Transitioning away from open access: lessons learnt from a comparative analysis of water allocation regimes worldwide

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doi: 10.2166/9781789062786_0255

Chapter 20

Transitioning away from open access: lessons learnt from a comparative analysis of water allocation regimes worldwide

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ABSTRACT

The transition from open to regulated access to water resources is a challenging task for water managers who have to address complex environmental, social and economic trade-offs. Water allocation is a powerful tool, yet its implementation is deeply conflictual. This chapter compares the process of transitioning to regulated access in 13 case studies worldwide. It shows the wide diversity of institutional settings and design choices, while exploring why differences occur and considering the advantages and disadvantages of the different approaches deployed in various contexts. It concludes with key takeaways and reflections on the need for ongoing work assessing the environmental, social and economic performance of allocation regimes.

Keywords: Allocations, case studies, governance, institutions, transitioning

20.1 INTRODUCTION

The transition from open to regulated access to water resources, and the setting of water allocations, can be a deeply conflictual and political process that can disrupt perceived historical rights and run against entrenched practices and interests. However, driven by the need to achieve more sustainable water use in over-allocated basins, this process is playing out across the world, amidst intense pressure from climate change, population growth, economic development, and other stressors on water supply and demand. Establishing water resources allocation regimes requires time and much collective effort to succeed, and to our knowledge, none of the cases presented in this book are yet truly successful, that is in adequately balancing environmental, economic and social goals of sharing water.

As Blomquist and Babbitt (Chapter 2) put it, 'there is no reason to expect that transitions from open access to allocations will be easy, quick, or inexpensive, or will be successful upon first attempt'. Furthermore, there is no single model that would fit all situations for an effective, efficient and fair allocation regime. Rather, we should expect allocation regimes to have unique features and require particular reform processes which 'reflect basin characteristics and conditions, uses, preferences

and priorities, and the historical, cultural, and political contexts of land and water use'. While we therefore cannot recommend a blueprint for transition, we can critically assess current institutional, social and technological innovations, learn from experience, foster knowledge exchange and promote experimentation through 'institutional bricolage' (Cleaver, 2017).

This book presents reflections on key dimensions of water allocation policies and a unique range of cases of water allocation regimes across the world. Building on the content presented earlier, this concluding chapter aims, first, to compare the process of transitioning to regulated access and key features of allocation regimes in 13 case studies. It shows the wide diversity of institutional settings and design choices, and aims to explain, where possible, why differences occur and point out the advantages and disadvantages of the different approaches deployed in various contexts. This comparison is organised around key features of allocation regimes presented in Chapter 1: the institutional framework, the process of setting extraction limits, (re)allocation rules, and compliance and enforcement. The chapter concludes with key takeaways and reflections on the need for ongoing work assessing the environmental, social and economic performance of allocation regimes.

20.2 ESTABLISHING A FACILITATING INSTITUTIONAL FRAMEWORK

20.2.1 Overview of the main steps of institutional development

The transition from open access to regulated access to water resources necessarily relies on the establishment of an enabling institutional framework which defines the roles and responsibilities of the state and user communities in sharing water resources, the characteristics of water use rights, and links with other policies impacting water use. Although each case reported in the chapters of this book had its own institutional development pathway, some common features appear, which are summarised in Figure 20.1 and in the following paragraphs.

❶ As most abstraction historically drew on surface waters, early institutional structures tended to address conflicts over access to surface water. The riparian doctrine was applied widely across Europe, although appropriation by royal decrees occurred in the middle ages in countries such as France (Chapter 9). Collective institutional arrangements were generally implemented by a local community

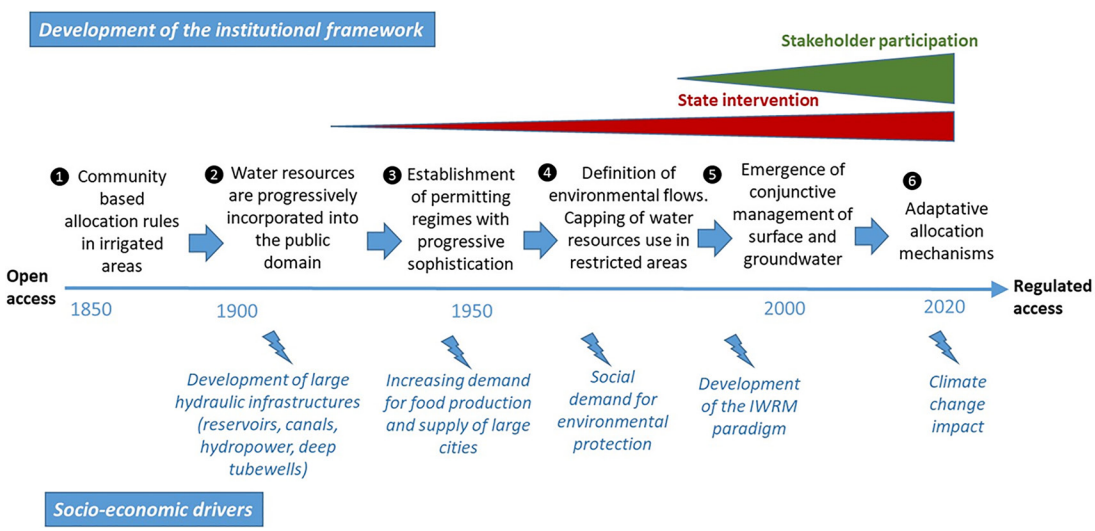

Figure 20.1 Main steps in the transition pathway from open access to regulated use of water resources. (IWRM: integrated water resources management).

or a community of irrigators and oriented towards enabling water use for economic development, as in the case of the allocation systems developed by settlers in Idaho in the late 1800s on the basis of the idea of 'first possession' (Chapter 16), or the *associações de vala* (canal cooperatives) set up by rice farmers in Brazil in the 1920s (Chapter 13). In some places, like Mediterranean Spain (Chapter 8), community-based institutions organising water allocation have been in place since the Arabic period in the early middle ages.

The growth of modern economies through industrialisation (e.g. hydropower development) and large-scale irrigation programmes in the late 19th and 20th centuries had increasingly significant impacts on hydrological regimes, leading many states to incorporate water resources in the public domain ❷ and to increasingly intervene in allocation – in particular through the establishment of permitting regimes regulating access to and use of surface water ❸. This is exemplified in Alberta as early as 1894 (Chapter 15), when the then dominant riparian common law could not accommodate the increasingly intense conflicts over the exploitation of water resources. Later on, in response to growing demand for environment protection, the concept of flows reserved for the environment was progressively incorporated into water legislation and systems of water use restrictions were implemented, progressively taking the form of a cap on water usage ❹.

Groundwater development brought new water management challenges, especially in the second half of the 20th century as surface water became more regulated and technological change facilitated access to groundwater resources. Dropping water tables and heightened tensions over resource availability saw interventions by authorities to control groundwater use and manage access. Controls began with requirements over well registration and locations, sometimes as early as the early 1900s (e.g. New South Wales in 1912; England and Wales in 1945; Turkey in 1960; India in the 1970s). Some major legislative changes were sparked by threats of further litigation between water users (see Nebraska, Chapter 17). This led to the emergence in the late 20th century of truly integrated regulatory frameworks facilitating the conjunctive management of surface water and groundwater systems ❺. Integrated Management Planning in Nebraska, and the recent settlement agreement in Idaho are cases in point. The most recent developments in allocation regimes aim at increasing resilience in a rapidly changing climate, through implementing adaptive allocation mechanisms (see New South Wales, Chapter 12) ❻.

20.2.2 Formalising water use rights

The transition to more regulated control has generally been accompanied by a formalisation of water use rights over the 20th century. The most frequent approach has been to transfer water use rights into the public domain, especially with regard to surface water. Use is managed with permits or concessions formalising individual (or, more rarely, collective) water extraction rights. Those rights, which often have a time-limited validity, can at least in theory be modified, reduced or even cancelled without compensation by the State (for meeting general interest objectives).

Regarding groundwater, although first left to landowners' appropriation, authorities in many countries have ultimately brought groundwater into the public permitting regime, as described in many cases presented in this book (see e.g. Brazil, Colorado in Chapter 19, France). In some places however, the legal framework recognises water as private property (e.g. Texas in Chapter 19, as well as places not covered in the book such as Chile). Those rights can be sold, leased and mortgaged and any reduction in allocation decided by the State would require compensation (buy-back).

Cases exist also where individual use rights are still not formalised through permitting regimes, especially in the case of groundwater (e.g. California). Users may nevertheless decide to formalise individual use rights through adjudication, but this is not systematic and other solutions are being developed to achieve more sustainable management of the resource (see Section 20.2.4).

Finally, hybrid systems of water use rights are also in place. For instance, Spain (Chapter 8) has opted for a dual system, by declaring all water as public, except where users opted to report their historical usage into a Catalogue of Private rights. Those private use rights are thus formalised but not

regulated through the permitting regime implemented for public waters. As a trade-off, the law forbids users to modify any characteristics of their private use rights, including location of the extraction point, volume withdrawn, timing, or the purpose of the water withdrawal.

Independently from the ownership issue, water use rights may be defined in very different ways: in the simplest allocation regimes, they consist of an access right, that is an administrative authorisation of the extraction point (well or borehole, pumping station, diversion weir); in that case, users have no limits on extractions. This access right can be complemented by an extraction right, specifying the pumping capacity in flow rate or total volume that can be withdrawn over a specific period of time (irrigation season, low flow period, year). Extraction rights can be further differentiated into entitlements and allocations, an issue examined in Section 20.4.

Extraction rights are generally implemented in water scarce areas, whereas access rights are typically used in less sensitive areas. This is explained by the high transaction costs associated with establishing extraction rights and monitoring actual use, as well as the political costs of establishing a sustainable abstraction cap (see e.g. chapters 2 and 6). Spain prioritises basins with an imbalance between supply and demand as well as those at risk of an imbalance. California identifies high to medium-priority, and critically overdrafted groundwater basins, where Sustainable Groundwater Management Plans must be adopted. Nelson (Chapter 3) supports introducing allocation systems preventatively, in order to avoid 'lock-in to unsustainable use and allow for adjustment at least cost, as needed, over time'. Similarly, Blomquist and Babbitt (Chapter 2) suggest setting an initial cap and controls on water usage, as imperfect as it may be, allowing for adjustments as knowledge on basin conditions improves.

20.2.3 The role of authorities and user communities in allocation decisions

Overall, the cases presented in this book clearly show that the establishment of a water allocation regime results from decisions made across multiple scales. Allocation decisions play out in complex multi-level or polycentric systems of interrelated governing bodies, often acting in partnership with user organisations. The diversity of situations can be characterised by looking at the role of public authorities and the involvement of communities, users and stakeholders in allocation decisions, as depicted in Figure 20.2.

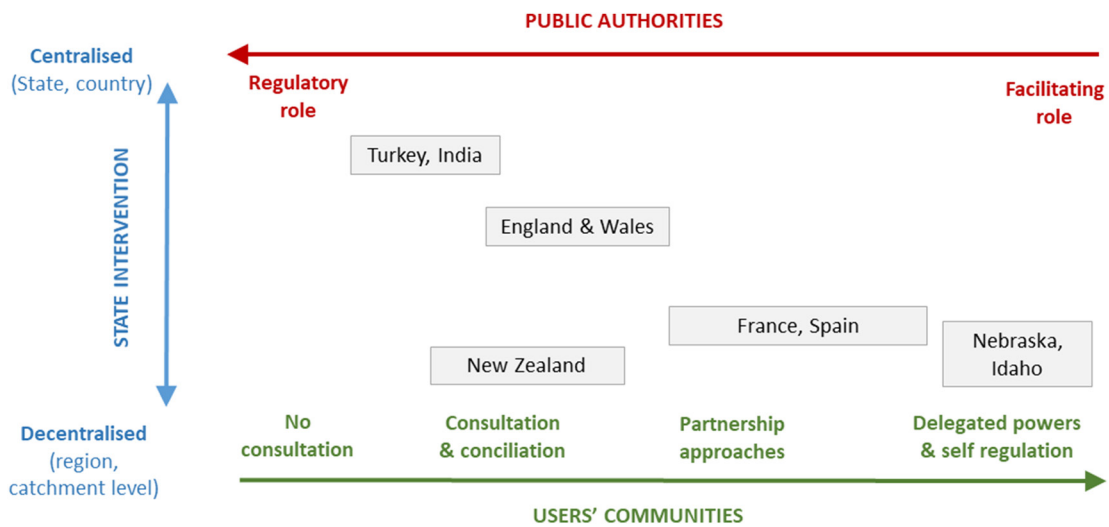

Figure 20.2 Role of public authorities and user communities in allocation. Note: selected examples.

20.2.3.1 The state: from centralised, regulatory interventions to decentralised, facilitative approaches

Concerning public authorities, their role in the transition to regulated access can range from regulatory to facilitative. In regulatory approaches, a centralised state agency makes the key decisions, including defining restriction zones, assessing environmental flows, setting allocation limits and adjusting individual water use permits, based on national procedures. In facilitative approaches, public authorities do not directly participate in allocation decisions, which are devolved to stakeholders; instead, authorities contribute to providing scientific and technical information and to establishing an institutional environment facilitating negotiation and conflict resolution; the State, however, reserves the right to intervene and make allocation decisions if stakeholders do not reach an agreement. As shown in Figure 20.2, most cases covered in this book are hybrid situations, lying on a continuum between those two extreme approaches.

The cases of England and Wales, and New Zealand are illustrative of the more regulatory approach:

- England and Wales illustrate a rather centralised regulatory approach: a national permitting regime defines legitimate users within a wider river basin planning programme under the EU Water Framework Directive; a long-established abstraction licensing regime, originating with the Water Resources Act 1963, is implemented by a central agency; allocation decisions are formalised in Catchment Abstraction Management Strategies and attendant Abstraction Licensing Strategies. Increasingly, this regime is oriented towards environmental sustainability at the catchment scale. Other strongly centralised and regulatory cases are Turkey, India (Chapter 14) and Uzbekistan (in the Amudarya Basin, Chapter 18).
- The case of New Zealand illustrates a more decentralised regulatory approach, where the central government delegates responsibility for water resource management to regional councils. These local government bodies, in consultation with communities and Indigenous groups, create binding statutory plans to deliver on nationally-defined limits and bottom lines, and locally identified objectives, under an overarching policy goal of sustainable management. Allocation decisions are made at the regional or sub-regional level and applied at the scale of catchments or 'freshwater management units' within an integrated management context directed towards ecosystem health and community wellbeing.

At the other extreme of the spectrum, the facilitative approach is illustrated by the US examples (Nebraska, Idaho). In Idaho for instance, in 2015, state authorities brokered a 'Water Settlement Agreement' between competing users of groundwater and surface water from the Eastern Snake Plain Aquifer to restore groundwater levels and sustain surface water flows. Implementation and monitoring of the agreement were devolved to a great extent to the groundwater districts, each of which decided how it would achieve the required reductions. The agreement was mostly achieved because the state threatened to intervene and impose reallocations centrally if users did not compromise.

20.2.3.2 A closer look at user and community involvement

The involvement of communities, users and stakeholders in allocation decisions varies considerably in terms of its form and extent in the cases presented in this book; however, a general trend across jurisdictions has been to make allocation regimes more inclusive, including with regard to Aboriginal values and interests (see chapters 3 and 4). More inclusive and transparent decision-making processes can better take into account local context, build trust, and ultimately craft rules that are more likely to be complied with (Newig *et al.*, 2018).

As public authorities move from centralised regulatory approaches to more decentralised facilitative ones (Figure 20.2), stakeholders are increasingly involved in allocation decisions. In the cases presented in this book, a progression of three tiers can be observed from no consultation and little communication to:

1 Consultation and conciliation, where the focus is on sharing information and creating a degree of shared understanding of the need and basis for capping use and making allocations;

2 Partnership approaches, involving various forms of cooperation or collaboration between users, communities and authorities, where a degree of power sharing is authorised on the part of authorities; and
3 Delegated powers and self-regulation, where user associations and communities regulate access to water.

The first tier of involvement is evident in the cases of India and Turkey. In India, the government has sought to regulate groundwater use since the 1970s, via a national Integrated Watershed Management Programme run by the Ministry of Rural Development. However, this programme was implemented without sufficient adaptation to the needs of specific aquifers and local conditions, and meaningful participation by communities has often been lacking. While there are calls to strengthen participatory processes in decentralised groundwater allocation and management, a techno-managerial paradigm still predominates, which limits scope for participation beyond consultation. Similarly, in Turkey, water users and their representatives are confined to consultative roles in Basin Management Committees and Provincial Water Management Coordination Committees.

The second tier involves communities and users in various forms of partnership alongside authorities in decision-making. For example, the cooperative approach adopted among French environmental authorities, river basin councils, and users involves co-defining management targets and allocations at river basin and catchment levels. Other examples include the collaborative 'catchment-based partnerships' that have proliferated in England and Wales since 2013.

In the third tier, water authorities may opt to delegate decision-making and management powers to communities or groups of water users, with requirements to self-regulate and self-monitor. In the US examples where the State has a facilitative role (see Section 20.2.3.1 above), the Natural Resource Districts in Nebraska exercise delegated authority to make institutional changes and sanction violators for over-abstraction (Chapter 17). In Brazil and France, for example, authorities have issued collective permits to groups of users who allocate to individual members and monitor use. Other instances of power delegation in decision-making can be seen in the allocation and monitoring responsibilities devolved to groundwater districts in Idaho (Chapter 16), and to irrigation collectives in New Zealand (Chapter 11). Forms of self-regulation may be efficient and effective in certain circumstances, but may fail in others. They can be captured by specific interests (Lopez-Gunn & Cortina, 2006) and fail to achieve environmentally sustainable management of the resource (see e.g. Chapter 2, Rouillard *et al.*, 2021). Hence, a key question is how to create institutions that build on the synergies between state and community control, rather than seeing them as antagonistic.

20.2.4 Establishing a wider supportive policy framework

Water allocation regimes seldom work in isolation in the transition from open access to more sustainably governed water resources. In particular, controls on water abstraction will need to be accompanied by a coherent and integrated policy framework that provides incentives and compensatory mechanisms to soften transitions to regulated access (Figure 20.3). Even a well-designed allocation regime can be undermined by perverse incentives in other sectors, such as subsidies that encourage over-consumption of water resources.

In the cases presented in this book, subsidies of various kinds are widely used to promote behaviours consistent with water conservation or to compensate for the economic impact of reduced allocations. In the Turkey, India and EU examples, subsidies are targeted at practices and technologies to prevent water losses and leakage, as well as to promote agri-environmental practices consistent with water conservation.

Subsidies need not be in the form of direct payments to water users. For example, in the US state of Idaho, the State committed to making a significant contribution to aquifer recharge to offset the costs of required reductions in groundwater withdrawals. Similarly, in France where most of the reductions required to achieve sustainable extraction caps affect the agricultural sector, farmers can access

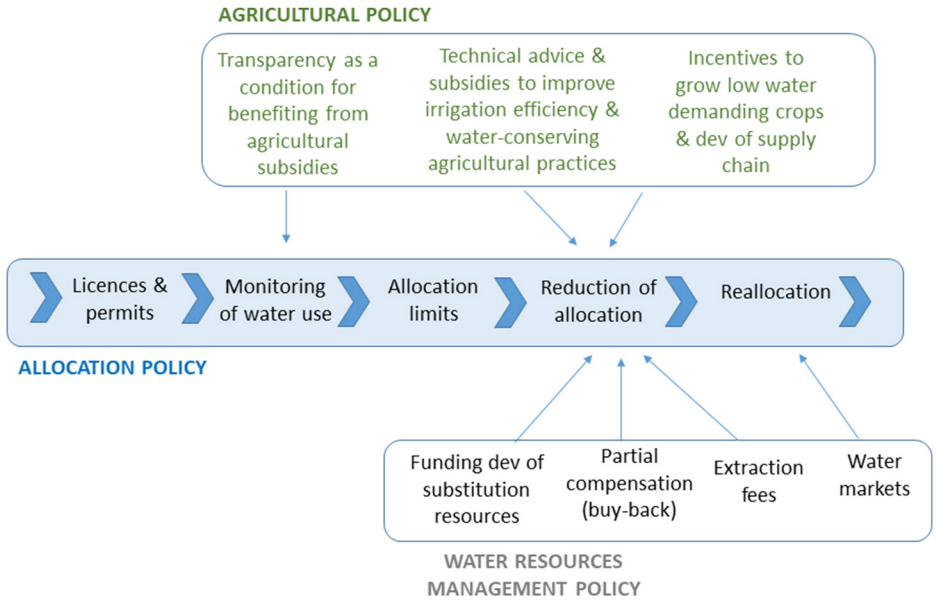

Figure 20.3 Elements of an integrated policy framework for the transition to regulated access with water allocations.

financial support to build storage schemes that can capture flood flows and winter runoff. With other societal groups opposing these solutions, 'contracts' are emerging to deploy an integrated approach to meeting allocation limits by making support for storage schemes conditional on adopting less water-demanding crops, increasing water use efficiency, and building resilience in farming systems through sustainable soil management, agro-ecological practices, and organic farming. This case highlights that policy and institutional arrangements should bring private-sector investments and community activity into line with objectives for water allocation and management.

Aside from subsidies, various other economic instruments may be deployed to complement allocation regimes, as outlined by Perez-Blanco (Chapter 6). Water charges or tariffs can incentivise water saving and efficiency gains on the part of water users, although, in many cases presented in this book, they are not set at sufficiently high levels to have an incentive effect. Various forms of pecuniary payments may be used to encourage temporary reductions in water withdrawals (see Brazil, Chapter 13), markets may facilitate transfer of water permits and increase efficiency of water use at basin or aquifer scales (see New South Wales, Chapter 12), and financial sanctions for non-compliance with allocations are an important tool available to regulators wherever education and engagement cannot secure compliance (see Section 20.5).

20.3 SETTING THE ALLOCATION CAP

As the cases presented in this book show, the process of setting an overall cap on allocations involves several steps and types of assessments (see Chapter 1 and Figure 20.4). All of these assessments are fraught with major technical difficulties and scientific uncertainties that complicate negotiations over the setting of the allocation cap. Below, we focus on three challenges which cases presented in the book have commonly identified: integrating environmental needs; addressing temporal variability of water resources; and accounting for connectivity between water sources.

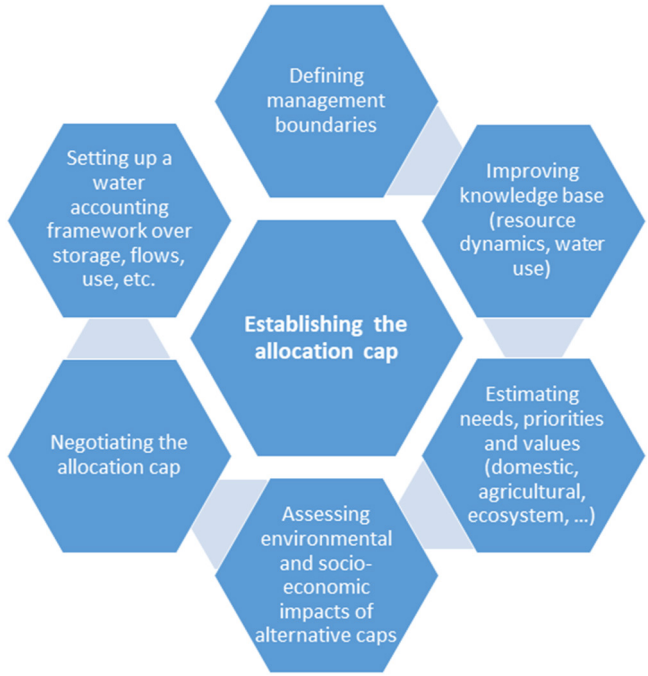

Figure 20.4 Key steps and challenges in setting an allocation cap.

20.3.1 Integrating environmental needs

In the majority of cases in the book, the main approach to integrating environmental needs in allocation limits is to set minimum flows for rivers, sometimes complemented by minimum aquifer levels where groundwater discharge plays a role in sustaining base flows during the low flow period. Minimum river flows and groundwater levels are used as thresholds for implementing temporary restrictions on water use (e.g. when rivers approach or drop below these levels). They may also be taken into account when establishing volumetric allocations to water users (see e.g. chapters 9 and 12).

In the chapter on environmental flows, Stein *et al.* (Chapter 5) highlight that, ideally, flow requirements should be set based on their functional role in maintaining resilient and healthy aquatic ecosystems. This means not only ensuring that minimum flows are not breached during the low flow period, but also maintaining the full range of flows needed to sustain ecosystems (e.g. including high and variable flows). According to the authors, greater use of functional flows may offer greater flexibility to allocate water among environmental and agricultural uses in times of need. However, no cases report using such an approach, although Spain does set various flow requirements (Chapter 8).

In the cases presented in this book, flow requirements are usually set according to water quality standards (i.e. maintaining certain flows for their dilution effect), sediment or temperature characteristics in rivers. In Turkey (Chapter 10), minimum flows are based on arbitrary criteria regarding hydrological characteristics using the Tennant method. In theory, European countries are required under the EU Water Framework Directive to maintain near natural hydrological and morphological character to maintain healthy aquatic ecosystems. In practice, flow requirements are still based on the needs of specific (protected) species rather than on maintaining whole ecosystem functions. Ecosystems and key protected species are taken into account in the US under the Endangered Species Act (see Chapter 17).

The task of determining the 'natural' character of a river or groundwater body and establishing the degree to which the natural flow of a river can be modified without hindering water-dependent ecosystems is still fraught with scientific challenges. This has exacerbated disputes and tensions over setting the 'right' minimum river flows, groundwater levels and volumetric allocations for environmental needs – and their implementation, especially where it has involved reallocating water from agriculture to the environment. Authors in the book advise appropriate attention be paid to local conditions, characteristics, and contexts when setting allocation limits and establishing a transparent process that allows for integration of not only physical considerations, but also social and historical ones (see chapters 2 and 5).

20.3.2 Addressing the temporal variability of the resource in the allocation cap

Available water resources are, by nature, highly variable between months, seasons, years and decades. However, the temporal dynamics of water resources are varied within river basins, as one may find:

- Rivers largely modified by reservoirs, where water storage can, in theory, support delivery of specific quantities of water downstream across the year;
- Rivers in which flows are not supported by reservoir storage and are thus likely to present a more variable flow pattern;
- Groundwater bodies, where there is often limited understanding and knowledge of water storage capacities, water levels, and aquifer structure and dynamics. Some will be connected to surface water bodies and terrestrial ecosystems while others will be shared with other river basins;
- Water transfers to or from other river basins, and unconventional water such as treated wastewater, desalinated water and intercepted rainwater.

When transitioning to regulated access, two general strategies appear to be applied in the cases studied in this book. The first strategy is usually to manage scarcity and drought conditions by restricting use when specific flows or groundwater level limits are reached. Particularly suitable for rivers with more variable flows (i.e. not supported by large storage capacities), these temporary limits on the authorised licensed flow rates are highly dynamic, allowing full use of the resource in times of abundance and providing a form of 'safety net' in emergency situations. However, as scarcity conditions worsen (due to aridification or higher levels of consumptive water use in the system), short-term, emergency limits become more problematic. A race to the bottom may start with agricultural users behaving strategically to appropriate more water before restrictions commence, resulting in even more frequent restrictions (e.g. Chapter 9). Short-term, emergency limits do not address structural over-allocation problems, leaving holders of more junior rights with more uncertain security of supply.

The second strategy involves adopting a collective volumetric cap (further specified in individual caps for authorised users, see Section 20.4.1). Volumetric caps limit withdrawals for specific timescales (e.g. monthly, seasonal, annual and interannual). Methodologies for defining volumetric caps differ between cases and include statistical and political exercises to define the acceptable security of supply to the authorised users. The volumetric approach is particularly suitable for surface water and groundwater systems where storage capacity negates the impact of rainfall variability between years. However, this approach has created tensions where the cap prevents increasing storage of abundant winter flows (Chapter 9).

20.3.3 Accounting for connectivity between water resource types

Recognising interactions between water sources – in particular between surface water and groundwater systems – is of increasing concern to allocation regimes in order to avoid unintended impacts of regulation of one source on another unregulated source (chapters 3 and 5). The cases collected in this book reflect a gradual process of increasing integration of allocation systems across surface water and groundwater. Several cases in the book have, in particular, moved to more integrated accounting

across water resource types. In New South Wales for instance, Water Sharing Plans have rules linking the management of surface water and groundwater where there is strong connectivity between the two resources. A proportion of groundwater recharge is assigned to the environment, recognising thereby that groundwater levels and discharge into surface ecosystems are still impacted even if extraction is less than recharge.

Cases of active conjunctive management remain rare in the cases outlined in this book. In Idaho (Chapter 16), conjunctive management of surface water and groundwater was adopted in 1994 in order to tackle dwindling groundwater resources driven by a reduction in incidental groundwater recharge and increased rates of groundwater withdrawal when farmers switched away from diversion-based irrigation to groundwater-based irrigation. Recent political agreement strengthened conjunctive management rules by diverting flood waters (and therefore water not appropriated by anyone) to recharge groundwater through the existing system of irrigation canals and dedicated spreading basins and injection wells. In Nebraska, surface water infrastructure has been repurposed to support groundwater recharge outside the irrigation season and to maximise the use of surface water in lieu of groundwater when surface supplies are high.

Other resource connectivity issues reported in the cases involve the increasing utilisation of previously unused treated wastewater, which has implications on downstream users who previously benefited from wastewater discharges. Changes in use patterns, especially higher consumptive uses such as agriculture, need to be accounted for in water balances as they can pose significant challenges in fully and over-allocated basins where several uses rely on wastewater-fed downstream flows. In Spain (Chapter 8), modification of concessions is required when a single user plans to reuse their wastewater, and reuse by another user is subject to a separate concession.

20.4 ALLOCATION AND REALLOCATION RULES

When transitioning from an open to a formally regulated system, decisions must be made on how to share the allocable pool through establishment of allocation and reallocation rules between users. We identify five steps, each with their own challenges and solutions (Figure 20.5).

20.4.1 Defining authorised users at initial implementation of the allocation cap

Historically, various legal principles and norms applied to prioritise uses in times of scarcity, such as the riparian doctrine or the rule of prior appropriation (see e.g. Chapter 15 for a discussion on the two regimes in Canada). In the cases presented in this book, authorities and user associations typically recognise historical users as the legitimate users, and their historical water use has generally been recognised ('grandfathered') as entitlements. This illustrates the difficulty of sharing water more equitably, at least when first formalising water use rights.

It is worth noting that several cases describe provisions for exemptions from registration and permitting. This may be based on the intended water use (e.g. drinking water for personal use or for animals), the source of water (e.g. spring water, rainwater), or the amount of water. For instance, Spain exempts users from the need to obtain a permit for withdrawals of less than 7000 m^3 per year, but registration is still required. Several authors discuss fairness and equity issues in relation to exemptions, as well as the risk of opening the door to overexploitation. As a result, some legislatures are progressively removing exemptions. In England and Wales, for instance, the rights of irrigators and the Crown to take unlimited amounts of water were removed in 2017, but the law still exempts abstraction of less than 20 m^3 per day (equivalent to $\sim$7000 m^3/year).

20.4.2 Adjusting individual allocations to the allocation cap

Where the sum of individual entitlements exceeds extraction limits, rules are needed to ramp down, or claw back, allocations to match extraction limits. However, modifying entitlements runs against entrenched views on historical water use rights and can face major legal constraints. The

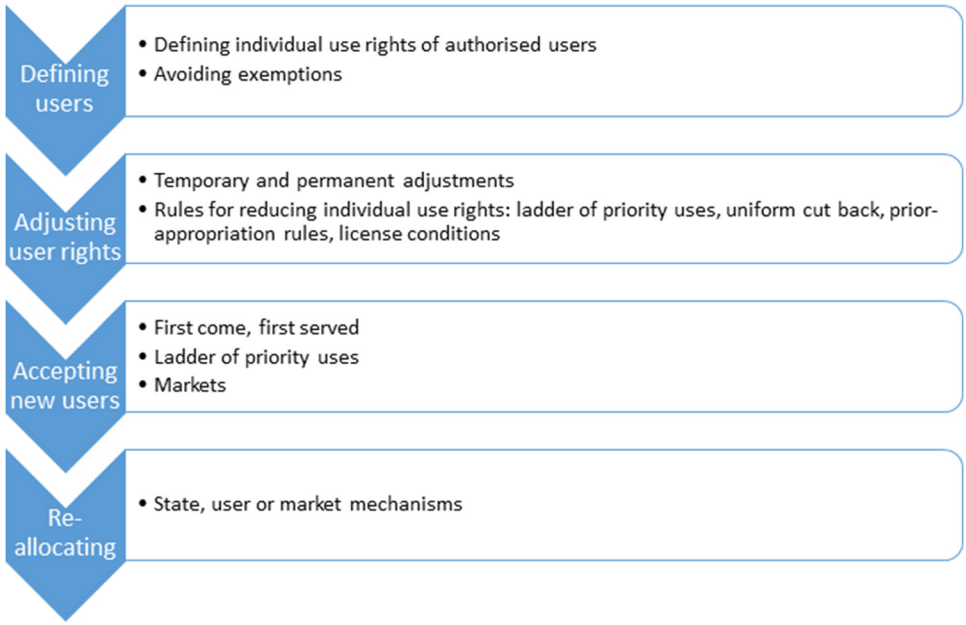

Figure 20.5 Types of allocation and reallocation rules observed in the case studies.

cases presented in this book describe two overarching strategies that have been adopted in reducing allocation.

20.4.2.1 Temporary reductions

The first strategy involves maintaining entitlements, for example at their historical levels, but reducing them temporarily to meet extraction limits. In this system, entitlements act as a right to a share of the available resource; hence, the user is authorised to withdraw only up to their allocation, not their full entitlement. This approach is the most widely implemented, and is used in particular during temporary drought restrictions. In Spain, it is used where institutional rigidity and the threat of significant compensation claims have prevented major permanent reductions of existing concessions in over-allocated basins. It has also been used in other contexts such as Idaho, where voluntary cuts were agreed upon until groundwater reserves were replenished, at which point allocations would return to the original specification of the entitlement. Some cases formally 'unbundle' long-term entitlements and annual allocations. New South Wales for instance presents a sophisticated accounting framework combining extraction limits, entitlements and allocations (called Available Water Determinations), where allocations are tied to resource availability throughout the year (see Chapter 12).

20.4.2.2 Permanent reductions

In some cases, the choice has been to permanently ramp down entitlements to reduce over-allocation and increase the likelihood that a given user is able to use their full entitlement in any year (in other words, to increase the security of supply to authorised users). This approach has been implemented at great social and political costs in New South Wales (Chapter 12). In France, several agricultural user organisations have established a multi-annual process to reduce individual volumetric allocations to a sustainable extraction cap. This approach was facilitated by the designation of water as a 'common good to the Nation' and development of a strong narrative against any private appropriation of water

resources. Authorities in England and Wales have taken a similar approach and facilitated the process by removing from the statutes all compensation measures for revoking and amending licences.

20.4.2.3 Rules used to reduce use rights

Rules to reduce use rights (temporarily or permanently) are described in several cases covered in the book:

- A first approach and the easiest one, is to remove unused or underused water rights (e.g. from valid permits). In the US, legal systems have historically accommodated the need to exploit water for 'reasonable' and 'beneficial' use, recognising therefore that use patterns can affect the legitimacy of a use right. However, this approach risks encouraging full use of licences by users who fear losing them otherwise.
- A second approach is to specify a ladder of priority uses. Many countries have established such prioritisations to implement drought restrictions. These typically prioritise drinking water over agricultural water uses. This approach can also be used to implement permanent reductions to entitlements (e.g. preserving entitlements for drinking water over those for agricultural uses) (e.g. Canada, France).
- A third approach exists in prior-appropriation systems which prioritise 'senior' rights (i.e. longer-standing, based on the date of permit issuance or well construction) over 'junior' (i.e. more recently assigned) rights. Junior rights are more severely affected by cuts than senior rights when cuts are implemented. In some cases, statutes have superposed a priority-based system to prior-appropriation to protect essential uses (e.g. Alberta in Canada).
- A fourth approach involves applying uniform reductions across entitlement owners (e.g. % of entitlement). This implies that all users are equally affected by cuts. It is coherent with some aspects of legal principles recognising the 'riparian rights' of surface water users and the 'correlative' rights of groundwater users to use a common water resource. It appears to be implemented more frequently for temporary cuts than for permanent reductions in use rights.
- Fifth, some countries, such as Spain, require that licensed users increase their efficient use of resources according to efficiency targets set in their concessions. This is implemented where the same use can be maintained with a smaller quantity of water. In agriculture, for example, this may lead to investments in more efficient irrigation. In order to avoid the 'saved' water being redirected to other consumptive purposes, potentially resulting in increased net water consumption, the saved water is subtracted from the licence, and no new entitlements are issued with the saved water.
- Sixth, in some places (e.g. New Zealand, Chapter 11), licence conditions provide a specified security of supply. Those with a lower security of supply will be limited in their use before users with a higher specified priority. The advantage of this system is that users can seek to obtain the most appropriate level of supply security when applying for a permit.

20.4.3 Accepting new users

Another challenge is how to prioritise between existing and prospective users when the resource is considered fully allocated. Issuing additional water use rights would impact environmental flows or reduce other users' rights or security of tenure. The authorisation process therefore requires consideration of the degree of flow or volumetric commitment, impacts on downstream flows, ecosystems and protected areas, and other users' security of supply. In most cases covered in the book, where a river or groundwater basin is considered over-appropriated and 'closed', new users are only accepted when water is 'freed up' when a legitimate user surrenders, loses or sells their water use rights.

In the case where market transactions are allowed, the water use rights may be acquired by buying the water use right itself, or indirectly by buying the land to which it is attached. Few cases allow

market transaction of the water use right itself (e.g. New South Wales, Spain, England and Wales) although this, in theory, leads to a more economically optimal allocation of water use rights (see Chapter 6).

In most cases, new users must buy (or rent) the land to which the water use right is attached, or apply for an authorisation for instance in the form of an administrative permit. Most authorisations are issued with a 'first come, first served' approach, wherein prospective users are prioritised according to the date of their original request (e.g. on a waiting list). This approach is applied in Brazil and New Zealand. This approach does not permit optimisation of the economic value of the allocable water as in the case of markets. A prioritisation that favours pre-defined water uses is however sometimes applied by the authorities or organisation responsible for issuing authorisations to use water. For instance, in Spain, the same priority ladder that is applied during droughts is implemented to prioritise the issuance of permits (e.g. for drinking water before agriculture). In France, rules have been defined by agricultural user organisations to prioritise higher-value agricultural production systems over lower-value ones, or young farmers (to encourage farm renewal and investments).

20.4.4 Facilitating state, user or market reallocation

In most systems presented in this book, the state reallocates water use rights. For instance, in the Uzbekistan part of the Amudarya Basin (Chapter 18), users apply to the government for yearly allocations. Similarly, in Turkey (Chapter 10), water reallocations are decided by state authorities. Where some form of devolution to users or communities exists (see Section 20.2.3), non-state actors may themselves manage reallocation of water. In Brazil and France, for instance, user associations have powers to reallocate among irrigators in their management areas.

Several authors (e.g. chapters 2 and 6) support the use of economic instruments to overcome institutional rigidity and enable rapid response and user adjustment to changing conditions. Cases in the book include incentive programmes, such as buy-backs of entitlements and short-term leases (e.g. Nebraska, New South Wales), pecuniary payments for fallowing land (e.g. California, Brazil), water markets (user-to-user trades, New South Wales) and water banks (user-to-authority trade) (e.g. Spain and England & Wales).

20.5 COMPLIANCE AND ENFORCEMENT

Enforcing allocation rules is a key challenge reported in most of the case studies covered in this book (e.g. Spain, France, New South Wales). Monitoring of water use and enforcing compliance with water use rights is particularly challenging in agricultural basins where thousands of individual extraction points may exist. Compliance issues reported in the chapters of this book as elsewhere in the literature (Schmidt *et al.*, 2020) include illegal extraction points, unlicensed use (e.g. domestic borehole used for irrigation), non-compliance with licence specification (in terms of volume, timing or place of extraction), failure to report use data, or tampering with water monitoring devices (e.g. meters). Compliance can be improved using five main mechanisms (Figure 20.6): (i) using modern technologies for water use monitoring; (ii) involving users and other societal groups in monitoring and enforcement activities; (iii) developing a graduated, progressive approach of enforcement; (iv) increasing transparency of water use information and compliance; and (v) encouraging the development of social norms of compliance and collective responsibility.

20.5.1 Technology

Many advanced cases initially relied on estimates of water use, but have moved to compulsory installation of water metering (e.g. Idaho, Spain). Modern monitoring technologies may also allow better control of water use in agriculture, for instance through the use of satellite imagery to identify irrigated areas, telemetry for real-time monitoring of water extraction, and smartphone applications allowing frequent water use reporting.

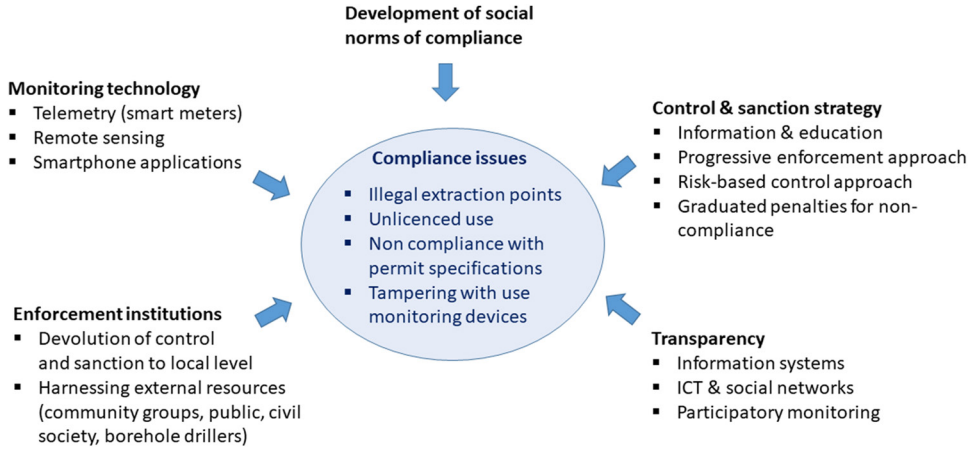

Figure 20.6 Five main mechanisms facilitating compliance with allocation regimes.

Several cases in the book report significant effort in improving surveillance and monitoring technologies. The installation of meters, along with record-keeping and reporting, have been made compulsory in several cases (e.g. Spain, Idaho, France, New Zealand, England and Wales), sometimes accompanied by telemetering and cross-checked with remote sensing (Spain).

20.5.2 Institutions

Enforcement institutions can be adapted to encourage compliance with allocation rules, in particular by (partly or fully) devolving control and sanctions to water user communities themselves, or to local institutions with greater legitimacy than government agencies. Another strategy involves enrolling other social groups, such as the public, experts, community groups, or civil society groups in compliance monitoring. Such an approach can harness human resources and capacity from within the community to augment or supplement insufficient government resources for compliance monitoring, but it requires careful management and trust-building among involved stakeholders.

Some countries have taken this general approach, enabling greater degrees of local control over allocations to enhance compliance with allocation limits. Natural Resource Districts in Nebraska, for example, are empowered to implement cease and desist orders and fines of up to $5000 per day for non-compliance. Brazil and France use collective licences granted to agricultural user associations to enhance compliance. These associations are tasked with registering all abstraction points in the course of establishing allocations, and subsequently reporting meter readings. Despite limited formal powers to sanction non-complying users, the process in France has resulted in identification of multiple unrecorded abstraction points, mainly thanks to peer pressure and self-policing within the agricultural community. The threat of further state intervention in the case of non-compliance played an important role. Similarly, in Idaho, communities of users and local organisations are given powers to enforce allocations, although compliance with recently agreed cut-backs (which were not legally binding) was driven by the threat of further state intervention.

20.5.3 Enforcement strategy

The effectiveness of enforcement activities can also be enhanced by implementing a graduated, progressive approach of enforcement relying on (i) education, information, advice and prevention activities; (ii) notice (requiring improvements) and warnings; (iii) administrative sanctions; and (iv) court action. Under such an approach, most enforcement action is concerned with directing

compliance, while activities involving administrative remedies and criminal proceedings are far less common. A risk-based approach can also help to optimise the effectiveness of limited government resources, by prioritising regulatory activities and deploying resources based on an assessment of the risks that users pose to regulatory objectives, for example at sites of intense pumping, or in areas with significant water-dependent ecosystems.

This is illustrated with the case of England and Wales, where the Environment Agency applies a graduated approach, starting from advice and guidance, followed by warnings, enforcement notices, civil sanctions and criminal proceedings. Similar approaches are implemented in France, New Zealand and Australia (Holley *et al.*, 2020; Montginoul *et al.*, 2020).

20.5.4 Transparency

Transparency of water monitoring is another factor likely to enhance compliance. Transparency can be fostered using open digital information systems, employing information and communication technologies, and mobilising social networks or participatory monitoring initiatives. The benefits of transparency in monitoring and compliance, using reliable, trusted and readily accessible information about water sources and water allocations, are highlighted by Nelson (Chapter 3).

Examples of the use of such technologies are found in several chapters of the book. In England and Wales, environmental authorities have focused on digitising individual licence management via an online user interface that allows users to access their licence details, and to submit abstraction records online. In addition, water abstraction licensing was streamlined with other environmental permit requirements to ensure consistency. In New Zealand and Brazil, authorities and agricultural user associations responsible for agricultural allocations offer similar services, sometimes developing computer applications and single interfaces to provide real-time monitoring and reporting to farmers. This can make the state of the water resource and water takes transparent to all users in order to support preventative measures to avoid the imposition of use restrictions. In India, Aleska *et al.* (Chapter 14) present a participatory approach to mapping, measuring and monitoring groundwater dynamics and use.

20.5.5 Social norms

Last but not least, compliance is highly dependent on social norms that emerge within each particular cultural context and that determine whether and to what extent water users comply with allocations set by agencies. Engaging non-government actors (community leaders or 'champions', who influence others through their good example) to promote broader social norms will provide the true 'glue' that cements and holds cooperative compliance behaviours together (Holley *et al.*, 2020). Consolidating a social norm of collective responsibility and compliance can be more effective than using 'enforcement sticks', in particular in the absence of sufficient enforcement staff or resources on the ground.

20.6 CONCLUDING REMARKS

The intention with this book was to present a range of water allocation regimes regulating agricultural water use in overexploited basins and contributing more widely to the transition away from open access to surface and ground water resources. More specifically, it aimed to fill a perceived gap in the scientific literature by providing a simple, concrete and more 'operational' description of such water allocation regimes. Hence, we hope this edited volume will be a source of information and inspiration to practitioners and scientists alike in their work striving to reform water allocation regimes in the transition towards more sustainable water use.

Based on our reading of the material presented in this book, and without striving for an exhaustive synthesis, we would like to briefly highlight some key takeaways that scholars and practitioners working on water allocation reforms may want to consider (see also the principles set out by Blomquist and Babbitt in Chapter 2):

- First, any reform needs to be implemented on the basis of trusted, transparent water availability and use data. This serves to build a common understanding of the challenges and the degree of transformation required in the exploitation of water resources. Systems must be in place to monitor conditions with triggers to enable action based on data that are accessible, transparent and reliable.
- Second, careful attention must be given to the governance of the water allocation process. Authorities and entities in charge of the process should have the authority and credibility to manage water resources and set allocation rules. At the same time, local control (with state oversight) in setting and enforcing allocation and reallocation rules may be an effective way to secure commitment to the reform process. In any case, emphasis during the reform process should be on securing stakeholder participation and buy-in to the allocation reform. Users need to understand the urgency of the situation and why allocations are needed.
- Third, setting a cap on water withdrawals and (re)allocating available water essentially entails questions of fairness and social justice. Users want to be treated fairly and need to know what the rules are so they can plan accordingly. This entails attention to both procedural and distributive justice.
- Fourth, capping and allocating water resources should not be seen as a rigid and fixed process. Water resources are dynamic in nature and allocations should respond to this variability to ensure environmental effectiveness. At the same time, greater user acceptance is likely if users have some flexibility on how to use their allocations within the limit required to keep the system environmentally effective. This may imply allowing users to carry-over some amount when it will not negatively impact effectiveness. It also calls for robust transfer and trading schemes which reallocate water between uses according to needs.
- Sixth, attention must also be given to the wider policy framework to ensure sufficient coordination across governmental agencies and avoid, for example, sectoral subsidies that run against the goals of the water allocation regime.
- Finally, although not always possible, it is preferable not to wait until the situation is dire, as this will result in more rigidities and limit adaptive capacity.

Beyond these recommendations, we would like to conclude on the urgent need for further work assessing the performance of water allocation systems. In line with the three pillars of sustainability, and the overarching need to adapt to climate change, allocation systems should support outcomes that are environmentally effective, socially equitable, and economically efficient, while being resilient in the long term. Some of the cases presented in this book provide some evidence of such sustainability performance. For instance, some positive signs of environmental recovery are visible in for example Nebraska and Idaho, where groundwater levels have been partially restored. Many cases also undeniably demonstrate increased participation of communities and users, and the increasing consideration of human and Aboriginal/Indigenous rights. And reallocation rules in several cases also allow for redistributing allocations to more junior permit holders, new users or higher value uses.

At the same time, many of these cases are still in the early phases of the transition process, and are constrained by opposition, lack of participation, and institutional rigidities. A robust assessment framework is needed to analyse the performance of water allocation systems in a long-term perspective, and adequately consider their capacity to work well under stress by maintaining effective, fair and economically optimal outcomes over time, taking into account the impacts of climate change. As water resources will increasingly face pressures from climate change, population growth, economic development, and other stressors on water supply and demand, scholarship on water allocation regimes must continue to identify, describe and assess innovations in water allocation systems and promote their diffusion across contexts to support efforts to transition towards sustainability.

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