and Intergenerational Equity. Meanwhile, Governance Frameworks comprise Stakeholder Participation, Economic Mechanisms, Institutional Innovation, Equity Approach, and Environmental Focus. All cases were scored for the ethical principles and governance frameworks pillars from 1–10. The scoring of 9 dimensions is explained in Appendices B.1–B.8 very detailed giving the referencing.

Dimension scores were determined by systematically extracting evidence from case study literature, assigning sub-scores to individual evidence items according to the criteria in Table 1, and aggregating these sub-scores. For instance, in the case of Rights-Based Integration within GAP, positive evidence, such as irrigation access improvements and women's programs, received sub-scores totaling +5.0, whereas negative evidence, including downstream impacts and displacement issues, totaled −5.0 in Appendix B.1. This resulted in a net score of 0, combined with a baseline of 5, yielding a final score of 5 out of 10. Detailed procedures for evidence extraction, sub-scoring, and calculations for all dimensions and cases are provided in Appendices B.1–B.8, along with source citations.

Each dimension comprises supporting reference sentences, termed elements, which are listed in Appendix B.1 through B8 and indexed by i , $i = 1, \dots, n$, each with a signed contribution S_i .

The element-level scoring procedure is as follows:

$$S_i \in [-5, 5] \text{ for all } i \quad (1)$$

Net score for each element of dimension:

$$S_{net} = \sum_{i=1}^n S_i \in [-5, 5] \text{ for all } i \quad (2)$$

or

$$S_{net} = \sum_{i=1}^n S_i^+ + \sum_{i=1}^n S_i^- \text{ for all } i \quad (3)$$

Neutral baseline:

$$S_b = 5 \quad (4)$$

Preliminary overall score calculated on a 0 to 10 scale:

$$S_o = S_b + S_{net} \quad (5)$$

Truncation rule: lower bound set at 0:

$$\text{If } S_o < 0 \text{ then } S_o = 0 \quad (6)$$

Therefore,

$$S_o \in [0, 10] \text{ represents the final overall score for the dimension} \quad (7)$$

Table 1. Description of the scoring system ranging from −5 to +5 for individual evidence items. Sub-scores were aggregated to generate final dimension scores (see Appendices B.1–B.8 for detailed applications).

Score	Description	Generic Description Applied to Any Dimensions
1	Minimal concern	Almost no explicit or implicit evidence related to the dimension; no relevant mechanisms, practices, or commitments are identifiable.
2	Weak	Dimension is mentioned or implied, but mechanisms are ad hoc, informal, or not clearly assigned; implementation is rare.
3	Moderate	Some formal mechanisms or practices exist and are implemented occasionally; coverage is partial, and monitoring is limited.
4	Strong	Clear mechanisms, responsibilities, and resources are in place and used regularly; some monitoring and feedback are evident.
5	Systematic	Dimension is fully institutionalized, regularly monitored, and adapted based on performance and stakeholder feedback.
−1	Minimal concern	Isolated indications of shortcomings; limited evidence that the dimension is undermined, and no clear pattern of problematic practice.
−2	Noticeable weakness	Repeated indications that mechanisms are poorly designed or inconsistently applied, producing tangible but still localized problems.
−3	Structural deficiency	Systematic gaps or biases in rules and practices; the dimension is regularly compromised and negative impacts are common.
−4	Pervasive violation	The dimension is broadly neglected or overridden; harmful practices are widespread and rarely corrected or sanctioned.
−5	Systemic rights failure	The dimension is fundamentally opposed or denied; harmful practices are institutionalized, persistent, and resistant to reform.

3. Results and Discussion

We have synthesized peer-reviewed literature, analyzed policy documents, reviewed ethical principles, examined governance frameworks for each case, and collected qualitative and quantitative performance data using established indicators. Table 1 provides a detailed description of the scoring system, which ranges from −5 to 5 for each dimension. Table 2 reports scores on a scale of 1 to 10 for the four cases (Türkiye-GAP, China-Yangtze, India-Community Watershed, California-SGMA) across nine dimensions, encompassing four ethical principles and five governance frameworks.

Table 2. Scores (1–10) for the four cases (Türkiye-GAP, China-Yangtze, India-Community Watershed, California-SGMA).

Dimension	Türkiye: GAP	China: Yangtze	India: Watershed	California: SGMA
Rights-Based Integration	5	6	8	7
Justice Integration	6	5	8	7
Intergenerational Equity	6	7	7	9
Ecological Integrity	5	7	7	8
Ethical P. Av. Score	5.5	6.3	7.5	7.8
Stakeholder Participation	4	6	9	7
Environmental Focus	5	7	6	8
Equity Approach	6	5	8	7
Institutional Integration	4	6	6	8
Economic Mechanisms	7	6	5	8
Governance F. Av. Score	5.2	6	6.8	7.6
Overall Average Score	5.3	6.1	7.1	7.7

3.1. Explanation of Scores

Figure 6 displays the ratings of ethical principles on a scale from 1 to 10. Figure 7 illustrates the governance frameworks of four major water management projects using radar spider graphics. Figures 6–8 use blue to represent Türkiye, red for China, green for India, and yellow for California. In order to identify patterns, strengths, and weaknesses in governance models, we analyzed cross-case comparison results, radar visualization, and qualitative synthesis.

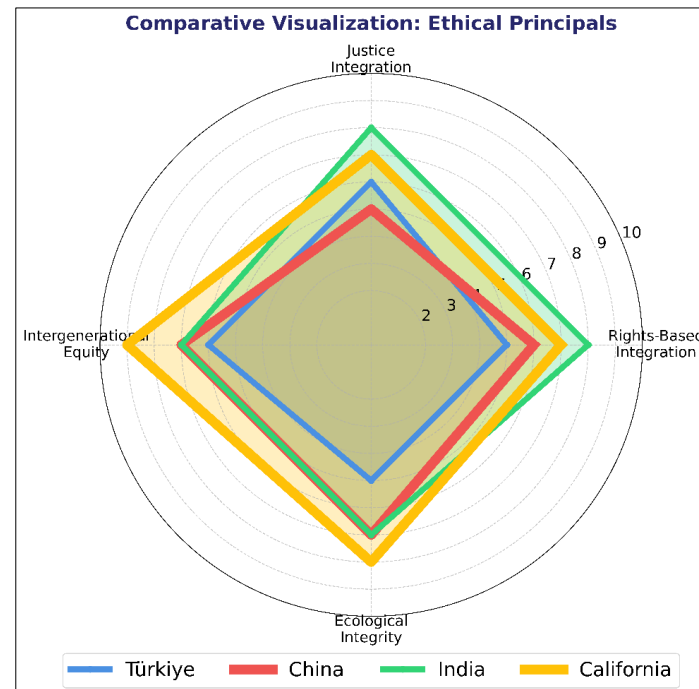


Figure 6. Comparative Visualization of Ethical Principles.

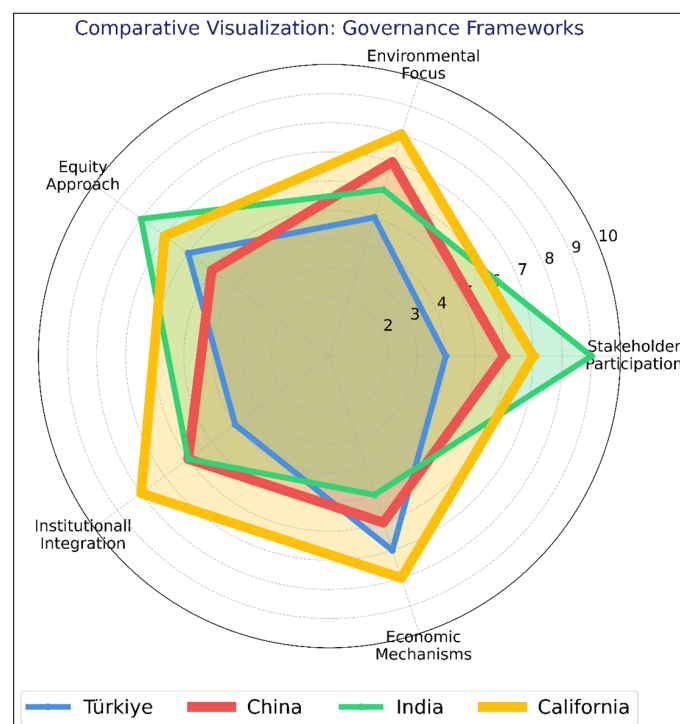


Figure 7. Comparative Visualization Governance Frameworks.

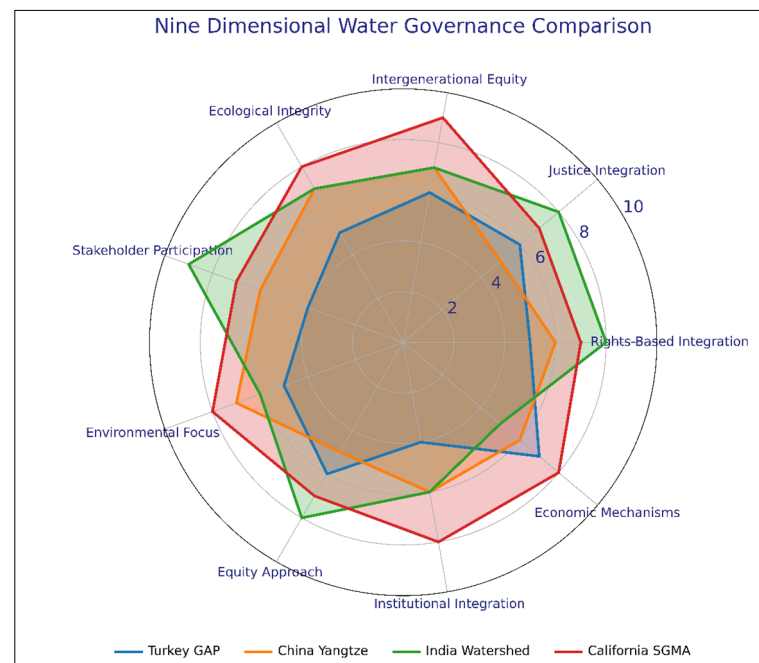


Figure 8. Comparative Visualization of all dimensions of Integrative Water Management.

Explanations for all scores are provided in Appendices B.1–B.8.

- Türkiye GAP scores moderate on rights and justice integration with a strong economic approach due to infrastructure focus but lower on participation and institutional integration reflecting its centralized model.
- China Yangtze emphasizes basin-wide ecological and environmental outcomes but weak local justice and participation due to limited local power.
- India Watershed excels in community participation, justice, and equity due to its grassroots, inclusive governance, but scores lower on economic mechanisms and institutional integration.
- California SGMA rates high on intergenerational equity, ecological protection, enforcement, economic mechanisms via regulation, and decent participation through GSAs.

According to Figure 6, ethical dimensions: India (8) and California (7) are the strongest in rights-based approaches. Justice integration is most advanced in India (8), with participation from all genders and segments. California (9) leads in intergenerational equity, trailed by India (7) and China (7). California (8); and India (7) and China (7) have top the ecological integrity dimension and Türkiye (5) receives the lowest mark.

Analysis of Figure 6 indicates that California and India exhibit stronger ethical integration, particularly regarding intergenerational equity and rights-based approaches. In contrast, Turkey and China display less developed ethical frameworks, with Turkey demonstrating notable weaknesses in ecological integrity considerations.

The comparative assessment presented in Figure 7 demonstrates that California leads in institutional integration and environmental focus, reflecting a mature governance structure. India demonstrates strengths in stakeholder participation and equity approaches. Turkey exhibits the most uneven profile, with notable deficiencies in environmental focus. In contrast, China displays a moderate yet balanced performance.

The results of Figure 7 may be briefly analyzed as follows: If we consider Governance Dimensions: Stakeholder participation is highest in India (9) and followed by California (7). For the equity approach, India (8) and California (7) receive the highest scores. The highest score in institutional integration belongs to California (8). Türkiye (7) closely follows California (8) in economic mechanisms. This concludes the analysis of governance dimensions.

Overall, California SGMA shows a balanced approach with strong sustainability and enforcement mechanisms, India emphasizes social equity and participation, China prioritizes ecological governance but struggles locally, and Türkiye is focused on large infrastructure and economic growth with moderate social integration.

California's institutional and environmental strength (Figure 7) translates into sustained high performance across those same dimensions in Figure 8. India's participatory excellence maintains its prominence in both visualizations. Turkey's governance gaps in Figure 7 compound with ethical principle weaknesses, resulting in the lowest overall profile in Figure 8. China's moderate balance in governance frameworks (Figure 7) remains consistent in the integrated model (Figure 8).

Figure 7 demonstrates that effective water governance requires simultaneous integration of ethical principles and operational frameworks.

The comparative analysis reveals fundamental trade-offs between technocratic efficiency (California), participatory equity (India), centralized environmental management (China), and development-oriented approaches (Turkey), each reflecting distinct political economies and cultural contexts of water governance. It can be deduced that high centralization (China, Turkey) correlates with lower stakeholder participation, community-based models (India) show participation strengths but institutional coordination weaknesses and finally hybrid models (California) achieve more balanced coverage but may face coordination complexity.

3.2. Strengths of Method and Comparison Approach

The visualization indicates that no single governance model is dominant across all dimensions. Each country displays distinct strengths that correspond to its particular context and priorities.

The evidence-based scoring approach utilized in this study presents several methodological advantages for comparative water governance assessment. In contrast to qualitative frameworks that rely on narrative synthesis, the systematic extraction and scoring of individual evidence items (as documented in Appendices B.1–B.8) facilitate transparent cross-case comparison and ensure traceability to source literature.

The bidirectional scoring scale, ranging from -5 to $+5$ for sub-scores, clearly differentiates between governance strengths and active violations or systematic failures, offering a more nuanced assessment than unidirectional or binary methods. Grounding sub-scores in specific documented evidence with clear citations, rather than holistic impressions, reduces evaluator subjectivity, although it does not eliminate it entirely. Further validation through inter-rater reliability testing and field research would enhance confidence in the scores' precision. Nevertheless, the current approach establishes a rigorous foundation for exploratory comparative analysis and for generating hypotheses regarding governance priorities and reform pathways.

3.3. Further Research Needs

Future research should prioritize climate adaptation strategies, transboundary cooperation mechanisms, the impacts of urbanization, and approaches to cultural integration.

3.3.1. Climate Adaptation

Understanding how governance systems can adapt to changing precipitation patterns, extreme weather events, and shifting agricultural zones while maintaining equity and sustainability requires continued research [42].

Climate change introduces unprecedented uncertainty that governance systems must accommodate [43].

3.3.2. Transboundary Cooperation

Developing frameworks for ethical water sharing across national boundaries remains critical, particularly in regions with historical conflicts. Benefit-sharing approaches offer promise but require further refinement [42].

3.3.3. Urbanization Impacts

It was suggested that urbanization should not be examined and framed solely as a problem or as a solution. It is dangerous for policymakers to consider urbanization solely as a problem, since it is an unavoidable part of economic development. A more useful way to think about global urbanization is as posing a series of socialenvironmental challenges that must be overcome to achieve sustainability [44,45].

3.3.4. Cultural Integration

Effective cultural integration necessitates examining how diverse religious and cultural traditions influence contemporary water governance. Additionally, a comprehensive analysis is required to ensure respect for pluralism and human rights [46,47].

3.4. Methodological Limitations

This study has several limitations. First, all scoring was conducted by a single researcher, which may introduce subjective bias despite the use of explicit criteria (Table 1) and transparent documentation (Appendices B.1–B.8). Future research should assess inter-rater reliability by involving multiple independent evaluators.

Secondly, a key limitation of linear aggregation is the assumption that positive and negative governance attributes can always offset each other equally. In practice, severe violations (e.g., -4 or -5) may outweigh moderate strengths ($+2$ or $+3$). Applying non-linear weighting rules or thresholds could introduce greater nuance in future applications.

A third limitation is that these scores are based exclusively on secondary literature, without field validation or stakeholder verification. This reliance limits the ability to identify implementation gaps or recent reforms. Incorporating primary data would enhance the robustness of future analyses.

Finally, the evidence sources offer a cross-sectional synthesis rather than a consistent temporal snapshot.

These limitations indicate that the scores should be interpreted as estimates rather than precise measurements. Nevertheless, the framework provides a systematic comparative structure, identifies governance priorities, and supplies documentation to facilitate independent verification.

4. Conclusions

Effective water governance underpins the future of sustainable food systems. A robust analysis of existing legal and social contexts enables governance models that ensure citizen participation and freedom of expression through legislative protections. Regulatory frameworks must rigorously protect natural resources and ecosystems, referencing clear standards such as environmental protection acts, waste management, and air quality rules. Systematic integration of diverse stakeholder perspectives in decision-making allows participants to directly influence and observe tangible results.

Developing the capacity to enhance knowledge, skills, and access to resources is essential for effective governance. Equitable economic systems should promote sustainable practices and safeguard vulnerable populations. Adaptive governance, incorporating systematic monitoring and feedback, enables organizations to respond effectively to change.

Institutions should implement robust regulations and transparent structures to ensure justice, equity, and balanced power, rather than depending on ambiguous commitments.

The transition from scarcity-driven water management to integrative ethical stewardship represents both an opportunity and a necessity for the development of future food systems. This transformation is achievable in various contexts through the deliberate integration of ethical principles into governance structures. It necessitates institutional innovations that bridge multiple scales and sectors, economic mechanisms consistent with stewardship values, technology integrated within participatory processes, and cultural change that recognizes the intrinsic value of water.

This study develops and applies a systematic framework for assessing ethical water governance through ten integrated dimensions spanning institutional, economic, environmental, and ethical principles. The evidence-based scoring methodology, fully documented with source citations and calculation procedures in Appendices B.1–B.8, enables transparent cross-case comparison while maintaining traceability to original literature. Application to four major case studies—GAP (Turkey), Yangtze River Basin (China), participatory watershed programs (India), and SGMA (California)—demonstrates the framework’s capacity to identify both common governance challenges and context-specific priorities. Across cases, dimensions related to stakeholder participation, transparency, and rights-based integration consistently scored lower than technical or institutional dimensions, suggesting systematic gaps in democratic and ethical governance components relative to operational water management capacity.

While the framework acknowledges methodological limitations including single-evaluator scoring, linear aggregation assumptions, and reliance on secondary literature, it provides a rigorous and replicable foundation for comparative governance assessment. The detailed documentation enables independent verification of scoring decisions and adaptation to alternative analytical approaches or additional case studies. By systematically linking governance mechanisms to ethical principles, this framework can inform evidence-based policy reforms, guide stakeholder engagement strategies, and support the development of more equitable and sustainable water management systems. Future research should focus on inter-rater reliability testing, field validation with primary data collection, and longitudinal assessment to capture governance dynamics over time.

In conclusion, the establishment of future food systems through integrative ethical water governance (IEWG) signifies a substantial shift in society’s relationship with natural resources. This shift underscores the interdependence of water and food security, equity, environmental stewardship, and public participation. The strategies outlined offer a foundational framework and emphasize the importance of local adaptation. Stakeholders are advised to apply these approaches within their respective contexts to achieve substantial progress.

Author Contributions: Conceptualization, D.O. and S.U.S.; Methodology, D.O.; Software, D.O.; Validation, D.O.; Formal analysis, D.O.; Investigation, D.O.; Resources, D.O.; Data curation, D.O.; Writing—original draft, D.O.; Writing—review & editing, D.O. and S.U.S.; Visualization, D.O.; Supervision, S.U.S.; Project administration, D.O. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author.

Acknowledgments: The authors thank the various governmental organizations, community groups, and research institutions in Türkiye, China, India, and California for sharing their experiences and insights that informed this comparative analysis. We are grateful to anonymous reviewers for their constructive feedback that strengthened this manuscript.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Comparative Analysis of Governance Frameworks

Dimension	Türkiye (GAP)	China (Yangtze)	India (Watersheds)	California (SGMA)
Scale	Regional (9 provinces)	River basin (11 provinces)	Local watersheds	State-wide basins
Institutional Model	Centralized with local participation	Federal coordination	Community-based	Local GSAs with state oversight
Primary Challenge	Development + transboundary	Economic-ecological balance	Poverty + water scarcity	Over-allocation + climate
Participation Level	Moderate (improving)	Limited (top-down)	High (community-led)	High (stakeholder-driven)
Economic Mechanism	Public investment	PES transfers	Livelihood programs	Water markets + recharge
Environmental Focus	Evolving integration	Ecological civilization	Traditional + modern	Ecosystem protection
Equity Approach	Regional development	Inter-provincial transfers	Caste/gender inclusion	Disadvantaged communities
Time Frame	1977-ongoing	2021-ongoing	1990s-ongoing	2014-ongoing
Key Innovation	Multi-sectoral integration	Payment for services	Participatory planning	Rights-based sustainability

Appendix B.

Appendix B.1. Overall GAP Assessment Summary Ethical Principles

Dimension	S_o (1–10)	Description of Referenced Element	S_{net} (−5 to +5)
Rights-Based Integration	5/10	Regional development targets historically marginalized poorest population's economic rights [48]	+3.5
		Water access improved for 9 provinces through irrigation infrastructure [48]	+2.5
		GAP-GIDEM Developing women's entrepreneurship and supporting micro-enterprises [49]	+2.0
		Water treated as a development source not a fundamental right [50]	−3.5
		Flow reductions violate downstream populations (Syria/Iraq) [50]	−2.5
		Displaced populations inadequately compensated; rights to livelihood and culture insufficiently protected [51]	−2
		Total Net Score = +5 + (−5) = 0 Baseline = 5 Score = 0 + 5 = 5	5
Justice Integration	6/10	Regional resource allocation addresses spatial inequality [49]	+2.5
		Water user associations provide some operational voice [49]	+2.5
		GAP-GIDEM recognizes women's knowledge and contributions [49]	+1.5
		Benefits concentrate among large landowners without redistribution mechanisms [51]	−2.5
		Top-down project design excludes affected communities from major decisions [29]	−2
		Some local identities not explicitly recognized; and project historically viewed as assimilation of some local culture [52]	−1
		Total Net Score = +6.5 + (−5.5) = +1 Baseline = 5 Score = +1 + 5 = 6	6
Intergenerational Equity	6/10	Infrastructure designed for long-term water storage [48]	3
		Renewable hydroelectric energy benefits future generations [53]	2
		Education and health investments for the future generations [53]	1.5
		Downstream flow reduction imposes enduring hydrological deficits on future generations in Syria/Iraq [50]	−3
		Soil salinization risks from lack of drainage threaten long-term productivity [54]	−2
		Climate adaptation planning inadequate; vulnerability to reduced Euphrates flow [42].	−1.5
		Total Net Score = +7 + (−6) = +1 Baseline = 5 Score = +1 + 5 = 6	6

Dimension	S_o (1–10)	Description of Referenced Element	S_{net} (−5 to +5)
Ecological Integrity	5/10	Modern irrigation more efficient than traditional; water savings potential [48]	3
		Environmental Impact Assessments (EIAs) required since 1990s; monitoring systems established [30]	3
		Large reservoir creation flooded ecosystems irreversibly [48]	−3
		Need to prepare new plans for the environmental issues [55]	−2
		Extinctions of some species such as the Euphrates softshell turtle (<i>Rafetus euphraticus</i>) [56]	−1
		Total Net Score = +6 + (−6) = 0 Baseline = 5 Score = 0 + 5 = 5	5

Appendix B.2. Overall GAP Assessment Summary Governance Frameworks

Dimension	S_o (1–10)	Description of Referenced Element	S_{net} (−5 to +5)
Stakeholder Participation	4/10	Functional water user associations with operational responsibilities [29]	4
		GAP-GIDEM program enhanced women's participation [57]	3
		Top-down legacy and top-down project design; communities consult but don't decide major policies [58]	−4
		Transboundary stakeholders (Syria, Iraq) completely excluded despite severe impacts [50]	−2.5
		Elite capture at local levels; large landowners dominate associations [59]	−1.5
		Total Net Score = +7 + (−8) = −1 Baseline = 5 Score = −1 + 5 = 4	4
Environmental Focus	5/10	Environmental Impact Assessments (EIA) mandatory since 1990s; monitoring systems established [60]	3.5
		Modern, more efficient irrigation, Renewable hydroelectric energy (27 billion kWh/year) [48]	2.5
		Euphrates flow reduced ~40% at Syrian border; Mesopotamian marshes degradation [58]	1.5
		Large reservoirs (817 km ²) flooded ecosystems irreversibly and 60,000 displaced [48]	−3.5
		No environmental flow allocations; enforcement gaps [50]	−2.5
		Soil salinization risks emerge from inadequate drainage [54]	−1.5
Equity Approach	6/10	Total Net Score = +7.5 + (−7.5) = −0 Baseline = 5 Score = 0 + 5 = 5	5
		In historically poorest region, perceptions of individuals consistently suggest that the GAP irrigation projects have brought about positive changes [61]	3
		GAP-GIDEM dedicated gender program, female literacy and economic participation increased [57]	2.5
		Poverty reduction documented; infrastructure gap narrowed [53]	1.5
		Education and health programs address social equity [42]	1
		Disproportionately allocated irrigated land, unequal distribution of land causes the unequal distribution of income [62]	−3
Institutional Integration	4/10	income	−2
		Displaced populations inadequately compensated; resettlement failures [51]	−2
		Limited procedural equity; some local communities marginalized in decision-making [52]	−1
		There are limited benefits available to landless laborers beyond temporary employment [62]	−1
		Total Net Score = +8 + (−7) = +1 Baseline = 5 Score = +1 + 5 = 6	6
		GAP Regional Development Administration (GAP-RDA) coordinates across 9 provinces and multiple ministries [30]	3
Economic Mechanisms	7/10	Strong water–energy–agriculture sectoral integration; dams serve dual purposes [48]	3
		The GAP Master Plan sets the development goals [55]	1
		Weak transboundary coordination; Joint Technical Committees ineffective [50]	−3
		Implementation authority dispersed across ministries; coordination gaps [54,55]	−3
		Limited horizontal coordination, institutional overlap [54]	−2
		Total Net Score = +7 + (−8) = −1 Baseline = 5 Score = (−1) + 5 = 4	4
Economic Mechanisms	7/10	Substantial public investment (~\$32 billion) [63]	4
		Comprehensive development incentives (tax exemptions, subsidized inputs, preferential credit) [52]	2
		Demonstrated economic impacts: GDP growth above national average; positive impact on employment; Rates of poverty in the region have decreased considerably [53]	2
		Hydroelectric revenue generation component [48]	2
		Irrigation water pricing heavily subsidized [64]	−3
		No market mechanisms; administered allocation creates inefficiencies [65]	−3
Economic Mechanisms	7/10	Economic sustainability concerns because of subsidy dependence [65]	−2
		Total Net Score = +10 + (−8) = +2 Baseline = 5 Score = +2 + 5 = 7	7

Appendix B.3. Overall China Yangtze River Basin Assessment Summary Ethical Principles

Dimension	S_o (1–10)	Description of Referenced Element	S_{net} (−5 to +5)
Rights-Based Integration	6/10	Yangtze Protection Law establishes environmental flow rights as legal entitlements [66]	3
		Ecological civilization framework elevates environmental protection to constitutional principle [67]	2
		Payment for ecosystem services recognizes upstream communities' rights to compensation [68]	1.5
		Limited recognition of community rights to participate in decisions affecting their resources [69]	−3
		Resettlement violated rights to land and culture despite compensation [70].	−2.5
		Total Net Score = +6.5 + (−5.5) = +1 Baseline = 5 Score = +1 + 5 = 6	6
Justice Integration	5/10	Inter-provincial PES transfers redistribute wealth from coastal to upstream regions [71]	3
		Scientific expertise highly valued; technical knowledge integrated comprehensively [72]	1.5
		Provincial governments negotiate PES agreements with some autonomy [68]	1
		Grassroots communities excluded from meaningful participation in planning [69]	−2
		Urbanization has often been accompanied by population growth and a resulting increase in human activities, lead to the deterioration of water quality [73]	−2
		Traditional ecological knowledge undervalued; more exploration is needed to integrate international experiences with local practices in China [74].	−1.5
Intergenerational Equity	7/10	Total Net Score = + 5.5 + (−5.5) = 0 Baseline = 5 Score = 0 + 5 = 5	5
		Intergenerational responsibility is explicitly emphasized in future oriented ecological civilization [75]	4
		Ecological restoration for sustainable development for natural capital of future [76]	3
		Long-term planning horizons (to 2050) institutionalize future thinking [77]	1.5
		In 2021, China launched a 10-year fishing ban in the Yangtze River Basin to restore depleted fish stocks [78]	1
		Historical Three Gorges Dam impacts on sediment transport and fisheries create permanent deficits [79]	−4
Ecological Integrity	7/10	Households with lower incomes receive no additional benefits from PES [80].	−3.5
		Total Net Score = +9.5 + (−7.5) = +2 Baseline = 5 Score = +2 + 5 = 7	7
		Ecosystem health is prioritized over economic development by the Protection Law—a paradigm shift [66]	5
		Protecting species, improving the living environment, and maintaining ecological balance [76]	4
		Dams construction caused irreversible ecosystem alterations [81]	−4
		Implementation gaps between policy ambitions and local enforcement [82]	−3
Environmental Focus	7/10	Total Net Score = +9 + (−7) = +2 Baseline = 5 Score = +2 + 5 = 7	7

Appendix B.4. Overall China Yangtze River Basin Assessment Summary Governance Frameworks

Dimension	S_o (1–10)	Description of Referenced Element	S_{net} (−5 to +5)
Stakeholder Participation	6/10	Effective inter-provincial coordination platforms; technical working groups function well [69]	4
		Provincial governments negotiate PES agreements with some autonomy [83]	3
		Grassroots communities may be excluded from decision-making [84]	−3
		Grain-for-Green (GGP) reduced rural household's net income and livelihood diversity [84]	−2
		The GGP was oriented to ecological goal and hindered farmers' access to land resources [84]	−1
		Total Net Score = +7 + (−6) = +1 Baseline = 5 Score = +1 + 5 = 6	6
Environmental Focus	7/10	Yangtze Protection Law prioritizes ecosystem over development [66]	5
		Comprehensive protection law, massive restoration [84]	3
		Grain-for-green program: converting 14.63 million ha of farmland on slopes of 15–25° or greater; revegetating 17.33 million ha of sparsely vegetated land by 2010 [84]	2
		Environmental flows legally mandated; The 10-year fishing ban in the Yangtze River Basin, launched in 2021 to restore depleted fish stocks [78]	2
		Advanced monitoring: remote sensing, big data, real-time tracking [85]	1
		Three Gorges Dam caused 1.13 million displaced, sediment/fish migration altered [79]	−4
		The forced resettlement of impacted populations, threats to endangered species and fragile regional ecosystems, sediment flow rates, and the development of dangerous algae blooms [70]	−4
		Implementation gaps between central policy and local governance [82].	−3
Environmental Focus	7/10	Total Net Score = +13 + (−11) = +2 Baseline = 5 Score = +2 + 5 = 7	7

Dimension	S_o (1–10)	Description of Referenced Element	S_{net} (−5 to +5)
Equity Approach	5/10	Inter-provincial transfers, poverty focus but limited procedural equity, Poverty alleviation explicitly integrated into ecological restoration programs [66]	4
		Limited procedural equity; communities excluded from major decisions, Urban populations benefit disproportionately from water quality [73]	3
		Need to develop a stronger eco-compensation system to maintain living standards [77],	−4
		Households with lower incomes receive no additional benefits from PES [80].	−3
		Total Net Score = + 7 + (−7) = 0 Baseline = 5 Score = 0 + 5 = 5	5
Institutional Integration	6/10	Yangtze River Basin Authority with legal supremacy over provincial regulations, unprecedented coordination power [66]	4
		Strong vertical accountability: China’s River Chief System (RCS) encourages cross-border cooperation; enhanced accountability mechanisms through collaborative water governance [86]	3
		Long-term planning horizons (to 2035 and 2050) with 5-year implementation cycles [77]	1
		Bureaucratic complexity slows some implementation despite strong coordination [87]	−4
		Local governments sometimes prioritize growth over environment despite central directives [87]	−3
		Total Net Score = + 8 + (−7) = +1 Baseline = 5 Score = +1 + 5 = 6	6
Economic Mechanisms	6/10	Innovative PES: downstream provinces pay upstream for conservation; billions transferred [88]	4
		Innovative PES, multi-level investment but subsidy sustainability, Multi-level public investment; central–provincial–local cost-sharing [89]	2.5
		Emerging green finance: environmental rights trading, green credit programs [90]	1.5
		Ecological compensation addresses inter-regional equity [71]	1
		After subsidies expire, the sustainability of the PES is uncertain, it depends on government commitment [91]	−4
		Market mechanisms nascent and incomplete; price signals distorted by intervention [87]	−4
		Total Net Score = + 9 + (−8) = +1 Baseline = 5 Score = +1 + 5 = 6	6

Appendix B.5. Overall India’s Watershed Programs Assessment Summary Ethical Principles

Dimension	S_o (1–10)	Description of Referenced Element	S_{net} (−5 to +5)
Rights-Based Integration	8/10	Community resource rights let communities manage shared property in program design [92]	4
		Women’s property rights strengthened through joint ownership of water structures [93]	3.5
		Scheduled Caste/Tribe rights explicitly protected through mandatory representation [94]	2.5
		Project efforts built consensus on local priorities, “democratizing” resource access and ensuring equitable benefit sharing [95]	2
		Landless populations’ rights limited; major benefits accrue to landowners [96]	−4
		No explicit human right to water framework; programs focus on resource management rather than rights entitlements [97]	−3
		Women’s knowledge often marginalized despite formal inclusion [93].	−2
		Total Net Score = +12 + (−9) = +3 Baseline = 5 Score = +3 + 5 = 8	8
Justice Integration	8/10	Mandatory inclusion of marginalized castes addresses historical discrimination [93]	4
		Common property benefits (grazing, fuel wood) accrue to landless and poor [98]	4
		Community-led planning with genuine decision-making authority; PRA methods ensure voice [97]	1
		Traditional water harvesting knowledge explicitly valued and integrated with scientific approaches [99]	1
		Irrigation benefits concentrate among landowners despite broader livelihood programs [92]	−4
		Women’s knowledge often marginalized despite formal inclusion [93].	−3
		Total Net Score = +10 + (−7) = +3, Baseline = 5, Score = +3 + 5 = 8	8
Intergenerational Equity	7/10	Soil and water conservation explicitly frames decisions around sustaining resources for future generations [95]	4
		Groundwater recharge builds long-term water security rather than mining resources [100]	3
		Agroforestry systems can significantly contribute to improving livelihoods and economic resilience [101]	2
		Community institutions designed for long-term resource stewardship beyond project period [92]	1
		Post-project sustainability uncertain; dependence on external support risks collapse [36]	−4
		Climate adaptation planning limited; vulnerability to changing rainfall patterns [102].	−4
		Total Net Score = +10 + (−8) = +2, Baseline = 5, Score = +2 + 5 = 7	7

Dimension	S_o (1–10)	Description of Referenced Element	S_{net} (−5 to +5)
Ecological Integrity	7/10	Traditional ecological knowledge integrated with scientific approaches; holistic watershed thinking [99]	4
		Ridge-to-valley treatment respects hydrological processes; works with nature [95]	4
		Documented environmental improvements: groundwater recharge (2–6 m), reduced erosion (50–90%), vegetation recovery [100]	2.5
		Biodiversity enhancement through native plantings and grazing management [98];	2
		Upstream interventions, particularly those related to rainwater harvesting (RWH) and watershed management, can sometimes reduce downstream flows; This is a critical consideration in water resource management, especially in regions facing water scarcity [103]	−3.5
		Agricultural intensification increases chemical inputs; pollution concerns [95].	−3
		Total Net Score = +8.5 + (−6.5) = +2, Baseline = 5, Score = +2 + 5 = 7	7

*Appendix B.6. Overall India's Watershed Programs Assessment Summary
Governance Frameworks*

Dimension	S_o (1–10)	Description of Referenced Element	S_{net} (−5 to +5)
Stakeholder Participation	9/10	Community-led governance; watershed committees have genuine decision-making authority [97]	4
		Mandatory inclusion: reserved positions for Scheduled Castes/Tribes, women, landless [93]	3
		PRA (Participatory Rural Appraisal) methods ensure local involvement in planning [104]	2
		Women's self-help groups provide dedicated platforms for female participation [105]	1
		Extensive capacity building: training in planning, finance, conflict resolution [98]	1
		Elite capture persists; dominant castes/landowners marginalize vulnerable groups despite formal inclusion [94]	−4
		Sustaining participation difficult after external support ends [36]	−3
Environmental Focus	6/10	Total Net Score = +11 + (−7) = +4, Baseline = 5, Score = +4 + 5 = 9	9
		Traditional water harvesting integrated with modern techniques; respects indigenous knowledge [99]	2.5
		Documented groundwater recharge (2–6 m rises), erosion reduction (50–90%), vegetation recovery [100]	2
		Ridge-to-valley treatment respects hydrological processes; soil–water conservation [95],	2
		Biodiversity enhancement through native plantings, grazing management [98]	1
		Climate resilience: multiple water sources, improved retention reduce drought vulnerability [102]	1
		Downstream impacts inadequately considered; upstream interventions sometimes reduce downstream flows [103]	−4
Equity Approach	8/10	Chemical inputs increase with agricultural intensification; pollution is a concern [94].	−3.5
		Total Net Score = +8.5 + (−7.5) = +1, Baseline = 5, Score = +1 + 5 = 6	6
		Mandatory caste/class/gender representation addresses India's entrenched hierarchies [93]	4
		Women's SHGs create economic empowerment; joint ownership strengthens women's rights [105]	3.5
		Landless provisions: employment, common property access, non-land livelihoods [96]	2.5
		Small/marginal farmers prioritized; poverty targeting in poorest regions [95]	2.5
		Documented poverty reduction (20–40% rate declines); improved food security [100]	1.5
Institutional Integration	6/10	Elite capture; dominant castes control committees despite formal inclusion [94]	−4
		Irrigation benefits concentrate among landowners; distributional gaps persist [92]	−4
		Cultural barriers limit women's participation despite formal mechanisms [93].	−3
		Total Net Score = +14 + (−11) = +3, Baseline = 5, Score = +3 + 5 = 8	8
		Panchayats, three-tier structure, provides democratic decentralization [106]	3
		NGOs serve as effective intermediaries; provide technical support and flexibility [36]	2
		Hybrid government–community institutions combine resources with local ownership [97]	1.5
		Farmer-to-farmer networks facilitate horizontal scaling [98]	1.5
		Policy integration across states enables replication with local adaptation [92]	1
		Limited sectoral integration; agriculture, forestry, water departments often siloed [96],	−3.5
		Program fragmentation creates coordination challenges [94]	−2.5
		Weak basin-scale coordination; individual watersheds lack larger hydrological coherence [103]	−2
		Total Net Score = +9 + (−8) = +1, Baseline = 5, Score = +1 + 5 = 6	6

Dimension	S_o (1–10)	Description of Referenced Element	S_{net} (−5 to +5)
Economic Mechanisms	5/10	Livelihood diversification: livestock, horticulture, microenterprises address multiple poverty dimensions [95]	2.5
		Documented income increases; employment generation [100]	2.5
		Microfinance linkages through women's SHGs; reduced exploitative lending [93]	2
		The government and NGOs provide the majority of funding, with a small portion of the contribution coming from local communities [35]	1.5
		Market connections improved; collective marketing reduces intermediary exploitation [92]	1
		Limited cost-recovery mechanisms; sustainability uncertain after project funding ends [96]	−3.5
		There is a concentration of benefits among landowners; landless people receive fewer benefits beyond employment [94]	−3
		No payment for ecosystem services; downstream beneficiaries don't contribute [92].	−3
		Total Net Score = +9.5 + (−9.5) = 0, Baseline = 5, Score = 0 + 5 = 5	5

Appendix B.7. Overall California SGMA Assessment Summary Ethical Principles

Dimension	S_o (1–10)	Description of Referenced Element	S_{net} (−5 to +5)
Rights-Based Integration	7/10	Human right to water explicitly recognized in California law [107]	3.5
		SGMA must protect domestic wells [108]	2.5
		Environmental flow rights legally protected; interconnected surface water protections [39]	1.5
		Disadvantaged community rights to participation and protection legally mandated [109]	1
		Property rights balanced with sustainability requirements; public trust doctrine applied [38]	0.5
		Agricultural pumping rights only gradually restricted; existing users protected [40]	−4
		Implementation timeline (20 years) delays rights realization [110]	−3
		Total Net Score = +9 + (−7) = +2, Baseline = 5, Score = +2 + 5 = 7	
Justice Integration	7/10	Disadvantaged community protections ensure equitable access to water resources [109]	3
		Domestic well mitigation programs address distributional impacts [108]	2
		Legal mandates for inclusive participation; public notice, comment, hearings required [38]	1.5
		Technical assistance and facilitation for disadvantaged communities [109]	1
		Scientific knowledge and local experience both valued in plan development [111];	1
		Large agricultural operations maintain disproportionate influence; small farmers burdened [112]	−3.5
		Indigenous water knowledge underrepresented despite tribal presence [38]	−3
Intergenerational Equity	9/10	Total Net Score = +8.5 + (−6.5) = +2, Baseline = 5, Score = +2 + 5 = 7	
		Sustainability as explicit legal mandate; must achieve sustainability within 20 years [38]	5
		Comprehensive monitoring ensures accountability to future generations [111]	3
		Climate adaptation required; plans must account for future conditions [113]	2
		Adaptive management provisions enable adjustment as knowledge evolves [38],	1.5
		Managed aquifer recharge invests in future storage capacity [110]	1.5
		Interim period (2015–2040) allows continued overdraft; costs imposed on future [40]	−5
		Insufficient funding for long-term monitoring and implementation [109]	−4
Ecological Integrity	8/10	Total Net Score = +13 + (−9) = +4, Baseline = 5, Score = +4 + 5 = 9	9
		Ecosystems recognized as legitimate water users; interconnected surface water protections [39]	4
		Six sustainability indicators include ecosystem metrics (GDEs, surface water depletion) [38]	3
		Comprehensive monitoring of groundwater-dependent ecosystems required [111]	1
		Environmental flow allocations legally mandated before extractive uses [39]	1
		Climate-ecosystem interactions explicitly considered in planning [113]	1
		Variable environmental protection across GSAs; some minimum thresholds insufficient [108]	−4
		Implementation capacity constraints may compromise ecosystem outcomes [110]	−3
		Total Net Score = +10 + (−7) = +3, Baseline = 5, Score = +3 + 5 = 8	8

Appendix B.8. Overall California SGMA Assessment Summary Governance Frameworks

Dimension	S_o (1–10)	Description of Referenced Element	S_{net} (−5 to +5)
Stakeholder Participation	7/10	Legal mandates for inclusive participation; public notice, comment, hearings required [38]	3
		Diverse representation requirements: agricultural, municipal, industrial, environmental, disadvantaged communities [108]	2
		Disadvantaged community (DAC) provisions: facilitation funding, technical assistance, translation [109]	1.5
		Transparency requirements: public data portals, annual reports, 5-year assessments [111]	1.5
		Collaborative GSP development through multi-stakeholder negotiation [110]	1
		Technical complexity creates barriers for non-expert stakeholders despite capacity-building [38]	−4
		Power imbalances: well-resourced agricultural/municipal interests dominate [40].	−3
		Total Net Score = +9 + (−7) = +2, Baseline = 5, Score = +2 + 5 = 7	7
Environmental Focus	8/10	Six sustainability indicators include ecosystem metrics; comprehensive framework [38]	4
		Ecosystems recognized as legitimate water users; interconnected surface water protections [39]	3
		Environmental flows legally mandated before extractive uses [108]	2.5
		Comprehensive monitoring of groundwater-dependent ecosystems required [111]	1.5
		Climate adaptation mandatory; plans must incorporate changing conditions [113]	1
		Variable environmental standards across GSAs; some minimum thresholds insufficient [39]	−3
		Long implementation timeline allows interim degradation [40]	−3
		Funding constraints may compromise ecosystem restoration [110]	−3
Equity Approach	7/10	Total Net Score = +12 + (−9) = +3 Baseline = 5, Score = +3 + 5 = 8	8
		Disadvantaged community protections legally mandated; technical assistance, facilitation, well protection [109]	3
		Domestic well user protections; mitigation programs when wells fail [108]	2
		Procedural equity: legal requirements ensure diverse voices; translation, accessible meetings [38]	1.5
		Environmental justice integration; DAC vulnerability explicitly addressed (Escriva-Bou et al., 2020 [109])	1
		Small farmer assistance provisions; recognition of adaptation burden [110]	1
		Pumping restrictions may disproportionately burden small farmers lacking capital [108]	−3.5
		Capacity constraints limit meaningful participation despite support [109]	−3
Institutional Integration	8/10	Total Net Score = +8.5 + (−6.5) = +2, Baseline = 5, Score = +2 + 5 = 7	7
		Subsidiarity principle: local primacy with state backstop; balances flexibility and accountability [38]	3
		Multi-level structure: local GSAs, regional coordination, state oversight [109]	3
		Long-term planning (20 years) with 5-year milestones; adaptive management [38],	3
		Statewide data portal centralizes information; enables learning across basins [111],	2
		Surface water–groundwater integration requirements in GSPs [39]	2
		Fragmentation where multiple GSAs exist; coordination challenges despite requirements [108],	−4
		Limited integration with land use planning; local governments control development [110]	−3
Economic Mechanisms	8/10	State capacity limited to oversee GSAs and plans [40]	−3
		Total Net Score = +13 + (−10) = +3, Baseline = 5, Score = +3 + 5 = 8	8
		Flexible implementation tools: water markets, managed aquifer recharge (MAR), fees, allocations [109]	3.5
		Water markets with environmental/equity safeguards; trading within sustainability limits [114]	3
		MAR Incentives: tax credits, streamlined permitting, cost-sharing [110]	2
		Market mechanisms enable least-cost sustainability achievement [114]	1.5
		High implementation costs; fiscal burden [110]	−4
		Agricultural resistance to fees and pumping restrictions [40]	−3
		Total Net Score = +10 + (−7) = +3, Baseline = 5, Score = +3 + 5 = 8	8

References

1. IPCC. *Intergovernmental Panel on Climate Change*; IPCC: Geneva, Switzerland, 2022.
2. Rosso, R. On Seven Principles of Water Governance. *Water* **2025**, *17*, 896. [CrossRef]
3. Zhang, Y.; Liu, B.; Ding, Y.; Zhao, J.; Li, C. Developing river ethics: Advancing the understanding of water governance principles and promoting the modernization of water governance systems and capabilities. *River* **2025**, *4*, 21–28. [CrossRef]
4. Groenfeldt, D.; Schmidt, J.J. Ethics and Water Governance. *Ecol. Soc.* **2013**, *18*, 14. [CrossRef]

5. Lv, C.; Chen, Y.; Huang, Q. Intergenerational equity based optimization model joint of water allocation and water quality management. *Sci. Rep.* **2025**, *15*, 19569. [[CrossRef](#)]
6. Julio, N.; Figueroa, R.; Olivia, R.D.P. Water Resources and Governance Approaches: Insights for Achieving Water Security. *Water* **2021**, *13*, 3063. [[CrossRef](#)]
7. Taylor, K.S.; Longboat, S.; Grafton, R.Q. Whose Rules? A Water Justice Critique of the OECD's. *Water* **2019**, *11*, 809. [[CrossRef](#)]
8. Spijkers, O. The Sustainable Human Right to Water as Reflected. *Utrecht Law Rev.* **2020**, *16*, 18–32. [[CrossRef](#)]
9. Gupta, J.; Hildering, A.; Misiedjan, D. Indigenous people's right to water under international law: A legal pluralism perspective. *Curr. Opin. Environ. Sustain.* **2014**, *11*, 26–33. [[CrossRef](#)]
10. Moreira, F.D.; Fonseca, P.R.S.; Miranda, R.M.; Oliveira da Costa, L.; Mejias Carpio, I.E. Stakeholder engagement for inclusive water governance in a rural community in Brazil. *Front. Water* **2024**, *6*, 1378514. [[CrossRef](#)]
11. Wehn, U.; Collins, K.; Anema, K.; Basco-Ca, L. Stakeholder engagement in water governance as: Lessons from practice. *Water Int.* **2017**, *43*, 34–59. [[CrossRef](#)]
12. Warter, M.M.; Tetzlaff, D.; Soulsby, C.; Goldhammer, T.; Gebler, D.; Vierikko, K.; Monaghan, M.T. Understanding ecohydrology and biodiversity in aquatic nature-based solutions in urban streams and ponds through an integrative multi-tracer approach. *Hydrol. Earth Syst. Sci.* **2025**, *29*, 2707–2725. [[CrossRef](#)]
13. Schneider, F.; Bonriposi, M.; Graefe, O.; Herweg, K.; Homewood, C.; Huss, M.; Kauzlaric, M.; Liniger, H.; Rey, E.; Reynard, E.; et al. Assessing the sustainability of water governance systems: The sustainability wheel. *J. Environ. Plan. Manag.* **2014**, *58*, 1577–1600. [[CrossRef](#)]
14. Rogers, P.; Hall, A.W. *Effective Water Governance*; Global Water Partnership: Stockholm, Sweden, 2003.
15. Higgs, J.C.; THill, R.; Meissner, R. Equity in water resource management: A theoretical dynamism. *Soc. Nat. Resour.* **2024**, *49*, 2736–2752. [[CrossRef](#)]
16. Higgs, C.; Hill, T.; Meissner, R. Water Equity: The South African Case. *Soc. Nat. Resour.* **2025**, *38*, 888–901. [[CrossRef](#)]
17. UN Water. *Progress on Implementation of Integrated Water Resources of Management*; United Nations Environment Programme: Nairobi, Kenya, 2024.
18. Grigg, N.S. Integrated Water Management in 2050: Institutional and Governance Challenges. In *Toward a Sustainable Water Future*; ASCE: Reston, VA, USA, 2013.
19. Hilbig, J.; Rudolph, K.-U. Sustainable water financing and lean cost approaches as essentials for integrated water resources management and water governance: Lessons learnt from the Southern African context. *Water Supply* **2018**, *19*, 536–544. [[CrossRef](#)]
20. Worrel, R.; Appleby, M. Stewardship of Natural Resources: Definition, Ethical and Practical Aspects. *J. Agric. Environ. Ethics* **2000**, *12*, 263–277. [[CrossRef](#)]
21. Mathevet, R.; Bousquet, F.; Raymond, C.M. The concept of stewardship in sustainability science and conservation biology. *Biol. Conserv.* **2018**, *217*, 363–370. [[CrossRef](#)]
22. West, S.; Haider, L.J.; Masterson, V.; Enqvist, J.P.; Svedin, U.; Tengö, M. Stewardship, care and relational values. *Curr. Opin. Environ. Sustain. (COSUST)* **2018**, *35*, 30–38. [[CrossRef](#)]
23. Chapin, F.; Power, M.E.; Pickett, S.T.A.; Freitag, A.; Reynolds, J.A.; Jackson, R.B.; Lodge, D.M.; Duke, C.; Collins, S.; Power, A.G.; et al. Earth Stewardship: science for action to sustain the human-earth system. *Ecosphere* **2011**, *2*, 89. [[CrossRef](#)]
24. Africa Regenerative Agriculture Study Group. *Regenerative Agriculture: An Opportunity for Businesses and Society to Restore Degraded Land in Africa*; IUCN: Gland, Switzerland, 2021.
25. Regenerative Agriculture Initiative and The Carbon Underground. *What Is Regenerative Agriculture?* Regeneration International: California, CA, USA, 2017.
26. Johnson, M.; Campbell, L.K.; Svendsen, E.S. Conceptualizing, analyzing, and supporting stewardship: Examining the role of civil society in environmental governance. *Ecol. Soc.* **2020**, *25*, 14. [[CrossRef](#)]
27. Margerum, R.D.; Robinson, C.J. Collaborative partnerships and the challenges for sustainable water management. *Curr. Opin. Environ. Sustain.* **2015**, *12*, 53–58. [[CrossRef](#)]
28. Walker, B.; Holling, C.S.; Carpenter, S.R.; Resilience, A.K. Adaptability and Transformability in Social–Ecological Systems (SESs). *Ecol. Soc.* **2004**, *9*, 5. [[CrossRef](#)]
29. Kibaroglu, A.; Scheumann, W. Euphrates-Tigris Rivers System: Political Rapprochement and Transboundary Water Cooperation. In *Turkey's Water Policy*; Springer: Berlin/Heidelberg, Germany, 2011; pp. 277–299.
30. Ünver, O.I. South Eastern Anatolia Project (GAP). *Int. J. Water Resour. Dev.* **1997**, *13*, 453–483. [[CrossRef](#)]
31. Salameh, M.; Al-Ansari, N. Deficient Developmental Planning Leading to Water Conflicts across Political Borders: The Way Forward. *Engineering* **2021**, *13*, 158–172. [[CrossRef](#)]
32. Li, M.; Zhang, H.; Meng, X.; Lu, Q. Spatiotemporal heterogeneity of the ecological civilization in the Yangtze. *Ecol. Indic.* **2025**, *177*, 113808. [[CrossRef](#)]
33. Chen, D.; Hou, L.-J.; Liao, Y.-D. Strengthening efficient usage protection, and restoration of. *Water Sci. Eng.* **2021**, *14*, 257–259. [[CrossRef](#)]

34. Pepper, K. Yangtze River Drainage Basin Map (Map of the Yangtze River Basin with Major Tributaries). 2018. Available online: https://commons.wikimedia.org/wiki/File:Yangtze_River_drainage_basin_map.svg (accessed on 20 January 2026).
35. Sharma, B.R.; Samra, J.; Scott, C.; Wani, S.P. *Watershed Management Challenges Watershed Management Challenges*; International Water Management Institute-IWMI: New Delhi, India, 2005.
36. Kerr, J. Watershed Development, Environmental Services. *World Dev.* **2002**, *30*, 1387–1400. [[CrossRef](#)]
37. Dubey, S.K.; Kim, J.; Her, Y.; Sharma, D.; Jeong, H. Hydroclimatic Impact Assessment Using the SWAT Model in. *Sustainability* **2023**, *15*, 15779. [[CrossRef](#)]
38. Kiparsky, M.; Milman, A.; Owen, D.; Fisher, A.T. The Importance of Institutional Design for Distributed Local-Level Governance of Groundwater: The Case of California’s Sustainable Groundwater Management Act. *Water* **2017**, *9*, 755. [[CrossRef](#)]
39. Grantham, T.; Viers, J.H. 100 years of California’s water rights system: Patterns, trends and uncertainty. *Environ. Res. Lett.* **2014**, *9*, 084012. [[CrossRef](#)]
40. Conrad, E.; Martinez, J.; Moran, T.; DuPraw, M.; Ceppos, D.; Blomquis, W. *To Consolidate or Coordinate? Status of the Formation of Groundwater Sustainability Agencies in California*; Stanford Water in the West: Stanford, CA, USA, 2016.
41. Cal Dept of Water Resources. Wikipedia. Available online: <https://commons.wikimedia.org/w/index.php?curid=130795354> (accessed on 1 January 2026).
42. Tortajada, C.; Biswas, A.K. Impacts of megatrends on the global water landscape. *Int. J. Water Resour. Dev.* **2018**, *34*, 147–149. [[CrossRef](#)]
43. Wilke, C.; Rannow, S. A Methodical Framework for Climate Change-Adapted Management in Protected Areas. In *Advances in Global Change Research*; Springer: Berlin/Heidelberg, Germany, 2014; Volume 58, pp. 159–172.
44. McDonald, R.; Marcotullio, P.J.; Güneralp, B. Urbanization and Global Trends in Biodiversity and Ecosystem Services. In *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities*; Springer: Berlin/Heidelberg, Germany, 2013; pp. 31–52.
45. Seto, K.C.; Güneralp, B.; Hutyra, L.R.H. Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proc. Natl. Acad. Sci. USA* **2012**, *109*, 16083–16088. [[CrossRef](#)]
46. Schmidt, J.J.; Matthews, N. *Global Challenges in Water Governance*; Springer Nature: Durham, NC, USA, 2017.
47. Groenfeldt, D. *Water Ethics: A Values Approach to Solving the Water Crisis*; Routledge: Abingdon, UK, 2019.
48. Altinbilek, D. Development and Management of the Euphrates-Tigris Basin. *Int. J. Water Resour. Dev.* **2004**, *20*, 15–33. [[CrossRef](#)]
49. Paksoy, S.; Aydogdu, M. Bölgesel Kalkınmada Girişimciliğin Geliştirilmesi GAP-GİDEM Örnekleri. *J. Entrep. Dev.* **2010**, *5*. Available online: https://dergipark.org.tr/tr/pub/girkal/article/565963#article_cite (accessed on 1 January 2026).
50. Warner, J.; Zawahri, N. Hegemony and asymmetry: Multiple-chessboard games. *Int. Environ. Agreem.* **2012**, *12*, 215–229. [[CrossRef](#)]
51. Bilgen, A. The Southeastern Anatolia Project (GAP) revisited: The evolution of GAP over forty years. *New Perspect. Turk.* **2018**, *58*, 125–154. [[CrossRef](#)]
52. Carkoglu, A.; Eder, M. Domestic Concerns and the Water Conflict over the Euphrates-Tigris River Basin. *Middle East. Stud.* **2001**, *37*, 41–71. [[CrossRef](#)]
53. GAP-RDA. *South-Eastern Anatolia Project (GAP) Action Plan 2014–2018*; TR Ministry of Development: Ankara, Turkey, 2014.
54. Kibaroglu, A.; Gürsoy, S.I. Water–energy–food nexus in a transboundary context: The Euphrates–Tigris river basin as a case study. *Water Int.* **2015**, *40*, 824–838. [[CrossRef](#)]
55. Soylu, N.; Yildiz, D. Southeastern Anatolia Project (GAP) in Turkey and Food Security in the Middle East. *Int. J. Water Manag. Dipl.* **2021**, *1*, 23–34.
56. Taher, S.A.; Abdulhay, H.S. Population estimation of the Euphrates softshell turtle Rafetus. *Baghdad Sci. J.* **2024**, *21*, 1448–1456. [[CrossRef](#)]
57. GAP-GIDEM. *Competitiveness Agenda for the GAP Region*; GAP Entrepreneur Support Centers Project: Ankara, Turkey, 2007.
58. Harris, L.M. Water and Conflict Geographies of the Southeastern. *Soc. Nat. Resour.* **2002**, *15*, 743–759. [[CrossRef](#)]
59. Kibaroglu, A.; Ünver, O.I. An Institutional Framework for Facilitating Cooperation in the Euphrates-Tigris River Basin. *Int. Negot.* **2000**, *5*, 311–330. [[CrossRef](#)]
60. Ünver, O.I. Global Governance of Water: A Practitioner’s Perspective. *Glob. Gov.* **2008**, *14*, 409–417. [[CrossRef](#)]
61. Miyata, S.; Fuji, T. Examining the Socioeconomic Impacts of Irrigation in the Southeast Anatolia Region of Turkey. *Agric. Water Manag.* **2007**, *88*, 247–252. [[CrossRef](#)]
62. Okten, S. Environmental Justice, Dams and Displacement in Southeastern Anatolia Region. *J. Int. Soc. Res.* **2017**, *10*, 414. [[CrossRef](#)]
63. Tortajada, C. South-Eastern Anatolia Project: Impacts. In *Water as a Focus for Regional Development*; Oxford University Press: New Delhi, India, 2004; pp. 190–250.
64. Ünver, O. The water pricing dilemma: South Eastern Anatolia project, Turkey. In *Eau et Économie. 27èmes Journées de l’Hydraulique; Congrès de la Société Hydrotechnique*: Paris, France, 2002.

65. Tortajada, C.; Altinbilek, D.; Biswass, A.K. The Atatürk Dam in the Context of the Southeastern Anatolia (GAP) Project. In *Impacts of Large Dams: A Global Assessment*; Springer Nature: Berlin/Heidelberg, Germany, 2012; pp. 171–199.
66. People's Republic of China. *Article 31*, 76; The People's Republic of China: Beijing, China, 2021.
67. Zhang, Z.; Zhang, L.; Liang, T.; Cheng, L.; Fang, L.; Zhao, B.; Zhang, J.; Wen, C. Has the Yangtze river economic belt strategy promoted the construction of ecological civilization in the upper reaches of the Yangtze river? *Front. Environ. Sci.* **2022**, *10*, 1–16. [[CrossRef](#)]
68. Bennett, M.T. *A Report from Phase I Work on an Inventory of Initiatives*; Forest Trends: Washington, DC, USA, 2009.
69. Xia, C.; Pahl-Wostl, C. Understanding the development of flood management in the middle Yangtze River. *Environ. Innov. Soc. Transit.* **2012**, *5*, 60–75. [[CrossRef](#)]
70. Carney, T.M. China's Three Gorges Dam: De ges Dam: Development, Displacement, and elopment, Displacement, and Degradation. *Neb. Anthropol.* **2021**, *29*, 20–27.
71. Bennett, M.T. China's sloping land conversion program: Institutional innovation or business as usual? *Ecol. Econ.* **2008**, *65*, 699–711. [[CrossRef](#)]
72. Chen, G.; Yang, Z.; Chen, S. Measurement and Convergence Analysis of Inclusive Green Growth in the Yangtze River Economic Belt Cities. *Sustainability* **2020**, *12*, 2356. [[CrossRef](#)]
73. Wang, R.; Liu, L.; Tao, Z.; Wan, B.; Wang, Y.; Tang, X.; Li, Y.; Li, X. Effect of urbanization and urban forests on waterquality improvement in the Yangtze River Delta: A qualitycase study in Hangzhou, China. *J. Environ. Manag.* **2024**, *351*, 119980. [[CrossRef](#)] [[PubMed](#)]
74. Bi, X. Digital agriculture's equalization effect in the Yangtze River economic belt. *Edelweiss Appl. Sci. Technol.* **2025**, *9*, 130–143. [[CrossRef](#)]
75. Han, X.; Sheng, J. Governing the Future through 'Ecological civilization'. *J. Contemp. China* **2024**, *33*, 774–789. [[CrossRef](#)]
76. Fu, B.; Liu, Y.; Meadows, M.E. Ecological restoration for sustainable development in China. *Natl. Sci. Rev. (Earth Sci.)* **2023**, *10*, nwad033. [[CrossRef](#)]
77. CCICED. *Ecological Civilization Shaping China's New Era*; The China Council for International Cooperation on Environment and Development (CCICED): Beijing, China, 2017.
78. Sun, J.; Lucas, M.C. Illegal Fishing Threatens Yangtze 10-Year Fishing Ban. *Conserv. Lett.* **2025**, *18*, e13161. [[CrossRef](#)]
79. Xu, X.; Tan, Y.; Yang, G. Environmental impact assessments of the Three Gorges Project in China: Issues and interventions. *Earth-Sci. Rev.* **2013**, *124*, 115–125. [[CrossRef](#)]
80. Wang, Y.; Zhang, Q.; Bilsborrow, R.; Tao, S.; Chen, X.; Wiley, K.S.; Huang, Q.; Li, J.; Song, C. Effects of payments for ecosystem services programs in China on rural household labor allocation and land use: Identifying complex pathways. *Land Use Policy* **2020**, *99*, 105024. [[CrossRef](#)]
81. Zhang, K.; Yang, X.; Xu, M.; Lin, Q.; Kattel, G.; Shen, J. Confronting challenges of managing degraded lake. *Anthropocene* **2018**, *24*, 30–39. [[CrossRef](#)]
82. Li, R.; Jin, W. The role of the Yangtze River Protection Law in the emergence of adaptive water governance in China. *Ecol. Soc.* **2023**, *28*, 32. [[CrossRef](#)]
83. Chen, C.; König, H.J.; Matzd, B. The Institutional Challenges of Payment for Ecosystem Service Program in China: A Review of the Effectiveness and Implementation of Sloping Land Conversion Program. *Sustainability* **2015**, *7*, 5564–5591. [[CrossRef](#)]
84. Wu, Z.; Dai, X.; Li, B.; Hou, Y. Livelihood consequences of the Grain for Green Programme across regional and household scales: A case study in the Loess Plateau. *Land Use Policy* **2021**, *111*, 105746. [[CrossRef](#)]
85. Chen, J.; Chen, S.; Fu, R.; Li, D.; Jiang, H.; Wang, C.; Peng, Y.; Jia, K.; Hicks, B.J. Remote Sensing Big Data for Water Environment Monitoring. *Earth's Futur.* **2022**, *10*, e2021EF002289. [[CrossRef](#)]
86. Zhou, X.; Lin, Y.; Hooimeijer, P.; Monstadt, J. Making collaborative water governance accountable? The River Chief System in China. *Int. J. Water Resour. Dev.* **2025**, *42*, 24–46. [[CrossRef](#)]
87. Guo, S.; Wu, J.; Dang, T.; Liu, W.; Li, Y.; Wei, W.; Syers, K.J. Impacts of fertilizer practices on environmental risk of nitrate in semiarid farmlands in the Loess Plateau of China. *Plant Soil* **2010**, *330*, 1–13. [[CrossRef](#)]
88. Yina, R.Y.; Liuc, C.; Zhaoa, M.; Yao, S.; Liuc, H. The implementation and impacts of China's largest payment for ecosystem services program as revealed by longitudinal household data. *Land Use Policy* **2014**, *40*, 45–55. [[CrossRef](#)]
89. Yang, W.; Lu, Q. Integrated evaluation of payments for ecosystem services programs in China: A systematic review. *Ecosyst. Health Sustain.* **2018**, *4*, 73–84. [[CrossRef](#)]
90. Chen, W.; Wu, Y. China's New Environmental Protection Law and Green. *Complexity* **2021**, *1*, 5566357. [[CrossRef](#)]
91. Guo, J.; Zhu, T.; Ou, M.; Pei, F.; Gan, X.; Ou, W.; Tao, Y. A Framework of Payment for Ecosystem Services to Protect Cropland: A Case Study of the Yangtze River Delta in China. *Sustainability* **2018**, *10*, 178. [[CrossRef](#)]
92. Kerr, J. Watershed Management: Lessons from Common Property Theory. *Int. J. Commons* **2007**, *1*, 89–109. [[CrossRef](#)]
93. Agarwal, B. Participatory Exclusions, and Gender An Analysis for South Asia and a Conceptual Framework. *World Dev.* **2001**, *29*, 1623–1648. [[CrossRef](#)]

94. Joy, K.J.; Paranjape, S. *Watershed Development Review: Issues and Prospects*; Technical Report; Centre for Interdisciplinary Studies in Environment and Development (CISED): Bangalore, India, 2004.
95. Smyle, J.; Lobo, C.; Milne, G.; Williams, M. *Watershed Development in India an Approach Evolving Through Experience*; The International Bank for Reconstruction and Development/The World Bank: Washington, DC, USA, 2014.
96. Reddy, M.G.; Sreedevi, N. Local Finances in Andhra Pradesh: A Situational Analysis. *Indian J. Public Adm.* **2004**, *50*, 829–839. [[CrossRef](#)]
97. Joshi, P.; Jha, A.; Wani, S.; Sreedevi, T.; Shaheen, F. *Impact of Watershed Program and Conditions*; National Centre for Agricultural Economics and Policy Research: New Delhi, India, 2008.
98. Wani, S.P.; Sidhu, G. Land Use Planning in Integrated Watershed Development Program for Improving Livelihoods. In *Proceedings of the Platinum Jubilee Symposium—Proceedings*, New Delhi, India, 17–19 December 2009; pp. 154–164.
99. Agarta, A.K.; Narain, S. *Dying Wisdom, Fall and Potential of India's Traditional Water Harvesting Systems*; Centre for Science and Environment: New Delhi, India, 1997.
100. Joshi, P.; Jha, A.; Wani, S.; Joshi, L.; Shiyani, R. *Meta-Analysis to Assess Impact of Watershed Program and People's Participation*; Comprehensive Assessment Research Report; AgEcon Search: St. Paul, MN, USA, 2005.
101. Kumar, R.; Veeraragavan, M.; Baral, K.; Saikanth, D.R.K.; Singh, V.; Upa, L.; Raj, S. Agroforestry and Its Potential for Sustainable Land Management and Climate Action: A Review. *Int. J. Environ. Clim. Change* **2023**, *13*, 620–629. [[CrossRef](#)]
102. Rockström, J.; Karlberg, L.; Wani, S.P.; Barron, J.; Hatibu, N.; Oweis, T.; Bruggeman, A.; Farahani, J.; Qiang, Z. Managing Water in Rainfed Agriculture—The Need for a Paradigm Shift. *Agric. Water Manag.* **2010**, *97*, 543–550. [[CrossRef](#)]
103. Glendenning, C.; Mishra, A.K.; Vervoort, R.W.; Van Ogtrop, F.F. Balancing watershed and local scale impacts of rain water harvesting in India—A review. *Agric. Water Manag.* **2012**, *107*, 1–13. [[CrossRef](#)]
104. Chandra, G. Participatory Rural Appraisal. In *Issues and Tools for Social Science Research in Inland Fisheries Bulletin 163*; Central Inland Fisheries Research Institute: Barrackpore, India, 2010; pp. 286–302.
105. Sharma, M.; Vanjani, U. When more means less: Assessing the impact of dairy ‘development’ on the lives and health of women in rural Rajasthan (India). *Soc. Sci. Med.* **1993**, *37*, 1377–1389. [[CrossRef](#)]
106. Singh, R. State-Local Relations in India. *Vidya J.* **2023**, *2*, 242–245. [[CrossRef](#)]
107. AB-685. AB-685 State Water Policy. (2011–2012). 2012. Available online: <https://phadvocates.org/wp-content/uploads/2020/04/2011-SB-685.pdf> (accessed on 23 November 2025).
108. Kiparsky, M.; Owen, D.; Nysten, N.G.; Christian-Smith, J.; Cosens, B.; Doremus, H.; Fisher, A.; Milman, A. *Designing Effective Groundwater Sustainability Agencies: Criteria for Evaluation of Local Governance Options*; Wheeler Water Institute: Tucson, AZ, USA, 2016.
109. Escrive-Bou, A.; Hui, R.; Maples, S.; Medellín-Azuara, J.; Harter, T.H.; Lund, J.R. Planning for groundwater sustainability accounting for uncertainty and costs: An application to California's Central Valley. *J. Environ. Manag.* **2020**, *264*, 110426. [[CrossRef](#)] [[PubMed](#)]
110. Hanak, E.; Escrive-Bou, A.; Gray, B.; Green, S.; Harter, T.; Jezdimirovic, J.; Lund, J.; Medellín-Azuara, J.; Moyle, P.; Seavy, N. *Water and the Future of the San Joaquin Valley*; Public Policy Institute of California: San Francisco, CA, USA, 2019.
111. Scanlon, B.R.; Reedy, R.C.R.; Fau, C.C.; Pool, D.P.; Uhlman, K. Enhancing drought resilience with conjunctive use and managed aquifer recharge in California and Arizona. *Environ. Res. Lett.* **2016**, *11*, 035013. [[CrossRef](#)]
112. Hanak, E.; Lund, E.; Lassiter, A.; Gleick, P. Portfolio Approaches to Reduce Costs and Improve Reliability of Water Supplies. In *Sustainable Water: Challenges and Solutions from California*, 1st ed.; University of California Press: Oakland, CA, USA, 2015; pp. 151–177.
113. Hanak, E.; Lund, J. Adapting California's Water Management to Climate Change. *Clim. Change* **2009**, *111*, 17–44. [[CrossRef](#)]
114. Grafton, R.Q.; Libecap, G.; McGlenn, S. An Integrated Assessment of Water Markets: A Cross-Country Comparison. *Rev. Environ. Econ. Policy* **2011**, *5*, 219–239. [[CrossRef](#)]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.