

Local Water Institutions and Infrastructure Performance: Allocation, Maintenance, and Control

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Assessments of water infrastructure in climate adaptation and recovery programs often focus on the physical assets — wells, irrigation channels, storage structures and distribution networks. The local *institutions* that co-determine whether that infrastructure continues to function are recorded less consistently. These are the rules setting who takes water and when, the obligations that keep channels and wells in working order, the authorities whose decisions are accepted, and the forums that settle disputes before they harden.

The Rapid Damage and Needs Assessment carried out after Storm Daniel in eastern Libya in 2023, for instance, assessed the floods' effects on physical assets, economic losses, and recovery and reconstruction needs across affected sectors. For water and sanitation, it estimated US\$136 million in physical damage and US\$234 million in reconstruction and recovery needs (around 13 per cent of total needs). Those estimates are necessary for recovery planning, but they do not by themselves establish whether the institutional arrangements needed to operate rebuilt systems remain functional.

This research brief argues that how water infrastructure performs depends on the local institutions through which water is allocated, maintained and contested, and that infrastructure investment can itself change how those institutions work by altering the physical conditions under which their rules operate. The brief sets out what these institutions do, how new works change the outcomes their rules produce, what happens when the institutions weaken or lack the capacity to act, and what infrastructure and recovery assessment teams could reasonably document alongside the physical asset.

Allocation Rules and Maintenance Obligations

Where irrigation and domestic supply depend on shared works, the rules governing who receives water are often tied to the obligations for maintaining the infrastructure. Oman still has around 3,000 *afaj*, traditional irrigation channels, in use, where water is shared among households and farms according to communal rules.

Similarly, in Yemen's Tihama plain, spate irrigation diverts seasonal floods through earthen bunds and canals. Research on water rights across Yemeni *wadis* (channels) found that the right to floodwater was tied to a farmer's contribution to maintenance

of the main and branch canals; a household that did not contribute could be refused irrigation.

Because earthen and brushwood structures had to be rebuilt repeatedly with hand labor and draft animals, upstream and downstream farmers needed each other to assemble a workable labor force, making that mutual dependence a practical check on how unequally water could be shared. It was observed that the Tihama sequencing rule, *al aela fil aela* or 'upstream first', did not usually produce unfair distribution, because large floods regularly breached the upstream works and carried water down the *wadi*.

These arrangements can also tie local observation directly to operating decisions. The irrigation plan for Wadi Tuban, a seasonal river valley irrigated through a spate system, allocates by the measured size of the flood: flows of roughly 5 to 15 cubic meters per second go to canals in the upper reach, 15 to 25 to the middle reach, 25 to 40 to one of two channels in the lower delta depending on which holds the turn, and anything above 40 is divided equally between them.

As another example, before the Wadi Laba system in Eritrea was modernized, the leaders of its five main canals gathered at the division structure before each anticipated flood and adjusted its orientation together, taking account of which areas previous floods had already watered. In Oman's *afaj*, water is likewise allocated through time-based shares, traditionally measured through astronomical observation (using stars at night) and community sundials (using shadows during the day).

Practical Takeaway: At project baseline, document how water is allocated and maintained in practice, including the observations, obligations and authorities on which those arrangements depend. A short institutional baseline should establish:

- which rule determines who receives water and when;
- who can enforce or vary that rule;
- what obligation follows from receiving water;
- who pays for maintenance, and from what source;
- where disputes are taken, and whose decisions are accepted;
- whether the arrangement has operated in the past year.

When Infrastructure Changes How Rules Work

The Tihama case demonstrates how permanent infrastructure can change who controls water without formally changing the allocation rule. Beginning in the 1970s and continuing over subsequent decades, structural modernization across the Tihama plain replaced earthen and brushwood diversions with permanent concrete weirs that no longer breached regularly during large floods.

¹ This research brief is derived from a study on Indigenous Knowledge Systems in the MENA region authored by the Corioli Institute & Paul Douglas Institute Climate Security Fellows in spring 2026: Anushka Vasudev, Julia Volpp, Juliana Cruz, Graham Hansen, Lily Haskett, Carleigh Hughes, Emily Kim, June Lu, Sebastian Pilacuan, Jack Riley,

Jack Ryan, Parjanya Tiwari, Jurain Zhu. The Fellows principally drew on Corioli Institute original research for the International Organization for Migration (IOM) in Libya, Sudan, Yemen, Jordan and Kenya.

Applying the same upstream-priority rule to the new structures gave upstream users close to full control of the flood. Upstream farmers subsequently shifted from food crops to banana cultivation using a combination of spate flow and groundwater, further reducing the water reaching downstream fields. Meanwhile, downstream fields were abandoned, and their owners took up sharecropping and daily labor on upstream holdings. In the Tihama *wadis* of Zabid and Rima, concrete diversion structures and changing cropping patterns similarly altered the distribution produced by traditional allocation rules.

Two conditions shaped the shift: greater physical control by upstream users, and the absence of an authority able to revise the allocation rule once the new infrastructure changed its distributional effect. Enforcement in the Tihama plain had rested with *sheikhs al-wadi* (chiefs responsible for enforcing water-allocation rules) acting under local sultans. After modernization, responsibility passed to government staff and agricultural cooperatives working with declining budgets and diminishing authority. Following the unification of North and South Yemen in 1990, the role of the cooperatives was further reduced without a replacement institution. Maintenance of the new structures also required earthmoving equipment rather than assembled labor, removing the practical reason upstream and downstream users had to accommodate one another.

A similar design problem appears in other systems. Modernization of the Eritrean Wadi Laba, completed around 2001, replaced a flexible earthen division structure with a permanent weir and gabions, and shifted maintenance onto loaders and trucks. In the 2003 flood season the researchers observed fifteen occasions on which upstream farmers irrigated two or three times before downstream fields received a single turn, and the 300 hectares furthest downstream received no turn at all in either 2002 or 2003.

On the Anambar plain in Balochistan (Pakistan), a weir built to divert spate flows to upstream fields also cut the base flow that downstream farmers had drawn on under long-standing rules; the design had been settled without reference to those rules, and after the resulting disputes became unmanageable the two communities agreed to destroy the weir and return to their earlier structures and sharing arrangement.

None of these cases establishes a general rule, and outcomes depend in part on the balance of power between upstream and downstream users. Together, however, they identify a recurring risk; physical redesign can change the distribution produced by an allocation rule that has not itself changed.

Practical Takeaway: Before construction, establish how the proposed structure would alter physical control over water and identify who has authority to revise the allocation rule if its distributional effects change.

Assets That Stop Working

An even more straightforward failure may occur when infrastructure is *built or repaired* without the arrangements needed to keep it operating. In focus groups conducted by the Corioli Institute in Libya, respondents across the public, private, academic and grassroots sectors described burst pipes, deteriorated networks, missing replacement parts, and

components that did not meet required standards. A 2015 assessment found that, of more than 70 wastewater treatment plants built in Libya, only 14 were fully operational.

Notably, weak water provision can also undermine environmental restoration projects that depend on it. In Jufra, a public-sector official described a reforestation project that secured donor funding for 1,500 trees but stopped once his office could no longer afford the water needed for irrigation.

In Corioli Institute data from Yemen, participants criticized infrastructure responses as reactive rather than planned, often addressing immediate shortages without resolving longer-term problems. In Ma'rib, for example, water from the dam reservoir was used to ease shortages while a planned study of the wider water basin remained delayed. Participants also described local authority and NGO efforts as poorly coordinated and uneven in their standards.

Evidence from community water points, including shared wells, boreholes and handpumps used for local water supply, points in the same direction. Analysis of more than 25,000 community-managed handpumps in Liberia, Sierra Leone and Uganda found absence of user-fee collection among the risk factors for non-functionality across all three countries. A nine-country study of rural water points in Sub-Saharan Africa and South Asia similarly found higher functionality where communities had water management committees that met regularly, collected fees and could name someone responsible for maintenance, and where those committees held savings. These systems differ from the customary irrigation arrangements discussed above, but they reinforce the broader link between water infrastructure performance and the financing and maintenance arrangements.

Practical Takeaway: Before commissioning an asset, assign responsibility and a funding source for each recurrent operating and maintenance cost — including energy, spare parts, purchased water and desludging.

Erosion Under Conflict and Changing Conditions

The local rules and institutions governing water allocation, maintenance and dispute resolution can deteriorate independently of the physical condition of the infrastructure. An assessment focused on physical condition alone may therefore miss risks to how the system is governed and sustained. In Yemen, for example, traditional mechanisms for resolving land and water disputes have been weakened by armed conflict and their marginalization by central political authorities. At the same time, conflict and displacement have increased the number and complexity of land disputes, while local authorities often lack the capacity to resolve them.

Tribal actors can carry more influence over land decisions than local government, and unresolved claims have contributed to violence and further displacement, particularly in Ma'rib and parts of southern Yemen. Repairing an asset does not, on its own, restore the capacity needed to govern access to it. Where the institutions that previously resolved such claims have weakened or become inaccessible, disputes over a rehabilitated system may be harder to resolve.

These arrangements can also come under pressure when environmental conditions alter where and when water is available. In Somalia's pastoral areas, customary law remains relevant to water access, with *Xeer*, a customary legal system, providing [rules for water sharing, queuing and the resolution of water-related disputes](#). During drought, however, [pastoralists may have to travel farther with their livestock in search of water and grazing](#).

As water sources dry up, [movement towards areas where water and pasture remain available can increase competition between users](#). The rules governing access may therefore have to operate under conditions different from those around which they developed. A project designed around existing allocation arrangements should account for whether those arrangements still match how and where water is accessed.

Practical Takeaway: At baseline and during implementation, check whether dispute forums still function and whether allocation rules still match how and where water is accessed.

Authority, Capacity and Representation

Local institutions cannot substitute for the public investment and technical support needed to keep water systems functioning. Assigning responsibility to a local body is different from [equipping it to exercise that responsibility](#), and local water-governance bodies do not necessarily [represent all groups](#) who use or maintain the system.

Sudan's Gezira Scheme, a large irrigation system between the Blue and White Nile, is a useful example. The Gezira Scheme Act of 2005 [transferred field-canal management to water user associations](#). Research on the reform links its poor performance to [unclear objectives, limited farmer involvement and gaps in technical knowledge](#), with some damage to irrigation infrastructure attributed to the latter. Later amendments shifted more responsibility back toward the ministry, while local farmer organizations have [continued to play roles in water distribution](#) while depending heavily on the state for technical support, finance and operations.

Existing institutions can also reproduce exclusion. In Libya, men and women agreed that water oversight should involve the community but [named different actors](#). Male participants tended to emphasize elders and sheikhs, while female participants stressed the involvement of women and younger residents. One woman noted that elders or sheikhs who opposed a project could obstruct it. Consultation that relies only on established authority figures can therefore leave out people who use the system, contribute to its upkeep, or experience its failures differently.

In Yemen, women have sometimes helped resolve resource disputes despite holding little formal authority, drawing on locally recognized mediation roles in communities where established leadership remains largely male. In Taiz, for example, a female mediator described [bringing local leaders together to negotiate civilian access](#) to water tanks.

This issue extends to other forms of local representation. In Nepal, recent research found that [lower-caste and other marginalized groups remained poorly represented in local water committees](#), which can undermine their overall effectiveness and

legitimacy. In rural Sri Lanka, [established local elites repeatedly occupied key positions in community water committees](#) while other members remained largely passive, weakening overall participation in maintenance and small construction works on water distribution lines.

For water user associations, participation should not be treated as a separate structure added alongside existing institutions. It should [build on the roles that people already play](#) in managing access, resolving disputes and maintaining infrastructure, while also addressing the exclusions those institutions may reproduce. This matters because a user association works best if it can draw on local knowledge, secure cooperation across different groups and [resolve problems before they disrupt the system](#).

Practical Takeaway: Where management is transferred to a user association, its membership and consultation should reflect those who use, maintain or help mediate access to the system. The transfer should also be backed by budgeted technical support, clearly defined responsibilities with the relevant ministry or agency, and a viable revenue base.

Policy Implications

For governments, donors, implementing agencies and technical teams working on water infrastructure, these findings imply four changes to project appraisal, design, funding and review.

1. Make institutional assessment part of infrastructure appraisal. Damage, feasibility and recovery assessments should include a [short institutional baseline alongside the engineering assessment](#), rather than relying on community consultation as a proxy. The baseline should establish how the system is governed *before* investment begins, providing a benchmark against which later changes in authority, maintenance, dispute resolution or cost recovery can be tracked.

2. Review the institutional effects of design choices before approval. Technical appraisal should consider [whether a proposed structure changes control over water](#), the distribution produced by an existing rule, or the decisions that users can still make once the works are built. Where it does, redesign or renegotiation should happen before construction. This makes the institutional consequences of a design choice part of project approval rather than a problem dealt with after implementation.

3. Fund the system that keeps the asset working. Capital budgets should include [a credible plan for operation, maintenance and technical support](#) over the life of the asset, particularly where new technology replaces local labor with machinery, energy or purchased inputs. Where a committee or user association will operate the works, budget for the technical and negotiating skills trainings needed: maintaining equipment, obtaining parts, enforcing contractor specifications, and making repair or funding claims to the responsible budget holder.

4. Define when and how institutional arrangements will be reviewed. Allocation rules, maintenance arrangements and local authority structures should [not be treated as fixed at baseline](#). Project design should specify the changes that trigger review — such as shifts in water availability, technology, use or local authority — and who participates, including users, maintainers and informal mediators as well as established leaders.

Diagnosing the system, not just the asset

Use this to place a site before deciding what to fund. A damage assessment should record two conditions separately: whether the physical works still perform as designed, and whether the local institutions that allocate, maintain and adjudicate water still hold authority. Read across for the state of the works, down for the state of those institutions, and the quadrant gives the response the case calls for — and, in the lower right, the case for not proceeding at all. Repairing the asset is appropriate only where the authority needed to operate, allocate and maintain it still exists.



	WORKS FUNCTIONING AS DESIGNED	PHYSICAL PERFORMANCE OR CONTROL CHANGED
AUTHORITY HOLDS	MAINTAIN AND MONITOR Record it now, and say when it will be reviewed - Document the allocation rule, the obligations that follow from receiving water, and the forum that settles disputes. - Specify what triggers a review: water availability, technology, patterns of use or local authority. - Name who takes part, beyond the most established leaders. - Record how maintenance is financed — the share of water, labour or revenue set aside for it — and whether that share still covers the cycle.	RENEGOTIATE THE RULE Renegotiate through the body that can vary the allocation - Record the flows or turns each reach receives across a season, with dates. - Put that record to the authority that can revise the allocation, before a dispute reaches the works. - Cost the maintenance cycle the new structure requires, including machinery and operators. - Expect unresolved shifts to end at the structure: where a new weir broke the prior distribution, communities have removed it and reverted.
AUTHORITY WEAKENED	REBUILD GOVERNANCE Repairing the asset will not restore the capacity to govern it - Record whether dispute forums still convene, how often, and who convenes them. - Name the party responsible for each recurrent cost — energy, spares, purchased water, desludging — and the source of funds. - Include women and others who already mediate access without formal office. - Where statutory and customary systems both claim jurisdiction, record which one actually governs access, and how a claim moves between them.	PAUSE HANDOVER Do not proceed to handover on the works alone - Treat redesign and renegotiation as one decision, taken before construction. - Establish a funded operator with a named repair lead and a defined support arrangement. - Where no body can vary the rule, expect the distribution the new works produce to stand. - Fix the operating body and its funding before commissioning; responsibility transferred repeatedly after the fact degrades performance.