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REFORMING WATER POLICIES IN AGRICULTURE: LESSONS FROM PAST REFORMS

Guillaume Gruère, OECD
Colette Ashley, University of Chicago
Jean-Joseph Cadilhon, OECD

Agriculture's water quality and quantity challenges continue to grow in many regions of the world. Policy solutions have been identified, but not always applied where needed nor implemented effectively. This report analyses eight past water and agriculture policy changes in OECD countries with the aim to identify steps towards adopting and implementing such solutions effectively. Selected reforms are assessed systematically via an institutional change analysis and a cross-cutting comparison of political economy factors. A characterisation of reforms is proposed according to the scope of the reform process, the scope of the reform's action, and the involvement of governments in the design of reforms and their implementation. The comparison of agriculture and water policy changes shows that introducing reforms can be facilitated by exogenous factors, including droughts and floods, and reform design features. Meanwhile, the outcome of reforms can be affected by their geographical scale and scope, the dynamic pattern of reform pathways, and compensation for farmers. There are, however, trade-offs between the effects of these factors on the reform's ambition, effectiveness, efficiency, and flexibility.

Keywords: Agriculture policy, water policy, political economy, reform process, water prices, water markets, irrigation, nonpoint source pollution

JEL codes: P48, Q18, Q25, Q28, Q58

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Executive Summary

Agriculture faces two inter-related water challenges: the sector needs to reduce its detrimental impact on freshwater resources, and it needs to address the increasing water risks it faces, resulting from water scarcity, water over-abundance or water quality degradation. These challenges will continue, if not intensify, unless additional meaningful action is taken, including by improving existing water and agriculture policies.

Policy solutions have been identified but have not always been adopted effectively. In particular, water in the agriculture sector remains available at a cost lower than that for other sectors in most countries. Similarly, policies aiming to improve water quality have not been sufficient to address the pollution problem resulting from agriculture nutrient and pesticide run-offs in many OECD countries.

Potential policy changes on agriculture and water have been discussed both at the international level by agriculture ministers and at the national one by governments. Turning possible solutions into actual policy change and implementation requires effective pathways to reform to be considered.

The objective of this report is to draw lessons on reforms from the past four decades and thereby help governments better understand how to undertake policy changes at the agriculture and water interface. In particular, identifying the key drivers and determining factors in past policy processes can increase the likelihood of the adoption and implementation of necessary policy changes. To this end, this report reviews and analyses lessons from eight past water and agriculture reforms in OECD countries, evaluating the political economy factors that contributed to policy changes.

The analysis identifies three groups of reform based on the scope of the reform process, the scope of the reform action and the involvement of governments in reform design and implementation.

- The first group of reforms involved major government-based changes in water policy, governance and institutions beyond agriculture. This group comprises water allocation regime changes in Australia's Murray Darling Basin, Israel's use of water pricing and the EU Water Framework Directive.
- The second group of reforms involved more specific agriculture and water policy changes that required significant government involvement but relied on existing institutions. This group comprises three reforms: the EU Nitrate Directive, the US Conservation Reserve Program and Korea's programme on manure recovery,
- The third group of reforms also involved agriculture and water policy changes, but the reforms relied on partnerships with private actors to implement changes. These are the US Regional Conservation Partnership Program and the United Kingdom's Catchment initiatives.

This characterisation and the comparison of the respective policy pathways under each group can help anticipate the steps needed for different types of future reforms. Reforms associated with significant changes in institutions and governance systems require different engagement than those that focus on revising existing policies.

The comparison of agriculture and water policy changes also helps identify the main factors that may contribute to the adoption of future reforms. First, the review identifies exogenous factors that define windows of opportunity for policy change. These include water-related events (such as droughts, floods or water impacts from pollution); a stable economy; political conditions that support the proposed reform; and advances from past reforms. Second, the review identifies some of the reform design features which are important in facilitating reform adoption. These include the preparation time before reforms, building a coalition of the willing, and including some type of compensation for farmers.

Lastly, the comparison of reforms suggests that factors which shape their outcomes include geographical scale and scope of the reform, the dynamic pattern of reform pathways, and possible instruments used to compensate farmers.

However, trade-offs in reform outcome characteristics – the reform's ambition, its degree of implementation (effectiveness), the time and costs required to advance the reform (efficiency), and the adjustability of the adopted policy in the future (flexibility) – arise from the influence of these factors. For instance, undertaking a rapid and significant change in water policy rather than a gradual one may reduce the initial transaction costs, but will likely require more implementation efforts. Similarly, transition payments for farmers, to compensate for reduced water or input use, can help raise the ambition and effectiveness of a reform process, but may be costly and could discourage future necessary policy adjustments.

While these conclusions are based on a study of selected reforms, and therefore not generalizable, they demonstrate the need for governments to consider the implications of different features of a reform process when considering policy change. To facilitate reform adoption and a desirable outcome, policy makers should discuss the reform approach they will take (and not just the policy design), while adjusting to the exogenous factors they cannot control. They should closely weigh the trade-offs of each component of the adoption and implementation of a new water policy in agriculture.

1. Understanding policy processes to improve water use in agriculture

1.1. Overcoming barriers to policy change requires improving reform processes

Agriculture faces two inter-related water challenges: the sector needs to reduce its detrimental impact on freshwater resources; it also needs to address the increasing water risks it faces, resulting from water scarcity, water over-abundance or water quality degradation (OECD, 2016[1]; OECD, 2017[2]). The agriculture sector is a major polluter and often an inefficient user of water resources in many regions, impacting farmers themselves and other surrounding water users (OECD, 2016[3]). Irrigated agriculture remains the largest user of water globally; it accounts for 70% of global water abstraction – over 40% in many OECD countries – and an overwhelming share of water's consumptive use in irrigating countries (OECD, 2010[4]). Agricultural activities also continue to be a major source of water pollution, particularly in OECD countries; agricultural nutrient run-off, pesticides, soil sediments, and livestock effluents all contribute to the pollution of waterways and groundwater (OECD, 2012[5]; OECD, 2017[6]). The overall costs of water pollution caused by agriculture across OECD countries both in terms of treatment for consumption and in terms of damage to ecosystems are likely to exceed billions of euros annually (Gruère, 2016[7]; OECD, 2017[6]).[1] At the same time, in many regions agricultural production is subject to water risks mainly due to climate variability, extreme events, depleting groundwater resources; but it also faces resource competition from other sectors (OECD, 2017[2]).

These challenges will continue, if not intensify, unless additional meaningful action is taken, including by improving existing water and agriculture policies. Recent reports show that diffuse pollution from agriculture continues to be problematic in spite of policy efforts (Wang, Tyau and Ybanez, 2017[8]; Wasley, Fiona and Davies, 2017[9]; Melia, 2017[10]; OECD, 2017[6]). Droughts and floods continue to have lasting and potentially devastating impacts on agriculture in many regions (OECD, 2016[1]). Groundwater depletion in some regions may intensify further unless better managed (OECD, 2015[11]). Moreover, water risks for agriculture are expected to grow in the future, with climate change and further competition for scarce resources potentially impacting the agro-food sector, markets and food security, unless adaptation actions are taken in regions facing high water risks (OECD, 2014[12]; OECD, 2017[2]).

Agriculture ministers from a large number of countries have acknowledged these challenges by making significant commitments to improve the sector's water use and increase its resilience to water risks. In January 2017, under the G20 German Presidency, G20 agriculture ministers adopted a declaration and an action plan entitled "Towards food and water security: Fostering sustainability, advancing innovation" (G20, 2017[13]; G20, 2017[14]), which includes a number of significant commitments to improve agriculture's water use and reduce its exposure to water risks. The G20 meeting dovetailed with the 9th

[1] For instance, in 2007, the annual cost of agriculture damage to water systems in the United Kingdom was around EUR 340 million (OECD, 2012[5]). In France, the impacts of agricultural nitrate emissions and pesticides on water amount to an estimated annual cost of EUR 610 and EUR 1070 million, respectively (Marcus and Simon, 2015[105]). The eutrophication process in freshwater bodies induced by agriculture alone is estimated to have reduced aquatic biodiversity by about one third globally (European Commission, 2017[104]).

Global Forum on Food and Agriculture, during which 83 agriculture ministers adopted the Communiqué "Agriculture and Water – Key to Feeding the World" outlining their intention to enhance farmers' water access, improve water quality, reduce water scarcity, and manage surplus water (Global Forum on Food and Agriculture, 2017[15]).

Policy solutions have been identified to fulfil these political commitments but have not always been adopted effectively. The OECD has identified flexible policy solutions for improving water use in agriculture, identifying best practices and proposing policy recommendations to help countries move towards more sustainable and productive use of water resources (OECD, 2016[3]). OECD studies highlight the need to align existing agriculture policies with better water management (OECD, 2010[4]) combined with the introduction of additional policies that enable better water use and planning (OECD, 2016[1]; OECD, 2017[2]). However, in a number of countries, the proposed policies are viewed as difficult to introduce and implement. This has been observed, for example, in the reduced prices for water used in agriculture (OECD, 2010[4]), the reluctance to remove energy subsidies for groundwater pumping (OECD, 2015[11]), or the failure to address nonpoint source pollution from agriculture in different countries (OECD, 2012[5]).

A number of countries have recently discussed potential policy changes on agriculture and water. For instance, as of mid-2017, Brazil's water authorities were considering changes in water pricing, with a particular interest in agriculture and hydro users (OECD, 2017[16]). The European Commission has launched a discussion on agriculture and water policies, releasing a review of past policies to identify possible gaps and areas for improvements (European Commission, 2017[17]). Korea's Ministry of Environment initiated a water policy dialogue with the OECD on integrating water policies across land and energy actors. New Zealand's 2017 general elections featured a discussion on water pricing that largely focused on agriculture, creating political tensions (Macdonald, 2017[18]). These and other future actions would be more likely to lead to successful outcomes if effective pathways such as those reviewed in this paper are considered. These and other future actions would be more likely to lead to successful outcomes if effective pathways are considered.

The objective of this report is to draw lessons on reforms from the past four decades in order to help governments better understand how to undertake policy changes at the agriculture and water interface.[2] A recurrent question among policy makers is how to introduce reforms to address water quantity or quality constraints, given existing political economy constraints in the agricultural sector. Water reforms, such as those in Australia or Israel, have been regularly presented by researchers in other countries, without considering the often complex pathway governments have had to follow to change policies. These discussions also rarely consider whether and how past examples could be used as benchmarks for water reforms in other country settings.

As a first component of a broader project on agriculture and water reform pathways, this paper reviews and analyses lessons from selected past water and agriculture reforms in OECD countries, evaluating the political economy factors that contributed to policy changes. Its focus is on policy processes rather than the success or otherwise of particular policy changes. The selected reforms are Australia's Murray Darling Basin water trading scheme; the EU's Nitrate and Water Framework Directives; Israel's use of water pricing in agriculture; Korea's regulatory reform on manure management; the United Kingdom's

[2] Reforms are here defined as changes in policies occurring in a particular location and over a specified period. In practice, these reforms are "episodes" in a continued evolution of policies.

adoption of catchment to tackle water quality; and the USDA Conservation Reserve Program (CRP) and Regional Conservation Partnership Program (RCPP) in the United States.[3]

The set of reforms for review was chosen to represent a wide range of policy changes rather than to cover all processes. These reforms address water quantity and quality challenges. They were carried out in different OECD member countries covering four continents, and they employ different approaches and instruments – from regulatory changes to economic and information-based approaches. All reforms involved actual policy changes, which may be a gauge of success, but these changes often involved multiple attempts before the stages discussed in this paper, and their degree of implementation varies significantly.

The analysis is based on information gathered in published reports, articles and books and, when needed, complementary information collected via interviews of local water and agriculture experts from government, the private sector, academia, or non-profit organisations.[4]

The next section presents the assessment method, which combines a historical approach analysing reform pathways with a crosscutting comparison of political economy factors. Part 2 reviews each of the selected reforms individually, using the historical approach, and Part 3 summarizes the findings from the political economy comparison. Section 4 closes the paper by drawing crosscutting conclusions, proposing a grouping of the different reforms, identifying factors that may help policy changes and those that affect their outcome.

1.2. Evaluating past water and agriculture policy reforms: A political economy assessment

There is an extensive research literature on the relationships between economics and policymaking (Sayer, 2000[19]). The objective of political economy studies varies widely from explaining electoral choices to government budget allocation, covering the role of different actors in discrete decision-making or comparing international policy choices (Persson and Tabellini, 2000[20]). In agriculture, political economy research has mainly focused on farm support policies and international trade (De Gorter and Swinnen, 2002[21]; Anderson, 2010[22]; Rausser and Goodhue, 2002[23]). In the case of water, research has examined the role of institutional and governance systems in water policy (Saleth and Dinar, 2005[24]; Dinar, 1998[25]). This section does not aim to review this literature, but rather to present the methodology for the review of selected agriculture and water policy changes.

This review uses a political economy approach to study reform processes, identifying driving conditions or potential constraints to policy change. Taking a political economy viewpoint of policy reform can provide insights on how barriers to specific reforms can be addressed and on the institutional leverages that are enabling factors for reform (ibid.). It

[3] Additional information is provided on revisions of the water right regime in Chile, the groundwater management reform in California, the use of regulatory and economic instruments to reduce pollution of nutrient and pesticides in Denmark, water quality trading in New Zealand and irrigation investments in Turkey and Chile.

[4] The list of consulted institutions is presented in Annex A.

can also help elucidate, within a specific context, the reasons why government support policies might end up being economically or environmentally harmful; the tactics used by various stakeholder groups to influence policy decisions, and therefore the reasons why governments shelter some industry sectors; and how to tackle some of these obstacles and impediments to reform (Persson and Tabellini, 2000[20]; OECD, 2006[26]).

Two general economic frameworks can be used to analyse the political economy constraints of reforms.[5] First, the "neo-classical economics" framework of policy reforms assumes that the policy stage is a pure and perfectly competitive market with political demand (expectations of stakeholders and the general public) and political supply (policy reform by government) leading to an optimal policy equilibrium, calculated according to the costs and benefits to beneficiaries versus those to society (Grossman and Helpman, 2001[27]; OECD, 2006[26]). From an individual's perspective, this model posits that the greater the benefits (or rents) from an existing policy, the greater the willingness to devote resources to protect these benefits. From an industry sector's perspective, this model posits that large polluting industries, which are very likely to lose benefits from policy reforms towards more sustainability, will have a strong incentive to lobby governments effectively on multiple fronts (ibid.). The advantages to this approach, when reviewing past policy, include the capacity to assess political decisions using game-theory analysis, and to obtain tractable and comparable results across reforms. At the same time, the approach's analytical assumption may not always reflect situations with complex sets of interlinkages among stakeholders.

Second, the "new institutional economics" framework of policy reforms considers that policy reform processes are fashioned by institutions, subject to the frictions and imperfections in existing institutional conditions or in the market for the goods or services being reformed (North, 1986[28]; Coase, 1998[29]). In the case of agriculture in particular, there are transactions costs of doing business in agricultural markets; there is an imperfect substitutability of assets, meaning that it is difficult for producers to reallot their assets to other economic activities; there are thresholds that trigger change between production system types leading to non-continuous response by producers to reform signals (Dwyer, 2007[30]). Furthermore, there is strong path dependency arising from the history of the sector and from previous policy reform attempts. Decisions are often irreversible; some policy and production choices cannot be undone once made (ibid.). The advantage of this approach to review past policies is that it emphasises the role of interactions across actors and institutions, thereby providing a realistic depiction of decision-making. Yet, at the same time, the approach makes it harder to draw cross-reform conclusions, as it focuses on specific institutional features of the country, region or policy, without considering changes in others.

This paper proposes to use elements from both frameworks to evaluate past policy reforms on agriculture and water. There is evidence that water and agriculture reforms are influenced by pressure group competition. For instance, discussions around the management of the increasingly saline Sacramento-San Joaquin Delta in California have opposed groups representing environmental interests to groups using upstream watercourses for irrigation. The former aim to preserve aquatic life and the ecosystem and the latter favour continuing or increasing their water allocation (Luoma et al., 2015[31]). At

[5] Many other frameworks could be used to assess reforms, such as neo-corporatism, neo-institutionalism, social movement theory, cognitive approaches. One of the limitations of the two selected frameworks is that they ignore the framing of problems and solutions. This limitation shall however not be ignored in the discussion.

the same time, institutions, transaction costs and path dependency have clearly contributed to shape water reforms in agriculture. Reforms of electricity subsidies for groundwater irrigators in Indian states facing groundwater depletion have been hindered not only by the pressure of interest groups and by the electoral system, but also by past policy changes, including the abolition of metering in electricity in the 1980s (Birner, Gupta and Sharma, 2011[32]). Despite a common understanding that improvements may be necessary, major water reforms are hard to change, as any change may be not only difficult to achieve politically but also lead to a less beneficial outcome for some parties concerned.

This paper investigates the role of political and institutional factors that favoured or hampered reform processes. First, following a historical or path-dependency perspective, the paper will consider how changes in institutions, policies, power and interests have evolved over time to trigger policy changes (see Section 3). Such a perspective can help understand the dynamics and timing of change, and better consider how policy changes can follow each other or develop in parallel. Second, a cross-section political economy perspective helps compare what general factors may have contributed to the observed policy changes (Section 4).

2. Mapping water and agriculture reform pathway in selected OECD countries

This section presents the pathways to policy change for each of the eight selected reforms. The order of reforms reflects their area of action. The first two reforms (Australia, Israel) focus on quantitative water resource management, including the management of quantitative water risks and water use. The following two reforms (the European Union's Water Framework Directive and the US Department of Agriculture's Regional Conservation Partnership Program) address both water quantity and quality challenges. The remaining four policy reforms (the EU's Nitrate Directive, the USDA's Conservation Reserve Programme, Korea's manure recovery programme and the United Kingdom's catchment approaches) focus primarily on water quality challenges.

Each reform pathway is characterised following four components: (a) an overview of the objective, reported achievements and limitations of the reforms, (b) a description of facilitating factors leading to the adoption of the reform with a specific focus on agriculture, (c) an identification of the factors that facilitated or inhibited the implementation of the reforms in the agriculture sector, and (d) whether the reform facilitates or hinders future adjustments.

2.1. The gradual evolution of water management in the Australian Murray-Darling Basin

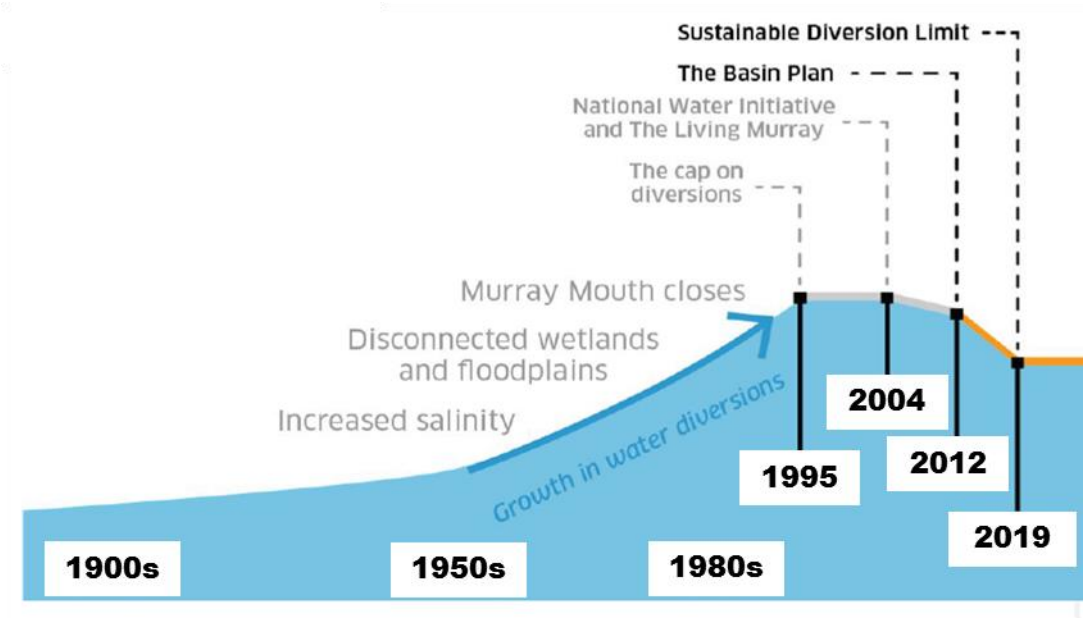
This section reviews the policy evolution for water management in the Murray-Darling Basin of Australia between the 1990s and 2017, with a particular focus on two reforms: the 1994 Council of Australian Governments' water reform and the *Basin Plan 2012 (Cth)* (Basin Plan).

2.1.a. Overview of the reforms

The Murray-Darling Basin, Australia's main irrigation and agriculture production area,[6] has been subject to multiple water policy changes, spanning over decades. Water management has evolved gradually from the early 20th century and accelerated over the last 30 years in successive stages, leading eventually to the development of a water trading system enabling irrigators to account for the opportunity cost of water. This evolution has contributed to progressively slow the growth in river diversion, as shown in Figure 1.[7]

From the 1950s to the 1970s, Australian state governments administering water resources in the Murray-Darling Basin sought to increase agricultural production by issuing new water-use licenses. The Australian government encouraged farmers to invest in on-site irrigation infrastructure through tax incentives (Marshall and Alexandra, 2016[33]). Irrigation became increasingly widespread as water was seen as an economic resource to encourage production.

Figure 1. River diversions and recent reforms in the Murray-Darling Basin



Note: The vertical axis represents the evolution of river diversion. Not all policy changes are indicated.
Source: Adapted from a presentation by J. Dore, Australian Ministry of Foreign Affairs and Trade, on August 18, 2017, based on materials developed by the Murray Darling Basin Authority.

[6] As of 2015-16 it accounted for 57% of the nation's total water used for irrigation and 58% of irrigation areas (Australian Bureau of Statistics, 2017[92]), although this total exceeds the long-term average, as it was reached during a relatively high rainfall year. It is generally considered the "food bowl" of Australia, e.g. farms surrounding the basin account for about 40% of the total gross value of Australia's agricultural production (MDBA, 2017[93]).

[7] Other factors may have contributed to this reversed trend, such as the record increase in precipitation in 2010-2011 after the Millennium Drought (Australian Bureau of Meteorology, 2011[98]).

In the 1980s, the Murray-Darling Basin began showing signs of stress, including a growing salinity problem, and closure of the Murray mouth in 1983. This led to a new approach for Basin water management. Southern basin governments collectively established the Murray-Darling Basin Commission and negotiated the Murray- Darling Basin Agreement in the late 1980s (Young, 2010[34]).

In 1994, following years of water stress, including droughts and quality concerns, the Council of Australian Governments (COAG), guided by the Industry Commission (the government's main economic research organisation), introduced a set of national reforms in water policies to reduce water demand and achieve cost-recovery for water infrastructure.[8] First, water charges were raised in an attempt to recover costs and reduce water use (Marshall and Alexandra, 2016[33]). The charges for irrigated agricultural communities, however, remained cheaper than the charges for other sectors. Additionally, the charges were based on average irrigation costs instead of accounting for wide variation across irrigators (Tompson, 2009[35]). In parallel, the COAG introduced tradable water entitlements by separating water rights from land property rights, established water allocations, and recognized the environment as a legitimate water user (Holley and Sinclair, 2016[36]).[9] The unbundling of land from water rights was instrumental in the development of the Murray-Darling Basin's water markets in the following two decades.

In 1995, consistent with the COAG reforms, agreement between most Basin jurisdictions was reached on the introduction of an interim surface water diversion cap,[10] the Murray-Darling Cap on Diversions (Grafton, 2017[37]). The cap triggered increased trading, which stimulated growth of the water markets. The Agreement to cap surface water diversions was intended to constrain growth in diversions, which, if left unchecked, would have had the effect of eroding the reliability of existing water entitlements, and of adding to the environmental degradation of water-dependent ecosystems. Once introduced, the cap also served to support the emerging water markets in the Basin, which in turn helped accelerate the movement of limited water resources towards higher-value uses.

Though these reforms were crucial for the foundation of water markets, they did not assign water rights to the environment or explicitly define environmental water beyond the legally determined minimum flows (Tompson, 2009[35]). Moreover, the five Basin States[11] were responsible for implementation and devised their own reform plans, often based on the involvement of local stakeholders mainly representing the agricultural sector. A broad basin-wide framework underpinned individual Basin State implementation of these reforms; it contained the possibility of funding being withheld if desired outcomes were not achieved. However, there were conflicts within states and growth of water markets was

[8] The COAG reforms were introduced as part of the National Competition Policy, which was more focused on economic competitiveness and efficiency than on the environment (Marshall and Alexandra, 2016[33]). The Policy also included incentives for states to apply the reforms, with possible withdrawals of funds, but this mechanism was rarely used (Tompson, 2009[35]).

[9] Water allocations generally refer to the specific amounts based on water availability (e.g. water available in a storage, river flow levels, etc.) that are granted to each user during a period of time (usually a year), and water entitlements are perpetual or ongoing shares to a given consumptive pool of water (Young, 2004[95]).

[10] Queensland did not sign on to the Cap until several years later.

[11] The Australian Capital Territory, South Australia, Victoria, New South Wales and Queensland.

stunted by localized trading, delays in establishing a framework for inter-state trade, unavailable information about trades, and the lack of water market intermediaries (Ibid.).

Due in part to these issues, in 2003-04, the Australian government led negotiations with all state and territory governments towards the Intergovernmental Agreement on a National Water Initiative (NWI). The NWI recommitted governments to the national water reform objectives that commenced in 1994 and which sought to improve management of water resources and water infrastructure, and to increase national cooperation via financial incentives and other mechanisms. The NWI also committed jurisdictions to defining water rights (water allocations and water access entitlements) in a manner which would encourage greater compatibility and facilitate more trading across state borders. It established water market and trading arrangements which facilitate the operation of efficient water markets, including to allow for the reallocation of entitlements away from consumptive use via market mechanisms; it improved charging arrangements and prices, established water accounting; and it returned overused water systems to extraction levels to fit environmental needs (Bischoff-Mattson and Lynch, 2016[38]). The NWI also set up a framework for future reforms, requiring the application of rigorous scientific research to include determinations of water allocated for the environment (Bischoff-Mattson and Lynch, 2016[38]). Further, the newly instituted National Water Commission was tasked with assessing how well Australia's States and Territories were progressing with implementing agreed NWI commitments, including in the Murray-Darling Basin.

The commitments made under the NWI constituted significant progress towards implementing a more widespread approach to water management across Australia, especially within the Murray-Darling Basin, but the level of commitment to implementing NWI reforms varied considerably between different state and territory governments. The proposed framework was not applied everywhere when the Millennium Drought (2001-09) started to affect the region.

In 2007, as the problems created by this historic drought were no longer manageable, the federal government undertook two major steps forward by introducing legislation and allocating a large investment plan specifically in the Murray-Darling Basin.

- The government passed the national Water Act in 2007, which effectively integrated water management in the Basin. The Act established the Murray-Darling Basin Authority (MDBA) and tasked it with developing a plan to address the imbalance of water allocations between the environment and consumptive uses within the Basin (Hart, 2016[39]). It also established the Commonwealth Environmental Water Holder to manage water holdings acquired by the Commonwealth of Australia for an environmental reserve (Bischoff-Mattson and Lynch, 2016[38]).
- An AUD 10 billion (Australian dollars), ten-point National Plan for Water Security (NPWS) was launched to address water over-allocation in the Murray-Darling Basin (Hart, 2016[39]). Two of the key NPWS programmes were: "Restoring the Balance", which received a total fund of AUD 3.1 billion for the government to purchase water entitlements from willing sellers (buy-backs); and the "Sustainable Rural Water Use and Infrastructure Programme", allocated AUD 5.8 billion for investing in water-saving infrastructure developments (Marshall and Alexandra, 2016[33]).

In 2008, following the election of a new government, the NPWS became the Water for the Future programme, which adopted the above-mentioned programmes for implementation

in the Murray-Darling Basin.[12] The budget for water recovery was subsequently increased in late 2010 because of an election commitment to fully bridge the gap, and again in 2012 with the AUD 1.78 billion Water for the Environment Special Account.

As required under the *Water Act 2007 (Cth)* (Water Act), the Basin Plan was developed and adopted in 2012, with the express agreement of all Basin governments. This Plan specifically sought to maintain water use at environmentally sustainable levels through the development of policy enforcement tools, including the definition of long-term average Sustainable Diversion Limits (SDLs) for surface water and, for the first time, for groundwater. The Plan includes a number of specialized plans and programmes whose deadlines for implementation vary between 2019 and 2024.[13] By specifying a set of Basin-wide water trading rules[14] designed to sit "on top" of existing Basin State water trading frameworks, it actively strove to facilitate efficient water markets for a wide array of water users that include farmers, households, and the environment (Hart, 2016[40]). Through their respective water-related agencies, the five Basin States and the Commonwealth government will co-operate to implement the Basin Plan, as enforced by the MDBA, which includes stakeholder engagement and specific design based on local variables. Funding support for the implementation of the Basin Plan, including for the recovery of water for the environment, comes from the Commonwealth government (Bischoff-Mattson and Lynch, 2016[38]).

As of mid-2017, Basin water markets were functional, allowing irrigators to hedge depending on water supplies, but the Basin Plan was still being implemented (Box 1).[15] Two amendments to the Basin Plan were adopted by the Minister for Agriculture and Water Resources and tabled in Parliament in late 2017 and early 2018. The first amendment proposed a 70 Gigalitre reduction to the water recovery target in the northern Basin; it was disallowed by Parliament in February 2018. The second amendment proposed to adjust the sustainable diversion limit (SDLs) by up to 605 Gigalitres in the southern Basin; it also provides for the recovery of an additional 450 Gigalitres in environmental water. This amendment, which was subject to a disallowance motion in Federal Parliament, was ultimately agreed in May 2018. In parallel, the government is working with Basin States towards full Basin Plan implementation by 1 July 2019, which is when the binding SDLs set by the Basin Plan will come into effect. It is also expected that by this time, all Basin State water resource plans will have been assessed by the MDBA as compliant with the Basin Plan and accredited by the Federal Minister.

2.1.b. Facilitating factors leading to the adoption of the reform

Most of the reforms discussed were initially spurred by water scarcity (intense droughts) and surrounding events, such as the observed decline in water quality, the loss of water for

[12] Following the election of the coalition government in 2013, the suite of programs was no longer referred to as Water for the Future programme.

[13] The majority of the Basin Plan is to be implemented by 1 July 2019, but the supply and efficiency measures do not have to be completed until 2024.

[14] The water trading rules, which are set out in Chapter 12 of the Basin Plan, commenced on 1 July 2014.

[15] An investigation on compliance in New South Wales indicated poor compliance and allegations of fraud by individual irrigators on their used of metering, possibly signalling a more systemic problem in irrigation in the Basin (Matthews, 2017[97]).

the environment and algal blooms. These events contributed to a mounting political pressure from the public, leading to policy and legislative action. In particular, the Millennium Drought, which lasted from 2001 to 2009, clearly played a role in triggering the development of the Water Act.

Other factors also played a role for specific reforms. The 1994 reform, led by COAG, was in part motivated by the mismanagement of water at state level. Water authorities in states and territory governments, whose leaders were members of COAG, were facing debt and unstable finances.

Additionally, to respond to growing tensions, COAG took years of stakeholder consultation into account when developing the 2004 NWI. Conflict had arisen between and within the states regarding environmental water allocation, water-sharing plans, and water prices, among other issues. Some states had sought to expand irrigated agriculture, giving out too many entitlements and allocations, covering more than the available amount of water—one of the main reasons for the cap's introduction.

Box 1. Water markets in the Murray-Darling Basin as of 2017

The growth of water markets in the Murray-Darling Basin has generated considerable economic benefits to irrigators and their communities. The growth of these markets allows for a wider co-ordination of knowledge and prices in relation to relative circumstances and risks. This growth also gives individual irrigators more choice and flexibility in how to manage their water, especially in response to scarcity. With the option to buy or sell their water, both on a temporary and permanent basis, irrigators can find the highest value and use sales to reduce debt or reinvest in agriculture or farm upkeep. Having a water access entitlement is seen as a financial asset and a way to provide financial security that is resilient to changes in climatic conditions.

Though water trading systems have proven effective, they have become much more complex than the original 1994 plan. Because states within the basin have not implemented the NWI framework to the same degree, different trading and regulatory arrangements give rise to variability in the market. In addition, water access entitlements have different value based on their location and reliability characteristics, meaning that differences across jurisdictions and sub-catchments would persist even if all Basin States fully implemented NWI reforms.[1] Typically, entitlements with higher reliability are used for permanent planting and dairy, whereas 'general security' entitlements (which have lower reliability) are more often used for annual crops such as rice and cotton. Trade of water rights can either be temporary (trade of water allocations or leases of entitlements) or permanent. There is high variability across the Basin in terms of supply and demand for these different types of rights, so they follow regional and local trading rules under the Basin Plan and the Basin States' water sharing plans.

During the Millennium Drought (2001-2009), temporary trade in scarce seasonal water allocations enabled water to move from lower-value uses, (including from dairy, where irrigated fodder could be replaced by dry feed purchased with water trade proceeds) to high-value permanent plantings. In this way, the market operated both to maximize the market value of irrigated production, and to ration scarce water between competing uses without the need for government intervention.

1. "Reliability" refers to the average frequency (based on historical records and forecast future water availability) with which water allocated under a water access entitlement can be supplied in full. Some jurisdictions refer to this as "security".

Source: Holley and Sinclair (2016[36]); OECD (2015[41]).

The 2007 reform, first developed by the then Prime Minister, John Howard, under the Liberal Party, was justified on the assertion that state and territory governments were not cooperating sufficiently on water management (Bischoff-Mattson and Lynch, 2016[38]). Moreover, the states were not managing Murray-Darling Basin water resources in a way

that maintained significant environmental sites such as wetlands in the manner committed to by the federal government in international agreements.[16]

In 2008, the Water for the Future programme was introduced by the Labor Party leader and new Prime Minister, Kevin Rudd, who was elected on a platform explicitly including the expansion of water funding and the implementation of the Water Act. Implementation continued under the Liberal Party in 2013 and the Liberal-National party coalition in 2015.

With regards to agriculture, considering that the vast majority of consumptive water use in the Murray-Darling Basin goes towards irrigated agriculture, agricultural interests have long been favoured over those of the environment. The agricultural sector has a significant amount of political influence in decision-making processes and planning. It has faced fewer interventions over environmental regulation than other sectors, such as mining or manufacturing (Holley and Sinclair, 2016[36]).

In particular, agriculture's political power played a large role in forming the NWI, influencing the decision to implement a 'government-pays' approach over an 'irrigator-pays' one when adopting the Restoring the Balance and Sustainable Water Use and Infrastructure Programs. Under an 'irrigator-pays' approach, irrigators would have had to give up a share of their water rights without compensation (Marshall and Alexandra, 2016[33]).[17]

At the same time, farmers have been wary of the programmes implemented by the government. Irrigators feared that their water rights would face large-scale reductions, meaning that water would 'move out' of their region, putting rural communities that are economically dependent on irrigation water at risk.[18] These apprehensions were widely voiced throughout various phases of stakeholder consultation and were well-heard by decision makers. In recent years, the Basin Plan process in the Murray-Darling Basin was nearly derailed by poor communication from the MDBA when it first presented its "Guide to the Basin Plan". At this point, many agricultural actors had become distrustful of the MDBA, and this has affected the implementation ever since.

2.1.c. Facilitating and inhibiting factors in implementing the reform in the agricultural sector

After the reforms in the 1990s, it was found that irrigators were given lower water charges that did not necessarily reflect the cost of supply. There was also a problem in issuing too many entitlements in the Basin States, leading to over-allocation and thus overuse of water, which was largely due to pressure from irrigators and their communities. While the original

[16] As specified in the Water Act, international agreements include the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change and the United Nations Convention to Combat Desertification. Bilateral treaties include the Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA) and the Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment (CAMBA). The full list of international agreements can be found in Section 4 of the Water Act.

[17] There were also serious questions about whether the Australian Constitution would allow for the acquisition of water rights without compensation.

[18] Some vocal farmers have also been concerned about the possibility of large investors entering the market and manipulating it to put smaller irrigators at a disadvantage (Doolan, 2016[94]).

cap was made as an interim measure to constrain further growth in diversions, in itself it was not sufficient from a holistic scientific perspective. Following years of study, the government approached environmental water rights with a scientific consensus on the environmental levels necessary to curb over-allocation to irrigators; however, the process is ongoing and the scientific consensus is still being challenged by some irrigators and other members of rural communities.

An important aspect of reform that came after the Basin Plan's adoption was the Water Recovery Strategy (2014). This strategy commits the Australian government to favour infrastructure investment over water entitlement buy-backs for water recovery; it also applies a cap on buy-backs of 1500 Gigalitres in surface water entitlements (expressed as long-term average annual yield) as legislated in the Water Act. Infrastructure investments largely pertain to improving the efficiency of irrigation projects, which can sometimes result in more agricultural water use (OECD, 2014, pp. 91-92[12]; OECD, 2015, p. 85[11]; OECD, 2016, pp. 41-42[1]; OECD, 2017, p. 166[2]). Economists have argued for increasing the use of buy-backs, but state governments continue to face political pressure from the agricultural sector and rural communities to avoid them.

Meeting the Sustainable Diversion Limits set out in the Basin Plan will require compliance on the part of state water resource plans, and for irrigators (and other water users) to comply with the terms of their individual water rights as specified under these planning frameworks. The MDBA is responsible for enforcement of the Basin Plan, while Basin States are responsible for individual water user compliance. Irrigators' compliance with their entitlements and the adequacy of state water planning frameworks have been questioned in the state of New South Wales. In mid-2017, the press reported allegations of water theft by irrigators in the Barwon-Darling river system in New South Wales through the use of unmetered water; allegations were also made that water extraction rules allowed irrigators to inappropriately harvest environmental flows and to take more water than had been allowed previous to the Basin Plan coming into effect (Besser, Fallon and Carter, 2017[42]). The presence of non-compliance and the inadequacy of state enforcement efforts was confirmed by an independent audit commissioned by the state of New South Wales, which recommended a package of measures to be rapidly introduced (Matthews, 2017[43]).[19]

2.1.d. Premises for future adjustments

The Basin Plan covers the next few years, but recent reform history suggests that water policies will continue to evolve in the Murray-Darling Basin. Going forward, an increased level of local state participation and expertise will be necessary, especially with the development of the states' water resource plans. Most of the remaining components of the Basin Plan need to be in place by 2019. The second statutory deadline of 2024 allows for more time to implement the final outcomes of the Sustainable Diversion Limit Adjustment Mechanism (part of the Basin Plan). Additionally, monitoring the implementation of reforms and their outcome on the environment still shows room for improvement, especially within the agricultural sector.

Chile has also encouraged water rights trading at the national level (Box 2), although in a different and more decentralised manner. Trading started earlier with the 1981 Water Code, a law establishing private water rights unbundled from land rights, and that has since been subject to attempts for revision to address observed deficiencies and new challenges. While

[19] There have also been calls to evaluate the actual environmental water saving of the entire plan (Grafton et al., 2018[101]).

the Chilean reform was more rapid than that of the Murray-Darling Basin, it has proven to be more difficult to change over time.

Box 2. Revising the private water right system to address new challenges in Chile

Chile has more than 101 river basins whose water goes from the mountain range to the sea, subject to a wide geographical and climatic variety and associated water availability, from the arid north to the water-abundant south. It is estimated that 82% of the water is used for agriculture. Over the last decades, the intensification of water use has been accelerating, driven by the development of mining and export-driven agriculture activities. This has exerted a growing pressure on the water system, particularly in the north.

Water-use regulations were first evoked in Chile's 1856 Civil Code. The country's first Water Code was issued in 1951, and then deeply modified in 1969 with the Agrarian Reform Law. Most importantly, the 1981 Water Code (and 1979 Decree Law n° 2063), issued during the Chilean military government, introduced the current system of individual private water rights, based on:

- Private property with unlimited desired quantity legally recognized, protected by constitutional guarantees and freely transferable.
- Absolute freedom in the use of water.
- Free and permanent status granted by the state.
- A free market with no state intervention possible in the transfer of water rights.

Under this Code, water rights are classified according to their use (consumptive or not) and to the way they are used (permanent or temporary, continuous, discontinuous or alternate). The Code also unbundled water rights from land property rights, thereby introducing separate water and land markets. Once the rights have been assigned, the market acts as a regulator, distributing the water rights to the more economically profitable uses. The user is free to transfer the water right, which is independent from the land ownership right and protected as a private property, like every other good.

Theoretically, the Chilean water-right model introduced with the 1981 Water Code should be associated with an active trade of water rights, leading to high water use efficiency and a redistribution of economic rents from high- to low-value water users. But the model has shown significant deficiencies, including: a lack of prioritisation between the different uses for the allocation of new rights; negative environmental externalities owing to the free transfer of water rights among users; a lack of water rights attributed to the environment; limited participation in the functions and capacities of the trading systems by water-user organizations; and a fragmentation of water management in the basins.

The 1981 Water Code was slightly revised in 2005 in light of some of these limitations, following 13 years of discussion in parliament. Revisions included the introduction of a tax to be paid by water right holders for unused water, the need to respect minimum ecological flows when assigning new water rights and a requirement to explain the type of water use.

The 2014-17 government tried to reform the Water Code more significantly. It managed to approve modifications on the strengthening of the State's role in the tax audit, sanctions and information. As of early 2018, Congress was still analysing revisions that proposed: defining human consumption and sanitation as a priority water use; protecting environmental and hereditary areas; trying to prevent and to sanction the unused ownership of water rights; and strengthening the administration's functions.

But the proposed new reform has faced significant resistance from water-using industries (agricultural, electrical and mining associations, among others). These industries opposed essential elements of the draft bill, especially the fact that the new water rights would have a fixed duration and could be forfeited if not used properly, and the higher margin of discretion given to the regulatory institution. This situation would affect the legal certainty of water rights and thereby have negative consequences for productive investments. The resistance to such measures have prevented the reform from being passed to date.

Source: Chilean Ministry of Public Works (2016[44]); Larraín et al. (2010[45]); Lajaunie et al. (2011[46]).

2.2. Raising water prices for agriculture as part of broader changes in water management and governance: The case of Israel[20]

This section reviews successive policy changes on water management for agriculture in Israel from the 1990s to 2017, with a particular emphasis on water pricing changes, the 2006 Farmers' Agreement and the 2007 establishment of the Water Authority.

2.2.a. Overview of the reforms

Due to its geography and extreme climactic conditions, Israel faces recurrent water scarcity and frequent intense spells of drought. Pressures on the water system have intensified especially with the development of the agricultural sector since the 1960s to address population growth (OECD, 2011[47]).

The first major decision driving water management in agriculture and other sectors was the introduction of the Water Law of 1959, under which all of Israel's water resources became public property; any abstraction or use of water required a permit (Feitelson, 2013[48]). The implementation of the law was accompanied by major infrastructure investments that conditioned water use throughout the country.

In the decades that followed, three major investments and policy changes were implemented that impacted water use in the agriculture sector. First, Israel started to recycle water effluents from cities for irrigation purposes while developing desalination primarily for cities, progressively shifting the surface water conveyance system from a north-to-south to a west-to-east orientation. Second, there was an expansion of pressurised irrigation systems, supported by the states. Third, starting in the 1990s, and as discussed in this section, water pricing was applied in agriculture to recover costs and reduce agricultural water demand. As shown in Figure 2, water prices increased significantly following incremental policy changes.

The water pricing system was first introduced to agriculture in 1991 with a three-tiered block pricing corresponding to the average cost of water (see Box 3 for details on pricing changes). This pricing system was developed to ensure farmers would not be forced to pay the full cost of water supply and to avoid driving out smaller farms (DiSegni, 2013[49]).[21] Since this pricing system was introduced during a time of severe shortages, it sent the message that the more water is consumed, the higher the price. While freshwater prices increased, recycled effluent water (REW) was increasingly available at a lower price.

In 2006, after a period of relatively stable prices, the Farmers' Agreement established higher water prices according to a formula to cover a change in the average cost of water production, with the understanding that the change would enable the construction of desalination plants, thereby increasing water security. The Agreement provided incentives like infrastructure investment and development of alternative water resources, namely

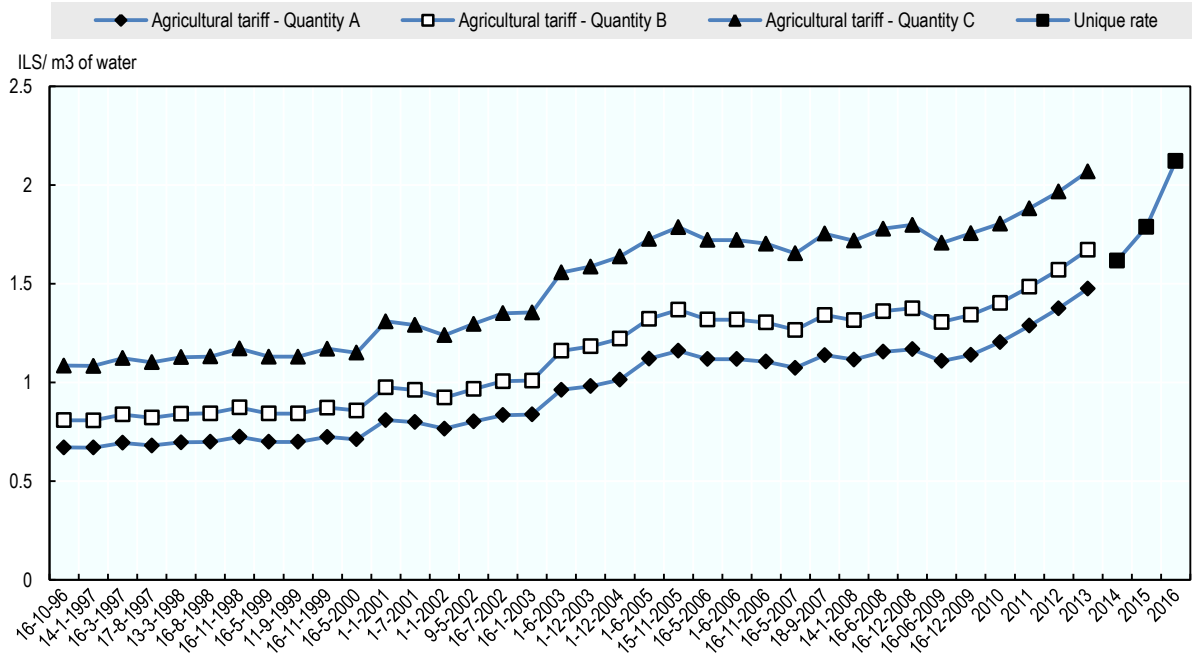
[20] The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

[21] Because small family farms do not use their quota, they were able to pay a lower price with a single higher rate than larger ones (OECD, 2010[99]). Bar-Shira et al. (2006[100]) showed that switching from the three-tier pricing system to a uniform rate would have resulted in 20% profit loss for the smallest quartile of farmers they surveyed.

desalination plants, and it created expectations among farmers that scarcity issues could be resolved at affordable prices. The Agreement also reinforced the role of pricing as the key instrument to curtail water use for irrigation; it stated that farmers would eventually cover the cost of water production through an increased price of water (OECD, 2011[47]).[22]

A major institutional change followed in 2007 with the creation of the Water Authority (to replace the Water Commission). This new Authority centralised the oversight of Israel's water, moving from cross-ministerial co-ordination to a single dedicated agency. The Authority assumed responsibilities for all aspects of water management – including allocation water quotas, water pricing, trading, and extraction levies. In particular, the Authority ensured that prices and efforts to curb freshwater use would be enforced. These efforts included determining agriculture pricing by increasing rates to recover costs and to further reduce freshwater uses. The Authority also granted water allocations for farms through quotas (Becker, 2013[50]).

Figure 2. Real prices of freshwater in agriculture from 1996-2016: A steep increase



Notes: Base year 2000, without VAT. The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.
Source: Source: Derived from data provided by the Water Resources Authorities.

Between 2007 and 2015, water prices for agriculture then continued to increase in an effort by the government to get irrigators to use lower-priced recycled effluent water (REW) instead of freshwater and to increase the rate of cost recovery for water. In 2014, the three-tiered block pricing for freshwater was eliminated to become a single price rate which was

[22] Before this agreement, irrigators were given funding for off-farm water infrastructure, paid compensation for quota reductions, investment grants for installing on-farm drip irrigation and other water efficiency initiatives, and provided with farm advisory support. After the agreement, the irrigators only received compensation for the cuts in quotas provided they could show that they had invested in water savings and efficient management or technologies (OECD, 2010[103]).

set to the average of the former three prices. This decision was supported by years of discussion and mounting evidence and observations, notably by economists, that the block pricing system was not effective in reducing water use.

Amendment 27 to the Water Law, adopted in late 2017, further changes the pricing of agriculture freshwater use, de facto equalising water rates across regions. This amendment removes the extraction levies for farmers and embeds a slightly lower rate of extraction cost in the water price to be applied to all regions. The amendment was meant to reduce regional inequalities; it increased water prices in the north and slightly reduced them in the south. This process also reallocated the collected revenue from the levy from the Ministry of Finance to the state-supported water company (Mekorot) and reduced cross-subsidies by other sectors.

Box 3. Evolution of pricing for freshwater in agriculture in Israel

Starting in the 1990s, the price for water within the agricultural sector was first determined by the percentage of the particular irrigator's allocation that had been consumed. Water-use quotas (allocations) for the agricultural sector are based on past water use per acre of crop, how much the land can produce, and the size of the particular community. Irrigation prices were then defined based on three tiers according to consumption shares of the water quotas: water used within 50% of the quota was charged a low rate, the following 30% at a medium rate, and the last 20% at a higher rate.

In 2006, the Farmers' Agreement defined a formula to adjust prices with the additional cost of desalination. The formula defined the cost due to desalination as [(A*B+C*D)/(A+C)]-B where A is total freshwater consumption, excluding desalinated water, C is desalinated water use, B is the average cost of extraction and distribution of potable water and D the desalinated water cost

Between 2007 and 2014, water prices for the agricultural sector increased by 52%, but remained much lower than the industrial and municipal sectors. The REW cheap price does not account for the price of treatment for this water, which is cross-subsidized by the municipal sector through a sewage charge. Farmers, however, cover the transportation costs of water that comes from the wastewater treatment plants.

In 2014, the freshwater pricing system for the agricultural sector changed to a unique tariff rate set at the average of the three former block prices. Most farmers were paying the second-block prices under the three-tiered system; under the new price, they pay the average, i.e. more than they paid in the past, but still insufficient to cover the marginal cost of water.

Until Amendment 27 in 2017, in addition to water prices, farmers were required to pay water extraction levies if they received water from private suppliers implemented to limit groundwater extraction for consumptive uses. These levies changed based on location to reflect water scarcity levels, and were defined based on water quality, type, production source, abstraction rate, and quantity, along with the purpose of production and the hydrological situation in the area. The levies were a unique process that attempted to account for the opportunity costs of agricultural water use instead of attributing it all to users in other sectors.

Source: Becker (2013[50]); Bismuth et al. (2016[51]); DiSegni (2013[49]) ; Katz (2013[52]); OECD (2011[47]; 2015[11]).

2.2.b. Facilitating factors leading to the adoption of the reform

Agriculture's water and economic constraints have always been a point of concern for Israel. Shortly after its independence in 1948, the country invested in water infrastructure development, mainly to support irrigated agriculture due to the new necessity for domestic food self-sufficiency (Becker, 2013[50]). The agricultural sector was a priority water recipient; it avoided implementing demand management and its water allocation quotas could not be allocated to the industrial or urban sectors. Until 1996, the Ministry of Agriculture managed the water sector and relied on natural water resources to meet all demands, with agriculture as the primary user. The Ministry kept the political objective of maintaining low water prices for farmers (World Bank, 2017[53]).

Water stresses began to proliferate, encouraging policy changes. In the 1970s and 1980s, freshwater sources were fully employed and by the 1990s, a period of severe drought, focus shifted to establish new water supply in replacement of freshwater use (Katz, 2013[52]). It was during this period that Israel's main freshwater sources – Lake Tiberias, the Mountain Aquifer and the Coastal Aquifer – were depleted, increasing the pressure to reform water policies. The 1998 drought (the third severe drought since 1986) created a window for political action on water that later triggered future policy changes (World Bank, 2017[53]).

In particular, the Israeli government restricted abstractions from Lake Tiberias and the aquifers and started to implement its plan for developing alternative sources of freshwater. Due to these changes, REW slowly became part of the normal water supply and, later, so did desalinated water. REW was allocated for irrigation and desalinated water for drinking water or other freshwater uses. The Water Authority was created to control these shifts of supply alongside a steadily heavy water demand. It was also introduced in response to a 2002 Parliamentary Investigation Committee of the Water Sector which showed that the previous agency, the Water Commission, had not managed water effectively (Becker, 2013[50]; World Bank, 2017[53]).

In 2006, the government intended to accelerate freshwater use reduction because freshwater supply was increasingly limited. Farmers were not enthusiastic about the creation of the Water Authority, fearing that its establishment would continue to reduce their water allocations. Government negotiations with groups of irrigators led to the Farmers' Agreement to ensure farms' use of REW and desalinated water. In line with the support that irrigators had received in the past, they managed to get many benefits as part of this agreement. Among other benefits, irrigators received incentives to switch to REW including: a price rebate, with REW priced at less than half of the price of freshwater; a quota incentive, in that irrigators who exchanged any part of their annual freshwater quota for REW would receive an extra 20% in volume for no charge; and through infrastructural subsidies that covered 60% of the effluent pipe costs (World Bank, 2017[53]).[23]

The 2014 removal of block pricing followed growing calls from experts that the system was not working. First, it was considered inefficient, in that farms did not use their full quotas. Second, it did not reflect the true value of water to each farm: farms that valued water more might not be able to afford the price of the quota level that they needed. Additionally, per-unit prices of water were entirely variable. The new price still does not reflect the opportunity cost of the water, but it avoids some of the flaws of the previous system.

Amendment 27 was introduced to address the concerns amongst farmers that the pricing system was unequal. The amendment eliminated price variations between different regions or supply sources and created one price that all farmers pay for irrigated water (World Bank, 2017[53]).

[23] *De facto*, agriculture has benefited from cross-subsidies from the industrial and municipal sectors in that the water prices of the these two sectors subsidized the price of water supply to agriculture; this policy is now being scaled down due to the resulting inefficiencies within the agricultural sector in addition to the sector's fall in political and economic power (Katz, 2013[52]).

2.2.c. Facilitating and inhibiting factors in implementing the reforms in the agricultural sector

For the most part, irrigators have been compliant with the prices and water management structure as set by the Water Authority, and no major issues have been reported with the Water Authority or the Water Authority Council. Farmers have progressively switched to high-value crops and implemented greater selectivity of food crops grown for export (World Bank, 2017[53]). They have adopted irrigation efficiency technologies with support from regional irrigation companies and the Agricultural Extension Service of Israel (*Ibid*). However, there have been some tensions within the municipal sector, as domestic (mostly urban) water users pay for the treatment and storage of REW and may receive water from sources other than desalination plants, leaving some doubt in their minds over quality.

On the technology side, major concerns have arisen due to the large costs in labour, finance, and energy involved in desalination plants and even the rebuilding of pipes for the irrigation water network for the use of REW. The goal for desalinated water is now centred on reducing its costs so that it can continue to be a reliable alternate source of freshwater (Bismuth et al., 2016[51]).

2.2.d. Premises for future adjustments

The gradual evolution in the pricing system suggests that policies will continue to change. As proposed in Israel's 2012 Master Plan for the National Water Sector, prices are expected to continue increasing until 2050. Since the block pricing structure was unpopular from its outset during the 1990s but took about 20 years to change, it is clear that even structural pricing changes will take time to adjust and find the middle ground for conserving freshwater while maintaining the interest of the agricultural sector. With the water pricing and allocation systems in place, it could be beneficial to more closely examine the cross-subsidies that are in place in Israel's water management scheme.

Future challenges include climate change causing irreversible reductions in water supply, in addition to population and economic growth, and higher demands to share water with neighbouring states (Katz, 2013[52]). In recent years, farmers' quotas have not been binding in agriculture, but this may change with changing conditions and extended drought in the relatively more water abundant northern region. With de facto increases in prices charged for water and lower quotas, farmers in the north have been encouraged to use much less water. These issues will require Israel to maintain control of its water as is doing, but also to develop better methods of allocation amongst farmers and across different sectors.

Other OECD countries facing water stress have taken measures to invest in irrigation and water storage, using increasingly decentralized and incentive-based initiatives. Turkey's government has continued to develop irrigation to cover rainfed agriculture area, but has moved towards encouraging improvement of the sustainability of agriculture's water use. There, irrigation investment is gradually opening to private actors, while management of irrigation systems has been largely decentralized to the responsibility of water-user associations (Box 4). Chile has invested in large dams, increasingly relying on user finance (Box 5). Successive governments in Chile have also continued to support a successful small cost-share funding mechanism to support irrigation efficiency, storage and maintenance projects since 1986.

Box 4. Evolution of irrigation policies in Turkey

Irrigated agriculture is a growing part of the Turkish agriculture sector. It is considered by the government to be a key element for productivity growth and competitiveness of the sector. Under the General Directorate of State Hydraulic Works (DSI), the government has invested largely in irrigation expansion and supported its management since the 1950s.

Yet several significant changes have been undertaken in the period 1990-2017, reflecting a change of role for the government.

- First, starting in 1993, DSI has gradually decentralised the responsibility of management, operation and maintenance of irrigation systems to farmers, mainly to water-user associations. As of 2016, these associations managed over two million hectares of the total net area of three million hectares. Studies have shown that this decentralization has improved the performance of irrigation schemes, both in terms of water productivity and financial sustainability, albeit results vary significantly across schemes. In particular, there is evidence that decentralization has improved water management by empowering water users, and that it has improved water charge levels and collection rates. DSI has carried out routine audits of these associations in terms of adequate irrigation performance and proper administrative conduct, and cases in which the government needed to step in and transfer management of the facilities back to DSI have numbered fewer than a dozen.
- Second, in 2008, the government decided to rapidly accelerate its financial effort to develop irrigation. DSI annual investments in irrigation infrastructure traditionally averaged approximately USD 0.5 billion (United States dollars) until 2008, when the government decided to raise this investment to nearly USD 1.75 billion per annum. This decision resulted in more than USD 10 billion invested in irrigation projects in less than 10 years.
- At the same time, to reduce the burden of these expenses, the Turkish government has tried to mobilise private investments in large-scale operation. It proposed tenders for which contractors would build and for twenty years operate an irrigation project. No successful bids have been made so far. There were also earlier efforts to rationalize investments by combining land consolidation and irrigation projects from the design to the construction phase.
- Most recently, several policies have aimed at improving the sustainability of agriculture's water use. The Tenth Development Plan (2014-18) has introduced a Programme for the Efficient Use of Water Resources in Agriculture. The programme aims at increasing water use efficiency, with specified targets to be reached. The programme involved modernizing irrigation infrastructure and increasing education of farmers, but also altering agriculture subsidies, implementing water pricing which accounts for water stress, and increasing coherence between agriculture policy and water objectives. For instance, farmers can get support for shifting to pressurised irrigation systems. Moreover, in basins undergoing water shortages, crops with higher water requirements have been excluded from agricultural supports, and those crops with lower water requirements have been provided with additional premium support payments.

Source: OECD (2016[54]); Personal communication with Mr. Murat Yazan of the Turkish Ministry of Development, November 2017.

Box 5. Cost-share irrigation investments: Concessions and small grants in Chile

Chile has been extensively investing in water irrigation and storage, in part to support its considerable horticulture production. Since 1911, the country has built 41 large reservoirs for irrigation and drinking water. As of 2017, the water-storage capacity in dams for irrigation reached 5 328 million m3, which supports the irrigation for 680 000 ha, or more than 60% of the total irrigated area. The other 40% of irrigation area is supplied by river canals.

However, these efforts have not been sufficient in several regions that increasingly face water stress, due to a combination of climate change and intensive water competition. Several large-scale and smaller water development initiatives have been developed to support more secure irrigation areas, with an increasing interest in involving private funds.

First, at a large scale, the Ministry of Public Works is carrying out an ambitious set of projects to increase the water storage capacity by 2 074 million m3 in the period 2015-2021, allowing irrigation on 338 661 ha with an irrigation security of 85%. Under this initiative, between 2014 and 2018, the government launched the construction of five large dams, which will allow irrigation of around 8 000 farms covering 40 000 ha in the central and northern regions, for a total investment of USD 1.3 billion.

Three of the five dams are being developed under a new cost-share mechanism. The Public Works Concessions mechanism is used to support construction. Under this plan, the state finances a part of the total cost, private investors build, exploit and maintain the dam, and the end users pay the license holder for water stored.

The use of this new funding mechanism results from long discussions with irrigators, as observed in the pilot case of the Convento Viejo dam. There, future beneficiaries criticized the programme because they considered that the water would have a "high cost", and "it was not fair" compared to other areas where the state was building directly. The opposition was particularly significant because crop cultivations of this area were not profitable enough to meet new water costs. In the end, approval of the dam construction led farmers to shift their production to high-value agriculture, like fruit trees, or to sell their land to other farmers.

Second, under the 1986 Law n°18.450 on the Promotion of Private Investment in Irrigation and Drainage works, the National Irrigation Commission manages a cost-share grant programme to support smaller-scale initiatives towards irrigation development and management. This programme allows mainly small and medium-sized owners to complement their investments in irrigation and drainage projects for community works (outside the land ownership) and in individual works (inside the land ownership). Proposals are submitted to the National Irrigation Commission, which reviews their eligibility (in particular, surface and amounts are limited). For the acceptable projects, a score is determined in accordance with the percentage of the candidate's contribution, the equivalent credited surface, the cost per beneficiary and whether the candidate is a small producer according to the Irrigation Law. The available funds are assigned to the selected projects based on scores and given to beneficiaries upon the completion of the projects.

The success of the initiative outlasted the government's initial ambition. Since 1986, about 23 000 farmers have benefitted from the program, which contributed to develop irrigation on 200 000 ha, including a growing number of small farmers over time. The programme also enabled 500 000 beneficiaries to shift to pressurised irrigation, representing a total area of 325 000 ha. In 1986, the government intended to spend less than USD 1 million for the implementation, but the National Irrigation Commission is still spending USD 100 million a year given the fact that it continues to deliver on its objectives.

Source: National Commission of Irrigation (2017[55]); National Congress of Chile (1985[56]).

2.3. Managing water comprehensively: The EU Water Framework Directive

2.3.a. Overview of the reform

The European Union (EU) introduced the Water Framework Directive (WFD) in 2000 to address widespread problems of water quality degradation and regional scarcity. It had been preceded by legislation dating back to the 1970s, including a 1990s directive targeted towards certain pollutants[24]. Designed as a comprehensive water policy, covering quality and quantity, the WFD integrated and centralised all water management activities at the river basin level with the objective of preventing deterioration of the aquatic environment and achieving a "good status" [25] of all water bodies by 2015.[26] It also aimed to improve the pricing of water, to increase public participation, and to repeal old legislation on water. Like other directives, the WFD was to be applied to all EU Member states.

Though environmental objectives were predominant, the WFD sought to address both water quantity and quality issues by consolidating previous water legislation and establishing a framework for sustainable water management. This framework was proposed through the introduction of cross-regional and cross-border River Basin Management Plans (RBMPs) and Programmes of Measures (PoMs). The PoMs included two types of basic

[24] See in particular the EU Nitrates Directive, discussed in section 3.5.

[25] "Good status" includes different qualitative and quantitative objectives for surface and ground-water bodies.

[26] 2015 was the target date for the achievement of good status, as it represented the end of the first cycle. In practice the WFD will continue for two additional five-year cycles (2016-21 and 2022-27) with the goal of achieving all the objectives by 2027.

measures: minimum requirements to regulate activities potentially impacting bodies of water, and supplementary measures, which are not obligatory, to encourage better water resource management by economic actors. Member states had to uphold existing water-related EU legislation, including the Nitrates and Urban Waste Water Treatment Directives under the basic measures. Basic measures also encompassed new administrative and regulatory instruments like permit regimes and binding rules to improve the control of authorities on activities likely to significantly impact bodies of water (European Commission, 2015[57]). The design of the PoMs required distinguishing which measures were necessary to reach good status from others, based on the specific issues faced by each individual member state.

Through both RBMPs and PoMs, the WFD introduced ambitious quantifiable targets, encompassing water pricing policies, quantitative measures for water management (water abstraction), and qualitative measures aimed at reducing pollution of water resources. In particular, the principle of cost recovery was explicitly put forth as part of the WFD through the PoMs. Pricing was required to cover abstraction, distribution, and treatment costs; it was also required to account for resource value and environmental costs, including in agriculture.

The 2012 evaluation of the WFD showed a disappointing level of achievement, with many member states reporting delays in implementing both basic and supplementary measures, making achieving the original objectives difficult (European Commission, 2015[57]; European Commission, 2017[58]). As of 2012, 47% of surface water bodies had not achieved a good ecological status (European Commission, 2017[58]). Although this proportion decreased by 10% from 2009 to 2012, the 2015 targets appeared out of reach in some of the member states (Ibid.). Agriculture likely played a role in this outcome: 9-23% of river basin districts reported substantial delays in implementing measures directly linked with agriculture; the majority of projects to make irrigation more efficient were still ongoing and many had not started by 2012 (European Commission, 2015[57]).

2.3.b. Facilitating factors leading to the adoption of the reform

Water pollution had been slowly mounting as a concern for the general public in the European Union. In 1988 the Council of Ministers of Environment requested the European Commission to work on a directive to tackle the issue in a holistic way. This began with the Nitrates and Waste Water Treatment Directives. In 1995, Council of Ministers of Environment and the European Parliament's environmental committee requested the EU Commission to proceed with a more global approach to water policy. A Communication followed by an open consultation and conference enabled the development of key recommendations in 1996, leading to the first draft of the WFD in 1997. Another three years of information, feedback and consultation with member states and stakeholders led to a co-decision by the Council and Parliament to adopt the directive in December 2000 (European Commission, 2017[58]).

The approach used by the WFD was reportedly the result of intense debate across member states at the European Council. The United Kingdom and other member states were in favour of the environmental outcome approach (defining a long-term environmental objective, namely, the "good status") that was adopted in the Directive. In contrast, other members, including Germany, were more in favour of an approach that would focus on reducing environmental problems at the source (e.g. acting on water users and polluters).

The passage of the WFD was also facilitated by a favourable political window.[27] The environmental policy agenda was relatively more prominent around 1998-2000 than in the years thereafter. This may be due to the converging interests of acting governments in member states, and the relatively positive regional and global economic outlook. Additionally, the reported opposition of some agriculture groups to the reform did not weigh significantly in the outcome as it covered all water-using activities, not just agriculture.

2.3.c. Facilitating and inhibiting factors in implementing the reform in the agricultural sector

Under the WFD, EU member states were in charge of gathering evidence of pressures, impacts, and status of bodies of water prior to designing their supplementary measures, but the stock-taking methods were sometimes criticised as unsuitable. In the first assessment of river basin management plans, agriculture was identified as a significant source of pesticide pollution in 25 out of 28 Member states and in 65% of River Basin Districts (RBDs). Few member states conducted assessment of the pressures from agriculture. Denmark established two inter-ministerial working groups who assessed the obligations under the directive and the implementing measures needed. Of 23 member states examined, only Lithuania undertook an in-depth assessment to quantify the scale of pollution pressures from agriculture (European Commission, 2015[57]). Ten other member states only quantified the nitrate and phosphorus load from agriculture without estimating the effort needed to decrease this load and reach expected policy outcomes (*Ibid*). Most member states performed cost-effectiveness analyses to identify the efficient policy instruments to tackle identified water constraints (*Ibid*). Given that much of the information gathered for the first assessments came from farmers and their representatives, many of the supplementary measures proposed were similar to pre-existing practices rather than to ones striving towards additional environmental stewardship.

Though basic measures of the WFD represent the minimum requirements, no fines or other enforcement measures were applied to member states or individual polluters who did not comply in time. This lack of enforcement did not favour the application of the polluter-pays principle stated in the objectives of the WFD.

Several discussion groups across member states were initiated to support the implementation of the WFD. One group, focusing on agriculture and water issues, was active from 2004-14, but it mainly involved the exchange of views related to the reduction of nitrates, without creating drivers for action.

Acknowledging that basic measures would not be sufficient to attain the WFD's objectives, the directive required member states to set up supplementary measures at their discretion, based on a prior gap analysis. These measures were supposed to foster changes in practices to attain environmental objectives from baseline situations in the different RBDs. In the agricultural sector, supplementary measures were set up to reduce nutrient pollution, strengthen advisory services to the sector and improve irrigation efficiency. At the same time, conditions were not always in place for effective implementation, e.g. the lack of water meters in irrigation basins prevented charging water users the resource costs of their irrigation, thus undermining the pricing policy objectives.

[27] According to an observer it was “the Golden Age of environmental policy making” in the European Union.

The EU Common Agriculture Policy (CAP) contributed significantly to supplementary measures applied in agriculture. Most of the funding for these measures came from the Rural Development pillar of the CAP in the form of co-funding for voluntary projects submitted by farmers and local communities, or through training activities.

Some elements of the reform's implementation mode can explain its underperformance: targets, timetables, and geographical location of measures to protect the aquatic environment were not always explicitly linked to the environmental objectives of the WFD; there were no quantified targets in terms of load reduction or water quality standards for the national supplementary measures at RBD level; most national action plans allowed derogations or benchmarked supplementary measures on pre-existing practices identified during consultation with farmers and other water users; and administrative burdens and lack of funding were also reported as causes of implementation delays (European Commission, 2015[57]).

2.3.d. Premises for future adjustments

The WFD has set a robust legal and institutional basis for future adjustments by streamlining the regulatory framework on water management and linking implementation to river basins rather than administrative boundaries. Future modifications will need to focus more on the application of policy instruments and their dedicated funding mechanisms. The combination of these efforts with stronger decentralized environmental objectives under CAP could create renewed incentives for better management of available water resources by farmers and other stakeholders.

In November 2017, the Commission launched a Fitness Check of the Water Framework Directive and the Floods Directive, which are to be completed by mid-2019. The Fitness Check will look at the relevance, effectiveness, efficiency, coherence and EU added value of the Directives. This will include an assessment of the potential for regulatory simplification and burden reduction, as well as a quantitative assessment of actual costs and benefits as far as possible. The main issues on the implementation of the WFD have been raised in previous implementation reports from the Commission and will be updated in its upcoming report, to be published mid-2018. The Fitness Check may identify areas where simplifications or improvements to the legislation or its implementation could be possible and therefore may serve as the basis for further action, which will be in any case decided by the next Commission.

The 2014 regulation on groundwater management in the U.S state of California shares some general design features with the WFD, albeit at a different geographical scale (Box 6). It requires defining basins and plans at the groundwater body level and sets long-term sustainability objectives. At the same time, it focuses solely on groundwater issues, and entails a more constraining regulatory oversight mechanism, with the credible threat of a state takeover of responsibilities in case local agencies fail to implement their plans.

Box 6. Regulating groundwater use with an outcome-based approach: The California Sustainable Groundwater Management Act of 2014

Facing variable water supplies and prolonged droughts, much of California's agriculture sector has relied on groundwater for irrigation since the 1920s. As of 2013, California was the last Western US state without groundwater use regulation. This situation resulted in intensive groundwater use during dry years, which progressively depleted some of the main aquifers and locally induced long-lasting and sometimes irreversible environmental damages, including stream depletion, saline intrusion, and land subsidence.

After a failed attempt to regulate groundwater in his first term as Governor of California in 1977, and amidst the most intense drought ever recorded in the state, Governor Jerry Brown introduced the Sustainable Groundwater Management Act in 2014. The adoption of the Act was supported by multiple consultations, including with water experts, and evidence of the cost of inaction on groundwater. The three bills defining the Act were passed by the Democrat-led state legislature, despite opposition from the California Farm Bureau Federation, and were signed into law by the Governor in September 2014.

Under this legislation, Groundwater Sustainable Agencies (GSAs) have to be formed for each high- and medium-priority groundwater body in the state. These agencies have the responsibility to set up Groundwater Sustainability Plans by 2022 and manage their implementation by 2042. Sustainability is defined by the absence of any "undesirable results" defined as: "persistent lowering of groundwater levels, significant and unreasonable reductions in groundwater storage, significant and unreasonable salt water intrusion, significant and unreasonable degradation of water quality, significant and unreasonable land subsidence, and surface water depletion having significant and unreasonable effects on beneficial uses". Failure to set up GSAs in medium- or high-priority areas, or failure by GSAs in these priority areas to establish plans and apply them can trigger probationary actions by state agencies, temporarily taking the responsibility for the groundwater body.

As of 30 June 2017, over 250 GSAs had been formed, thereby meeting the first milestone of the reform on time.

Source: California Department of Water Resources (2017[59]); Cooley et al. (2016[60]); Gruère (2016[7]); Walton (2015[61])

2.4. Encouraging partnerships to improve agricultural water use and environmental quality impacts: The USDA Regional Conservation Partnership Program (RCPP)

2.4.a. Overview of the reform

The USDA Regional Conservation Partnership Program (RCPP) was adopted as part of the Agricultural Act of 2014 (or 2014 Farm Bill). The objective of this programme is to enable public and private partnerships to promote the restoration and sustainable use of soil, water, wildlife and related natural resources at a broader regional scale. The programme also serves to consolidate ongoing regional and water conservation programme efforts administered under the US Department of Agriculture (USDA), specifically the Agricultural Water Enhancement Program (AWEP), the Chesapeake Bay Watershed programme, the Cooperative Conservation Partnership Initiative (CCPI), and the Great Lakes basin programme, which all focus on water quality and quantity.

The RCPP specifically followed the Agricultural Water Enhancement Program (AWEP), which encompassed the USDA's prior watershed-based conservation partnerships. But where AWEP applied only to water, and was implemented on the basis of farm partnerships, RCPP's mission expanded geographically and broadened (i) to include both land and water resources; (ii) to ensure stakeholder buy-in by requiring stakeholder-funded financial leveraging of approved conservation projects; (iii) to ensure stakeholders and projects accountability and transparency; and (iv) to provide the ability of stakeholder partnerships to organize and form at alternative geographic scales (watershed, critical conservation area, state or national), depending upon the stakeholders involved and the uniqueness of the resources of concern.

A key innovation of the RCPP is to enable new types of partnerships to respond to regional natural resource and conservation challenges. The partnerships in RCPP are forged between a number of eligible stakeholders, among "agricultural or sylvicultural producer associations, farmer cooperatives or other groups of producers, state or local governments, American Indian tribes, municipal water treatment entities, water and irrigation districts, conservation–driven nongovernmental organizations, and institutions of higher education" (USDA Natural Resources Conservation Service, 2017[62]). These partnership agreements last up to five years, with a possible one-year extension issued after applications are submitted and reviewed.

The USDA's Natural Resources Conservation Service (NRCS) manages RCPP and provides federal funding plus 7% of available conservation programme funds from the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), the Agricultural Conservation Easement Program (ACEP), and the Healthy Forests Reserve Program.[28] The Secretary of Agriculture oversees the designation of Critical Conservation Areas, which receive 35% of annual funding for RCPP and are limited to eight areas nationwide. One-quarter of funding comes from Competitive State Projects, granted through the USDA NRCS State Conservationist, and 40% of funding comes from Competitive National Projects that are administered and managed by the USDA at the national level (Stubbs, 2014[63]; Schaible and Aillery, 2016[64]).

2.4.b. Facilitating factors leading to the adoption of the reform

The RCPP's introduction was a sensible measure to simplify and reinforce the overarching theme of several coinciding conservation policies. It built on the 2008 Farm Bill (Food, Conservation, and Energy Act of 2008) that included AWEP, one of the first landscape and partnership programs involving water conservation.

Several factors may have contributed to facilitate the introduction of RCPP in the 2014 Farm Bill. First, since federal funding comes through ongoing USDA programmes, the additional budget commitment is reduced. Second, that fact that the programme leverages non-federal conservation funds – partners are expected to cover at least half of total costs – was a major factor facilitating its approval. Third, the programme's reliance on voluntary engagement with stakeholders at the regional level gave it broad political appeal, considering increasing concerns by agricultural producers about the consequences of regulatory actions and the emphasis on regional solutions. Lastly, the RCPP enables federal, state and local governments to work with partners with a diverse array of stakeholder interests; these partnerships help producers apply water conservation methods that promote sustainable resource use through innovative strategies (Schaible and Aillery, 2016[64]).

The RCPP seeks to work on a regional or watershed scale to improve land and water stewardship and was approved because it promoted conservation on a broader regional scale, integrating many stakeholders and regions into partnerships that work on multiple aspects of conservation simultaneously to achieve regional conservation goals. Past conservation programmes tended to focus on individual farms, with less attention to broader conservation implications. The programme effectively enabled investments and

[28] In 2016, the 88 selected projects under RCPP had received USD 225 million of federal funding, and partners had proposed to contribute up to an additional USD 500 million. These amounts however did not indicate the time period (USDA Natural Resources Conservation Service, 2017[62]).

prioritized solutions across particular basins and regions. These added values of RCPP contributed to facilitate the programme's approval.

2.4.c. Facilitating and inhibiting factors in implementing the reform in the agricultural sector

Implementation of the programme has been facilitated by the substantial funding exceeding usual conservation projects, by political support and engagement at the local level, and by improved targeting of conservation investments resulting in funding efficiency.

On the other hand, the reliance on local initiatives and decentralized project control, and the complexity and transaction costs associated with multi-stakeholder co-ordination may contribute to inhibit the programme's implementation.

Beyond strict implementation, the programme does not allow for an effective measurement of success in terms of outcome. Instead of focusing on the performance of the delivered grants or their environmental outcome, success is measured based on the amount of funding allocated to partnerships with varying conservation goals.

2.4.d. Premises for future adjustments

Since the RCPP has been implemented relatively recently, a full programme evaluation would be required before determining the next steps. Such evaluation could be better done if the program's objectives were adjusted to go beyond funding amount to fulfilling measurable program-based resource conservation, eco-system, and farm-economic goals.

There are hopes that locally-led multi-stakeholder initiatives can explore more innovative solutions to complex regional resource conservation challenges. The evolution of other conservation programmes suggests that adjustments could be undertaken as part of future farm bills to improve design or accommodate changing priorities in the conservation agenda.

2.5. Regulating water pollution from agriculture in priority areas: The EU Nitrates Directive

2.5.a. Overview of the reform

The Nitrates Directive (ND) was adopted in the still-growing European Union (EU) in late 1991. Its main goal was to reduce and prevent further water pollution caused by nitrates from agricultural sources in both surface and groundwater. The directive specifically aims towards changing practices in the agricultural sector, as agriculture is the region's largest source of nitrate pollution. The cross-country EU-wide approach marked the ND as an innovative contribution to water policy (Monteny, 2001[65]).

The essential provisions of the ND require member states to undertake a set of actions to reduce pollution, especially in areas facing or at risk of nitrate pollution, and to report activities and outcomes periodically. Member states were first asked to identify surface water or groundwater bodies polluted with a concentration of nitrate exceeding 50mg/L, or subject to eutrophication. This identification exercise was used as a basis for the designation of Nitrate Vulnerable Zones (NVZs), defined as land where farming activities likely contribute to observed or potential nitrate pollution. Member states are also required to develop voluntary codes of good agriculture practices for all farmers. In parallel, member states need to develop and apply action programmes for NVZs, which include the

application of the codes of practices on a mandatory basis, and other measures to limit fertiliser use based on agronomic characteristics of different activities, and to limit the quantity of nitrogen applied with animal manure (in practice, 170kg nitrogen/ha/year).[29] Lastly, member states are required to continue to monitor pollution and report both on surface and groundwater quality and activities undertaken or to be implemented in NVZs every four years (Monteny, 2001[65]; European Commission, 2002[66]; European Commission, 2010[67]).

There was a large implementation delay in the first few years following the ND's adoption, and the first set of Action Programmes was defined and presented between 1996 and 1999, with a second set that followed from 2000 to 2003. In many countries, cycles have followed a four-year pattern of Action Programme presentation in the years since. Implementation has been slow due to the wide breadth of the reform and lack of communication at its outset.

The ND was adopted alongside other directives and related policies (e.g. the Urban Waste Water Treatment Directive that came earlier in 1991). At the time of adoption, other water-related directives were gradually set, but each one targeted a particular pollutant and the approach was not as comprehensive as the ND. The Common Agriculture Policy also underwent reform in 1992 and later in 2000. The ND was focused on monitoring NVZs and keeping levels of nitrates below 50 mg/L, which is the threshold for drinking-water safety. Although eutrophication risk was one of the criteria for the definition of NVZs, the environment was less of a concern in determining its provisions.[30]

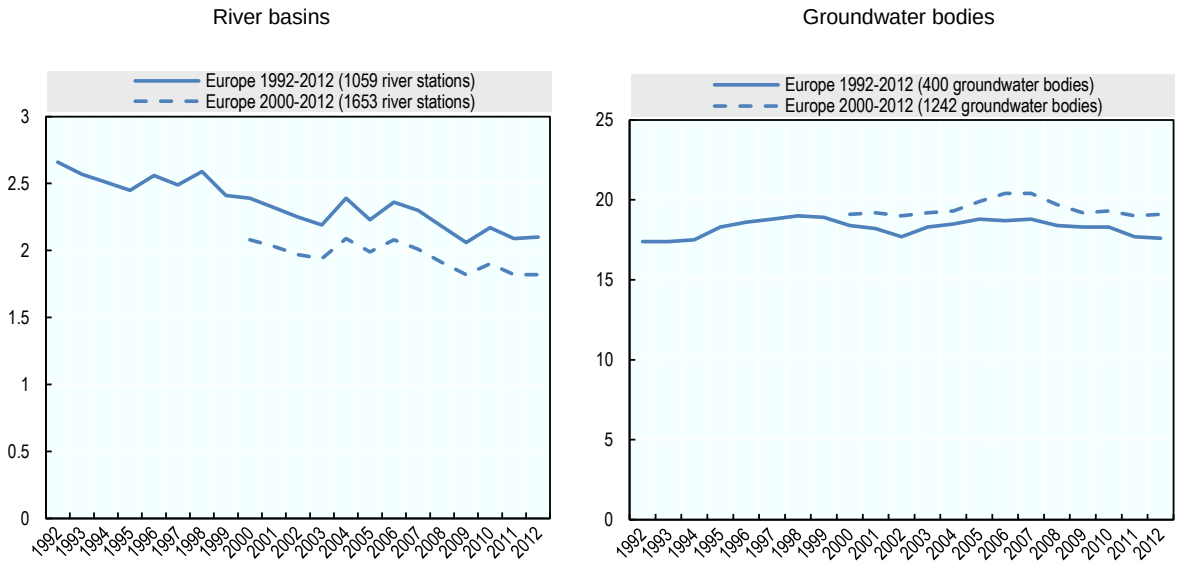
The ND has constituted one of the basic measures for WFD implementation since 2001.[31] During the 2008-2009 period, all Member States formally submitted implementation plans for the first time. A 2010 evaluation showed that action programmes had been effective especially for surface water: it was estimated that nitrate concentrations in surface water remained stable or fell for 70% of monitored sites between 2004 and 2007 (European Commission, 2010[67]). However, the impact on groundwater nitrate concentrations was less clear (Ibid.). Figure 3 shows that nitrate concentration fell in rivers and remained high in groundwater from 1992 to 2012. Consumption of fertilisers in Europe also decreased significantly in 1992-93, potentially in part because of the signal created by the ND (*Ibid*).

[29] EU Member states can also decide to apply their Nitrates Action Programmes to the entire national territory and therefore be exempt from the obligation to identify NVZs.

[30] Safe nitrate levels for the environment vary, but can be much lower than 50 mg/L.

[31] See section 3.3 for details on the EU WFD. The integration was not complete, in that the nitrate issues are still overseen by different officials from Member states, and monitoring is run quasi independently from the WFD.

Figure 3. Annual mean concentration of nitrates reduced in rivers and remained stable in groundwater in Europe after 1992 (mg/L)



Note: For each figure the two time series correspond to a different set of measurements (expanded in 2000).
Source: European Environmental Agency (2015[68]).

2.5.b. Facilitating factors leading to the adoption of the reform

A major driver of passing the ND legislation was mounting public concern regarding the safety of nitrogen-polluted drinking water and regions in which eutrophication negatively impacted aquatic ecosystems. However, overuse of nitrogen has remained high in many countries of the European Union.

At the time of the ND's adoption, there was more room within the Commission to target different environmental media or pollutants individually with separate reforms, such as the Sewage Sludge and the Urban Waste Water Treatment Directives. Only later did the Commission begin to take a more comprehensive approach to reforms that encompass many different aspects of water policy reform, as seen with the Water Framework Directive.

Although consultations did take place, the agricultural sector and agriculture authorities reportedly did not participate fully in the development of the ND.[32] This may be partially due to the fact that agricultural actors were focusing their attention on the 1992 reform of the Common Agriculture Policy (the MacSharry reform of 1992), which signalled the beginning of the EU's shift from production support to producer support.

2.5.c. Facilitating and inhibiting factors in implementing the reform in the agricultural sector

As mentioned above, communication with and amongst the agricultural sector was not strong enough at the time of reform adoption to ensure proper implementation measures were being taken. There was a delay of at least five years by member states to satisfy the agreed-upon implementation of the ND. In 2002, the water monitoring networks were neither complete nor coherent and 20% of EU groundwater was shown to have excessive

[32] Observation made by consulted experts.

concentrations of nitrates (European Commission, 2002[66]). Member states needed more coordination amongst each other to improve these networks and to ensure proper monitoring. The action programmes were not introduced all at once, and their development, along with that of good agricultural practices to reduce N pollution, remains at the centre of water management for these countries.

However, after implementation issues began to arise, more communication started to take place. Robust action programmes were led by solid interactions between research scientists, the government, and the agricultural sector, in addition to more communication between farmers themselves to understand methods of water pollution prevention (European Commission, 2002[66]).

The ND triggered the introduction of regulatory measures for nutrient management in agriculture. Even though the Directive lists the type of measures to implement, there have been variations among EU member states in implementation. Some member states have chosen to put ceilings on nitrogen application at the field level whilst others focus on 'calculating' the dose of fertilizer to be applied (fertilizer budgeting). Some have introduced additional measures in their nitrate action plans to tackle issues they are facing, like phosphorus management measures or requirements on cover crops or buffer strips. Some examples of management reforms that took place include Denmark's Nitrogen Management Programme, Wallonia's Prop'eau-Sable programme, and Germany's Baden-Wurtemberg. Each of these programmes started differently but followed the framework set forth by the ND. Finally, many member states have implemented additional programs on nutrient management in agriculture, complementary to nitrate action plans. These are usually voluntary in nature, like the *Ferti Mieux* programme in France.

These programmes largely varied in design and consequently in effectiveness. Some member states set up regulatory and economic instruments directly aiming to reduce N applications, others used indirect and voluntary approaches, as seen in the case of livestock manure management (OECD, 2012[5]; Le Goffe, 2013[69]). Denmark had started regulating fertilisers in 1985, using a fertiliser budget approach, and they continued tightening their regulations, enforcing regulatory compliance and increasing the coverage of their programmes over time (Box 7). The Netherlands introduced an economic instrument in 1998 that was based on mineral accounting (MINAS) on farms; it was proven effective but faced some implementation issues and was found in violation of the ND in 2003 (Le Goffe, 2013[69]). The Dutch government later adopted a system of quantitative restrictions on N emissions with fines, conceptually similar to Denmark's (Ibid.). Both systems were accompanied by structure change, with lower numbers of herds and larger crop farms. In contrast, France emphasized controlling and supporting its farming structure, with less emphasis on mineral control and less change of industry structure, but a relatively lower performance in reducing pollution in NVZs (*Ibid*).

In recent years the EU Commission has referred several member states to the EU Court of Justice for violating their compliance with different provisions of the ND. As a result, several member states have had to pay significant fines for violation of compliance with different provisions of the ND. The jurisprudence helped explain the requirements of the ND, thereby extending common rules. Furthermore, these legal actions and other implementation initiatives by national Courts of Auditors have triggered policy responses, encouraging stricter enforcement of Nitrate Action Plans, but they did not result in an effective incentive for farmers to change practices.

Box 7. Reducing agricultural input uses via a combination of instruments: The case of Denmark

Beginning in the 1980s, awareness rose of the nutrient contamination of Denmark's primary water supply of untreated groundwater and the overall declining quality of the aquatic environment. This led to the adoption of a series of Action Plans that focused on non-point pollution, mainly from nitrogen and phosphorus applied in agriculture. These Plans developed clear targets (quantitative objectives to be realised by a specific time) and demonstrated how different initiatives could contribute; they were established gradually, and, with time each Plan was reshaped to adapt to new needs. Through these Action Plans, Danish agriculture achieved a complete decoupling between agricultural production and the consumption of various fertiliser types as of 1991, as well as a continued decrease in N surpluses during the following two decades.

The instruments within these Plans focused on reducing the use of specific chemical inputs. One of the fundamental instruments addressing nutrient runoff is the fertiliser accounting system, which is obligatory for farms of a large proportion of holdings. The Danish Agricultural Agency runs the system and publishes annual guidelines for individual farms, including the maximum total amount of nitrogen that can be used on the farm within a season. Farmers are responsible for completing their annual fertilisation account by the end of March each year. Furthermore, under the fertiliser accounting system, nitrogen standard quotas are calculated annually at the farm level. These quotas depend on crop and soil type, climatic conditions, irrigation, precipitation, and the pre-crop. The quotas are set at least 10% below the estimated economic optimum for the various crops.

The Danish government is currently in the process of implementing a new targeted regulation of nitrogen in agriculture. With the targeted regulation, the farmer's fertilization and cropping management will be restricted based on the sensitivity of the aquatic environment and local conditions. Denmark has also implemented a pesticide tax that has effectively changed farmers' use of pesticides and thereby lowered the impact of pesticides on human health and the environment.

Source: Institute for Global Environmental Strategies (2014[70]); Danish Ecological Council (2016[71]); Ministry of the Environment and Food of Denmark (2017[72]); O'Brien and Høj (2001[73]); OECD (2012[5]).

2.5.d. Premises for future adjustments

Now considered one of the basic measures for WFD implementation, the ND may be difficult to revise, but changes in its application could help progress towards reduction in nitrate pollution for agriculture. In particular, it may be necessary to perform more cost-effectiveness analyses in order to compare the costs of programmes or methods to their impacts. Such economic analyses should differentiate private and social costs (European Commission, 2002[66]). Action programmes could also be reviewed more systematically. NVZs where no improvements have been made would also need stronger oversight and efforts.

2.6. Reducing livestock effluents by investing in manure recovery plants: The case of Korea[33]

2.6.a. Overview of the reform

In 2006, Korea adopted the Livestock Excretion Management and Use Act. Under the Act, enforced in 2007, any agricultural activity that releases liquefied fertiliser into public water by leaking or leaving livestock manure, compost, or liquefied fertiliser, or by spraying liquefied fertiliser without complying with specific criteria, is banned.

Under this Act, the Ministry of Environment deals with livestock manure management (control), and the Ministry of Agriculture, Food and Rural Affairs (MAFRA) with its utilization. In this way, this Act aims to promote "circular agriculture" by turning livestock manure into usable inputs and energy, and by supporting a programme establishing

[33] This section is largely drawn from communications with experts from the Korean Ministry of Agriculture, Food and Rural Affairs.

livestock manure treatment facilities and equipment for livestock farmers, thereby preventing water pollution through adequate livestock manure treatment. In particular, the programme aims to ferment livestock waste into solid or liquefied fertiliser and energy resources, which can be easily absorbed by plants. This aims to prevent direct entry of livestock waste into streams, thereby reducing environmental pollution.

The concept of collective manure resource recovery plants that generate solid and liquid fertilizers for crop uses from livestock manure was developed in several steps. Agricultural enterprises started disposing of manure jointly at four large-scale plants equipped with specialized technologies and facilities in 2007 with the intention to build stable infrastructure for manure processing and to efficiently manage livestock waste in areas with high-density livestock farms, including pigs. These facilities started to produce solid or liquefied fertilisers, partly motivated by the Korean government's decision to ban the ocean-dumping of livestock excretion in 2012. The objective of energy recovery from livestock manure was added to the project in 2010 under the action plan "Measures on Waste Resource and Biomass Energy (reported to President/interdepartmental coordination in July 2009)" for producing and supplying low-carbon energy.

This programme provides different means of support to agricultural businesses, agricultural/livestock cooperatives, and private companies. The support ranges from facilities to machinery and equipment necessary [34] to produce and utilize solid/liquefied fertiliser and energy from livestock manure. Participation in the program is based on voluntary application. Following MAFRA's call for project proposals, eligible applicants, such as producer groups (agricultural or dairy cooperatives), agricultural enterprises, the Korea Rural Community Corporation, or private entities can submit proposals to local governments (municipal, provincial or county). After evaluating each proposals' feasibility – analysing their manure-supply plan, the feasibility of a solid/liquefied fertiliser/energy resource recovery plant, and plan for use – the Ministry selects the proposals eligible for funding. The amount of programme funding varies by processing type and capacity. On the basis of 100 tonnes processed per day, KRW 6.4 billion (Korean won) is provided for solid and liquid fertiliser recovery plant and KRW 9.2 billion for energy recovery plant. If the facilities also produce biogas, an additional KRW 5 billion is financed. Considering the raw material supply, the maximum volume is limited to 300 tonnes per day. In addition, MAFRA conducts regular inspections and provides up to KRW 500 million to the best performing plants for their refurbishment.

While the evolution towards collective recycling has been slow, as of 2016 eighty-four plants (eighty for solid and liquefied fertiliser and four for energy) were operating, treating 3 179 thousand tons of livestock manure. This figure represents about 6.9% of the total livestock manure and 16.8% of pig faeces in 2016.

The programme also helped apply the ban on manure dumping in oceans. The total amount of livestock manure dumped into ocean decreased from 2.61 million tons in 2006 to 1.46 million tons in 2008, 1.07 million tons in 2010 and zero by 2012.

The improvement in the quality of solid and liquefied fertilisers under this programme has seen farms increasingly opting for them. The programme is expected to contribute to promoting eco-friendly farming and use of sources of organic fertiliser, which then would gradually replace chemical fertiliser. By recycling livestock manure, the programme is

[34] These include pre-processing facilities for receiving and storing, digester, agitator, sludge and gas storing tank, gas purification facility, generators, boilers and heat exchangers

expected to promote natural recycling agriculture practices; livestock manure will proceed to composting and liquefaction processes for use as fertiliser in crop farming, producing crops that would then be used for animal feeding. This circular process would lead to a reduction in the use of chemical fertiliser and water contamination.

2.6.b. Facilitating factors leading to the adoption of the reform

The 2006 Act introduced the issue of water pollution from fertilisers and manure and the 2012 ocean dumping ban was instrumental in pushing the manure recycling programme to be expanded. The programme on solid and liquefied fertilisers was applied in various areas in Korea. In 2007, with ocean dumping of livestock manure expected to be banned in 2012, the programme was expanded in earnest with the target of treating livestock manure in areas that used to practice ocean dumping. The public complaints of manure odour have driven an expansion of the programme. Past policies on livestock manure did not show visible progress for the general public in terms of reduced manure odour. The effect of past odour management policies was limited due to the lack of management know-how, the absence of experts and inadequate facilities.

In parallel, the programme on energy recovery from livestock manure was first envisaged in 2010 for promoting low-carbon green energy, tackling climate change, and providing renewable energy.

2.6.c. Facilitating and inhibiting factors in implementing the reform in the agricultural sector

The programme has benefitted both livestock and crop farms by managing livestock waste efficiently and replacing the need for farm investments in chemical fertiliser. In addition, it has contributed to social welfare by systematically managing livestock waste that would otherwise produce odour and water pollution.

Urbanization, an increase in urban-rural migration and relocation of public institutions to other cities have intensified conflicts between local residents and livestock farms. Complaints about livestock odour increased by 52.3% from 2,838 cases in 2014 to 4,323 cases in 2015. With a growing interest in animal welfare and sanitation, there is a demand for more rigorous sanitary management of livestock facilities and a change in livestock-raising practices and facilities management (e.g. hygienic status of cattle sheds).

In an increasing number of cases, the programme has been postponed, mainly because collective recovery plants are considered unpleasant facilities by local residents. This perspective becomes a barrier to the establishment of new plants. People's perception towards the livestock industry worsened with the increase in complaints about livestock's manure odour.

Investment in facilities has been insufficient due to strengthened environmental regulations which may have created impediments to the development of new plants. The increase in environmental awareness among the general public has led to stronger environmental regulations, such as the introduction of separation distances and stronger quality standards for manure-laden water.

2.6.d. Premises for future adjustments

The amount of livestock manure is expected to increase with the growth in domestic demand for animal products (in turn linked to GDP growth). As a consequence, MAFRA is continuing to develop its activities to improve manure management. A reform on the

livestock farm environment is planned within the 2017 long-term plan, "Measures for Creating a Clean Livestock Farming Environment". This reform would further encourage the use of livestock manure as resource and the reduction of manure odour. The main goals of the plan include: creating clean livestock farms (fostering 10,000 clean livestock farms by 2025); optimizing the treatment of animal manure at the local level, with 150 collective resource recovery plants to be established by 2025 (where 30% of pig manure would be disposed of); managing odour in livestock facilities; producing and marketing high-quality solid or liquefied fertiliser; fostering human resources for the livestock environment; and enhancing institutions and expanding research and development.

In parallel, the Ministry of Environment is planning to introduce a nutrients management system which will aim to eliminate water pollution created by livestock manure. A pilot project has been in place since mid-2017; by December 2017, the plan included surveying livestock manure impact at the local level, analysing nutrient balance, and researching the proper targets and measures for nutrient adjustments.

As in other areas of water policies, the government will need to make sure that actions undertaken by different ministries are co-ordinated to confirm that there is no overlap, and that the different initiatives support each other in bringing about a better environmental performance of livestock operations.

Beyond regulation and investment in treatment facilities, another approach to control nutrient management from animals in OECD countries has been the use of water quality markets (OECD, 2017[6]). Box 8 examines the case of the Lake Taupo in New Zealand, where a market for nutrient quotas led to a reduction of nutrient from animal effluents. Other nutrient trading systems have been introduced (Shortle, 2012[74]), such as in the Eastern United States (Chesapeake Bay), and are in development in the United Kingdom.

Box 8. Trading nutrient quotas to reduce runoffs from agriculture: The case of Lake Taupo, New Zealand

Starting in the 1980s with pilot initiatives in the United States, several regions in Canada, New Zealand and the United States have set up water quality trading schemes to address point and nonpoint source pollutions from agriculture and other sectors. While the designs vary, the objective is always to set up a cap-and-trade systems for pollutants, to encourage an efficient reduction of water pollution in a particular basin.

Lake Taupo, the largest and most iconic lake in New Zealand, has faced significant nitrogen increases due to effluents from farm operations (dairy, sheep and beef) since the late 1990s. Upon identification of the problem, the Waikato Regional Council initiated multiple rounds of discussions and consultations on how to resolve it. Farmers strongly opposed any effort at first. After 11 years of discussion, an agreement was reached on an objective and method, and a system of cap-and-trade of N discharge was set up in 2009. The objective was to constrain the load of nitrogen into the lake and encourage allocation of efforts across farmers. The system design was supported by sophisticated tools to track N runoffs and by the establishment of a trust to fund the system. To encourage N runoff reductions by farmers, the government set up a cap to current loads and a buy-back 20% of the quotas. Farmers received allocations and were encouraged to reduce their nitrogen emissions to gain from selling water discharge allowances.

Although the number of quotas traded has been limited, in 2015, the system had reduced N loads in the lake by 20% three years ahead of schedule, but at a high public cost for buy-backs (NZD 79 m).

Source: OECD (2015[75]); Shortle (2012[74]).

2.7. Supporting efforts to reduce water pollution via voluntary conservation programmes: The United States' Conservation Reserve Program

2.7.a. Overview of the reform

The Conservation Reserve Program (CRP) was introduced as part of the Conservation Title (XII) of the Food Security Act of 1985 (1985 Farm Bill) (Cook, 1989[76]). Unlike previous efforts that focused on production control or rural development, its principle objective was to address the environmental concern of soil erosion. Reducing soil erosion brings long-term soil-productivity gains and additional benefits, mainly improving water quality by reducing agricultural nonpoint pollution in drinking water (including fertiliser runoff, leaching, and nutrient contamination). Other conservation programmes that were initiated alongside the CRP included Swampbuster, Sodbuster, and Conservation Compliance. These programmes restricted farmers' conversion of wetlands into crop production through penalties and required farmers' upkeep of minimum conservation levels on highly erodible land (Stubbs, 2014[63]). [35]

The first version of the CRP prioritized soil conservation for the environment, rather than productivity gains (Cain and Lovejoy, 2004[77]). For farmers, CRP was intended to maintain farm income and control commodity supply; for the environment, it focused on improving wildlife habitats and water quality (Reichelderfer, 1988[78]). This intentional environmental emphasis was the first seen in a Farm Bill – it was the first conservation title written into one. This set CRP apart from previous efforts to address erosion, and it was supported by intensive enforcement measures for enrolled farms to comply. The introduction of the CRP influenced many future conservation provisions, namely broader efforts that focused on improving water quality, like the Water Quality Incentives Program and, later, the Environmental Quality Incentives Program (EQIP).

Thirty years later, despite incremental changes in the programme, the CRP remains a voluntary programme that enrols landowners in ten- to fifteen-year contracts under the agreement to remove land from agricultural production and instead apply conservation practices to it. Programme participants receive land rental payments, in addition to payments that cover a share of the conservation implementation. Enrolments to CRP can be operated under Continuous or General Signup authorities (USDA Farm Service Agency, 2014[79]). Under the Continuous Signup, environmentally sensitive land can be enrolled at any time provided the land and producer meet certain eligibility requirements. In contrast, in the case of the General Signup, where these requirements do not apply, landowners must apply and submit their offers to a selection to be accepted into the CRP. Their application is evaluated by the USDA's Farm Service Agency (FSA) based on the Environmental Benefits Index (EBI). The EBI quantifies and ranks the environmental benefits and costs from a landowner's proposal. There are five environmental factors assessed in the EBI along with a cost factor (attributing more points to less costly proposals for the government). One of the environmental factors is water quality improvements from decreased leaching, erosion, and runoff (OECD, 2017[80]).

The CRP is also the largest public-private partnership for conservation efforts in the United States and has a budget of almost USD 2 billion (Ferris and Siikamäki, 2009[81]). Land retirement initiatives under CRP have received the largest amount of federal funding and have used about 50% of all USDA conservation spending since 1985, although CRP

[35] The CRP, Swampbuster, and Sodbuster are still all in effect as of today, though they have evolved throughout different years' Farm Bills.

funding has declined relative to working lands programmes in recent years. (OECD, 2011[82]). The maximum surface of land that can be enrolled under CRP is set by the Farm Bill. The 2014 Farm Bill reduced the acreage from 27 million acres in the fiscal year 2014 to 24 million by the fiscal year 2018 (OECD, 2017[80]).

2.7.b. Facilitating factors leading to the adoption of the reform

Water quality issues were brought forward starting in the early 1970s, with the Clean Water Act of 1972 and the Safe Drinking Water Act of 1974, which regulate point source pollution and wastewater treatment and public drinking water systems, respectively, with states in control of enforcement. This movement later influenced agricultural policy, focusing on water pollution from sediment runoff, beginning with the Food and Agriculture Act and the Soil and Water Resources Conservation Act of 1977 (Cain and Lovejoy, 2004[77]).

Unlike in the case of previous Farm Bills, environmental lobbyists saw an opportunity to make environmental adjustments *within* agriculture policy (Cain and Lovejoy, 2004[77]; Helms, 1990[83]). These lobbyists joined forces with soil conservation groups to form the "conservation coalition," which pushed the conservation agenda through different channels. The concept of the CRP was introduced to Congress well before the legislative decision of the 1985 Farm Bill, allowing for adequate discussion and understanding of the proposed programme (Cook, 1989[76]). Additionally, in the months before addressing the proposed 1985 Farm Bill, public concerns began to arise over sustainable agriculture and environmental issues, to then reach Congress for discussion.

The farm economy leading up to 1985 was severely weakened, with farmers facing losses in export markets and, starting in 1981, farmland values dropping by the largest percentage amount over a five-year period since the Civil War (Helms, 1990[83]). This was due to the increase in production, encouraged by the USDA, under the then belief that higher foreign demand was a long-term trend. Grain prices rose during the early 1970s because of large purchases by the Soviet Union, encouraging increased production.

The increased agricultural production and expanded farmland acreage started to increase soil erosion, raising awareness for the associated problems by the late 1970s, when other environmental issues were becoming prominent and brought to national attention.

Congress responded to soil erosion concerns by passing the Soil and Water Resources Conservation Act of 1977 (RCA), which was a key step towards passing CRP and the conservation title of the 1985 Farm Bill. The RCA required reports from Congress on status, condition, and trends relating to the nation's soil and water resources. The passing of RCA acted as a shift in mentality, encouraging agriculture programmes to consider and target water quality concerns (Cain and Lovejoy, 2004[77]; Helms, 1990[83]).

Along with these changes, the RCA began the process of quantifying soil erosion and initiated stakeholder engagement by opening up a forum for public commentary and opinions to consider. The USDA's analysis of these data was used in presenting recommendations for the future to Congress, which allowed for major conservation provisions to pass in the 1981 Farm Bill. Though different versions of land retirement programmes existed in the past, they began to be more widely implemented through contractual agreements between the USDA and individual farmers or ranchers on specific problem areas where soil erosion or other environmental issues were extreme.

Large tracts of wheat were planted in a few western states between 1977 and 1982 that resulted in wind erosion, affecting surrounding landowners. Some of these affected landowners in Colorado were vocal enough to drive a Colorado Senator to legislative

action: a 1981 bill that proposed denial of USDA programme benefits to farmers who convert environmentally sensitive land to cropland. This "Sodbuster Bill" was the first step in the Sodbuster provision in the conservation title of the 1985 Farm Bill and created a platform for interest groups to work on passing a bigger conservation section. Conservation and environmental groups, along with agricultural sector representatives like the American Farm Bureau Federation, supported the bill. Additionally, the USDA approved the provisions proposed by the Sodbuster Bill but wanted to wait until the 1985 Farm Bill to introduce them.

Before 1985, another initiative was introduced: the Payment-in-Kind programme, designed to reduce crop surpluses by paying farmers to lower their planted acreage. Since this programme and, later, CRP were voluntary, conservation became appealing for farmers as a way to ensure financial support. These precursor programmes and their congressional hearings gave farmers adequate experience with conservation programmes in general, making them more familiar with what was necessary for CRP. Representatives from organizations like the American Farmland Trust and the Conservation Foundation provided testimony for conservation programmes in 1985 before the Senate Agriculture Committee (Helms, 1990[83]).

2.7.c. Facilitating and inhibiting factors in implementing the reform in the agricultural sector

A difficulty for CRP's proper implementation upon its introduction was the insufficient communication and sharing of information to farmers who might want to participate. Actors in the agricultural sector were missing information when CRP started. In particular, landowners were unaware of eligibility rules for their land. Furthermore, the definition of "highly erodible land" was not always accurately applicable to farmers' cropland. Educational materials and information were not effectively dispersed before efforts to implement CRP were underway (Reichelderfer, 1988[78]). Since the eligibility criteria was not clear for farmers when CRP was first introduced, quick adjustments were made to include more acreage that could be classified as "highly erodible" land.

In the early years, CRP's objectives proved difficult for adherent farms to achieve due to the vague implementation guidelines and simply because prioritizing one objective often diminished another. Since accomplishing objectives was left up to implementers' discretion, they had to decide whether or not to focus on one goal or attempt to meet all of them without pushing forward on any one in particular. At the outset, CRP rental payments for enrolled acreage were relatively low; however, within a few years, the average price of CRP rental rates began to increase, but not enough to offer significant rates of returns for farmers. As a result, administrators began to see the need for further incentives (Reichelderfer, 1988[78]).

2.7.d. Premises for future adjustments

Many adaptations of CRP have formed over the years and it still exists as a statute in the most recent 2014 Farm Bill. The 1985 first version of CRP opened dialogue to create more conservation programmes, which first appeared in the 1990 Farm Bill, specifically water-related ones like the Wetland Reserve Program and the Agricultural Water Quality Protection Program (Cain and Lovejoy, 2004[77]). The CRP continued to evolve with the development of the EBI in 1991, the inclusion of a continuous sign-up in 1996, and the shift in emphasis to the conservation of working land in 2002 (OECD, 2010[84]). The CRP certainly created the first significant link between environmental efforts and

agriculture, which opened an avenue for future conservation programmes that are continuously evolving. The September 2017 continuous sign-up program (including CRP and farmable wetlands) equalled 7.4 million acres, about 31% of all CRP contracts. The next version of the Farm Bill is set for 2018 and there have been debates on increasing the current CRP acreage cap. It is clear that land retirement through the CRP is still a key strategy for addressing environmental issues (OECD, 2017[80]).

2.8. Engaging with partners to tackle water pollution: Catchment initiatives in the United Kingdom

2.8.a. Overview of the reform

Catchment management schemes propose to set partnerships at the river catchment level primarily to reduce water pollution by taking preventive actions at the source of pollution (upstream) rather than at the pollution treatment level (downstream). These schemes, which started in the early 2000s in the United Kingdom as relatively small scale, private company-led initiatives, have been recognised as best-management practices by UK government agencies, who have embraced the concept. The objective of these agencies is now to scale up and reinforce the use of catchment schemes nationally.

Two types of approaches have been used in parallel by the government to encourage the use of such schemes, denoted "catchment solutions" and "catchment-based approaches".

- First piloted by a few English water companies in the early 2000s; catchment solutions have been encouraged by the key regulatory agencies Ofwat and the Environment Agency, starting in 2009 (Environment Agency, 2017[85]). These initiatives "address environment impacts at source (e.g. reducing demand for water, slowing run-off and flow upstream or reducing contamination of surface and groundwater), rather than treating problems downstream once they have occurred (e.g. end of pipe)" (Ibid.). If they are initiated by water companies, these initiatives are generally led by third-party, non-government entities, River Trusts and other local civil-society actors. The initiatives can involve different types of transactions between companies and catchment stakeholders, from the exchange of expertise to cost-share investments and, in some cases, payments for ecosystem services. With regard to agriculture, catchment solutions aim to reduce nutrient runoffs, notably from manure in basins with significant dairy activities.
- In parallel, in 2013, the UK Department of Environment, Food and Rural Affairs (DEFRA) initiated a strategy and guidance for the application of catchment-based approaches, which propose the use of partnerships at the catchment level "to deliver positive and sustained outcomes for the water environment by promoting a better understanding of the environment at a local level; and to encourage local collaboration and more transparent decision-making when both planning and delivering activities to improve the water environment" (Department of Environment, Food and Rural Affairs, 2013[86]). These partnerships can have a number of objectives beyond pollution reduction, from flood control to ecosystem protection. The concept has expanded rapidly; four years after their introduction, there were 108 catchment partnerships throughout England and Wales.

While there is a keen interest to continue expanding these voluntary approaches to additional catchments and landholders, the government's objective is to merge the two initiatives (the regulatory approach to reduce pollution at the source and government

agency-based partnerships) and to create a single programme for catchment approaches in the future.

2.8.b. Facilitating factors leading to the adoption of the reform

The concept underlying catchment initiatives was influenced by discussions in the setting of a European-Union-funded cross-country exchange programme, the Interreg North Sea Program. In particular, two projects – the Water for All and Water Cost projects – discussed innovative approaches to pollution control. As part of these projects, water companies, authorities and regulators from the United Kingdom, Denmark, Netherlands and Germany participated in a study programme to help exchange experiences. The concept was then operationalised by a few water companies.

Policy changes operated from the bottom up, with water companies encouraging regulators and then government programmes to support the use of their initiatives. Water companies, in charge of water supply services since the late 1980s in England and Wales, experimented with catchment solutions around 2004-06, in the belief that such source-based pollution control initiatives could reduce the treatment cost for drinking water for their customers (Box 9). Encouraged by early successes, these companies then pushed the regulatory agencies to approve the use of these approaches in their regulatory guidance for business plans.

Box 9. The role of water companies in the uptake of catchment solutions by regulatory agencies: The case of South West Water

In the early 2000s, the South West Water company was in charge of a number of reservoirs that were increasingly subject to eutrophication in southwest England. This phenomenon was largely attributed to pastureland-related activities. The company therefore considered the possibility of working to improve land management, but the problem was that they did not own the land. The solution was to work with a third-party organisation to get landowners to launch a new initiative.

Piloted in 2005 as a small-scale initiative managed by the Rivers Trust, with support from EU funding, the Upstream Thinking mechanism South West Water proposed was to combine farm advice with cost-share investments on land to reduce pollution. Investments were designed to become profitable for the farmer and beneficial for water quality. Grants were funded by investment from South West Water and some public support (in some cases from the EU CAP's rural development programme).

The initiative was launched without regulatory approval or official government support. The plan was to include the approach in the company's 2010 business plan. In order for this plan to be compliant with the next edition of the regulatory guidance "PR09" (to be developed by 2009) the company lobbied the government and regulators in 2008 about the benefit of the approach as a means to invest in natural capital around the catchments. They also lobbied the local government and non-government organisations about this benefit.

Ofwat approved the approach in the regulatory document PR09, and the company's plan was approved in 2009 for a total of GBP 8 million. The company's approach was then referred to as an example of good practice in Ofwat and DEFRA's guidance documents on the use of catchment initiatives. The Upstream Thinking initiative now operates on ten catchments in target areas, working with over a thousand farmers.

Source: Personal conversation with a representative from South West Water.

The financial regulator for water companies, Ofwat, publishes price review (PR) reports every five years that frame what companies can and cannot do in terms of pricing and managing water quality as recommended by the Environment Agency. Following extensive discussion in 2007-09, guidance leading to the PR09 review included catchment solutions as an option companies could use to address water quality challenges (Ofwat, 2009[87]). In the run-up to PR14, Ofwat supported the development of catchment solutions. It released a specific guidance on catchment solutions in 2011, which highlighted the potential importance of catchment solutions and set out a number of key principles to guide water

companies (Ofwat, 2011[88]). With further experience, the regulatory agencies recommended that the approach be used more broadly by water companies in PR14.

In parallel, DEFRA developed its strategy for catchment-based approaches, initially set in 2013, with the intention to better operationalise the implementation of the EU Water Framework Directive, and to ensure more integrated and local-based solutions to improve the ecological status of water bodies. With time, the scope of catchment-based approaches expanded, particularly to include flood risk management and flood control measures.[36]

The 2017 Water Industry Strategic Environmental Requirements ((Environment Agency and Natural England, 2017[89])) document provides guidance for companies on their environmental, resilience and flood risk obligations as they develop their business plan for the 2019 price review (PR19). WISER is expected to encourage a further expansion of the use of catchment solutions, encouraging water companies to work in partnership (e.g. with local catchment partnerships and the agricultural sector) to improve catchment resilience to water risks.

Several factors may have played a role in the uptake in agriculture. In the case of catchment solutions, pioneering companies rapidly realised that they could engage in such efforts by working through intermediaries even if they did not own the land. Companies initiating catchment solutions have benefited from strategic partnerships with local institutions and from the availability of funding. Working with locally recognised third party organisations has helped promote the catchment solution concept to land owners that might not have been as receptive to a water company or to a government agency. Partial funding, including from the EU's CAP Pillar II programmes, helped launch some of these initiatives, even before regulatory approval.

In the case of catchment-based approaches, discussions following the first cycle review of the EU Water Framework Directive highlighted calls from many rural stakeholders to go beyond management at the river-basin scale. River-basin-level management was perceived as too broad and too difficult a level at which local stakeholders could participate. The same discussions showed the limitation of the results with existing regulatory and economic approaches; the overall outcome-based policy was not sufficient to trigger meaningful results. This likely encouraged DEFRA to consider acting at the catchment level.

2.8.c. Facilitating and inhibiting factors in implementing the reform in the agricultural sector

Land and farm organisations have been supportive of the initiatives, which has encouraged uptake by farms. Land actors were generally familiar with such initiatives due to the precedent created by the Voluntary Initiative for Pesticides (VIS), which relied on the establishment of a national consortium to discuss and give advice on best management practices. The National Farmers Union (NFU) has actively supported partnerships and catchment approaches, providing advice to water companies on how to approach farmers. Some agro-food processing and retailing companies have also increasingly engaged in agriculture sustainability activities and contributed to some of the partnerships. Taken

[36] In complement to partnerships, in 2014, DEFRA's Natural England and Environment Agency initiated the catchment-sensitive farming initiative, which delivers tailored and targeted information on best practices to reduce water pollution from agriculture. The program has been funded partially by governments and by some water companies (Natural England, 2014[96]).

together, these actions signify that a coalition of farm, land, water companies, agro-food companies, regulatory and government actors agreed on the usefulness of the approach.[37]

Despite this coalition, some farmers have remained opposed to participating to catchment approaches. While the approaches are voluntary in nature, calls for their expansion may encourage government agencies to take enforcement actions. The Environment Agency has the option to use the credible threat of enforcing regulatory zoning (protecting catchments), which could restrict land activities. Land owners are aware of that threat and may be encouraged to participate on their own terms to avoid any regulatory intervention.

2.8.d. Premises for future adjustments

Policy changes are continuing with an evolution towards a consolidation of efforts and there has been encouragement for such approaches to become the norm in most catchments. New approaches are in development that could either build on or replace catchment schemes. For instance, another water company, Wessex Water Services Ltd, is now moving towards implementing a nutrient trading system that could supplant the basic catchment approach if successful locally.[38] Yet another water company has developed trials to pay farmers to conserve moorlands to preserve the future value of a possible carbon (C) offset. Farmers are remunerated at the value of estimated environment benefits (C storage and water quality benefits).

Due to their scope and design, catchment initiatives remain a very flexible, tailor-made type of solution that is bound to continue to evolve with or without government guidance.

3. Cross-cutting comparison political economy analysis: Comparable conditions, long processes

A rapid review of the literature helped isolate different political economy factors that may be worth exploring for each reform (see Annex B). Table 1 shows the factors selected for screening the eight policy reforms. These factors are grouped under five themes: reform outcomes, political cycles, macro- and sectoral economic conditions, the interaction with other policy reforms and factors related to the process and decision-making.[39]

Ten policy changes were evaluated under the eight reforms. For the cases of Australia's Murray Darling Basin and Israel's water prices, which involved multiple policy changes over 25 years, two specific sets of policy changes were selected, the 1994 COAG water reform and the 2012 Murray Darling Basin Plan, and the 2006 Farmers Agreement preceding the 2007 Water Resource Authority and the 2017 Amendment, respectively.

[37] In practice the only issue for farmers working with South West Water has been the reluctance to engage in the covenant paperwork and associated transaction costs, but these have not been impediments to the participation of land actors to these initiatives.

[38] The programme is called the EN-trade initiative.

[39] If some of the selected macroeconomic factors may have limited influence on agriculture and water policies, it is important to know if general macroeconomic conditions varied across cases.

Table 1. Reform evaluation grid: Political economy factors examined

Reform outcome and characteristics	Political factors	Macro- and sectoral economic conditions	Interactions with other policy reforms	Process and decision making
Reform adopted (Y/N) Reform implemented Follow-up with more reform (Y/N) Transition payments (Y/N) Evaluation of reform progress Reform fills a policy gap Reform entrenches vested interests	Government mandate for reform (Y/N) Number of years left for current government at time of reform Government control of parliament or not at time of reform Government 's internal cohesion and coordination Government's political composition at time of reform	GDP growth Unemployment rate Government budget deficit Producer support estimates (PSE) levels PSE growth Share of industry in total GDP Trend in real agricultural prices	Reform under way in other sectors of the economy (Y/N) Coherence of reform objectives with those of other policies	Preparation time before launching reform Exogenous event as trigger to reform Scope of reform Institution in charge of gathering evidence (Y/N) Awareness among stakeholders of need for change (Y/N) Institution in charge of consensus-building Participation of individuals, groups and institutions involved in reform process Size of vested interests in the industry under reform Share of new actors in the industry under reform Reform winners: active lobbyists or not?

Note: Y/N indicates that the factor aims to trigger a yes or no response.
Source: Authors, based on Dywer (2007[30]); OECD (2017[90]; 2006[26]); Tompson (2009[35]); and VanGrasstek (2011[91]).

The results are presented in Annex C, tables A.1, A.2, A.3, A.4, and A.5. This section outlines patterns emerging across factors from the comparison of the ten policy changes by thematic area. These findings are then combined with conclusions from Section 2 to draw some general lessons in Section 4.

- ***Reform outcome and characteristics*** (Table A.1.) All policy changes were adopted, through means of legislation, regulation, or funding, but their degree of implementation varied. While a minority of reviewed policy changes included transition payment or compensation for the change, several of those do not provide funding for farmers to change practices. Vested interests are not entrenched in three of the ten policy changes; these were changes for which farmers were not actively involved in the process.
- ***Political factors*** (Table A.2.) While the governments in place all had a mandate for reform, they did not always control parliament and they had few years until the next election. The studied reforms were on average operated 1.5 years before the next national election. Government-leading parties were in control of parliament only for half of the reforms. Seven of the ten examined policy changes were operated under centre or left-leaning governments or government-led coalitions.
- ***Macro and sectoral economic conditions*** (Table A.3.) Countries and regions enacting policy changes experienced positive economic growth (+3.3%), relatively high unemployment (7.4%) and most had a budget deficit. The countries had a low agriculture share of GDP (2%), with the agriculture market price indices decreasing in

six of ten cases and producer support estimate (PSE) also decreasing in seven of nine policy changes (with available data) during the reforms.[40]

- ***Interaction with other policy reforms*** (Table A.4.) All the policy changes were undertaken in parallel with other reforms, and their objectives were generally coherent with agriculture and water policy changes.

- ***Reform process and decision making*** (Table A.5.) Almost all policy changes followed external factors; some were water-related events, others were increased concerns about water quality or quantity or calls for improvement. But these factors did not mean that reforms happened rapidly – the preparation period lasted on average more than five years from the initial step to the actual policy change. For all policy changes, specific government agencies were in charge of gathering evidence and building consensus. Reform processes involved stakeholder engagement in addition to powerful, entrenched groups in agriculture. Active pressure groups obtained relative gains in the end compared to what they could have gotten without engaging in the process.[41]

4. From the past to the future: Lessons from a comparison of reform policy processes

Findings from Sections 2 and 3 are used in this section to draw lessons from the reviewed reform processes. Subsection 4.1 proposes a typology to characterise reform processes in agriculture and water, sub-section 4.2 analyses factors that may help push forward policy changes, and sub-section 4.3 discusses factors that impact on the results of these reforms.

4.1. Characterising reform processes: Three groups of reforms

The analysis has enabled classification of the studied reforms into three groups based on the following criteria: (A) the scope of the reform process (e.g. from processes encompassing simple policy revisions to processes requiring major institutional changes), (B) the scope of the reform's action (from policy changes tackling a single issue to those addressing multiple issues), and (C) government's degree of involvement in the proposed policies (from low to high, accounting for the possible role of other actors).

- The first group comprises three reforms which included wide policy changes. These reforms were accompanied by changes in institutions and governance that expanded beyond agriculture, covering issues such as water resource allocation across sectors: the Australia's Murray Darling Basin reforms, water pricing reforms in Israel, and the Water Framework Directive of the European Union.

[40] Trends are looked at, starting before the year of the policy change, to avoid simultaneity. Although some of these policy changes affected the PSEs of the respective countries, e.g. via changes in budgetary payments, they were not sufficiently significant for the agriculture sector to drive major changes in PSEs.

[41] In some cases, governments deliberately decide to initially set the announced environmental target much higher than what the target levels seek to achieve. This approach allows them to make offers to opposing pressure groups and ensures some gains for those actors, even if the ultimate result is closer to the actual objective of the government.

- Reforms in the second group of three have induced new policy changes focusing on specific issues at the intersection of agriculture and water, without requiring institutional or governance changes: the EU Nitrate Directive, the US Conservation Reserve Program and Korea's project on recovering and recycling livestock manure.
- The remaining two policy programmes rely on voluntary approaches encouraging partnership between governments and non-government entities to achieve water and agriculture objectives: the US Regional Conservation Partnership Program and the Catchment initiatives in the United Kingdom. Policy change for the latter reform was even partially inspired by a private initiative. Both programmes also followed previous efforts in the same areas and could use those to pilot the concepts they meant to expand.

Reforms can then be rated qualitatively according to their relative level of fulfilment of the three proposed criteria (A, B and C) (Table 2). For instance, reforms in the first group share a relatively broader scope of reform process (high level of A), a broader scope of action (high level under B) and a high level of government involvement (C) compared to others. Reforms in the second group have a relatively medium scope of reform (A) and action (B) while maintaining a high level of government involvement (C). The third group is characterised by a relatively narrower scope of reform (a low A), medium to low government involvement (C) and a medium scope of action (B).

Other permutations may be possible for other reforms; for instance, a small level of (A) (B) and (C) may represent a small-scale partnership programme between government and other entities focusing on a particular issue (e.g. the use of a practice to reduce irrigation in certain cropping activities). The groundwater management reform in California (Box 6) may represent a case with a moderate level of the three characteristics. The nutrient trading program in New Zealand (Box 8) could be depicted with a medium scope of reform and government involvement and a low scope of action. Chile's small grant program to fund irrigation and reservoirs (Box 5) involve medium government involvement, for a relatively low scope of action and reform. Turkey's conditional support to farmers based on crop and irrigation choices (Box 4) may show the case of a medium scope of reform, a low scope of action and high government involvement.

Table 2. Characterisation of the reviewed reforms

	Reviewed reforms	(A) Scope of the reform process	(B) Scope of the reform's action	(C) Government's involvement
Group 1	Australia's Murray-Darling-Basin, Israel reforms, EU Water Framework Directive	High	High	High
Group 2	EU Nitrate Directive, USDA Conservation Reserve Program, Korea Manure Recovery Program	Medium	Medium	High
Group 3	US Regional Conservation Partnership Program, UK water Catchment Initiative	Low	Medium	Medium

Note: The qualitative ratings should be interpreted as relative to the group of studied reforms.
Source: Authors' own work.

This characterisation is useful in that it can help to analyse the type of policy change to be undertaken in future reforms. Implementing water and agriculture policy changes as part of a holistic water policy change differs from dedicated changes in policies addressing specific agriculture and water issues. Reforms associated with significant changes in institutions and governance systems will require different engagement than those that will focus on revising existing policies. At the same time, policies that involve partnership with

other actors present some key differences in design, requiring extra efforts that may challenge implementation, compared to more traditional top-down policy programmes.

4.2. Identifying factors that help advance policy changes: External events, socio-economic and political conditions, and reform process characteristics

The information gathered is insufficient to identify all of the factors that influence the adoption of reforms, but the qualitative comparison of the reviewed reforms (Sections 2 and 3) can help single out shared characteristics that seem to have been influential in the process. The results of this exercise are shown in Table 3, which separates factors depending on the context from factors that can be influenced by reforming agents.

Table 3. Factors positively influencing the adoption of water and agricultural reforms

	Political factors	Economic Factors	Environmental factors	Path dependency factors	Design of reform
Contextual (exogenous) factors	-Mounting public pressure -Favourable political window on environmental policies -Environmental-oriented government majorities	-Stable macro-economic situation	-Environmental pressures: major droughts, aquifer and lake depletion, eutrophication, erosion, odour -Impact and costs of pollution	- Past programmes to build on* -Framing regulations* -Funding from existing policy programmes* -Flexibility of governance systems*	
Controlled (endogenous) factors	-Reforms included in the electoral platform of incoming government - Coalition of the willing			- Past programmes to build on* -Framing regulations* -Funding from existing policy programmes* -Flexibility of governance systems* -Regular adjustment of policies -Evaluations of past policies	-Awareness of stakeholders, participation of stakeholders in discussion -Review mechanisms or adaptive management -Engaging with trusted 3rd party -Long time for reform development -Promised increased water security -Transition payments -Paying farmers - Voluntary programmes

Note: * Denotes factors that may be controllable or contextual depending on the context
Source: Authors' own work based on a review of eight past reforms.

Several of the contextual factors are comparable across adopted reforms (Section 3). First, at the time the reforms were adopted, most countries had stable growing economies, and agriculture represented a limited share of value-added. These conditions may have had an indirect role in the reforms adopted; economic growth may imply more willingness to increase investment, and low agricultural shares of GDP may signify lower political importance of the agriculture sector and therefore less initial reluctance to engage in policy change. Producer support estimates were declining in most cases, indicating possible lower influence from general farm groups. Second, several reforms were adopted under relatively favourable political contexts: mounting public pressure, a political window of opportunity, and government interest in environmental issues. Third, exogenous events, such as continued drought or extreme pollution, in most cases acted as catalyst for the reforms, increasing pressure by affected stakeholders to change policies, leading to a favourable

political context (Sections 2 and 3). Fourth, past policy changes may have made the possibility of further changes easier.

Several other factors appear to have contributed to the likelihood of the adoption of reforms. First, the building of pre-reform political support, resulting in an electoral platform or coalition, helped overcome barriers. Second, the evaluations of past policy changes appear to have helped prepare for a change, as they helped identify both gaps in previous policies and potential policy imperfections. Furthermore, by evaluating and then building on past reforms, a new reform can build on top of the legitimacy of the case for reform that was previously established, fastening the process and increasing the likelihood of policy change. Third, the reform process itself may have been designed to favour a change of policy. All the reforms required lengthy preparation times, which often included first iterations, consultation and discussions. Awareness was high among relevant stakeholders (affected by the reform), and there was some participation of key groups in the process. Farmers may have embraced programmes with stated benefits, such as long-term water security or increased efficiency of input uses, even if they came at a cost for those in charge of the reform. Voluntary programmes and programmes with funding support are more easily accepted than mandatory requirements or those programmes with sanctions or fines.

In view of these observations, a successful pathway to policy change at the agriculture and water intersection may require at once adapting to external factors, by taking advantage of favourable conditions to bring a reform forward, and including in reform design all the possible elements identified here that may help advance the reform itself.

4.3. Trade-offs in reform outcome characteristics arise from varying influences of reform scale, scope, dynamics and process

The comparison of reforms can also help identify some of the factors influencing selected characteristics of the reform outcome: the time and cost spent in the process ("efficiency"); the degree of changes implied by the reform objectives ("ambition"), the degree of implementation of reforms ("effectiveness"), and the capacity of reforms to enable further changes in the future ("flexibility"). The results of this qualitative assessment are shown in Table 4.

Table 4. Reform processes and design influence reform outcomes: findings from the case studies

Characteristics of the reform processes	Efficiency	Ambition	Effectiveness	Flexibility
Higher geographical scale	(~)	(+)	(~)	(-)
Lower geographical scale	(~)	(~)	(+)	(+)
Broad water policy objectives	(~)	(+)	(-)	(~)
Targeted policy objectives	(~)	(-)	(+)	(~)
Rapid policy change	(+)	(~)	(-)	(-)
Gradual policy change	(-)	(~)	(+)	(+)
Stakeholder engagement	(-)	(~)	(+)	(+)
Transition payments	(-)	(+)	(+)	(-)
Payments for farmers	(-)	(-)	(+)	(+)
Investment in infrastructure	(-)	(+)	(~)	(-)

Notes: (+) means likely to positively influence the factor, (-) likely to negatively influence the factor, (~) ambiguous (could have a positive or negative influence). The efficiency of the reform process stands for minimising cost and time to achieve a result. The effectiveness stands for the degree of implementation of the reform (complete or incomplete).
Source: Author's own work.

The choice of geographical scale is associated with a trade-off between a reform's ambition and its implementation. The review of reforms suggests that operating a policy change at a wider geographical scale can help increase its ambition but does not guarantee its level of implementation. Operating on a lower geographical scale can facilitate changes even if these changes may not satisfy the same level of ambition. The EU directives have set new water objectives for agriculture and other sectors at a continental scale, with actions in many regions; however, smaller scale programmes, like catchment initiatives in the United Kingdom, or regulations in Denmark, may be more likely to turn into small but lasting changes in pollution levels.

The breadth of the reform objectives can result in diverging levels of ambition and effectiveness. Broader policy objectives can aim for more important changes than targeted ones, but they may be more difficult to apply consistently. There are multiple links between water quantity and water quality issues in agriculture. Yet targeting efforts on specific concerns, such as water scarcity, flooding risk, or pollution is more likely to lead to effective results given the complexity of each of those problems for agriculture.

Notably, most reforms reviewed here originated from change in water policies that covered agriculture, rather than changes in agricultural policy. This is probably because water quantity and quality are rarely affected only by one sector. At the same time, agricultural policies can be instrumental to progress on water objectives, and environmental policies can trigger action on agriculture. For instance, the EU directives affecting water benefitted from Pillar II rural development fund from the Common Agriculture Policy (CAP). The manure recovery programme in Korea was triggered by an environmental regulation and could be accompanied by environmental plans in the future. There is insufficient evidence in the reviewed reforms to discern the impact of the initial origin of policy changes (agriculture or water policy) on the likelihood of policy adoption and the characteristics of reform outcomes. As a result, this factor is not listed in Table 4; however, it could merit further consideration.

While none of the reviewed reforms identified agriculture and water policy incoherence as a significant obstacle to implementation, general agriculture policies may have reduced the effectiveness of reforms. For instance, support for dairy production in the EU likely did not facilitate the implementation of the Nitrate Directive. Communication mishaps were also present during the lead-up to the Basin Plan in the Murray-Darling Basin.

The dynamics of reforms also appear to matter. Four characteristic patterns can be distinguished from the reviewed reforms (Figure 4). Some of the reforms involved a clear-cut change in policy, with emphasis on implementation (EU Nitrates Directive). In the case of other reforms, policies seem to be continuously evolving, with incremental changes building on or correcting errors from past policy changes (Australia's water trading system and the Murray-Darling Basin Plan, Israel's water pricing). Between these two models, some reforms have included significant initial changes followed by gradual changes of underlying policies (EU Water Framework Directive and USDA CRP). A fourth pattern is identified for reforms that are based on a combination of past changes (USDA RCPP and the United Kingdom's catchment schemes).

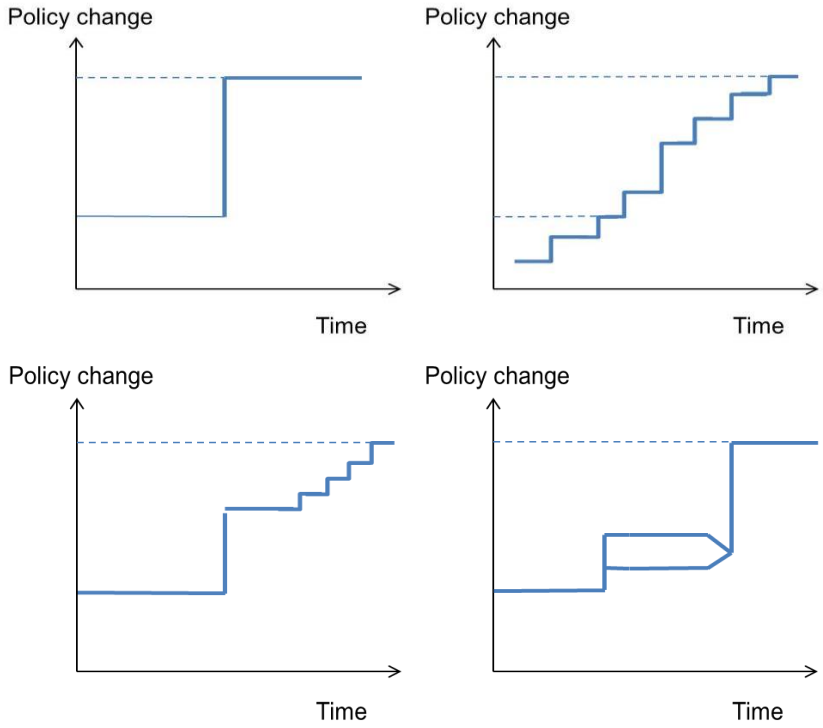
These different patterns contribute to a trade-off between pace, implementation and adjustability of policies. A rapid policy change may take relatively less time and involve lower initial transaction costs, but it will likely require continued emphasis on implementation (and long-term transaction costs) with no guarantee of success. Chile's

change in the water policy code is an example (Box 2).[42] In contrast, gradual changes could ease implementation and enable adaptation and improvement of policies as needed, with more flexibility. At the same time, the dynamic features of reviewed reforms do not seem to influence the ambition of any reform. Major changes can happen discretely or continuously. Combining past policy programmes (e.g. merging them into one policy instrument) can benefit users and policy makers if the overall results are improved and efforts required are lowered. But this combination may also create losers by possibly eliminating some of the specific features of original policy programmes.

Regarding the reform process, attention to stakeholder engagement appears to be necessary but not sufficient for the successful implementation of a policy change. The European Union's Nitrate Directive reportedly did not involve intense consultation with agriculture actors, which may have contributed to its delayed and imperfect implementation. In contrast, the United Kingdom's catchment solutions, initiated by companies, gathered the approval of the farm union and the approval of governments before moving forward. The consulted stakeholder and type of consultation may also matter. The European Union's Water Framework Directive involved extensive stakeholder consultation but perhaps less interaction with farmers, which did not result in satisfactory levels of implementation, particularly in agriculture, in every region.

Figure 4. Dynamic patterns of reform pathways

Top left: Discrete change, Top right: Gradual changes;
Bottom Left: progression from a change; Bottom right: combining policies



Note: The characteristic patterns will typically be combined in any reform process.
Source: Author's own work.

[42] An alternative pattern would be that of a long prepared radical change which may involve high initial transaction costs but lower transaction costs in the long run.

The presence of compensation, such as payments or in-kind support for farmers, generally facilitates implementation (effectiveness) but raises the cost of reforms, with mixed effects on ambition and flexibility. More specifically, compensation mechanisms (transition payments) and farm payment schemes can increase a reform's effectiveness but may have different impacts on its ambition and flexibility.

- Transition payments or in-kind supports, which give short-run compensation for a change of policy and are often the result of negotiations, can help implementation (effectiveness) and contribute to raising the ambition of a reform. In Australia, irrigators in the Murray-Darling Basin were invited to participate, on a voluntary basis, in government programmes to purchase water entitlement for environmental use, or to upgrade their on-farm irrigation infrastructure while returning a share of water efficiency savings to the environment (again in the form of water entitlement). In New Zealand, the Lake Taupo water nutrient market was accepted with the understanding that allocations would be partially bought back by governments. Israel's farmers have been active in water price-setting discussions, obtaining partial access to new water sources in exchange for price increases for freshwater and the centralisation of water decisions in the Water Authority. At the same time, compensatory payments can generate inflexibilities with respect to future policy revisions. They can create a precedent, encouraging affected stakeholders and farmers to ask for new compensation for any future change in policy.
- Payments for farmers also facilitate implementation of policy changes (effectiveness) but their ambition can be limited by budget constraints. Voluntary conservation payments programmes such as the CRP have certainly been an effective means to advance policy changes, but their scope is limited by available funding. The exception is the case of the RCPP, as it leverages funding from partners in addition to government involvement. Voluntary payment programmes are also relatively flexible with respect to future policy revisions, as their objectives can be adjusted from one funding period to the next.

Lastly, infrastructure investments to help reduce pollution and reduce water use tend to have a positive effect on the ambition of the programme, but they could also lead to inflexibilities to adapt to future conditions.[43]

While these observations, drawn from a limited set of reforms, are not sufficient to formulate robust recommendations for future policy changes on water and agriculture, they highlight the need to consider the implications of different features of a reform process when considering possible policy change. Reform processes are generally not direct lines from an intended objective to a policy design and a result; these three features of a reform (objective, design and results) affect one another right from the first discussions that initiate a reform, and each of them may change as the process continues. Still, the factors and conditions identified through this review of case studies show that there are inherent trade-offs across reform characteristics, so it will likely not be possible to maximise all reform process outcomes at once. Future efforts will explore those changing factors in reform pathways to then feed into more specific recommendations for particular objectives and choices of instruments.

[43] For instance, in the Northern Victoria region of the Murray-Darling Basin, investments on infrastructure upgrades underestimated the number of exiting irrigators, leaving remaining users subject to high annual infrastructure charges (GHD, 2015[102]).

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Annex A. List of Consulted Institutions

The following institutions were consulted.

Australia	Agri-Food Economic Systems, Australian Department of Agriculture and Water Resources, Australian Bureau of Agriculture and Resource Economics
Chile	Ministry of Agriculture and National Commission for Irrigation
Denmark	Danish Agricultural Agency
European Union	Fresh Thoughts, Stefan Scheuer Consulting
Israel	Ministry of Agriculture and Rural Development, Water Authority, Hebrew University of Jerusalem, Tel Aviv University
Korea	Ministry of Agriculture, Food and Rural Affairs
Turkey	Ministry of Development
United Kingdom	South West Water Company, Environment Agency
United States	United States Department of Agriculture

Annex B. Selected Findings from Past OECD Reports on Political Economy of Reforms

Several OECD reports have studied the political economy of reforms in different contexts, using policy and empirical analyses; see Dywer (2007[30]); OECD (2017[90]) (OECD, 2006[26]); Tompson (2009[35]); and VanGrasstek (2011[91]). Their conclusions suggest that reforms may be more likely to succeed when:

- The policy objectives are coherent with other policy objectives.
- The existing policy regime is prepared for reform, i.e. there is a broad recognition on the low cost-benefit ratio of reform, a pressing danger of not reforming, strong competition between firms in the sector, unwillingness of stakeholders to lobby strongly against reform.
- Governments have an electoral mandate for reform.
- Solid research provides conclusive enough evidence to support a reform.
- There is a cohesive and coordinated position on reform across departments and geographical levels.
- Government and third parties lead a consistent and targeted communication effort all along the reform process to persuade voters, legislators and different stakeholders.
- Governments plan and quickly address political issues arising from reform; i.e. competitiveness of the affected sectors, impacts on "fair" income distribution, vested interests, and political acceptability across stakeholders and the general public.
- Governments sustain the momentum for reform in the long term by maintaining implementation efforts, continuing communication, training government and industry stakeholders, and evaluating the progress of the reform.

Some of these conclusions assume that governments are in control of a reform process – which is not always the case – and are drawn from much broader economic policy changes, and therefore not all tested on more specific policy changes. They nonetheless provide possible questions to assess the selected reforms.

Annex C. Matrices of Comparison of Reforms

Table A.1. Reform outcome and characteristics

	Australia 's COAG Water Reforms (1994)	Australia Murray-Darling Basin Plan (2012)	EU Nitrates Directive (1991)	EU Water Framework Directive (2000)	Israel Farmers Agreement & Water Authority (2006, 2007)	Israel Water Law Amendment 27 (2017)	Korea's manure resource recovery program (2007-10)	UK Catchment management schemes (2009-13)	USDA CRP, Farm Bill 1985	USDA RCPP, Farm Bill 2014
Reform adopted	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Reform implemented	Yes	Still ongoing	Incomplete, still ongoing	Incomplete, still ongoing	Yes	Yes, still ongoing	Still ongoing	Still ongoing	Yes	Still ongoing
Follow-up with more reform (Y/N)	Yes: multiple	Presumably after 2024	Yes	Probable	Presumably	Presumably	Yes	Yes ongoing	Yes, iterations with each new Farm Bill;	Likely, but it's still new
Transition payments or compensation (Y/N)	Yes	Yes	Yes, with CAP	No	Yes	No	No - funding for manure recovery plants	No, but available funding	No, but available funding	No, but available funding
Evaluation of reform progress	Yes	Yes	Yes	Yes	Yes	Reform still underway	Yes, regular inspection of facilities	Yes	Yes, acreage reports	Yes
Reform fills a policy gap	Yes	Yes	Moderately, in that policy plans had started in parallel	Yes for objectives, No for implementation	Yes, addresses high water demand in agriculture	Yes, first to address regional differences in final cost	Yes, first to address water quality and odour issues explicitly caused by livestock manure	Yes. It changes the paradigm of water quality management, to improve results	Yes, first reform to address conservation explicitly	Moderately, in that it consolidates a number of programmes
Reform entrenches vested interests	Yes, agriculture	Yes, agriculture	Yes	No	Yes, agriculture	Yes, for farmers in the south	Yes	No	Yes, to benefit agricultural sector and environment	No

Source: Authors' own work.

Table A.2. Political factors

	Australia's COAG Water Reform (1994)	Australia's MDB Plan (2012)	EU ND (1991)	EU WFD (2000)	Israel Farmers Agreement & Water Authority (2006, 2007)	Israel Water Law Amendment 27 (2017)	Korea's manure resource recovery programme (2007-10)	UK catchment management approaches (2009-14)	USDA CRP (1985)	USDA RCPP (2014)
Government mandate for reform (Y/N)	Yes	Yes	Not applicable	Not applicable	Yes	Yes	Yes	Yes	Yes	Yes
Number of years left for current government at time of reform	2 years	1 year	Change of Commission 1 year after reform	Change of Commission during reform	2 years (February 2009)	NA	2007 was election year; Lee Myung-bak won	2009: Brown 2 years, 2011-2013; Cameron, 2-4 years.	4 years (start of second Reagan administration)	2 years (last 2 years of Obama's second term)
Government control of parliament or not at time of reform	Yes	Yes	No	1999 change of majority from Socialists: 35% to Christian and European Democrats: 37%	No (coalition)	No (coalition)	Yes	Yes in 2009 and in 2011-13	Democratic majority in the House and Republican majority in the Senate	Republican majority in the House and Democratic majority in the Senate
Government's internal cohesion and co-ordination	Only provisional guidelines from federal government; implementation decided by states	Co-ordination with regional water management and MDB Authority	No	No	Yes	Yes, across many ministries	Yes	Two parallel tracks early on, that shall join in the future	Yes	Yes
Government's political composition at time of reform	Australian Labor Party majority	Australian Labor Party majority *	Socialist majority	Socialist majority in Council of the European Union	Kadima-Labor coalition (Centre)	Likud-National Liberal Movement	Uri Party (2006); Grand National Party (conservative) in late 2007	Labour government in 2009, Tory-Liberal Democrat coalition in 2011-13	Republican Party President	Democratic Party President

* The 20017 Water Act was passed under a liberal-national coalition.
Source: Authors' own work.

Table A.3. Macro and sectoral economic conditions

	Australia's COAG Water Reforms (1994)	Australia's MDB Plan (2012)	EU ND (1991)	EU WFD (2000)	Israel Farmers Agreement & Water Authority (2006, 2007)	Israel Water Law Amendment 27 (2017)	Korea's manure resource recovery programme (2007-10)	UK catchment management approaches (2009-14)	USDA CRP (1985)	USDA RCPP (2014)
GDP growth	3.4% (1985-1995 average)	2.8% (2005-2015 average)	3.1% (EU-12 average 1987-1991)	4.6% (EU-15 countries 1997-2000)	2006: 5.8% 2007: 6.1%	3.86% (2010-2016 average)	2006: 5.2% 2007: 5.5%	2009:- 4.3% 2011: 1.5% 2013: 1.9%	2.8% (1980-1985 average)	2.1% (2010-2014 average)
Unemployment rate	9.7% (1991-1996 average)	5.2% (2005-2015 average)	8.8% (1991)	7.7%	2006: 10.7% 2007: 9.4%	5.9% (2010-2016 average)	2006: 3.4% 2007: 3.2%	2009:7.5% 2011: 8.3% 2013: 7.5%	8.1 % (1980-1985 average)	8.0% (2010-2014 average)
General budget deficit or surplus (% of GDP)	No data available	-2.9%	No data available	No data available	2006: -0.7% 2007: -1.7%	2015: -2.1%	2006: 2.3% 2007: 4.2%	2009: -10.1% 2011: -7.5% 2013: -5.6%	No data available	-4.8%
Producer Support Estimates (PSE)	1994: 9.0%	2012: 2.0%	1991: 38.3%	2000: 33.2%	2006: 8.0% 2007: 2.7%	2016: 17.08%	2006: 58.5% 2007: 56.9%	No data available	No data available	2014: 10.0%
PSE growth	-0.2%	-1.2%	5.4%	-5.3%	2006: -2.7% 2007: -5.4%	-0.7%	2005-06: -1.1%	1986-87: -1.1%	No data available	3.1%
Share of agriculture in value added total GDP	3%	3%	2.7% (1991)	2.4%	2006:1.7% 2007: 1.6%:	2015: 0.5%	2006: 3.0% 2007: 2.7%	2009: 0.6% 2011: 0.7% 2013: 0.7%	1.7%	1.3%
Trend in agriculture real price index (2010=100)	Positive 1993:66.8 1994:76.9 1995:73.2	Negative 2011:109.5 2012:103.9 2013: 96.9	Negative 1990: 66.9 1991: 66.7 1992: 64.8	Negative 1999: 62.9 2000: 61.4 2001: 61.3	Positive 2005: 70.2 2006: 75.7 2007: 85.0 2008: 99.4	Negative 2016: 95 2017: 93.4	Positive 2006: 75.7 2007: 85.0 2008: 99.4	Positive 2008: 99.4 2009: 92.6 2010: 100	Negative 1984: 99.7 1985: 84.6 1986: 70.2	Negative 2013: 96.9 2014: 95.1 2015: 91.5

Source: Authors' own work based on OECD and World Bank data.

Table A.4. Interactions with other reforms

	Australia's COAG Water Reforms (1994)	Australia's MDB Plan (2012)	EU ND (1991)	EU WFD (2000)	Israel Farmers Agreement & Water Authority (2006, 2007)	Israel Water Law Amendment 27 (2017)	Korea's manure resource recovery programme (2007-10)	UK catchment management approaches (2009-14)	USDA CRP (1985)	USDA RCPP (2014)
Other reforms under way (Y/N)	Yes: National Competition Policy (1994) focused on modernizing economy, increasing competition, and introducing the "user-pays' principle	Built on previous water reforms	CAP	Urban Waste Water Treatment Directive, the Directive on Sustainable Use of Pesticides, and the Industrial Emissions Directive	Yes	Yes	Yes, Good Agricultural Practices (GAP) regulations	Yes: under CAP	Yes: Program for Economic Recovery (1981); built on previous agriculture reforms	Yes, many other energy/environmental reforms underway (e.g. Secure Energy Future)
Coherence of reform objectives with that of other policies	COAG Reforms, National Competition Policy, and Murray-Darling Diversions Cap worked together to develop water markets	Result of the National Water Act 2007; response to Water for the Future (2008; previously National Plan for Water Security)	CAP, Urban Wastewater Directive	Floods Directive and Nitrates Directive implemented concurrently	Yes, the Farmers Agreement and the Water Authority creation were coherent, in addition to expanded construction of desalination plants	Yes - opening agricultural and food sectors to imports	Yes, the later ban on dumping livestock excretion in the oceans in 2012	DEFRA program designed to help implement the Water Framework Directive	Yes, with the Program for Economic Recovery; lowering of federal funding for agriculture	Yes, with other programmes within the Farm Bill and with previous programmes that it consolidated

Source: Authors' own work.

Table A.5. Reform process and decision-making

	Australia's COAG Water Reforms (1994)	Australia's MDB Plan (2012)	EU ND (1991)	EU WFD (2000)	Israel Farmers Agreement & Water Authority (2006, 2007)	Israel Water Law Amend-ment 27 (2017)	Korea's manure resource recovery programme (2007-10)	UK catchment management approaches (2009-14)	USDA CRP (1985)	USDA RCPP (2014)
Preparation time before launching reform	4-5 years	5 years	6 years, starting with the CAP debate in 1985	12 years	3-4 years	4-5 years	1 year between adoption and implementation; preparation time unknown	4-5 years for solutions; 7 years for approaches	4 years (last Farm Bill was in 1981)	6 years (last Farm Bill was in 2008)
Exogenous event as trigger to reform	Yes, poor water quality and diminished flows (algae blooms); closure of Murray River Mouth;	National Water Act 2007 triggered by the Millennium Drought	Yes	No	Yes, drought and overall country scarcity	Yes	Yes, poor effects on water quality and public outcry regarding odours from livestock manure	WFD reviews triggering more interest by DEFRA	Yes, increased levels of soil erosion; Previous land retirement programmes were only 3 years without strict enforcement	Increased political concern on environmental and conservation matters
Scope of reform	Focused on water market	Comprehensive	Fairly comprehensive	Very Comprehe nsive	Comprehensive desalination plants, water prices, creation of Water Authority	Limited	Moderate but expanding	Moderate, with increasing adoption rates	Primarily centred around highly erodible land	Fairly comprehensive for a regionally-focused programme
Institution gathering evidence base (Y/N)	No	Yes	Yes, but Member States are responsible for monitoring	Yes	Yes	Yes, Water Authority	Yes, Ministry of Environment; Ministry of Agriculture, Food and Rural Affairs	Yes, regulatory agencies	Yes, USDA	Yes, USDA
Stakeholder awareness of need for change (Y/N)	Yes	Yes	Limited; left up to Member States	Yes	Yes	Yes	Yes	Some calls by stakeholders for improvements of WFD implementation	Yes	Yes, because regionally focused

	Australia's COAG Water Reforms (1994)	Australia's MDB Plan (2012)	EU ND (1991)	EU WFD (2000)	Israel Farmers Agreement & Water Authority (2006, 2007)	Israel Water Law Amend-ment 27 (2017)	Korea's manure resource recovery programme (2007-10)	UK catchment management approaches (2009-14)	USDA CRP (1985)	USDA RCPP (2014)
Institution in charge of consensus building	Council of Australian Governments	Murray-Darling Basin Authority; National Water Commission (closed in 2014, replaced in part by Productivity Commission)	Member States' governments or water management sectors	Water Framework Directive Common Implement ation Strategy	Ministry of National Infrastructure; Water Authority	Water Authority, Ministry of Agriculture, Ministry of Internal Affairs	Ministry of Agriculture, Food and Rural Affairs	Non-government organisations for catchment solutions.	USDA	USDA
Participation of individuals, groups and institutions	Yes, questions on the participation of non-irrigators	Yes, but questions on the level of participation of those groups who are not irrigators	Yes, wide	Yes, wide	Yes	Yes	Yes	Yes	Yes	Yes
Size of vested interests in the industry under reform	Large; agricultural communities and their economies seen to be at stake	Large; agricultural communities and their economies seen to be at stake	Large; aimed at nitrate pollution from agricultural sources	Several industries involved	Large	Large	Large	Large national farmers union	Large	Large
Share of new actors in the industry under reform	Not many	Not many	Not many new actors in agricultural sector	Several industries involved	More desalination and wastewater treatment industries becoming involved	No	Not many	Not many	Not many	Not many
Reform winners: active lobbyists?	Yes	Yes	Yes	Yes	Yes	Yes	Yes, mostly indirectly	Companies yes, but also others.	Yes (environmental groups in this case)	Yes

Source: Authors' own work.