

Rivers, Regions and Resilience: An Environmental History of Water, Agriculture, and Community Adaptation

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Abstract

The dual nature of water as both a vital source and a destructive force suggests trade-offs. Human interactions with aquatic resources depend on accessibility and security. As a result, water governance becomes an important issue. Participation in South African scholarly studies highlights varied responses to infrastructure and stewardship in agricultural and semi-urban settings. Several competing claims lead to conflicts between private and communal systems. The relationship between water and land is examined through comparative historical geographies of river piers, agricultural practices, and logistics. Issues of temporal and spatial adjustments in aquatic systems are explored through analysis of archives at river-basin, suburb-perimeter, and indigenous transformation boundaries. Methods include comparing land tenure and infrastructure classification through adaptive cycles and the resilience of farming and slope processes. A significant focus is the long-standing scholarly engagement with stability and diversification at freshwater-agriculture interfaces. Levels of transversal autonomy influence governance challenges. Data include thematically related knowledge from archives and environmental remediation proxies. Historical maps outline changes in territory and hydrology over long periods of formative epochs and hydro-technological developments. Perceptual dialectics favour new water sources, making centrifugal riverscapes key areas of interest. Other geomorphological and vegetative phases seek to elucidate the implications for the territory-aquatic relationship.

Keywords: *Water management, Environmental international relations, Agricultural adjustment, River systems, Communities, Social-ecological systems, Climate change, Sustainable food production.*

1. Introduction

Late-nineteenth-century British Raj military engineers developed river engineering projects to stabilise and control floods in the Hindon and other rivers. Only decades ago, flood control efforts characterised the irrigation advocacy of the colonising physicist Martin Water in the same area, during the period when the Bostonian statesman and House of King Governor of India had the power to celebrate an irrigation boom fertilising its Dominion of India, established in 1882, as a pacifist formation acting as a colonial biophysical boundary of enumerative prediction, transforming local thought units into expanding continua. The Times, in line with Tonto Vickers, presciently examined follower-return.

Modelling enterprise compression manifests through antecedents such as instruments' equivalence-in-hind and sustainability-encapsulative indexing principles that govern the evolution leading to cyclogenesis and meta-geo-relocation, which are then grouped under the Bar-on-as-a-matter-of-course unit normalising (Macklin & Lewin, 2019).

2. Potential Grounds: Water, Landscape, and Resilience.

Water is a fundamental component of existence and scientific progress in civilisation. It is used in domestic and agricultural activities, industrial

production, transportation, power generation, tourism, ecosystems, and many other areas within society. Water supply comes from rivers, lakes, dams, reservoirs, tanks, and wells. Interactively, water connects and shapes various landscape contours, enabling the development of well-irrigated areas; however, seasonal water fluctuations, whether limited or abundant, can lead to large-scale landscape degradation.

Landscape is the technical term for the morphology or external composition of landforms. It therefore deals only with the surface characteristics of the earth's crust, such as hills, river gullies, plains, and different climates, such as tropical, temperate, and tundra. However, factors such as fertilisation, irrigation, terracing, agronomic systems, advanced crops, including cotton, tea, turf, vegetables, and vegetative laws controlling each land contour are not considered. Without a clear understanding of the geoscientific contour of the territory, one cannot refine the surface of a landscape. Nonetheless, scientific observations have illuminated the changes in crustal elevation and the periods of deposition, erosion, and sedimentation caused by water. However, there has been limited focus on analysing the manners of cover extension in phases, the formation of land cover indices, land cover alteration, and transition to urban environments; similarly, the influence of vegetation cover on hydrology and its use in

monitoring geo-hazard systems like landslides, floods, and earthquakes remains underexplored.

3. Rivers and Regions, Historical Geographies.

The census from 1860 to 2000 shows changes in how rivers and regions played roles in the study area. The evidence and interpretation based on historical sources establish the dominance of rivers as the leading focus of regional urbanisation in Kansas; the river and region become central to collective identity; and governance structures evolve into key factors influencing regional water policies, technology, and control. Settlements around the three major river systems- Arkansas, Smoky Hill, and Republican- began in the 1860s, driven by economic activity and water conditions, which brought together local ranching, farming, milling, and agricultural activities. The earliest investments in water supply infrastructure occurred along the Arkansas River and later along the Republican River, while communities along the Smoky Hill River continued to face disadvantages. Between the mid-1880s and 1970, agricultural systems were characterised by farming and diversion-based surface irrigation, followed by dryland farming, feedlots, non-irrigated cropping, and pivot irrigation. Historical river management and farming generally impacted agricultural development and

negatively affected inter-basin transfer proposals.

3.1. Riverine Systems as Cultural and Economic Centres.

Throughout human history, communities have clustered where land meets water. Rivers have enhanced human livelihoods by balancing essential resources, attracting people to settle and form societies. Since rivers transport water, nutrients, toxins, wood, and sediment, they become centres of culture, settlement, trade, and resource flow, much like ancient caravanserais (Macklin & Lewin, 2019). In Australia, the Murray-Darling river basins, in India, the Ganges-Brahmaputra basin, and in Egypt, the Nile Valley illustrate the common pattern of river systems shaping regional development. Although the physical, hydrological, and cultural features of each basin are unique, river dynamics strongly influence technology, population patterns, and farming systems. Rivers continue to serve as the main basis for spatial planning and governance in these regions and others. The link between river characteristics and regional history creates landmarks that can be leveraged to promote social-ecological change and community initiatives toward resilience.

3.2. Water Governance and Regional Identity.

Regions are social constructs used to guide governance at the watershed level. Water governance in many parts of the global South that were under colonial rule has been categorised into three areas: surface irrigation, groundwater, and flood management (Kuuteryiri Chireh, 2018). Watershed-scale water management has often adopted a top-down, authoritarian approach that isolates local social-ecological systems for control by higher levels of government. However, the opposite can also occur: political landscapes shaped by rivers and water may become so naturalised that further attempts to organise them are seen as overreach and face resistance. Within these frameworks, efforts to modify governance systems to better match social-ecological conditions might be undertaken without altering the existing socio-ecological basins, enabling bigger changes along a different trajectory (Cosens et al., 2014).

4. Water, Agriculture and Technological Change.

Various hydrological and agricultural systems also define distinct agricultural trends and processes across the Americas. Such variations, in turn, affect the susceptibility and resilience of farms, farmers, and farming communities to climatic stressors, such as shifts toward less predictable, more variable precipitation patterns and directions. The information-gathering infrastructure includes climate normals (temperature,

precipitation, drought indices) and agricultural systems (cropping patterns, irrigation), based on data from many sources (e.g., historical censuses; press articles; doctoral theses). The example of increasing inter-annual and intra-annual variability in precipitation is notable, as seen in the development of perennial agriculture in California and New Mexico, which is expected to rise with climate warming. The situation was analysed to develop rational-use and drinking-water policies by the Agro-Hydrology and Water Quality program of the United Nations Institute of Water, Environment and Health, a predecessor of the so-called climate-smart agriculture, which requires adapting to changing conditions (D. Basche & F. Edelson, 2017; Fort, 2011).

4.1. Land use transitions, Drainage and Irrigation.

The hydraulic interventions developed new irrigation systems and drained existing wetlands, transforming previously unproductive landscapes into farmland. The increased agricultural productivity resulting from new technologies has received little econometric analysis, with no quantification or modelling of how these changes affect agricultural development, regional output, water resources, or the environment. Changes in water regimes associated with agricultural shifts in the region influence food security under climate change, but remain poorly

understood. The expansion of reliance on groundwater since the mid-1970s has affected the organisation of farming systems, but has not been assessed at the regional level. In response to current climate conditions, communities adapt to changes in water access through cropping choices, land cover adjustments, and land tenure, knowledge of which can help shape agricultural policies and resilience elsewhere. The decline in groundwater has led to various local physical, agronomic, and governmental responses, such as diverting surface water or regulating water use for crops; a record of interactions and social-ecological outcomes across different cases provides broader insights.

4.2. Food System, Adaptation, and Crop Systems.

The development of crop systems demonstrates important connections with current hydrological changes. At the start of droughts in the early nineteenth century, drought-prone areas were

planted with the hardiest cereal crops. Climate feedback in the early twentieth century and increased access to water led to a broader crop selection, including less hydrophobic cash crops, which boosted productivity and food security during dry periods. By the late twentieth century, the crop variety was again reduced due to climate effects and less irrigation, forcing the system to readjust. Regions with greater crop flexibility maintained higher food security and production during this transition. Additionally, significant changes have occurred in water-harvesting methods. These temporary technological shifts under different water regimes challenge the long-term, basin-wide efforts toward social resilience and ecological sustainability (J. Vermeulen et al., 2011). Furthermore, data support the idea that multiple equilibria exist between different crop systems today, not only across regions but also within specific areas, a pattern rarely documented elsewhere.

Table 1: Historical shifts in crop systems, water access and food security

Period/phase	Water access and hydrological context	Dominant crop system	Technological / management shifts	Food security and resilience outcome
Early 19th century (drought onset)	Drought-prone areas, limited irrigation, and high climatic stress	Hardest cereal crops in drought-prone areas	Minimal water-control infrastructure, basic drought coping	Low but stable subsistence; resilience grounded in hardy crops
Early 20th century (wetter phase)	Increased access to water, broader hydrological availability	Wider crop selection, including less hydrophobic cash crops	Expansion of irrigation and water-harvesting methods	Higher productivity and improved food security in dry periods
Late 20th century (renewed stress)	Climate effects and reduced irrigation, more variable precipitation	Reduced crop variety, contraction of options	Adjustments in water use; pressure on existing infrastructures	Food systems forced to readjust; vulnerability where flexibility is low

Period/phase	Water access and hydrological context	Dominant crop system	Technological / management shifts	Food security and resilience outcome
Flexible regions (cross-period)	Variable conditions, but better managed access to water	Greater crop flexibility and diversification	Adaptive crop choices and evolving water-harvesting practices	Higher food security and production are maintained through transitions

5. Stressors and Community Responses by the Environment.

Certain communities have managed to survive increasing environmental demands, while others have shown little resilience to change and have had to look elsewhere or vacate the area altogether (Baird et al., 2016). Flood-exposed communities have experimented with different building materials, urban flood-proofing, seasonal preparedness, and joint research, while dealing with the risks of glacier-induced lake outburst floods and glacial-dominated transitions in the meltwater regime. During dry spells, they have adapted by shifting crop rotation, fallowing, and making crop decisions due to constrained access to irrigation. Contaminated, channelised, and redirected water- connecting city and rural areas, upstream and

downstream regions- has created conflicting demands and rivalry within and between societies. Several co-management systems have been developed in collaboration with social movements advocating for environmental and water rights.

Some areas face new stressors, which can directly destabilise preexisting systems of mutual adjustment. Mechanisms for coordinating water access across sectors, places, and media (e.g., surface, groundwater, and soil moisture) have emerged. Long-term historical management regimes became organised around the kasungwa systems of coordination and their social reciprocity in seasonal and stochastic water contexts, and their socio-political expression to the larger ecosystems' contingent mechanisms of the large and informal.

5.1. Floods, Droughts and Temporal Remedies.

Flooding and drought are natural processes that are worsened by human activities. The various geographical areas are prone to flooding due to climatic factors and the terrain. In most cases, flood disasters instil significant apprehension regarding the security and well-being of individuals, as well as environmental destruction, such as extreme soil erosion. Drought is another phenomenon, but it is a gradual process that occurs over time (Macklin & Lewin, 2019). Drought and flooding are two extreme phenomena that have adverse effects. Flooding occurs over hours, days, or weeks, whereas drought requires weeks to months or years to complete. In most cases, flooding occurs as land and road flooding, and traffic disruption in its final phases. The drought comes in ever-increasing magnitude, beginning with social water deprivation, restrictions on agricultural water use, wilting and drying of natural vegetation, bushfires, rationing of drinking water, and ultimately, until the groundwater level returns to depleted and normal levels. In a year with a flood or drought, relying on the annual precipitation pattern is sometimes expected, and alternating floods and droughts occur, allowing mitigation to be integrated.

5.2. Pollution, Resource Conflicts, and Co-management.

Community responses to disruptive events bridged the regions, despite the physical separation of the chosen study areas. There was concern about possible cross-regional contamination as the frequency of river contamination by urban and agricultural chemicals increased. This led to increasingly heated arguments among farmers about the management of water, nutrients, and chemicals, which eventually overshadowed concerns about the quality of water sourced from the river for irrigation. They highlighted the rivalry of interests influenced by different irrigation modes. In 1965, the first regional governments emerged, focusing on quasi-external resources that individual farming communities could not control. Joint bargaining and co-ownership presented new possibilities to actively enhance upstream-downstream discourse, which was suppressed at the basin level. New Institutional Capacity, Experimental Governance, and Regional Autonomy. Obvious local attributes were formed at the beginning of the agricultural transition. Supplies and demands were created by water and agricultural development, and these have given birth to both supply-based and demand-based governance styles. Growth of basin-scale systems, which focused resources on the so-called key areas, however, overlooked the regions where uncontrollable multi-cropping stimulated both upstream water-conservation responses and downstream

nutrient demand. Salinisation of soils, pesticide pollution and fertiliser run-off created conflictual pressures of improved basin coordination and differentiation between hitherto homogenous alluvial or alluvio-lacustrine zones. Once reduced by more pressing economic and rural-urban inequalities, environmental concerns have developed rapidly in the late 1990s. The increase in the regional administrative status to department-director equivalents and in territorial subdivision from four to sevenfold, respectively, improved problem identification and experimental institutional innovation (Farinosi et al., 2018).

6. Mechanisms of Social-Ecological Change and Resilience.

The findings of social-ecological change that pressurised the ecosystems of a social-ecological system were coupled with resilience mechanisms implemented to manage current changes and aspects of the social-ecological system that were on the brink of collapse (Varis et al., 2019). The conceptualisation of the social phenomenon ensured that the same people did not research the same issue, and that diversification in water governance and epistemology was accounted for (Cosens et al., 2014). The chosen areas were required to be homogeneous in terms of landscape characteristics and the natural eco-

hydrologic atmosphere that regulated the adaptation of water and agriculture, which were the dependent themes of the topic. However, it was also necessary that the system of collective knowledge, social-ecological interaction, and the complexity of water governance were insightful and interesting to investigate in relation to the transition of social-ecological systems and adaptation to water-agriculture systems.

Historical landscapes that share major rivers and river systems that have changed over time were selected. The completion of the regions in the past served the river systems, giving rise to the transition originally in the regions by historical investigation to retain transportation and supply by river basin since the past economic change, as all routes serving the river basin altered as shopping centres became a major factor by both the collective of river basin water-agriculture and water supply.

6.1. Locals and KSLEs: Knowledge Systems and Local Ecologies

Adaptive agricultural practices represent contingent relations among farmers, their environment, and the knowledge systems. Farmers evaluate changes in microclimates, crop emergence times or rates, soil moisture or salinity, insect infestations, and other biotic or abiotic conditions when making individual decisions and practices over time.

Farmers endeavour to locate their farms in ways that enable them to access the hydrological terrain as part of a wider regime of administrative and institutional determinations. These empirical constraints are exacerbated by changes in the organisational practices for distributing water. Some researchers focus on the extent to which the local communities and particularly people experiencing poverty would fear natural occurrences, but through their indigenous system of knowledge, locally enabling a receptor of adaptive governing regime under which a localised coping mechanism is harnessed in order to achieve a level of agricultural production beyond subsistence levels (Šakić Trogrlić et al., 2019).

6.2. Institutions, Policy and Public Intervention.

Water governance structures and institutional systems affect regionally specific policy decisions, levels of involvement, and water-resource management methods (Cosens et al., 2014). The interaction of policies, cycles of plan-making and implementation, and stakeholder involvement all combine to create, transform, and maintain landscapes, communities, and practices; in either instance, a regionally different combination of hydro-social strategies ensues. The positions of water are limited or facilitated by laws, border arrangements, and not-for-profit societies within the structural and

infrastructural compositional topologies of the socio-technical systems, and by the actor-colourings of the arrangements within them. Social-ecological change describes the feedbacks among hydro-geological, environmental, and technical regimes, multi-scale infrastructures, livelihoods, and cultural convenings. Varied policy-legislative formations are indicative of temporal scaleness, agglomeration economies, changing cartographies, techno-environmental circumstances, socio-technical modernities, and institutional histories. The lack of regulatory experience, overall high growth rates, huge rural bases, and willful agricultural industries. Other arrangements include sectoral segregation, flood-drought seasons, long-running informal practices, particularly at problematic tops, and hydraulic economies. Topographically less complex, hydrologically eclectic, and multi-asset watershed-wide changes and arrangements in land ownership and tenure recur across varying historical junctions in the case studies (Sylvan Johnson, 2015).

7. Case Studies across Regions

Climate determines the type of river basin, the form of agriculture to be practised there, the water-oriented technologies used, and thus the types of adaptation that a community dependent on water can experience (Gunderson et al., 2017). When there is sufficient water

in a basin, irrigation and drainage can be established to support productive staple-crop systems, resulting in a gradual upgrading of land and water rights. In areas with water shortages, water-saving crop-vegetation systems prevail, with far less technological advancement and more occupation and discharge cycles. The complexity of co-management arrangements that may develop in the human-river interactions depends on the system selected.

The adaptation strategies in two basin orientations work at one or the other end of the socioeconomic development and technological change spectrum. One, typical of areas with superior precipitation and water supply surpassing or closely matching topical demands, practices a traditional high-input staple crop system encompassing irrigation and drainage, forage, and livestock, partly due to its maximising the capability to upgrade assets via value added, one of several ways of betterment and development. The other, formulated for dry or drought- or shrub-prone conditions in particular, incorporates woody species into conservation choices, which are highly favourable under the stipulations of dry-farming cereal and grain legumes, and yield very favourable social-ecological outcomes.

7.1. Case Study A: River Basin Agricultural Adaptation.

The agricultural changes in highly seasonal river basins indicate fluctuations in formal water management requirements, institutional adjustments, and participation with the constituency. Although these systems also govern water scarcity, basin forms of consolidation of regional states represent alternative ways of governance that determine the result of collective management and adaptation (M Werner, 2016). Devolution after the attainment of national independence led to the development of varied types of local governance that make up the agendas of larger participative democracies. Water control mechanisms in several areas operated at a moderate level. Participatory irrigation management did not have a parallel decentralised form to other water governance practices. The cross-sectoral management work was constrained by overlapping formal demands, underscoring the need for complementary institutional needs in the development of fully integrated community-based approaches (Corrigan, 2011).

7.2. Case Study B: Interfaces and Water Management in the Cities.

The city-country interface brings a set of important water management dilemmas that do not manifest in densely populated urban areas (J. F. Penn, 2016). These places of interface have more complex and variable water systems, are

shaped by historical context, and integrate different governance structures within an urban-rural hyphenated organisation. Modular systems, as a complement to local knowledge and custom, can help address some of the complexities of urban-rural relations. The participation mechanisms at the interfaces of water governance are borrowed by both rural and urban developmental directions, where the rural end is traditionally top-down participation in the form of rural end consultation (as in Kapit), and the urban fusion end is a more participatory-based engaging nature that is yet to be introduced (as in Kuching). It has been argued that urbanisation and the resultant management of natural resources are primarily social-ecological developments. However, water remains inevitably impregnated with the polemic of unequal development, evidenced by a social standing of (relative) otherness in a highly connected, economically driven water-rich State such as Sarawak.

The balancing exercise between irrigation and river well-being, which has been a thorn in the flesh of sustainable agriculture across most of the world, has given the new Sarawak, which is rapidly urbanising, a new spin. However, the water aspect of the issue has been largely overlooked. City settlements, which gradually increase, but far surpass the changes in legislation on water management and do not have

the status of a social resource at all. Due to the conversion of the river encircling the floodplains into residential and industrial estates, the Loss of floodwater retention areas along the river banks and floodplains was discussed. The massive development of the industry and warehousing space at the floodplains has not been left behind either.

7.3. Case Study of Indigenous and Traditional Water Regimes.

The case studies capture indigenous and traditional water regimes that institutionalise other rights and values alongside dominant state structures. They involve various definitions of water and ways of understanding or seeing water systems, acknowledge the agency of other entities, and incorporate various histories, cultures, and spiritualities into sustainability parameters. These arrangements are also resilient in that they prefer community ownership and control; are based on agreements, trust, and good-faith negotiation; respect other values, definitions, and worldviews; and integrate various land- and water-use practices.

All these strengths notwithstanding, indigenous and traditional arrangements face some constraints on their ability to continue with adaptive practices. The dynamism of multi-centred systems creates strains between the variety of local regimes and the further concentration of power and decision-

making capacity within states. Water chambers in the most pure form may be able to sustain water arrangements in the whole basin without regard to state systems. In fact, local and regional organisational networks are more likely to form to enable modern-day negotiations and operational deals with state authorities. However, their formation already indicates a certain degree of vulnerability. The set of contradictions surrounding the subject of empowerment through organisation, the creation of forums that ensure interaction with wider institutions, has always been a known characteristic of social movement studies. In this manner, institutional structures adopted or adapted in response to more powerful forces may help create strength across the areas under analysis (Gunderson et al., 2017) and (Galewski, 2010).

8. Approaches and Resources to Historical Inquiry of the Environment.

Most environmental historical investigations use a composite methodology, which entails reconstructing water and farm expansions with endogenous evidence and explaining how agrarian communities adjust to evolving water access.

A broad spectrum of qualitative, quantitative, and ancillary data is collected to support the reconstruction of

spatial and temporal changes in water and agriculture. The selected resources include geographical information reinforcement, hydro-climatic differences, storytelling, pollen, and tree-ring timescales, sediments, oral history, and maps, among others. It is also incorporated into the long-term view of how the interplay between physical fluvial environments, human habitats, self-organising communities, and governance arrangements has historically and continues to function in the history of water, agriculture, and river basins, reflecting how they interact and synthesise their relationships.

Sources of data include of various streams, such as on-site observations, climatological movie photos, archives, publications as early as the second half of the nineteenth century, and nineteenth and nineteenth-century and later maps, historical reports on rivers, newspapers, remote sensing images, weekly or bi-weekly recordings river level gauges, sediment-core registrations and analyses, and free-of-charge web Consultees were local historical societies, government sources, and private archives, university collections, peri-urban farming communities, and other members of public.

8.1. Landscapes. Archival Anthropologies and Landscape Databases.

The empirical basis of this environmental historical study is a list of archives and landscape data sets. Cartographic materials are available in institutional collections, such as the Manuscript Division of the National Library of Spain, map collections at the University of Valencia and the Instituto Geográfico Nacional, and various governmental archives. Rivers and landscapes: Community archiving projects, such as listening to local families, preserve oral histories of rivers and landscapes, including the Río Seco near Pica and the Segunda and Gualmapu in Patagonia (Grace Ellis, 2019). Lastly, administrative documents and modern scientific works provide data on existing watershed or river basin management regimes across diverse agricultural environments.

The landscape data used in the analysis will include freely available GIS data and other spatially referenced materials. Formal records from the Ministerio de Agricultura, Direccion General de Aguas, and water companies of various types, as well as river basin management plans, show diverse water-diversion structures, irrigation systems, and plans. The development of the system for estimating the area of cultivation, crops, and the type of irrigation used is also portrayed in other materials. These factors are added to national cartographic data, remote sensing imagery, and photographs to guide the

reconstruction of key landscape changes between ca.1880 and the present.

8.2. Environmental Narratives and Reconstruction.

Environmental history requires the reconstruction of past environments and interactions between society using indirect evidence or proxy evidence. This has enabled the reconstruction of water histories using tree rings, sediment records, and flood chronology (L. Pastore et al., 2010). These strategies address the changing climate, water supply, and land use. Hydrological stories thus employ proxy-funded reconsiderations of pre-instrumental states of affairs, thereby providing the basis for examining current changes (D. Jones et al., 2019).

Pollen studies of marine and terrestrial sediments can be used to reconstruct vegetation changes, and consequently, climate and human-made changes. North American hydrological changes have been put in perspective by reconstructions of pre-settlement and post-European forest composition. Past and present sedimentary records suggest sedimentary and flood regimes. The proxy framework offers a more comprehensive picture of the interdependence and mutual reactions among regional water-landscape systems than traditional narrow-spectrum frameworks. The water-historical dataset is based on archival and secondary documentation of hydrological

materials, which inform adaptive governance and the resulting outcomes across various regions.

9. Consequences to Resilience Theory and Practice.

Resilience theory is a solution to long-standing water governance issues, offering a disjointed, uncoordinated, and uneven system in the face of growing pressures from climate change, urbanisation, and pollution (Cosens et al., 2014). There is a reevaluation of methods that affect freshwater accessibility across the natural and human-world system with the framework of resilience (al. Hannah E. Birge, 2019). A more human-physical water-agriculture perspective on the world, including the underestimated forms of governance of the past, is needed to address water policy and food security. The study of various historical experiences validates well-known and, so far, unexplored avenues that strengthen community resilience. They include

(1) linking the restoration of the ecosystem water flow to local food production policies,

(2) the existence of regional agrarian or peri-urban-based population centres, with intensive interactions to a wider network of interrelated communities,

(3) the promotion of systems of collective co-governance of the resources that appeal to the local frames of environmental concern.

The community capacities in response to the combined ecological-economic socio-environmental shocks become more comprehensible as the transition to these pathways unfolds within historical contexts. Various interrelations are drawn between social dynamics and environmental change through these frames of water-agriculture consideration, with examples that point to trajectory-specific leverage points for action. These understandings are consistent with those observed in the context of the relationship between formal and informal water governance, the necessity of levelled governance across the spatial spectrum, and the connection between human-water systems and disturbances, among other dimensions central to planning, policy and socio-legal analysis. Freshwater, agriculture, and adaptation, as subjects of historical interest, take these arguments further by providing a temporal dimension to the field of inquiry and placing greater emphasis on the significance of historical sensitivity in understanding the community-building and community-engagement pathways that underpin community resilience.

9.1. The Governance, Planning and Community Action lessons.

Rivers constantly shape and reshape landscapes and societies, and are essential to existence. However, floods, droughts, pollution, and inappropriate water management endanger flow patterns and accessibility and negatively impact the vulnerable communities (Gunderson et al., 2017). The scarcity of this basic resource will continue to increase. To maximise resilience, the question is how societies recover following disturbances by becoming resilient through adaptation and bouncing back (Cosens et al., 2014).

Recovery is fast-tracked through good governance, proper planning and community involvement. However, current strategies often provide minimal advice, and strategies used in other locations may not be generalizable. The histories of three countries reveal similar trends and provide useful lessons relevant to the current state of affairs.

The comparative study of diverse regions and varied situations promises avenues of good governance, meaningful planning and action in the community. The water-related challenges, relief, and responses have strong impacts on recovery tracks; the less-than-optimal social-ecological water systems in the impoverished situations continue to be large reservoirs of resilience, and the stimulating and flexible methods of planning, particularly the participation of the community in the plan, can inspire

positive changes even under the constrained environment.

9.2. Possible ways of creating sustainable water-agriculture systems.

Various ecological, social and political circumstances shape such interactions between water, agriculture and human communities. Even though each component differs significantly across the six case study areas, three basic connections are universal. The nutritional makeup and soil composition determine the sustainability of agricultural systems; socio-political stability is relevant in part to the resilience of crops and arable land; and the use of sustainable and retimed drainage systems would reduce floods and waterlogging and improve agricultural productivity (D. Basche & F. Edelson, 2017). In the given regions, interactions among the various scales of water-agriculture systems are complex; thus, the regions face the challenge of finding integrated pathways to adapt to the various components simultaneously (Cosens et al., 2014). The focus on spatial and temporal changes helps to understand common mechanisms that support different development patterns and sheds light on possible evolutionary pathways.

10. Conclusion

Opposing deterministic explanations of adaptation to climate cycles, shifting

regimes result from human actions and are reactive to change. These changes reduce adaptive capabilities; the attempts to increase stability can have negative long-term consequences. The transitions can make systems intractable and can endanger the security and sustainability. Case studies represent interactive paths as historical events, binding and liberating other trajectories and, in turn, influencing them. The view supports conceptual, methodological and epistemological concurrences widely recognised throughout the resilience literature. Developments also rely on observations to address perverse government incentives that exacerbate externalities in resource use, thereby impeding climate-change initiatives and excluding environmentally favourable paths in similar basins. Clues to boundaries restrict the opportunity to initiate guided, negotiated interventions that provoke desired directions of adaptation, have extensive impact on large-scale and urban-rural alterations, and form the basis of co-management or participatory arrangements akin to governance experiments elsewhere.

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