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Chapter 1
Introduction

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ABSTRACT

This chapter introduces the book by exploring the role of water allocation policies in the transition from open to regulated access in the use of water resources. Various allocation approaches and frameworks have developed over time, crafted by water users and communities, and by governments and public authorities. It examines the specific challenges of regulating agricultural water use and implementing water allocation policies in agricultural basins. In this context, the chapter then presents the overall aim of the book and the key dimensions that should be considered when characterising and assessing allocation systems in the context of agricultural water use. The chapter concludes with an outline of the content of the book. In particular, the book is structured in two main sections providing (i) an overview of cross-cutting issues related to the establishment of water allocation systems and (ii) a compilation of 13 chapters presenting water allocation systems across the world.

Keywords: Agriculture, allocations, regulated access, transition, water resources

1.1 TRANSITIONING AWAY FROM OPEN ACCESS IN THE USE OF WATER RESOURCES

1.1.1 The need to regulate water use

Throughout history, societies have developed large infrastructure, such as canals, reservoirs, pumping stations, wells and boreholes, to secure water supplies, benefiting millions in food production, improved drinking water provision, energy supply, and flood risk reduction. Yet, many regions around the world are increasingly facing water shortages, which are disrupting livelihoods and damaging economies, while depleting aquifers, rivers and lakes, and degrading associated ecosystems. Many river basins are 'closing', that is the flows required to meet societal and environmental needs cannot be met for at least part of the year (Molle *et al.*, 2010; Falkenmark & Molden, 2008; Garrick, 2015). In river basins approaching closure, competition over water and conflicts between users become more intense, with societal actors advocating for competing values and uses of the resource. Hard decisions must be taken over how water resources are used, shared and/or preserved for future generations

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and the environment, implying complex trade-offs between economic performance, social justice and environmental protection.

Authorities have generally responded to water scarcity by mobilising new water resources, through surface water storage and transfers, groundwater development and desalination. However, as these supply options become exhausted, prohibitively expensive or contested, authorities are increasingly looking to reduce demand, and shift from open and unlimited access, to regulated access of water resources. Regulated access relies on setting a sustainable limit on total water extraction in a river basin, groundwater body or other water management zone (i.e. a cap), and adjusting authorised extractions to meet that cap. The core issue when restricting access to water resources becomes how to best (re)allocate scarce water supplies among competing users, and between users and the environment (Arthington *et al.*, 2018).

1.1.2 Water allocation as a strategy to regulate water use

Water allocation regimes are 'the combination of actions which enable water users and water uses to take or to receive water for beneficial use according to a recognised system of rights and priorities' (Taylor, 2002). They define who is allowed to access water, how much may be taken and when, how it must be returned, and the conditions attached to the use of the extracted water (OECD, 2015). Allocation regimes need not only to specify and distribute water use authorisations, they may also regulate the exchange and transfer of such authorisations. Their prescriptions can remain informal and embedded in customs and local practice; or constitute rights explicitly codified in written agreements, legislation and formal permits (Abernethy, 2005; Bruns *et al.*, 2005).

Since the late 1980s, with growing awareness of environmental problems, policymakers have increasingly addressed the issue of water allocation as a trade-off between consumptive use and environmental protection. Hence, water policies have increasingly sought to regulate extraction within whole river basins or aquifers, and therefore to regulate access to water resources. Many water allocation regimes are moving away from solely avoiding resource exhaustion (Blomquist, 1992) and towards better providing for environmental and community needs (OECD, 2015). The most sophisticated regimes now design allocations with a more integrated and dynamic view of the water cycle, incorporating the ecological health of surface water and groundwater, environmental flows to maintain a flow regime supportive of diverse and rich aquatic biodiversity, and surface–groundwater exchanges benefiting groundwater-dependent ecosystems.

These allocation regimes are typically implemented by public authorities, although they can involve users and communities in the design and implementation of allocation rules in different ways. Allocations are then issued as time-limited allowances, permits or long-enduring entitlements. Water use charging schemes may also be implemented to recover administrative costs of the regulatory framework or to encourage efficient water use. Trading mechanisms may allow the temporary or permanent exchange of water use rights (Dinar *et al.*, 1997). More informal (re)allocation strategies may co-exist with, or override formal ones (Bruns *et al.*, 2005). For instance, water may be shared within communities on the basis of local customs and local agreements between users.

1.1.3 Regulating agricultural water use through allocation policies

Agriculture is the largest net water use in many regions (UNESCO, 2020). Surface water allocation regimes in agricultural systems have existed for centuries and millennia (Ostrom, 1990), usually to facilitate the sharing of water supplied via collectively developed irrigation schemes that capture and distribute water into networks of canals. Access to water then depends on contributions to the original investment, on fulfilling continuing obligations for operation and maintenance, and on complying with agreed procedures for distributing water during periods of scarcity. In the 20th century, agricultural water supply also benefited from larger, state-led surface water storage schemes, which regulate river flows to secure beneficial use during dry periods. Allocation decisions in infrastructure projects (user-based or state-led) are generally made by the user community or infrastructure operators,

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complemented by pricing mechanisms to recover the cost of infrastructure and, in some cases, to encourage efficient water use.

The issue of water allocation in agriculture has thus long been addressed as a problem of apportioning water resources between competing consumptive users, often within hydraulic systems. As water extraction from rivers and aquifers increases and ecosystems become further degraded, users increasingly have to deal with allocation decisions over larger and more loosely connected areas (including unregulated rivers and groundwater systems). They are also increasingly forced to account for minimum environmental flows while designing and implementing allocation regimes.

Allocation regimes have received considerable attention in the last three decades, and research in the field has offered general guidance on the design of allocation systems (Bruns *et al.*, 2005; Speed *et al.*, 2013; OECD, 2015, 2017). Despite progress in the understanding of institutions underpinning allocation decisions, most research has focused on traditional, user-based irrigation systems, and few studies have examined how integrated water resource allocation regimes manage extraction across whole river basins and aquifers with consideration for environmental, community and agricultural user needs. In addition, relatively few allocation systems integrate groundwater and surface water. In many places, these two resources are allocated through separate institutional arrangements, adding a layer of complexity to the challenge of meeting community, environmental, and agricultural needs through reform of allocation regimes. It is in integrating these dimensions that this edited collection makes a significant and novel contribution to the literature.

1.1.4 Challenges of establishing allocation policies in agricultural basins

Implementing water allocation regimes is particularly challenging in rural areas where water resources have been progressively developed and used outside any regulatory framework, generating a feeling of appropriation by thousands of historical agricultural users. Policies aiming at capping and reducing water use then face strong acceptability problems, as they have severe consequences for agricultural businesses and rural livelihoods. In such contexts, acceptability problems may emerge at different sensitive stages of the establishment of allocation regimes.

The first sensitive stage corresponds to the development of a registry of water users, that is identifying who is currently using water, where, when and how much. This initial inventory of users may trigger political debate and opposition for different reasons. Some users may resist, as they fear this first step will lead to greater control on extraction, announcing future restriction on use and possibly the implementation of an extraction fee. Opposition may also come from stakeholders fearing that historical users will be given (unfair) advantage in future allocation decisions, if the grandfathering principle applies. Overall, initiating an inventory of users inevitably triggers intense debates on which users are legitimate and which criteria should be used to perform future allocation. Thus, this first stage must be carried out with attention to participation, transparency, and accountability.

The second sensitive stage corresponds to the definition of a global extraction limit that will constrain allocation to users. Due to the complexity of water resources, insufficient knowledge of interactions between surface, groundwater resources and dependent ecosystems, but also to the variability of climatic and environmental conditions, there are huge uncertainties associated with the assessment of extraction limits. This fuels controversies among stakeholders who contest scientific assumptions when this can serve their own interests. Transparency and participation are here again the keywords to ensure that the extraction limit imposed on users is perceived as technically and scientifically sound, in spite of remaining uncertainties.

The third sensitive step is when the new public, river basin-wide allocation regime superimposes onto pre-existing localised, user-based or customary arrangements. This may create institutional complexities, synergistic or conflictual, disrupting established practices and norms (Bruns *et al.*, 2005). Replacing or augmenting historically derived institutions with new ones is likely to face resistance, especially when older rules favour particular local appropriative issues rather than tackling provisioning ones (Schlager and López-Gunn, 2006). For instance, allocations derived in irrigation

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systems are more likely to integrate irrigators' concerns and requirements regarding the timing and intensity of irrigation, while river basin-wide allocations are designed to protect environmental flows and make fair allocations. These overlapping definitions of allocations can be seen as problematic and a source of confusion and conflict.

Different countries, states and regions have made unique choices on how to deal with the socio-political sensitivity of these issues. There is an urgent need to take stock of recent institutional developments and present alternative strategies and options for designing robust allocation rules in agriculture.

1.2 OBJECTIVE AND SCOPE OF THE BOOK

The main objective of this book is to present and evaluate integrated water resource allocation regimes that aim to reduce and adapt agricultural water demand to available resources, taking into account environmental, community and other needs. This book aims to contribute to the literature on water governance, by drawing lessons on alternative allocation mechanisms and providing insights into the design of more robust allocation regimes for agricultural water use.

The originality of the book is two-fold. First, at a conceptual level, it examines governance frameworks on allocations along the full groundwater–surface water continuum, rather than considering them separately. In addition, it considers how diverse allocation regimes integrate environmental and community needs, instead of focusing on allocation regimes in the context of supply infrastructure development or complete resource exhaustion.

Second, this book intends to highlight the range of institutions (e.g. regulations, formal and informal rules, incentives, organisations, etc.) that have been developed to control agricultural extraction based on detailed analysis of different advanced cases of water allocation regimes in selected countries. Allocation systems in the reviewed countries and states exhibit a wide diversity of design parameters regarding the institutional framework guiding allocation decisions, the approach for defining the available resource pool, the rules underpinning allocations and reallocations, monitoring and enforcement mechanisms, and the wider policy mix within which the allocation regime is embedded.

1.3 KEY THEMATIC AREAS OF THE BOOK

Allocation systems exhibit a wide diversity of design options regarding:

- The institutional framework guiding allocation decisions,
- The basis for defining allocation limits,
- The rules underpinning allocations and reallocations,
- Compliance and enforcement mechanisms.

1.3.1 The institutional framework

Allocation regimes work within a legal and policy context characterised by governmental priorities for water management and procedures for integrated water resources management. Regulating water use involves establishing rules on the management of available water resources (i.e. defining spatial and temporal conditions to access and extract water) and on the rights to access and use the resource by excluding specific types of water uses, and controlling how rights to access and use the resource can be transferred between users. Who will be empowered with the right to manage, alienate or transfer water is a key question which will influence the effectiveness of any allocation regime (Ostrom, 1990; Rouillard *et al.*, 2021).

The nature and characteristics of water use rights is important to consider, as this affects the level of institutional 'rigidity' faced when implementing reallocations. Rights to water will vary in character between countries and states. Allocations may be issued as formal permits, concessions, or full property rights, or, more informally, via decisions among users or the community (Rinaudo *et al.*, 2020). The

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legal status of water rights varies widely, as does the level of oversight afforded to authorities, user groups and communities, and the degree of flexibility that exists in adjusting allocations.

Of particular interest is the relationship between rules established at national or state level and those set locally, by users and/or communities. Some authors warn of the inherent limitations of state-driven controls on water extraction and allocations, for instance due to the lack of acceptability amongst users of state-set rules, or the lack of capacity of the state to monitor compliance by users (Ostrom, 1990; Molle & Closas, 2020). They emphasise that the role of higher-level authorities is to empower water users and community groups in making allocation decisions and in implementing these decisions. Other authors warn of the fundamental risk in self-regulatory systems of 'capture' by specific users, resulting in poor environmental performance and unfair allocation outcomes (López-Gunn, 2006).

Finally, allocations cannot be examined in isolation. They need to be viewed as part of a wider policy instrument mix, which supplements controls on water use with for example incentives to promote behavioural change or mitigate the negative social impacts of reducing allocations (Rey *et al.*, 2019; Rouillard, 2020). Molle and Closas (2020) insist on the importance of 'carrots', through for example compensations, to secure commitments by water users when implementing 'sticks', such as regulated water extraction and use.

1.3.2 Setting allocation limits

Allocation regimes issue allowances to extract from specified water resource pools for specific periods of time. How authorities and users deal with these characteristics to issue functional allocations is of interest, including the use of particular water accounting frameworks and assessments of water balances. This must provide for user needs, but also environmental needs through for example recognition of environmental flows, impacts on protected habitats and species, and key groundwater-dependent ecosystems. Allocation must respond to variability between years and set out how the cap might be modulated accordingly. Hence, several factors may be taken into account when setting a cap on allocations: the temporal and spatial variability of water resources, such as periods of low or high flows, storage capacity of dams and aquifers, the role of groundwater in provision of sustainable baseflow in rivers, groundwater recharge rates, and so on.

Overall, allocations should ideally be consistent with the way water is stored and how it flows, accounting for return flows and connectivity between water bodies, and taking into account the impact of transferring water from one extraction point to another. For instance, regulating surface water but leaving groundwater to landowner appropriation could encourage shifting use from surface to groundwater. Also, establishing a limit on individual withdrawals at farm level may encourage increased water use efficiency as farmers strive to maximise the production value of their allocated water. However, reduced return flows to the natural environment and downstream contributes to the well-known rebound effect, changing the overall water budget at the basin scale. Adequate monitoring and return-flow accounting can mitigate this issue.

1.3.3 Allocation rules

Allocation relies on a set of rules defining:

- How individual allowances are defined (flow rates, volumes or proportional shares) and over which period they are valid (seasons, months, weeks, days, hours).
- Who has the right to use water, how much, how and when.
- How individual allocations will be ramped down in cases where the total amount of water allocated exceeds the extraction cap (which is likely in the early stages).
- How water can be reallocated between users over time to provide flexibility, and account for new users and uses and changing conditions (e.g. climate change).
- How to prioritise among agricultural uses (if different farm types for instance), and between agricultural uses and other uses such as communities and environmental needs.

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- How to account for interactions between surface and groundwater and implement conjunctive use of surface and groundwater.
- How to deal with fluctuation of resource availability: in times of extreme scarcity (drought), allocations may not follow the agreed fixed time slots or proportional shares, but rather may be distributed on an agreed priority ladder between users, for instance when drinking water supply is prioritised over irrigation.

The design of those rules raises issues of social justice (i.e. what is a fair allocation of a scarce natural resource?) and of economic efficiency (i.e. how should water be allocated to maximise economic production and social welfare?). How to integrate the needs of agricultural water users and communities (social resilience) while protecting environmental flows (ecological resilience) is an often overlooked but central question in the elaboration and implementation of allocation rules. Different countries, states and regions have made unique choices on trade-offs between social, environmental and economic priorities. There is an urgent need to take stock of recent institutional developments and present alternative strategies and options for designing robust allocation rules in agriculture.

1.3.4 Compliance and enforcement

Ostrom (1990) has shown how important monitoring and enforcement procedures were in irrigation systems to increase compliance with allocation rules. Designing and implementing an effective compliance and enforcement strategy raises three main issues:

- The first one relates to the role played by the State and users' communities. While some countries have opted for a fully decentralised approach where users are given legal powers to monitor water use and impose sanctions in need, others rely on a hybrid approach where powers are shared or strictly keep enforcement as a duty of public administrations.
- Organising effective water use monitoring is a second key issue. Technology can now help with controlling use, for instance through satellite images or smart volumetric meters. Encouraging social control by users themselves is a complementary strategy which can also be supported by ICT (information and communications technology; smartphone applications to report extraction points for instance).
- The cost of monitoring and enforcement is the third issue: human and financial resources invested in compliance and enforcement must be proportionate to the level of water scarcity in the basin, with potential conflicts between agriculture and the environment.

1.3.5 Performance of allocation regimes

When crafting allocation rules, stakeholders are (implicitly or explicitly) making trade-offs between four main competing water management objectives: effectiveness, economic efficiency, social justice and resilience. However, when implemented in practice, allocation rules may not exactly match initial expectations and they may prove to perform less well than anticipated at the design stage. Evaluating the performance of rules in use along the aforementioned criteria is an exercise that should help improve allocation regimes.

Effectiveness corresponds to the ability of the allocation regime to ensure predictability of supply to water users (including domestic as well as agricultural and industrial water users) and environmental sustainability. Effectiveness depends on how actors integrate the complexity of hydrological systems into the allocation rules in order to enhance their environmental effectiveness. Economic efficiency is achieved when the apportionment of water among users maximises social welfare, with minimum transaction costs. Economic efficiency is dependent on the capacity to transfer allocations between uses, and to do this in such a way that water ideally moves towards the highest use value. Equity or fairness refers to two distinct dimensions: distributive justice which refers to fairness in the allocation itself (who gets how much water) and procedural justice which

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refers to the way allocation rules have been crafted (users' participation in the decision process) (Syme *et al.*, 1990). Resilience refers to the ability of allocation rules to maintain effective, fair and economically optimal outcomes during multi-year droughts and over time, taking into account the impacts of climate change.

1.4 STRUCTURE OF THE BOOK

This is an edited book with 20 chapters, including the present introduction and a conclusion. It is divided into two sections.

The first section deals with five cross-cutting issues in the transition from open to regulated access through allocation regimes. Blomquist and Babbitt (Chapter 2) focus on the political nature of the transition to regulated access, focusing on groundwater. Based on several experiences across the world, they provide nine concrete recommendations to support the transition process.

Nelson (Chapter 3) then describes how the 21st century has seen a geographic broadening of arrangements for allocating water sources. She argues that allocation regimes across the world increasingly include non-traditional water sources, interactions between sources, environmental needs, and cultural purposes. There is a broadening beyond current water rights holders to include a wider range of values in decision-making, and to recognise human rights to water. Similarly, Hurlbert (Chapter 4) reviews how previously ignored Indigenous rights to water are now increasingly recognised, drawing from examples in Canada, the United States, Central and South America, and New Zealand. She argues that recognising these rights and worldviews, such as respecting Mother Earth and the concept of Buen Vivir, move law, practice and water governance closer to a fairer and more socially just sharing of water resources.

Stein and colleagues (Chapter 5) provide insights into the increasing integration of environmental needs in water allocation regimes. They argue that a holistic environmental water allocation approach focuses on protecting overall ecological structure and functions, including preserving environmental flows at broad spatial and temporal scales, and consideration of surface–ground water interactions and the relationships between flow, sediment, temperature, and water quality. At the same time, they emphasise that environmental flow programmes will only be successful if they are sensitive to social issues and concerns, and integrate traditional values and perspectives.

Finally, Perez-Blanco (Chapter 6) explores the major economic challenges in implementing allocation regimes, and proposes key design features for an optimal water allocation framework, which achieves sustainable, equitable and robust economic growth. The chapter also provides examples of economic instruments that can facilitate the transition to regulated access through allocations where agriculture is a major water use.

The second section of the book presents 13 examples of transitions away from open access through the development of water allocations. These examples were selected to cover a wide range of geographical, environmental, social, economic and political contexts, while all addressing allocations to major agricultural irrigation water uses (Figure 1.1). Most cases present allocation systems applied to surface water and groundwater resources, although some focus more specifically on surface water or groundwater, especially where they represent the more dominant resource.

The first four cases experiences are linked to the implementation of the EU Water Framework Directive (WFD). Benson and colleagues (Chapter 7) present how authorities in England and Wales have established a catchment-based approach to regulating water abstraction, and reformed licensing arrangements to better take into account environmental sustainability. Sanchis-Ibor and colleagues (Chapter 8) examine the case of Spain and the consequences of a historically permissive policy in issuing water use rights in a context where scarcity is more pronounced. To tackle widespread overallocation and institutional rigidities of the concessional regime, new economic instruments have been sought to induce more flexibility in allocation decisions. In France, Rouillard and Rinaudo (Chapter 9) describe how authorities have started to devolve allocation decisions to catchment groups

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Figure 1.1 Cases included in the book as individual chapters.

and agricultural user associations in a move towards collective management of water use rights. Ak and colleagues (Chapter 10) present the Turkish case of national governance of allocations in a context shaped by the adoption of several principles set out in the WFD.

Two contrasting chapters from the Pacific region and with vastly different climates (i.e. New Zealand and Australia) are then presented. Challies and colleagues (Chapter 11) present the institutional framework in New Zealand which combines a decentralised approach to allocating water in a context where Aboriginal Maori rights over water resources are increasingly recognised nationally. Guillaume *et al.* (Chapter 12) describe the experience of New South Wales (Australia) in regulating groundwater use. A robust framework of extraction limits and a shares approach to allocations has been implemented, together with flexibility built-in thanks to a regulated water market.

The following three chapters present insights into approaches carried out in three large, federal states. First, Marques (Chapter 13) characterises key water allocation strategies followed in multiple Brazilian states, showcasing innovative solutions crafted often collaboratively between users and authorities. Aleskar and colleagues (Chapter 14) report on the overtly technical India's experience in groundwater allocations, and propose an alternative socio-hydrogeological approach that promotes participatory mapping of aquifers and decentralised groundwater allocation for agricultural decisions. Tremblay (Chapter 15) contrasts the legal framework for water allocation of two Canadian provinces (i.e. Québec and Alberta) to show the implications of different legal histories over water use rights (i.e. riparian and prior-appropriation).

There follow two cases from the United States which illustrate the potential for successful local governance of water allocations. Running (Chapter 16) describes how a cooperative five-year agreement between ground- and surface-water farmers in Idaho's Eastern Snake Plain Aquifer has contributed to the recovery of groundwater levels. The agreement was the result of multi-decadal legal, regulatory, and policy disputes, and had to operate within a rigid institutional setting comprising overlapping existing water use rights. In contrast, Jedd and colleagues (Chapter 17) present Nebraska's transition towards conjunctive use of surface water and groundwater, and provide insights into the benefits

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and limitations of the polycentric water governance model based on strong local control over water resources in the form of Natural Resources Districts.

The last two case chapters present transboundary cases of water allocation. Ziganshina (Chapter 18) presents the key principles and rules of water allocation in the Amudarya basin shared by Afghanistan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. Starting in Soviet times and validated by the Almaty Agreement in 1992, the basin now has a long experience of international cooperation for sharing water. This longevity can be explained partly by the treaty's flexible modalities and specific water allocation formula. Major improvements are nevertheless needed to deal with the dual pressures of increasing water demand and diminishing water supply in the near future.

Similarly, Buono and Eckstein (Chapter 19) report on the experience of the Rio Grande basin, shared by several US states and Mexico. Its innovative and collaborative cross-border governance model has come under intense pressure in recent years. The authors explore, in particular, three major challenges regarding consideration of groundwater and ground–surface water interactions; processes for greater participatory governance; and the recent crisis linked to Mexico's water debt.

The conclusion (Chapter 20) provides a comparative assessment of the 13 cases together with insights from the cross-cutting chapters. Critical reflections on the key design features, implementation processes, and performance of water allocation regimes are made, concluding with recommendations for future research.

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