Water Resources Allocation
Sharing Risks and Opportunities

Chapter 1

Re-allocating water in a water scarce world

This chapter provides an overview of current and future challenges facing water allocation regimes, which are compromising their performance. It examines how competition for water resources is growing due to shifting demand, climate change, and changing societal preferences. The chapter also discusses how these pressures increase the value of well-designed allocation regimes that perform well across a range of conditions (averages as well as extremes) and can adapt to changing conditions at least cost.

Key messages

- Allocation regimes determine who is able to use water resources, how, when and where and directly affect the **value** (ecological, socio-cultural, or economic) that individuals and society obtain (or forego) from **water resources**.
- Allocation regimes are strongly conditioned by **historical preferences and usage patterns**. They trace their roots to previous decades or even centuries and have usually evolved in a piecemeal fashion.
- **Current and growing pressures** on water resources increase the **value of well-designed allocation regimes** that perform well across a range of conditions (averages as well as extremes) and can adapt to changing conditions at least cost.

Water resources serve multiple purposes and provide value to individuals, ecosystems, farms, firms, and society in various ways. The value obtained from water resources encompasses many forms – from ecological value provided by supporting key species, to socio-cultural value, to economic value derived from productive uses of water, to the existence value of iconic lakes or rivers.[1] How much water is left in water bodies (rivers, streams, aquifers) and how much is diverted for various uses; who is able to use these resources, how, when and where are questions that directly affect the value that individuals and society obtain from water resources. These questions are determined by allocation regimes, whether formal or informal. In this report, the term "allocation regime" is used to describe the combination of policies, mechanisms, and governance arrangements (entitlements, licenses, permits, etc.) used to determine who is allowed to abstract water from a resource pool, how much may be taken and when, as well as how much must be returned (of what quality), and the conditions associated with the use of this water (see glossary for key terms).[2]

The growing pressures on water resources and intensifying competition to access and use water is widely documented (OECD, 2012; WRI, 2015; UNESCO, 2012; Vörösmarty et al., 2010; Vörösmarty et al., 2002; Alcamo et al., 2000). Both demand and supply side pressures are on the rise, driven by economic development, population growth, deteriorating water quality and climate change. The *OECD Environmental Outlook to 2050* highlights that water resources are already over-used or over-allocated in many places. This is the case where current levels of abstraction exceed the sustainable level ("over-use") or where existing water entitlements (e.g. licenses or permits) to abstract water exceed the sustainable level ("over-allocation"). For example, groundwater[3] in many parts of the world is being exploited faster than it can be replenished and is also becoming increasingly degraded due to the impact of pollutants. Between 1960 and 2000, the rate of groundwater depletion more than doubled (OECD, 2012). Often, adequate environmental flows have not been secured, threatening the health of freshwater ecosystems.

The situation is compounded by climate change. Climate change increases water risks – both quantity and quality, along with disrupting freshwater ecosystems. It also generates increased uncertainty about future water availability and makes historical climate conditions a less reliable guide to current and future planning. Climate change can provoke significant shifts in the timing, location, amount and form of precipitation (for instance from snowfall to rain). More frequent and intense droughts can also be expected in many regions.[4] Beyond changes in both averages and extremes, climate change can also result in "state level" shifts. Increasing variability and less predictable supply pose new challenges for allocation (OECD, 2013a; OECD, 2014a).

These pressures have already made water allocation a pressing issue in a number of countries and an issue that is rising on the agenda in many others, even some traditionally water abundant countries, like Brazil, the Netherlands, France and the United Kingdom. Water allocation regimes in most countries have evolved gradually over time, often in a piecemeal fashion. Their design was driven by past development policies, based on historical water availability, and influenced by social preferences, general economic context and available techniques of previous generations. Some allocation regimes trace their roots to previous centuries and many were not designed to adjust to changing conditions and societal preferences. Growing pressures are making existing inefficiencies in water allocation regimes increasingly costly; 19th century allocation arrangements are poorly equipped to serve a 21st century society and economy.

However, once established, allocation arrangements have proven difficult, and often costly, to adjust. These allocation arrangements exhibit a high degree of path dependency, which manifests itself in both institutional arrangements (law, property rights and policies) and long-lived water infrastructures, such as dams, canals and pipelines. As a result, allocation regimes are usually not well-equipped to deal with mounting pressure on the resource, the emergence of new scientific understanding (of the resource or of related ecological needs), or adapt to shifts in societal preferences, such as increasing value placed on water-related ecological services. The challenges for allocation are aggravated by the entrenchment of weak water policies (under-pricing water or lack of regulating use), which contributes to structural water scarcity, increasing the risk of shortage for users and for the environment.

Growing pressures on water allocation regimes

The lack of a sufficient quantity of water of adequate quality to satisfy demand creates a risk of shortage for certain users. There are a number of drivers (both demand and supply side) that affect the risk of water shortage. The risk of shortage is determined by: 1) the consequences (impacts) of a shortage of water for a given use; and 2) the likelihood of its occurrence. It is driven by the intersection of hazards, exposure and vulnerability. Water shortage arises from conditions of scarcity, which can be defined as "*an imbalance between the supply and demand of freshwater as a result of a high level of demand compared to available supply, under prevailing institutional arrangements (including price) and infrastructural conditions*" (Winpenny, 2011).

When considering scarcity, it is useful to make a distinction between economic and absolute scarcity. Economic scarcity exists when there has been underinvestment in water infrastructure to supply sufficient amounts of water. Absolute scarcity exists when there is no affordable source of additional water, or where the costs of additional water supplies exceed the benefits of their provision. In the case of absolute scarcity, it is necessary to keep use within the limits of sustainable use. Once absolute scarcity has been reached, the design of the allocation regime becomes crucial (Young, 2013).

The availability of water is not only a question of quantity. Deteriorating water quality as a result of both point source and diffuse discharges, also affects water availability. Degraded water quality changes the economics of resources use, as inadequate quality requires treatment before use and reduces the value that can be derived from certain in-stream uses (bathing, ecosystem functioning, etc.).

Current and growing pressures that contribute to the risk of shortage increase the importance of well-designed allocation regimes. The availability of the resource pool for allocation is determined by the physical characteristics of water resources, investments in water infrastructure, as well as shifting, and increasingly less predictable climatic conditions. In a changing climate, the frequency and intensity of extreme events is projected to increase in many areas. With the "exceptional" becoming more commonplace, these changes mean that the way in which "exceptional circumstances" are currently defined in allocation regimes merit re-evaluation. Finally, changes in aggregate water demand, as well as the composition of that demand, affect the allocation among various uses, reducing or intensifying competition among and within certain categories of uses.

Changing societal preferences are an important factor in determining the repartition between *in situ* and diverted uses, in particular the determination of environmental flow requirements, and the sequence of priority uses (where they exist). Improvements in water use efficiency effectively change the rates of consumption, affecting return flows and the available resource pool. All of these trends create pressures on existing allocation regimes, increasing the value of flexible, clearly defined, effective and efficient allocation arrangements. These trends and their relevance for allocation are summarised in Table 1.1 and then discussed in the following sections.

Table 1.1. **Trends affecting water allocation regimes**

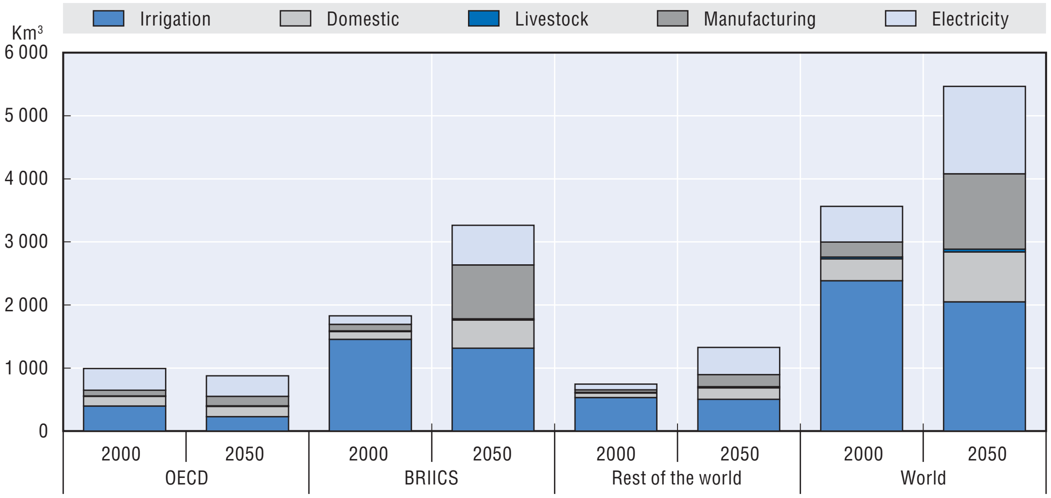
Trend	Implications for allocation regimes
Changing demand patterns	● Affects the available resource pool. ● Affects the competition among and within categories of water uses. ● Affects the type of water (piped, level of quality) demanded and the desired reliability of supply.
Climate change impacts on freshwater	● Shifts the timing, location, form and amount of precipitation, affecting the available resource pool. ● Increases uncertainty about the availability of freshwater. ● To the extent that extreme events will occur more frequently, makes "exceptional circumstances" more commonplace.
Deteriorating water quality	● Affects the available resource pool. ● Increases the cost of water resource use.
Improving water use efficiency	● Affects the available resource pool. ● Changes rates of consumption. ● May reduce return flows, reducing availability for subsequent uses. ● Increases the importance of specifying return flows in entitlements.
Shifting societal preferences	● Changes the value placed on *in situ* and diverted uses. ● Affects the value placed on water for environmental purposes, influencing the definition of environmental flows.
Improving scientific understanding of the resource or environmental flow requirements	● Affects the understanding of the resource and its interaction with other water bodies. ● Affects the definition of environmental flows or other *in situ* flow requirements. ● May also influence the understanding of the value of environmental flows (e.g. in terms of supporting key species or habitats).

Changing patterns of demand

A world economy four times larger in 2050, and with over 2 billion additional people, will need more water. Under the *OECD Environmental Outlook's* baseline scenario, global water demand is expected to increase by around 55% between 2000 and mid-century. This is primarily due to growing demand from manufacturing (+400%), thermal power plants (+140%) and domestic use (+130%), as depicted in Figure 1.1. As a result, there is little scope for increased use of irrigation water use in most regions. This "squeeze" on irrigation use comes about because domestic and industrial uses are usually prioritised over lower value or less efficient irrigation uses in water allocation regimes (at least in most OECD countries). Water for the environment will also be competing with these demands, adding to existing stressors on freshwater ecosystems (OECD, 2012).

However, trends in water demand diverge between OECD and non-OECD countries. In OECD countries, water demand is actually projected to decrease somewhat (from 1 000 km^3 in 2000 to 900 km^3 in 2050). This projected decrease in demand in OECD is expected to be driven by efficiency gains as well as a structural shift in the economy towards service sectors that are less water intensive. In contrast, water demand is projected to increase significantly in the BRIICS (from 1 900 km^3 in 2000 to 3 200 km^3 in 2050) and to a lesser extent in the rest of the world (from 700 km^3 in 2000 to 1 300 km^3 in 2050). Most of the population in river basins expected to be under severe water stress live in the BRIICS (OECD, 2012).

Figure 1.1. **Global water demand, baseline scenario from 2000-50**

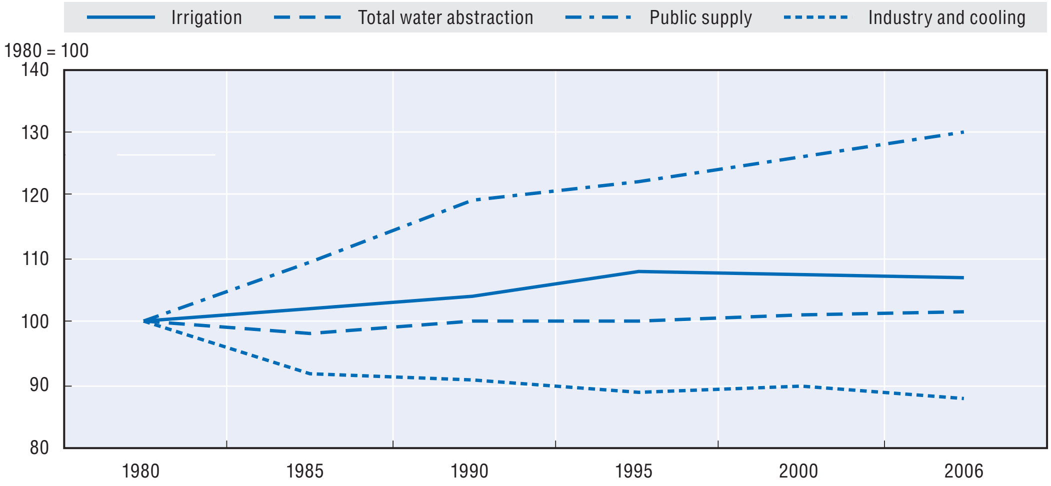


Source: OECD (2012), *OECD Environmental Outlook to 2050: The Consequences of Inaction*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264122246-en*; output from IMAGE.

Nevertheless, it is important to note that aggregate demand projections can be misleading, as figures at the national level can mask regional or local scarcity and temporal issues. The location and timing of demand relative to supply determines the scarcity conditions, and hence, the risk of shortage. Even water-abundant countries, like Brazil or the Netherlands, face localised and seasonal episodes of scarcity. As a result, it is doubtful, that this reduction in demand will be enough to address the serious regional stresses that already exist in parts of Australia, Israel, Mexico, Spain and the United States (OECD, 2013b) and emerging stresses elsewhere.

Changes in aggregate demand affect allocation, but how demand is repartitioned among various uses is also relevant. Recent trends in abstraction per use in OECD countries reveal a substantial re-allocation of water among various uses (Figure 1.2). Trends indicate a shift towards typically higher value and higher priority uses. For instance, the increase in

Figure 1.2. **Freshwater abstractions in OECD countries**



Source: OECD (2010), *OECD Factbook 2010: Economic, Environmental and Social Statistics*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/factbook-2010-en.*

demand for public water supply (e.g. water supply for domestic consumption), shifting away from irrigation is significant since public supply uses tend to have a higher priority status in allocation regimes. There is also an implication for the type of water demanded (piped, level of quality) and the level of reliability required. While farmers growing annual crops can make adjustments in cropping decisions if rainfall is delayed, a fruit grower, a city or some industries cannot. If overall demand for water may be levelling off and even declining in OECD countries, competition among higher priority uses is in fact intensifying, narrowing the margin of manoeuvre for adjustment during episodes of shortage.

Climate change impacts on freshwater

In a changing climate, precipitation patterns are shifting rainy seasons and affecting the timing and quantity of melt water from snow pack and glaciers. More torrential rains, floods and droughts can be expected in many regions. Climate change impacts on freshwater resources are already evident and are projected to become more significant and to accelerate over time (Bates et al., 2008). Projected changes in the water cycle can have significant impacts on agricultural production in practically all regions of the world resulting in destabilising impacts for agricultural markets, food security and non-agricultural water uses (OECD, 2014a). These changes present a singular challenge for water systems by rendering the historical assumption of stationarity[5] increasingly unreliable as a basis for water management (Milly et al., 2008). This means that a fundamental assumption upon which many water allocation regimes are based will no longer be a sufficiently reliable basis for future planning and allocation (Brown, 2010).

Climate change is bringing about not just shifts in mean precipitation, but also shifts between seasons and between years, as well as extremes, with more frequent and severe floods and droughts expected in some regions. Changes may be gradual or sudden, resulting in "state level" shifts.[6]

Despite abundant evidence of climate change impacts on freshwater, there is significant uncertainty about the precise nature, timing and magnitude of expected shifts at the relevant scale for allocation decisions. The level of confidence in climate change projections for key water parameters decreases as their potential utility for water management decision-making increases (OECD, 2013a). In the future, allocation regimes will need to accommodate considerable uncertainty about water availability and the needs of ecosystems. Increasing variability and frequency of extremes as well as greater uncertainty about future conditions increases the value of well-designed and flexible allocation regimes.

One of the most common mistakes made when considering how best to manage water allocation is to assume that the impact of climate change on water supply will be gradual. Experience has shown that sudden climatic shifts can occur. In the case of Perth, a sudden shift appears to have occurred in 1974, as illustrated in Box 1.1 Since then, the amount of water available for consumptive use in this region has more than halved.

Reductions in rainfall can produce an even more drastic reduction in streamflow. In the case of Jarrahdale, a 14% reduction in rainfall resulted in 48% less stream inflow; 20% reduction in rainfall resulted in 66% less stream inflow. The impact of the reduction in stream inflow has an even greater impact on consumptive use. This is because sufficient base flows are still required before water can be extracted. This means that a relatively small reduction in mean rainfall can ultimately have a massive and disproportionate impact on the volume of water available for use (Figure 1.5).

Box 1.1. **Abrupt shifts to a drier climate, an example from Perth**

In 1974, the city of Perth in Western Australia appears to have experienced a sudden unexpected shift to a drier climatic pattern. Since that year, mean rainfall has been between 14% and 20% less than it was for the first two thirds of the century (Figure 1.3). As a result, inflows into Stirling Dam have more than halved (Figure 1.4).

This experience demonstrates how state level shifts in climatic patterns are possible and how relatively small reductions in mean rainfall can result in a dramatic reduction in the quantity of water available for use.

Figure 1.3. **Historical trends in rainfall for Jarrahdale**

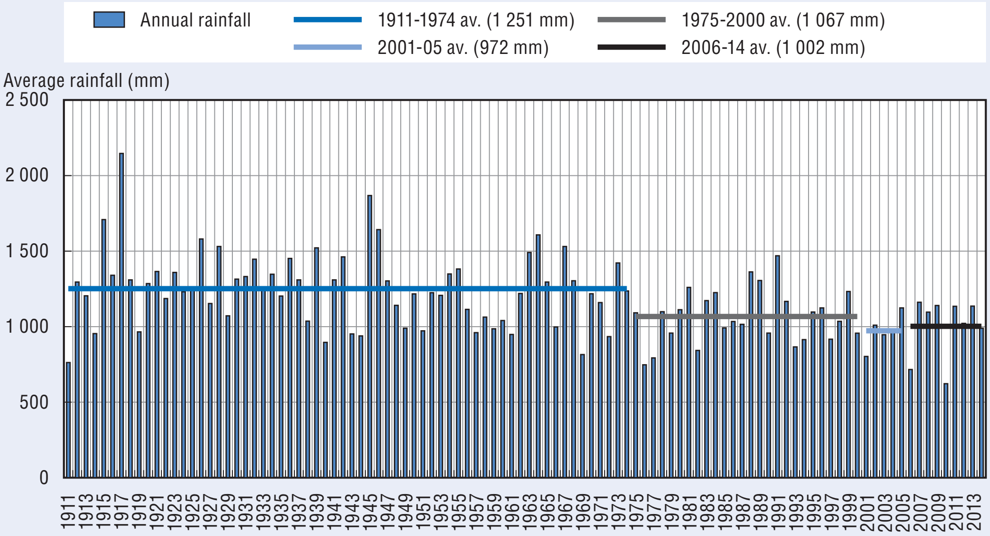
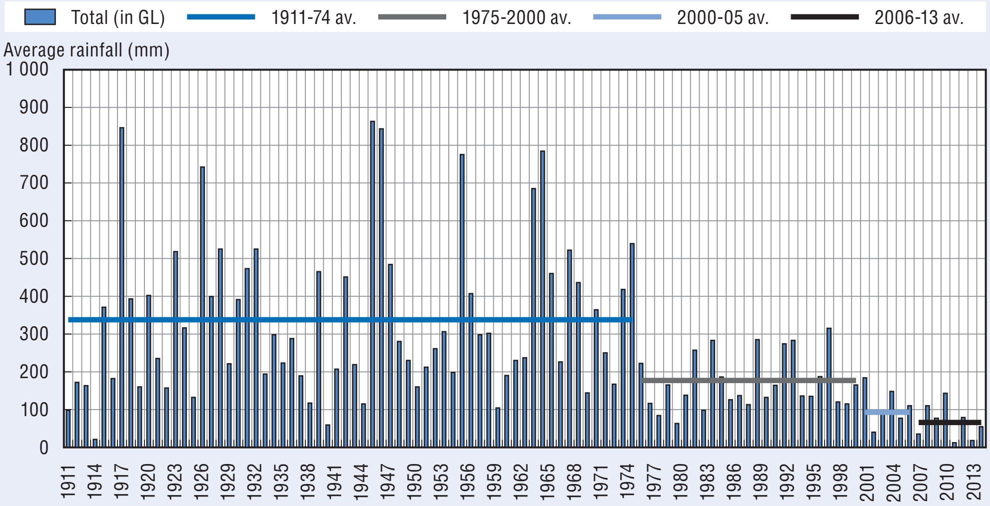


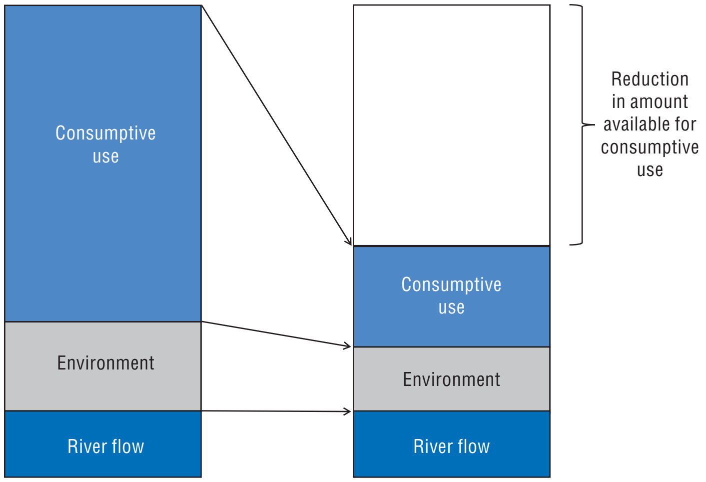
Figure 1.4. **Historical trends in streamflow into Stirling Dam**



Notes: Streamflow is from May of labelled year to the following April. In order to provide an accurate historical comparison streamflow from Stirling, Wokalup and Samson Brook Dams are not included in this data as these dams only came online in 2001. Inflow is therefore modelled on Perth dams pre-2001.

Source: Water Corporation of Western Australia (2014), *www.watercorporation.com.au/water-supply-and-services/rainfall-and-dams/streamflow/streamflowhistorical.*

Figure 1.5. **Effect of reduction of stream inflow on the amount of water available for consumptive use**



Source: Young, M. (2013), *Improving Water Entitlement and Allocation*, background paper for the OECD project on water resources allocation (unpublished).

Deteriorating water quality

Water availability is affected not only by the available quantity of water, but also its quality. Deteriorating water quality constrains water availability (varying by type of use and the degree of quality required). It also affects the economics of water resource use, as poor water quality requires costly treatment before use and also reduces the value that can be derived from in-stream uses (impeding ecosystem functioning, fisheries, bathing, etc.).

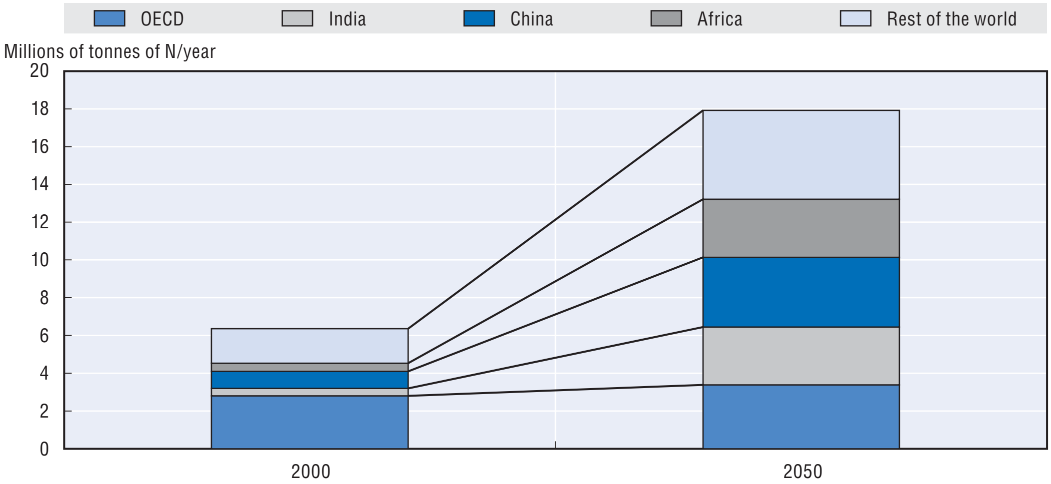
Globally, trends indicate that water quality is expected to stabilise or improve in most OECD countries by 2050, while outside the OECD, water quality is expected to deteriorate (OECD, 2012). Declining water quality is mainly due to nutrient flows from agriculture and from absent or poor wastewater treatment. This results in increased eutrophication, biodiversity loss, water-related disease and an increase in costs for treatment prior to use. Worldwide, a significant portion of wastewater remains untreated, especially in developing countries. Water pollution from urban sewage is expected to increase 3-fold by 2050, as compared to 2000 (Figure 1.6), as progress in urbanisation and wastewater collection outpace investment in wastewater treatment.

Another example of deteriorating water quality is in the Netherlands, where increasing salinity in some regions has contributed to the increasing risk of shortage. This is spurring a review of policy options for freshwater supply, including allocation arrangements (Box 1.2).

Water use efficiency gains and changes in rates of water consumption

Improvement in water use efficiency is among the factors behind declining demand in OECD countries. Generally, this is a positive trend, as improved efficiency can relieve stress on water resources and free up water for other uses (*in situ* or diverted). However, even radical gains in efficiency of current uses may not be enough to avoid a more fundamental appraisal of the allocation of water (OECD, 2012). Furthermore, efficiency improvements can result in unintended consequences for water allocation, when consumption rates change and return flows are not properly accounted for.

Figure 1.6. **Nitrogen effluents from wastewater: 2000 to 2050**



Source: OECD (2012), *OECD Environmental Outlook to 2050: The Consequences of Inaction*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264122246-en*.

While some arid countries have been managing water scarcity for centuries, in many other countries water allocation regimes were established during times of abundance (perceived or actual). As a result, it is common for many regimes to give little attention to the effects of use by one user on the use of another user. One of the most common oversights is a failure to account for return flows. Thus, in many allocation regimes, return flows of water entitlements are not specified, and consumption rates of various uses are estimated (if at all) using generic co-efficients. Increasing efficiency of water use increases the consumption-intensity, meaning that return flows (a positive externality of water use) are reduced. This leaves less water available to seep into groundwater or available for downstream users. This situation can also arise with significant interceptions of run-off, such as afforestation, which are not usually considered “water users” in formal arrangements. This can result in an over-estimation of available resources and as a result, over-allocated or over-used resources.

A striking example is the case of water use for energy production. According to the IEA’s *World Energy Outlook* (2012), the water-intensity of global withdrawals and consumption for energy production (water withdrawals and consumption per unit of energy produced) head in opposite directions in the period assessed in the study. Figure 1.7 depicts projected shifts in water-intensity of energy production. Withdrawal-intensity of global energy production falls by 23%, whereas consumption-intensity increases by almost 18%. This is mainly the result of an expected shift in the power sector away from traditional once-through cooling systems towards wet towers (that reduce withdrawals but raise consumption).

A reduction in withdrawal-intensity implies that less water will be abstracted per unit of energy produced, which can have a positive impact on water resources allocation (depending on the overall trend for energy production) by freeing up water for other uses. However, as consumption-intensity increases and if return flows are not properly accounted for, the integrity of the allocation system may be undermined.

Box 1.2. **Increasing risk of shortage in the Netherlands strains the current approach to water allocation**

Even in a water abundant country like the Netherlands, periodic and localised scarcity can arise, putting pressure on the existing allocation regime and resulting in costly impacts. The Netherlands is experiencing a growing risk of shortage due to a lack of water in some regions and increasing salinity in others as sea water intrudes into the delta and saline groundwater rises. Climate change is expected to increase the variability of water supply and slightly reduce water availability. Periods of drought and low river discharge occurred in 1976, during the very dry summer of 2003, the dry spring of 2005 and in 2011. In some cases, water had to be trucked in from other regions to avoid significant losses to high value agriculture. Competition among users is also intensifying, such as increasing demand for electricity, increasing power stations, which sometimes conflicts with other water interests (OECD, 2014b).

Water shortages impose significant costs or result in reduced revenues or benefits for the agriculture, shipping and energy sectors, and for nature conservation and recreational uses. Remarkably, with a total surface area of 41 500 km^2 (of which 7 500 km^2 is water and 19 100 km^2 is agricultural area), the Netherlands is one of the largest net exporters of agricultural products and foods in the world (along with France and the United States), exporting EUR 65 billion worth of vegetables, fruit, flowers, meat and dairy products each year (OECD, 2014b). According to Jeuken et al. (2012), estimates of economic loss to the Dutch agricultural sector may reach EUR 700 million in a "dry year" (frequency of 1 out of 10 years) and EUR 1 800 million in an "extreme dry year" (frequency of 1 out of 100 years).* These figures are equal to 0.1% and 0.3% of GDP respectively. These damages could increase significantly due to climate change and socio-economic developments. The Ministry of Economy, of Economic Affairs (2011) estimated that damages could increase fivefold in 2050, translating into a loss for the agricultural sector of EUR 700 million once every two years (Jeuken et al., 2012).

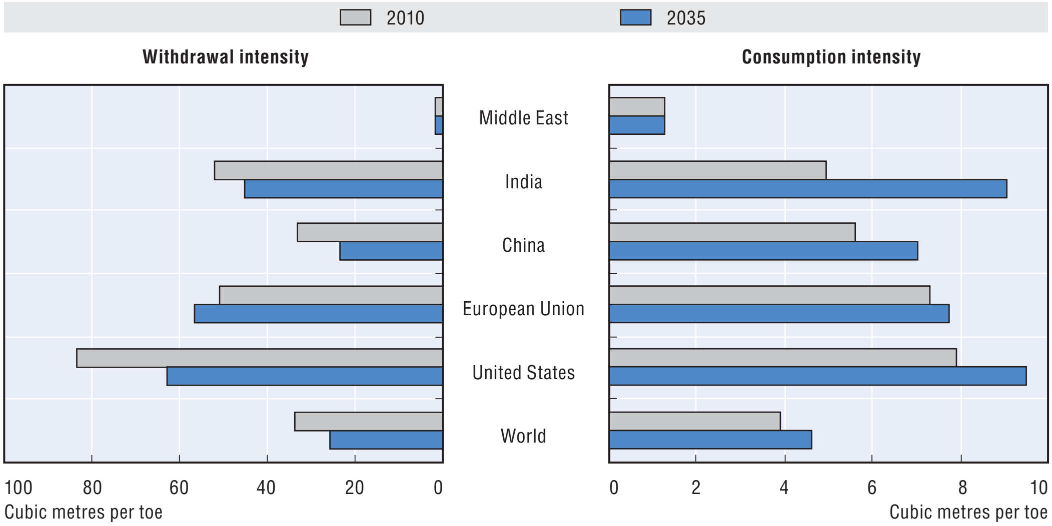
Recognition of the increasing risk of shortage and the challenges they present, the Delta Programme has included freshwater supply as one of the main programme areas. It is spurring reconsideration of the prevailing approach to allocation. Currently, a priority regime is used to limit abstractions during periods of water shortage. Flood safety (ensuring that dykes do not dry out and collapse) and the prevention of irreversible damage to the environment are the top priority. Second priority is given to drinking water and power supply needs. Capital-intensive agriculture and industrial uses are the third priority, while the fourth priority is given to other types of agriculture, the environment (aside from cases where irreversible damage can occur) and other uses.

Managing shortage incidents takes the form of priority regime banning. This is a pragmatic approach and works as a short-term strategy in cases where shortage incidents occur infrequently. It also has a relatively low cost of implementation as elaborate administrative arrangements are not necessary. However, the blunt nature of priority ranking regimes means that there are few incentives for water users to proactively manage the risk of shortage. When shortage occurs in such a priority regime, the introduction of a ban is often sudden and final. Users within a given priority category are treated uniformly, even if there are significant differences in their water needs, the value they assign to water, or their risk preferences (e.g. willingness to pay to avoid the risk of shortage). They have few or no options to respond when shortage occurs. Since the expectation is that water shortages will become more frequent in the future, the limitations of the current approach are likely to become more evident.

* A "dry year" has a precipitation deficiency of more than 220 mm in the summer. An "extreme dry year" has a precipitation deficiency of over 360 mm in the summer.

Sources: OECD (2014b); Jeuken et al. (2012).

Figure 1.7. **Projected shifts in water-intensity of energy production**



Source: IEA (2012), "Water for Energy", *World Energy Outlook 2012*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/weo-2012-en*.

Shifting social preferences

The value derived from water uses and the objectives of water allocation have changed over time, reflecting shifting social preferences. Water resources have traditionally provided a range of socio-cultural values. These include the existence value of an iconic lake or river; aesthetic value, which may be reflected in property values located near attractive water bodies; or values associated with Indigenous heritage or other community uses of water resources. Historically, the terms of access to water have often been used as an incentive to drive certain development priorities, including supporting irrigated agriculture, energy production and water-intensive industrial sectors. In the western United States, water use entitlements were used as an incentive to settle and develop land, privileging early users over those who made claims later. This arrangement was institutionalised in the system of *prior appropriation*, whereby the "first in time" is the "first in line" to access water, which has proven difficult to change.

Water requirements to ensure adequate environmental flows have begun to be seen as a legitimate and valuable use of water only relatively recently in many countries. The need to restore adequate environmental flows to support vital ecosystem functions and freshwater biodiversity is generating increasing attention in many countries. This is reflected in efforts to allocate more water to support ecosystem services, often requiring the curtailment of diverted uses in situations of scarcity. The EU Water Framework Directive's requirement for member states to achieve good ecological status, for which flow is a supporting factor, for natural water bodies, (and good ecological *potential* for heavily modified and man-made water bodies) is indicative of this trend. The need to secure sufficient water for the environment is among the factors driving the reform of the abstraction licensing regime in England and Wales (Box 1.3).

Another example of this trend is seen in Australia. In the Murray-Darling Basin, an environmental watering plan has been developed to co-ordinate environment water use. One of the three primary objectives of the draft plan is ensure the resilience of water-related ecosystems to climate change and other risks. To help achieve these aims, the

Box 1.3. **Inflexibility of current regime and growing pressures help build the case for abstraction reform in England and Wales**

Despite its reputation as a wet country, the east and southeast of England have very low water resource availability, with as little as 300 mm per annum of effective rainfall. Many rivers are of high ecological sensitivity and of international importance for their conservation value. Population density is highest in these areas of lowest rainfall so demand is greatest where resources are the scarcest. This has led to many rivers are being damaged or threatened by unsustainable abstraction.

The current system for managing abstraction of water from rivers and aquifers in England was set up in the 1960s, when water was perceived to be abundant. It was not originally intended to manage competing demands for water. Passed in 1963, the Water Resources Act was, for its time, innovative and far-reaching. Although the act required every licence to be assessed according to its reasonable need and its impact on the aquatic environment, over time the former has changed and the latter is now much better understood. In addition, changing patterns of demand have left many licences under-utilised, with no straight-forward mechanism for trading resources.

The United Kingdom's Environment Agency manages and regulates the allocation of water resources in all catchments in England. It currently has a major programme to address these damaging abstractions. However, because abstraction licences are deemed to be a property right, compensation may be payable when licences are forcibly changed or revoked. This means that the process of achieving a sustainable flow regime, or reacting to changing patterns of resource availability or demand, can be slow and expensive.

The Environment Agency has modelled a range of climate change scenarios to understand their potential impact on river flows and water availability out to the 2050s. It has also matched these with scenario planning using different socio-economic models in order to understand how demand for different purposes (public water supply, energy and agriculture) might change over a similar time horizon. This work has demonstrated that under some scenarios, water availability could decrease significantly and that demand – driven in particular by projected population growth – might also increase in a way which would mean widespread impacts on rivers and ecosystems together with risks to security of supplies.

Although there is a structured approach to public water supply planning which takes account of changes in demand and the impacts of climate change over a 25-year horizon, the Environment Agency and the United Kingdom government were concerned about the long-term risks to the environment and water supplies.* It was recognised that the current system is too inflexible to be able to cope adequately with changes in demand and resource availability, and potentially could act as a drag on economic growth. The government launched a consultation in December 2013 on proposals for a more flexible and dynamic system which would be able to react to future uncertainties and allow access to resources in a reformed regulatory system. At its heart, any new system would ensure that there was sufficient water for the environment, adequately protected at all flow states, and that above this threshold, water would be available for allocation. As long as all abstraction licences have a sustainable basis, there is then the potential for greater trading and economic benefit from more efficient use.

In parallel, water companies are responding to the need to improve the connectivity of their supply systems in order to increase their resilience, and also to seek opportunities for sharing water across company boundaries. The Environment Agency is also working to take a more strategic approach to the long-term water demands of the agriculture sector and energy generation so as to drive a more integrated approach to resource management across the water-food-energy nexus.

* The Environment Agency developed a "Case for Change" which supported a government *White Paper* ("Water for Life") in 2011. This set out a range of proposals for the reform of the public water supply industry and the abstraction licensing system.

Source: OECD (2014b) based on input from Ian Barker, former Head of Water, Land and Biodiversity at the UK Environment Agency.

Commonwealth Environmental Water Holder was established as a statutory position under the Water Act to manage water recovered by the Australian Government to protect and restore environmental assets. A water entitlement buy-back programme is underway, with AUD 3.1 billion set aside for purchasing water entitlements to help restore the health of vitally important rivers, wetlands and floodplains (OECD, 2013a). These policy orientations reflect the greater value placed by society on ensuring adequate water to maintain ecosystem services. They also require a re-evaluation of allocation arrangements.

Conclusion

Growing pressures are making existing inefficiencies in water allocation regimes increasingly costly. Current water allocation regimes are strongly shaped by historical preferences and usage patterns. Most allocation regimes have been established in piecemeal fashion over the course of previous decades (and sometimes centuries). As such, they are usually poorly equipped to adjust to changing conditions and to deal efficiently with current and future pressures. This can result in various costs, or lost opportunities to capture greater value from water resources. Impacts include degraded environmental performance (where minimal flows required to support ecosystem services are not secured), lost opportunities for economic development (when water insecurity holds back investment), and inequitable management of water risks (where responses to water scarcity, such as banning low priority uses, place the risk of shortage disproportionally on certain groups of users).

To ensure that the use of water resources can better meet the needs of society today and in the future, allocation regimes deserve review and where necessary, reform. The remainder of the report elaborates a framework that public authorities and water users interested in identifying and improving allocation arrangements can use to enhance their performance and reap greater benefits from water resources.

Notes

1. The TEEB report, *The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations* (2010), provides a detailed discussion on the various types of values provided by natural capital.
2. This report discusses issues related to both surface and groundwater allocation. The specificities of groundwater allocation will examined in greater depth in a forthcoming OECD project. See: OECD (2015a) for a report on groundwater use in agriculture in OECD countries.
3. See: OECD (2015a) for a comprehensive overview of the status and characterisation of groundwater resources in agriculture in OECD countries.
4. See: OECD (2015b) for a comprehensive analysis of policy approaches to droughts and floods in agriculture.
5. As expressed in Milly et al. (2008), stationarity is the idea that natural systems fluctuate within an unchanging envelope of variability. It is a foundational concept that permeates training and practice in water-resource engineering.
6. See: Wickel and Matthews (2012), “Modes of Climate Change”, in OECD (2013), *Water and Climate Change Adaptation: Policies to Navigate Uncharted Waters*, OECD Publishing, Paris.

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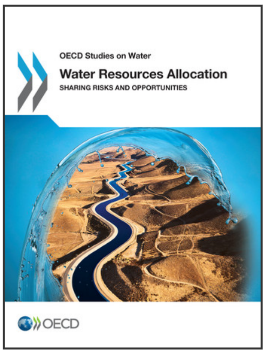

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