An analysis of the water security effectiveness of integrated river basin management through comparison of the Konya Closed Basin and Kern County Subbasin

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Abstract

The world is experiencing unprecedented water related issues. Due to climate change, over-abstraction and pollution, water related problems will continue to increase, contributing to water insecurity. In consequence, water governance is undergoing a paradigmatic transformation from reductionist, top down, engineering approaches to more integrated ones featuring inclusive institutions and adaptive management predicated at the river basin scale. Here, globally leading water governance mechanisms such as the EU Water Framework Directive (WFD) and the California Sustainable Groundwater Management Act (SGMA) aim to counter water insecurity through integrated river basin management. However, comparative evaluations of the effectiveness of these different institutional arrangements for achieving water security are limited. The aim of this thesis is therefore to comparatively assess these two different forms/models of integrated river basin management for achieving water security outcomes, to inform policy learning. Meeting this aim involves meeting five objectives, namely: (i) identifying relevant gaps in the water security literature through critical review; (ii) developing a methodological approach for assessing how integrated river basin management supports water security; (iii) theoretically comparing different forms of integrated water governance, using a modification of Ostrom's IAD framework, to examine key institutions, processes and outcomes; (iv) comparatively assessing the extent to which these two governance models support water security through the use of a dedicated assessment tool; and (v) making policy recommendations on lesson-drawing for future integrated river basin planning, to better support water security globally. To meet these objectives, quantitative and qualitative research methods are utilized to examine the effectiveness of integrated river basin planning within an embedded comparative case study design. This thesis concludes that WFD implementation in the Konya Closed Basin in Turkey only partially leads to water security while asserting that the Kern County Subbasin in California shows stronger institutional capacity for supporting water security in the implementation of SGMA. Recommendations for enhancing water security through integrated river basin management therefore include mechanisms for increasing institutional capacity through collaboration between agencies, more inclusive public participation, and better data collection and characterization of groundwater data, monitoring of plan implementation and document preparation.

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My thesis is dedicated to my heroes: Malcolm X and Ismet Ozel.

In recognition of their stance towards every matter.

For their sincerity, transformation, and dignity.

For still being the source of huge inspiration in my life.

“The ability to read awoke inside of me some long dormant craving to be mentally alive”

Malcolm X

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List of acronyms

ACF	Advocacy Coalition Framework
CPRs	Common Pool Resources
CVP	Central Valley Project
CWA	Clean Water Act
EU	European Union
DSI	General Directorate of State Hydraulic Works
DWR	Department of Water Resources
FAO	Food and Agriculture Organization
HUGE	Human Gender and Environmental Security
GAP	Southeastern Anatolian Project
GSAs	Groundwater Sustainability Agencies
GSPs	Groundwater Sustainability Plans
GWP	Global Water Partnership
IAD	Institutional Analysis and Development
ICWE	International Conference on Water and the Environment
IWRM	Integrated Water Resources Management
KGA	Kern Groundwater Authority
MDGs	Minimum Development Goals
MDSD	Most Different System Design
MSSD	Most Similar System Design
NATO	North Atlantic Treaty Organization
PCA	Principal Component Analysis
PCF	Political Contracting Framework
RBMP	River Basin Management Plan

RBOs	River Basin Organizations
SES	Socio Ecological Systems
SDG	Sustainable Development Goals
SGMA	Sustainable Groundwater Management Act
SYGM	General Directorate of Water Management
OEHHA	Office of Environmental Health Hazard Assessment
TVA	Tennessee Valley Authority
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
WEF	Water Energy Food
WFD	Water Framework Directive
WMO	World Meteorological Organization

Chapter 1. Analysing the water security effectiveness of integrated river basin management through comparative analysis

1.1 Introduction

Water security is one of *the* critical global sustainability issues for the 21st Century. Despite significant progress towards meeting targets for ensuring access to water set by the global United Nations (UN) Millennium Development Goals (MDGs), agreed by the international community in 2000[1], domestic access to basic water services and safe drinking water is a widespread problem (WHO/UNICEF, 2015). Meanwhile, threats to water resources are increasing through industrial and domestic water pollution, over-abstraction, population growth and climate change (United Nations, 2018a). Maintaining water security or '[t]he availability of acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies' (David Grey & Sadoff, 2007a, p. 545), therefore raises important questions regarding the most appropriate forms of governance for its effective maintenance. Water security is also a critical normative focus for the current UN Sustainable Development Goals, or SDGs, that will guide global developmental objectives to the year 2030 (UN, 2015, 2017). Sustainable Development Goal 6 specifically requires the improvement of water quality, increasing water-use efficiency, enhancing access to water and sanitation, and implementing integrated management of water resources (ibid.).

To meet these pressing challenges, countries globally are now moving away from so-called 'hydraulic' (Molle, 2009), 'reductionist' (Zeitoun et al., 2016) or 'engineering' (Benson et al., 2015) forms of water management, based on large scale infrastructure projects such as dams and associated irrigation schemes. A shift is occurring towards institutionalizing more integrated, plan-led approaches based on the river basin scale that consider the different uses, and users, of water sources through incorporating multiple actors in planning processes

[1] 'The Millennium Development Goals set a target (7C) of halving the number of people without sustainable access to safe drinking water and sanitation in the period between 2000 and 2015' (UN 2000).

(Benson et al., 2015; Molle, 2009). Although not new (Biswas, 2004; Molle, 2009), these approaches have increased significantly since the adoption of the 1992 Dublin Principles for integrated water resources management (IWRM), which endorsed participative planning and the integration of multiple resource uses. Indeed, the global diffusion of these norms through concepts such as integrated river basin management, under a new 'paradigm' of resources governance (Benson et al., 2015), raises the prospect of more secure sources of water to better meet global sustainability challenges. But little comparative research exists assessing the degree to which integrated river basin management incorporates these principles through institutional structures, processes and outputs in order to achieve water security outcomes – a feature further discussed in Chapter 2. Such research has additional value, given the significance attached by the UN to integrated management for meeting SDG water security targets by 2030 (UN, 2015, 2017).

In this respect, this chapter will briefly introduce the thesis. Firstly, it will contextualise water security issues globally to show why they pose a significant threat to global sustainability and effective implementation of the SDGs. Secondly, it will outline shifting patterns of governance, from the 'reductionist' mode towards integrated forms of resource management, including the integrated river basin management concept: a feature returned to in Chapter 2. Thirdly, this chapter then sets out the main aims, objectives and research questions of the thesis. Here, it focuses on the extent to which different forms of integrated river basin management are supporting water security in order to meet global sustainability targets. The study focuses on two diverse national case studies of integrated river basin management, from the Kern County Subbasin in California USA and Konya Closed Basin in Turkey where water security issues are becoming critically significant, as detailed later in this thesis. Finally, it provides a brief overview of the structure of thesis.

1.2 Water security as a critical sustainability issue

While the world faces multiple threats to sustainable development (see Baker, 2016), water security is one of *the* most important issues globally since it impacts the lives of billions of people and effects the functioning of local and global ecosystems. Problematically, 40 percent of the world population is 'living in river basins under severe water stress' and one fifth of the population will potentially experience floods (World Water Council, 2018). In 2018, people experiencing water stress numbered around 2.3 billion people, which equates to one third of world population during that year (FAO and UN Water, 2021). The prospect of major urban areas facing 'Day Zero' scenarios similar to that of Cape Town in 2017 (Maxmen, 2018), when cities run out of water entirely, is a real possibility. The expectation that ever more people will be living under water stress further puts the sustainability of water resources, along with economic and social development into jeopardy (WMO, 2021).

As a result, policymakers will have to increasingly consider the concept of water security. Although a contested term, Grey and Sadoff (Grey & Sadoff, 2007a, p.545; see also (Cook & Bakker, 2012) in their widely cited conception cited above, refer to water security in relation to its qualitative and quantitative aspects, involving the maintenance of existing water resources and reducing related risks. While water security is consequently a critical concern for future sustainability at national and global levels, policy responses are failing to address this challenge. For example, the WMO (2021) recently reported that global water management is not fit for purpose and new thinking is required on achieving water security.

This lack of management effectiveness is demonstrated by water resources impacted by increasing demand, climate change and pollution (United Nations, 2018a). Due to expanding populations, growing industrial and agricultural production and changes in consumption, global water demand is increasing by 1% per annum, and it is anticipated that it will continue to increase over the next twenty years (ibid. p. 3). As water is a finite resource, increasing demand from population growth has left significant numbers without access to clean water and sanitation. Progress towards implementation of the Millennium Development Goal 7C – aimed at providing water supply to low income countries - was mixed, with a reported 2 billion additional people globally accessing water supplies between 2000 and 2010 (WHO/UNICEF, 2012). However, in 2015 over 2.1 billion people still lacked access to safe water domestically, while 844 million were without basic drinking water services (WHO/UNICEF, 2015). Growing populations in developing countries, particularly in Africa and South Asia, will exacerbate future demand (United Nations, 2018a).

While the global population continues to increase, water use has consistently outstripped supply (Cosgrove & Loucks, 2015). Human actions are changing the global ecosystem, degrading the environment and transforming the quality and quantity of water resources: a trend revealed in the form of growing water issues (Cosgrove & Loucks, 2015). However, it is the over-exploitation of groundwater, primarily for the sake of improving irrigated agriculture or drinking water supply, which poses the greatest threat to water resources (Besbes et al., 2019). Global groundwater storage decline is estimated at around one fifth or quarter of total groundwater use (United Nations, 2022). One third of the world's largest groundwater systems are experiencing over-abstraction and main aquifers face significant abstraction pressures (Richey et al., 2015). In China, 400 cities out of a total of 657, use groundwater as the primary source of their water needs (J. Liu & Zheng, 2016). Moreover, in regions such as North America and South Asia groundwater is used in more than two thirds of irrigated areas (United Nations, 2022). Furthermore, groundwater abstraction can result in land subsidence. For instance, over-extraction of groundwater in California's San Joaquin Valley has caused more than 8.5 m of land subsidence over the 50 years from 1920 to 1972 (Poland et al., 1972). Other impacts include lowering of water tables, increased costs and energy use associated with increasing depths of groundwater extraction, saline intrusion into groundwater in coastal areas, heavy metal contamination and concentration in groundwater of pollutants such as arsenic, and social conflicts resulting from declining water resources (Llamas & Martínez-Santos, 2005). However, among other drivers the main factor for declining groundwater sources is water use for irrigation on worldwide (Burek et al., 2016).

Water pollution from domestic, industrial and agricultural sources also presents significant challenges to water security. Untreated wastewater release to the environment accounts for 80 percent of industrial and municipal wastewater on a global scale (United Nations, 2021). Pollution in rivers has worsened in Asia, Africa and South America in the last two decades (United Nations, 2018a). For example, the Upper Tiete River Basin in Brazil endures high levels of contamination from toxic chemicals, nitrogen, pathogenic microorganisms and phosphorus (UNEP, 2016). The Wolta River Basin in West Africa has seen increasing faecal coliform bacteria prevalence, mainly attributed to growing domestic inputs from waste water discharges, while the Chao Phraya Basin in Thailand has experienced an overall decline in water quality over the last 10 years (ibid.). Accordingly, nutrient loading, from agriculture and urban wastewater, is a chronic issue worldwide (United Nations, 2018a). However, the most serious threat from water pollution results from waste water discharge from towns and industries (Dybern, 1974).

Over the years, new water pollution challenges are being added such as risks from agricultural chemicals or salinization. Intensive agriculture presents particular threats to water resources through the use of chemicals such as nitrates, phosphorus and pesticides, causing significant ecosystem deterioration (Parris, 2011). For instance, annual agricultural water pollution in the UK is estimated to cost almost £500 million in damages (Parris, 2011). Additionally, around 50 billion m^3 water per year in Latin America and Caribbean region is exposed to nitrogen pollution caused by crop production (Mekonnen et al., 2015). Furthermore, new contaminants such as micro-pollutants were identified as a significant threat to public health, and it was acknowledged that water treatment plants were not tailored for identifying and removing these contaminants (Bolong et al., 2009). Groundwater pollution is particularly problematic as pollution water can exist in aquifer systems for decades, which makes it difficult to recover and treat (United Nations, 2022). Such pollution comes from variety of sources such as fertilizer, pesticides and animal wastes, while non-point pollutants are predominantly salt and nitrate contamination (Harter, 2003). In addition to these pollution sources, urbanization and climate change are the other drivers of groundwater contamination that create substantial threats to the quality of these hidden water resources (Al-Hashimi et al., 2021).

Despite these immediate risks, it is climate change that will place increasingly significant long-term constraints on water security, in both developing and developed countries. The latest data show that, despite international pledges to limit national emissions under the 2015 Paris Agreement, CO_2 related greenhouse gas emissions rose by 1.7% globally in the year between 2018 and 2019 (UNFCCC, 2019). As a result, water-related risks from climate change such as floods, droughts and extreme storm events are also increasing (UNFCCC, 2017). According to UN estimates (2018, p. 3), 3.6 billion people globally are now classed as residing in water-scarce areas, defined in terms of enduring water scarcity for at least one month per annum; a figure which by 2050 could grow to over 5 billion with population growth. Impacts are also predicted to be geographically uneven, with existing wetter regions experiencing more precipitation and drier regions receiving less under future climate change (ibid.). This trend will exacerbate water insecurity between and within countries. For example, in the Middle East significant conflicts already exist between Turkey and Iraq over the sharing of water resources (Aysegül Kibaroglu, 2015; J. Warner, 2008). In the USA, California experienced severe drought conditions between 2011 and 2017, with NOAA attributing abnormally high temperatures associated with naturally occurring drought conditions to human-induced climate change: a feature that may contribute to increasingly severe droughts in future (Seager et al., 2014). Moreover, California is currently enduring another severe drought period which has resulted in decreasing water availability and heavy dependence on groundwater, thus becoming problematic to residents particularly farmers (OEHHA, 2019). Lastly due to melting glaciers, attributable to rising temperatures caused by change in climate in Himalayas, there has been a reduction up to 80 percent of available water for irrigation in South Asia (Norwood, 2012). This situation shows that further groundwater use for irrigation could be impaired due to declining water bodies (Qureshi, 2011).

Finally, water security-related issues such as drought, floods or intense rainfall could cause serious social disruption, leading to national security issues. For instance, the drought that took place in Syria between 2007-2009 contributed to the Syrian civil war (Kelley et al., 2015). Underestimation of drought and its effects along with poor governance by the Syrian government compounded the problem (Femia & Werrell, 2012; Mhanna, 2013). An inability to address drought problems or mismanagement of water infrastructure resulted in massive migration to big cities in Syria and increased unemployment (Femia & Werrell, 2012; Gleick, 2014). Additionally, the Konya region of Turkey experienced a drought related migration problem similar to Syria, with seasonal and permanent migration of people leaving farming areas for major cities (Lelandais 2016). A recent study shows that drought is projected to increase human migration by at least 200 million people in the remainder of the 21st Century (Smirnov et al., 2022). All these examples highlight the importance of maintaining water security during extreme weather events such as drought, demonstrating that water is not just an asset or commodity but also a critical component of national security. However, the nature of governance responses to water security is rapidly changing.

1.3 From 'reductionist' to 'integrative' responses to water security

Water management has historically evolved via paradigmatic shifts in the nature of governance, institutional structures and the technical responses employed to maintain the security of water resources. In the modern era, the concept of river basin management can be traced to the establishment of the federal government Tennessee Valley Authority (TVA) in the USA in 1933 (Molle, 2009). Created as a means of generating economic development of a deprived region during a period of recession, the TVA was revolutionary in that it introduced a technocratic river basin management approach incorporating an 'engineering ethos' linked to 'scientific knowledge and systematic rational planning' (ibid., p. 487). In what Scott (1998, p. 87) refers to as 'high-modernism', the TVA brought together centralised planning of water resources on a basin wide scale with engineering mega-projects, primarily a series of dams on the Tennessee River, used for electricity generation, flood control, irrigation and navigation improvements. The overall effect was to significantly increase economic activity in the river basin, thereby providing a model which was copied by other US states (see Andrews, 2006).

This 'hydraulic paradigm' also provided the blueprint for international development policies in the post-War era (Molle, 2009, p. 488). With the support of US President Truman, the TVA approach was exported to developing countries as a means of accelerating economic development and extending international diplomacy during the Cold War (Ekbladh, 2002). For developing countries, such large scale engineering projects provided a fast route to modernising their economies through providing hydro-electric power and water for irrigation, leading to widespread adoption of the TVA model (Barrow, 1998). River Basin Authorities were established in many countries, including India, Brazil, Sri Lanka, the Philippines, Mexico and in Africa (Barrow, 1998). International development donors, including the World Bank, actively supported the use of river basin planning during this period, particularly in South America (World Bank, 1992).

However, by the 1970s problems started to emerge with such models of river basin planning. Due to their 'reductionist' (Zeitoun et al., 2016, p. 145) nature, based upon technocratic decision-making, rational use of science and hard engineering responses to water security, little account was taken of ecological impacts or even indigenous needs. Barrow (1998, p. 179) notes multiple problems, most notably 'a failure to consider the maintenance of environmental quality or to support existing economic activities' resulting in safeguards in project development being considered 'luxuries' prior to the 1980s. Construction of the High Aswan Dam in Egypt, for example, resulted in multiple negative environmental and social externalities, including waterlogging, loss of soil fertility and damage to cultural heritage (Abd-El Monsef et al., 2015; Kashef, 1981). The lack of public accountability in project implementation was also a significant problem, with World Bank funded dam projects experiencing widespread condemnation for their lack of inclusion (Goodland, 2010). As criticisms grew of this engineering-led approach, new thinking started to permeate global responses to water security (Benson et al., 2015).

Molle (2009, p. 490; see also Gleick, 2000;) notes that the following period in the 1980s witnessed declining support for this technocratic approach, particularly as a means of promoting international development. Growing issues with non-point source pollution of rivers, from multiple diffuse sources including agriculture, also highlighted the need for joined-up management and less top-down, technocratic control (Barrow, 1998). The genesis of this integrated management approach can be traced back to the UN Mar del Plata Water Conference in 1997 (UN, 1977). At the Conference, governments agreed to adopt integrated planning for water management combined with water-use efficiency, public participation in decision-making and greater information provision (ibid.). In addition, the United Nations Conference on Environment and Development (UNCED) in Rio 1992 promoted the concept of sustainable development and heavily endorsed public participation in environmental decision-making through its main output policy, Agenda 21 (UNCED, 1992). In the run up to the UNCED, the International Conference on Water and the Environment (ICWE) 1992 adopted the Dublin Principles, which now form the basis of Integrated Water Resources Management (IWRM):

1. 'Principle No. 1 - Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment

2. Principle No. 2 - Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels

3. Principle No. 3 - Women play a central part in the provision, management and safeguarding of water

4. Principle No. 4 - Water has an economic value in all its competing uses and should be recognized as an economic good' (WMO, 1992)

In the intervening period, 'integrated' water governance has become a global phenomenon, leading to different approaches to countering water insecurity. Here, the key principles of IWRM, including consideration of multiple water uses and public participation, have primarily been adopted within river basin management (Gain et al., 2013). Such 'integrative' approaches (Zeitoun et al., 2016) spread rapidly on a global scale in the 1990s, endorsed by bodies such as the UN and the Global Water Partnership, leading to multiple IWRM interpretations (Savenije & Van der Zaag, 2008). In the USA, participative watershed planning and local collaborative partnerships have proliferated (Koontz, 2004; Sabatier, Leach, et al., 2005). The Dublin Principles also informed the European Union's Water Framework Directive (WFD) 2000, adopted in response to the perceived failure of earlier EU water directives to address diffuse pollution problems (Benson & Jordan, 2008). Key features of the WFD include river basin management planning, the integration of multiple uses of water, public participation and economic valuation of resources (Official Journal of the European Communities, 2000). Although the actual influence of the public in planning is contestable (Jager et al., 2016), it nonetheless has become a defining feature of WFD implementation. Meanwhile, the River Basin Management Planning (RBMP) concept has been transferred by the EU and other international organisations to various countries globally (Fritsch et al., 2017), including Turkey (Demirbilek & Benson, 2019) – a feature described further in Chapter 5. The rise of IWRM as a set of an organising principles for water management globally has also been recognised by the adoption of the United Nation's Sustainable Development Goal 6.5 (SDG 6.5), where it provides an important implementing focus for achieving different water security targets (UN 2015).

One outcome of this integrative paradigm shift is a proliferation in concepts encompassing integrated water management at the river basin scale. For example, river basin management planning in the EU, watershed planning in the USA and IWRM in the Global South. Concept stretching and neologisms are now common within a burgeoning academic literature and in practice, causing considerable confusion (see for example Benson et al., 2013; Downs et al., 1991). However, fundamentally, all these approaches reflect *integrated river basin management*, a term originally forwarded by Van Beek (1981). Essential components of this concept include:

> '… the management of all surface and subsurface water resources of the river basin in its entirety with due attention to water quality, water quantity and environmental integrity… [a] participatory approach is followed, focusing on the integration of natural limitations with all social, economic and environmental interests' (Jaspers, 2003, p. 79).

In this conceptualisation, building on IWRM and river basin planning, all components of water management are considered together within the river basin, along with public participation designed to represent different water interests, reflecting both socio-economic and environmental aspects. Although other comparable terms are potentially available to denote integrative forms of water governance, this integrated river basin management conceptualization does allow cross-national comparison of how water security is being achieved through this paradigmatic shift. It is therefore the main conceptualization employed for comparative analysis in this thesis.

Comparative research is timely. In their much cited paper, Zeitoun et al. (2016) argue that 'integrative' approaches are well placed to support water security in the shift away from the 'reductionist' paradigm; a feature discussed further in Chapter 2. The argument here is that considering water resources in an integrated manner for management purposes better allows for tackling the causes of water insecurity (ibid.). That said, little research has been conducted into the effectiveness, real or perceived, for integrated river basin management to achieve water security outcomes despite the growth of such approaches worldwide, providing significant scope for comparative research. For example, Turkey – as discussed further in Chapter 5 – is implementing the EU's WFD model of river basin management planning, primarily to counter water security impacts from climate change, pollution and over-abstraction. In the USA, the state of California has adopted integrated river basin planning under its 2016 Sustainable Groundwater Management Act (SGMA), in order to manage groundwater in sustainable way. Ongoing drought and pressures from agricultural abstraction are placing significant strain on water resources in South West USA and the SGMA might be considered the 'gold standard' in attempts to use river basin management planning to address water security. There is a clear need to analyse how integrated river basin management, in the form of governance models such as WFD and SGMA, integrate water security and assess the extent to which the security of resources is being achieved as a basis for lesson-drawing and policy learning, particularly in the context of the wider SDG 6.5 agenda.

1.4 Aims, objectives and research questions

On the basis of these observed trends, the aim of this thesis is to comparatively assess different forms of integrated river basin management in order to determine how well it supports water security outcomes. While the emphasis of this concept on integrated management should theoretically enhance water security – a key hypothesis for testing - there is an evident need for not only empirically based analysis but also development of assessment tools designed for this purpose. In meeting this aim, the thesis will seek to answer the following overarching research question: *to what extent do different forms of integrated river basin management support water security?* Answering this question will be addressed through the achievement of five main objectives, which underpin the research study:

1. *Objective 1: To identify relevant gaps in the water security literature through critical review of the literature;*
2. *Objective 2: To develop a methodological approach for assessing the degree to which integrated river basin management in the WFD and SGMA supports water security;*
3. *Objective 3: To compare different forms of integrated water governance in Turkey and the USA in terms of key institutions, processes and outcomes;*

4. *Objective 4: To comparatively assess the extent to which these different forms of integrated river basin management support water security through the use of a dedicated assessment tool;*

5. *Objective 5: To make recommendations on future integrated river basin management in order to better support water security.*

Each of these objectives are supported by a secondary research question. These will provide structure to the thesis analysis and link into the methodological approach outlined in the next section and detailed in Chapter 3:

1. *How can water security be defined in terms of its key principles?*

2. *How can water security be assessed methodologically?*

3. *To what extent do different forms of river basin management integrate water security into institutional structures and processes?*

4. *To what extent do these forms of river basin management support water security in terms of environmental, social and economic outcomes?*

5. *What recommendations can be made for future implementation of integrated river basin management to better support water security and SDG targets?*

1.4.1 The original contribution to knowledge of this thesis

The thesis makes an empirical, theoretical and methodological contribution to knowledge in four different areas of literature: security studies, water policy and governance, and lesson-drawing and policy transfer, and in institutional frameworks. Firstly, the thesis adds to the expanding security studies literature. As discussed in Chapter 2, the emergence of new areas in security studies such as food security, climate security and water security have increasingly become an important area for discussion in the academic literature. Yet while water security has received significant attention as a normative academic agenda, there is only limited discussion of its implementation in practice. This thesis therefore contributes to the water security literature specifically but also the security studies literature generally through its examination of new empirical cases. Moreover, this study treats water security as a national security matter on the basis that local issues can contribute to or result in national security problems. Secondly, although water security research is growing (for example, Cook & Bakker, 2012; Gerlak et al., 2018), few studies to date have taken an integrated, interdisciplinary approach to study. There is barely any emphasis given to understanding how the decision-making process or water management actions taken at the institutional level influence outcomes as measured through water security indexes. In our research therefore, an interdisciplinary approach is employed to address this evident gap in the literature and in this way our work brings a holistic view to the field. By employing a hybrid Institutional Analysis and Development and Social-Ecological Systems (IAD-SES) framework (Ostrom, 2010; see Chapter 3), moreover, this study combines assessment of water security through its physical and social dimensions, as encompassed by integrated river basin planning. The central contribution of this thesis therefore is to explain the implementation of integrated river basin management in Konya Closed Basin, Turkey and Kern County River Basin in California, USA by evaluating how the independent variables (socio-physical context) affects the dependent variables (water security outcomes) through the analytical framework of the IAD-SES. Finally, this study makes a significant contribution to water security research by providing normative policy prescriptions (Chapter 8) for both academicians and practitioners and will have broader implications for future studies on water security.

1.5 Structure of the thesis

The thesis is structured as several chapters. A *literature review* (Chapter 2) is provided to ground the study in the extant academic context, develop the main themes of the research and identify gaps for further investigation. In this respect, the chapter first introduces the notions of security and shows how it developed in the international relations (IR) literature to encompass environmental security in domestic contexts. Later on, the chapter reveals how the new security fields such as water security, climate security, food security emerged from this context. From these arguments, the concept of water security evolved to provide a set of normative principles to guide decision-making, although as described in the chapter, definitions vary. Key governance mechanisms for implementing water security are then identified. Here, the review shows that a paradigm shift is occurring in the nature of governing water resources, from top-down, centralised and engineering based approaches to more integrated, participative and plan-led processes; encapsulated by integrated river basin management approaches such as WFD and SGMA. While WFD and SGMA are promoted at regional level as integrated water management models globally, the chapter argues that there is little comparative assessment on the extent to which they are supporting water security. A rationale for in depth research is thereby established.

Building on the arguments presented in Chapter 2, *theory* on assessing water management institutional forms is used to develop the analysis in Chapter 3. Chapter 3 starts by establishing the epistemological and ontological context that sets the thesis direction. Established theoretical arguments are drawn from the work of Ostrom (2010, 2005, 1990) and others to provide a basic framework for analysis. The Institutional Analysis and Development (IAD) framework is used as a means of analysing the extent to which river basin management institutions and processes integrate water security, and a focus on their influence on specific outcomes. Here, drawing upon Ostrom et al. (2014, p. 269) the framework 'provides a shared orientation for studying, explaining, and understanding phenomena of interest', in this case water security outcomes. However, to provide greater analytical purchase, the IAD framework is hybridized with governance elements of Social-Ecological Systems (SES) theory (Ostrom 2014) in order to capture the wider setting and better understanding of governance mechanisms. Therefore a revised IAD-SES framework is introduced, alongside a comparative lesson-drawing/policy transfer framework (Benson et al. 2012) to provide a unique, holistic perspective. As discussed above, the role of integrated river basin management in supporting water security is uncertain and the revised framework therefore aims at allowing investigation. In addition, theoretical arguments on water security are further developed to provide a set of parameters for guiding data collection and measuring integrated river basin planning outcomes.

Thirdly, the *methodological* background to the research is also explained in Chapter 4. The research design employed is a comparative (i.e. multi) embedded case design (Yin, 2018). The chapter carefully constructs a comparative design methodology, crucial for grounding the thesis. Two case studies of integrated river basin planning implementation, one from Turkey the other from California in the USA, are compared to assess firstly how institutional structures and planning processes integrate water security, and secondly the extent to which this has resulted in water security outcomes. In this respect, the socio-environmental, institutional and process contexts act as independent variables that influence biophysical and socio-economic outcomes as the dependent variable. By comparing between cases, the key contextual features of integrated river basin management that contribute to positive or negative outcomes can be identified as a basis for comparative learning. As explained in Chapter 3, the specific case studies adopted are ideal for this purpose as they represent similar examples of water stressed regions in the USA and Turkey that suffer a variety of pressures on river basin resources, quantitative and qualitative, but have introduced differing integrated river basin management responses.

Case selection justification is also discussed in Chapter 4. The two study cases fit with our study objectives and are comparable through their water security issues and integrated river basin management approaches. The Konya Basin in Turkey is a large agricultural area where past development of river resources has impacted negatively on the environment and led to user conflicts. The Government has consequently introduced integrated river basin management under its national implementation of the EU Water Framework Directive, which started in 2014 (Demirbilek & Benson, 2019). However, since the introduction of river basin management the basin has experienced increasingly significant problems such as sinkholes that are attributed to extensive groundwater abstraction. Meanwhile, in California, the constant threat of drought has led to the establishment of specific institutions for integrated river basin management (Langridge & Ansell, 2018). In addition, California passed a new law for improving water governance, namely the SGMA in 2014, for sustainable groundwater management at the river basin scale. These two cases are similar in terms of water issues such as groundwater dependence, groundwater depletion, water pollution and climate conditions, while both are semi-arid places prone to periodic drought.

Assessing water security in the examples of integrated river basin planning necessitated the development of a dedicated analytical method. As detailed in Chapter 3, the thesis draws on the theoretical literature on common-pool resource (CPR) management and river basin management planning to establish an assessment framework. Using the Institutional Analysis and Development (IAD) framework of Ostrom (2010, 2005, 1990) as a starting point, then hybridizing it with the SES framework, it develops a novel theoretical approach to examine the influence of integrated river basin management contextual factors on water security outcomes in these river basins. Data were collected from official government sources, supplied by agencies managing these basins, and academic studies. Finally, a dedicated water security assessment tool, comprised of an aggregate of five quantitative indicators, is developed from the existing academic literature in order to measure the degree to which river basin planning achieves water security outcomes, which is integrated into the IAD-SES theoretical framework.

Case Study 1 is located in Turkey (Chapter 5). The Konya Closed basin is one of 25 river basins in Turkey, covering 5.5-million-hectares and 7 percent of the total Turkish surface area (Berke et al., 2014). The basin is the largest agricultural area nationally, often referred to as the bread basket of Turkey, and is also a significant bird breeding area (Divrak & Demirayak, 2011). Konya Closed Basin stands out as one of the 200 most crucial 'hotspot' ecological areas in the world due to its unique biodiversity (Berke, 2009; Olson & Dinerstein, 2002). Furthermore, 60 percent of salt production in Turkey comes from the Tuz Lake, located in the basin which is also bird migration route as well. Given that agriculture accounts for 90 percent of water used in the basin and more than 100,000 water wells exist, there are significant water security issues emerging in Konya (Berke et al., 2014). Due to these water security issues, the basin was prioritized (one of only a few nationally) for implementing integrated river basin planning as a WFD pilot in Turkey (Demirbilek, 2019; Salmaner, 2008). More latterly, there are increasing numbers of sinkholes occurring in the Konya Basin, attributed to low groundwater levels and extensive agriculture (Tapur & Bozyiğit, 2015a). Although sink holes are a natural process, resulting from the interaction between soluble rocks and water, it is believed that the growing numbers of sink holes in the region are a consequence of excessive groundwater use due to new wells being dug as agricultural patterns change (Doğan & Yılmaz, 2011). Furthermore, the sinkhole occurrence has significantly increased over recent years, raising concerns among residents and decision makers, including farmers. For instance, it was revealed that while annual sinkhole occurrence was around 17 in the period of 2010-2014 and doubled by 2015 to 35 sinkholes in a single year, and in 2019 and 2020 the numbers went up to 44 and 43 respectively[2]. This significant increase happened during river basin planning implementation in Konya after 2014. Therefore, concerns over whether integrated river basin management supports water security are evident: the chapter concludes by applying the IAD-SES theoretical framework to analyse the drivers and outcomes of water security.

Our *Case study 2* focuses on California (Chapter 6). California is one of the top ten economics in the world and largest populated state in the USA[34]. California experiences severe and prolonged drought, and during such periods groundwater dependence increases by more than half (Department of Water Resources, 2003a, 2021). Drought in the basin has adversely impacted groundwater levels. For instance, between 2010 and 2014 the groundwater table decreased more than 10 feet on average in the Central Valley region (Department of Water Resources, 2014). These alarming groundwater conditions forced the California state government to introduce integrated river basin management under the SGMA in the middle of a severe drought (2012-2016) (Department of Water Resources, 2021). As described in the Chapter, the SGMA legally requires the classification of high and medium priority basins as a prelude to implementing integrated river basin management, also requiring basin authorities to establish their own groundwater sustainability agencies (GSas) and plans (GSPs). Kern County stands out as one of the most highly prioritized basins due to it being critically over-drafted (Department of Water Resources, 2016, 2020, 2021). In addition, the Kern County subbasin has experienced notable groundwater decline[5], land subsidence issues (Kern Groundwater Authority, 2020) and contamination problems such as salinity, nitrate and arsenic pollution. As in Chapter 5, this chapter concludes by theoretically analyzing water security outcomes and the integrated river basin management approach, using the IAD-SES framework.

A discussion of the results is provided to determine the key findings, as presented in Chapter 7. The discussion chapter returns the research objectives and questions to show how it answers them and adds value to existing literature. Using the modified IAD-SES Framework,

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[2] https://www.aa.com.tr/tr/cevre/konya-ovasindaki-yillara-gore-obruk-olusum-sayisi-belirlendi/2470651
[3] https://lao.ca.gov/LAOEconTax/Article/Detail/90
[4] https://dof.ca.gov/Forecasting/Demographics/2020-census-demographics/
[5] https://waterdata.usgs.gov/ca/nwis/gw/

the analysis of the water security index is discussed to examine how well integrated river basin management institutions are achieving water security. The chapter comparatively discusses governance structures, biophysical factors and socio-economic contexts, and the extent to which these variables influence the water security outcomes. Furthermore, the governance structures of integrated river basin planning are discussed to inform further analysis through examining their strengths and weaknesses. Potential lessons and policy prescriptions for integrated river basin management are then discussed in terms of their transferability, using policy learning and lesson-drawing concepts. The discussion chapter concludes by examining potential transfer opportunities and analyses which integrated river basin management performs better as a basis for further learning.

Finally, our conclusions return to the research aims/questions and objectives to provide our findings, situate the findings within the extant literature and show, again, how they bring originality to different academic research areas. The thesis contribution to existing literature is described in detail. Our key findings provide recommendations for future studies, both academically and in support of practical implementation of integrated river basin management.

1.6 Summary

To sum up, this introduction chapter briefly summarized the main arguments globally about water security issues and then illustrated the transformation of water management from the 'reductionist' approach to the current 'integrative' paradigm, exemplified by integrated river basin management. Here, it presented the argument that integrated river basin management could, theoretically, provide an important mechanism for attaining water security but those studies of effectiveness are limited. The importance attached by the UN SDGs to integrated management implementation provides added significance to such research. This chapter then established the aims, objectives, as well as the research questions of the thesis. This chapter also briefly describes the analytical and methodological framework that will be implemented throughout the research. Additionally, it also outlines the characteristics of the case study basins and reasons for case justification. Finally, it outlines the structure of the thesis, showing how the case study approach will support the thesis aims and objectives. Links to the academic literature, in order to ground the study aims, are provided in the next Chapter (2).

Chapter 2. Literature review: water security, integrated approaches and a research agenda

2.1 Introduction

The aim of this chapter is to give an overview of the security, environmental security, water security and water governance literatures in order to critically identify gaps and develop the research questions set out in Chapter 1. The notion of 'security' is initially contextualised by examining contemporary definitions (Section 2.2). The chapter then provides an examination of the origins of this term in the international relations literature, to show how it evolved from a rather narrow 'traditional' conception of inter-state security in the Cold War era where the state is the 'referent object' being secured, to a focus on 'non-traditional' sectors such as the economy, the military and the environment, that can also be a source of insecurity (Section 2.3). The Chapter also shows how more recently the concept of environmental security evolved out of this shift in the IR literature, that increasingly blurs the line with political science (see Collins 2013: 2), to engage with more human focused, sub-national or transnational threats to states and individuals such as water security (Section 2.4). The recent development of the water security concept within a burgeoning water governance literature is then described to identify the key arguments, gaps and research opportunities in order to develop the overall research agenda (Section 2.7).

A critical review of this literature reveals several areas of interest (Section 2.6). For instance, this literature increasingly asserts that so-called 'integrative' or integrated approaches to water management, which have developed since the early 1990s as part of a shift away from 'reductionist' engineering-based approaches, are best placed to support water security on a global scale through recognising social diversity, multiple water resource use and adaptive management (Zeitoun et al., 2016). A central hypothesis thus developed is the argument that because integrated river basin management does, in theory, already promote such features it should normatively better support water security through mechanisms such as the WFD and SGMA: a feature of particular relevance to attainment of UN Sustainable Development

Goal (SDG) 6 (UN, 2015). That said, the Chapter argues that few studies to date have holistically assessed the effectiveness of integrated river basin planning in supporting water security. In Section 2.7, the literature review then provides linkage back to the aims, objectives and research questions established in Chapter 1 before providing a lead into the theoretical arguments and methodological approaches (in Chapters 3).

2.2 Security as a concept

Security is a highly contested concept, requiring careful definition. Etymology of the term can be traced back to the Roman god of security 'Securitas', which in turn stems from the Latin word 'securas' meaning carefree or free from threat (Adkins & Adkins, 2001). The word then entered the English language from the French 'securite' but has evolved to cover a variety of meanings. However, in its most basic sense, the Oxford Dictionary (1998, p. 1681) defines security much like its original form as 'the state of being free from danger and threat'. Similarly, the Cambridge Dictionary Online (2018) refers to security as the 'protection of a person, building, organization, or country against threats such as crime or attacks by foreign countries'. Here, the concept is often equated to freedom afforded by a specific action to an actor from external harm but generally such definitions lack clarity and could cover multiple contexts. A more precise delimitation is therefore required for informing scientific analysis.

According to scholars, there are three levels of security namely, *individual*, *state* and *international* (Stone, 1991). The individual is the most basic unit, although there is no obvious individual security definition in the literature. However, according to Hough (Hough, 2008, p. 10), if individuals 'perceive an issue to threaten their lives… and respond politically to this, then that issue should be deemed to be a security issue'. Within international relations (IR), the state is the key 'referrent object' when analysing security within the wider international system (Collins, 2009, p. 2). Here, the state can be both a source of threat to and security for individuals (Buzan, 1991b). From this perspective, state security is equated with freedom from war (Bellany, 1981), aggression from abroad (Luciani, 1988; 1981), external threats (Ullman, 1983; Wolfers, 1952), or internal and external vulnerabilities that 'threaten or have the potential to bring down or weaken state structures, both territorial and institutional, and governing regimes' (Ayoob, 1995, p. 9). However, states exist within an anarchic international system with no overarching government: any level of security in states cannot be isolated from that in others. In other words, the security of any state referent becomes, to some degree, a condition for the security of all within the international system (Buzan, 1991b). For instance, the war on terror is a significant example of international security that affects all states to different degrees (Allouche, 2011). As we explain below, the water security concept eventually emerged from this original international focus within the IR literature via a gradual shift towards examination of internal state vulnerabilities to environmental threats, before crossing over to the water governance literature where it has been redefined again by scholars in terms of individual and state vulnerabilities to water resources.

2.3 Security: an international relations perspective

Security as an academic object of study has a long history. Much of the early development of security studies within IR was focused on how external threats or aggression are addressed by states under conditions of international anarchy by realist and liberal theorists (Glaser, 2010). Originally, the concept of security emerged via neo-realist perceptions of the international system in the post-war era. Scholars such as Waltz (1979, p. 111) sought to explain security in structural terms: because of international anarchy, states have limited opportunities to cooperate hence must 'self-help' to achieve their own security and hence survival. These arguments predict that a global balance of power will emerge as states compete with each other to achieve security. Initially Waltz did appear to provide a credible explanation for how security was achieved in the Cold War period, by focusing on the global power struggle for supremacy which led to an uneasy counterbalancing between superpowers. Later structural realists challenged these interpretations, with Mearsheimer (2001) in particular arguing that states, rather than being compelled to act through competition, offensively pursue dominance or hegemony as a strategic goal in order to achieve security. In contrast to Waltz, offensive realists perceive security as a derivation of power: if an actor has enough power to act, it will eventually gain security (Buzan, 1991b). But the explanatory credibility of offensive realism itself was questioned by scholars such as Glaser (1994) who maintain that states can act more defensively by cooperating with others to enhance their security. However, this can create a so-called ‘security dilemma’ whereby tensions occur through a state increasing its security capabilities by military means or alliances but in doing so it can cause insecurity in other states (Jervis, 1978).

Other rational theoretical conceptions of security then emerged in response to realism, most notably liberalism. In disputing its claims, liberalism denounced the realist model as ‘dangerously self-fulfilling’, seeing it as conflict driven (Buzan, 1991b). Neo-liberalism in contrast sought to move the security debate away from state competition to examining how cooperation can be achieved without dilemmas (Morgan 2013). While accepting anarchy as inherent to the international system, liberalism also argues that state security is possible through cooperation, with each other and non-state actors, primarily through international regimes (Keohane, 1984; Keohane et al., 1993). As Hasenclever et al. (1997, p. 24) state, such institutional structures ‘redistribute states’ expected utilities over options, thus turning previously too risky cooperative strategies into a rational means for reaching states’ unchanged goals of welfare and security’. Security can therefore be achieved through creating positive-sum outcomes from cooperation, for example the enhanced security of Western countries achieved through membership of NATO: a feature particularly evident in the 2022 Ukraine conflict.

When it comes to the historical evolution of security studies, the period between 1955 and 1965 has been defined as the “golden age” of security studies by Waltz (1991), due to the nuclear arms race and superpower rivalry (Baldwin 1995). Realist arguments tended to dominate academic debates as they appeared to provide a credible explanation for Cold War military expansion. Thereafter, the research sector declined in popularity under an era of international détente in the 1970s. A revival of security studies in the 1980s was described as a “renaissance” of the field (Waltz 1991). During heightened tensions in the Reagan era, superpower military threats once again predominated over others (Baldwin, 1995). The ‘traditional’ focus of security studies was still therefore military security during this period (see Sheehan, 2013). However, with the end of the Cold War in the late 1980s, non-military threats such as domestic poverty, educational crises, environmental hazards, resource shortages and global poverty could technically be tackled with state resources that had once been diverted to military threats, leading to an expansion of research on this subject (Romm 1993).

As Roe (2016, p. 216) describes, ‘significant moves took place designed to take security studies beyond the confines of the dominant realist and neorealist paradigms’. So-called ‘wideners’ such as Mathews (1989), Ullman (1983) and Booth (1991) sought to expand security studies into non-military areas. With the subsequent publication of Barry Buzan’s book ‘People, States and Fear’ (1991a), an important development in theorising about security occurred (Collins, 2009) which filled this gap in the literature (Stone, 1991). Buzan (1991a) categorised non-military levels of security, which are individuals, states and international systems, and also identified five main security sectors reflecting the changing political context globally. These sectors are Political, Military, Economic, Social and Environmental security (Buzan, 1991b; Stone, 1991). With this categorisation, the security area in IR evolved from the traditional security approach into new security fields. For instance, the collapse of the Soviet Union in the late 1980s led to Islam becoming the new challenge to the Western hegemony in terms of political security aspects, while the arms trade between the centre and periphery states could be seen as an example of emerging military security (Buzan, 1991a). Economic security research was developed to understand the threats posed to the welfare of a state, for example, periphery countries who might get aid from centre ones in order to prevent migration to the West unless living standards are sustained (Buzan, 1991a; Stone, 1991). Social security is possibly one of the most prominent sectors of the five, and, for instance, the migration issue is one of the most challenging issues in relation to societal security, especially to European countries (Buzan, 1991a). However, of most interest to this thesis is the rapid development of the environment as a referent object within the academic literature throughout the 1990s, leading ultimately to the notion of water security.

2.4 Environmental security

In response to the development of these ‘non-traditional’ sectors, environmental security emerged as an important research concept within IR, with four main drivers apparent (Jon Barnett, 2016). A key factor was the rise of environmental awareness in developed countries, which had increased since the 1960s and 1970s (Connelly et al., 2012). There were a number of events that motivated the rise of environmental consciousness. For instance, publication of the book 'Silent Spring', by Rachel Carson (1962), was among the first notable studies to highlight environmental pollution by demonstrating the use of pesticide DDTs on animals and the food chain. Other significant publications followed thereafter, including Paul Ehrlich's (1968) 'The Population Bomb', Garett Hardin's (1968) 'The Tragedy of the Commons', Herman Daly's (1973) 'Toward a Steady-State Economy' and James Lovelock's (1979) 'Gaia'. Environmental disasters such the Torrey Canyon oil pollution disaster, the Seveso industrial accident and the Cuyahoga River fire received huge public attention and created demands on politicians to act. The growth of non-governmental environmental organisations such as Greenpeace, the World Wildlife Fund, Friends of the Earth and the Stockholm Environment Institute then raised environmental awareness globally, as they integrated environmental security into their work. Major international events such as the Earth Day 1970, the United Nations Conference on the Human Environment (Stockholm Conference) in 1972 and the UN Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, also helped promote this environmental agenda (Connelly et al., 2012). Landmark reports such as the Club of Rome's 'Limits to Growth' (Meadows et al., 1972) and 'Our Common Future' (WCED, 1987) contributed to the growth of political concerns over the environment.

Other reasons are apparent for the growth in environmental security as a research area. The second major development was critiques by scholars relating to the inability of traditional security discourses to put environmental risk on national and international security agendas (Barnett, 2016). For example, 'This Endangered Planet', by Richard Falk (1973), and 'Toward a Politics of Planet Earth', by Harold and Margaret Sprout (1971), both discussed environmental problems as threats to the international system. As a result, national welfare needed to be addressed comprehensively and collectively by international political action to address environmental issues. Richard Ullman (1983), in the article titled 'Redefining Security', argued that environmental change might be a source of war. Some scientists have argued that environmental deterioration will generate violent conflict (Barnett, 2016). Problematically, the environment and security were not the central concerns of security institutions preoccupied with winning the Cold War. However, the end of the bipolar world of the Cold War shifted the strategic landscape, becoming the third reason why environmental security assumed more importance. The final reason for the growing recognition of an environmental consciousness is that change in the environment can entail risks to human well-being along with ecosystems. For instance, a lack of access to clean water, food and productive soil poses significant risks to human security more generally (Matthew, 2009). As a result, the literature on environmental security expanded rapidly throughout the 1990s and into the 2000s as scholars sought to fill the gap left by more traditional security studies (Barnett, 2016).

There are six broad approaches to environmental security taken by scholars which can be detected from this literature (Barnett, 2016). The first approach is *ecological* security, which assesses human impact on the environment, highlighting the importance of securing ecosystems. In these symbiotic arguments, humans require a secure environment in order to ensure their own survival (Pirages 2001; Pirages and Degeest, 2003; Pirages and Cousins 2005). A critical point made is that globalization is increasing pressures on ecosystems from human-induced sources leading to ecological 'discontinuities' and 'insecurities' (Pirages & Degeest, 2003, p. 1). Problematically, global threats such as climate change and biodiversity loss present challenges to entire ecosystems and populations that depend upon them (IPBES, 2019; UNFCCC, 2018). Review of the literature suggests that the concept has found particular resonance with researchers in China and the Far East, although primarily as a focus for ecological risk assessment rather than the wider IR debate (for example, Liu and Chang, 2015). As Barnett (2016) argues, the IR conception of environmental security has yet to fundamentally influence either global security discourses or policy making, despite overwhelming evidence of such threats.

Common security is the second approach to environmental security (Jon Barnett, 2016). The argument presented here is that because global environmental problems are transboundary then they should be addressed as common security problems. For example, climate change, acidification and ozone depletion do not recognise state borders, and one country's pollution affects another (Smith et al. 2012). Furthermore, environmental issues such as water scarcity and industrial pollution affect more than one country, because many river systems are transboundary, leading to inter-state conflict (Zeitoun et al., 2013). Therefore, collective action to achieve environmental security is required, leading to a proliferation of international environmental regimes such as the Montreal Protocol, UNCLOS, Convention on Biological Diversity and the UNFCCC (Sands, 2012). Indeed, a whole sub-literature has developed within IR studies examining the institutional development and effectiveness of environmental regimes (e.g. Miles, 2002; Mitchell, 2002; Young, 2001, 1989; Young et al., 1994). Scholars such as Oran Young eschew neorealist assertions on the limited capacity for state cooperation, arguing that environmental security is achievable through such institutionalization (Young et al., 1994). One particular example, the Antarctic Treaty System, is often presented as a model regime for managing common environmental resources from a security perspective (Dodds, 1998; Stokke & Vidas, 1996). More latterly, IR scholars have debated the role of global governance as an antidote to transnational environmental problems (Dingwerth & Pattberg, 2006).

The third approach is the environmental *violence* perspective, which focuses on determining whether environmental change contributes to violent conflict or not, and this approach has been at the heart of environmental security studies (Barnett, 2016). According to Gleick (1991), there are obvious links between environmental deterioration and violence at the local scale as degradation of resources leads to competition between groups. Taking this argument further, Ullman and Myers (Myers, 1986; Ullman, 1983) argue that disputes over resources and environmental problems could cause wars between countries. For Homer-Dixon (1999, p. 6) this prospect was already becoming a reality with 'environmental scarcities… already contributing to violent conflicts in many parts of the developing world'. Here, six types of inter-state conflict were detected: 'greenhouse-induced climate change; stratospheric ozone depletion; degradation and loss of good agricultural land; degradation and removal of forests; depletion and pollution of fresh water supplies; and depletion of fisheries' (ibid.). Such conflicts have been recorded in multiple contexts globally, driven by different causal factors (see Hauge and Ellingsen, 1998). Other scholars have focused on the prospects for environmental conflict resolution, within the wider remit of peace studies (Emerson et al., 2009). But it is the prospect of wars over water resources, in particular, which is most heavily emphasised in the literature, through authors such as Thomas Naff (1992) and former Egyptian Foreign Minister Boutrous Boutrous-Ghali (cited in Gleick, 1991). Many studies identify a clear potential for interstate conflict over resources in the water-scarce Middle East (Issac & Shuval, 1992; Zeitoun & Mirumachi, 2008). Similarly, for Shiva (2001), future conflicts may result from declining access to water, both between and within states, i.e. so-called 'water wars', necessitating greater equity in access. However, for some scholars, there is no strong correlation between environmental change and violent conflict (Barnett, 2016).

The fourth approach to environmental security is the *national security* approach, which looks at whether environmental change can undermine national security (Barnett, 2016). Change in the environment or a decline in natural resources, it is argued, can decrease economic growth and employment, with environment-related sectors such as agriculture, tourism or fishing then negatively affected by these changes. Such impacts can also exacerbate the potential for refugee migration, particularly around climate change, thereby impacting national resilience (Methmann & Oels, 2015). Many countries are deemed at risk, particularly low-lying Pacific Island states (Farbotko & Lazrus, 2012). This issue is argued to be so much of a threat to national security that scholars now argue for effective global institutions to manage future climate refugees (Biermann & Boas, 2010). Others have argued that responses to securitization of climate refugees must incorporate more critical dimensions (Baldwin et al. 2014). These examples show the linkages between environmental change and national security. However, Deudney (1990) believes that linking environmental issues to national security is analytically deceptive, and gives three reasons to support his argument. Firstly, the sources of environmental issues are uncertain and incidental, but military threats are easily detectible because they are visible (ibid.). Second, tying environmental issues with national security might not receive more attention or lead to more action on environmental problems compared to military threats (ibid.). The final reason why Deudney (1990) warns against environmental security is that war caused by environmental change is not likely between two countries.

When considering linking environmental change with security, *military* force is a fifth approach to environmental security (Barnett, 2016). Wars always lead to devastating environmental deterioration. There are many examples of war's impact on the environment, such as the nuclear bombing of Japan, depleted uranium munitions in Kuwait and Kosovo, the destruction of Kuwaiti oil wells, crop annihilation in Eritrea, and Saddam Hussein's draining of marshes in Southern Iraq (ibid.). Indeed, the literature on ecocide, the direct targeting of the environment by military means in conflict, has expanded significantly since the 1970s (Falk, 1973; Ide, 2015; Zierler, 2011). This argument gained significant traction as a result of the US military's use of the defoliant Agent Orange in the Vietnam War (Johnstone, 1971), now becoming a focus of international criminal law (Mehta & Merz, 2015) and even demands for environmental justice. Wars can also indirectly effect the environment. War costs are sustained by resource extraction, or sometimes the cause of conflicts is access to resources such as 'blood' diamonds in Sierra Leone or gems and opium in Afghanistan (Jon Barnett, 2016). Furthermore, spending on war usually hinders government investment and aid, and the money expended could have been spent on environmental improvements.

The sixth approach to environmental security is *human security* (Barnett, 2016). The environment is one of the dimensions of human security, as defined in the United Nations Development Program (UNDP, 1994). It also features in the Millennium Development Goals (UN, 2000) and the Sustainable Development Goals (UN, 2015), where environmental objectives are considered alongside those for human development. One reason is that change in the environment brings insecurity to people, because it might affect where they live and change their living conditions, and the ability of people to readjust to change, i.e. resilience, matters. When people are environmentally insecure they are insecure by other means (Barnett, 2016). Multiple examples exist in the academic literature of such insecurity (see Dodds and Pippard, 2005). For example, climate change is argued to present new challenges to governments in providing for human security by undermining 'the capacity of states to provide the opportunities and services that help people to sustain their livelihoods' (Barnett, 2003; Barnett & Adger, 2007, p. 639). Furthermore, the role of women in terms of human security has been recognized in the environmental security literature over the years, and the concept of 'Human, Gender, and Environmental Security' (HUGE) was introduced with the aim of considering the issue from a feminist perspective and including 'other vulnerable groups such as children, elders, indigenous, and minorities' (Spring, 2009). That said, the issue of gender is under-researched in this area, as indeed in other literatures such as water governance (Benson et al., 2015, 2023). As concern over environmental security has expanded generally the attention of scholars has turned to specific subfields. As a result, recent years have witnessed the emergence of new security fields, such as food security and water security (Collins, 2009; Kaldor & Rangelov, 2014). It is the latter research area which is of specific interest to this thesis research and is therefore examined in detail in the next section.

2.5 The emergent concept of water security

After the evolution of the security concept from 'traditional' militarised concerns and territorial control of states to alternative, 'non-traditional' issues such as environment, academic research has evolved further to focus on specific sub-environmental areas such as water security, which in turn has emerged to dominate debates over water resources globally. The water security concept derived from its interrelations with food security, energy security, environmental sustainability and human health (Allouche et al., 2016). Interest in the concept of water security among academicians and practitioners has increased over the past decade, as echoed in numerous publications (Bakker, 2012) as well as research and conferences (Pahl-Wostl et al., 2016). One of the reasons for this growing interest in water security is concerns of the scientific and policy communities about the state of and challenges faced by the world's freshwater resources, and the immediate need for sustainable water and land management (Pahl-Wostl et al., 2016).

The term water security was originally introduced by Savage (1991) in the academic article "Middle East Water", illustrating the geopolitical concerns of the time over water resources in semi-arid and arid regions. As discussed above, academics had by this point already noted the potential for conflict to emerge over scarce water resources, particularly in the MENA region, thereby threatening state security. Savage (1991) set out requirements for ensuring water security, including self-sufficiency in use during disruptions to infrastructure, ensuring self-reliance as a counter to future population growth, maintenance of groundwater, providing good water quality to support good health, and alternative water supply systems. Water security was therefore conceptualized primarily in terms of the supply side of water provision but, as discussed below, the concept has been subject to significant 'stretching' (see Sartori, 1970 for a discussion).

This process started almost immediately after the initial introduction of the water security term, through contributions by Ewan Anderson (1992) and Hillel Shuval (1992); leading to a geopolitical framing. According to the former, water is an important strategic resource in arid and semi-arid regions and hydro-political actions will be significant when there is a water crisis, meaning water security can be seen as an international policy issue (Anderson, 1992). For instance, the proposed 'Water for Peace Plan' introduced 125 cubic meters/per person/per year water requirement for domestic, urban, industrial and fresh food supply needs for water security between Israel, Jordan and the Palestine (Shuval, 1992). In this plan, water, it was argued, should be secured for all partners with each having an adequate and sufficient equitable allocation for the purposes mentioned above (Shuval, 1992).

Further contributions were made by Tony Allan (1997) in developing the water security concept from his work in researching economic development in the Middle East. Here, water insecurity is equated not with lack of resources, which is argued to frame contemporary policy discourses in the region, but with state inability to limit water use through economic means, what Allan refers to as 'social adaptive capacity' (ibid., p. 1). In this sense, water security is linked to the notion of environmental services provision.

Then, as the literature grew, more formal attempts were made to define water security more expansively. According to the definition forwarded by Witter and Whiteford (1999, p. 2): 'Water security is a condition where there is a sufficient quantity of water at a quality necessary, at an affordable price, to meet both the short-term and long-term needs to protect the health, safety, welfare, and productive capacity of position (household, communities, neighbourhoods (sic), or nation).' So, within this definition, water, both in sufficient quantities and quality, is a priority for human needs. But a discernible shift is apparent in the conceptual framing from the original state-centric emphasis of water security to a more developmental, human-centric focus. This shifting emphasis was seemingly linked to the cross-over of the water security concept to international development discourses at a point when the international community was prioritising the UN Millennium Development Goals in the late 1990s and early 2000s.

The first formal attempt to conceptualise water security from this perspective was made by the Global Water Partnership (GWP) in 2000. Reflecting the GWP's developmental agenda, water security was seemingly redefined to mean ensuring that 'at any level from the household to the global… every person has access to enough safe water at affordable cost to lead a clean, healthy and productive life, while ensuring that the natural environment is protected and enhanced' (Global Water Partnership, 2000, p. 1). It is important to mention here that this is the only definition to date which has a global view of water security, and also promotes sustainable life along with the protection of ecosystems. The Ministerial Declaration at the Hague (Ministerial declaration of The Hauge, 2000), in the same year expanded the GWP definition to define water security in the 21st century. This definition entails 'ensuring that ecosystems are protected and improved and improved, that sustainable development and political stability are promoted, that every person has access to enough safe water at an affordable cost to lead a healthy productive life, and that the vulnerable are protected from the risks of water-related hazards' (Ministerial declaration of The Hague, 2000). This definition adds new dimensions to the GWP definition by including protection from extreme weather events, such as floods and droughts, and bolstering political stability (Nikki Funke et al., 2019).

As conceptualisations of water security expanded at the international level, academics then contributed to the further stretching of the concept beyond individual needs to include commercial use. Swaminathan (2001, p. 35) therefore refers to water security as involving 'the availability of water in adequate quantity and quality in perpetuity to meet domestic, agricultural, industrial and ecosystem needs'. Within this conception, significance is attached to agricultural, industrial and ecosystem water needs. Similarly, Cheng et al. (2004) define 'water security to include access to safe water at an affordable cost to enable healthy living and food production, while ensuring the water environment is protected and water-related disasters such as droughts and floods are prevented' (cited in Lautze and Manthrithilake, 2012). This definition also implies the presence of safe and affordable water for food production. That said, academics were still defining water security in terms of basic human needs, for example Rijsberman (2006, p. 6) who argues that from an individual perspective, water security is maintained 'when she has access to sufficient safe and affordable water to satisfy her needs for drinking, washing, and livelihood'. Water is needed for basic human needs, in this definition. It could be argued that with this individual perspective, this definition captures the human security perspective of environmental security. It stands out as crucially important that without an individual perspective any conceptualisation could risk ignoring human catastrophes. For instance, it was stated earlier that a projected 200 million people could migrate as a result of drought which highlights the importance of a human security perspective. A 2020 projection predicts that 1.2 billion people could be displaced due to changes in climate (Institute for Economics and Peace, 2020). Therefore, human security from an individual perspective is a vital element for the security of water and the environment, plus national and even international security.

As a result of this conceptual expansion, water security had evolved into a catch-all term covering multiple resource uses. Therefore, it is useful to consider a suitable conceptualization to inform analysis. According to Cook and Bakker's (2012) review, the most cited definition by this point is that of Grey and Sadoff (2007, p. 545) which, as identified in Chapter 1, encompasses 'the availability of acceptable quantity and quality of water for health, livelihoods, ecosystem and production, coupled with an acceptable level of water-related risks to people, environments and economies'. Here, the definition appears to incorporate much of the earlier conceptualisations by including quantitative and qualitative aspects of water use with individual, environmental and economic security, using a risk-based assessment. This definition has subsequently established itself as the guiding approach for academic analysis but it should be noted that the literature also contains alternative perceptions.

These alternative definitions diverge according to context, focusing on inter alia global threats, scales of interaction and hazards. For example, some reflect a violence related securitization perspective. The US Environmental Protection Agency therefore defines water security 'as prevention and protection against contamination and terrorism' (Crisologo, 2008; Minamyer, 2008; Morley et al., 2007). This definition specifically pertains to protecting water infrastructure along with preserving water quality, equating it with national security. This type of definition not only considers national security but also equates it with ecological security and environmental violence through an environmental security dimension. Scales of water security are also prominent. Norman et al. (2010, p. 14), for example, propose a water security definition at a watershed scale, based upon: 'Sustainable access, on a watershed basis, to adequate quantities of water, of acceptable quality, to ensure human and ecosystem health'. This definition provides linkage to emergent forms of water governance globally, most significantly integrated river basin management (discussed further below). Indeed, WaterAid (2012, p. 6) also puts an important emphasis on small and local scale subsistence and ecosystems in their definition: 'Reliable access to water of sufficient quantity and quality for basic human needs, small-scale livelihoods and local ecosystem services, coupled with a well-managed risk of water-related disasters'. Other definitions focus on hazard based conceptions, with UNESCO – Institute for Water Education (2009) highlighting the importance of water infrastructure and systems, and defining water security as 'protection of vulnerable water systems, protection against water related hazards such as floods and droughts, sustainable development of water resources and safeguarding access to water functions and services'. Pensore (2012) also brings attention to equality in terms of having access to water and lessening water-related hazards:

> 'Sustainable and equitable access to water of appropriate quantity and quality for all users (e.g. for drinking water and sanitation, agriculture, energy, industry and ecosystems) whilst reducing the impact and costs of water shocks and stresses including floods, droughts and pollution to an acceptable level'.

According to Hall and Borgomeo (2013), the possibility of water-related hazards can hardly be eliminated, and the UN definition disclaims the random nature of these events and the uncontrolled potential for some extremes:

> 'The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustainable livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability' (UN-Water, 2012b, p. vi).

People who live in poor conditions today confront intolerable risks which arise from water issues, and water is insecure, thus water security is also defined as 'a tolerable level of water-related risk to society' (Grey et al., 2013, p. 4). Ultimately, water security it would appear can only be understood through its multiple different perspectives.

One attempt to take these definitions forward is introduced by Scott et al. (2013) includes a resilience aspect. Here, water security is defined as: 'The sustainable availability of adequate quantities and qualities of water for resilient societies and ecosystems in the face of uncertain global change' (ibid. p.281). What makes this concept important is that it proposes a resilience dimension as required, and this differentiates the definition from the more static water security conceptualisation, which is insufficiently focused on 'mutually interactive coupled human-natural dynamics', thus adaptation becomes an important analogy for defining and going after water security (Scott et al., 2013, p. 281).

To sum up, there is a diverse range in the definition of water security. With this review of water security definitions, it can be noted that the focal point of the literature initially has been the quantity and availability of water for human uses, and has then widened to include water quality, human health and ecological concerns (Cook & Bakker, 2016). Analytical approaches have been propagated due to the wide range of disciplines in the use of the term water security (Cook & Bakker, 2012). Most definitions include five themes: access to water, quality, quantity, ecosystems, and a risk-based approach. To avoid the loss of analytical precision associated with 'concept stretching' (Sartori, 1970), this thesis therefore favours the Grey and Sadoff (2007) definition which, while far from comprehensive, nonetheless recognises all of these dimensions: a feature that is returned to in Chapter 4 when setting out the thesis methods. Lastly, a critical overall comment was made by Zeitoun (2011) regarding water security concepts, in saying that water security definitions are heavily weighted in favour of the physical aspects of water and are environmental determinism-oriented, and rarely is there an emphasis on the social dimension, meaning that there should be a balance between these dimensions (Zeitoun, 2011).

2.6 Mapping the main arguments in the water security literature

2.6.1 Introduction

The following section builds on this conceptual development to show how scholars have applied the water security concept to emergent water resource use issues globally. This review shows how an early focus on understanding global, transnational, national and urban implications for water security, from a variety of perspectives, has evolved to discuss the role of governance in implementing water security at the river basin or catchment scale. Most notably, for the purposes of this thesis, academics have claimed that integrative forms of water resources management, the main implementation approach recommended by the international community for achieving SDG 6 (see Chapter 1), have significant potential to achieve water security, as defined above, at this scale. However, a more critical view would maintain that the capacity of integrated river basin management for this purpose lacks empirical foundation and rather guiding principles. Furthermore, on this basis, leading policy mechanisms that support integrated river basin management such as the WFD and SGMA require comparative assessment of their effectiveness in supporting water security. On this basis, the section concludes by drawing out the research aims and questions forwarded in Chapter 1.

2.6.2 The multi-level landscape of water security research

After its initial focus on conceptualisation, evident in the overview above, water security research has expanded to examine this issue at multiple scales, from global, transnational, national and local (Tortajada & Fernandez, 2018). This examination has been undertaken using a variety of empirical, theoretical and normative strategies, which are outlined in this section. More latterly, the literature has begun to discuss water security at the river basin scale and the role of governance solutions such as integrated river basin management to securing such water resources.

Some studies on water security are primarily concerned with understanding the *global* aspects of water security. Such attention has been given to water because water insecurity costs the global economy $500 billion annually (Sadoff et al., 2015). Multiple studies have highlighted the threat of global water insecurity (for example, Grey et al., 2013; Hanjra and Qureshi, 2010; Vörösmarty et al., 2010). One overriding theme of these studies is that inattention to water security poses significant risks to planetary and hence human survival. For example, Grey et al. (2013, p. 1) conceptualise water security in terms of risks to the poor, who are already insecure, due to what they term 'complex hydrology'. In this respect, they call for a redefining of water security to include risk-based assessment, in order to guide global policy.

These academic studies have also been matched by specific global policy initiatives. For example, 'the World Economic Forum's Global Water Initiative, the World Bank's A Water Secure World for All, the Global Water and OECD's Global Dialogue on Water Security and Sustainable Growth, the WWF's Water and Security Initiative, the Water Programme of Nature Conservancy's Global Solutions, and the Global Human Water Security Fund' have promoted water security at their conferences and initiatives (Grafton et al., 2017; Tortajada & Fernandez, 2018, p. 16). More recently, the World Economic Forum has promoted water security as part of its wider water-energy-food (WEF) nexus agenda (Benson et al., 2015; WEF, 2012). Here, water security is considered alongside energy and food security as a central objective of development planning, with the concept now increasingly promoted by multiple UN agencies. Indeed, UNESCO has developed methodologies for assessing the WEF nexus to support global development policy (UNESCO, 2018).

Other studies have examined the *transnational* or *international* features of water security, both empirically in terms of emergent disputes, theoretically through developing explanation and normatively in terms of presenting potential cooperative solutions. Empirically speaking multiple studies have been published on transboundary water conflict (see Zeitoun et al., 2013). Since 40% of the world's population lives in transboundary river basins (UNDP, 2006), which are shared by more than one country, and transboundary basins cover nearly half of the land surface (Wolf, 2007), regional or transboundary water security becomes one of the most important and challenging tasks in the world. There are several attention-grabbing water-related disputes recorded in this literature, such as the Egypt-Ethiopia disagreement over damming of the Nile River (Abseno, 2013), the Israel-Palestinian conflict over water allocation (Fröhlich, 2012), or the Mekong Dam issue (Cronin, 2013). These approaches account for the common security of an environmental security approach, by assessing how transboundary problems affect one another and then become common issues for all the stakeholders who share the water. Moreover, the Himalayan example, discussed further below, highlights the importance of a common security perspective in that cooperation over water resources is needed as well.

Scholars have attempted to interpret interstate water conflicts, particularly through the lens of conventional IR theory. In taking forward Mearsheimer's original neorealist conceptions discussed above, Zeitoun and Warner (2006) forward the notion of 'hydro-hegemony' to uncover power asymmetries between upstream states who can hold significant influence over downstream states through control of water resources (see also Warner et al., 2017; Warner and Zeitoun, 2008). Such authors have drawn upon Joseph Nye's (1990) notion of soft power to interpret non-violent water conflicts between states (Zeitoun et al., 2011). More recently, critical theory has been employed within a so-called 'critical hydropolitics' to theorise power and hegemony in transboundary water contexts (Cascão & Zeitoun, 2013), while others focus on a securitisation approach (Mirumachi, 2013).

Furthermore, scholars have employed their analyses to forward potential cooperative solutions, reflecting a more liberal institutionalism perspective. Magsig (2015) for example examines water security in Himalayan Asia to determine whether there could be regional cooperation or further disputes, particularly between China and India. The Himalayas is a vitally important region, because 'more than 1.5 billion people bank on transboundary rivers rooting in the Himalayas' (Grey & Connors, 2009, p. 60). Ultimately, despite the important legal-administrative developments, a regional water security framework governing Himalayan Asia's sharing of water resources seems far from being resolved (Magsig, 2015).

Dropping down a scale to the *national* level, a great number of comparative water security analyses have been carried out so far[6], including studies on Australia, China, Singapore, Morocco, Brazil, and the USA. According to Besbes et al., (2019, p. 48), water security can be 'a central political issue for which public authorities have to develop appropriate strategies to secure supply for all uses and promote human well-being through socio-economic development'. From an Australian perspective, even before the federation was agreed in 1901, water security was a prominent issue in Australia's history, and in the 1990s microeconomic reforms made significant progress in cementing water security in rural and urban areas (Horne, 2018). In 2006, a national water security plan was introduced by the government, with specific emphasis given to the Murray-Darling Basin (Howard, 2006). In

[6] See for example, Russia (Dudarev et al., 2013), Israel (Tal, 2017), France (Tardieu, 2018), South Africa (Steyn et al., 2019) and Spain (Lopez-Gunn et al., 2016)

2017, the Australian Water Association (2017, p. ii) emphasised 'the need for a holistic framework to ensure long term water security for all Australians moving forward', while it has been stated that there is no single accepted water security definition used in Australia (Horne, 2018). Unfortunately, the water security level in several regional and remote areas in Australia is still very low, presenting a threat to future development (Australian Water Association and ARUP, 2016). It also presents a wider challenge to national security under future climate change in what is the driest continent on Earth.

In China, water security covers three aspects, which are drinking water, water supply and ecosystem security, and it is intrinsically intertwined with national security (Yang et al., 2016). More than 400 cities suffer water shortage in various dimensions, thus making water security a national security issue (Ministry of Water Resources, People's Republic of China, 2018). Furthermore, China has an uneven spatial and temporal distribution of water resources and different precipitation patterns from north to south or from east to west (Yang et al., 2016). However, these difficulties are added to by a growing population and human activities which lead to climate alteration, which will make it difficult to achieve long term national water security (Ministry of Water Resources, People's Republic of China, 2018; Yang et al., 2016).

According to Tortajada et al. (Tortajada & Wong, 2018), Singapore, as a city-state, has tried to achieve becoming a water secure state. The ultimate aim of this country is to be completely secure and self-sufficient in terms of water by 2060. Although dependent on outside water supplies, energy and food, knowing that it has no natural water resources and hinterland, these apparently critical issues have been coped with through long-term comprehensive strategies, sound policies, and innovation in all sectors (ibid.). One response has been the NEWater recycling system for potable water (Lee & Tan, 2016; Lefebvre, 2018), which could be considered globally leading as engineering solution to urban water security.

Although Morocco is rich with groundwater resources, it prepared and put into practice policy reforms in its water management system due to a change in climate, lessening precipitation, and a hike in the frequency of droughts (Ait Kadi & Ziyad, 2018). The country additionally planned to adopt a strategy for integrated water resources management in order to support water security (ibid.).

Moreover, Brazil has similar uneven water resource distribution, as in the case of China, although it is one of the wealthiest countries in terms of water resources. The northern part of Brazil holds 65% of its total water for only 5% of Brazil's population, and the southern part has 6% of the total water, while having 40% of the population (de Assis Souza Filho et al., 2018). Water security became prominent in Brazil due to the severe droughts that affected different parts of the country. For instance, during the drought between 2014 and 2015, the average precipitation was at its lowest level for the last 85 years. In the wake of severe drought, the country now attaches great importance to water security (ibid.).

The US Intelligence community takes the national water security assessment further by including countries that are important to the US due to water shortages and poor water quality. These issues will pose significant risks, such as state failure, an increase in regional tension, and diverting the country's attention away from working with the US on national security interests (NIC, 2012). According to Busby (Busby, 2017), there are strategic allies to the US, which are vital for raw materials, have strategic sea routes, and are important to the international supply chain in the global economy, or in terms of US military operations. Any water insecurity in a strategic partner to the US could trigger national security concerns. Furthermore, water security has been assessed in terms of water being used as 'a weapon' in US Intelligence reports (NIC, 2012), and it was argued during the assessment that terrorists or insurgents could potentially target dams or water infrastructure locations such as desalination plants or water aqueducts. These arguments were extensively investigated by King (2015), after the so-called ISIS took over Iraq's Mosul Dam in 2014 and threatened local people with water cutoffs, and furthermore the diversion of the Khalis tributary of the Tigris River flooded parts of the town of Mansoriya in Iraq, resulting in mass migration. This type of water related problem, especially weaponization of the resources, links to military security in a broader sense and the use of military force in an environmental security sense.

Theoretical conceptions of national water security, like transboundary studies, tend to draw upon pre-existing frameworks. For Bakker, water insecurity is intrinsically linked to globalization and the perceived expansion of neoliberal norms (Karen Bakker, 2005, 2007, 2013). Critical theoretical perspectives are utilized to argue that neoliberal water privatization in many countries has led to sub-optimal outcomes and political backlash (ibid.). Water insecurity created under this neoliberal agenda has been highlighted in the work of other authors (Ahlers, 2010; Barlow & Clarke, 2003; Harvey, 2003).

Other research has examined water security at the sub-national scale. Significant numbers of studies have been conducted on urban water security, along with work based on rural areas and remote communities (Bichai et al., 2015; Chen et al., 2013; Daley et al., 2014; Finlayson et al., 2013; Kandulu et al., 2014; Kujinga et al., 2014; Narain et al., 2013; Oswald Spring, 2011; Prakash, 2014; Stebbing et al., 2013; Yang et al., 2012). On the one hand, few research projects that were conducted on rural areas and remote communities regarding water security used any water security-oriented concepts or frameworks. One study which did use the water security concept, for instance, was a remote community study in Canada, with water security defined as "a function of water access, availability, quality and preference", and the aim of the research was to understand water security in terms of the drinking water perspective in rural communities in Rigolet and Nain, located in eastern Subarctic Canada (Goldhar et al., 2013, p. 463). The study was conducted through interviews with individuals and households, and the results show that there are restrictions in access to adequate, desirable and clean drinking water for some, and that the majority of people prefer to use water collected from the land in respect of other alternatives (Goldhar et al., 2013).

On the other hand, water security issues from a city perspective has become an important concern due to growing urbanisation and climate-induced uncertainty in terms of water availability (Bichai et al., 2015). Among many others, Shanghai is a specifically important study that is intentionally highlighted here for several reasons. For instance, Shanghai as a mega city, due to increasing urbanisation and heavy water pollution, is shifting its approach to managing water resources; it was previously receiving 80% of its water from Taihu, via the Huangpu River, and it has become heavily dependent on the Yangtze River basin, where the city is located (Finlayson et al., 2013). According to Chen et al. (2013), water security issues in Shanghai come from the national-scale and basin scale decisions about water management in China, and river basins should be managed more efficiently in China; thus, this brings attention to the importance of basin scale water security.

According to Norman et al. (2010), water security can be best practiced at the watershed or river basin scale. The watershed and river basin scale are synonymous and are based on hydrological boundaries. Some studies to date have been conducted on the basin scale in terms of assessing water security, primarily in China (Jia et al., 2015; Ma et al., 2010). For instance, a study of the Yellow River Basin used statistical methods in order to evaluate water security, with the results showing only low levels of security (Jia et al., 2015). On the other hand, water security assessment results in the Haile River basin indicate that water security appears enhanced, but the Tuhai River and Majia River were in poor condition (Ma et al., 2010). However, these studies were based on statistical analysis of physical parameters, and the social aspects of water security were neglected. Lastly, basin scale studies have not attracted as much attention as they deserve in widely recognised water security books or the most cited review papers, such as nation state studies do. It should be mentioned here that the river basin scale can contribute to national scale water security, as local level actions have an effect on global actions (Wilbanks & Kates, 1999), so more studies are required at a local scale to better comprehend water security and its effects at a national scale.

2.6.3 Research gaps and opportunities: the potential (and potential challenges) of integrated approaches for supporting water security

Another important argument to emerge from this literature is that specific forms of governance, located at specific scales, can support water security. Here, scholars have taken a critical stance towards 'reductionist', 'hydraulic' or 'engineering' forms of water governance in supporting water security. In addition, others have normatively maintained that more integrated approaches such as the WFD and SGMA through integrated river basin management to managing water have significant potential in this respect. The latter argument, moreover, is strongly endorsed by emerging policy at both global and national levels worldwide. However, conspicuous issues are evident in the practical application of the WFD and SGMA that may impair its capacity. Problematically, while studies of integrated river basin management have assessed specific components of this process such as public participation, holistic analyses of its water security capacity are poorly developed. Assessment of the effectiveness of integrated river basin management in supporting water security therefore presents a critical gap in the literature both empirically, methodologically and normatively, opening up the need for comparative analysis.

2.6.3.1 Reductionist approaches

Scholars have become increasingly critical of so-called 'reductionist' (Zeitoun et al., 2016), 'engineering' (Benson et al., 2015) or 'hydraulic' (Molle, 2009) approaches to water security. Here, as explained in Chapter 1, water is managed in a top-down manner, primarily through large scale water projects and investments for schemes such as dams, irrigation and water supply. However, three main criticisms are made in the literature of this paradigmatic approach.

Firstly, this approach seeks to offset uncertainty around water resources through quantitative risk assessment. According to Zeitoun et al. (2016, p. 145), such risk framing argues that uncertainty can be dealt with 'by building more storage on-farm, near cities or regionally' after such assessments. In the past, as described in Chapter 1, this approach equated to predictive analysis followed by construction of projects such as dams and reservoirs. However, this policy, which is grounded in engineering sciences, is often restricted in practice due to adverse hydrological, geological and soil conditions, is less useful because of different climate conditions in parts of countries, and ill-fitted to tackling unpredictable changes such as instantaneous changes in water demand or long-term drought and other uncertainties (ibid.). Also, a policy that is based on quantitative risk assessment could lead to undervaluing of the role of adaptive management in reducing uncertainty (Hall & Borgomeo, 2013).

Secondly, another problem that has arisen is due to the social externalities of reductionism. As Molle (2009, p. 489) suggests early proponents of such project building envisaged greater engagement of communities through the improvements in society that they would offer. But many dam projects in particular have excluded the public. For example, Goodland (2010) details a catalogue of criticisms of the World Bank's policies on the funding of large dam projects, calling for better guidelines and oversight. Problems have included governments using force to relocate impacted residents, inadequate compensation paid to them and the limited involvement of the public in project planning (ibid.). One recent and ongoing example is the controversy surrounding the resettlement rights of communities impacted by the Illusu dam in Turkey (Hommes et al., 2016; Morvaridi, 2004). Lack of public engagement and issues around relocation were also a feature of the construction of the Three Gorges dam in China (see Jackson and Sleigh, 2000; Liu and Chang, 2015; Padovani, 2006; Qi et al., 2016).

Lastly, the reductionist approach is politically problematic, for the following reasons. Some definitions that are used justify large investment plans that are weak and groundless. Other approaches which are characterised by uncertainties which can make emergent policy recommendations ineffective or gloss over the social distributional issues and power asymmetries that favour the prosperous and strong over the marginalized (see Zeitoun et al., 2016). For instance, it was found by scholars that the Palestinian Authority (PA) was compelled to develop its water supply infrastructure by Israel, paving the way for 'settlement expansion' by Israelis (Selby, 2013, p. 18). This example illustrates how power imbalances can result from a reductionist approach.

2.6.3.2 The case for integrated approaches to water security

As discussed in Chapter 1, criticisms of the reductionist approach precipitated changes in water management globally towards more integrated forms of governance. Normative arguments are increasingly being made in favour of such integrated approaches for supporting water security, by both academics and policymakers (see Al-Saidi, 2017; Zeitoun et al., 2016). Again, several reasons are forwarded, primarily related to uncertainties, adaptive management, social diversity and integration.

Firstly, it is suggested that such approaches can overcome the uncertainty issues associated with the engineering paradigm (Pahl-Wostl et al., 2008, 2011; Pahl-Wostl & Sendzimir, 2005). For example, Huntjens et al. (2012) forward normative design principles for adaptive governance of water resources in response to climate change that incorporates a role for learning in integrated approaches. In this respect, through adopting an iterative planning cycle, institutions can be continually modified to account for changing contexts rather than the 'predict and provide' approach typical of reductionist governance (ibid.).

Secondly, the integrative water security approach can go beyond an infrastructure prescription, which usually involves supply-side solutions (Zeitoun et al., 2016b), and adopt adaptive and innovative approaches, which are essential to addressing the principle of uncertainty (Hall et al., 2014). For instance, Allan (2013) uses China's National Water Policy, the European Flood Directive and Australia's Murray-Darling Basin Plan as convincing cases in tackling the social ecological complexity of water security with adaptive water management (Raadgever et al., 2011; Sigel et al., 2010). This method of basin scale water management concentrates on learning and adapting consumption patterns rather than focusing on measuring 'water use efficiency' in production (Clement, 2013). Developing adaptive and flexible approaches in research and policy can help with creating more innovative and responsive water security concepts (Zeitoun et al., 2016b). Additionally, this type of approach explores the reduction of the complexity of social diversity without underestimating it, which is not easy work (Schmidt, 2012).

Thirdly, integrated governance can also increase social diversity and reduce environmental degradation in support of water security. According to Krueger et al. (2016), for instance, water issues can be tackled through a transdisciplinary approach by bringing together a wide range of different expertise, both academic and non-academic, within an integrated context. Public participation has long been considered a normatively desirable component of integrated river basin management. Since its identification in the UN Mar del Plata conference recommendations and the Dublin Principles, public participation has become a key component of integrated systems globally (Gain et al., 2013). Article 14 of the EU's Water Framework Directive, for example, mandates public participation in the preparation of river basin management plans but practice is highly uneven (Jager et al., 2016). A review of the literature reveals numerous examples of public participation mechanisms within integrated river basin management systems in different countries. These include those conducted on Zimbabwe (Fatch et al., 2010); Tanzania (Dungumaro & Madulu, 2003); Sri Lanka and Bangladesh (Evans & Varma, 2009); Mexico (Wester et al., 2009); China (Jingling et al., 2010; Yu et al., 2014); and Ghana (Poolman & Van De Giesen, 2006).

Finally, the integrated approach also aims to go 'beyond river' and combine biophysical and social processes and look at multiple scales, particularly the river basin (Sadoff & Grey, 2002; Zeitoun et al., 2016), and less readily controlled and measured water bodies should be carefully assessed (Zeitoun et al., 2016). For instance, establishing water security research that specifically focuses on groundwater to make a contribution to the development of analytical methods for global water accounting (Karimi et al., 2013; Lawford et al., 2013). In places where there is shortage of precipitation, runoff or surface, groundwater is heavily being dependent on in order to meet water demand (Lawford et al., 2013). However, if the abstraction of groundwater is far more than the discharge of aquifers while having overreliance on groundwater, then it can create water insecurity in long term, resulting in land subsidence and poor water quality (Gun, 2012; Lawford et al., 2013). On the other hand, groundwater is relatively undervalued in the water management due to its invisibility rather than surface water, but it should be noted that its use in irrigation significantly increased (Conti et al., 2016; Siebert et al., 2010). In this respect, accounting for groundwater as part of integrated approach gives better understanding of global water accounting and thus can contribute to water security.

2.6.3.3 Integrated river basin management and water security: critical research gaps

In parallel with these normative claims on the benefits of an integrated approach, integrated river basin management approaches have been heavily promoted in global, regional, national and sub-national policy circles to counter water security concerns. The UN adopted IWRM as a key target for implementing SDG 6 for ensuring access to water and sanitation (UN, 2015). Countries globally are requested to implement IWRM by 2030. UN agencies such as UNESCO have therefore promoted integrated approaches as a means of supporting this target. According to the UN (2018), a total of 172 countries now employ a form of governance based on integrated water resources management principles, typically through river basin management, making it the key organizing approach for the institutionalization of water management globally. At the regional level, the European Union has sought to counter growing water insecurities through its flagship WFD policy that mandates integrated river basin management in its 27 Member States, plus the UK and EU accession states. River basin planning and catchment partnerships, featuring integrated management of water resources is now evident in Northern countries such as the UK, USA, Denmark, the Netherlands and Australia (Smith et al. 2015). In the Global South, integrated river basin management is practiced in such diverse national contexts as Malaysia (Mokhtar et al., 2011), China (te

Boekhorst et al., 2010), Brazil and Mexico (Tortajada, 2001), Ethiopia (Asmamaw, 2015) and Vietnam (Molle & Hoanh, 2011). California's Sustainable Groundwater Management Act (SGMA), moreover, is a globally leading form of integrated river basin management. The shift from reductionism to the integrative paradigm could be argued to be well under way on the basis of these examples but the implications for water security – this thesis argues - are not well understood.

Problematically, few studies have sought to assess the extent to which integrated river basin management supports water security. A plethora of research has for example been conducted on the EU Water Framework Directive processes, institutions and outcomes but the majority of it focuses on specific aspects of implementation, concerning public participation, economic valuation or monitoring, with little theoretically-driven assessments of its implications for water security (Boeuf & Fritsch, 2016). Water security issues are examined, for example the integration of climate change into the WFD (Brouwer et al., 2013), although are not explicitly linked to the water security concept. Indeed, the majority of work related to water security has focused on examining specific WFD outcomes such as 'good ecological status' of river basins (Everard, 2012), participation (Kochskämper et al., 2016) and basin pollution levels (Bouleau et al., 2020) rather than providing a holistic assessment.

Indeed, this feature is visible in the wider literature on integrated river basin management, where the water security concept is not widely considered. Here, analysis has covered multiple aspects, again divisible into structures, processes and outcomes. Significant research has been conducted in charting integrated river basin management institutional arrangements (for example, Jaspers, 2003; Nielsen et al., 2013; Tortajada, 2001). Critical debates have emerged moreover concerning the integration of competing water users or economic sectors within such processes (Biswas, 2004, 2008; Downs et al., 1991). Others have criticised the technocratic implementation of integrated management norms, principles and practices, particularly IWRM (Al-Saidi, 2017). Outcomes such as public participation effectiveness are also widely discussed (Agyenim & Gupta, 2012; Beveridge & Monsees, 2012; N. Funke et al., 2007; Nikki Funke et al., 2019; Horlemann & Dombrowsky, 2012; Saravanan et al., 2009), along with the capacity of integrated river basin management for promoting inter basin and inter-state cooperation (Asmamaw, 2015; Chenoweth et al., 2001). Other perspectives have considered actors perceptions of management (den Haan et al., 2019) and the implementation challenges (Habersack et al., 2016; Mokhtar et al., 2011; Molle & Hoanh, 2011). Although comparative studies of integrated river basin management are also prominent in the academic literature (Blomquist et al., 2005; Zhao et al., 2015), what becomes apparent is the almost complete absence of comparative, theory-driven research that links the water security concept to the implementing concept of integrated river basin management and analogous terms such as IWRM.

This aspect, it is argued, represents a significant gap in the literature, particularly when considering the normative claims for integrative vis-à-vis reductionist approaches as a means of better achieving water security (for example, Zeitoun et al. 2016). Such research, it is argued, also remains critical for policy practice given the increasing prevalence of water security risks, particularly from climate change, over-abstraction and pollution, and also the developing global SDG agenda that aims to address water security concerns through integrated approaches. It also becomes significant when considering the global growth of the integrated river basin management concept at global, regional, national and sub-national levels in the past three decades.

2.7 A research agenda

This literature review has provided an overview of water security in order to identify gaps and research questions that will guide the thesis. Chapter 1 identified the thesis research objectives. Objective 1 is: *To identify relevant gaps in the water security literature through critical review of the literature.* In this respect, This Chapter (2) initially described how the concept of water security emerged from wider security study debates in the IR literature to inform a range of studies at different scales. Then it showed that the field has evolved to encompass water governance issues from an initially broad environmental concern. The transformation of the concept of water security is shown in the literature review to encompass both physical and social dimensions, as conceptualized by Grey and Sadoff (2007).

The review then examined how scholars have criticized the reductionist paradigm in different ways, primarily in terms of its increasing inability to counter water security risks. In this respect, the normative claims for more integrative approaches as a means of supporting water security were examined to identify a critical gap in the academic literature, namely that in practice few studies have actually assessed the capacity of integrated river basin management in achieving water security.

Identification of this gap allows for the development of a research agenda to guide the rest of the thesis study. To bridge this research gap, analysis is therefore required into the water security capacity of integrated river basin management, necessitating a methodological approach (Objective 2). As described in Chapter 3, this first necessitated developing a dedicated theoretical framework that allows for such an assessment, in this case drawn from the environmental management and public policy literatures. Specific methods, based upon combining case study design with development of a water security assessment index, using mixed qualitative and quantitative methods. Comparative analysis of two leading models of integrated river basin planning, the WFD and the SGMA, could then be undertaken to assess the extent to which they consider water security (Objectives 3 and 4). Such research can then seek to identify lessons for policy learning on integrated river basin management to better support water security, particularly in the context of the SDG 2030 agenda.

Assessing whether integrated river basin management is contributing to water security in this way also then moves the thesis research beyond a mono-disciplinary perspective; another evident gap in current studies. Some existing research utilising inter or transdisciplinary approaches have emerged in the water resources field in the last decade, with the aim of understanding water in a comprehensive way (Krueger et al., 2016a; Maia & Pereira, 2015; Sivapalan et al., 2012; Vogel et al., 2015; Wheater & Gober, 2015). In this respect, the water security issues societies confront are 'cross disciplinary boundaries' problems and disciplinary barriers hinder the capacity to investigate such complex systems, thus there is a requirement for inter or transdisciplinary research (Wheater & Gober, 2015, p. 5410). Additionally approaches are believed to address the increasingly complex nature of pressing problems (Jahn et al., 2012). For instance, the term socio-hydrology was introduced by Sivapalan et al., (2012, p. 1271) with the purpose of comprehending 'the dynamics and co-evaluation of coupled human-water systems'.

To sum up, this review has identified a critical gap in the literatures on water security and integrated river basin planning. It argues that assessing the extent to which integrated river basin planning supports water security has attained added significance since the inclusion of the requirement to implement integrated water resources management in the UN SDGs but that studies are limited. However, any assessment has to account for the integrative, holistic nature of water security. The rationale for developing a dedicated methodological approach with an assessment framework and tools, using case studies to examine outcomes, is therefore established. This approach will allow the thesis research to address the aim of thesis, namely: '*to comparatively assess different forms of integrated river basin planning in order to determine how well it supports water security outcomes*'.

3. Theory Chapter

3.1 Introduction

In this chapter, our aim is to illustrate the theoretical framework which relates to the empirical questions developed in the introduction and literature review (Chapters 1,2) and provides a link to the methods (Chapter 4) and the empirical chapters (Chapter 5,6). The chapter starts with ontological and epistemological context, which provides the basis for the research direction taken in the thesis. Our investigations are based upon a foundationalist ontology, along with a positivist epistemology (3.2). Then the chapter (3.3) explains the IAD framework and its relationship to the study aims. The IAD was chosen for its simplicity and easy applicability, along with its capacity to inform comparative case research. After taking a critical perspective on the IAD (3.3.3), the chapter outlines how a hybrid IAD-SES framework combination was considered appropriate for meeting the study aims (3.4). Furthermore, by combining this approach with comparative analysis, this chapter shows how the thesis will utilize lesson-drawing theory (3.5) to identify what could be potentially transferred in terms of learning on effective integrated river basin management for achieving water security from California by Turkey.

3.2 Ontology and epistemology

In any research design, whether qualitative, quantitative or mixed methods, one overriding design principle is coherence between the research aims, questions, design and methods (Robson, 2002). Consistency should also be achieved between these elements and the ontological and epistemological position of the researcher, which in turn determine the theoretical approach adopted and methods.

According to Guba and Lincoln (1994) all research is conducted in relation to specific theoretical perspectives grounded in fundamental assumptions about reality. These assumptions dictate not only the object of study but also the use of theory and attendant research techniques. Determining them is dependent on answers to several questions (Corbetta, 2003, pp. 22–23). The first relates to ontology or *how is reality understood?* In other words, does reality exist independently of human knowledge or does it exist only through our interpretations, i.e. is it socially constructed? These questions then lead on to further questions regarding how we can then research reality from these different ontological standpoints, i.e. epistemology or knowledge generation. So for example, if a researcher accepts that reality exists independently of our knowledge, it can be measured and interpreted using traditional scientific methods, i.e. it can be more readily subjected to the experimental techniques of quantitatively based science.

This thesis is based upon a realist or foundationalist ontology and positivist epistemology. A realist ontology maintains that there is a 'real' world that exists independently of our knowledge (Furlong & Marsh, 2007, 2010; Hay, 2007; Spencer, 2000). This ontology invariably underpins statistically-driven natural science but also informs theory-testing social science, where deductive approaches are employed to observe causal relationships between social processes through experimentation (Yin, 2018). In this positivist perspective, falsifiable hypotheses drawn from theoretical assumptions can be tested, generally using quantitative, qualitative or mixed method techniques. To an extent, this philosophical grounding became the established approach to social sciences in the 20th century, although was later challenged by post-positivism, based in a constructivist or phenomenological ontology which infers more qualitative, 'grounded' approaches to theory development (Sanders, 2002). However, these approaches adopt an anti-foundationalist perspective and are invariably based on immersive qualitative methods such as participant observation (Furlong & Marsh, 2010). Additionally, the relationship between the conceptual framework, namely integrated river basin management and water security, can be observed directly; so can be researched using qualitative and quantitative data which allows for a mixed methodology. Moreover, the theory-testing nature of the study means that it is not suitable for a constructivist interpretivist ontology (for more detail, see Furlong & Marsh, 2010). Finally, an entirely qualitative view, unlike a quantitative one, might not be able to generate 'objective and generable findings' (see Furlong & Marsh, 2010, p. 193). This could limit the testing of our theory in the comparative cases.

3.3 Theoretical perspectives: institutional rational choice

Since the aim of the study is to provide an integrated assessment of water security in integrated river basin management the theoretical framing had to encompass social, institutional and environmental aspects of water management. While some studies have attempted more integrated theoretical analysis, primarily focused on river basin management (Benson et al., 2014; Bielsa & Cazcarro, 2014; Soncini-Sessa et al., 2007; Tarlock, 2007), most studies in this area lack a strong theoretical underpinning or fail to link socio-environmental aspects.

However, one established sub-section of the environmental management literature draws upon the institutional rational choice (IRC) tradition to overcome this deficit. Several theories seek to analyse institutional arrangements for common pool resources[7] management such as river basins (e.g. Sabatier et al., 2005). For example, Sabatier et al. (2005) develop the Political Contracting Framework (PCF) that analyses institutional development and effectiveness. The PCF specifies several conditions for the successful formation of CPR 'partnership' institutions (Benson, Jordan, Cook, et al., 2013). Institutions, it is argued, can be conceptualised as contracts or sets of rules governing interactions between parties, employing economic-legal concepts first developed in the organisational theory literature (North, 1990; Williamson et al., 1975). Factors affecting institutional formation (or 'contracting') include the availability of scientific knowledge of CPR problems, the existence of severe environmental problems and where partnerships can subsidise transaction costs (Sabatier et al. 2005).

Although this approach could be used to analyse integrated river basin management institutional effectiveness (see Benson et al., 2013), it does not readily encompass management outcomes due to its temporal emphasis on institutional development and its long term survival. For example, Benson et al. (2013) draw upon a modified version of the PCF

[7] Common pool resources (CPR) can be defines as 'as resources for which the exclusion of users is difficult (referred to as excludability), and the use of such a resource by one user decreases resource benefits for other users (referred to as subtractability). Common CPR examples include fisheries, forests, irrigation systems, and pastures' (Heikkila & Carter, 2021).

framework to analyse the formation of catchment management partnerships in England, finding that 'success' is related to various contracting factors such as finance, trust and agency engagement. Similarly, scholars have also inter alia drawn from networks theory (Lubell & Fulton, 2007; Mark Lubell et al., 2012), social capital (Sabatier et al., 2005), advocacy coalition framework (ACF) (ibid.), social learning (Pahl-Wostl, Craps, et al., 2007) and collaborative governance theory (Benson, Jordan, Cook, et al., 2013) to examine institutional effectiveness. But none of these theories provides a holistic perspective in that they tend to focus on specific actor-centred aspects of environmental management institutions, for example learning and policy development in ACF or collaborative processes in collaborative governance. Neither, as identified above, do they say much about the environmental outcomes of such processes. Critically, there is a need, in meeting the study aims, to employ theory that provides a more holistic framework for comparatively analysing integrated river basin management that integrates process and outcomes.

3.3.1 IAD framework and its features

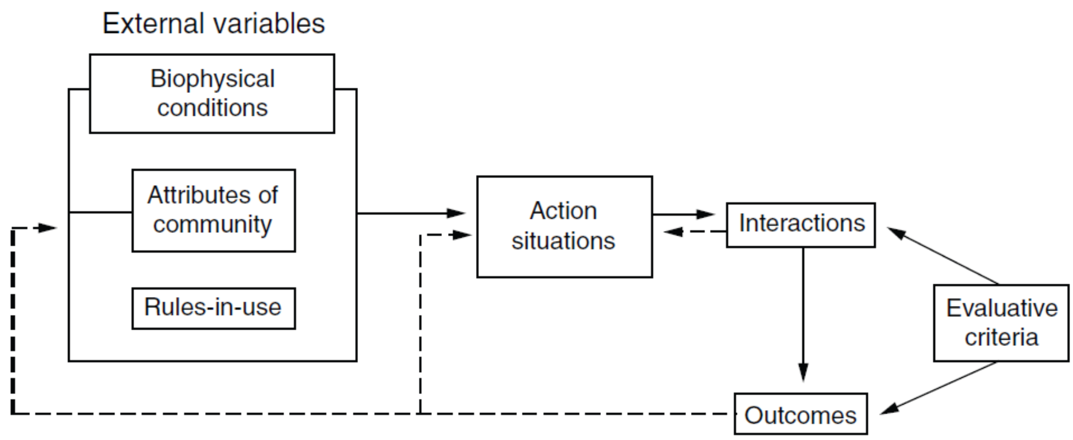


Figure 3.1: the IAD framework (Elinor Ostrom, 2010, p. 646).

An alternative approach is therefore to employ established arguments provided by the Institutional Analysis and Development (IAD) framework of Elinor Ostrom (2010, 2005, 1999, 1990) which was originally developed by Kiser and Ostrom (1982), and extended forward in many studies. Given that our overarching question is "*to what extent do different forms of integrated river basin management support water security?*", IAD provides a good match with the study aims (Chapter 1) in that it establishes a holistic framework for analysing common pool resource (CPR) management by linking institutional, biophysical and social (community) aspects to outcomes (Figure 3.1). These aspects are described in the outline below.

The IAD framework's essential value comes from being a tool to orchestrate a subject or set of variables to investigate any specific question an analyst might wish to ask about how CPR is governed (Blomquist and de Leon, 2011). As mentioned in Chapter 1, a theoretical framework as opposed to traditional theory provides a 'shared orientation' for explaining specific phenomena and has particular relevance to studying CPR issues (Ostrom et al. 2014: 269). The essence of this framework is the 'action situation' which takes central place in any analysis, and it can be disaggregated into several actions which includes: (a) which actors can be involved; (b) who could fill the specific positions; (c) what are the allowed actions; (d) which roles or knowledge do they have over choice and influence on outcomes; (e) what are the costs and benefits that can be perceived as incentives and deterrents appointed to actions and outcomes (Floriane Clement, 2010; Ostrom, 2005; Ostrom et al., 2014). Having these components of the action situation can provide the basis for investigation of likely problems in a specific context (Floriane Clement, 2010), by highlighting the importance of the actors. Actors in an action situation can be recognized as "the engine that sets the action situation in motion" and with that it yields a common pool resource, involves rule making, provides services, then results in outcomes (Ostrom et al., 2014: 274). Additionally, this detailed insight of the action situation can help better understand institutional settings. For instance, adaptation of integrated river basin management for each country raises questions over the effectiveness of the institutions established. In the case of Turkey, due to the recent creation of departments for water management, analysis is required of who controls the design of river basin management plans and who participates in applying them.

The IAD framework has a multi layered structure involving a three stage analysis namely operational, collective and constitutional levels. These layers are intrinsically connected and each one affects the another, thus impacting outcomes influenced by the action situation (McGinnis & Ostrom, 2014). Furthermore, the action situation is determined by a set of external variables: *'biophysical conditions'* such climatic factors or size of the CPR; '*attributes of a community'* including for example levels of socio-economic development and human and social capital; and *'rules-in-use'* that determine management, including formal and informal rules and sanctions for non-compliance (Ostrom, 2010: 646–647). For example, the lack of formal rules between local communities and government agencies in the application of tidal river management in Bangladesh was considered an impediment to effective implementation within the action situation (Gain et al., 2019). It is the interaction between these independent variables in shaping the action situation that, according to the theory, determines management outcomes, i.e. the dependent variable. Evaluation of outcomes then allows for adaptive change to the external variables such as rules-in-use, thereby supporting institutional learning through time and incremental adjustment to the action situation (Ostrom, 2010).

3.3.2 Usefulness

The features of IAD framework therefore make it potentially ideal for assessing the capacity of integrated river basin management to achieve water security outcomes, for several reasons. Firstly, a river or groundwater basin are both common-pool resources, using the definition of Heikkila and Carter (2021). In this respect, they are generally 'non-excludable' from users and the use of such water resources decreases other user's benefits. These resources are then best understood through micro level theories such as IAD (Ostrom, 2010), as we focus on the basin scale for water resources. Secondly, the framework has an embedded set of conceptual building blocks that allows a social scientist to understand human interactions and outcomes across diverse scales, both temporally and spatially (Ostrom, 2010). Here, our study aims at understanding how (and to what extent) integrated river basin management results in water security outcomes. Thirdly, the framework helps an analyst examine institutional settings in the context of multiple variables, including rules-in-use, biophysical contexts and community attributes, their interaction and also the effects via the action situation on specific outcomes such as water security (Ostrom, 2010). With respect to this point, the framework provides a robust set of independent variables that integrate with river basin management that allow analysis of such outcomes. Finally, the IAD has been successfully used to analyse CPR institutions in multiple contexts and so is directly comparable between different countries (Lejano et al., 2014; Muradian & Cardenas, 2015; Schlager, 2016;

Shen et al., 2014). Indeed, Ostrom emphasizes the utility of IAD as a mechanism for comparative analysis between CPR problems in different contexts (Ostrom 2010).

3.3.3 Criticisms of IAD

Although IAD has been applied in a number of new areas and promoted by practitioners, it has received some criticisms, even from the IAD developer Ostrom herself. One of the criticisms that has emerged in the literature is the consideration of power relations in the framework. Ostrom (Agrawal & Ostrom, 2001) and other scholars such as Sikor (2006) have criticized the limitations of the framework for its application at the governance and government level by saying there is not enough consideration of power and an inadequate focus on political processes within institutions**.** However, power is ingrained in daily social and political routines (Foucault 1977). Analysis of power is also fundamental to understanding how political actions are initiated, adopted and implemented (see Hill & Varone, 2017; Lukes, 2021). Additionally, institutions influence power distributions and its application in practice to achieve outcomes (Floriane Clement, 2010). The IAD framework therefore not only lacks consideration of power distributions but also the historical and social context in which the framework exists, and this aspect is problematic when analyzing the effect of natural resource policies on institutional transformation within CPR (for more details: see Floriane Clement, 2010; Whaley & Weatherhead, 2014).

Another criticism and potential challenge that the IAD has received is its empirical application to small scale and local resources, as can be seen from the studies mentioned above. However, this does not mean that the IAD framework is only suitable for local scale CPR, as these studies have explicitly chosen such cases for their study area. Ostrom acknowledged that CPRs differ in scale and can include multiple forms of environmental problems (Ostrom et al. 2014). Groundwater basins are common pool resources, as determined above, and IAD is therefore an ideal theoretical tool for evaluating CPR, as discussed earlier (see the work of Heikkila and Carter (2021)). Additionally, the river basin scale is the most suitable hydrologic unit defined by integrated river basin management (see the work of Norman et al. (2010) as well). Without accounting for the entire basin scale, it would prevent full understanding of how the hydrological unit is being governed. For instance Nigussie et al. (2018) use the upper Nile

River Basin for their soil water conversion study, however they do not account for the lower Nile River Basin, which is part of the same hydrological unit.

Responding to these criticisms, some of which were made by Ostom herself, she later developed the Social-Ecological (SES) framework (Ostrom, 2007; Ostrom, 2009). In contrast to the IAD Framework, SES has number of second tier elements, one of which is the governance aspect that can help with understanding power relationships in common pool resource institutions (Schlager & Cox, 2018). Another criticism that has emerged in the literature is the ambiguity of the participation process, which impacts active participation in decision making. For example, Clement (2010) argues that in reality there is a desire by governments to actively add grassroots input to decision modification and making, however they often do not give opportunities to grassroots groups to fully influence institutional decision making mechanisms. This participatory issue is also linked with the power distribution problem mentioned above (Klok & Denter, 2018).

Since its initial introduction, IAD has subsequently been refined and updated by its originator in response to its critiques (see Kiser and Ostrom, 1982; Ostrom, 2010, 2005, 1999, 1990). The framework has proved enduringly popular, with multiple studies in the academic literature (Ostrom et al., 2014). It also has been used extensively to examine environmental problems within CPR globally (Briassoulis, 2004; Gain et al., 2019; Hess & Ostrom, 2006; Kim, 2012; Koontz & Newig, 2014; Mincey et al., 2013; Torell, 2002; Wang et al., 2017). However, Ostrom always envisaged that the IAD framework would evolve and adapt to specific contexts (see Ostrom 2010). In this respect, the IAD framework has been purposely changed, adapted and enriched by scholars. For example, IAD has been adapted for addressing specific CPR management analyses by Bisaro and Hinckel (2016), who adjust Ostrom's notion of the action situation to focus specifically on climate adaptation in CPR. Research led by Clement (2010) for analysing afforestation in Vietnam also modifies the IAD framework with two components (politico-economic context and discourse) in its external variables: the author also criticizes the framework for being too localized without encompassing higher government levels of decision-making and institutional status (Floriane Clement, 2010). The framework has been further extended by development of the related SES framework (Ostrom, 2007; Ostrom, 2009) which could also be integrated with an IAD approach, as we discuss in the next section.

3.4 A hybrid approach - theoretical novelty

In view of these criticisms and the innate capacity of IAD for bespoke modification, this thesis developed an innovative, hybrid approach drawing on these arguments, in order to meet the study objectives (Chapter 1). Here, the thesis first modifies the IAD and then hybridizes it with the SES before linking the 'action situation' to the main features of integrated river basin management, adding theoretical novelty to the literature in the process.

Firstly, the study modified the IAD framework by integrating it with the water security concept, a feature not evident in existing studies, thereby adding to the body of existing research. In recent years, the framework has been used in natural resource fields in increasing numbers of studies that cover multiple national and local contexts. For example, water governance analysis in Canada (Cave et al., 2013), soil water conversion analysis in Ethiopia (Nigussie et al., 2018), irrigation analysis in Mexico (Raheem, 2014), waste disposal analysis in China (Zhang & Zhao, 2019), water related issue analysis in Australia (Smajgl et al., 2009) and land reform analysis in Vietnam (Clement & Amezaga, 2013). By using water security as the outcome of the action situation, the research adds to the IAD literature in a novel way.

Secondly, in response to previous criticisms of IAD, discussed above, an alternative approach considered was to apply the SES to analyse water security outcomes from integrated river basin management. The SES framework was proposed by Ostrom in 2007 (McGinnis & Ostrom, 2014; Ostrom, 2007; Ostrom, 2009). It was devised to strengthen the IAD framework, and the two frameworks are shaped around a set of action situations (McGinnis & Ostrom, 2014). The SES framework consists of four main components: resource systems; resource units; governance system; and users (Ostrom 2009). These components are designated as the 'First-Level Core Subsystems' or first tier of the framework (ibid. 421). Each tier is linked to a set 'second-level variables', for example government organizations and constitutional rules for the governance system component, although several are not quantitatively measurable variables (ibid.).

Schlager and Cox (2018) outline the similarities and differences between IAD and SES, concluding that the main components of IAD are effectively replicated in those of SES. The most significant variation is that the SES framework poses additional hypotheses regarding biophysical aspects of governance because the IAD framework was built specifically for analysing common-pool resource management generally (McGinnis & Ostrom, 2014). The governance system of SES accounts for 'government organizations, network structure, constitution rules, monitoring and sanctioning processes and etc.' (Ostrom, 2007, p. 15183). With this widened perspective, instead of using rules-in-use attributes from the IAD, that has limited capacity to consider governance mechanisms and is insufficient for understanding the structural, political and historical characteristics of governance, SES can provide a wider context while encompassing power relations. It can do this through allowing analysis of governmental and non-governmental organizations, different types of rules (organizational, constitutional, de facto) and monitoring and sanctioning processes (ibid.). Several studies to date have employed SES for this reason: for a recent overview of SES applications see Partelow (2018). For instance, one study which aimed to characterize ecological issues at the local level chose the SES framework, primarily for the governance rules emphasis of the framework (Delgado-Serrano & Ramos, 2015). Another strength of SES is its multi-tiered structure which although expands the analytical capacity of the framework significantly also increases the complexity of analysis.

In spite of its advantages, the SES has two prominent challenges for application to understanding integrated river basin management. First, there is a lack of a coherent road map for using the SES framework (Ostrom et al., 2014). Despite application of SES in several studies to date (Partelow 2018), it is still being developed and therefore testing is quite preliminary, unlike the IAD. Second, another criticism is of the vagueness of the status of objects or components in the second tier of the framework (Ostrom et al., 2014; Schlager & Cox, 2018). A problem is that 'the second-tier elements are not readily interpretable as variables, although they are frequently referred to as such' (Schlager & Cox, 2018, p. 235). In contrast, the IAD framework is supported with robust variables, more theoretical guidelines and a broader implementing literature than the SES framework (ibid.). In addition, existing studies on Social-Ecological Systems (SES) are often quantitative, modelling based and not generally grounded in social science theory (for example Gain et al., 2012). Some of the SES objects are better measured through qualitative indicators, for example network structures (GS3) or history of use (U3). Furthermore, IAD puts institutions at the heart of the framework, making rules important to its analysis (Schlager & Cox, 2018) reflecting the rational choice collective action foundations of the theory, however this limits observations of the wider governance aspect. Governance, defined as 'any pattern of rule that arises either when the state is dependent upon others or when the state plays little or no role' (Bevir, 2009, p. 3), therefore encompasses the different actors, state and non state, involved in applying rules rather than just the rules themselves. This concept is also understood to involve different governing structures (hierarchy, networks, markets, communities) and processes of steering and coordination (Pierre & Peters, 2000, 2021).

In view of the potential problems with application of the SES framework, the thesis synthesised its components with the IAD framework through developing a modified and updated framework specifically linking the institutional analysis component of IAD with the water security concept and governance aspects of SES (Figure 3.2). In addition to identifying outcomes in terms of water security, the rules-in-use institutional component of IAD was replaced with a modified governance component of SES that combines rules with organizational objects in its second tier of analysis. This approach then allowed examination of wider governance aspects within the IAD framework, particularly the role of governmental and non-governmental organizations, operational, de facto and constitutional rules, plus monitoring and sanctioning processes, all within the broader governance context. In both California and Turkey this context is significant since it encompasses multi-level interactions between river basin actors and governmental agencies all within the context of national and state legislation; elements that are problematic to analyse through IAD application alone.

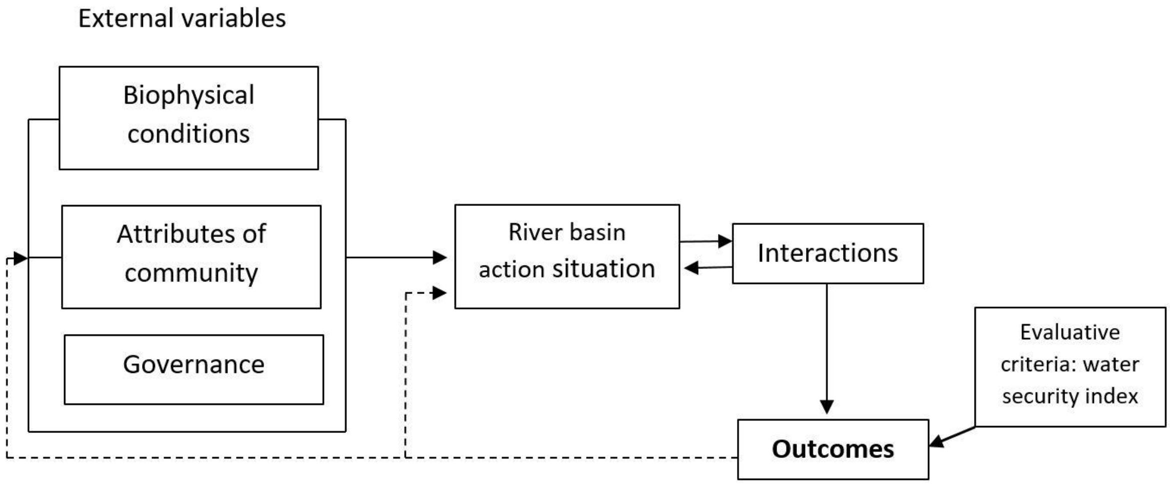


Figure 3.2: The modified IAD framework (derived from Ostrom, 2010).

Finally, the framework also modified the 'action situation' to comply with key principles of integrated river basin management. As outlined in Chapters 1, the period up to the 1970s had been typified by engineering-led responses. Starting with the Tennessee Valley Authority model in the 1930s, river basins were typically managed by government agencies, with little or no public involvement, using large scale infrastructure such as dams and irrigation projects (Molle, 2008). Although 'integrated', in that they often linked agricultural and industrial uses of water resources, they became criticized for lacking consideration for public users or the environment (ibid.). Modern conceptions of integrated river basin management are distinguished by several aspects, which in turn define the 'action situation'.

Following Japser's (2003) review of the literature and subsequent studies, five key features of integrated river basin management can be discerned as constituting the action situation. First, management should be holistic. Because the river basin is a hydrological unit involving interaction with the wider environment, management must consider the physical aspects of water with other socio-economic and political factors (for example, Margerum, 1997; Krueger et al., 2016b; Sivapalan et al., 2012). Second, most obviously, the river basin is considered the fundamental unit of management; a feature of multiple models globally, including the EU Water Framework Directive and US watershed partnerships (Benson, Jordan, & Smith, 2013). Third, another important feature is the participatory approach (Carr, 2015; Jaspers, 2003;

Song et al., 2010; Tippett et al., 2005). Water is believed to belong to everyone, so any stakeholder should participate in the process where decisions are discussed and taken (Global Water Partnership 2000a). Participation should be an active process where stakeholders influence decisions or management choices (ibid.). Additionally, participatory mechanisms require a consensus in order to reach common targets; each part should be willing to compromise or sacrifice some of their long-term wishes (ibid.). Again, one example is the Water Framework Directive obligation to include stakeholders in the RBMP process, in order to determine management objectives for a programme of measures (Jager et al. 2016). Fourth, due to the influence of the Dublin Principles and IWRM (Chapter 1), most forms of integrated river basin management globally now consider economic valuation of water resources, for example the WFD (see Feuillette et al., 2016). This aspect is to ensure that fair allocations are achieved as benefits are maximized for users and costs are optimized (Global Water Partnership 2000a; International Water Association And United Nations Environment & Programme, 2002). Fifth, integrated river basin management is generally associated with adaptive planning processes (Pahl-Wostl, 2008). Adaptive management can be defined as "a systematic process for improving management policies and practices by learning from the outcomes of management strategies that have already been implemented" (Pahl-Wostl, Sendzimir, et al., 2007, p. 4). Adaptive management is crucial especially under changing climate change due to the uncertainties created for water resources (Beek & Arriëns, 2013). For example, in the EU WFD, river basin planning occurs in six-year cycles whereby implementation monitoring is used to adaptively inform the next planning phase (Official Journal of the European Communities, 2000). Finally, integrated water management needs strong institutional structures in which stakeholders can participate, data resources are provided to policymakers, and public awareness regarding water issues is considered (Global Water Partnership, 2000a). Here, institutions can be defined in terms of their rule-based structures and organizational forms (see Peters, 2012 for discussions).

3.5 Comparative learning on integrated river basin management: lesson-drawing/policy transfer

Objective 5 (Chapter 1) required the need to identify recommendations for future implementation of integrated river basin management to better support water security and SDG targets. To meet this Objective, the modified IAD-SES framework was combined with arguments on learning from the public policy literature, thereby significantly increasing the degree of theoretical novelty of the thesis.

Learning between political contexts is not new. To an extent, political jurisdictions have always learned, or more accurately engaged in 'systematically pinching ideas' (Schneider & Ingram, 2017; Schneider & Ingram, 1988), from each other since ancient times. Research into such learning, however, is more recent. As this section shows, initially academic studies were more interested in how policy ideas or innovations move. Recently, research has taken an analytical-normative view, i.e. the extent to which can policies *can* move and the related constraints on learning as a basis for showing how learning *should* occur. By examining these constraints, a framework for analyzing comparative river basin management using the hybrid theory will be developed. Here, the aim is to compare practice in the USA as a basis for learning in Turkey; a feature analysed further in Chapter 7. To develop this framework, this section initially reviews academic notions of diffusion, lesson-drawing and policy transfer before then outlining the main constraints to learning in comparative analysis, before finally relating them to comparative water management through integration with the IAD-SES theory.

3.5.1 Diffusion of policy innovations

Policy learning analysis first originated from the work of Walker while assessing the diffusion of policy innovations in the states and cities of the US (Walker, 1969). Diffusion is the 'process by which an innovation is communicated through certain channels over time among members of a social system' (Rogers, 1983, p. 5). Here, early diffusion research was concerned with how policy innovations moved between state governments in the USA (Walker 1969). Diffusion researchers then became interested in the main mechanisms of diffusion between governments, including policy learning, imitation, normative pressure, competition and coercion (F. S. Berry & Berry, 2016, pp. 310–314). In two early studies on environmental policy diffusion, Munton (1981) and Hoberg (1991) both examined the factors shaping diffusion of water policy norms between the USA and Canada.

More latterly, diffusion research crossed over from examining such processes in the national policy context to the international and regional levels. In particular, scholars have shown how the European Union has become an active diffuser of its norms to EU and non-EU states within Europeanisation processes such as conditionality or funding mechanisms (Börzel & Risse, 2012; Checkel, 1999; Grabbe, 2001; Demirbilek and Benson 2019). Meanwhile, the diffusion of internationalization norms such as neo-liberalism under processes such as globalization has caught the attention of a growing number of authors (Meseguer & Gilardi, 2009). Others have since sought to understand the translation of policies by implementing actors as they move between jurisdictions (Mukhtarov, 2014, 2017), often through neoliberal globalization and 'policy assemblage' (Prince, 2010) or via transnational networks (Béland et al., 2018; Stone, 2004, 2010).

3.5.2 Policy learning research: lesson-drawing to transfer

In parallel to diffusion research, academics then became interested in examining how specific policies move between political arenas due to learning by policy-makers. For Rose (1991, 1993, 2005), policy-makers engage in a rational, conscious process of learning about policies in other contexts in order to address domestic problems: what he terms 'lesson-drawing'. This notion was developed further by Dolowitz and Marsh (1996; 2000) as 'policy transfer', informing a significant number of studies in multiple contexts (De Jong & Edelenbos, 2007; Kwon, 2009; Padgett, 2003; Pierson, 2003; Prince, 2010). Policy transfer is defined as 'a process by which knowledge of policies, administrative arrangements, institutions and ideas in one political system is used in the development of similar features in another' (Dolowitz & Marsh, 1996a, p. 3). Policy transfer was widely used in comparative analysis in the US and EU (Bulmer et al., 2007; Dolowitz & Marsh, 1996a). As the demand for policy learning grew for different policy aspects (Dunlop et al., 2018), the literature analysing it extended as well (for more details, see: Bennett & Howlett, 1992; Dunlop et al., 2018; Dunlop & Radaelli, 2020; Goyal & Howlett, 2018; Haas, 1990; Hall, 1993; Louvaris Fasois, 2018; Rietig, 2018).

3.5.3 Lesson-drawing for policy prescription

Rose (2005) moves beyond his earlier arguments that seek to understand how such learning occurs to establish a more normative agenda that sets out approaches for such learning to occur. In other words, the emphasis here is on how policy-makers could or indeed should learn from other contexts. To do this, he advocates development of a model or checklist of considerations for lesson-drawing from abroad. In his 'Ten-steps in lesson-drawing', he argues that policymakers should:

> '1. Learn the key concepts: what a programme is, and what a lesson is and is not.
>
> 2. Catch the attention of policymakers.
>
> 3. Scan alternatives and decide where to look for lessons.
>
> 4. Learn by going abroad.
>
> 5. Abstract from what you observe a generalized model of how a foreign programme works.
>
> 6. Turn the model into a lesson fitting your own national context.
>
> 7. Decide whether the lesson should be adopted.
>
> 8. Decide whether the lesson can be applied.
>
> 9. Simplify the means and ends of a lesson to increase its chances of success.
>
> 10. Evaluate a lesson's outcome prospectively and, if it is adopted, as it evolves over time.' (Rose 2005: 8)

According to Rose, the 'challenge… is to identify the necessary features of a foreign programme in order to create a portable model that transcends its national context' (ibid.: 69). By way of prescription, he further argues that a model or 'generic description of a programme' be generated for learning (ibid.: 71). Such a model it is argued should include contextual factors that frame the implementation of the policy, including legal, economic and institutional factors. The aim is then to determine whether the programme could be transferred intact, or 'photocopying', or whether some degree of modification or even a new programme is required to account for contextual difference (ibid.: 80-81).

These arguments are taken forward by Benson et al. (2012) who examine lesson-drawing in comparative analysis. They argue that policy-makers can learn from each other regarding public participation in river basin planning, particularly within the context of the Water Framework Directive. However, another feature discussed in this study, is the potential constraints on lesson-drawing in practice. Practical challenges to lesson-drawing are acknowledged in the literature (Benson, 2009; Benson & Jordan, 2011; Dolowitz & Marsh, 1996a; Dolowitz & Marsh, 2000). The significant critique of normative arguments for lesson-drawing made is that learning and policy transfer are invariably more difficult than can be anticipated particularly when learning occurs between different cultural, political, economic and environmental contexts.

3.5.4 Constraints to comparative lesson-drawing

Across this broad body of research, multiple constraints have been identified to lesson-drawing and hence transfer of policies. Rose (1991) predicts, quite logically, that simpler programmes are more easily transferred, while the complexity of policy problems and solutions is an evident constraint. Of interest however is the 'the way complexity interacts with the other factors… to help shape what is transferred and in what form' (Dolowitz & Marsh, 1996b, p. 353). Other factors identified include the existing policy context, plus structural and institutional constraints, the availability of resources and ideological similarity between countries (ibid.: p. 353-354). Since these seminal studies, further factors have been discussed in the academic literature (Benson and Jordan 2011). Benson (2009) attempts to synthesise these diverse arguments into a typology of constraints on lesson-drawing. Constraints are divided into institutional-legal, political, economic and social factors that potentially inhibit the scope for transferring policies.

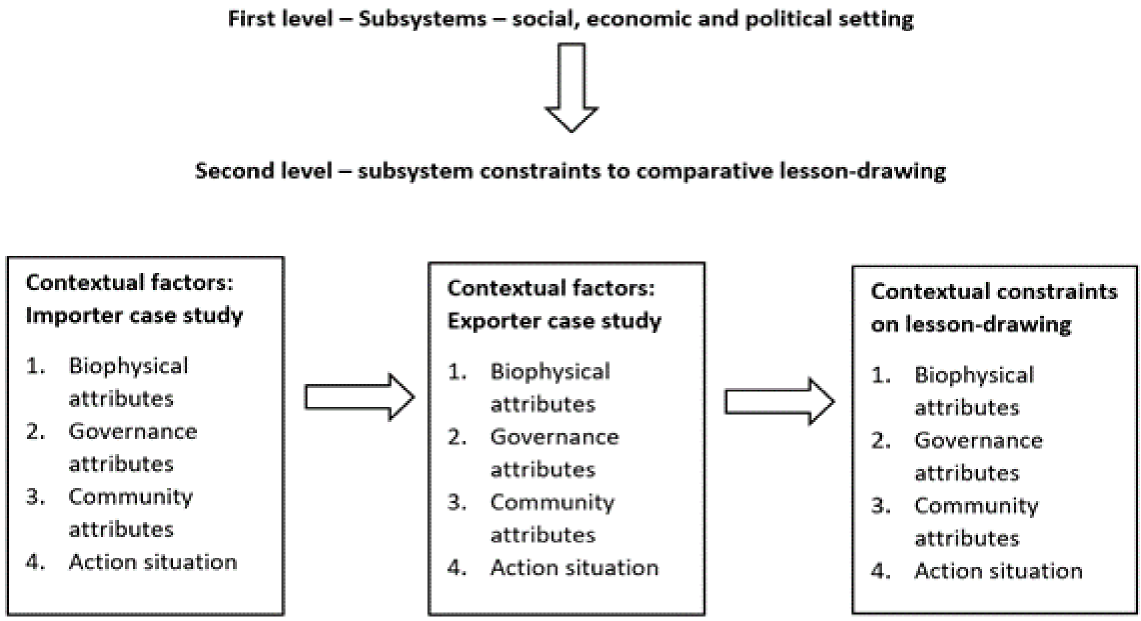
To provide a practical framework to guide analysis of such constraints, Benson et al. (2012) consequently specify the need to sequentially consider (i) contextual factors in the 'importer' country and (ii) the potential 'exporter' country in order to (iii) understand the potential constraints on lesson-drawing. When applied, the framework suggests that public participation measures can theoretically 'travel' between countries but generally modification is required, i.e. 'photocopying' is invariably impractical. Such a conceptual framework could therefore be employed to assess the scope for comparative learning on groundwater allocation regimes in river basin planning, through combination with the hybrid IAD-SES framework.

3.5.5 Potential constraints to comparative lesson-drawing with the IAD-SES framework

On this basis, we can identify theoretical constraints to lesson-drawing on the hybrid IAD-SES framework developed (Figure 3.3). These potential constraints relate to contextual, biophysical, institutional/governance and community-based factors.

For Ostrom, the IAD and SES frameworks were designed specifically to allow comparison between governance contexts through providing generalized frameworks for analysis (Ostrom 2010). The IAD framework consequently promotes ‘comparative institutional analysis as its one of the significances’ (Schlager & Cox, 2018, p. 226). Since the hybridized IAD-SES framework therefore allows us to research comparatively, this thesis will utilize comparative policy learning. Starting with policy learning, it means that states can learn from their practices and experiments and also that they can alter their actions by looking at previous experiences in which they lived through (Bennett & Howlett, 1992; Sabatier, 1988). The policy learning process uses feedback loops for altering the objectives which cannot be achieved or do not originally work (Sabatier, 1988). This instrument is situated in Ostrom’s IAD framework (Ostrom, 2005). However, any analysis must be aware of constraints to such learning.

Figure 3.3 Analysing constraints to lesson-drawing using the comparative IAD-SES framework.



In the research the hybrid IAD/SES framework was used to compare two distinctly different water management systems, in this case California and Turkey, to understand how the systems work or do not work. Lesson-drawing theory then allows us to assess the potential for learning, i.e. from California to Turkey, because our working assumption is that California is better at governing water security, although the vice versa might be possible as well. In such situations, policy transfer might not be easy or lessons learnt might not be applicable in the converse case because of different political, institutional, legal and cultural factors. Not only does the thesis use policy transfer and lesson-drawing in comparative analysis of two cases but also this concept helps us to investigate how the Water Framework Directive (WFD) is applied in Turkey. This implementation analysis could also provide lessons for future EU candidate members or how WFD policy transfer could be applied in existing Member States. Additionally this comparative analysis can help practitioners to understand how integrated river basin planning generally can be better applied to tackle water security issues.

In order to do this, the research will employ the analytical approach outlined in Figure 3.3. Here, in order to compare integrated river basin management implementation in the two river basins in the USA and Turkey for lesson-drawing, four important considerations will be made. Firstly, understanding the wider subsystem context in terms of the social, economic and political characteristics in Turkey and the USA. Secondly, understanding the contextual factors for water security outcomes in the 'importer' case study (Turkey) in terms of IAD-SES variables (biophysical attributes, governance attributes, community attributes, action situation), understanding the contextual factors for water security outcomes in the 'exporter' case study (USA) and then analyzing the potential constraints to lesson-drawing using these variables. For instance, we could hypothesise, on the basis of previous studies (e.g. Benson et al. 2012) that learning can occur by Turkey from the USA on how to effectively manage water security through integrated river basin management – but that, critically, there will be constraints on lesson-drawing due to contextual differences, particularly due to differences in governance arrangements and community attributes.

3.6 Summary

The aim of this chapter was to describe the theoretical basis of the thesis, originating from arguments set out in Chapters 1 and 2. This chapter therefore initially discussed the ontological and epistemological questions that inform the thesis research direction. In this respect, the thesis adopts a foundationalist ontology with a positivist epistemology, which guides theory choice and their application through the thesis methods (Chapter 4). The modified IAD framework was then described and linked to the thesis objectives. Modifications to the framework related to including water security as the primary outcome of the IAD process, plus substituting the rules-in-use attributes of the IAD with the governance First-Level Core Subsystem to overcome deficiencies in the former when investigating the multi-level nature of integrated river basin management. Moreover, the chapter showed how lesson-drawing could be utilized in comparative analysis of water security in California and Turkey. These theoretical arguments also informed the methodological development and data collection within the comparative case study research design, which are described in the next chapter (4).

4. Methodological overview

4.1 Introduction

The aim of this chapter is to give an overview of the methodological basis of the thesis and its relationship with the theory, data collection and analysis. Here, as specified in Chapter 3, the study adopts a realist/foundationalist ontology and positivist epistemology based upon objective theory testing of the hybrid IAD-SES lesson-drawing framework. This theoretical basis in turn informed the comparative research design and specific data collection and analysis techniques. The chapter then illustrates methodological techniques, namely qualitative documentary analysis and quantitative water security assessment tools, developed specifically for this research. Developing the former involved documentary analysis to determine institutional attributes in the two case studies. Developing the latter focused upon the initial establishment of a suitable water security index, comprised of quantitative indicators of water security, then used to measure the outcome effectiveness of institutions in the case studies (Chapter 5, 6). Such data then also informed the lesson-drawing analysis, discussed further in Chapter 7.

4.2 Research design

Application of the IAD-SES lesson-drawing framework to assessing water security in integrated river basin planning was conducted through a specific research design that encompassed theory, data collection and analysis. Here, in order to provide a fit with the study aims and objectives (Chapter 1), a mixed method comparative case study design was chosen. Although definitions vary, a case study is understood to involve 'an intensive study of a single unit with an aim to generalize across a larger set of units' (Gerring, 2004, p. 341) but often involves comparison between such cases for theory testing. Such a case study design was considered appropriate for several reasons.

4.2.1 Comparative case design

A comparative case design is ideal for meeting the study aims as it allows the use of several examples of a social process, in this case the WFD implementation and SGMA as both involve river basin planning, and comparison of these processes in-depth in a controlled manner (Yin, 2018). Comparative case study designs are commonly used for identifying theoretically-derived intervening variables for specific outcomes or the dependent variable (Caramani, 2020). Typically, comparative research involves cross-national comparison to understand these variables (ibid.). Broadly speaking, comparative research is a form of methodological approach encompassing the perspective of rules, standards and procedures to analyse and interpret similarities and differences between cases using a concept which is operable within more than one county or case (Halperin & Heath, 2017). However, not all empirical research in itself is comparative regardless of whether it involves individual case analyses or not (Almond, 1966; Halperin & Heath, 2017). This idea is further discussed in several papers (Berrington & Norris, 1988; van Biezen & Caramani, 2006; Bogdanor, 2003; Smith, 1997). The point being here is that comparative research must be structured as such through careful case design. Lastly, comparative research usually has two main challenges: case selection bias and equivalence of meaning (Halperin & Heath, 2017). It is noted that without careful selection of cases, the design could affect the results and careful consideration of this aspect is needed (ibid.). When it comes to 'equivalence of meaning' which is mainly a problem in large N comparative research, using a concept with the same meaning and allowing for contextual difference is crucially important otherwise comparison would mean two different things compared in different contexts (ibid.).

Case studies are commonly used, particularly in social sciences or interdisciplinary research, when research involves investigation of complex processes (Yin, 2018). With case studies, the aim is to elucidate data on the research object from selective examples rather than a large N sample typical of statistical analyses. The latter approach would not allow for in-depth testing of the IAD-SES lesson-drawing framework, given the need for multiple data on multiple variables. Case studies can therefore allow for examination of how different (intervening) factors interact to produce water security outcomes. In fact, case studies deliberately allow examination of contextual conditions relevant to integrated river basin management concepts, based on the assumption that they may influence outcomes. Another reason why case studies were employed, as discussed below, is that they can encompass multiple data sources, both qualitative and quantitative (Gerring, 2007; Yin, 2018), which is necessary for application of the IAD-SES lesson-drawing framework developed in Chapter 3.

4.2.2 Case study design considerations

For Yin (2018: 27-28), there are five key considerations for case study design: the research question; theoretical propositions; case definition and 'bounding the case'; the logic linking data to propositions; and the criteria for interpreting findings.

4.2.2.1 The research question

The research question is identified in Chapter 1, along with the aims of the study. Our overarching question: *to what extent do different forms of integrated river basin management support water security?* This broad question enables us to examine our hypothesis, namely 'integrated river basin management should theoretically enhance water security'. Both the question and hypothesis can be linked to the case design.

4.2.2.2 Theoretical propositions

Theoretical propositions are provided by the hybrid IAD-SES and lesson-drawing framework in Chapter 3. Here, it was hypothesised that learning by Turkey from the USA on effective management of water resources was possible through institutional analysis of integrated river basin management in the WFD and SGMA but that constraints on potential transfer will be evident due to contextual differences, particularly in governance arrangements and community attributes. To test this hypothesis, derived from the hybrid framework, a specific case design was then necessary.

4.2.2.3 Defining the cases

In defining the cases, the comparative approach required a multiple-case design, comprised of two cases sharing common characteristics, which were chosen in order to facilitate direct comparison between regional and national contexts. In essence, four main types of case study design are employed by analysts: single-case (or holistic); single-case (or embedded); multiple-case (or holistic) designs; and multiple-case (or embedded) (Yin, 2018: 48). Single case designs allow in depth theory testing development and are probably the most common approach used in mainstream political science, for example in EU studies where single case designs dominate in theoretical research into European water policy (Benson & Jordan, 2008). Multiple case designs comprising of either a single level of analysis (holistic) or multiple levels (embedded) within each case are more common in comparative politics, which could now be considered a distinct area of political science (Caramani 2021).

A multiple-case single design was therefore employed in this thesis since it allows for direct comparison between specific cases of the WFD and SGMA in different national contexts, namely the USA and Turkey. Additionally, the design employed a Most Different System Design (MDSD) rather than a Most Similar System Design purposely in this study. A Most Similar System Design focuses on similarities of important characteristics and differences in one considerable respect (Halperin & Heath, 2017). For example, this types of study would be appropriate if the intention of research was just to examine WFD implementation in EU Member States, allowing direct comparison of application of key legal requirements. In contrast, the Most Different System Design bases case selection on differences in many aspects and similarity based on only key explanatory variables (ibid). In this respect, the MDSD suits our case selections, in which California and Turkey implements river basin management through the WFD and SGMA, but have completely different institutional, community, and to an extent, biophysical contexts, i.e. independent variables. The similarity comes from their water related problems, particularly related to agricultural water allocations and significant dependence on groundwater, and climatic closeness: both share a Mediterranean type climate with low levels of precipitation. These are important factors because it would put our case selection in jeopardy and bias outcomes without considering these similarities and differences. For instance, although Canada experiences some water problems such as water pollution, it does not experience the same water security concerns (Clarke, 2008). In this case, it would be questionable to compare a basin in a water rich county and a basin that experiences water stress or is heavily dependent on groundwater due to surface water limitation, since comparative learning would prove problematic.

Another critical consideration for comparison is 'functional equivalence', i.e. comparing similar dependent variables through the research design, in order to then analyse the intervening (independent) variables (Benson et al., 2013). This consideration addresses Halperin and Heath's notion of 'equivalence of meaning', discussed above. To take it further, an example could be used to highlight this equivalence. For instance, when focusing on comparing a common political concept such as 'democracy', this could be perceived differently in Latin America countries than in Europe. However, in essence, democracy is a functionally equivalent variable regardless of political cultural and institutional difference since it can be – and indeed is in many academic studies - empirically compared (Halperin & Heath, 2017). Therefore, even though completely different political institutional contexts are evident for the cases, integrated river basin management is the main variable on which functional equivalence is compared. A self-evident need therefore existed to only use cases that were firstly river basin management institutions and secondly those with water security risks. Within river basin management worldwide, multiple institutional forms are discernible that differ even within countries, however Schmeier (2015) determines the institutional design characteristics of river basin organizations (RBOs). These are categorized into organizational structures and basin governance mechanisms. A key factor is 'functional scope' that can encompass a single issue water focus or multiple issues, plus the 'instruments for governing the respective basin', namely:

> '(1) Decision-making mechanisms (2) Data and information-sharing mechanisms (3) Monitoring mechanisms (4) Dispute-resolution mechanisms (5) Mechanisms for stakeholder involvement'. (Schmeier, 2015, pp. 54–55)

When comparing cases, a conscious decision was taken to ensure that both cases met these criteria. The Konya Closed basin like the Kern County case, is overtly predicated on managing several severe water risks while institutional processes in both include decision-making, data and information-sharing, monitoring, dispute-resolution and stakeholder mechanisms. In these respects, they exhibit functional equivalence while accounting for contextual difference.

Here, the 'cases' are specific river basin institutions located in each country: the Konya Closed Basin and Kern County Subbasin/Basin. These two cases were selected because they represent ‘diverse cases’ (Seawright and Gerring 2008: 300), providing a basis for learning. There are several reasons for selecting these cases for analysis. Starting with the Konya Closed Basin, the basin began implementing integrated river basin management with the ‘Through the Toward Wise Use of Konya Closed Basin’ project in 2003 and was one of the first basins to implement RBP out of 25 basins in Turkey (Demirbilek, 2019; Salmaner, 2008). The basin was considered significant for several reasons, primarily in water security terms. Firstly, the basin was designated one of the most ecologically crucial areas out of 200 globally under the Ramsar Convention, which means it accommodates exceptional biodiversity and its distinctiveness should be preserved (Berke, 2009; Olson & Dinerstein, 2002). It highlights the sensitivity of the Konya Closed basin and why it is a logical case to examine how river basin planning is implemented to maintain water security. Secondly, in this respect, the Konya Closed Basin has experienced significant water related problems such as sinkholes due to groundwater abstraction through agricultural activities, while the basin is economically significant as the breadbasket of Turkey (Berke et al., 2014; Bozyiğit & Tapur, 2009; Tapur & Bozyiğit, 2015b). Thirdly, the basin was prioritized for implementing river basin planning due to these problems but since 2014 in Konya, sinkhole incidents have doubled with respect to previous years[8]. For instance, from 2010 to 2014 the annual sinkhole numbers were around 17, but in 2015 the amount went up by 50 percent to 35; between 2019 and 2020 the numbers were 44 and 43 respectively[9]. This appalling increase shows that implementation of integrated river basin management is sub-optimal, otherwise the planning process would theoretically have contributed to better water security. In light of these problems, the Konya basin is of great importance nationally – even internationally - and thus becomes a useful and meaningful case study to examine the effectiveness of integrated river basin management implementation in attaining water security.

Similarly, the Kern County case might be considered a nationally significant case for studying the impacts of integrated river basin management on water security. In 2014, California ranked as the 7th largest economy in the world and home to nearly 40 million residents, with

[8] https://www.aa.com.tr/tr/cevre/konya-ovasindaki-yillara-gore-obruk-olusum-sayisi-belirlendi/2470651
[9] Ibid.

the largest population of any state in the USA[10][11]. However, California has historically experienced frequent, severe and prolonged drought[12] (Department of Water Resources, 2003a, 2021). During drought years, dependence on groundwater increases by up to 60 percent, a figure achieved in 2014 (ibid.). This situation adds a burden on groundwater resources which are already strained under non-drought conditions (Department of Water Resources, 2003a, 2014). State government reporting shows that from 2010 to 2014 groundwater levels decreased more than 10 feet on average in the Central Valley, a key agricultural area stretching over 700km from Bakersfield to Sacramento (Department of Water Resources, 2014). Moreover, as of today, groundwater levels are below normal conditions by 63 percent[13]. Due to these water related issues, the state introduced the SGMA in the midst of a prolonged drought (2012-2016) which is described as a historic defining moment for California's water management (Department of Water Resources, 2021). Given the size of the population and economy, the existing problems such as drought and groundwater level decline, examining SGMA integrated river basin management is timely and logical as a case for studying water security.

The Kern County case was selected from a wider sample of basins. California has 515 groundwater basins which were classified into four categories ranging from high, medium, low and very low priority[14]. As the SGMA legally requires high and medium priority basins to establish their own groundwater sustainability agencies (GSAs) and plans (GPSs), the study excluded low and very low priority basins from case selection research. Furthermore, the study only examined high and medium prioritized basins forming their own GSAs by 2017, to provide at least five years' worth of implementation data (Department of Water Resources, 2021). The Department of Water Resources identified 46 basins as high priority and 48 basins as medium priority using a comprehensive basin prioritization analysis (Department of Water Resources, 2020). However, only critically overdrafted basins from high and medium priority basins were requested to submit a GSP by 2020 (Department of Water Resources, 2016, 2020, 2021). Therefore, the study focused attention on 21 critically overdrafted basins in California

[10] https://lao.ca.gov/LAOEconTax/Article/Detail/90
[11] https://dof.ca.gov/Forecasting/Demographics/2020-census-demographics/
[12] https://www.drought.gov/states/california#current-conditions
[13] https://sgma.water.ca.gov/CalGWLive/
[14] https://water.ca.gov/Programs/Groundwater-Management/Basin-Prioritization

with the aim of finding the most suitable case for comparison. This process started by eliminating the basins which are not comparable to the Konya Closed basin or not suitable for analysing given other basins show crucial significance or similarity. Basins with a low population were excluded, namely West Side, Borrego Spring, Pajaro Valley, 180/400 Foot Aquifer, Paso Robles Area, Mid County, Pleasant Valley, and Chowchilla. By comparison, Konya is home to around 4 million people, mainly in rural areas. Additionally basins where the water supply rate coming from groundwater is less than 70 percent were discounted because high dependence was highly likely leading to excessive groundwater abstraction: in Konya groundwater dependence was around 70 percent as well. On this basis, Oxnard, Tulare Lake, Eastern San Joaquin, Merced, Mendota basins were discounted. This left 5 basins as best case study options and they were ranked based on their basin size for comparability.

Kern County was chosen for several reasons. Firstly, its size: Kern County is the largest subbasin in California (Kern Groundwater Authority, 2020). Secondly, compared to the other five basins it experiences significant water related problems and therefore has similarities to the Konya Closed Basin. According to USGS data groundwater levels are in decline[15]. Thirdly, this groundwater decrease is mainly attributed to land subsidence issues (Kern Groundwater Authority, 2020). Land subsidence and sinkholes are derived mainly as a consequence of excessive groundwater usage, thus making Kern County a good comparison case area for the Konya Closed basin. Additionally, having no regulatory authority for dealing with land subsidence makes the problem more complex (Borchers & Carpenter, 2014). Fourthly, another reasons for selecting Kern County as a case is that prior to the SGMA, groundwater was not regulated while surface water has been regulated by the state for more than a century (Department of Water Resources, 2021, p. 15). This makes the case more interesting in order to understand how effective implementation of river basin management is for groundwater and to what extent it contributes to water security. Fifthly, Kern County has experienced other crucial water problems such as water quality degradation derived from salinity, nitrates and arsenic pollution. These water related problems add to the justification of case selection criteria for Kern County as the Konya Closed basin also experiences water pollution, primarily from agriculture. Finally, as we noted above climate is an important factor

[15] https://waterdata.usgs.gov/ca/nwis/gw/

that allows comparison and it might impact outcomes or conclusions. Using the Koppen classification, Kern County has a similar semi-arid Mediterranean 'hot-dry summer' climate to the Konya Closed Basin, featuring hot summers with low precipitation and milder, wetter winters.

On the other hand, Yin (2018, p. 28) refers to 'bounding the case', in other words setting limits on the extent of data collection by deciding what to include and exclude. This process was effectively already pre-determined by the nature of WFD and SGMA institutions and their focus on the river basin scale[16]. In river basin management, institutions are based upon specific hydrological units rather than political levels.

4.2.2.4 Linking data to propositions and interpretative criteria

One advantage of case studies for addressing the research aims, noted above, is that they can encompass multiple methods and data sources, if suitably integrated. Some case study designs purely focus on quantitative data analysis and statistical methods (see Gerring, 2007). However, this approach was discounted for the study since the IAD-SES lesson-drawing framework combines qualitative (for example, rules, organisations, monitoring and sanctioning processes) with quantitative (for example, biophysical attributes, social capital or CPR size) variables. In addition, water security outcomes were measured in quantitative terms. As a result, in the study qualitative data are combined with quantitative sources, which are detailed in this section.

Firstly, documentary analysis is employed to uncover patterns of WFD and SGMA operational rules, processes and relevant organisations in the case studies. In the context of Turkish integrated river basin planning, formal operating rules are established by the European Union's Water Framework Directive (WFD) (Official Journal of the European Communities, 2000). Turkey, as part of its EU accession process, has transferred the WFD into national implementing policy (Demirbilek & Benson, 2019). The Directive compels implementation of several RBMP features. These include the establishment of river basin districts, characterization of water resources, economic valuation of water resources, development of

[16] IWRM considers the basin is the most suitable scale to overcome water related problems

a programme of measures for plan implementation, river basin management planning that includes public participation, monitoring of water resources, reporting of impacts, and the achievement of ‘good’ water status objectives for surface and groundwater (ibid.; Official Journal of the European Communities, 2000). Implementation of the Directive also occurs within a complex framework of pre-existing national legislation, particularly for water use and allocations: discussed further in Chapter 5. Implementation of these rules at the national and river basin scale is studied by examination of Turkish government documents, obtained from official sources. Informal ‘collective choice’ rules, or de facto implementation of these official rules, is studied through local documentary sources.

In Kern County case, the thesis research utilized state reports and data as it was known that the California Department of Water resources provides ‘technical information, and models, and data, facilitation and outreach support, and financial support to local agencies’ (Department of Water Resources, 2021). The updated documents of Bulletin 118, which are require by SGMA as well, helps to track groundwater conditions in California basins. The DWR also has a SGMA portal which gives essential information regarding basins and their prioritization and current and historical conditions[17]. Additionally, the Kern Groundwater Authority provides groundwater sustainability plans of each local authority as well as an umbrella plan that encompasses the entire subbasin, while releasing annual reports[18]. Lastly, academic studies, journals and local documents were derived from Kern County agencies.

Secondly, such data were combined with quantitative sources. Biophysical variables such as basin size, river width and land use data were obtained from official or published sources. Similarly, community attributes such as human capital and social capital were derived from official sources. For example, human capital can be measured in different ways but a typical proxy indicator is levels of education, in the case of integrated river basin management study (Benson et al., 2014; Sabatier et al., 2005). Social capital is more problematic to measure but indicators such as number of participants in the planning process, or inclusivity, can be employed (ibid.). Finally, water security is quantified according to a dedicated index weighting, comprised of several factors, discussed in more detail in the next section. Water

[17] https://sgma.water.ca.gov/portal/resources
[18] http://www.kerngwa.com/reports.html

security data for the Konya Closed Basin are derived from official government ministry sources, primarily the General Directorate of State Hydraulic Works and General Directorate of Water Management. Additionally, the California State Water Resources Control Board and Kern Groundwater Authority were the main sources for obtaining data to assess the Kern County for the variables that described above. More recently, the USGS provides significant data availability for helping to understand groundwater storage change, in order to calculate the water security index.

4.3 Measuring outcomes: water resources assessment tools

The study is based upon the notion that 'water cannot be managed without measuring' (Stewart, 2015, p.1). Our study therefore intentionally focuses on water assessment indices in this section. Of particular concern for the methodology is how to measure water scarcity within integrated river basin management case studies. As part of this process, a dedicated water assessment tool was developed from the academic and practitioner literatures, specifically designed for this thesis.

4.3.1 Water availability – quantity and quality

Long before the introduction of the water security concept, water availability assessment tools have been used to analyse water resources, although multiple approaches are apparent. Water availability could be simply perceived as a matter of quantity (U.S. Geological Survey, 2002). One of the first and most well-known water availability indicators was developed by Falkenmark in the late 1980s (Falkenmark, 1989). This indicator calculates annual renewable water resources per capita, designating regions under "water stress" when per capita water availability is below 1700 cubic meters, and regions being "water scarce" if water availability per capita is less than 1000 cubic meters (Falkenmark, 1989). However, a criticism made of this index is that it only considers one physical factor (available water), with no consideration made for social dimensions which entails the response capacity of the nation to water scarcity (Gunda et al., 2015).

Over the last two decades, several water indices have been developed in response. A literature review of indices conducted reveals a gradual expansion of this initial quantity approach to encompass other factors (Brown, 2011; Chenoweth, 2008; Cook & Bakker, 2012; Gunda et al., 2015; Plummer et al., 2012). In 2002, the Water Poverty index, introduced by Sullivian (2001), sought to link physical water availability with socioeconomic variables which provide indicators of relative poverty (Sullivan, 2002). However, this index too received several criticisms. For instance, Molle and Mollinga claim that the indices "conflate disparate (and often correlated) pieces of information, with arbitrary weights, giving rise to intriguing associations" due to their multidisciplinary nature (2003, p. 535). Additionally, a more critical review came from (Kumar, 2017) and (Gine & Pérez-Foguet, 2010) regarding statistical preference. It is believed that numbers alone are not enough to comprehend the complexity of water issues (Kumar, 2017). Additionally, such an index should include the policy cycle of problem perception, policy formulation, monitoring and evaluation (OECD, 1993, p. 5), and in this way it can allow users to better understand the complex nature of water security problems in a systematic way (Gine & Pérez-Foguet, 2010).

That said, there are water assessment tools developed in order to assess water quality. For instance, a water quality index was developed by incorporating three environmental parameters—turbidity, total phosphorus and dissolved oxygen (Simões et al., 2008). Another quality assessment index was introduced by Bordalo (2001), which added more parameters into the previous index. These additional parameters are suspended solids, pH, ammonia, faecal coliforms, biochemical oxygen demand and chemical oxygen demand along with conductivity of heavy metals (Bordalo, 2001). However, these indices still focus on biophysical aspects of water security, suggesting a need for broader assessment tools.

One approach is to include the notion of vulnerability. This concept is defined as "the ability or inability of individuals and social groupings to respond to, in the sense of cope with, recover from or adapt to, any external stress placed on their livelihoods and well-being" (Kelly & Adger, 2000). According to Gain et al. (2012), each group or individual can then define vulnerability in a different manner; so for water systems, external burdens (stresses) contain natural hazards such as droughts, floods, and tidal surges along with changes in runoff due to changes in climate. One of the first attempts at creating a vulnerability index came from Raskin et al. (1997). This work focuses on "water supply and storage parameters, a withdrawal to discharge ratio, and a coping capacity index considering the nominal GDP per capita" (Gunda et al., 2015, p.7). Due to ongoing changes in climate variations and increasing population, and a requirement to adapt to these changes, vulnerability studies have gained significant attention (see for example, Alessa et al., 2008; Eriksen & Kelly, 2007; Paladini, 2012).

4.3.2 Water security assessment tools

The assessment tools discussed in the previous section provide insight into changes in water resources. But although these indexes are employed by a wide range of academicians and practitioners, to some extent they are not comprehensive and do not fully encompass water security issues, meaning dedicated assessment tools are needed: as developed in this thesis study.

Earlier conceptualizations of water security, which considers water quantity and quality, are usually employed in water security assessment tools (Cook & Bakker, 2012). A combination of two indices - water stress and water shortage - is the most well-known approach (Falkenmark et al., 2007; Falkenmark & Molden, 2008). Water stress calculates the ratio of water use to availability and a project's demand-driven scarcity by assessing how much water is extracted from rivers and aquifers ('blue water' resources), while water shortage indices assess population-driven real water shortages by calculating how blue water resources are shared by a given number of people (Falkenmark and Molden, 2008; Falkenmark et al., 2007). With the aim of providing a holistic view of water assessment, several indexes regarding water security have been proposed which bring together existing indices or have advanced previous tools by including additional parameters. These advancements have occurred in parallel with the evolution of water security concepts (see Chapter 2).

For example, the national water security index was promoted by The Asian Water Development Outlook (Makin et al., 2013). This index has five components: household water security; urban water security; environmental water security; economic water security and resilience to water related disasters (ADB, 2013a). Although the index brings together many dimensions in its framework, water related shocks are barely considered: a significant oversight (Gunda et al., 2015).

Furthermore, a recently developed index by Gain et al. (2016) assessed water security through four main components: availability, accessibility, safety and quality, and management. However, these indices are only applied on a national scale rather than the regional or river basin/watershed scale. Results show that significant water availability issues exist in India, China, parts of the USA and African countries, while many African people are also unable to access clean water and improved sanitation (see Gain et al., 2016). There are also a few other studies that focus on the local scale using statistical analysis methods such as principal component analysis (PCA), set pair analysis (SPA) and the fuzzy analytical hierarchy process (FAHP) (Jia et al., 2015; Ma et al., 2010). However, these assessment tools are not widely recognized by water security academicians and practitioners. Conversely, Dickson et al (2016) have recently developed a more comprehensive set of indicators to measure water security but this assessment is restricted to local scale-community rather than the global scale (Gain et al., 2016). In this respect, as no one water security assessment tool entirely fits this study's aims, there is a need to develop a dedicated approach, based upon these pre-existing studies.

4.3.3 A water security index

As this study is not aimed at the evaluation or assessment of the indices we use (i.e. assessment tool evaluation), a specific method for assessing water security was chosen based upon several factors. Most notably, these included fit with the study aims in terms of measuring water security comparatively in integrated river basin management but also simplicity of use and practicality since availability of data sources is a significant limiting factor to this type of doctoral study. Moreover, the water security index captures the most important parameters that are vital for evaluating overall water governance; which are addressed thoroughly later on in this chapter. For instance, it accounts for an agricultural production parameter and requires water availability data, which is valid for most of the countries and basins although it differs in variables such as water potential and water storage. The water security index also shows overall water trends so is a good fit for our study and selected cases. What makes this assessment concept more advanced when compared to other approaches is its potential for flexible application at multiple scales, including the river basin or watershed. Therefore, it can easily fit with the basin scale, which matches our theoretical and methodological approaches. After consideration of these factors, five components of water security are employed within an overall aggregate water security index in order to provide a quantitative measure of integrated river basin management outcomes.

This approach is based on the work of Lautze and Manthrithilke (2012). They developed a water security index in order to (with the aim of promoting) a concrete understanding of the concept. Their index has five components for evaluating water security: 1. basic needs; 2. agricultural production; 3. the environment; 4. risk management; and 5. independence. This index is used to assess water scarcity in 46 countries (ibid.) (Figure 3.2). Results show that the water security index is strongly associated with national economic development (Gunda et al., 2015; Lautze and Manthrithilake, 2012). With this feature in mind and the potential for application to other cases, this thesis study develops its own set of indices using the approach of Lautze and Manthrithilake and others to establish a novel water security assessment tool, based on five dimensions: basic needs; agricultural production; water security for the environment; water security for risk management; water security for independence.

Overall Water Security = A + B + C + D + E			
Component	Definition	Scoring System	Source
A = Basic Household Needs	Percentage of Population with Sustainable Access to an Improved Water Source	High percentage of population with access to improved water source = 5 to low percentage of population with access to improved water source = 1	WHO (2009)
B = Food Production	The extent to which water is available and harnessed for agricultural production	Water security for agricultural production = (a + b)/2 a. Water availability (RWR/population) — From low availability = 1 to high availability = 5 b. Water use (Withdrawal/population) — From low withdrawal = 1 to high withdrawal = 5	FAO AQUASTAT (2007)
C = Environmental Flows	Percentage of Renewable Water Resources (RWR) available in excess of environmental water requirement (EWR). That is, [RWR – (environmental water requirement + withdrawn water)]/RWR.	High percentage above EWR = 5 to low percentage above EWR = 1	converted from Smakhtin *et al.* (2004)
D = Risk Management	Risk Management measures the extent to which countries are buffered from the effects of rainfall variability through large dam storage	Risk Management = (a + b)/2 a. Inter-annual CV — From low CV = 5 to high CV=1 b. Storage — From high storage = 5 to low storage = 1	Mitchell *et al.* (2002); ICOLD (2003); FAO AQUASTAT (2007)
E = Independence	Independence measures the extent to which countries water and food supplies are safe and secure from external changes or shocks	From low dependence on external waters = 5 to high dependence = 1	WRI (2009)

Figure 4.1: Water security index (Lautze & Manthrithilake, 2012, p. 78)

Basic needs

This component calculates the percentage of population with access to an improved water source. This aspect is important because access to water is still a significant problem worldwide (see Chapter 1). Changes in access to clean water can provide an effective measure of whether water security is improving or not. This component is based on the percentage of a population who have access to water within 1 km. However, due to lack of data for the basins used in the study, it will not focus on this problem in calculating water security in the case studies (Chapters 5 and 6). Additionally, national water access is around 90 percent in both countries, so this parameter does not represent an urgent water security problem in Turkey and California.

Agricultural production

This is the most important parameter since water use in agriculture accounts for 80-90 percent of total water withdrawal globally (Morison et al., 2008). Also, this feature will become more important in the future as population growth is accelerating, meaning meeting the increasing demand for food will be one of the greatest challenges in the 21st century (Food and Agriculture Organization of the United Nations, 2017). This parameter has two sub-indicators: 1- water availability[19] per capita; and 2- water withdrawal per capita. Water availability per capita involves the quantity of total water potential for agricultural production, and water withdrawal per capita states to what extent a country can utilise its water resources (Lautze and Manthrithilake, 2012). The combination of per capita water withdrawal and per capita water availability divided by two gives the agricultural production component (ibid.).

Water security for the environment

Environmental needs and water quality are important factors for achieving water security. Adequate water for the environment encompasses only part of the picture (Lautze and Manthrithilake, 2012). The environmental water requirement is calculated through water quantity because of the lack of data on water quality (ibid.). This component may also be assessed by the water stress indicator (WSI) (Smakhtin et al., 2004). Due to a lack of data, analyses of environmental stress typically is undertaken through the WSI. WSI calculations are based on the ratio of total water withdrawal to total water availability (Food and Agriculture Organization of the United Nations, 2018) . If the WSI is higher than 1, the basin is labelled as environmentally water scarce, also where the WSI<0.3, the basin is defined as an environmentally safe basin (Smakhtin et al., 2004).

Water security for risk management

This component emphasizes the sustainability of many processes in countries that are highly sensitive to fluctuations in rainfall and therefore drought and flooding. Thus, assessment seeks to measure the effects of all fluctuations or natural disasters (Lautze & Manthrithilake, 2012). This is especially important for our cases which are both semi-arid basins subject to water scarcity and drought. The component has two sub-indicators: 1. storage capacity, calculated by measuring storage capacity in dam reservoirs; 2. inter-annual rainfall variability,

[19] Water availability is the combination of groundwater and annual runoff.

assessed by using an inter-annual rainfall coefficient of variation (Lautze and Manthrithilake, 2012).

Water security for independence

According to the authors (Lautze and Manthrithilake, 2012), a country's national security is dependent on the extent to which it's capacity for meeting its own needs through internal water resources is met, i.e. water security independence. Independency is calculated as the ratio between water area and water use internally. Given policymakers and practitioners in the Konya Closed Basin are actively considering water transfers from other parts of Turkey, river basin independence, or more accurately inter-basin dependency, will no doubt became increasingly important in the future. Overall, the parameter results in the paper assessment were ranked for more than 50 countries, and each ranking group divided into 5 groups by each group scored from 1 to 5 (ibid.). A 5 indicates higher water security achievement for each parameter (ibid.). However, since this thesis compares only two countries, which is important for comparative analysis, we will firstly assess the water security parameter trends annually, and our approach will not score them from 1 to 5 after ranking them.

4.3.4 Broader implications of parameters

The water security index indicators have broader implications which are beyond the case study areas. So, in our analysis we will assess these indicators in a broader sense.

Access to improved water resources

More than 70 million people are currently displaced due to war, persecution or conflicts, and the world is seeing one of the greatest forced displacements since the WW II (HLP, 2017; UNHCR, 2018). In addition to this, water crises are perceived as one of the highest concerns globally for years to come (WEF, 2016). According to the United Nations Convention to Combat Desertification (UNCCD), water crises might force significant number of people to flee their homes by 2030 (2014). In this respect, access to water becomes vital for providing basic human needs. Although more and more people have been accessing clean water as part of MDG/SDG target, adding around 2.6 billion people since 1990, over 2.4 billion people are still unable to access safe water (WHO/UNICEF, 2015; WWAP, 2019). Moreover, military attacks on water supplies in Lebanon in 2006 resulted in the displacement of 25 percent of its inhabitants (Amnesty International, 2006). These forced displacements put a strain on existing water resources at the final destination for migrators as well, as the existing populations, cause marginalization for the displaced population and restrictions over accessing to water (WWAP, 2019). For these reasons, access to water is essential to continue a sustainable basic life for people, and absence of it might result in unexpected and calamitous ways as illustrated above. So this parameter is also important for us, but due to lack of data it will not be calculated. However, it will be monitored through annual reports for the basins selected.

Agricultural production parameter

This parameter is a combination of water availability and water use per capita. The change in these sub indicators might have an adverse impact on a variety of areas from the environment to economic sectors and also reflects on the other parameters. Due to water shortage, people might consider leaving their homes to find another area for settling in (UNCCD, 2014) Additionally, any change in water usage or water availability can lead to either increased storage capacity which is attached to a risk management parameter or planning to find outsource water which is linked to independence which we discuss below.

Environmental requirement

One of the significant components of water issues is environmental problems (Tundisi, 2008). Water pollution from sectors such as agricultural, domestic and industrial sources poses significant water security challenges. Degradation of ecosystems is one of the most serious water management problems, and poor water quality leads to further deterioration of human health, the environment and sustainable development (United Nations, 2018a). For instance, excessive fertilizer use in agriculture results in the eutrophication of lakes, reservoirs and rivers, ending up in groundwater as well (Tundisi, 2008). Additionally, arsenic contamination of groundwater has caused a significant health catastrophe in Bangladesh (Safiuddin & Karim, 2001). In this sense, an environmental requirement becomes one of the most important parameters that we will assess, because its consequences are likely adversely impacted beyond the environment.

Risk management

This indicator is particularly important because changes in climate reflects in rainfall variability or climate variation and thus increases the frequency and intensity of extreme weather events. If a country experiences extreme weather events such as drought, it can create a problem beyond water availability. The typical example for this is Syria. Syria's drought between 2006-2009 went beyond a simple water access problem and contributed to civil war in the country. If Syria had enough reservoir capacity and preparedness for drought and use water, the problem might not have led to civil war. Moreover, drought problems do not recognize borders and spill over to other countries in this interconnected world. For instance, any drought or flood can result in an export ban thus impacting an importer country's national security matter through food security. In this aspect, Egypt is an important case to show how a drought could cause social disruption and then create national security problems. In 2011 there was a drought in Russia which hit grain production and as a result of the event, Russia put an export ban on wheat (Kramer, 2010). Accordingly, Egypt which is heavily dependent on wheat imports and Russia's biggest importer was adversely affected (Welton, 2010). As a result of this export ban increasing bread prices through increased grain demand contributed to the revolution which took place in 2013. Moreover, bread availability was one of the main themes of the protests ("Bread, Dignity and Freedom," 2016). These examples highlight the importance of a risk management parameter and explains how water security can indirectly contribute to national security of any country.

Independence

In terms of an independence parameter, decreases in independence can affect overall water security, but also it can create another problem by bringing additional costs and result in increasing water price or create ecological damage, thus indirectly affecting other securities such as environmental and food security. A basin might consider inter basin water transfer due to the internal water availability shortage, as in the case of China and Australia or India's basin projects (Gao & Yu, 2018; Gupta & van der Zaag, 2008; Shao et al., 2003). However, this water conveyance or transfer requires engineering work, which is extremely costly (Gupta & van der Zaag, 2008). For instance, the inter-basin water transfer project from the Euphrates to the Konya Closed Basin in 2013 involves transfer costs for annual supply of 500 hm^3 water, calculated at $500 million (DSI, 2017). As a result of these additional costs by increasing water prices, there might be impacts on the agriculture sector through placing additional expenses on farmers' shoulders, and indirectly decreasing food security. Lastly, these transfers also have environmental consequences: both positive impacts such as 'mitigating ecological water shortage' and negative impacts such as 'damage to the ecological environment of the donor basin' (Zhuang, 2016, p. 12867). In this respect, an independence parameter has broader implications beyond just bringing in external water resources, and these implications highlight the importance of the parameter. We will therefore consider them in our analyses and assess at the river basin scale.

Before concluding, our intention is not to rank cases for the water security index or evaluate their overall water security from the perspective of statistical analysis. Additionally, our study can encounter data limitation as we compare two different countries' basins. At this point it is important to note that we mainly focus on institutional analysis of integrated river basin management implementation, and this would be supported via the water security index. However, when the data is not accessible, we make reasonable assumptions or find other data for replacing intended ones to assess our outcomes.

4.4 Summary

This chapter describes the methodological research design. It described the comparative method and illustrated the importance of the approach. The thesis research is based on case studies for several reasons. Case studies allows us to investigate complex processes such as integrated river basin management, and they are commonly used in social science or inter/trans disciplinary research. In this respect, they are optimal for comparatively studying the Konya Closed Basin and Kern County Subbasin. Additionally, the case design especially small N cases allows in-depth testing of the IAD-SES lesson-drawing framework. The most crucial part of the methodological section is case design considerations, and these are described along with case study design assessments. Case justification was made using a logical process, as described above. The chapter then described data sources for both cases.

Furthermore, since the thesis aims to assess the water security in integrated river basin management, we chose a mixed method, allowing quantitative data analysis and qualitative measurement. The chapter then illustrated the development of the water security assessment tools, and the adopted water security index. The chapter then set out the broader implications of water security parameters that can be manifest themselves beyond water security per se to include inter alia displacement, food security, increasing water prices and environmental problems.

Chapter 5: Understanding the implementation effectiveness of integrated river basin management in the Konya Closed Basin, Turkey

5.1 Introduction

The aim of this chapter is to provide insight into Konya Closed Basin's WFD implementation and its results in terms of water security. Firstly, it provides context to integrated river basin planning in Turkey. Secondly the chapter shows physical, community and rules characteristics of the Konya Closed Basin in southern Turkey. Then it provides information regarding water related issues in the basin, with a specific focus on groundwater problems. Here, water security has been impacted by multiple drivers, including agricultural over-abstraction and climate change. The research then focuses on water security indicators with statistical trend analysis to measure the degree of groundwater problems in the basin. Later, with the help of IAD Framework, the chapter starts investigating what has been done in the implementation of IWRM, to identify key drivers of water insecurity, as measured by the indicators. Here, as argued in the last section, application of the IAD framework shows that water insecurity is resulting from a combination of factors, including weak institutional arrangements. The chapter finishes with significant results in conclusion.

5.2 Context to integrated river basin planning in Turkey

Turkey has a long history of managing water resources at the basin scale, although integrated approaches are more recent (Demirbilek 2019; Demirbilek and Benson 2018). The history of Turkey's water governance in the 20th Century, moreover, perfectly illustrates the shift from the 'reductionist' paradigm to the 'integrative' era.

The 'reductionist' era has its roots in efforts by the new Turkish Republic to create a systematic approach to water management in the 1930s (Kibaroglu et al. 2012). Reflecting the influence on other countries of US global development policy that prioritized the TVA model (Chapter 1; Ekbladh, 2002, 2010), the Turkish 5-year industrial plan of 1934 set out policy for modernizing the national economy through large scale hydropower generation (ibid.). A General Directorate of Electric Power Resources, Survey and Development Administration was then established in 1935 to implement the policy. A Department of Hydraulic Works, established in 1939, then undertook studies into national water resources (Demirbilek & Benson, 2018). This research was then followed by a period of large scale dam construction, along with the development of irrigation schemes such as the Adana-Seyhan Regulator and drainage of marshes (Yıldız & Özbay, 2012). After World War II, the US influence on Turkish water resource development grew through the Marshall Aid programme, leading to further expansion of large scale water infrastructure construction (Demirbilek & Benson, 2018). Multipurpose dam projects, particularly for energy generation, flood control and irrigation, then became prioritized in national water policy in the period between the 1950s and 1970s (ibid.). Important early examples are the Seyhan and Sanyar dams, completed in the 1950s. These projects were followed by the Southeastern Anatolian Project (or GAP), involving construction of twenty-two large dams on the Euphrates, Tigris and Illusu river basins, was initially developed in the 1970s (Morvaridi, 2004). While this engineering paradigm still persists in Turkish water policy, to an extent it is now being overtaken by the integrated river basin management approach introduced by the EU accession process.

Although Turkey's EU accession has largely stalled due to political factors, national water policy has nonetheless been subject to 'Europeanization' (Demirbilek 2019). Turkey was accepted as an EU candidate in 1999, meaning that under the Copenhagen accession process it was obliged to assimilate the EU acquis communautaire (or body of laws), including European water policy. A key policy component of Turkey's water policy transfer from the EU was its adoption of the Water Framework Directive (Demirbilek & Benson, 2019). This process started with a series of implementation 'projects' funded by the European Commission, designed to develop the WFD process in Turkey through capacity building (Demirbilek, 2019). Meanwhile, the Turkish government adopted a series of by-laws and regulations to provide legal support to the WFD implementation (ibid.). The result has been a unique, hybrid form of integrated river basin management in Turkey that utilises the main implementing elements of the Directive but within an 'assemblage' of the pre-existing institutional framework of

Turkish water management established during the 'reductionist' era (Demirbilek & Benson, 2019). Co-existence of these two forms of water management therefore defines current water governance in Turkey.

5.3 Konya Closed Basin: An analysis of water security

Chapter 3 explained how the IAD Framework argues that biophysical, community and rules-in-use are mediated through an action situation to result in specific outcomes in the institutional setting. Instead of the rules-in-use component, this thesis opted for a hybrid IAD-SES approach that substituted a governance component focusing on organizational, rules and processes to integrated river basin management in the action situation. Using this hybrid approach, this chapter will first apply the framework, starting with biophysical parameters, community and governance attributes, in order to illustrate how water security has become a problem in the Konya Closed Basin. Water use issues are then described, before showing how the WFD process as an institutional 'action situation' has been developed in response. This multi-layered feature of IAD allows easy identification of the factors determining the degree of water security as an outcome, as measured by our indicators (see Chapter 4) in this context.

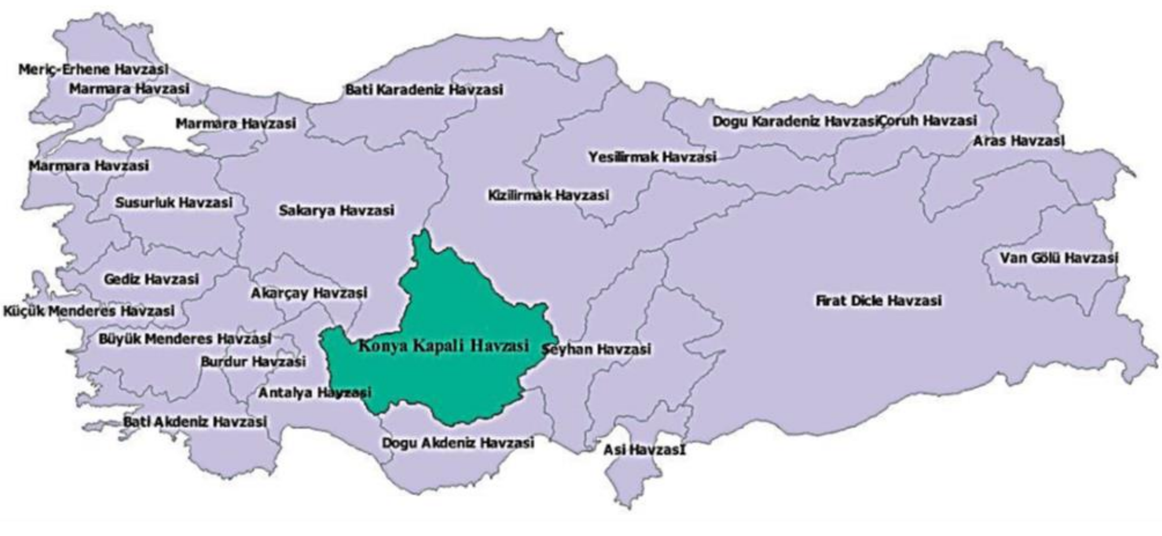


Figure 5.1. Konya Closed Basin location along with other 24 basins in Turkey (SYGM, 2019)

5.3.1 Konya Closed Basin: external variables

In terms of *biophysical attributes*, the Konya Closed Basin is the third largest river basin in Turkey, covering 53,000 km^2 (Divrak and Demirayak, 2011: 166). In terms of size, the Konya basin is equivalent to the Netherlands. This river basin was designated as part of Turkey's adoption of the EU Water Framework Directive in the period of 2001-2003 (Kibaroglu & Sumer, 2007; Moroglu & Yazgan, 2008). It is located in the heart of Turkey and is often called the breadbasket of Turkey due to the agricultural dominance of land use. Additionally, the Konya Closed Basin is one of the 25 river basin districts (see Figure 5.1) (it was originally 26, then turned into 25 with the merging of the Euphrates and Tigris into one basin) which is required by WFD Article 3 (Demirbilek, 2019). The Basin is bordered by several other rivers basins: Sakarya; Kizilirmak; Kizilirmak; Seyhan; Eastern Mediterranean Basin; Antalya; and Akarcay (Duygu et al., 2017, p. 55). Konya contains nine sub basins (Fig 5.2). One of the important features of the Konya Closed Basin is that it does not border the sea, hence the name 'closed' (DSI, 2017). Additionally, significant water comes from groundwater sources due to the climatology of the region (Ribamap, 2017). Very limited available water comes from surface water. Rain fed agricultural areas account for 45.9 % of total agricultural area, while the irrigated fields ratio is around 34% (Ribamap, 2018). Furthermore, Konya suffers issues with both aridity and water scarcity (Ribamap, 2018). Annual basin wide precipitation on average is only 407mm, one of the lowest in Turkey (Ribamap, 2017, p. 2).

The Konya basin is one of only 200 eco-regions designated globally, and is crucially important for biodiversity "for its wetlands, the extensive areas of remaining salt steppe (the largest and most pristine in Turkey), and for the diversity of its fauna and flora" (Divrak & Demirayak, 2011, p. 167; see also Olson & Dinerstein, 2002; Berke 2009). The basin has 18 groundwater bodies, 58 rivers and 34 lakes, making in total 110 water bodies (Ribamap, 2018). Moreover, the basin is known as a significantly 'important bird area (IBA)', with 13 of the most endangered bird species in Europe using the region for breeding (Divrak & Demirayak, 2011, p. 167). One of the most important lakes in the Konya basin for bird migration and winter shelter is the Salt Lake (Tuz Golu in the Turkish acronym), formed as a result of tectonic processes. It is the second largest lake in the Basin after the Van lake, covering around 110,000 hectares (Diri, 2018, p. 32). In addition to its size, due to the Salt Lake's location on a major migration route, the area is home to flamingos, windhovers, pied avocets, plovers along with 38 other endemic bird species (TVKM, 2014). The Salt Lake produces 1,400,000 tons of salt annually, covering 60 percent of Turkey's total production (Berke, 2009). Because of its unique features, it is an 'A level' wetland according to the Ramsar criteria and it is also a specially protected environmental area (TVKM, 2014, p. 12). Lastly, the Konya Closed Basin has two 'Wetlands of International Importance' Ramsar sites; namely Meke Maar and Kizoren Obruk[20] while being home to the biggest freshwater lake in the country, Beysehir lake, which is also a tectonic subsidence wetland (Diri, 2018).

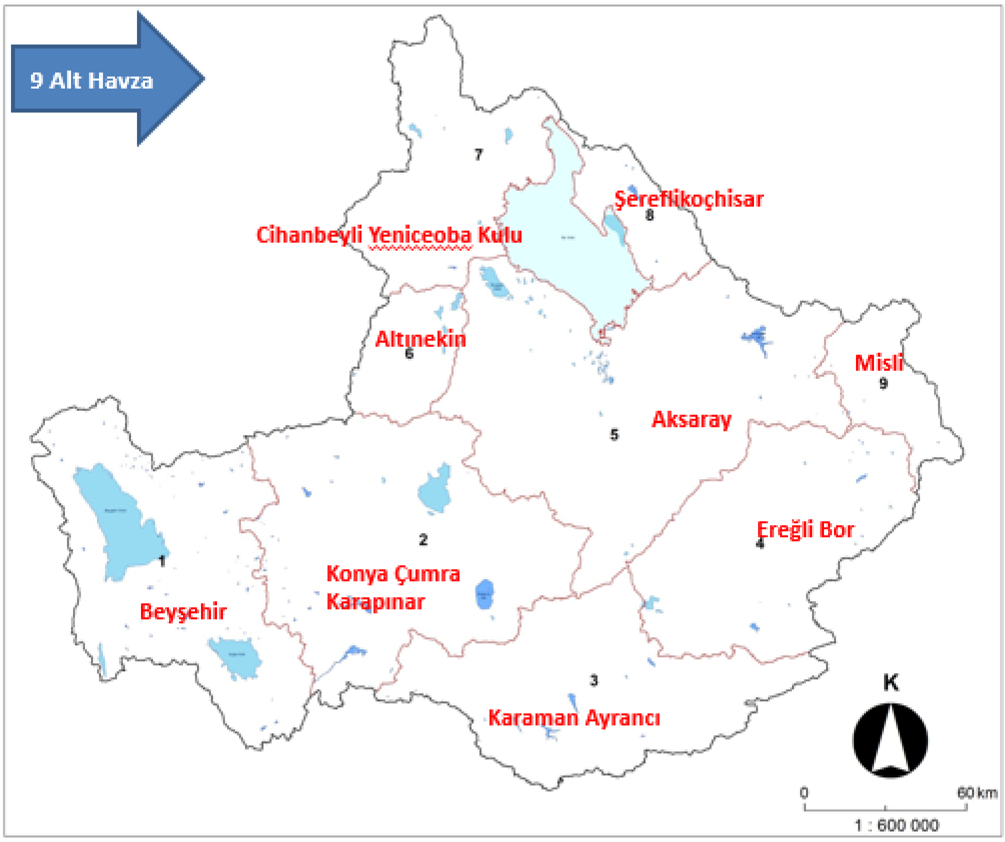


Figure 5.2. Konya Closed Basin map showing the nine sub basins (Ribamap, 2018)

Community attributes of the basin include a growing population and an economy dominated by agriculture. Three million people live in the Basin, mainly in the cities of Konya, Aksehir and Isparta. From 2014 to 2017, the population in the basin increased by 3 percent. Agriculture accounts for 45 percent of the Konya area's economic production. Main crops include sugar

[20] https://www.ramsar.org/sites/default/files/documents/library/sitelist.pdf

beet, wheat and corn (Divrak and Demirayak, 2011). Moreover, the Konya closed basin constitutes 2.7 percent of the gross value added (50.90 million TL) and accounts for 3.5 percent of employment in Turkey (Ribamap, 2018). Agriculture constitutes 34 percent of the basin labour force, thus water becomes an important input for the agriculture sector (ibid.). A total of 91 percent of the population is served by the water supply network, the rate of sewerage system connection is 82 percent, and 62 percent receives water treatment plant services, mainly in the Nigde and Aksaray provinces (Ribamap, 2017). According to reports, due to an estimated population of around 100 million in 2030, available water potential is expected to decrease to 1,120 m^3/year (Öktem & Aksoy, 2014).

When considering *governance attributes,* several governmental and non-governmental organizations are responsible for water management. During Ottoman times, waterways, dikes, drains and embankments were originally managed by foundations (NGOs) rather than governmental agencies. Later on, with the reorganization of the General Directorate of Public Works, water related works became controlled in more systematic and consistent ways (DSI, 2012). More latterly, the agency fell short of meeting with forecasted developments due to a shortage in grants, although several provincial water affairs agencies were founded such as Bursa, Adana, Edirne and Izmir (ibid.). In the following years there were several attempts to reform the water affair directorate from 1929 to 1936. However, forming the Directorate of Water Hydraulic works (DSI in Turkish acronym) in 1954 is one of the cornerstones in water management history of Turkey. The DSI then became the main institution regarding water for planning, developing, improving, allocating and governing water bodies [21]. The DSI led development of water facilities such as building dams, creating irrigation plants, bringing water to cities and villages which dominated by engineering works during these years (AK et al. 2022). Additionally, the DSI was the main water body for providing licensing, planning and implementing water allocation for several decades. However, planning for water bodies under the State Hydraulic Works was to provide water supply, rather than managing water in an efficient way (ibid.).

Water governance through rules, sanctions, compliance and subsidies at the national, regional and local levels are of crucial importance. A crucial groundwater law was enacted in

[21] https://www.mevzuat.gov.tr/MevzuatMetin/1.3.6200.pdf

1960 in order to provide the framework for protection of groundwater in Turkey. This law mandates that the permission of opening water wells and their locations, elevations, and numbers, abstraction amounts were under the decision of the State Hydraulic Works[22]. Additionally, according to this law anyone has rights to look for groundwater on their own land and opening and using wells but requires licensing by the DSI (Ak et al., 2022). However, until recently the Groundwater Law was not implemented as it should be by national government agencies (Demirbilek & Benson, 2018). Moreover, the DSI has 26 regional authorities for enabling local water works such as controlling the administration of irrigation facilities or hydropower, improving all related water and land resources (Ak et al., 2022). Therefore, the majority of work related to water on the ground is dominated by the DSI. More latterly, Irrigation unions were given the administration role for managing water provided to farmers by the Law No. 6172[23]. This law transferred significant control of facilities to irrigation unions, also making 23 percent of irrigated lands governable by these unions (Saritas et al., 2001). However, deciding the water fees is determined by the DSI and water allocation is managed by irrigation unions under the oversight of the DSI (Ak et al., 2022).

Furthermore, in Turkey there are several other legal frameworks or duty allocations given to specific institutions. For instance in the 1980s there was a desire to protect water quality leading to enacting of the 1983 Environmental Law, followed by formation of the General Directorate of Environment (TOB, 2019b). More latterly, Water Pollution Control Regulations came into force to protect surface and groundwater and enable water bodies to be used in an efficient way thereby avoiding water pollution in compliance with sustainable development targets[24]. These developments in the water and environmental sector revealed the need for a new ministry, leading to the establishment of Ministry of Environment in 1991 (TOB, 2019b). Other ministries including the Ministry of Health, Ministry of Culture and Tourism, Ministry of Finance and Treasury, Ministry of Natural Resources and Energy, Ministry

[22] The Groundwater Law (1960, No. 10688): https://www.mevzuat.gov.tr/MevzuatMetin/1.4.167.pdf
[23] The Irrigation Unions Law (2011, No.6172): https://www.mevzuat.gov.tr/MevzuatMetin/1.5.6172.pdf
[24] https://www.mevzuat.gov.tr/File/GeneratePdf?mevzuatNo=7221&mevzuatTur=KurumVeKurulusYonetmeligi&mevzuatTertip=5

of Foreign Affairs, Ministry of Technology and Industry, Ministry of Environment and Urban, Ministry of Interior Affairs have some duties or share cooperation regarding water management. For instance, the Ministry of Interior Affairs is responsible for Coastal Law (1990, No.3621), aimed at standardizing the usage of rules in a normative way for protecting and serving all coastal areas surrounded by lakes, seas, rivers and related areas for the benefit of society[25]. Lastly, the Ministry of Energy and Natural Resources is responsible for geothermal resources and natural mineral waters laws (2007, No.5686) that provides rules and methods for searching, developing and protecting geothermal resources and natural mineral waters. It also conveys rights upon these resources by evaluating their economic values while assessing compliance with environment standards[26].

With the foundation of the General Directorate of Water Management (SYGM being Turkish acronym) in 2011, the intention was to manage water in an integrated way and ensure compliance with the European Union's WFD (Water Framework Directive) Framework, based on governing water through river basin planning (Öktem & Aksoy, 2014). The EU accession process has given significant impetus to the development of the SYGM (TOB, 2019b), since as mentioned above compliance with the EU water acquis communautaire is a key criteria for Union membership (Demirbilek 2019). It is apparent that since the formation of this new governing body, Turkey has experienced significant transformations and crucial developments in the water field. The SYGM has government authorization to determine water allocation tasks between sectors in order to implement river basin management plans, as emphasized in the National River Basin Strategy (Ak et al., 2019). The agency has additionally the responsibility of determining the quality and quantity of water nationally, of preparing protection strategies and standards, and for monitoring water quality (Öktem & Aksoy, 2014). To support these powers, a new national water law was developed by the Turkish Government in 2012 in order to better implement EU Directives and better water regulations, however it is still waiting parliamentary approval (Demirbilek, 2019; Demirbilek & Benson, 2019). In relation to governance attributes, therefore, the DSI and SYGM are the main responsible water institutions implementing the majority of legal frameworks and rules.

[25] https://www.mevzuat.gov.tr/mevzuatmetin/1.5.3621.pdf
[26] https://www.mevzuat.gov.tr/MevzuatMetin/1.5.5686.pdf

These agencies are also part of a highly centralized system of water governance operating at the basin scale (Ak et al., 2019, 2022, 2022), that we explain later on in this chapter.

5.3.2 Konya Closed Basin Water Security Issues

Without identifying issues, it is difficult to find a solution or even address them. This part therefore first identifies water-related problems using academic studies such as journals and dissertations. It also uses information from non-government organizations such as WWF-Turkey (World Wild Fund) and government agencies reports such as the General Directorate of Water Management, State Hydraulic Works and General Directorate for Protection of Natural Assets to name but a few, which provide more sophisticated and detailed data.

Given that agriculture accounts for 90 percent of water used in the basin and more than 100,000 water wells exist, there are significant water security issues in Konya (Berke et al., 2014). In total 70 percent of water wells are non-licensed which leads to alarming effects for groundwater availability (Divrak & İş, 2010). Water related issues range from sinkholes to water quality, salinization, ecological problems, as well as farmer related issues such as urban migration. For instance, in recent years increasing numbers of sinkholes are occurring in the Konya Closed Basin, attributed to low groundwater levels and extensive agricultural activity (Berke et al., 2014; Bozyiğit & Tapur, 2009; Tapur & Bozyiğit, 2015b) (see Figure 5.3). Additionally, sinkhole occurrence has doubled[27] in the Konya Closed Basin since 2014, which is also the starting point for river basin implementation under the WFD process. Although sink holes[28] are formed through a natural process, occurring as a result of interaction between soluble rocks and water, it is believed that the growing numbers of sink holes in the region are consequences of excessive groundwater use due to new wells being dug as agricultural patterns change (Doğan & Yılmaz, 2011). Over-abstraction has lowered the groundwater table resulting in unstable geological conditions developing.

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[27] https://www.aa.com.tr/tr/cevre/konya-ovasindaki-yillara-gore-obruk-olusum-sayisi-belirlendi/2470651

[28] Sinkholes are 'the most distinctive features of in karst lands', and often described as 'closed depression with an internal drainage, and in most of the cases a direct connection with the underground' (Parise, 2019, p. 934)

Figure 5.3. A vast sinkhole visible in two agricultural fields in the Konya Closed Basin (Sabah, 2019)

Furthermore, the Konya Closed Basin has surface and groundwater issues. Initial analysis shows that 64 percent of surface (rivers and lakes) and groundwaters are identified at high risk, while 18 percent are at significant risk (Ribamap, 2018). For instance, important reed beds have dried up in a significant number of basin wetlands; in Karapinar the reed drying ratio is 43.43 percent while in Hotamis the reed bed desiccation rate is 27.85 percent (Durduran, 2008; Tunçez & Candan, 2008; Yilmaz, 2010). Reed beds are particularly susceptible to decline in groundwater levels (ibid.). Beysehir Lake, which is one of the largest freshwater bodies in Turkey, lost 75 percent of its area, while the Kulu, Kozanli and Bolluk lakes dried up by 90 percent: an overall loss of 65 percent of wetlands in the basin (Divrak & İş, 2010). This dire situation puts habitats, bird populations and wild animals dependent on wetlands in jeopardy (Ozdemir & Aydin, 2018). The Konya Closed Basin has a water deficit of around 2 billion m3 (Berke et al., 2014). This deficit is countered by using groundwater, thus it leads to constantly unstainable downward groundwater levels (Öktem & Aksoy, 2014b). In a recent study, statistical trend analysis showed that groundwater levels showed a 'statistically decreasing trend' and this pattern 'gradually increased in recent years' spanning the period from 1987 to 2020 (Demir et al., 2021). It was shown that groundwater levels due to groundwater abstraction also does not follow linear a pattern, but rather shows an increasing upward trend over time (Berke et al., 2014). This groundwater level decrease was also linked to deformation of the aquifer system and thus is leading to slow subsidence in the case of the Karapinar subbasin (Orhan et al., 2021). The paper also revealed that the subsidence rate increased from 15mm/yr (2002-2010) to 70 mm/yr (2014-2018) (ibid.)

Water quality issues are also among the most significant environmental pressures in the Konya Closed basin. Pollution from domestic and agricultural waste is observed in all lakes (Berke et al., 2014). There are two types of pollution: point sources[29] and non-point source or diffuse[30]. In 2018, 35.9% of 92 surface water bodies, or 33 lakes and rivers, experienced significant point source pressures such as domestic wastewater, industrial wastewater, geothermal discharges, solid waste landfill site discharges, untreated water discharge or industrial pollution to name but a few (Ribamap, 2018). Diffuse source pressures from nutrients or sediments coming from agricultural lands, vehicle related emissions or as a result of rainfall flushing diffuse sources to the surface or groundwater bodies - exist in 73 water bodies (Ribamap, 2018). For instance, sewage water from Konya province and unprocessed wastewater coming from a large amount of industries were discharged to the Salt Lake (Divrak & Demirayak, 2011). Additionally, the Acigol lake experienced low water levels along with significant potassium and salination issues (Bozyiğit & Tapur, 2009). There are also morphological issues such as dam building or flood protection which could result in decreasing or disappearing species, thus leading to habitat damage, eventually paving the way to failing WFD environmental objectives for 'good' water quality (Ribamap, 2018).

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[29] USEPA characterizes point source pollution as "any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack." For more details see: https://oceanservice.noaa.gov/education/tutorial_pollution/03pointsource.html

[30] Nonpoint pollution derives from 'land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification'. For more details see: https://www.epa.gov/nps/basic-information-about-nonpoint-source-nps-pollution

To sum up, 11 basin water bodies are under morphological pressures (Ribamap 2018). According to the Water Framework Directive article 3, the effects of water pressures should be categorized into four levels, which forms the basis of the risk based approach of river basin management planning (ibid.). Using these classifications, 58 of 92 water bodies are not complying with national water quality standards. They are highly likely to fail to achieve environmental targets, while 52 of them failed on the basis of their chemical condition and 49 of them from their ecological condition (ibid.). When it comes to groundwater pressures, groundwater quality assessment shows that 16 groundwater bodies out of 18 illustrate significant chemical risk, while 10 groundwater bodies poses significant risk for water quantity (ibid.). Furthermore, river basin planning reports shows that only 7 sites of surface water bodies pass the environmental goal while 66 water sites failed to meet standards, mainly failing due to the chemical conditions of water bodies (ibid.). Lastly, a recent study shows that nitrate concentration is higher than 10 mg/l, which is the standard value for water quality, in 55 percent of samples taken from basin groundwater, reasonably attributed to agricultural activities (BOZDAĞ, 2017). These groundwaters, belonging to the Geç Pliyosen-Kuvaterner aquifer around Üçhüyükler, Ovakavagi Küçükköy and Karkin, are not suitable for agricultural irrigation due to nitrogen derivatives levels being too high (ibid.).

Regarding agricultural issues, water-intense crops such as alfalfa, sugar beet, corn and sunflowers are primarily grown in the basin while the basin features arid/semiarid climate zone with being breadbasket of Turkey (Öktem & Aksoy, 2014b). Official statistics show that while wheat and barley production have gradually decreased over recent years, high water consuming crops like potatoes, sunflowers, alfalfa and corn were increasingly produced in the same period (Berke et al., 2014). Moreover, while Turkey is one of the top sugar beet producers in the world with 6 percent of the total production, the Konya Closed Basin produces 35 percent of Turkey's sugar beet (WWF, 2014). In addition to this trend, by 2007 the cultivation area for corn increased by 100 percent and for sugar beet by 40 percent (Divrak & İş, 2010). In addition, corn, sunflower and sugar beet cultivation did not widely exist in the Karapinar subbasin before 2000 but production has significantly increased during recent years (Yilmaz, 2010). Flooding irrigation is widely used in the basin, and a conveying system uses an open canal mechanism for surface irrigation, while sprinkler irrigation and drip irrigation can save 70 percent and 85 percent of irrigation water use respectively (Berke et al., 2014; Divrak

& İş, 2010). Although no statistics exist on how the irrigation system has changed over the years, significant financial subsidies have been provided to farmers over the last decade. These subsidies were facilitated through the through State Agricultural Bank (Ziraat Bankasi is the Turkish acronym) from the then Ministry of Agriculture and Rural Affairs, with zero interest payments for modern irrigation systems and 50 percent subsidies for tools and equipment (Divrak & İş, 2010). More lately, agricultural irrigation processes have adversely impacted the Salt Lake, in the central part of the basin, with investigation showing that the water springs and rivers that feed the Salt Lake do not reach it due to agricultural irrigation (Berke et al., 2014). Moreover the lake lost one third of its size from 1990 to 2005 (Ekercin & Örmeci, 2008), and it was also reported that the lake shrank by 85 percent since 1915[31]. In this case, Lake Tuz in Konya Closed Basin could experience a similar catastrophic fate similar to Lake Urmia in Iran or the Aral Sea in Eurasia (AghaKouchak et al., 2015; Micklin, 2007; Micklin, 1988). According to one report, a wetland, namely the Tersakan lake used by flamingos for breeding, entirely dried up in 2011 (Berke et al., 2014).

On the other hand, while the basin has a semi-arid climatology, drought contributes to the existing water related issues. In normal climate conditions, the agricultural sector's needs for water are 90 percent met. With more severe drought, meeting water demands of the agriculture sector might not be possible (SYGM, 2018b). In future projections with severe drought conditions, this rate goes down below 50 percent (35 percent in 2040), which is a serious concern for sustainable water management (ibid.). Additionally to this threat, due to changes in precipitation, it is believed that the region might undergo a significant change in its climate status from semi-arid to arid, with a 10- 25 mm decrease in precipitation projected over the next 30 year period (Berke et al., 2014). According to a government 2018 report groundwater related problems reflect not only quantitative but also qualitative pressures (Ribamap, 2018). These qualitative issues could be seen in the form of fallowing, farmers related issues such as cooperative problems, or migration issues. For instance, in recent years due to the decrease in water availability linked to extensive agricultural water use and drought there has been an increase in the amount of fallow areas while also increases in irrigation costs (Divrak & İş, 2010). Farmers were interviewed about irrigation cooperative

[31] https://www.hurriyet.com.tr/gundem/tuz-golu-90-yilda-yuzde-85-tukendi-8527255

operations and the majority complained about expensive irrigation costs (Candan, 2020; Topak & Ceran, 2020). Half of the cost of growing sunflowers for example arises from irrigation expenses, with electricity costs accounting for 80 percent of these irrigation payments (ibid.). Furthermore, the study by Lelandais (2016) shows that decreasing agricultural productivity led farmers to migrate, firstly seasonally (moving to cities to find temporary jobs) and then permanently (out of Konya, mainly to cities) due to weak water management regulations and an insufficient insurance scheme for farmers during droughts.

Soil degradation is also another water-related problem in the basin. Soil degradation means a decrease in soil quality as a result of salination, desertification and concretion (United Nations, 2018b). These issues have become more visible in the basin and impact upon people (Berke et al., 2014). Due to insufficient fertilisation and poor irrigation practices, 325,000 hectares became infertile (barren) (Zengin et al., 2008). Soil degradation and salination could result in declining soil structure, and thus eventually leads to soil becoming unfit for agriculture in the long term (Yilmaz, 2010). Furthermore, salinity increases in groundwater was visible on the western and eastern part of the Konya Closed Basin (TAŞ et al., 2013).

5.3.3 The 'action situation': integrated river basin management implementation in Konya Closed Basin

The previous section has provided an overview of the main characteristics or 'external variables' of the Konya Basin and significant water related issues. Here, we can describe how WFD institutions have been developed to respond to these water security challenges, with an emphasis on groundwater protection, in effect constituting the institutional 'action situation' identified in our framework (Chapter 4), which determines the actual management of water security issues in the basin.

Institutions

Institutional attributes for managing water security focus primarily on the Water Framework Directive (WFD) process. Formal institutions are framed by the national obligation to implement the EU Water Framework Directive (Demirbilek & Benson, 2019). Prior to the early 2000s, water management in the basin was conducted by centralized agencies determined by national water laws (ibid.). Then, in response to Turkey's EU accession process, a system of river basin management was established in 2003, starting with the WFD pilot project, 'Towards Wise Use of the Konya Closed Basin', initiated by the Turkish government in 2003 in order to facilitate the IRBM process. At this time, the Konya basin was being used as a test case for rolling out WFD implementation across Turkey due to its various management problems. Capacity building activities and communication mechanisms were established between inter-sectoral stakeholders (Divrak & Demirayak, 2011, p. 170). Prior to implementation of a river basin action plan several EU-funded implementation projects were initiated as steps towards helping the adoption of WFD. For instance, the 'Capacity Building on Water Quality Monitoring' EU Twinning Project was undertaken from 2011 to 2014 in the Konya Closed Basin, along with other basins such as Akarcay, Susurluk, Buyuk Menderes, Meric Ergene and Sakarya (SYGM, 2016b, p. 6). Moreover, training projects such as " The Training of Trainers on the Implementation of the Water Framework Directive and the Preparation of River Basin Management Plans" from 2010 to 2012 were undertaken with the aim of contributing to water management policies in compliance with the WFD in Turkey (SYGM, 2017b). All these projects were believed to have improved capacity and the efficiency of basin management (ibid.)

In the period since, river basin management planning has been developed in the Basin. A river basin action plan was adopted between 2009-2011 (Demirbilek, 2019; SYGM, 2016a). This plan provided the formal institutional framework for surface and groundwater management, but is being replaced with a full river basin management plan (Demirbilek & Benson, 2019). In terms of which institution is responsible for tasks in the Konya Closed Basin, while the DSI (State Hydraulic Works) is in charge for providing water supply and the implementation of works for infrastructure and drinking water allocation, the SYGM (Directorate General Water Management) established in 2011 is currently undertaking implementation of the river basin management plan. The SYGM is also responsible for preparing reports for implementation and annual reports that inform the public and the EU Commission on progress (Ak et al., 2022). The initial task for staff in the SYGM was to identify water related issues and map the Konya Closed Basin to generate information on water bodies. For instance, the reports produced groundwater and surface water body monitoring results about their ecological and chemical status, and thus assessing environmental objectivities for several sites in the basin (SYGM, 2018c). Annual reports have been released, as required by WFD objectives, covering basins such as Buyuk Menderes, Meric Ergene, Susurluk along with the Konya Closed Basin to show implementation progress during the year (SYGM, 2016b, 2016a, 2017b). However, these annual reports do not show progress that has been made regarding water resources in Konya basin, to what extent implementation of WFD has been achieved or how water security is being met (for more information see: SYGM, 2016b, 2016a, 2017b).

Participation approach

In the implementation reports, assessment shows that the WFD has been adopted in Konya, with a significant number of meetings and workshops with stakeholders undertaken in the preparation process (Divrak & Demirayak, 2011; Demirbilek 2019). These events increased the awareness among people over water related issues and the WFD process (ibid.). However, it is difficult to say if there is real integration of stakeholders in the water allocation process (Demirbilek 2019). Local users do not fully participate in the decision making while choices made by authorities were not changed or revised using the advice of farmers or local stakeholders (Ak et al., 2022). In a real participatory mechanism, governance is described as 'institutions and processes, both formal and informal, which provide for the interaction of the state with a range of other agents or stakeholders affected by the activities of government' (Mitlin, 2004, p. 3). However, it is hard to say that this happens in Turkey and the centralized government agencies in control of water related decision-making are not willing to share this power.

It also appears that national priorities prevail over local needs in the public participation. During the WFD implementation process, 3 national stakeholders' meetings and 3 basin stakeholders meetings were held in order to provide knowledge about project works (SYGM, 2018a). Additionally, 3 national awareness and 1 basin awareness campaigns were prepared to explain the planning (ibid.). These activities also contribute to capacity building amongst local actors. Another capacity building example is that farmers were given training regarding new technologies such as organic agriculture and new drip irrigation techniques (Salmaner, 2008).

Adaptive management

With climate change, it is believed that the intensity and frequency of droughts will increase (Seneviratne et al., 2012). In line with this view, the GDWM undertook the project ‘Preparation of Drought Management Plan of the Konya Basin’. The aim of the project was to ease drought risks by improving stakeholder coordination, preserving water bodies both in terms of quality and quantity, raising awareness and information among people, plus conducting planning with local authorities and managers of different ministries (Duygu, 2015; Duygu et al., 2017). Climate risks assessments for future water allocation planning and future projections on water use allow authorities were undertaken to understand how they could take action in the time of no rain or adapt to enduring water shortages (SYGM, 2018b). Lastly, gender issues have never been expressed in official documents, while no single initiative has been undertaken regarding the role of women in the plan process.

Economic good

During the WFD implementation process, water was widely seen as an economic good, in harmony with integrated river basin management principles. This task was carefully assessed in each project using a cost and benefit perspective, assessing much income would be gained measured against costs. For instance, the report illustrates that the ratio of water that does not realise income is 42 % (SYGM, 2018a). The water that does not bring income are those which are lost in conveying or unregistered (i.e. illegal) water use, significant undesirable aspect of water management in the basin. More latterly, water abstraction costs were calculated in each sub basin. In the basin, water abstraction costs were around 0.28 Turkish liras per m3 (ibid.). Annual water abstraction costs for 495 hm^3 is 137 million Turkish liras. Water cooperatives provide 37% of the cost, totaling 51 million Turkish liras (ibid.). Due to extensive groundwater abstraction, low level water table costs are high for farmers because of the high energy requirement needed for extraction. Furthermore, subsidies for advanced irrigation technologies have slightly improved over the years (SYGM, 2018a). Assessments show that high profits per hectare come from vegetables and fruit growing, with potato cultivation coming first in income generation (SYGM, 2018a). In order to increase income, the water allocation plan was also analyzed to identify how water could generate more income for different agriculture sectors or industrial areas (SYGM, 2018b).

Holistic approach

Water management in Turkey has a partially holistic approach. As we discussed earlier, management of water resources has been significantly transformed from an engineering focus to more institutional. Although a technical approach still dominates the field, a more institutional, inclusive and holistic approach is emerging under the WFD. In line with this change and to keep up with developed countries, the General Directorate of Water Management (SYGM) was founded. The previous agency responsible for water resource management was the Hydraulic State Works (DSI). Hydraulic State Works is more of a technical engineering department. Therefore, how they see water is completely different to other modern water agencies and far away from real integrated water management (Ak et al., 2022). If the DSI was responsible for implementing WFD, a different approach would have emerged in Turkey.

In this respect, the SYGM has made significant improvements in drafting planning strategies for basins. In Konya, the department accounts for all sectors even mining and has tried to analyze economic aspects of water in the basin. However, a holistic approach as we said earlier is only partial, because the SYGM has only limited management duties; especially as it does not have power of sanctioning. The SGYM role is more focused on coordinating and implementing plans, but the DSI collects the data plus builds dams, creates reservoirs and governs all water related infrastructure works. This does not allow SYGM to fully become responsible for water management. It is possible to have divergent views on water by the two agencies. Lastly, in the implementation process of river basin planning, they also took account of every aspect of water, significant emphasis on water quantity and quality to meet with WFD’s environmental objectives. They neither nested on water budget side nor more planning side for water resources management. Including the agricultural sector, many different aspects have been accounted for. Although the SYGM agency has made enormous efforts in implementing river basin planning, the institutional level is still at an early stage. Lastly, weak agricultural unions or cooperatives were not actively involved in decision making mechanism or the planning process; however, this disrupts bringing holistic approach to General Directorate of Water Management. Other stakeholders and knowledge should be involved in the planning.

In general principles, the planning was strategic and systematic. Firstly, they prioritized the agriculture sector because 90% of water is used for agriculture and the main income of the basin comes from this sector. Secondly, the planning was also systematic in implementing each stage. Models and analyses were utilized during the implementation for both for accounting water volumes and future projection analyses (SYGM, 2018a, 2018b). Each method and analyzing way were carefully explained in each report due to sharing them with EU partners as part of WFD requirement. Groundwater and surface water were analyzed together during the implementation although the basin is heavily dependent on groundwater because it is believed that deficit in surface water impacts groundwater and even adversely impacts ecological habitats (SYGM, 2018a). Hydro morphological assessments were done along with water pollution analyzes (Ribamap, 2018). Although the results do not show whether the water pollution problems were tackled or solved, single point source pressures on water bodies still pose threats (SYGM, 2018a).

Furthermore, additional reservoir making is still in consideration to collect more water (SYGM, 2018a). However, we can question this because the recent study criticized the reservoirs by saying that building reservoirs increase water use and demands (Di Baldassarre et al., 2018). This will be discussed in water security indicator sections as well. In the implementation process, due to water deficits, water transfer and conveyance were discussed (SYGM, 2018b). Although this could mitigate water shortages, it could pose serious threats to the independence of the basin; discussed in the next section.

5.3.4 Water Security indicators

What then has been the outcome of this institutional ‘action situation’ from the implementation of integrated river basin management in the basin? To answer this question we will now focus on water security indicator results.

5.3.4.1 Agricultural production indicator

While Konya has the lowest rainfall of any basin in Turkey, agricultural production is heavily dependent on groundwater and relatively less dependent on surface water. Therefore, water availability and water use are the most important parameters for assessing water security. As population in the basin has increased between 2014 and 2017, the available water potential decreased (Figure 3). It means that available water potential[32] for this population significantly declined and did not keep pace with the growth of population in the basin (Table 5.1). In this way, our study calculated the first part of indicator, which is water availability per capita. This water availability is a combination of annual runoff and groundwater across the river basin.

Year	2014	2015	2016	2017
Available Water Potential (hm^3)	6938.5	6543.0	4623.0	4623.0
Population (million)	2.74	2.79	2.83	2.85

Table 5.1: Total Available Water Potential versus Population in the Konya Closed Basin between 2014-2017

[32] The accessed data informs us that there was a significant decrease in surface water potential due to changing methods of water potential estimation, and the total water potential decrease could be attributed to this. However, our judgement says that even though the decrease could be the result of a different method, the water potential still decreased but further information and assessment is needed.

Year	*2014*	*2015*	*2016*	*2017*
Per capita water potential	2532.314	2345.161	1633.6	1622.105

Table 5.2: Total Available Water Potential per capita in the Konya Closed Basin between 2014-2017.

Table 5.2 firstly shows that water availability per capita decreased by 36 percent from 2014 to 2017. This statistic is significant because water availability per capita decreased 3 percent more than water availability in the basin. Moreover, while the basin was above water shortage levels with 2532 m^3/capita/year in 2014, it fell declined to a water stress level with 1622 m^3/capita/year in 2017 (see Table 5.2), which is a dramatically significant change in the status of the basin. The data imply that if the basin authorities do not find new water resources through water transfer, or decrease water use, there will be serious issues in the basin, which could result in farmers losing their livelihoods and migrating to other places. This in turn can create broader security issues due to unemployment, poverty and additionally depopulation of agricultural areas. On the other hand, we so far only have data for obtained agricultural water use (Table 5.3) which accounts for 90 percent of total water in Konya (Berke et al., 2014). Although the data only shows the agriculture sector, it provides significant results. Additionally, this data is based on the master plan scenario produced by the SYGM department as part of integrated river basin management. While water withdrawal per capita from the basin was 2719 m^3/per capita in 2012, it increased by slightly in 2018. The data shows it increased to 3114 by 14 percent in 2022. In 2030, water withdrawal for agriculture is predicted to increase by 21 percent. Additionally water use increased at the end of the WFD implementation in 2018, meaning that the WFD process has not led to efficient water use in the case of Konya.

Year	2012	2018	2024	2030
Total Water Use(hm^3)	2719	2915	3114	3301

Table 5.3: Total Water Withdrawal Water scenario in the Konya Closed Basin between 2012-2030.

5.3.4.2 Environment indicator

There are few environmental flow requirement assessment methods. One of them is the Tennant Method. We therefore used a Tennant Method for assessment by assessing the poor ecological dimension that calculates an environmental flow requirement by taking 10 percent of annual surface water potential.

Year	2014	2015	2016	2017
Surface Water Potential (hm3)	4520	4520	2650	2600
Environmental Flow (hm3)	452	452	265	260

Table 5.4: Surface water potential versus Environmental flow in the Konya Closed Basin between 2014-2017.

The trend shows that environmental flow has decreased over several years. However, in 2016 it remained same with respect to the previous year. This decrease in environmental flow could lead to disastrous results, with potential ecological damage, if not addressed.

5.3.4.3. Independence indicator

Year	2014	2015	2016	2017
Independence ratio (0-1)[33]	1	1	1	1

Table 5.5: Independence ratio of the Konya Closed Basin between 2014-2017.

Our analysis shows that although there is significant water deficit every year of 50%, so far no transfers of water have occurred from outside of its delineated borders. Therefore, the basin has to date maintained its independency status. However, with future projections and ongoing water transfer works, it is likely that water conveyance will occur to mitigate future water deficits. Although it could help in replenishing extremely low groundwater levels, the independence indicator will be adversely affected as the basin will increase its dependence on external water sources.

5.3.4.4. Risk management indicator

Year	2014	2015	2016	2017
Dam fill rate	8.10	32.20	15	22.70

Table 5.6: Dam fill rate of the Konya Closed Basin between 2014-2017.

Lastly, Table 5.6 shows the occupancy rate of dams in the Konya Closed Basin from 2014-2017. This figure is a significant indicator of risk management that also helps in predicting future demand. Our data illustrates that from 2014 to 2017 the rate has significantly increased. From 2014 to 2015 the fill rate increased four times, and then lowered by half in 2016, with an increase occurring again in 2017. While this significant increase could be part of increasing precipitation, the Konya Closed Basin did not receive notable rain. This trend can then be partly attributed to successful implementation of integrated river basin planning along with commissioning and building dams and reservoirs.

[33] Independence ratio is between 0 to 1.0 means fully dependent, 1 means fully independent

5.4. Discussion

In analyzing water security indicators, 2 out of 4 indicators show decreasing water security over time, since the adoption of integrated river basin management via the WFD process. The agricultural indicator and environmental flow requirement indicator remained the same over the last two years of the implementation period. However, the independence indicator and adaptive management indicator are highly significant to assessing water security (see Chapter 4), and both show a significant decline in water security over time. We could then conclude that, in water security terms, the basin is experiencing increasingly serious problems, despite the application of integrated river basin management. But what then are the factors influencing the capacity of the WFD institutional process to respond to these challenges?

In interpreting these trends, we can revert to the IAD-SES framework for interpretation. Firstly, biophysical attributes of the basin, in terms of river characteristics and rainfall per annum over this period, were largely unchanged based on the initial assessment (Yılmaz, 2017) so it is unlikely that the decline in water availability is significantly linked. Secondly, socio-economic factors may be important in terms of increased population and agricultural production, however the 3 percent growth in population cannot easily account for the significant decline in water availability that occurred. Additionally, the irrigated agricultural area in Konya Closed basin only increased by 12 percent during this period (Table 6). During this period, the decline in water availability per capita was 36 percent, so the increase in irrigated area does not explain the resultant gap. One factor could be the type of irrigated agricultural production. Over the last few years, water intensive production of crops such as sugar cane and sunflowers has increased, so the observed increases in water use and concomitant decrease in water availability could be a consequence of this change in production. This feature could be due to insufficient implementation of integrated river basin management, which would normatively promote less water intensive production cultivation in river basin planning in the light of water deficits in the basin, and the significant occurrence of sinkholes, mainly attributed to intensive groundwater use. Lastly, increased filling rates of dam reservoirs could be a consequence of successful implementation of adaptive management, thus effective implementation of the Water Framework Directive.

Year	2014	2015	2016	2016
Irrigated Agricultural area (ha)	1433226	1461444	1577095	1616676

Table 5.7: Irrigated Agricultural area in the Konya Closed Basin between 2014-2017.

Thirdly, governance changes in the rules based institutional structures may be more influential on the 'action situation'. In this respect after the implementation of the WFD in Konya, we can provisionally say that water withdrawal did not change in the long term. There is significant WFD implementation in the basin. After the decrease in water availability and environmental flows, there has been a flattening in these trends. However, this stabilization could be a consequence of successful implementation of WFD rules around protection of water resources, its holistic approach and adaptive management. Although the WFD implementation was not fully completed, our judgement is that its effects are moderate when considering the political and institutional capacity of water agencies. The DSI still dominates groundwork through activities such as licensing, giving permission to irrigation unions for water use to farmers and issuing allowances for water allocation between stakeholders. The SYGM maintains the role of implementing river basin planning without interfering in the DSI's duties or other stakeholders such as irrigation unions or municipalities or provincial special administrations. Furthermore, most key aspects of integrated river basin management were carefully applied, and if the stats do not lie the implementation of the global dimensions of the concept is becoming partially effective. However, the WFD may be less effective when considering water availability. The data show that water withdrawal has increased and projected to increase again in the future. Total water availability declined throughout the period of 2014 to 2017. The WFD has so far supported independence for the basin in terms of water security. Our interpretation says that the WFD could be more effective if the overlap in responsibilities between the DSI and SYGM was solved for water management.

5.5. Conclusions

This chapter used the IAD-SES framework to analyse the water security effectiveness of the implementation of the WFD process in the Konya Closed Basin. Firstly, it provided context to integrated river basin management in Turkey by showing how there was a shift from a reductionist paradigm in the post-War era, based on engineering solutions, towards an 'integrative' approach via the WFD in the 2000s; a process that is still ongoing. Secondly, the external theoretical variables were analysed to show the biophysical, community and governance attributes of integrated river basin management. Water security issues and the action situation are also described in detail. Specific issues of note are the chronic over-abstraction of groundwaters, primarily for agricultural use, and the attendant ecological impacts such as sinkhole proliferation. Thirdly, this chapter then analysed the water security effectiveness of the WFD process to show that rather than increasing it, as could be expected through implementation of integrated river basin management, this security outcome is actually declining over time. Water availability for agriculture and environmental flows still remain unchanged, albeit at low levels, but the variability in independence and risk management capacity during this period are concerning. Although data limitations and the relatively recent implementation of the WFD prevent a definitive conclusion on water security effectiveness, it is clear that outcomes are sub-optimal. Factors influencing such sub-optimality in integrated river basin management can therefore be compared with those in the second case study, the Kern County Subbasin, presented in the next chapter.

Chapter 6: Understanding the implementation effectiveness of river basin planning under the SGMA in Kern County, California

6.1 Introduction

The aim of this chapter is to analyze the effectiveness of integrated river basin management under SGMA implementation in the Kern County Basin, California as a comparative case study for the purpose of understanding if it supports water security at the basin scale. In the first section, this chapter briefly provides a contextual overview of the economic, social and environmental importance of water and its place in the United States. Secondly, the chapter gives an overview of California water governance and management while showing its historical evolution in the state, again charting the paradigmatic shift from the 'reductionist' approach to an 'integrative' era, characterized by the SGMA.

Later on, the chapter gives insight into the Kern County Subbasin with external variables and water related issues in the basin identified. As discussed, Kern County is a critical comparative case for understanding river basin planning in California as it endures water security risks similar to the Konya Closed Basin (Chapter 5). This chapter shows how actors implement SGMA in Kern County, and the action situation with the help of the IAD-SES framework, allowing analysis of the groundwater sustainability plans (GSP) over time. This section provides a significant amount of information regarding the institutional structures adopted in the basin at both local and basin scale. The chapter then assesses how well they are fulfilling the objectives of the SGMA. It utilizes annual reports along with existing GSPs. Lastly, the chapter concludes with an overall assessment of whether river basin planning implementation in Kern County is supporting water security, using the indices developed in Chapter 4. Analysis conducted allows comparison with integrated river basin management institutional structures in the Konya Closed Basin in terms of their contribution to water security, discussed further in Chapter 7.

6.2 The role of water in the United States

Water is life. It is known that water plays a crucial role when it comes to development of societies, especially advanced ones (Deason, 2001). The United States is the biggest producer of goods and services, and the national economy and its development is dependent on water resources (Marston et al., 2018). However, while overall water use is declining, groundwater use increases is conversely increasing in the USA. Like many other countries, the US is experiencing the effects of change in climate though the overuse of groundwater. Changes in climate are increasing the frequency and intensity of weather-related hazards such as drought. Moreover, drought is one the most harmful natural disasters in the country: the annual cost to the US is around 6-8 billion dollars ((FEMA), 1995). Given this significant damage to US economy, effective water resource management is more important than ever. However, only in recent decades has a more 'collaborative' approach to water management in river basins been adopted reflecting the importance of states and local jurisdictions in the US federal system.

Sabatier et al. (2005) refer to successive eras of water management in the USA. Early expansion of populations westward after the US Civil War led to an era of 'Manifest Destiny', whereby land without ownership title was divided up amongst settlers, along with watersheds (river basins). This notion, linked to the view of '"the endless frontier" all derive from the perception 'of open-ended opportunity associated with the seemingly unlimited availability of western public lands and resources' (Andrews, 1999, p. 93). Linked to the Manifest Destiny is the doctrine of riparian use of water, developed from English common law, which is the legal concept of providing benefit of river water solely to land owners for growing crops or for their daily use (Apple, 2001). As Sabatier et al. (2005, p. 26; see also Pisan, 1992) describe, this doctrine became associated with the notions of 'prior appropriation' and 'reasonable use': in other words, whoever owned land over which rivers flowed was legally entitled to abstract as much water as they needed according to their own purposes.

This reliance on common law rights to water began to change in the 20th Century due to pressures placed by industrialization, agricultural expansion and population growth on river resources. In what Sabatier et al. (2005, p. 26) call the Progressive Era, during the 1890s to the 1920s, river management increasingly became based on the watershed (river basin) scale and involved limited federal and state government intervention. This trend continued between the 1930s and the 1960s, when federal government started to take the lead in river basin planning and management: the US Army Corps of Engineers and Bureau of Reclamation were charged with preparing integrated river basin plans, and the multi-purpose Tennessee Valley Authority (TVA) was established as a federal agency in 1933 (ibid.). Federal government subsequently intervened to prevent water pollution in states, through the Water Pollution Control Act 1948 and then the Water Quality Act 1965 and Clean Water Act (CWA) 1972, aimed at controlling point and then non-point source contaminants in surface waters. The CWA Section 303(d) consequently required states to list 'impaired waters' in their jurisdictions and establish Total Daily Maximum Loads (TDMLs) for pollutants, under US Environmental Protection Agency direction[34].

However, despite increasing federalization of river basin management in the post-war era, 'there was relatively little control by the federal government with resource protection on private lands' (ibid.: 35). Abstraction of water resources was generally left to individual landowners exercising their common law use rights. This doctrine was eventually criticized by states where precipitation is not enough to maintain environmental flows, especially in semi-arid or arid zones in Western states (Apple, 2001). Therefore, a new water management mechanism was needed, resulting in recommendations for revised arrangements for the governance of river basins or watersheds made in 1992 by a Congressional committee (Case and Alward 1997). Such recommendations were then influential in changing water governance in states such as California where water quantity issues are more significant than water pollution.

[34] TMDL pollution allocations from point sources are controlled through the EPA's National Pollutant Discharge Elimination System (NPDES) permitting system, under Section 402 of the CWA.

6.3 California and Water

6.3.1 Introduction

Any discussion of river basin planning in the USA must consider California. With 40 million people residing within a total area of 163,496 square miles (3.1 million km^2), California is the largest US state by population and the third largest in total land area[35]. The state contains the second largest city, Los Angeles, and largest county (Los Angeles County) in the USA, along with three other major urban conurbations (San Francisco, San Jose, San Diego). Additionally, California is ranked as the 5th largest economy on global level if it were an independent country (Department of Water Resources, 2003a). A key economic sector is agriculture. California is ranked as the largest agricultural producer in the US, with some specific products such as almonds, garlic and artichokes almost entirely produced in this one state (Kern Groundwater Authority, 2020). It was calculated that California earned 264 billion dollars from agriculture in 2018, which makes agriculture backbone of the state in terms of generating money and providing employment opportunities (Kern Groundwater Authority, 2020).

6.3.2 Water conflicts and governance in California: from 'reductionist' to 'integrative' approaches

Historically, conflicts over water resources have existed in California since the Progressive Era. By the late 1800s, Los Angeles began to run out of water supplied by the Los Angeles River, leading city authorities to controversially purchase land in the Owens Valley in the Eastern Sierra Nevada Mountains. An aqueduct was constructed to transport water from the Owens Valley to Los Angeles. Completed in 1913, the aqueduct diverted water away from farmers in the Owens Valley, destroying their agricultural industry (Libecap, 2007; Walton, 1993). The so-called California Water Wars broke out in the 1920s, with farmers sabotaging the aqueduct and diverting water back to the Owens River (Kahrl, 1982). However, the city of Los Angeles

[35] https://dof.ca.gov/Forecasting/Demographics/2020-census-demographics/

eventually secured this water supply by purchasing further land in the Valley and preventing agriculture occurring.

Several state policies based upon 'reductionist' engineering solutions were adopted to address such conflicts. Firstly, the first comprehensive State Water Plan was established in 1931 comprising the construction of 24 reservoirs to cover the needs of 90 percent of the state population (Wehrwein, 1932). The plan covered surface and groundwater storage, while also involved pumping water from the Sacramento-San Joaquin Rivers to the San Joaquin River. The State Water Resource Control Board was also founded in 1945, with the objective of providing state-wide integrated planning of water resources. As a result, the California Water Plan (CVP) was published in 1951. The Plan aimed at coordinating all uses of water, including irrigation, navigation and public supply, while preserving water resources through flood control, drought remediation and preventing soil erosion, salinization and pollution (W. L. Berry, 1950). Periodic updates to the Plan have been introduced in the intervening period, most notably in 1957. The State Water Project, to implement this Plan, began in 1960. Other major initiatives include the Central Valley Project plus Bureau of Reclamation and US Army Corps of Engineers' reservoir construction, in addition to State and Federal government funded projects. A review of Plan implementation was undertaken in 1966, with the conclusions referring to 'substantial progress' but also significant challenges in meeting future water demands (Department of Water Resources, 1966, p. 137). Several revisions of the Plan have since been undertaken, with the most important changes introduced in 2013 with the California Water Plan Update. A key commitment in the updated Plan was the adoption of Integrated Water Management (IWM) that also encompasses an inter-agency approach by aligning agency delivery in a collaborative manner. The latest Plan, adopted in 2018, prioritises sustainability of water resources (Department of Water Resources, 2018).

Despite these policy developments and projects, significant water related issues have emerged since then. One of the biggest problems is groundwater depletion and deteriorating water quality. As a result of these issues, land subsidence and unsustainable groundwater levels are quite apparent in central part of California. The need for groundwater monitoring and evaluating were promoted and discussed in many reports including Bulletin 118 update in 2003 (Department of Water Resources, 2013). When it comes to California water use, of the 43 million acre feet consumed between 2005-2010, groundwater provided 38 percent of total water use, and the agricultural water use ratio was 76 percent (Department of Water Resources, 2013). While in a normal year groundwater use is at 38 percent of total use, it goes up to 46 percent during drought (ibid.) This increases the deficit of groundwater levels which is already exists and could be seen especially in central parts with identified over-abstracted groundwater basins.

Another linked problem is climate change related droughts. California is experiencing more frequent and intense droughts, along with other climate related water issues (Andrew et al., 2015). For instance, extreme weather events can lead to short term wildfires, heatwaves, or flooding and fire damage to residential areas like homes, business areas and infrastructure in long term, or higher sea level rise and more prolonged droughts resulting in permanent damage (Petek, 2022). A change in climate would cause warming of the mountain snowpack in California, and thus could result in earlier melting snow and reducing snow related water resources (The Public Policy Institute of California, 2020). Furthermore, land acreages that are suitable to walnut, apricot, peach and nectarine production are predicted to decrease by 50 percent and yield loss for other products such as avocados by 40 percent and almonds by 20 percent by 2050 (Merrill & Shobe, 2018, p. 11; Pathak et al., 2018, p. 14). Therefore, this water related problem stands out as crucially important among others faced by the state. The importance of agriculture along with the 80 percent of total state water use by the sector has led water authorities to think about more 'integrative' solutions regarding water use efficient and radically change the course about water management due to significant water related issues and frequency of drought experience.

To deal with these challenges, California has also adopted regulatory policy instruments alongside and in support of the strategic policy of the CVP. The state's groundwater prioritization dates back to 2009 by Department of Water Resource of California with the enaction of 'California's 2009 Comprehensive Water Package'[36]. The DWR is now responsible for providing an overarching framework on managing groundwater in line with the SGMA. The SGMA, as described in Chapter 4, has several key characteristics. In legislative terms, the

[36] Water Code sections 10722.4 and 10933

Act is comprised of three related State Bills: AB 1739; SB 1319; and, SB 1168[37]. The former Bill establishes the role of locally controlled Groundwater Sustainability Agencies (GSAs) in each river basin. Functions of each GSA include collecting fees and supporting groundwater protection and water conservation through technical assistance, plus preparing a Groundwater Sustainability Plan (GSP) for each basin to implement SGMA requirements. Plans must be periodically reviewed by the Department of Water Resources. Agency powers to implement SGMA through the use of 'cease and desist' orders and fines for violations are also included. SB 1319 sets out the requirements for implementing AB 1379. Meanwhile, SB 1168 recognises common law water use rights of landowners, as set out in the State Constitution, by requiring that groundwater use is 'reasonable and beneficial', with GSAs obliged to register, monitor and force compliance for groundwater abstraction in basins under DWR oversight. The Act also compels the identification of high-priority, medium-priority, low-priority or very-low priority groundwater basins, a process completed in 2015. In total, 96% of state groundwaters are designated high or medium priority – for which groundwater sustainability plans are mandatory under the SGMA. Low or very low priority basins are 'encouraged' to adopt such plans in the legislation.

6.4 The Kern County Basin/Subbasin

As described in Chapter 4, the Kern County Basin is the chosen comparative case for examining how integrated river basin management institutions are influencing water security outcomes. In order to cross-compare with the Konya Closed Basin (Chapter 5), the IAD-SES framework developed in Chapter 4 will be employed, comprised of three external variables: biophysical, community and governance attributes. The influence of these variables on the 'action situation' and thereby water security outcomes is then assessed, using the indicators also developed in Chapter 4.

[37] All three instruments amend the Water Code and were adopted in 2014.

6.4.1 Kern County Basin/Subbasin: external variables

Firstly, this section implements the IAD-SES framework biophysical, community and governance attributes in order to better explain water security outcomes. In terms of *biophysical attributes*, Kern County (see Fig. 6.1) is the largest subbasin in size in California and the hydrological boundary covers 1,945,000 acres. Nearly half of its land, some 900,000 acres, produces a range of crops which makes the basin a significant contributor to not only Californian but also the US economy (Kern Groundwater Authority, 2020). Furthermore, during drought times the groundwater ratio of total water use increases significantly (TODD Groundwater, 2020, 2021). Annual average precipitation is classified as 127mm in the interior basin and extends to 228 to 304 mm at the eastern, southern and western boundaries of the basin (Department of Water Resources, 2003b). Moreover, the basin is located in the south side of the San Joaquin Valley. The climate reflects a Mediterranean type 'hot-dry summer' climate and the basin is known for its rich soil which makes the basin one of the top agricultural production areas in the United States (Kern Groundwater Authority, 2020). The Kern River is the main surface water resource in the subbasin while significant canal and conveyance systems for water supply and transfers are used (ibid.). More than half of basin surface water in 2019 is supplied from water conveyance systems such as the Central Valley Project and State Water Project (TODD Groundwater, 2020).

When it comes to c*ommunity attributes*, the economy of Kern County is primarily based on agriculture. While California is ranked as the largest agricultural producer nationally, Kern is also ranked as the leading producer county in the entire US, and is known for generating $7.669 billion dollars in 2020 from agricultural sales (Department of Agriculture and Measurement Standards, 2021; Kern Groundwater Authority, 2020). The leading products are grapes, almonds, milk, pistachios, and citrus fruits, which together result in sales exceeding $5.5 billon dollars (more than two thirds of the total value) (Department of Agriculture and Measurement Standards, 2021). Grape production takes first place in terms of generating the most income, followed by citrus fruit and almonds (ibid.). In total, 554,580 acres are devoted to nut and fruit production while almond production comprises nearly half of these acres harvested in 2020 (ibid.). China, Mexico and Japan are the top three destination countries for exports from the basin (ibid). Moreover, the total value generated from agriculture and livestock was more than $2.2 billion dollars in 2000 which then increased to more than $7.6 billion dollars in 2020 (Department of Agriculture and Measurement Standards, 2001, 2021). It means that the agricultural market has tripled in value in the Kern County Subbasin during this period (See Table 1). Furthermore, Kern County is one of the richest counties in terms of energy sources (oil), along with its rich soil for agriculture (Hamilton et al., 2015). In addition to this, the County's location in Southern California along with its own natural and social resources has attracted many businesses, boosting its economy over the last decade (ibid.).

Year	2000	2005	2010	2015	2020
Total Value($billion dollar)	2,209	3,546	4,757	6,878	7,669

Table 6.1 Total Agriculture and Livestock production value in Kern County 2000-2020 (Department of Agriculture and Measurement Standards 2021).

In social terms, Kern County has several main community attributes. The total population was 909,235 in the 2020 census (Census Bureau, 2021). Population densities are highest in the metropolitan area of Bakersfield (population 400,000), although surrounding agricultural areas have low densities. The Kern County unemployment rate decreased from around 18 percent in April 2020 to 8.3 percent in October 2021 (Employment Development Department, 2021). The highest average wage is in the energy sector ($91,060), followed by logistic and health care services. The agriculture sector average wage is much lower at around $24,172, according to a report by the Milken Institute (Hamilton et al., 2015).

Governance attributes of the Kern County basin can only be considered within the wider context of the multi-level US political system. In the United States federal system of governance, the principal water management powers are reserved for states. Despite landmark federal laws such as the Clean Water Act 1972 (as amended 1977, 1987) aimed at maintaining surface water quality (Andreen, 2003), state governments are responsible for managing the qualitative and quantitative aspects of water resources and implementing federal water mandates. In respect of water quantity, California has developed both strategic policy under the State Water Plans and legal instruments such as the SGWA. Governance of water in California involves state steering of multiple actors at different government levels through institutions and their implementing processes.

At the state level, the Department of Water Resources (DWR) has been responsible for managing water in California since 1956. The Department, appointed by governor of the state, is in control of water allocation, regulations, quality of water and assisting local authorities on water management. However, while the DWR monitors water related tasks, local water authorities are responsible for managing water at the local scale, especially groundwater management. For instance, in Kern County there are 12 governing authorities at the local level.

After the enacting of the SGMA, the rules and governing system completely changed. The SGMA is one of the most sophisticated frameworks for water management in California and also globally. Although 40 percent of total water comes from groundwater, in which the percentage goes up to 60 percent during dry years, there was no concrete groundwater institutions prior to the adoption of the Act (Department of Water Resources, 2003a, 2013). The SGMA requires basins to create specific institutions, Groundwater Sustainability Agencies (GSAs), and prepare and implement Groundwater Sustainable Plans (GSPs) (Altare, 2018). These agencies identify water related problems, monitor the conditions, and set indicators for assessing sustainability (ibid.). Significant attention is given by the Act to groundwater because of the chronic over-abstraction problems in California. The institutional duties of Kern County are discussed below in the Action Situation section by using the multi layering dimensions of the modified IAD Framework.

6.4.2 Kern County Water Related Issues

This section will describe Kern County water problems. After mapping out the problems it will give a more clearer view on how the SGMA is implemented in practice through integrated river basin management in the '*action situation*' section below. Kern County is defined as one of the most critically over-abstracted (or overdrafted) groundwater basins in California (see Fig. 6.1).

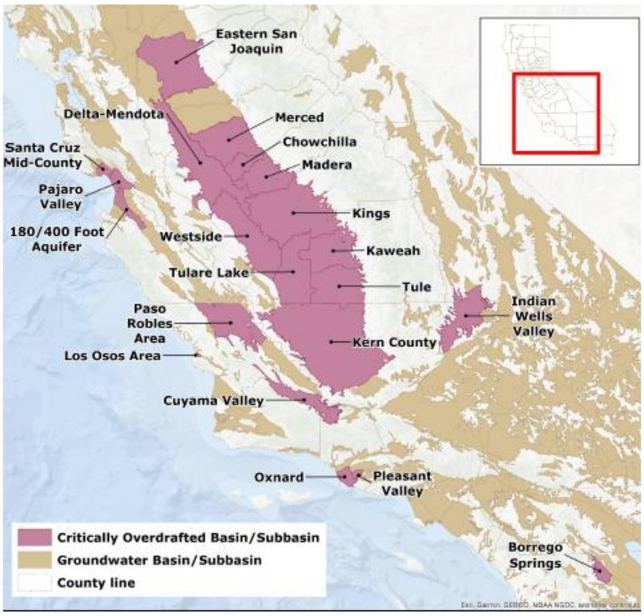

Figure 6.1 shows the critically overdrafted basins in California (Department of Water Resources, 2021)

The Kern County subbasin has experienced prominent water related problems including groundwater decline, degraded water quality and increased pumping lifts (Kern Groundwater Authority, 2020). For instance, groundwater levels experienced a substantial decrease during the severe drought in Kern County that lasted between 2012 and 2016 (ibid.). Moreover, historic graphs shows that groundwater levels at some local wells were typically only around 300 ft and 350 ft depth in 2016 (Parker, 2019). More latterly, increased groundwater level decline in California has been attributed to land subsidence, and this is also the case in Kern County (Kern Groundwater Authority, 2020). As no state level or federal level agency is responsible for monitoring land subsidence, it makes addressing such cases difficult in the basins of California (Borchers & Carpenter, 2014). Of even greater concern is that land subsidence could lead to increased arsenic levels, although arsenic levels are not yet exceeding unhealthy levels (Kern Groundwater Authority, 2020). For example, one study shows that raised arsenic concentrations were found in the Kern River Fan, with above 50 ppb (Negrini et al., 2008). Water quality degradation in Kern County Subbasin area have been discussed in a few studies (Burton & Belitz, 2012; Flower, 2014; Harou & Lund, 2008; K. D. Schmidt & Sherman, 1987; Wright et al., 2019). For instance, higher nitrate concentration in some aquifers (5 percent of primary aquifers) were found and these could be the consequence of human activities (Burton & Belitz, 2012). However, previous studies show that significant nitrate exceedance in Kern County has historically occurred and it was attributed to past potato growing and grape cultivation, which used high levels of nitrogen fertilizer (K. D. Schmidt & Sherman, 1987). Some disadvantaged people at the local level were exposed to water quality issues related to nitrate problems due to septic systems (Viers et al., 2012). Lastly, a recent study shows that there has been a significant increase in the risk of nitrates to groundwater (Kimmelshue & Tillman, 2013). Another water quality problem in Kern County is salinity mainly due to nitrate concentration (TDS). For instance, research shows that Kern County is ranked the second most salinated groundwater aquifer after Fresno due to human activities (Kang & Jackson, 2016). It is worth mentioning here that increasing salinity could also adversely impact crop productions. High salinity water results in damage to almond production during drought in which groundwater becomes more salty due to concentration of contaminants (Romero, 2015). The last groundwater related water issue is increased pumping lifting, which is poorly understood. However, the consequences of in-depth pumping are widespread. One study showed that agricultural energy consumption increased in the time of drought which is attributed to decreasing groundwater levels through raising of abstraction levels (i.e. more deep pumping) became inevitable (Ak, 2017). Unfortunately, this is an issue in Kern County because land subsidence could lead to a decrease in storage capacity and inevitably result in increased pumping lifts (Kern Groundwater Authority, 2020). In the light of these significant problems and the SGMA critically over drafted basin designation, Kern County is one of the highly prioritized basins in California, as Figure 6.2 shows.

California Department of Water Resources

Figure A-1 Statewide Map of SGMA 2019 Basin Prioritization Results

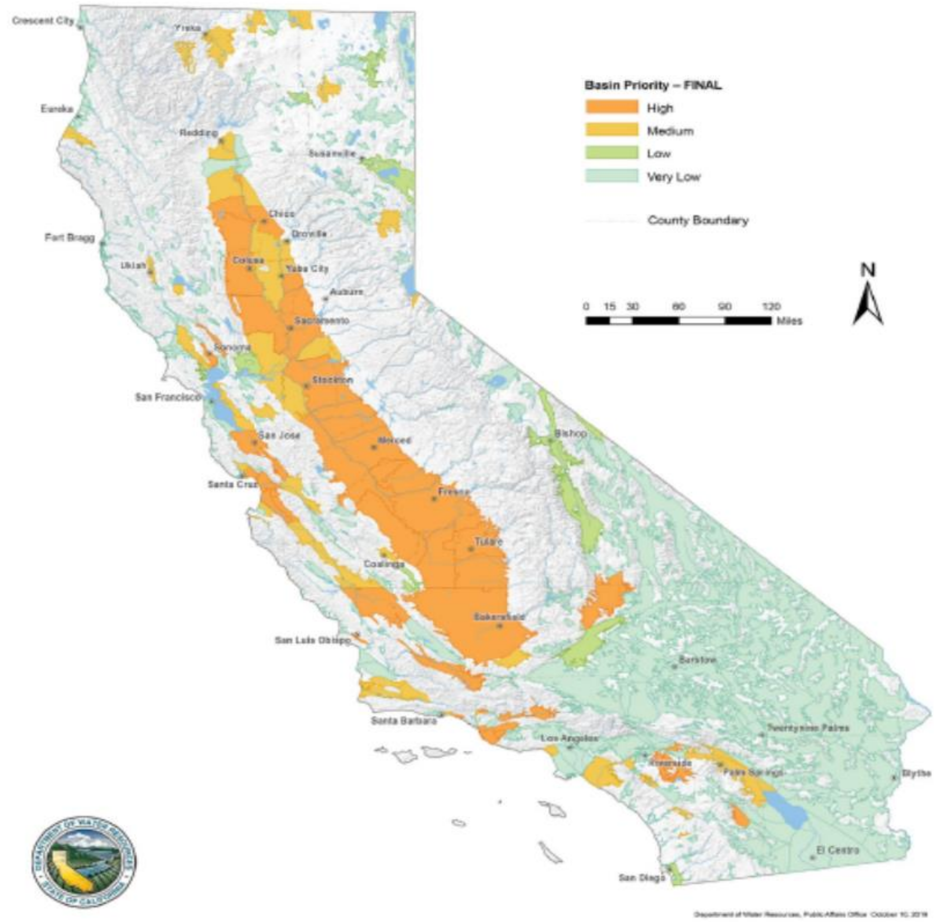

Figure 6.2 California basin prioritization (Kern County is located in Bakersfield and its surrounding areas) (Department of Water Resources, 2019)

Figure 2-12. Kern County Subbasin and Vicinity

Figure 6.3 Kern County Subbasin boundaries (Department of Water Resources, 2016)

6.5 The 'Action Situation': SGMA Implementation in Kern County Subbasin

6.5.1 Institutional structure of the Kern County basin

The previous section gave an overview of the main features or external variables of the Kern County basin and crucial water related issues. In this section, we can detail how the SGMA has been implemented to address and tackle these water security challenges with a special focus on groundwater, essentially forming the institutional 'action situation' which demonstrates the actual management of water issues. The 'action situation' is again examined using the key aspects of integrated river basin management identified in Chapter 3.

The SGMA, in essence, is the institutional mechanism that was adopted to address water security issues, especially around groundwater, in California. As a consequence of being designated a high-priority basin under the SGWA, Kern County started its plan preparation procedures in 2016, then formed the Kern Groundwater Authority (KGA) in 2017 in order to implement SGMA in the basin (Kern County Water Agency, 2014; Westside District Water Authority, 2019). The role of the Kern Groundwater Authority is to coordinate groundwater management, map out and address issues regarding groundwater governance, and create an overarching framework for local groundwater management (Kern County Water Agency, 2020). To do this, Kern County initially started implementing the SGMA with the new planning system, but the initial plan covered only 13 percent of the 2,834 square miles of the Subbasin (Kern County Water Agency, 2020). The Kern County GSA was then gradually implemented using four phases of GSP production. Additionally, with respect to this idea, the planning of groundwater basin that covers entire Kern County Basin, which is known the largest groundwater subbasin in size in California, was submitted with four new additional GSPs in the beginning of 2020 (Figure 6.3 shows the delineation of the Kern County subbasin) (ibid.). For instance, the Westside District Water Authority prepared a GSP for its boundaries: it is believed that this contributes to the entire basin GSP (Westside District Water Authority, 2019). Additionally, the SGMA requires inclusion of vital elements such as sustainability goals, the planning area, consideration of stakeholder outreach, setting and tracking sustainability indicators, identification of previous and present groundwater conditions along with a water budget assessment (Olcese Groundwater Sustainability, 2020). More latterly, setting the sustainability goal at the local scale is coherent with basin wide targets which are endorsed by other GSAs (ibid.). The reason for the partial district-based basin GSP was to provide more detailed analysis of subbasins and identify groundwater conditions at the local scale, identify any unexpected results that might be seen in applying SGMA and how these undesired conditions might be observed and tackled over the future period (long or short terms as well) (Westside District Water Authority, 2019). Moreover, these local GSPs contribute to what is called an “umbrella KGA GSP”, which forms the Kern County Groundwater Sustainability Plan (ibid.). This plan provides the overarching framework for managing groundwater at the basin/subbasin scale (ibid.). This feature provides a powerful institutional mechanism linking local GSPs to the umbrella GSP, thus creating one single plan. Furthermore, although the Kern County Groundwater Authority was formed, this agency is not the only ruling agency for governing the Kern County basin. It is managed in coordination with another 16 district agencies including Bakersfield, Kern Delta, Cawelo Water District and Olcese Water District (TODD Groundwater, 2019). After each of these local GSPs were agreed, the umbrella GSP for

Kern County Basin was published (Kern Groundwater Authority, 2020). The KGA embodied 11 arranged GSAs. However of these, only five GSAs managed to organize the implementation of GPSs due to the coordination agreement (Olcese Groundwater Sustainability, 2020). The Umbrella KGA GSP identified and modelled the overall water budget of the basin, and it set the thresholds to avoid overdraft of groundwater storage and support sustainability of the basin (Kern Groundwater Authority, 2020). In addition to this, all the GSPs along with the overarching basin wide plan determined six sustainability indicators such as "Chronic lowering of groundwater levels, reduction in groundwater storage, seawater intrusion, degraded water quality, land subsidence, depletion of inter connected surface water" (Olcese Groundwater Sustainability, 2020, p. 15). In our assessment, these indicators are vital to monitor groundwater levels to check if they are at heathy levels, because unsustainable levels show up in the other five indicators. Moreover, KGA members have provided a significant amount of management opportunities in which projects and tasks include water transfers, charge duties, incentives for less groundwater abstraction, and a water allocation framework which is based on health yield conditions of farm management areas (Kern Groundwater Authority, 2020). This general GSP also assesses previous existing plans that were implemented or enacted before what is known to be highly likely integral to groundwater management of local authorities in sustainable manner (ibid.). Furthermore, because of legislative obligations, each local authority has its own responsibility for implementing GSPs but member agencies of the KGA board have the ultimate duty to implement SGMA at local and basin level (ibid.).

More latterly, GSP plans have identified the main issue as lowering groundwater levels which leads to undesirable and unsustainable results. It was assessed that even though long drought periods could occur, the groundwater levels might not go beyond unhealthy levels if they can be managed properly by taking necessary actions such as increasing or offsetting groundwater levels or recharging them during other periods (Kern Groundwater Authority, 2020). Under the monitoring system a "unsustainable result watch area" could result if for instance the levels of 51% of groundwater wells go beyond minimum threshold levels that were set. Here, each local management area establishes their own minimum threshold based on their well level conditions (ibid.).

6.5.2 Participatory approach

While implementing the SGMA, GSPs and annual reports are evaluated under a participatory mechanism that assesses the benefits for all water users from groundwater and allows them to participate in the GSP development process. Here, KGA members meet each month publicly to clearly communicate actions to all users (Kern Groundwater Authority, 2020). This approach started in local GSPs, as in the case of Olcese. The Olcese GSA generated a 'Stakeholder Communication and Engagement Plan (SCEP)' with the purpose of informing and communicating its planning prerequisites (Olcese Groundwater Sustainability, 2020, p. 41). This plan, like in the other GSPs, tries to ensure each user benefits from groundwater and profitable use is achieved. For instance, there were 18 public meetings in the Rosedale-Rio Bravo Water Storage District, some of which were in the form of stakeholder workshops. During these meetings stakeholders had several chances to express their concerns and/or help in developing GSPs (Rosedale-Rio Bravo Water Storage District, 2019). Lastly, the overarching GSP requires a 90 days review period after the first meeting. A public workshop in Bakersfield took place in 2019 to consider the plan (Westside District Water Authority, 2019). In overall assessment, regards the participatory mechanism and the inclusion of all users, the Kern County basin plan seems effective. That said, limited information regarding farmers' participation and union units were observed throughout the implementation reports, suggesting not all stakeholders were consulted.

6.5.3 Adaptive management

According to research, the climate in California has substantially varied while water capacity is decreasing over time (Andrew et al., 2015). California is historically prone to extreme events, most notably drought. It is believed that drought would highly likely increase in frequency and intensity under a warming climate (Dai, 2011). Therefore, the SGMA requires adaptive management to better prepare basins for worsening conditions through reducing uncertainty over impacts (Department of Water Resources, 2015). Moreover, this concept recognizes the need for flexibility in managing operations and planning (ibid.). While adaptive management has been a common term used among water managers, until recently little study has been conducted into practice, this commonly attributed to institutional limitations caused by a lack of data (Conrad et al., 2019).

In the umbrella Kern County GSP, it was intended to apply adaptive management for reducing surface water losses and assisting stakeholders in mitigating these losses (Kern Groundwater Authority, 2020). When it comes to local level adaptive management there are a significant number of management projects that seek to reduce risk from climate uncertainty and prepare for future conditions. For instance, a groundwater storage project was proposed in Rosedale-Rio Bravo, with the aim to save up to 150,000 AF (acre-feet) of water during wet climate conditions. Analyses showed that the project is feasible and eco-friendly over the long term (Rosedale - Rio Bravo Water Storage District, 2019). In another subbasin, the local GSA tried to reuse brackish groundwater through installing new treatment technology. This treatment should bring benefits such as additional water provided to 'adjacent and nearby disadvantaged communities (DACs)' while supporting drought resilience and improving water security (Westside District Water Authority, 2019, p. 118).

6.5.4 Economic good

Water is an economic good within integrated river basin management but is invariably not considered in this way. However, the economic impact of water was discussed by stakeholders as one of the most important factors affecting groundwater in Kern County (Kern Groundwater Authority, 2020). It was shown that declining groundwater levels could lead to loss of jobs or industry (ibid.). Therefore, in our assessment we found that seeing water as an economic good and focusing on adaptive management should be discussed at some point together. For instance, the Westside local authority assessed the reuse of brackish water: by doing so they could save up to 50,000 AF in full operational form (Westside District Water Authority, 2019). This could be seen cost effective and both economical and environmentally feasible (ibid.). However, by analyzing TDS concentration that are exceeding certain thresholds, few groundwater bodies for beneficial use were labelled as economically and technologically feasible (ibid.).

6.5.5 Holistic management

In our initial assessment, SGMA implementation and Kern County Groundwater Sustainability plans seem relatively holistic in their management of the basin. All the planning not only considered a managing mechanism and objectives but also included the geological and economical perspectives of water. Seeing local GSPs contributing to the bigger picture of groundwater management in Kern County shows how effective the implementation of SGMA is and how an holistic perspective is being adopted, in line with the Act's requirement for integrated water management. Additionally, the significant number of workshops and meetings staged could be seen as integral to the integrated implementation of the SGMA. Each local authority is responsible for their district but also exchanges views with others where interaction and working together is required (Kern Groundwater Authority, 2020; Olcese Groundwater Sustainability, 2020; Rosedale - Rio Bravo Water Storage District, 2019; Westside District Water Authority, 2019). Furthermore, it can be seen from the authority reports that people identify and analyze groundwater in Kern County subbasin using a governance perspective. For instance, they set and assessed sustainability goals, as the SGMA required, while not neglecting an economic perspective and considering stakeholders' thoughts (Rosedale - Rio Bravo Water Storage District, 2019).

In general terms, the planning is well conducted and increasingly systematic. Groundwater management has been prioritized in a sustainable way by putting agriculture in first place followed by other sectors in each local level. The planning scheme shows how a framework implementation was undertaken systematically from the local to the basin scale, each one contributing to the overall planning outcome. Each GSP assesses the groundwater storage of Kern County in terms of both historic and current conditions. Projected climate change scenarios for each GSP were also calculated, while a water budget was calculated through different modeling approaches. Reports and GSPs also focus specifically on monitoring of groundwater levels, including statewide elevation levels for comparison. Lastly, each GSP has a minimum threshold for groundwater and measurable objectives: this allows assessment on how these criteria were met in annual reports.

6.6 Water Security Indicators – assessing water security outcomes

Having examined the attributes of the Kern County Subbasin, followed by the action situation of integrated river basin management, this section will consider water security. One caveat at this point is that although it proved problematic to identify data for some water security indicators, other data such as total water use and use by sectors plus groundwater storage changes helped analyze the indicators from a water availability, storage capacity and independence status. This approach allowed examination of specific features such as groundwater changes that is one priority factor in assessing the action situation outcomes.

According to the SGMA requirements and agreement between local agencies that was identified in the umbrella GSP, the annual GSPs concerning groundwater conditions of the subbasins should be published and updated. In response, the first annual report for the 2019 Water Year for the GSP in Kern County Basin was published in 2020 (TODD Groundwater, 2020). Although this report is the first one which identifies certain limitations and obstacles, it provides insight into how Kern County implements the SGMA through adoption of the GSPs in local areas (ibid.). The report states that in some subbasin areas there are a lack of data or information that prevents development of persistent hydrographic or water level maps for all the aquifers (ibid.). The report consequently utilises groundwater extraction data which was provided by local agencies or using the assessment tool that was created to estimate outcomes in case of no data provided (ibid.). For the year 2019, total groundwater use was estimated at 1,284,183-acre feet, of which 85 percent of water was used by the agricultural sector. Surface water provided 2,768,267-acre feet, which results in total water use of 4,089,583-acre feet for the 2019 water year.

The report assessed the groundwater storage change by analyzing levels since 2016 (TODD Groundwater, 2020). It illustrated that in 2016, WY groundwater decline was 1,229,970-acre feet, while it increased to 1,722,971-acre feet in 2017, then declined in 636,030-acre feet in 2018, thereby increasing again to 851,260-acre feet in 2019, then it declined to 788,078 in 2020, finally decreasing to 1,812,211-acre feet in the following year, i.e. there was high variability. Moreover, it is apparent that during a wet year, groundwater storage change responds positively, or during a dry year period groundwater storage is negatively impacted. Between 2017 WY to 2021 WY there is a decrease in 209,373-acre feet in groundwater storage change: an annual decrease of 58,075 -acre feet in storage conditions (TODD Groundwater, 2022). This data is contrary to the annual change from the period of 1995 to 2014 which is a -277,114-acre feet decline each year on average (ibid.). It is important to note that 5 years annual average groundwater decrease (58,075 - acre feet) is way below than the long term annual change (-277,114 – acre feet) even though there was a severe drought period in 2021 that significantly and adversely impacted groundwater storage data. This significant change could well be resulting from the SGMA preparation and implementation process since it cannot be accounted for by climatic conditions. So, we can further question this observation by evaluating the institutional approach to groundwater management. The report also covers each local area groundwater planning and conditions. For instance, the Buena Vista GSA GSP shows that they implemented a GSP Monitoring network, and the implementation of this is 100 percent of the basin area. Monitoring shows that the 2019-year water conditions improved in the southern part due to decreasing groundwater pumping and it was identified in the report that no water levels fell below the target set for the local area during the reporting period. (ibid.)

Year	2016	2017	2018	2019	2020	2021
Annual change (acre-feet)	1,227,970	1,722,971	636,030	851,260	788,078	1,812,211
Decrease/Increase	Decline	Increase	Decline	Increase	Decline	Decrease
Wet/Dry	dry	wet	Below normal	Wet	Dry	Critically dry

Table 6.2 shows the annual groundwater change from 2016 to 2021.

A following report for the GSP was published in 2021 April for water year 2020 (TODD Groundwater, 2021). The report shows that 1,835,054-acre feet of abstraction was obtained from groundwater in 2020 WY (Water Year) and 1,405,576-acre feet surface water contributed to total water use in Kern County Basin, making the total use of 3,240,630-acre feet. There is consequently a 848,953-acre feet decrease in total water use with respect to 2019 WY. Furthermore, the most recent report that assess if the GSP implementation successful and meeting Sustainability Goals was published in 2022 April for water year 2021 (TODD Groundwater, 2022). The report shows that 2,471,156-acre feet of water volume was received from groundwater resources in 2021 WY and surface water contributed 774,033-acre feet; with total water use 3,297,235–acre feet. There is a slight increase in total water use by 56,605–acre feet with respect to 2020 WY. More latterly, during the years of 2019-2021, surface water use significantly decreased in the absence of significant precipitation from 2,805,400–acre feet in 2019 to 826,080–acre feet in 2021, and making the users heavily depend on groundwater sources from 1,284,183–acre feet in 2019 to 2,471,156–acre feet in 2021. This is mainly due to the significant drought experienced in California, and it should be understood that drought increased in severity in 2021 making it a critically dry year (TODD Groundwater, 2022). However, it can be seen that from 2019 WY to 2021 WY there is a downward trend in total water use, or at least a flattening slope is obvious even though the drought became more severe which one could expect to see decrease in total water use prior to 2020 with respect to 2021. This can be attributed to successful implementation of the GSP. This conclusions can be reached because this decrease in total water use is in line with the groundwater storage change slowdown we mentioned above. This shows again that, in the absence of other explanatory factors, the GSP is working efficiently even while significant drought occurs across California.

However, it should be noted that the agricultural water use proportion is 73 percent in 2021 while it was 63 percent in 2019, showing that the GSP may less effective in this specific sector (TODD Groundwater, 2021). Although there was an increase in groundwater use by 10 percent, a significant decrease in total water use stands out. On the other hand, groundwater levels increased in 2019 WY by 851,260-acre feet, decreased in 2020 WY by 788,078 and decreased again in 2021 WY by 1,812,211-acre feet, however this could be due to a dry year period, so unsuccessful GSP implementation could be the factor for this change. Furthermore, while comparing this to the 20-year period decline of -277,114 AFY, this change is so high that it can be mainly attributed to the critically dry year period in 2021 after the wet year in 2019.

However, this is not the only reason for this increase in total water use (ibid.). When it comes to progress in implementing the GSP, the report says that many GSAs implemented GSP monitoring activities in full, while some have long term monitoring history issues. Therefore, in the future they will be able to obtain important data for better groundwater management to fully implement monitoring activities of GSPs (ibid.). Additionally, according to its second year report, the Kern County Subbasin GSAs managed to coordinate its basin-wide monitoring network (TODD Groundwater, 2021). This network mechanism is utilized to evaluate and harmonize sustainable management criteria that were set by the SGMA (ibid.). This GSP implementation is further updated by third year annual report.

There has been progress in implementing many dimensions of the GSPs from previous year. For instance, the reports highlight the importance and implementation of coordinated land subsidence investigation, and there was regional support for developing local monitoring land subsidence while it was known that regional scale of some critical infrastructures make an impact on local land subsidence (ibid.). Therefore, this coordination plays a crucial role in attaining minimum sustainable criteria. Local areas were also included in the annual report, and each were assessed based on the criteria including GSP Monitoring activities, progress in achieving interim milestones. For instance, the Buena Vista local area looks in good condition and no significant issues were reported in the 2020 report, with additional information showing that water wells are also in good condition and levels are beyond the Milestone Objectives (ibid.)

Lastly, Kern County receives a significant amount of water from the State Water Project (SWP) and Central Valley Projects (CVP). This creates dependence on outside sources and puts the independency of the basin in jeopardy, visible by assessing 2019 and 2021 dependency. In 2019 1,627,126-acre feet of water came from the SWP and CVP canals, which is 39 percent of total water used in Kern County (TODD Groundwater, 2019). This means that more than one third of water is transferred to the subbasin from outsources. This percentage decreases to 26 percent from 39 percent in 2020. Moreover, 500,971–acre feet of surface water came from the SWP and CVP canals, constituting 15 percent of water provided by external sources out of the basin. This outsource decreased to 15 percent. This figure cannot be understood as dependency on outside water resources decreasing and the basin gaining more independence status. It is mainly as a consequence of a dry year period, because total surface water use also decreased to 774,033 acre-feet in 2021 from 2,805,400 acre-feet in 2019 (TODD Groundwater, 2020, 2021, 2022). Nearly four times surface water use decreased, and the basin became heavily dependent on groundwater, thus causing a significant decrease in groundwater volume. Therefore, the independence status is still risky for Kern County even though in the last year external water resources provided 15 percent of total water use.

6.7 Conclusions

The aim of this report was to provide insight into the Kern County Subbasin water management practices through its implementation of the SGMA. First, we briefly summarized United States water management before describing California water governance. Then with the help of the IAD-SES framework, this chapter showed the external variables which impact upon the Kern County Basin. Secondly, a detailed description of water related issues helped to better understand basin conditions for comparison with the Konya Closed basin. The chapter then focused on the implementation process of the SGMA and its Groundwater Sustainability plans, i.e. the action situation of integrated river basin management. Data obtained from local agencies showed how the SGMA was implemented at the basin level. This section provided a significant amount of information regarding the framework mechanism. According to our assessment, the SGMA has been implemented in a systematic and holistic way. Institutional capacity is large because local groundwater authorities are part of the Kern Groundwater Authority and it has the legal power to provide the overarching subbasin groundwater plan under the requirements of the SGMA. The water security outcome results shows that a significant groundwater storage decrease occurred in 2021 according to the third report, but it cannot be attributed to implementation of the SGMA and was more likely a result of climatic conditions. However, the additional data shows that in the short term (5 years period) groundwater storage decrease is significantly better than the long term storage decrease. This trend is, in the absence of other intervening factors, attributable to successful implementation of the SGMA. Additionally the figures shows that the basin is heavily dependent on external water sources through SWP and CVP even though the dependence on external source rate went up to 15 percent from 35 in the light of dry year period not because of promoting internal water supply. Additionally the California state restricted water to Kern County farmers, so this could potentially impact these data to lower external water resources availability. This is one significant result that puts long term water security of the basin at risk.

Although the SGMA is quite new and only recently implemented, evaluation of the SGMA in Kern County Subbasin shows that is a promising approach for learning and potential lesson-drawing (see Chapter 7). The case is significantly important because the basin is a major contributor not only to the Californian but also to the wider US economy. It is also therefore a nationally significant example of how to manage groundwater related problems while boosting the economy at regional, state and national levels. However, additional data about groundwater, particularly time series data of long-term implementation, could make the Kern County case valuable for further research into water security governance. The reports, unlike many such documents, are not overwhelmed by technical information. The data published support in a constructive way the management capacity of subbasin authorities and higher-level actors. To sum up, the Kern County Subbasin implementation of SGMA shows credible results and provides potential lessons for comparison with other basins which have very different water management systems but are struggling water security issues.

Chapter 7: Discussion

7.1 Introduction

The aim of this chapter is to discuss the key findings of this thesis in terms of the research Objectives stated in Chapter 1 and in relation to the existing academic literature, to show how it adds to existing knowledge. Firstly, it briefly summarises the literature review (Chapter 2) to show how Objective 1 was met. It reiterates the research gap in the water field and forwards the thesis' falsifiable hypothesis. Secondly, then the chapter summarises the theoretical approach and methodological selections, detailed in Chapters 3 and 4. Thirdly, it discusses in detail how our cases, namely the Konya Closed Basin and Kern County performed in ensuring water security through river basin planning, specifically regarding groundwater resources. To support this discussion the cases are compared using the IAD-SES framework in terms of social, biophysical, institutional aspects and outcomes. From this analysis, strengths and weaknesses of both river basin planning approaches, primarily relating to governance structures, are identified for further analysis. Finally, potential lessons on integrative river basin planning are discussed in terms of their transferability using policy learning and lesson drawing concepts. We then conclude which case performs better and if policy transfer is indeed possible how this could occur.

7.2 Objective 1: To identify relevant gaps in the water security literature through critical review of the literature

A critical review of the academic literature on water security was conducted in Chapter 2, to identify critical gaps and show how the research adds to knowledge: a key requirement of a doctoral thesis. In this respect, the thesis does provide innovation by taking forward existing research on water security and integrated river basin management, while also innovatively combining these arguments with comparative analysis and lesson-drawing/policy transfer to give a unique, interdisciplinary perspective that links to the theoretical approach, methods and empirical strategy.

Research gaps were initially identified by reviewing the security, environmental security and water security literatures. Firstly, our review identified how the literature on water security has tended to focus on either reductionist or integrative aspects. While the former had been already been heavily researched, the latter – it was argued – still left many unanswered questions and gaps in knowledge. The first major inconsistency in the literature relates to the difference in normative theory and actual practice. The integrative approach is now becoming widely supported by academics for addressing water security (see Al-Saidi, 2017; Zeitoun et al., 2016). But more knowledge is required into exactly how it works in reality; particularly regarding the role of river basin planning which is now the main integrative water governance 'paradigm' worldwide due to the promotion of integrated river basin management and mechanisms such as the Water Framework Directive.

Secondly, the review then identified the critical need for more comparative data to examine how and to what extent such integrative approaches can contribute to water security. Again, there are few examples in the literature that allow direct comparison and hence examination of the challenges to and facilitators of water security in integrative river basin management. The review revealed that two of the most significant regions globally facing water security challenges are California in the USA and countries in the MENA region such as Turkey. Here, the California Sustainable Groundwater Management Act (SGMA) 2014 could provide a significant heuristic for comparative learning. This legal framework aims to manage groundwater in a sustainable manner and avoid undesirable results while the State experiences multi year drought or land subsidence problems. Therefore, in essence it should theoretically support the water security concept. However, framework is relatively new and no assessment to date has been done so far for evaluating the effectiveness of SGMA. In addition, the review shows that no study to date has compared the integrative river basin planning approach of the SGMA to those in other national contexts to inform lesson-drawing. Therefore, the review shows that the study can make a major contribution to knowledge in the areas of security studies, water policy and governance and comparative lesson-drawing/policy transfer.

7.3 Objective 2: To develop a methodological approach for assessing the degree to which integrated river basin planning in the WFD and SGMA supports water security

The thesis also provides novelty in its theoretical and methodological approaches in testing these arguments. Since our aim is to analyze integrated assessment of water security in WFD and SGMA, the theoretical framework had to incorporate social, institutional aspects of water management. We identified that while there are some studies tried to analyze water management with integrated theoretical analysis (Benson et al., 2014; Bielsa & Cazcarro, 2014; Soncini-Sessa et al., 2007; Tarlock, 2007), however most of them do not provide a strong theoretical foundation or are unable to integrate socio-environmental aspects.

In response, an alternative approach then is presented that combines Institutional Analysis and Development (IAD) with elements of SES and lesson-drawing/policy transfer to provide an innovative theoretical framework. As discussed in Chapter 3, the SES Framework, which is another institutional analysis framework, can complement IAD. SES can deal with the power distribution by having second tier governance aspect in its framework, thus it can strengthen IAD with a governance and participation mechanism focus. Therefore, we introduced a hybrid IAD-SES framework. Additionally, we emphasized the multi-level governance aspect as this can contribute to IAD which does not properly consider it. While SES is more quantitative, IAD is based on institutional qualitative approaches and the IAD framework has more guidelines than the SES framework which does not have coherent roadmap. Lastly, we identified that SES features a wider social, economic, and political setting that encompasses a larger scale than the IAD framework does.

Chapter 3 also outlined how this hybrid theory can be used in comparative analysis to better understand how water security is achieved through integrated river basin mangement. This comparative analysis can be achieved via utilisation of policy learning and lesson-drawing theory. These processes could lead to learning practice for Turkey from California in this case or vice versa. In this respect, policy makers could involve learning process about policies in other contexts to scrutinize/alleviate the existing domestic problem which he called ‘lesson-drawing’ (Rose, 1991, 1993, 2005). Then it was shown that this notion was extended to develop ‘policy transfer’ and later then explained that it was extensively used in comparative analysis in the US (Bulmer et al., 2007; D. Dolowitz & Marsh, 1996a; D. P. Dolowitz & Marsh, 2000). The theory chapter detailed how learning can be conveyed through lesson-drawing which creates policy prescription from other context (Rose, 2005). Lastly, we identified how lesson-drawing could be assessed through analyzing constraints to lesson-drawing using the comparative IAD-SES framework. We illustrated that importer and exporter case studies could help provide lessons; in this respect our assumption says that California has better water security in governing the resource. The theory chapter concluded by saying that constraints could make policy transfer difficult due to cultural political, institutional and legal factors.

In order to meet with research aim and objectives illustrated chapter 1 a bespoke, innovative mixed methods comparative case study design was designed specifically to meet the study aims. It was shown that with comparative case studies we can evaluate how different factors interact to produce water security outcomes. Data is one of the most crucial factors for multiple methods research design. Documentary analysis of the implementation of river basin planning in Turkey and Californian cases were initially studied through official documents such as annual progress reports on implementing water management frameworks. Moreover, through local documents we were able to analyze de facto implementation attributed to informal rules which are designated in the IAD framework as external variables. These documents were supported by quantitative sources. Quantitative data helped us to analyze external variables such as basin biophysical and community attributes. Additionally quantitative data was utilized to analyze outcomes through the water security indicators developed in Chapter 4. Data was accessed from official government agency sources in both contexts to support the comparative analysis. While a potential limiting factor, such data were nonetheless accessible for the study.

7.4 Objective 3: To compare different forms integrated water governance in Turkey and the USA in terms of key institutions, processes and outcomes Objective 4: To comparatively assess the extent to which these different forms of integrated river basin planning support water security through the use of a dedicated assessment tool

This chapter discusses the comparative analysis of integrated water governance in Turkey and California to address Objectives 3 and 4 of the thesis, which are considered together in this section. The discussion is framed by the analyses in Chapter 5 and 6 which employed the IAD-SES framework to identify key intervening variables for water security in the two examples of river basin planning. As such, we can start by comparing planning in the Konya Closed Basin and Kern County basin in terms of their external variables.

7.4.1 Comparison of external variables

By examining the *biophysical attributes* of the two cases it was apparent that, while significant in terms of water security outcomes, similar problems existed in the basins. One obvious difference is size: while Konya Closed basin is the largest river basin with covering the area of 53,000 km^2 in Turkey, Kern County subbasin covers 1,945,000 acres (equivalent to 7,800 km^2) with making it the largest subbasin[38] in California State (Divrak & Demirayak, 2011; Kern Groundwater Authority, 2020). But apart from this factor, there are obvious similarities. Critically, the two basins receive historically low levels of rainfall. In Konya, precipitation is on average around 407mm annually, while in Kern County it is 304 mm, with southern and western boundaries receiving 127mm in the interior side of the subbasin (Department of Water Resources, 2003b; Ribamap, 2017). Because of this semi-arid climate in both basins they are heavily dependent on groundwater abstraction for economic activities. This dependence is in turn reflected in similarly adverse water related issues, especially groundwater over-abstraction, which we will comparatively illustrate below. Additionally,

[38] In the US, basins and subbasins are designated as institutional forms, in this case Kern County is one of the subbasins that is highly prioritized within SGMA basin planning. In Turkey, basins are only a hydrologic unit. Therefore, we needed to highlight this basin/subbasin difference. We consider both the hydrological unit and focusing on institutional integrated water governance transformation rather than focusing on hydrological unit or its size which is mainly attributed to an engineering perspective.

these two basins are significant agricultural production areas due to their climate and rich soil.

Again, comparison of c*ommunity attributes* highlights some differences but also significant economic similarities between the cases. Although there are obvious socio-cultural differences, in economic terms the two basins are similar. Firstly, there is a contrast in population figures. The population in Konya Closed Basin is three million people mainly living in big cities such as Konya populating more than 1.5 million people while Kern County is home to 909,235 people, and Bakersfield is the major city in the basin with 400,000 people. Secondly, the economies in both basins are dominated by the agriculture sector. Kern County is one of the most important agricultural areas in the USA, generating $7.669 billion dollars in 2020 (Department of Agriculture and Measurement Standards, 2021). The Konya Closed Basin is similarly an important agricultural producer nationally in Turkey. Agriculture constitutes 34 percent of the labor force in Konya and Kern County (Department of Agriculture and Measurement Standards, 2021; Ribamap, 2018). The main crops are sugar beet, wheat and corn in the Konya Basin while grapes, almond milk, pistachio and fruits are the top agricultural products in Kern County Basin (Department of Agriculture and Measurement Standards, 2021; Divrak & Demirayak, 2011).

As outlined in Chapter 3, *governance attributes* include the wider context of multi-level rules, organisations and institutional structures spanning different levels, from national to local. In Turkey, one of the first national legal measures of relevance was the 1960 Groundwater Law which originally gave powers to The State Hydraulic Works (DSI) for maintaining groundwater protection, usage designation and abstraction use registration (Ak et al. 2022). Later years showed that Turkey required several laws or other institutions for protection environment and water resources i.e., water pollution standards and formation of new ministries. It was illustrated that developments regarding water and environment led to legislate Water Pollution Control Regulations and formation of the general directorate of environment, and thus ultimately formation of the ministry of environment (TOB, 2019b). The Konya Chapter (Chapter 5) also identified that 8 other ministry including ministry of energy and natural resources and ministry of interior affairs involves in water management scheme. Over the intervening years, water management has evolved in Turkey, with a significant transformation occurring with implementation of the Water Framework Directive as part of Turkey's EU accession process (Demirbilek & Benson, 2019). As part of this process, 25 river basins have been established. The government Directorate of Water Management (SGYM) has the responsibility for water management and preparing and implementing river basin planning (SYGM, 2017a). These two state water agencies are responsible for monitoring and governing water but there is no clear division of tasks in river basins (Ak et al. 2022).

In contrast, California has a different approach due to the US federal system of governance. The federal government adopted the Clean Water Act 1972, which requires states to implement the National Pollutant Discharge Elimination System (NPDES), a permit based approach for regulating point source pollution (Andreen, 2004). However, responsibility for managing water resources resides with state governments such as California. In this respect, since 1956 the California Department of Water Resources (DWR) has been the principal governing body for managing water. The DWR however shares this responsibility with local authorities. For instance, Kern County has 12 governing authorities. Within SGMA implementation, the rules and governing systems have completely changed. The SGMA requires basins to form specific institutions, Groundwater Sustainability Agencies (GSAs), and to prepare and implement Groundwater Sustainable Plans as part of their groundwater management program (Altare, 2018). In analyzing both basins governing rules of water management, we can say that while Turkey is a more centralized county for water governance, California shows significant decentralized governance mechanisms in water governance and gives both management freedom and responsibility to local authorities which is beyond that basin's authority. This feature of multi-level water governance is also reflected in the higher degree of agency collaboration in California than Turkey – discussed further below.

7.4.2 Water Related Issues in Basins

Chronic water related issues are similar in both cases in their causes and effects. The Konya Closed basin has experienced, and is still experiencing to date, an increasing amount of sinkholes, mainly attributed to low groundwater level as a consequence of intensive agricultural water use (Berke et al., 2014; Bozyiğit & Tapur, 2009; Tapur & Bozyiğit, 2015b). Extensive water abstraction has lowered groundwater tables, becoming the main concern in the basin. More latterly, Chapters 3 and 5 identified that sinkhole occurrence doubled from the official start of WFD implementation in 2014. Furthermore, in the basin almost 70 percent of wells that are used for irrigation are non-licensed which makes the conditions in the region worse (Divrak & İş, 2010). Government reports state that more than two third of water bodies including groundwaters are at high risk (Ribamap, 2018). Important reed lakes such as Karapinar and Hotamis dried up by 43.43 and by 27.85 percent respectively and lost their features due to insufficient nutrient flux and low groundwater levels leading to water retreat (Durduran, 2008; Tunçez & Candan, 2008; Yilmaz, 2010). Additionally these groundwater levels are statistically proven to follow a decreasing trend that has accelerated in recent years (Demir et al., 2021). As a consequence of this decline, land subsidence is visible in the Konya Closed Basin. For example, a recent study revealed that the land subsidence rate is 70 mm/year 2014-2018 compared to 15 mm/year during 2002-2010 (Orhan et al., 2021).

The Konya Closed Basin case study chapter illustrated that the basin experienced environmental problems such as pollution. For instance, more than one third of surface water bodies experienced significant point source pressures that were caused by domestic waste water, industrial waste water, geothermal discharges and solid waste landfills, untreated water discharge. In addition, 72 water bodies were exposed to diffuse source pressures that originated from nutrients or sediments coming from agricultural land, vehicle related emissions or rain-derived flows to water bodies (Ribamap, 2018). Moreover, the basin faces crucial morphological issues: 11 water bodies have morphological problems with around 60 percent of 92 water bodies not meeting with national standards and likely to fail to meet environmental targets (Ribamap, 2018). Only 7 sites of surface bodies pass the environmental regulation objective (ibid.). The Konya Closed Basin exhibits agricultural related problems due to increasing water intensive production over recent years through crops such as potato, sunflower, alfalfa, corn: in the new cultivation area, sugar beet cultivation increased by 40 percent while corn cultivation increased by 100 percent (Berke et al., 2014; Divrak & İş, 2010). The basin is home to some specific habitats such as Lake Tuz. However, the lake retreated in size by around one third from 1990 to 2005 (Ekercin & Örmeci, 2008), while has shrunk by around 85 percent since 1915. Chapter 5 suggested that the lake could suffer a similar fate to the Aral Sea and Lake Urmia and disappear almost entirely (AghaKouchak et al., 2015; P. Micklin, 2007; P. P. Micklin, 1988). Water salination and soil degradation are other water related issues in the Konya Closed Basin. For instance, Tersakan Lake, used by flamingos for breeding, entirely dried up in 2011 due to over-abstraction (Berke et al., 2014). Lastly, due to incensing and frequent drought, the Konya Closed Basin has experienced important problems such as increasing water costs, fallowing of land areas, and migration. For instance, decreasing agricultural productivity due to water scarcity forces farmers to leave their land fallow and migrate to cities outside of Konya (Lelandais, 2016).

Kern County has also experienced groundwater decline and deteriorating water quality in relation to increasing pumping levels, resulting in land subsidence in the basin (Kern Groundwater Authority, 2020). Water quality issues are illustrated in the Kern County basin Chapter (Chapter 6). One significant concern identified in the thesis research comes from nitrate concentration increases in groundwater in parts of the basin (Schmidt & Sherman, 1987). However, the nitrate risk to groundwater has decreased significantly over the years (Kimmelshue & Tillman, 2013). Another water quality problem is salination of groundwater bodies, as it is known that almond production is adversely affected by high salinity of water, while Kern County is one of the top almond production areas in the USA (Kang & Jackson, 2016; Romero, 2015). Due to these problems, Kern County is defined as one of the most critically over-abstracted basins in California and therefore received a high priority categorisation from authorities in the SGMA implementation.

7.4.3 Institutional attributes (action situation of IAD-SES)

The wider multi-level governance context in turn has shaped the institutional attributes of the action situation in both basins. The Konya Closed Basin is implementing the WFD as part of Turkey's EU accession process. In order to facilitate the river basin management planning process the Turkish government initiated a WFD pilot project 'Towards Wise Use of the Konya Closed Basin' (Demirbilek & Benson, 2019). A river basin action plan was brought into force in 2014 (Demirbilek, 2019). Chapter 5 highlighted that there are now two institutional agencies responsible for governing river basin management planning in Konya. The State

Hydraulic Works (DSI) is in charge of water related works such as water supply for irrigation and building reservoirs and dams for multiple purposes, plus determining allocation by providing licenses for water use. Maintaining water quality in groundwater and surface water bodies is now another role given to the State Hydraulic Works, apart from municipal water management which is assumed by municipalities and provincial special administrators. This leads to institutional over-lap and incoherence. Critically, the Directorate of Water Management, formed recently in 2011, undertakes the role of river basin management planning and water allocation planning in the river basin.

In comparison, Kern County started SGMA implementation procedures in 2016 by creating the Kern Groundwater Authority (KGA) to carry out these legal requirements in the basin (Kern County Water Agency, 2014; Westside District Water Authority, 2019). The role of this governing authority is to coordinate groundwater management, identify and address water related issues, and establish an overarching framework for local water management and make the local authorities cooperate with each other (Kern Groundwater Authority, 2020). In contrast to the Konya Closed basin, which started with full implementation of its river basin plan, Kern County gradually implemented its groundwater sustainability plan. An initial plan covered 13 percent of the basin (Kern County Water Agency, 2020). The plan was then expanded with four phases of GPSs and the umbrella groundwater sustainability plan that covers the entire basin, which was submitted at the beginning of 2020 (Kern Groundwater Authority, 2020). The reason for each local area forming GSPs is that each one contributes to whole basin planning by considering stakeholder outreach, tracking sustainability indicators and assessing previous and present groundwater conditions (Olcese Groundwater Sustainability, 2020; Westside District Water Authority, 2019). More latterly, each local authorities' GSPs were discussed and agreed, with the overarching GSP for Kern established (Kern Groundwater Authority, 2020). Unlike the Konya Closed Basin, Kern County modelled a water budget of the basin and set certain thresholds to avoid overdraft of groundwater bodies to ensure sustainability in the basin (ibid.). Furthermore, the overall groundwater sustainability plan evaluates the previous existing plans are a component of groundwater management at local authority levels (ibid.). Lastly, Kern County authorities formed 'a unsustainable result watch area' under the monitoring system to set limits for groundwater levels in case of exceeding minimum thresholds if this happens for 51% of groundwater wells (ibid.)

Comparative analysis can also be undertaken of the *participatory approach* for both basins. Significant numbers of events such as meetings and workshops with stakeholders were undertaken in the Konya Closed Basin and this is argued to have increased awareness of the planning process among local people (Demirbilek, 2019). Despite this approach, it is difficult to say that real integration of stakeholders in water allocation processes exist (Demirbilek, 2019). It is our assessment that local people are not completely involved in the decision-making process and decisions were not changed after consultations or feedback by farmers and local stakeholders. This is far away from a real participatory mechanism (Mitlin, 2004) and reflects what Arnstein (1969, p. 217) would call 'tokenism' whereby stakeholders are included but lack any influencing power over decisions. In the Konya Case, centralized government agencies dominate this participatory mechanism that brings the question of power distribution among stakeholders which mainly favors government officials. In contrast, Kern County aims to benefit all water users from groundwater allocations and allows them to participate in the GSP development process, with KGA members meeting each month publicly to openly communicate decision-making to all users (Kern Groundwater Authority, 2020). For instance, 18 public meetings took place in the Rosedale-Rio Bravo Water Storage District while a few of them were in the form of stakeholder workshops (Rosedale - Rio Bravo Water Storage District, 2019). The umbrella GSP also allowed 90 days for stakeholders or farmers to feedback their views after the first meeting, giving them opportunities to provide a formative steer on the plan process. According to our evaluation, the Kern County basin plan appears effective in its participatory mechanism through being inclusive for all users but provides only limited information regarding farmers involvement in GSPs in the implementation reports (Kern Groundwater Authority, 2020). In overall comparison, participatory approaches for both basins indicate that Kern County is consequently more effective and supports inclusiveness by communicating with all users each month. While Konya's work on public awareness is useful, its participatory mechanism is insufficient in terms of including farmers and other stakeholders in discussions.

One of the world's most concerning issues is climate change and as a consequence the intensity and frequency of future extreme weather events such as drought is predicted to increase over time (Dai, 2011). Konya Closed Basin and California are historically prone to extreme weather events, most notably drought. Therefore, *adaptive management* capable of dealing with uncertainties from climate change is one of the most significant institutional attributes of the action situation in our modified IAD-SES framework. The SYGM started its preparation of a drought management plan in Konya Closed Basin in 2014, releasing the report to the public as part of the WFD process in 2015 (SYGM, 2015). The aim of this planning project was to ease drought effects by improving stakeholder coordination, protecting water quality and quantity in water bodies, increasing awareness and information among people, and managing the planning framework with local authorities and managers in ministries who are related to drought issues (Duygu, 2015; Duygu et al., 2017). The drought issue is also assessed in sectoral water allocations using moderate to worst case drought scenarios (SYGM, 2018b). For instance, with severe drought conditions, water needs for all sectors cannot be fully satisfied where the supply ratio of water demand for agriculture sector could decrease to 75 percent in some subbasins such as Cumra, Beysehir, Karaman (ibid.). This ratio goes down to 35 percent in Altintekin, which is very concerning.

When it comes to Kern County the SGMA requires adaptive management for preparing basins and subbasins to tackle worsening climate conditions and easing uncertainty, while it urges the need for flexibility in managing tasks (Department of Water Resources, 2015). However, putting this approach into action through adaptive management was in reality constrained due to the lack of data caused by limitations to institutional capacity (Conrad et al., 2019). Furthermore, adaptive management was intended for lessening surface body declines and aimed at helping stakeholders in reducing these losses (Kern Groundwater Authority, 2020). Additionally, few storage projects or reuse of water applications were recorded (Rosedale - Rio Bravo Water Storage District, 2019; Westside District Water Authority, 2019). In comparing both adaptive management approaches, the two basins appear, on paper at least, effective in terms of implementing drought planning to ease burdens that could happen, and the two basins anticipate frequent and intensified drought conditions in their management protocols.

Water is seen as an *economic good* and how it is treated in the action situation of the IAD-SES framework as part of institutional attributes is crucially important. Understanding how much income is gained is essential because it allows assessment of how much water is wasted through production or loss. For instance the Konya WFD report showed that 42 percent of water use in the basin does not generate any income (SYGM, 2018b). This percentage is lost or was not conveyed or unregistered (ibid.). In addition to this in the Konya basin, water abstraction costs were calculated, while also calculating the percentage of this cost subsidized by water cooperatives (ibid.). River basin planning and associated water allocation plans were assessed to determine profit production per hectare in the basin and which sector generates more income per level of water use (SYGM, 2018b, 2018a). In Kern County, the economic impact of water was discussed by stakeholders by noting that the decline in groundwater could lead to loss of jobs and industry (Kern Groundwater Authority, 2020). Kern local authorities also assessed the value of reuse of brackish water, which is not only an economic good but also can be seen as an environmental backup within the perspective of adaptive management (Westside District Water Authority, 2019). Our assessment shows that both basins take into account water as an economic good in their management, although do not calculate how much costs would occur as a result of severe drought.

The Konya Closed basin case shows us that water management in Turkey does partially exhibit a *holistic approach*. As described in Chapter 5, there are two governing agencies. The SYGM is responsible for implementing and coordinating river basin planning however the DSI is responsible for major ground works and is more of a technical rather than a managerial department. With the river basin planning implementation reports it is evident that they aim to account for different uses of water including economical aspects and even consider the geothermal and mining sectors in water allocations (SYGM, 2018b).

However, this dichotomy in responsibilities undermines a fully holistic perspective. As mentioned earlier, the SYGM has limited powers and if implementation of river basin planning was in the hands of the DSI it would have been done quite differently. In comparison, Kern County experiences of implementing river basin planning under the SGMA are relatively more holistic than in the Konya Closed Basin. Planning included different components such as a geological assessment of water, which is highly crucial in groundwater management, and analysis of the economic aspect of water. What is most positive from the perspective of a holistic approach is that each local GSA contributes to the umbrella GSP via production of local GSPs and with that each one becomes the part of whole picture in water governance for sustainable groundwater goal across the state. The monthly meetings, that are publicly staged, could also be seen as successful to the integrity SGMA implementation. Lastly while it is difficult to consider both the economic perspective and all stakeholders' needs, Kern County stands out as a successful example of managing these elements holistically.

In general, authorities in both cases are systematic in their approach but differences are apparent. While in Konya they were systematic in modelling and analyzing water budgets and water allocations for future scenarios and drought conditions, Kern County was systematic in implementing GSPs that included local authorities linked to subbasin river basin planning while accounting for groundwater storage conditions over time. In both Konya and Kern County not only was groundwater assessed but also surface water included with a specific focus given to water quality issues, as well as morphological and geological conditions accounted for (Kern Groundwater Authority, 2020; Ribamap, 2018; SYGM, 2018a; TODD Groundwater, 2020, 2021).

7.4.4 Water Security Indicators

When considering actual outcomes of these two processes, comparison of the water security indicators shows that Kern County is proving more effective in achieving water security than Konya through its integrated river basin management approach. This difference in outcomes becomes visible by comparing and contrasting our four indicators: *water availability*; *environmental; risk management*; and *independence*.

In Chapter 5, we showed that Konya Closed basin experienced significant temporal decrease in *water availability* per person. Our analysis showed that water availability reduced by 36 percent from 2014 to 2017, and the basin status changed to a 'water stress' area with only 1622 m^3/capita available in 2017. This figure stands out as significant because the WFD process, theoretically, should lead to better water security. It means that without finding additional water resources or reducing water use, the consequence could be that farmers lose their jobs, and potentially be forced to migrate to other places. This could be interpreted as a critical security issue due to unemployment and displacement, as in the case of Syria discussed in Chapter 2.

In Kern County data on groundwater storage was employed them to measure the water availability indicator. Groundwater storage availability decreased from 2017 to 2021 by 209,373-acre feet with an annual decrease of 58,075-acre feet (TODD Groundwater, 2022). These data show that this increase has occurred after a historical decrease from 1995 to 2014 to 277,114-acre feet. This increase could be attributed to the SGMA implementation that has occurred since 2016, since no other factor would account for such a significant change particularly given drought conditions during this period. It is important to note that groundwater annual decline was -277,114- acre feet in the period of 1995 to 2014 while in the 5 year average from 2017 to 2021 it was 58,075, thus it is obvious that the recent years decline was eased and was better than previous years (1995-2014). Although the last year (2021 WY) was a critically dry period and led to significant decrease in groundwater storage, the data shows that SGMA implementation seems effective and a downward trend in groundwater storage decline flattened and was above the previous annual storage change in a positive way. The reports also showed that surface water use significantly decreased between 2019-2021 from 2,805,400-acre feet to 826,080-acre feet and that groundwater use crucially increased from 1,824,183–acre feet to 2,471,156-acre feet in the same period. However, there is a caveat. When considering whether this change is because of the SGMA, the data shows that it can be attributed to a dry year whereby groundwater dependence and use would be high. Indeed, during this period groundwater dependence increased and surface water abstraction decreased. That said, we see that groundwater use has increased during these years while the historical groundwater storage decline has flattened out, although additional up to date data is required to establish this observed trend.

In the Konya Closed basin case, water availability data was employed to calculate *environmental flow* needs. In this case, it was shown that from 2014 to 2017 the environmental water volume decreased by nearly half, although it has remained at the same level in the last two years. This figure reveals that the WFD process has not yet led to increases in water security in the basin, reflecting wider criticisms of the Directive process in protecting environmental flows (see Benson et al. 2014). While the environmental indicator for water security was analysed in the Konya Closed Basin, it was not possible to fully assess the same indicator in Kern County due to data non-availability. However, by analyzing the annual GSP reports it was obvious that there are no reported environmental issues. They revealed that Kern County meets with minimum sustainable criteria under the SGMA, meaning that the GSP has contributed to meeting environmental objectives or at least helped maintain good environmental status during these years (TODD Groundwater, 2019, 2020, 2022).

For *risk management,* data obtained for Konya Closed Basin show the important feature of increasing demand in the absence of rainfall. The dam/reservoir fill rate significantly increased in the basin from 2014 to 2017. The basin experienced a decline in the dam fill rate in 2016 that then improved in 2017. While knowing that the basin did not experience notable precipitation, this increase can be interpreted as an increase in risk management capacity through expanding dam/reservoir capacity. This trend can be attributed to successful engineering work but building dams is criticized in the academic literature as a risk management strategy (Di Baldassarre et al., 2018). Given that more severe and frequent drought would be prominent factors for risk management in the future, reservoir capacity and capacity rate can ease water related problems during extreme weather events. This conclusion is only possible for the Konya Closed Basin, due to limitation to data availability on the Kern County reservoir capacity rate. However, it was revealed from annual reports that little storage/reservoir construction has been planned in Kern County. The Kern County management focuses mostly on groundwater banking opportunities to boost the groundwater capacity (i.e. New Cawelo GSA Banking partner talk, Kern Water Bank, Kern Fan Groundwater Storage Project) (see TODD Groundwater, 2020,2021,2022)

In Konya**,** our data shows that during 2014-2017 the basin maintained its *independence* status which is vital to water security. However, the authorities did nonetheless assess the feasibility of bringing water from external water bodies to increase water availability. If this happens it could increase water availability in the short term, but it will create dependence on other basins outside of Konya and put long term water security in jeopardy. In Kern County, the basin does receive water from external water sources such as the State Water Projects and Central Valley Projects. Dependence over these two resources were 37 percent, however this dependence decreased to 26 percent in 2020. This decrease could be due to a dry period because total surface water decreased as well thereby placing an increased dependence on groundwater. Overall, Konya maintained its water security independence while experiencing significant water availability decreases; which is unsustainable in the long term. Kern County in contrast is significantly more dependent on external water bodies, although this dependence slightly decreased from 2019 to 2020 and the trend is to reduce this dependency over time.

In overall analysis of water security indicators, Konya showed that the WFD integrated river basin management process is less effective in 2 out of the 4 factors. We could then conclude that while implementation of river basin planning at the institutional level is systematic and partially holistic, while using adaptive management and economic assessment in a positive way for water security, serious water problems still exist in the basin. The basin has experienced a significant decrease in water availability but farmers conversely still widely use water intensive crops. By using long-term data, research could provide a more robust judgement on these observed trends. However, even within the time and data limits of this research, there is still an observable disintegration of river basin management effectiveness, with weak institutional capacity undermining future water security. When it comes to Kern County, the outcomes do not show an overwhelmingly strong indication of success in SGMA implementation, however through examining the annual reports we can determine from the monitoring data that no significant water related issues are occurring in the basin, suggesting some positive implementation effect. According to our assessment there is effective integration of holistic water management, and institutional capacity is high because each local authority is part of the Kern Groundwater Authority and contributes to overarching planning and annual progress reporting. Only one notable water security risk exists in Kern County, with significant dependence on external groundwater resources a potential problem for future integrated river basin management.

Evaluating Kern County SGMA implementation provides a significant contribution to the literature because it is not only a major agro-economical contributor basin in the USA but also illustrates how water security can be enhanced, although not necessarily achieved, through effective integrated river basin management. With additional data, future research could be conducted to provide a more in-depth assessment of this observed trend over a longer time scale. But from our comparison, Kern County shows strong institutional capacity and effective participatory mechanisms that engage stakeholders, including local water authorities, evidently better than in the Konya Closed Basin. Kern County is also observably more advanced in implementing integrated river basin management to achieve water security outcomes. This observation relates to its monitoring and annual reporting, which are a critical component of effective adaptive water management since they influence learning under uncertainty (see Pahl-Wostl, 2006, 2008, 2009; Pahl-Wostl, Craps, et al., 2007; Pahl-Wostl, Sendzimir, et al., 2007; Smith et al., 2015). Despite the ongoing establishment of a basin monitoring regime (Demirbilek & Benson, 2019), the Konya Closed Basin lacks this critical institutional aspect of river basin management implementation and historical progress towards water security is limited as a result.

Konya Closed Basin			
Number	**Component**	**Data**	**Indicator/Operationalization**
1	Agriculture	Agricultural production	Water availability and use
2	Environment	Environmental flows	Environmental flows
3	Basin independence	Independence	External water calculation
4	Risk management	Storage data and Climate variability data	Water replenishment/Storage data
Kern County Subbasin			
Number	**Component**	**Data**	**Indicator/Operationalization**

1	Agriculture	Agricultural production	Annual Groundwater Storage change
2	Environment	Environmental flows	Qualitative assessment
3	Basin Independence	Independence	External water calculation
4	Risk management	Storage data and Climate data	Qualitative assessment

Table 7.4 Water security index data measurement

Table 7.4 shows the data and indicator assessment for the water security index. Column 1 shows the components of the index, and Column 2 indicates the data required for assessing the components and the indicator/operationalization column provides the data used in the assessment. This table can also provide a basis for future study by comparing it with other cases.

7.5 Objective 5: To make recommendations on future integrated river basin management in order to better support water security

Objective 5 aimed to understand how the comparative analysis could inform lesson-drawing on enhancing water security through integrated river basin management in order to make recommendations on future practice. In this respect, it was originally hypothesized in Chapter 4 that the Konya Closed Basin and Turkey could potentially learn from the experiences of SGMA implementation in California and Kern County specifically**.** In this respect, the thesis shows that much potentially could be learned from the Californian experience but there are potential constraints on transferring such a highly regulatory SGMA approach to the current Turkish context of integrated river basin management framed by the WFD model. Lesson-drawing between the cases is therefore more nuanced than originally thought.

The first point to make is that our results (Chapters 5 and 6) show that Kern County is more advanced and generally more effective in terms of implementing integrated river basin management than Konya in ensuring water security. While from an IAD-SES perspective, the biophysical/material conditions and community attributes such as economic activities are similar, as discussed above, the main intervening variable for such difference is the nature of governance structures since they critically determine the action situation. However, learning from the Californian experience in relation to governance of river basin management in Turkey comes with significant caveats, which in turn reflect wider arguments in the lesson-drawing and policy transfer literatures.

Lesson-drawing theory predicts that it is often problematic to transfer whole programmes, or 'photocopy', between national contexts due to differences in political and legal structures (Benson, 2009; Benson & Jordan, 2011; Dolowitz & Marsh, 2000; Dolowitz and Marsh 2000; Benson 2009; Benson and Jordan 2011). Indeed, so-called 'peer to peer' policy transfer at the national scale involving the complete transfer of water policy is rare (David Benson et al., 2012). For example, Dolowitz and Medearis (2009) show that political-cultural factors in the USA are a significant impediment to the transfer of environmental policies to and from other countries, in their case Germany. As we stated earlier in the thesis, the US federal system devolves powers to states for managing water; a critical difference with Turkey's more centralized water governance. In this case, the differences with the US federal system stands out as one of the constraints since it makes political transferring difficult but also lesson-drawing problematic. Additionally, while this federal system supports a participatory approach in managing water, Turkey has experienced strong centralized governance over water (Demirbilek and Benson 2019). This feature is another constraint that makes political learning difficult. Moreover, biophysical conditions hinder the possibility of lesson drawing/policy transfer because in California basins can be divided into several subbasins each with their own governing authority, however this is not evident in the Turkey case.

That said, transfer at lower scales of governance around elements of river basin planning is easier to achieve, particularly between institutions at the basin scale where constraints are potentially lower – a feature already identified in the academic literature (Benson et al., 2012; Swainson & de Loe, 2011). There are elements of the Californian system that, on this basis, could potentially be transferred to the Turkey context through a process of partial or targeted learning at lower institutional levels; what Dolowitz and Marsh (2000) call 'emulation'. Lesson-drawing theory shows that specific policy instruments or management approaches are, in contrast to whole water management programmes, much more transferable, subject to suitable modification for contextual difference (Benson et al., 2012) or 'translation' (Mukhtarov, 2017). Our study shows that several areas of Californian river basin management practice could potentially furnish valuable lessons for Turkey but also other countries, that relate to data collection, characterizing groundwater issues, public participation and collaboration between agencies, monitoring of plan implementation and plan reporting.

Firstly, regards characterization of the groundwater environment, the Californian experience demonstrates the need for effective understanding of baseline water conditions for supporting groundwater security via river basin planning. For instance, the Groundwater Exchange website was created under the SGMA with the purpose to provide information regarding basins and groundwater basin conditions that is available to all users (Groundwater Exchange, 2022). This platform also provides details of the legislation along with its implementing regulations regarding groundwater bodies and management rules in California basins, with linking to the California Water Library, making information easily available to all interested persons (ibid.). The SGMA requires that aggregated groundwater data for basins must be provided to the state Department of Water Resources. On this basis, the Department issued a SGMA Prioritization Report identifying 'critically overdrafted' basins such as Kern County and obliging the production of Groundwater Sustainability Plans. Not only do the Plans identify responsible agencies, they also require descriptions of the physical environment and the aquifer system, maps and use of historical data to establish water demand and future water use projections. Compared to the approach adopted in Turkey for river basin planning, this approach is significantly more advanced: river basins, including Konya, are required by government in the National River Basin Strategy to develop sectoral water allocation plans to coordinate with river basin plans - but progress has been slow in plan production (Ak et al. 2019; 2022). This water allocation plan considers the future projected climate conditions such as severe drought as well as analyzing the meeting ratio for water demands for each sector (TOB, 2019a). However, water allocation plans are still awaiting updating in order to assess if each sector receives the allocated water. Moreover, the river basin planning implementation required water authorities in Turkey to prepare characterization reports for the basins including details of the basin character, pressures on surface and groundwater and economic analysis of water use (SYGM, 2016b). Implementation of the WFD also necessities collecting data. For instance, the initial basin report required data on the 'biological, chemical, physico-chemical, morphological, economic data, water uses, pricing, cost recovery, consumption amounts, waste water production, population equivalents and etc' of water resources (SYGM, 2016b, p. 10). Despite the requirement of the WFD to inform the public and interested parties using this information, it is difficult to find data such as consumption amounts, water use, cost and recovery rates to name but a few in implementation reports.

Secondly, lessons can be drawn regards public participation and collaboration between agencies in planning. Public participation processes within river basin management can be transferred between national contexts (Benson et al., 2012). According to the Ground Water Exchange (2022), a non-profit organization established to support SGMA participation across California:

> 'All GSAs are legally required [under the SGMA] to consider all beneficial uses and users of groundwater, including domestic, agricultural, municipal, environmental, tribes, and disadvantaged communities; it is critical that local water users participate in the process to ensure the management changes address the diverse needs and priorities of the region. A Groundwater Sustainability Plan developed through robust involvement with all stakeholders within the basin will ensure the Plan's success.'

As such, the SGMA specifically mandates localised action. Implementation of the SGMA in the Kern County case has consequently involved regular monthly meetings with farmers, while in Konya these actors were not widely consulted in the planning process. Additionally, the SGMA requires collaboration between local agencies in the basin with the formation of the KGA. Each member is part of the Joint Power Agreement and is therefore obliged to collaborate. Little equivalent collaboration occurs in Konya or other Turkish river basins. In Konya, inter-agency 'incoherence' is an evident feature, with different agencies assuming different roles and powers (Ak et al., 2022; Ak & Benson, 2022). This feature leads to inter-agency competition in planning (Demirbilek, 2019). One lesson from the Kern case and indeed the USA generally is that collaborative management is much more ingrained in river basin planning culture while also is often legally mandated in some states (see for example, Sabatier, Focht, et al., 2005; Smith et al., 2015).

Thirdly, monitoring of plan implementation is certainly more advanced in the Kern County case. Under the SGMA implementation, California makes significant investment in monitoring progress towards sustainability in river basins. For instance, the SGMA requires sustainable management criteria which includes assessment of the 'sustainability goal, undesirable results, minimum thresholds, measurable objectives', plus negative sustainable indicators: lowering groundwater levels, reduction of storage, seawater intrusion, degraded quality, land subsidence and surface water depletion (Department of Water Resources, 2017, pp. 1–2). However, assessment of these criteria is based on data and information provided as prerequisite that we mentioned as a first lesson above. Additionally, setting these indicators and conducting monitoring against them requires significant investment both economically and at technically at the institutional level. Water authorities in Kern County can monitor progress and make decisions based on evidence provided due to their investments in monitoring and technical capacity. In contrast, although the WFD requires the characterization of basins and identification of water related issues, as in the Konya Closed Basin, here such capacity was lacking. Although authorities were identifying issues and mapping the basin, our research found that limited monitoring of groundwater was occurring in Konya and across other Turkish river basins (Ak et al., 2022). Annual reports present limited data on progress and information about the baseline of decision-making that has been made in the basin (SYGM, 2016a, 2016b, 2017b). Therefore, transferring monitoring lessons to the Konya Closed Basin could be hindered due to limited institutional capacity.

Finally, learning could also occur on annual reporting and adaptive plan revision. Under the SGMA, river basins report on progress. While reporting occurs in the Konya basin through the WFD process, it primarily relates to surface and ground water quality rather than their quantitative aspects. According to our understanding, all these three areas contribute to good reporting mechanisms. For instance, characterization of the environment brings the requirement of data or leads to data collection, thus it enables monitoring of the implementation of river basin planning, and eventually leads to informing stakeholders through enabling strong participation. Therefore, a credible, robust reporting mechanism stands out as a significant tool for securing water security through integrated river basin management. The reverse is also true. Informing local agencies as part of a joint power agreement requires a good reporting mechanism: for report preparation there should be a monitoring process for river basin planning and characterization of basin environment is must. The Konya Closed Basin started with characterization of the basin and collected important data. However, the ongoing informing of stakeholders and monitoring is limited due to the lack of institutional capacity. The Kern County reporting could be an example for Turkish authorities and institutions to follow as a policy prescription.

In terms of institutional capacity there could also be some lesson-drawing from Kern to Konya. Kern County sets sustainability indicators and evaluates them in annual reports, with the contribution of local authorities. Konya could also sets some criteria related to integrated river basin management and monitors them in annual reports. Additionally, Kern County annual reports could be a good example of progress monitoring documents. It was difficult to identify whether progress reporting exists in Konya annual reports. Lastly, water quality and environmental needs could be better supported with statistical data in order to show progress as a policy prescription for both cases.

In conclusion, political, economic and governing systems makes it difficult to draw programmatic lessons from Kern County to Konya Closed basin. It is difficult to transfer one model of river basin planning from one context to another one in its entirety. However, the Kern County case shows how elements of this model namely strong participatory mechanisms, monitoring of results and progress reporting could be transferred to support enhancement of water security through integrated river basin management in Konya, if institutional and technical capacities are enabling. These observations can be seen as a policy prescription for a different water management concept with a different political culture.

Chapter 8: Conclusions to the thesis

8.1 Introduction

This chapter concludes the thesis. It initially summarizes how the thesis addresses the overarching research aim, objectives and questions. This chapter then shows how the findings provide an original contribution to different academic fields and also inform new research opportunities; a process which was started in Chapter 7. The thesis provides added value to the academic literature in three main areas, through the theoretical, analytical and empirical approaches adopted, primarily within security studies, water policy and governance research and comparative lesson-drawing/policy transfer studies. Lastly, research gaps are outlined along with opportunities for further study through theoretical and methodological development and empirical testing.

8.2 Aims, objectives, research questions

This thesis seeks to answer one main research question, with five sub questions. As we identified in Chapters 1, 2 and 7, countries have experienced in the past two decades a significant transformation in water management from a hydraulic (Molle, 2009), reductionist (Zeitoun et al., 2016) or engineering (Benson et al., 2015) paradigm to integrated, inclusive and plan led approaches typically based upon river basin management (Benson et al., 2015; Molle, 2009; Zeitoun et al., 2016). This transformation is widely discussed in the water security literature. In the meantime, countries are being advised by international agencies to adopt integrated river basin management in order to better manage water resources, further extending this paradigm shift. This shift is reflected in the academic literature, whereby a significant body of work has emerged to empirically map and theoretically explain such changes. Yet, we identified that a significant gap exists in the water governance literature regarding the evaluation of effective integrated river basin management implementation in relation to water security, in Chapter 2. We then established one overarching research question, '*to what extent do different forms of integrated river basin management support water security?'*, thereby addressing this gap in knowledge. Our hypothesis then maintained that '*any form of river basin management should theoretically enhance water security*'. The existing literature has not addressed this kind of question or tested this hypothesis before. Answering this question now has added political significance due to the UN SDG 6 requirement for countries to implement IWRM by 2030, while it is also promoted in international agencies such as the GWP and UNESCO. As we discussed in Chapter 2, water should be seen as a trans/interdisciplinary research subject, and evaluation therefore needs to be inclusive in accounting for all aspects of water management. These gaps then informed the main aim of the thesis to analyse the effectiveness of integrated river basin management implementation in Konya Closed Basin and Kern County, as basis for lesson-drawing on how such approaches can support water security. Indeed, the ultimate goal of this thesis is to help establish water security as a key objective of integrated water governance, primarily in response to over-abstraction and climate change, through further academic research.

Meeting the study aim was achieved through the pursuit of five key objectives of the research. *Objective 1* sought to identify relevant gaps in the water security literature through a critical review. In order to meet this objective, the review examined security studies and water security studies by illustrating the critical discussions that have arisen from the water governance transformation debate, in order to identify critical gaps in the literature. From this critical review, it was identified that assessing integrated river basin management effectiveness would be an ideal research approach and significantly add value to the literature.

From the critical review, key water security arguments were identified. The review evaluated how water security perceives integrative and reductionist approaches. Then it was shown that the integrative management approach to water security was widely supported by academics and practitioners (see Al-Saidi, 2017; Zeitoun et al., 2016). However, existing studies showed us that there is huge gap between normative theory and practical implementation, with few comparative analyses of this key claim. This critical review paved the way for assessing how integrative river basin management works in reality and identifying the need for more work using comparative analysis. The review then showed that this need could be fulfilled with selecting cases from USA and Turkey, both experiencing extreme water security issues. However, this created the need for analytical tools to assess the water security outcomes of integrated river basin management.

This led us to researching our second objective, *to develop a methodological approach for assessing how integrated river basin management supports water security*, as a basis for lesson-drawing. This objective was studied in detail because the methodological and theoretical stance can significantly impact any study. It was revealed that previous studies on water management using integrated theoretical evaluation does not exhibit a strong theoretical foundation or fails to integrate key aspects such as socio-environment attributes. As a result, an alternative approach was posed in Chapter 3 using the hybrid approach of IAD-SES, combined with lesson-drawing and policy transfer.

The hybrid approach provides strong theoretical innovation. It was identified that each theoretical framework has weaknesses. Ostrom's IAD is rules-based and lacks a governance and participation aspect. The SES, with its emphasis on governance rather than rules, complements IAD in this respect, as intended by Ostrom (2014). Policy learning and lesson-drawing theories were then utilized to examine the scope for learning following the application of the framework. Our assumption was that California achieves better water security in managing at the river basin scale. A lesson-drawing approach was then developed from the literature to assess the scope for policy transfer for Konya and Turkey more widely, particularly regarding the institutional aspects of river basin management.

In order to utilize the theoretical framework, a novel methodological approach was required. Therefore, in Chapter 4 a comparative research design was developed and case study design considerations were described. Case selection was carefully evaluated, in order to avoid bias and other effecting factors that could affect the outcome interest. By selecting two differing examples of integrated river basin management, the study ensured that functional equivalence was achieved on the dependent variable (i.e. the water security outcomes of integrated river basin management) while allowing comparative analysis of intervening factors (i.e. the institutional, environmental and community attributes of integrated river basin management). Lastly, we identified our data sources for the mixed method approach used in the research. After deciding theoretical and methodological approaches, the third and fourth objectives were then considered.

Objectives 3 and 4 sought *to compare integrated river basin management order to assess the extent to which it supported water security, using a dedicated assessment tool*. The cases from Turkey, Konya Closed Basin and USA-California, Kern County were examined using an IAD-SES hybrid approach through a comparative case study design method. The IAD-SES framework allowed analysis of each case in a systematic way. Due to the multiple layers of IAD-SES it helped to clearly identify the external variables significant in both cases. These variables were crucially important ones that can include the action situation or outcomes, in this respect water governance in the action situation and water security results in outcomes.

Chapter 5, 6 and 7 detailed the governance attributes. Groundwater in Turkey is predominantly managed under the Groundwater Law, for resource protection, allocation, licencing and user designation (Ak et al. 2022). Over the years, water management has experienced enormous transformation as part of the EU accession process through implementing the Water Framework Directive. However, it was identified that there are two central agencies who experience a dichotomy over the division of tasks, described in Chapter 5. In comparison, Chapter 6 illustrated that in the California water governing system, which is mainly overseen by the Department of Water Resources, there has been a historical transformation in California as well. With SGMA becoming an enacting law, the responsibilities of agencies have changed and significant power has been allocated to local authorities. SGMA requires a unique governing authority in each basin, with local authorities part of this governing body within an overall hierarchy. For instance, Kern County has 12 governing members. In comparing these governing attributes, river basin planning in Turkey is more centralized with its two main governing bodies creating a dichotomy of responsibilities, in contrast to California which shows significant decentralized governance mechanism through its 'Joint Power Agreement' and responsibilities for local agencies. Konya and Kern County also show similar water related problems. Both cases experienced decreasing groundwater level trends and thus deteriorating water quality deterioration. One of the consequences of these overdrafts in groundwater was sinkhole development in Konya and land subsidence in both cases.

In relation to objectives 3 and 4, the thesis mainly focused on institutional aspects of the analysis; primarily how actions took place and how they affected water security outcomes. It was identified that in the Konya Basin a key feature was institutional incoherence. It was shown that The State Hydraulic Works is responsible for tasks such as providing water to farmers for irrigation and building dams and reservoirs, plus licencing of water use. Maintaining water quality is another duty of the DSI. However, the Directorate of Water Management became responsible for river basin planning implementation in 2011, with this new agency responsible for long-term water allocation planning thereby creating coordination problems in responsibilities. In comparison, Chapter 6 illustrates how SGMA implementation took place step-by-step and in a more systematic manner, with better agency coordination. It was revealed that Kern County authorities implemented Groundwater Sustainability Plans (GSPs) in coordination with relevant agencies. Each local Groundwater Sustainability Agency (GSAs) contributed to the overarching basin planning. These agencies also had the responsibly to support other agencies and could comment and receive feedback about GSPs. Our assessment also showed that Kern County set thresholds and modelled water budgets for river basin planning. It was shown that its participatory mechanism increased awareness among stakeholders and agencies in Kern County. For instance, stakeholders had 90 days to express their ideas and give feedback for the umbrella GSP after the first meeting. Additionally, KGA members met monthly in public to open communication channels with all users. In contrast, key findings shows that in Konya the central (i.e. Turkish national) government dominates participatory mechanisms and there is, in contrast to California, no real integration of stakeholders' preferences in decision making.

Additionally, our key findings show that both basins prepared themselves well for drought scenarios as climate change increases the frequency and intensity of such events. Therefore, each case addressed adaptive management in their reports and river basin planning. Our findings show that both basins see water from the perspective of economic value. While Konya assessed the water that did not bring economic value, Kern evaluated how declines in groundwater could lead to job losses while considering reuse of brackish water for adding economic value. Moreover, our cases show that the Konya case showed only a partial holistic approach as a two agency dichotomy exists and this presents obstacles to a full holistic perspective. The agency, in this case the SYGM, who plans, prepares and implement river basin processes as well as monitors its implementation has limited power in the Konya Basin. Again in contrast, another key finding shows that Kern is more holistic than the Konya basin when accounting for other facets of water resources such as geological assessment and coordinating how each local authority contributes to the umbrella GSP, also ensuring that monthly meetings are part of holistic implementation of SGMA. The last key findings regarding institutional attributes illustrate that both cases had positive aspects. For instance, Konya undertook modelling, analyzed water budgets and calculated water allocations for future drought and severe scenarios. Kern County was effective in implementing GSPs with local authorities and through its accounting groundwater budget.

Critically, the thesis findings show that Konya is more water insecure than Kern County. We evaluated three aspects of the water security index to measure this difference. The Konya basin experienced a significant decrease in potential water availability, from 36 percent from 2014 to 2017. This is one the crucial finding because it contradicts the assumption that the WFD should lead to better water security. In the Kern case, groundwater storage decline flattened over the 5 years from 2017 WY to 2021 WY by 58,075 -acre feet average while the long term storage change average from 1995 to 2014 is -277,114 acre feet. This figure illustrates one feature of the successful implication of SGMA implementation. It stands out because Californian experienced a drought from 2011 to 2019 according to official estimates. During these years it could have been expected groundwater storage change would decrease beyond the long-term average. However, the data says otherwise. The research also found that environmental water needs in Konya decreased by nearly half from 2014 to 2017. This figure also shows that WFD process has not lead to increased water security, given that the basis was a national pilot for the Directive’s implementation. However, Chapters 5, 6 and 7 show that the Konya Closed basin maintained its independence status while Kern is dependent on external water bodies, but this dependence slightly decreased from 2019 to 2020.

In the overall water security outcomes assessment, the findings shows that for 2 out of 3 criteria we assessed shows that river basin management implementation through the WFD did not lead to better water security in Konya. It was revealed that weak institutional capacity is causing significant disintegration of the river basin planning and, in consequence, undermines future water security. In Kern, SGMA is not completely successful but annual reports shows no significantly increasing water issues in the basin. It can be said that integration of holistic management and institutional capacity is good enough. In a comparative perspective, Kern County has better institutional capacity that accounts for stakeholders and other parts of water management in a holistic manner much more than Konya. This point leads us to the final objective (objective 5).

Objective 5 involved *making recommendations on future integrated river basin management to better support water security*. In order to meet objective 5, the thesis research utilized lesson-drawing and policy transfer theory to comparatively learn from the export case for the import case with the purpose of enhancing water security through integrative river basin management. Our initial hypothesis was that Kern County in California manages water better in terms of water security and Konya Closed Basin in Turkey could learn from it; an assumption supported by the difference in water security outcomes. Lesson-drawing theory could then be used to suggest potential transfer of the SGMA approach to Turkey, to enhance water security outcomes.

However, we found that higher level, political cultural factors could create obstacles for wholesale transfer of this model. In this respect, the federal system in the US could make policy transfer difficult due to the nature of governing differences in both cases, also reflecting arguments in the lesson-drawing literature. Our findings show that while California is more participatory in water governance, Turkey has adopted a more centralized perspective, thus making political learning problematic. In conclusion, the thesis established that political, economic, and governing systems makes it difficult to draw lessons on transferring the SGMA integrated river basin planning approach in its entirety from Kern County to Konya Closed basin to increase water security. However, lesson-drawing could be possible via basin or local level aspects of planning, at an institutional level. As discussed, there are some aspects of the SGMA institutional mechanisms in the Kern planning process that are potentially transferable to the Turkish context, such as the participatory processes employed at the basin scale and the holistic view of water management, which could provide the basis for policy prescription.

8.3 The added value of the study to the literature

As discussed in Chapter 1, the study contributes to four different areas of the academic literature: security studies (theoretical and methodological contribution); water policy and governance research (empirical contribution); comparative lesson-drawing/policy transfer studies (analytical contribution); and theoretical implementation of IAD-SES (theoretical contribution).

8.3.1 The contribution to security studies

This thesis found that the emerging security studies fields of water security is still in its infancy. The majority of the security literature studies is dominated by IR and Cold War studies, with an emphasis on liberal, realist and constructivist perspectives. Water security is a relatively new addition to this body of research, along with food security and climate security. The thesis review revealed that water security has received much less attention in the normative academic area and, as a result, there is a huge gap in our understanding of practice. Therefore, this thesis contributes empirically to the water security literature specifically but also security studies generally through its examination of new cases. In addition, this study treats water security as a national security matter on the basis that local issues can contribute to or result in national security problems. Furthermore, while the water security literature is growing (for example, Cook & Bakker, 2012; Gerlak et al., 2018), few studies to date have taken an interdisciplinary approach to its study.

This thesis also makes an important methodological contribution to the water security literature through its development of the novel indicators. In security studies, assessing the normative academic assumptions of water security requires the development of relevant frameworks and logical methodological design for empirical analysis. Developing the IAD-SES framework for the purpose of analyzing water security cases and designing methodological approach through water security indicators is a first of its kind, thereby contributing to the water security literature and security studies within social science. Combining this approach with lesson-drawing and policy transfer (see below), adds even greater novelty to the thesis.

8.3.2 The contribution to water policy and governance research

The thesis research found that there is barely any emphasis given to understanding how the decision-making process or water governance action takes place at the institutional level and how it influences outcomes through use of water security indices. In our research therefore, an interdisciplinary approach is employed to address this obvious gap in the literature: by adopting this approach this study brings a holistic view to the field. With the use of IAD-SES, we holistically evaluate water governance, additionally evaluating outcomes through the water security index. An important contribution of this thesis therefore is to explain water security within integrated river basin management. Evaluation of the SGMA implementation makes a significant contribution because not only is Kern County a major agro economic producer but also it also shows how water security is partially achieved through integrated river basin management. Additionally, by evaluating Kern County, this study contributes to research into water governance and policy fields in California. This basin is critically over-drafted and important signifier of wider water management problems in the state. Furthermore, assessing the Konya Closed basin also contributes significantly to research into integrated river basin management generally and the WFD specifically, contributing to Europeanisation studies as well. It also contributes to research into how weak institutional capacity can lead to water insecurity. Finally, the Konya Closed Basin evaluation also contributes to Turkish water management studies, which to date are under-theorised and often empirically descriptive.

8.3.3 The contribution to comparative lesson drawing/policy transfer

By evaluating the possibility of policy learning, this thesis contributes to comparative research, lesson-drawing and policy transfer studies. There are few studies comparing integrated forms of river basin planning on a global scale for lesson-drawing: most research has been undertaken comparatively in an EU context. In this respect, the study could provide the basis for further comparative analysis based upon international comparison using large N studies, to examine how institutional factors as intervening variables are shaping how water security is being addressed within such forms of water governance. In a more normative sense, the research demonstrates the scope for lesson-drawing between countries, which is particularly significant given the promotion of IWRM globally for the SDG agenda and the growth of integrated river basin management globally. While policy transfer, as discussed above, remains problematic given the significant differences between political contexts, there are nonetheless aspects of practice such as public participation mechanisms and monitoring methodologies that could be transferred, after careful evaluation.

8.3.4 The Contribution to Theoretical Implementation of IAD-SES

This thesis used two institutional analysis frameworks in combination to develop a novel analytical approach. This is one of the main contributions of this study. By combining two concepts of IAD and SES into a new form, the thesis brings novelty to the theory field within the environmental management literature. Furthermore, we utilized the flexibility of the IAD-SES to integrate it with the water security index, again adding a degree of novelty to the thesis. So, it is a fundamental contribution of the thesis to bring independent variables and the dependent variable together in one framework frame, in this case through IAD-SES. Moreover, this thesis combines qualitative and quantitative data for the water security analysis of river basin planning and this provides a new methodological contribution to the field of water security.

Variables	Indicator
Bio-physical conditions	Basin size Primary land use Water availability Precipitation

Attributes of a community	Population characteristics Primary economic sector Access to water and sanitation
Governance	Participating governmental and non-governmental actors Network structure Property rights Rules (operational, constitutional, collective choice) Monitoring and sanctioning
Action Situation	Institutions Participation Approach Adaptive management Economic Good Holistic Approach
Water Security Indicator	Agricultural Production Environmental Flow Independence Risk Management

Table 8.3 The IAD-SES framework with integration of the water security index

Table 8.3 shows the holistic table that another researcher can use for their analysis. It identifies the variables and indicators that were used during the PhD study and can be easily applicable if the approach is replicated.

8.4 Future research directions

The thesis could inform further future research in three main areas: theoretical, empirical and methodological. From a theoretical perspective, future research can continue to developing the use of the IAD-SES framework within water security studies in order to highlight the intervening variables influencing insecurity in practice. Combined with lesson-drawing and policy transfer theory, such research can potentially offer new opportunities for learning on best practice. Climate change will present new water security challenges to water managers, so the case for learning between and within countries will increase as part of efforts to increase adaptation and resilience. The WFD is being implemented by other countries that want to join European Union, particularly in the Western Balkans, and potentially Moldova, Georgia and Ukraine, while SDG 6.5 requires all countries to adopt IWRM by 2030. California's roll-out of SGMA provides further opportunities for learning: the state contains 550 groundwater basins that will be preparing and implementing SGMA. With this opportunity, new countries or basins could be evaluated for integrated river basin management implementation and could draw lessons from previous experiences and policy transfer when it is possible.

From an empirical perspective, the IAD-SES framework can then be applied to other basins to test the effectiveness of river basin planning (see Chapter 3). As suggested above, large N studies could be employed to test the explanatory variables across a much wider sample, with statistical testing of hypotheses. However, case selection is crucially important (see Chapter 4). Comparative research may well be become more significant as water security issues increase under a changing climate. Therefore, knowledge of policy and management innovations will be required. There is still gaps in water security assessments due to data limitations (see Chapter 5, 6, 7): with more timely and accessible data, future research can contribute to the water governance as well as the water security field. As SGMA is relatively new and WFD implementation is also still being implemented in Turkey, in the future years, new analyses would be needed to gauge progress in river basin management.

Changes in climate also brings uncertainty within water management, requiring methodological innovation. By applying the IAD-SES framework and integrated water security index, one can analyze future water issues in a basin by looking at biophysical attributes, socio-economic values and water security outcomes. However, for this type of future prediction, sophisticated methodologies such as stochastic probability and machine learning techniques could be used to forecast future data and thus develop the water security index to inform additional research. Indeed, machine learning algorithms have significant potential to inform future water governance but this aspect is largely unexplored outside of the USA, where only preliminary studies are evident (see Malekzadeh et al., 2019; Miro et al., 2021; Sahoo et al., 2017). Access to available 'big data' can increasingly bolster developments in water security index research through allowing real time and time series analysis across different scales (for an overview of the latest methods, see Sun & Scanlon, 2019). In combination, these new techniques can also support 'algorithmic governance' (Kalpokas, 2019) in water management planning through providing powerful predictive tools for policymakers and practitioners that massively increase the rapidity of learning within adaptive processes. Collaboration between quantitative water and climate scientists and qualitative social science researchers could also help develop new water security indices that can be used in both fields.

8.5 Summary

This research has achieved the aims set out in Chapter 1. The overarching research question is answered through consideration of several sub-questions (see Chapter 1). Two case studies have assisted to analyze to what extent river basin planning can enhance water security. With that, we were able to assess effective implementation of river basin planning with the help of IAD-SES hybrid approach. The results shows that weak institutional capacity exists in Konya Closed Basin, leading to water insecurity, while Kern County demonstrates a strong institutional mechanism which partially leads to water security. In answering the question, *to what extent do different forms of integrated river basin management support water security?* the answer is manifestly that it can help achieve this outcome but that institutional factors are critical to effectiveness. On this basis, much could be learned from Kern County for the Konya Closed Basin specifically and Turkish river basin planning generally in increasing water security, but such lessons are limited for potential transfer and require careful consideration due to contextual differences. Future studies could learn lessons from these cases or take the research approach utilised in the thesis forward to show how it could contribute to understanding water security conditions in other contexts.

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