Diffuse Pollution, Degraded Waters
Emerging Policy Solutions

Chapter 4

A policy framework for diffuse source water pollution management

This final chapter presents a policy framework for diffuse source water pollution management and concludes with recommendations for central government. The framework and recommendations are based on the outcomes from the OECD Workshop on Innovative Policy Responses for Water Quality Management, and draws upon the policy analysis of case studies throughout the previous chapters of the report.

Key messages

A policy framework can assist policy makers and stakeholders through the myriad of decisions required to establish new or alter existing water quality management regimes. A policy framework for diffuse water pollution management operates on three levels: *i)* political ambition; *ii)* policy principles; and *iii)* policy instruments. There is also a specific role for central government to help facilitate and expedite reductions in diffuse water pollution and improvements in water quality.

The first level of the framework – political ambition – stresses the importance of knowing and targeting diffuse water pollution risks. Completely eliminating water pollution risks is often technically impossible and not cost-effective; risks must be prioritised and policy responses targeted based on the acceptable level of risk for society (economic, social and environmental), and the cost of amelioration. A lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. Connecting with higher level policy issues can assist in triggering political action (e.g. health, food security, economics, energy production and tourism). New knowledge and tools are available to assist in reducing uncertainties for the development of policy responses.

The second level of the framework – policy principles – outlines a hierarchy of OECD principles for water quality management: The Principles of Pollution Prevention; Treatment at Source; Polluter Pays and Beneficiary Pays. Equity should be considered with regards to who the costs and benefits of policy reform fall upon and the needs of future generations. Policy coherence is required to ensure initiatives taken by different policy sectors (e.g. agriculture, urban planning, and climate) do not have negative impacts on water quality and freshwater ecosystems, or increase the cost of water quality management. A number of OECD Principles on Water Governance are also applicable with regards to: the management scale of diffuse pollution; data and information; implementation and enforcement of policies; and stakeholder engagement.

The third and final level of the framework – policy instruments – recognises that it is not economical to observe individual diffuse water pollution sources directly. Policy makers seeking to achieve environmental goals, while minimising transactions costs and the direct cost of diffuse pollution control must choose from three alternative management options with which regulations, economic instruments and/or voluntary mechanisms will apply to: *i)* managing land use practices as proxies; *ii)* rewarding or penalising polluters collectively for their jointly determined impacts on ambient pollution levels at particular receptors; or *iii)* managing estimated diffuse emissions via computer modelling. The third option offers an opportunity to design policy instruments directly proportional to the amount of estimated pollution generated or reduced from individual properties as part of a wider catchment.

Greater use of economic instruments is required to effectively manage diffuse water pollution. In particular, better utilising economic instruments (e.g. pollution charges, taxes or water quality trading) can create incentives to reduce pollution, and increase the cost effectiveness of and innovation in pollution control strategies.

Central government has a critical role to play in the transition to more effective management of diffuse water pollution. Recommendations include: *i)* providing overarching national policy guidance and minimum standards; *ii)* creating the institutional framework setting the distribution of responsibilities across levels of government; *iii)* stakeholder engagement on approaches to manage perceived and actual risks, and a commitment to reach solutions in partnership; *iv)* signalling policy changes and highlighting options for implementation; and *v)* stimulating the diffusion of innovative technical and policy approaches that minimise the cost of water quality management (including seed funding, space for experimentation and making pollution costly). Lastly, monitoring, enforcement and evaluation of policy implementation, ongoing stakeholder engagement, and reassessment of the risks, are necessary in order to adapt to future changes in climate, economic growth, population dynamics and advances in science and technology.

A policy framework for diffuse source water pollution management

As discussed in the previous chapter, policy approaches used to date for the management of water pollution have largely focussed on point source pollution control with large investments in wastewater treatment, and a reliance on voluntary participation and compliance measures for diffuse sources of pollution (Shortle, 2017). However, water quality remains an issue of concern in OECD countries. Governments have struggled to implement policies that successfully reduce pollution from diffuse sources of pollution. This limited success reflects the inherent complexity of diffuse pollution, and political resistance to regulation and application of the polluter pays principle.

While there is no silver bullet or one-stop-shop for effective diffuse water pollution management, this chapter presents a policy framework (outlined in Table 4.1) that provides a structure to support policy makers to make more robust and defensible decisions. Recommendations for central government to help facilitate and expedite reductions in diffuse water pollution and improvements in water quality are also provided.

Table 4.1. **A policy framework to manage diffuse water pollution**

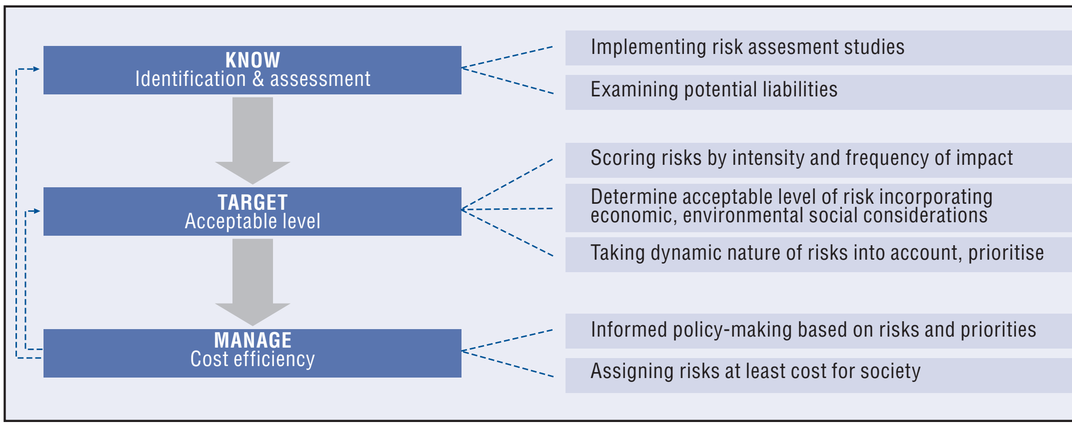
Level	Description
Political ambition	*Know the risks* Identify pollutants, sources, pathways, timing and sensitivity of the receiving environment. Assess the diffuse water pollution risks (environmental, economic and social) taking into account time lags, historical pollution and planned land use change. *Target the risks* Limiting diffuse pollution comes at a cost. Set the appropriate level of risk and ambition and determine priorities informed by thorough assessments, robust knowledge and stakeholder engagement.
Policy principles	Hierarchy of principles for action: • Principle of Pollution Prevention • Principle of Treatment at Source • Polluter Pays Principle • Beneficiary Pays Principle Consider Equity with regards to who the costs and benefits of policy reform fall upon and the needs of future generations. Encourage Policy coherence across sectors that affect diffuse pollution. Ensure good water governance, with reference to the OECD Principles on Water Governance, in particular: geographical scale; data and information; implementation and enforcement; and stakeholder engagement and outcome-oriented contributions to policy design.
Policy instruments	*Manage the risks* Because it is not economical to observe diffuse water pollution directly, the choice and design of policy instruments should build upon one of three alternative management options: • Manage land use practices and inputs as proxies • Reward or penalise polluters collectively • Manage estimated diffuse emissions via modelling. Develop policy responses proportional to the magnitude of the risk. Target adoption of low cost strategies that achieve a high benefit return. Include local differences in the land resource (e.g. their ability to filter and retain water and pollutants) as an integral part of policy development. Consider economic instruments (e.g. pollution charges, product charges, and water quality trading), in combination with regulatory and voluntary mechanisms.

Political ambition

Know diffuse pollution risks

A risk-based approach to water quality utilises the OECD water security risk framework - "Know the risks", "Target the risks" and "Manage the risks" (OECD, 2013) (Figure 4.1).

Figure 4.1 **A Risk-Based Approach to water quality management**



Source: Adapted from OECD (2013).

The first step in a risk-based approach to water quality is to identify pollutants, their origin, timing and pathways, and their risks to water quality, including their likelihood and impact. This will involve understanding the relative contribution of both point and diffuse sources of pollution. Knowledge and information are necessary to understand the causes and impacts, both short- and long-term, and to assess the hazards, exposure, and vulnerability of people and assets. Time lags in the system of diffuse pollution from current and historic land use add complexity to the management of water quality.

The identification and management of diffuse water pollution would benefit from improved scientific knowledge and understanding; greater understanding of the scientific and economic relationships will allow policies to be better targeted, informed and refined. New knowledge and tools are available to assist in this process and should be harnessed (Box 4.1). Stakeholder engagement is an important component of knowing the risks of diffuse water pollution, and understanding the risk perceptions of stakeholders.

Box 4.1. **Make the best of new knowledge to manage diffuse water pollution**

Diffuse water pollution is considered difficult to manage because of the challenges to regulate large numbers of small sources and because the science associated with assessing the impact of each diffuse source is complex (Anastasiadis et al., 2013). And yet, a science-based approach is essential to formulate a multidisciplinary approach to the complex issue of water quality; to manage water quality and quantity in unison, their shocks and tipping points, and their spill-overs to other locations, media (i.e. water, air, land) and sectors (Grey et al., 2013). New knowledge and tools are available to assist in this process.

Advances in computer modelling enables estimation of diffuse pollution based on farm practices (such as crop rotations, stocking ratios, tillage practices, fertiliser, pesticide and irrigation applications), and the hydrological, soil and geographical conditions that effect the transport of pollutants to surface and groundwater bodies (Fishmana et al., 2012). With modelling, diffuse pollution can be projected from individuals to the scale of the catchment, and thereby offers an opportunity for diffuse pollution to be managed as a "point source" with individual land owners held responsible for their actions, and individual land parcels managed as part of a wider catchment to achieve water quality objectives.

Box 4.1. **Make the best of new knowledge to manage diffuse water pollution** *(cont.)*

More monitoring often identifies more problems. Computer modelling can offer a way forward by identifying pollution hotspots and pollution source priorities. By merging physical water quality models with economic models and sensitivity analysis, the efficiency and effectiveness of "what-if" scenarios of various policy and infrastructure options can be tested without recourse to expensive testing in reality (Anastasiadis et al., 2013). Such a decision-support tool can save time and resources, assess the potential risks to stakeholders and prioritise policy and management actions.

An increasingly networked world offers opportunities for capturing new data, reducing uncertainties and engaging with the public. Remote and real-time sensing can generate new knowledge of the state of water quality, pollution sources, and options to address them. For example, Korea's water agency, K-Water is responding to uncertainty in water quality and quantity by developing a Smart Water Grid that combines existing water grids with real time monitoring to ensure adequate quantity and consistent water quality, and to detect leakages in water systems, thereby maximising water and energy efficiency with significant economic and environmental benefits (Brears, 2016).

Earth observations and drones can be used to assess water quality in remote regions. Citizen science (i.e. mobile phone apps, online pollution reporting and pollution hotlines) and earth observations can overcome challenges of inadequate data and data sharing for transboundary management. For example, the Creek Watch iPhone App enables the United States public to capture data on the quality and quantity of any water body at any point and time (IBM, 2012). The App enables new sources of data to be collected at little added cost, from which new insights can be derived and management decisions prioritised. Some challenges associated with using citizen science strategically include: integration and coherence of data gathered from various citizen and other sources; that data gathered is also made available to citizens, scientists, regulators, and polluters in accessible and understandable ways; and that citizen science efforts and online platforms for accessing data are sustained beyond typical three-year project funding cycles.

All of these new sources of data have the ability to reduce monitoring, compliance and enforcement costs. The new digital environment also offers opportunities for more collaborative and participatory relationships that allow relevant stakeholders to actively shape political priorities, collaborate in the design of public services, and participate in their delivery to provide more coherent and integrated solutions to complex challenges (OECD, 2016a). The benefits of providing free and publically accessible data on water quality are recognised by several OECD countries. For example, the United States Water-Quality Watch website displays real-time water quality data collected remotely by sensors installed in rivers, lakes, and other water bodies, and the Rivers and Streams Water Quality Website presents interactive annual graphical summaries of streamflow information, and nutrient and sediment concentrations and loads. Users can compare recent and long-term water quality conditions, download data, evaluate nutrient loading to coastal areas, and more (USGS, 2015). New Zealand has established a similar national public database (lawa.org.nz) to improve utilisation of reliable real-time and historical water quality data for a range of users to inform business, recreational and environmental decisions. Sharing data frees up significant overheads in delivering routine data requests, avoids double-monitoring, and redirects effort into additional monitoring or policy work.

Sources: Anastasiadis et al. (2013); Fishmana et al. (2012); Vörösmarty et al. (2010); Brears (2016); IBM (2012); OECD (2016); Grey et al. (2013).

Target diffuse pollution risks

Completely eliminating water pollution risks is often technically impossible and not cost-effective (OECD, 2013). The second step of the risk-based approach is prioritising and targeting selected water quality risks. This involves determining the acceptable level of water risk for society, depending upon the balance between economic, social and environmental consequences, and the cost of amelioration. Action should be targeted on pollutants of particular significance at the scale and sensitivity of the catchment, basin, or aquifer, on the basis of characteristics such as toxicity, persistence and bio-accumulation (see typology of water pollution, Figure 1.2, Chapter 1). Threats of serious or irreversible environmental damage should be prioritised.

Risk assessments coupled with cost-benefit analyses and computer modelling can help in ranking priorities, identifying the high risk pollution hotspots, and the policy responses most likely to achieve the greatest societal benefit under a range of potential future scenarios. Such tools can be used to support decision-making, but in the end, decisions have political influence which may be informed by the following criteria:

- Stakeholder engagement to help determine the level of acceptable risk to society
- Economic impacts, including cost of amelioration and burden sharing
- Human health and social impacts
- Impact on freshwater biodiversity, ecosystems and ecosystem services
- Geographical extent of impacts
- Longevity and irreversibility of impacts.

A lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. Connecting with higher level policy issues can assist in triggering political action (Box 4.2).

Whether land is used for intensive agriculture, forestry, conservation, roads, city living or other purposes, the interaction between the land and other production inputs inevitably changes the physical and chemical characteristics of water. Including local differences in the land resource itself (e.g. its ability to filter and retain water and pollutants) should be an integral part of diffuse water pollution risk assessment and policy development.

The third and last step of the OECD risk-based approach involves managing the risks, which is discussed in level of "policy instruments" of the Framework.

Box 4.2. **Connect with higher level policy issues to trigger political action on water pollution**

In order to trigger political action to set and enforce regulations, and to raise stakeholder awareness, marketing the importance of water quality objectives beyond environmental protection can be a strategic way forward. Successful initiatives often connect water quality issues with issues of higher political value, or are readily associated with obvious benefits, such as health, ecosystem services, economics and food security. A compelling case for action can be made to central and local governments, and to the public and stakeholders, by highlighting the co-benefits valued by policy leaders and public opinion. The table below lists a range of co-benefits to governments for improved water quality management.

Box 4.2. **Connect with higher level policy issues to trigger political action on water pollution** *(cont.)*

Identifying touchstones can make tangible connections with water quality improvements and support compelling stories. For example, restoration of otters, salmon and other fish in England's rivers has triggered a strong political coalition to improve water quality (Defra, 2011). Making the economic case, computing the cost of inaction, and strengthening valuations of diffuse water pollution in environmental impact assessments can support proposals for action. Information campaigns can rally public support.

Examples of co-benefits to governments for improved water quality management

Co-benefits of improving and protecting water quality	
• Secure water resources (increase water of useable quality). • Adapt to a changing climate. • Reduce flood risk (e.g. catchment protection management, permeable pavements, swales, wetlands). • Reduce health costs (e.g. cancers associated with nitrates). • Improve biodiversity, ecosystem health and the value of ecosystem services. • Improve long term sustainable agricultural, aquaculture and industrial productivity. • Energy production and utilisation of finite minerals and nutrients through wastewater reuse. • Increase cultural and social relations and trust in government.	• Reduce economic losses associated with sick days. • Sustain and increase food security. • Boost and protect tourism. • Improve marketing image/reputation for exports. • Reduce energy consumption (pumping stormwater, water treatment). • Reduce water treatment costs (reduce the need for upgrades or additional plants). • Improve amenity of waterfront properties and public spaces. • Mitigate climate change (e.g. forested catchments, wetlands and build-up of soil organic matter). • Increase recreational use of water bodies. • Increase value of water resources (economic, cultural, spiritual, environmental) and human wellbeing.

Sources: Authors own; Defra (2011).

Policy principles to guide decision-making

The following set of OECD principles can usefully guide the development of policy for the management diffuse pollution sources. They are captured by the *Recommendation of the OECD Council on Water* (OECD, 2016b):

Hierarchy of principles for action

The Principle of Pollution Prevention reflects that prevention of diffuse pollution is often more cost effective than treatment/restoration options. This means preventing pollutants from reaching water bodies by means such as recovery and re-use of wastewater, product substitution, modification of industrial processes, best land management practices and retirement of land.

The Principle of Treatment at Source considers that pollution control measures should be applied as close to the source as possible. In effect, the later the stage of control, the less effective it is likely to be due to wider dispersion of the contaminants. Particularly strict measures of control should be enforced for certain categories of hazardous pollutants with a view to preventing their dispersion into the environment. This applies especially to toxic substances which are persistent in the environment and/or subject to bioaccumulation in living organisms and concentration through the food chain (e.g. heavy metals, DDT). Management measures should aim to prevent uncontrolled pollution transfers to other water resources, or to soil or atmospheric systems.

The Polluter Pays Principle creates conditions to make pollution a costly activity and to either influence behaviour to reduce pollution, or generate revenues to alleviate pollution and compensate for social costs (OECD 2012a). Examples include pollution charges, taxes on inputs (such as fertilisers and pesticides) and sewer user charges. The polluter pays principle should not be accompanied by conflicting subsidies, tax advantages or other measures that encourage polluters to pollute, or assist polluters in bearing the costs of pollution, thereby creating distortions in the market (OECD, 1972; 1974). While there is a case for a public subsidy to address the accumulated damage caused by historical pollution (particularly when the polluters are no longer around to pay), the polluter pays principle should be the first line of defence in securing water quality and incentivising behaviour change (e.g. through water pollution charges and water quality trading).

There are several challenges that result in the polluter pays principle not frequently being applied in the control of diffuse pollution (it is more commonly used with the control of point source pollution) (Table 2.7, Chapter 2). They include difficulties with identifying and targeting polluters, determining reliable estimates of pollution costs, poor enforcement of existing regulations, and strong political opposition. Possible ways to overcome these barriers are captured in Table 4.2 below.

Table 4.2. **The Polluter Pays Principle for diffuse water pollution: Barriers and solutions**

Barriers	Solutions
Difficulties with identifying and targeting polluters	• Computer modelling as a cost-effective alternative to directly observing individual diffuse pollution emissions • Taxes on inputs (e.g. fertilisers, pesticides, cleaning products) or land use (e.g. paved urban surfaces, livestock numbers, intensive land use) • Collective accountability at catchment level
Difficulties with determining reliable estimates of pollution costs	• Economic modelling and scientific monitoring to inform costs and justify action (new data sources are available, see Box 4.1) • Market mechanisms to reveal pollution costs and differentiated abilities to cope with them
Poor enforcement of existing regulations	• Computer modelling as a cost-effective alternative to directly observing individual diffuse pollution emissions • Taxes on inputs (e.g. fertilisers, pesticides, cleaning products) or land use (e.g. paved urban surfaces, livestock numbers, intensive land use) • Collective accountability at catchment level • Increased financial and technical support for local authorities to enforce regulations
Strong political opposition	• Economic modelling and scientific monitoring to inform costs and justify action (new data sources are available, see Box 4.1) • Stakeholder engagement • Collective accountability at catchment level • Connecting with higher-level policy priorities

The Beneficiary Pays Principle allows sharing of the financial burden of water quality management. It takes account of the high opportunity cost related to using public funds for the provision of private goods that users can afford. A requisite is that private benefits attached to water resources management are inventoried and valued, beneficiaries are identified, and mechanisms are set to harness them (OECD 2012a). For example, wastewater treatment plants help to protect water quality in rivers and lakes, and green infrastructure, such as wetlands and forested catchments, provide water filtration ecosystem services. Beneficiaries include city residents provided with quality drinking water; reduced water treatment costs for utilities and health systems, and downstream industrial and agricultural users; improved business for fisheries and tourism operators; and benefits for recreational users, waterfront property owners, the environment, and society at large. Compliance with baseline regulations must be achieved before a payment for ecosystem service scheme is implemented. This is required to ensure additionality and to prevent polluters being rewarded.

Additional principles for policy design

Equity should be considered with regards to who the costs and benefits of policy reform fall upon, and the needs of future generations. Disproportionate costs to users, while important, should not be overstated. Where high levels of taxes have been applied to chemical inputs to comply with the polluter pays principle, often coupled with a mix of other policy measures, they have usually led to reductions in input use without loss of farm production or income (OECD, 2012b). Due consideration of the equity principle for water quality management financing should also be given for public subsidies (OECD, 2009). Equity and fairness in burden sharing do not preclude efficiency.

Policy coherence is required to ensure initiatives taken by different policy sectors do not have negative impacts on water quality and freshwater ecosystems, or increase the cost of water quality management. Multiple policy sectors affect diffuse water pollution and its management, for example, urban development, agriculture, climate, natural resources, forestry, energy, conservation and human health. Policy coherence would entail:

- The removal of subsidies that encourage land use change or intensification that can result in diffuse water pollution.
- Looking for win-win solutions such as NOx reductions to improve air and water quality and reduce greenhouse gas emissions simultaneously.
- Integrating water pollution control (both point and diffuse source) with air pollution control, land use management, and water quantity management.

In "knowing", "targeting", and "managing" water quality risks, identifying trade-offs and impacts is critical. In particular, water quality and water quantity should be managed in unison as the two are interrelated and interdependent. For example, poor water quality reduces the quantity of useable water and therefore exacerbates the problem of water scarcity. Water scarcity reduces the capacity for dilution of point source pollution. High rainfall events and flooding cause diffuse pollution from land runoff (agricultural and urban) and combined sewer overflows into rivers.

In addition, there may be trade-offs and co-benefits between water quantity and quality management, and other important sectoral policies, such as land, energy, biodiversity, urban planning, health care, waste, construction, transport, and climate change. Increasing desalination to improve water security requires large amounts of energy and produces highly concentrated brine. Intensifying land use for food security requires greater inputs of water, energy and nutrients, and contributes to water pollution and climate change.

The potential synergies and complementarities among the sectors should be used to guide formulation of effective options to maximise gain, optimise co-benefits, and avoid negative impacts. Examples of the potential trade-offs and co-benefits from water quality interventions are provided in Table 4.3. Similarly, there are benefits of factoring water quality into policies that affect water availability and use.

When considering new policy in other sectors that may have potential impact on water quality (e.g. agriculture, urban development, energy, climate, mining, etc.), it is important that their impacts on water quality, freshwater ecosystems, the economy and social welfare, and their underlying causes (e.g. market, information, institutional and enforcement failures, and perverse subsidies) are identified. Strengthening valuations of diffuse water pollution in environmental impact assessments can assist with the identification of trade-offs and co-benefits. The decision to commit to a new policy can be guided by a benefit-cost framework that measures whether the potential benefits of water quality protection, adjusted to account for risks, outweigh the potential costs. International experience and lessons learned from previous policy successes and failures should be applied. Evaluating the impact and effectiveness of new policy after implementation (ex ante) is equally important.

Table 4.3. **Examples of water quality policies and trade-offs and co-benefits to other sectors**

Water quality intervention	Potential trade-offs and co-benefits
Wastewater reuse to avoid pollution of rivers	Trade-offs: reduced environmental flow of rivers, additional energy requirements to process and/or transport wastewater and sludge from surplus regions to regions with a deficit. Co-benefits: utilisation of finite resources, such as phosphate, increased water security.
Higher drinking water quality standards to improve human health	Trade-offs: increased energy and chemicals consumption associated with increased water treatment, and increased carbon footprint. Co-benefits: reduced health costs.
Conversion to decentralised water and wastewater systems	Co-benefits: reduced energy consumption and carbon footprint from pumping water over large distances.
Restoration of wetlands	Co-benefits: reduced water treatment and energy consumption, increased biodiversity, carbon capture and storage, reduced flood risks.
Soil conservation to prevent erosion and sedimentation	Co-benefits: increased land use efficiency, biodiversity, food production, and water and fertiliser efficiency.

Principles on Water Governance

The OECD Principles on Water Governance (OECD, 2015a) can guide institutional arrangements for diffuse water pollution control. Four deserve particular attention:

- **Manage water at the appropriate scale(s) within integrated basin governance systems to reflect local conditions.** Because diffuse pollution is largely linked with hydrological processes, the catchment or basin scale is often the best scale for management. However, there may be atmospheric sources of pollution which do not conform to catchment or basin scales which should be considered. Cooperative transboundary water quality management may be required when water pollution affects another riparian country or state in a significant manner.
- **Produce, update, and share timely, consistent, comparable and policy-relevant water and water-related data and information,** and use it to guide, assess and improve water quality policy. Review data collection, use, sharing and dissemination to identify overlaps and synergies and track unnecessary data overload. Promote regular monitoring and evaluation of water quality policy. Develop reliable monitoring and reporting mechanisms to effectively guide decision-making and make policy adjustments when needed.
- **Ensure that sound water management regulatory frameworks are effectively implemented and enforced in pursuit of the public interest.** Develop a coherent legal and institutional framework that sets rules, standards and guidelines for achieving water quality policy outcomes, and encourages integrated long-term planning. Set clear, transparent and proportionate enforcement rules, procedures, incentives and tools (including penalties and rewards) to promote compliance and achieve regulatory objectives in a cost-effective way.
- **Promote stakeholder engagement for informed and outcome-oriented contributions to water quality policy design and implementation.** This is a key role for central and local government in the management of diffuse water pollution. The importance of stakeholder engagement is outlined in section 4.3.

Risk management and selection of policy instruments

Manage diffuse pollution risks

The third and last step of the OECD risk-based approach (Figure 4.1) involves managing the risks, and assigning risks to achieve the selected level of risk in the most equitable and cost-effective way.

It is not economical to observe individual diffuse water pollution sources directly. Policy makers seeking to achieve environmental goals, while minimising transactions costs and the direct cost of diffuse pollution control must choose from three alternative management options with which regulations, economic instruments and/or voluntary mechanisms will apply to:

- **Manage land use practices** (e.g. stormwater, nutrient management and erosion control practices) and inputs (e.g. fertilisers, irrigation) as proxies that can cause distribution of diffuse emissions. This is the most commonly used management approach for voluntary mechanisms to control diffuse water pollution. If applied to regulatory or economic policy instruments, it can limit land use practices and innovation, and can be less effective at reducing pollution in some instances (OECD, 2010).
- **Reward or penalise polluters collectively** for their jointly determined impacts on ambient pollution levels at particular receptors. This approach transfers the burden of asymmetric information and the difficulties of the measurement of ambient diffuse pollution and predictions under certain management scenarios from regulators to individual polluters.
- **Manage estimated diffuse emissions via modelling.** Computer modelling offers an opportunity for individual land parcels to be managed as part of a wider catchment to achieve water quality objectives. Policy measures to reduce diffuse pollution can be directly proportional to the amount of estimated pollution generated or reduced. It allows land managers to innovate farm and land management practices within a pollution limit without being restricted by the inputs and land use practices they use. However, the approach relies on a robust calibrated and validated model and reliable input data. This approach is discussed in application to economic instruments in the section below.

Policy responses should be proportional to the magnitude of the risk (OECD, 2013). When considering which particular policy instruments should be used to meet a given target for a water quality risk, an assessment should be made of how each instrument, or mix of instruments, is likely to contribute to the goals of water quality, economic efficiency and social equity. Risk assessments coupled with cost-benefit analyses and computer modelling can help in ranking priorities, identifying the high risk pollution hotspots, and the policy responses most likely to achieve the greatest societal benefit under a range of potential future scenarios. The risks, costs and benefits should be assigned according to the OECD policy principles outlined in the previous section. The adoption of low cost strategies that achieve a high cost-benefit return should be targeted.

Monitoring and evaluation of policy implementation and reassessment of the risks are necessary in order to adapt to changes; changes to the climate, population dynamics, economic growth, ageing infrastructure, evolving priorities and advances in science and technology make achieving and maintaining water quality a moving target. Criteria for assessing the viability and success of water quality policy reform may include: environmental effectiveness, economic efficiency, equity, administrative feasibility and cost, and acceptability.

Economic instruments as part of an effective policy mix

A policy mix to manage diffuse water pollution is required for effective and sustainable outcomes (economic, social and environmental). However, the present mix of regulatory and non-regulatory instruments in OECD countries limits the ability to address key pressures on water quality in the most cost-effective way. A number of examples of policy instruments to manage diffuse water pollution are presented in Table 4.4 and discussed in Chapter 3. In particular, economic policy instruments are under-utilised, although government interest in them is growing (Shortle, 2017). For sectors that increase aggregate amounts of water pollution, it is especially important that environmental externalities and opportunity costs be internalised where possible through the polluter pays principle. The addition of economic instruments (such as pollution taxes, charges, and water quality trading) would be one important step towards an effective policy mix.

Table 4.4. **Policy instruments to address diffuse water pollution and protect freshwater ecosystems**

Water-related risk	Regulatory	Economic	Voluntary or information-based
Water pollution	Water quality standards Mandatory best environmental practices and restrictions on inputs Pollution discharge permits Non-compliance penalties – non-renewal of resource permits or greater restriction on current permits Non-compliance fines	Pollution taxes (on inputs) Pollution charges (on outputs) Water quality trading Payment for ecosystem services	Information and awareness campaigns Farm advisory services for improved farming techniques (to minimise negative impacts on water quality) Contracts/bonds (e.g. land retirement contracts) Best environmental practices (or good management practices) Environmental labelling – products that meet certain environmental standards can be marketed and sold at a premium and/or subsidised.
Risk to the resilience of freshwater ecosystems	Minimum environmental flows (also for pollution dilution) Specification obligations relating to return flows and restrictions on point source discharges and irrigation in drought conditions	"Buy-backs" of water pollution allowances to ensure adequate water quality for ecosystem functioning	Information and awareness campaigns Voluntary surrender of pollution discharge allowances

Advances in nutrient pollution modelling provides an opportunity to utilise diffuse pollution charges, rather than taxing inputs as proxies (e.g. fertiliser use and livestock numbers), which can be less effective at reducing pollution[1] (OECD, 2010). For example, the price elasticity of demand for agricultural inputs is relatively inelastic meaning that low level taxes on pesticides or fertilisers in OECD countries have in many cases led to raising revenue but little change in behaviour. Using computer models, pollution charges could be directly proportional to the amount of diffuse pollution generated and set at a level where the marginal cost of reducing pollution is equal to the marginal benefit of emitting it.

In line with the polluter pays principle, water pollution taxes and charges should account for the following costs: *i)* direct costs (e.g. infrastructure, clean-up, wastewater treatment and drinking water treatment costs, and administrative, monitoring and data analysis costs); *ii)* external costs (e.g. negative environmental externalities such as reduced freshwater biodiversity and ecosystem functioning); and *iii)* opportunity costs associated with exclusion of other potential users in areas where water quality is unsuitable for use. In principle, revenue raised from such a regime should feed into the general budget of government and be applied to the highest priority public use. Some requisites for the design of water pollution charges and taxes are summarised in Table 4.5.

Table 4.5. **Some requisites for water pollution charges and taxes**

Requisite	Explanation
Clear objectives	The objectives of a pollution charge (i.e. a charge based on the quantity of pollutants that are discharged into the environment) or pollution tax (i.e. product charges on inputs that are believed to have environmentally harmful effects) should be clearly stated about what it aims to achieve: protecting the environment, raising awareness, re-balancing competitiveness across users, and/or raising revenue. The goal could be to ensure that water resources are used in a manner that maximises the net benefits, and that water of sufficient quality is available over time for its highest value use (economic, environmental and social). Obligations related to minimum water quality standards should be unambiguous.
Incentives to polluters	Water pollution charges (and taxes) should be linked to the quantity and toxicity of pollution discharged (or products used) to send a clear signal to users about the importance of water pollution reduction.
Reflection of environmental and opportunity costs, in line with the polluter pays principle	The level of the pollution charge or tax should reflect as best as possible the environmental and opportunity costs so that polluters get an accurate market signal about the costs of pollution. There is an economic rationale to differentiate the level of the charge/tax depending on the volume and toxicity of the discharge and the sensitivity of the local environment to pollution. Proxies can be used to estimate the negative externalities and opportunity costs associated with water pollution so that they can be reflected. Natural capital accounting may be a useful tool to assist with calculating appropriate charge or tax levels. Pollution charges and taxes should be indexed to inflation.
Equity	Differences in pollution charges or taxes should be based only on pollution characteristics (volume, toxicity, location, time) and the likely environmental and opportunity costs, rather than on the economic activity (e.g. agriculture versus industry) or the specific activity of pollution (irrigation versus industrial use).
Provisions for re-allocation of pollution allowances/ permits	Allowing polluters to trade pollution allowances both short term (within a season) and long term (for the duration of a permit) can improve efficiency in allocating abatement reduction effort.

Source: Adapted from Ambec, S. et al. (2016).

Water quality modelling also enables the ability to assign pollution allowances (or permits) much like regulation of point source pollution. Efficiency and equity impacts of allocating pollution in a performance-based regulatory setting differs across land uses and local contexts, and as such should be informed by economic analysis and stakeholder engagement.

Allocating diffuse pollution allowances within a cap then provides an opportunity for water quality trading (particularly in catchments approaching, or already at or above the cap). As discussed in Chapter 3, water quality markets can stimulate innovation, often achieve water quality targets at a lower social cost than traditional performance standards, taxes and payments/subsidies and eliminate the difficult task of setting pollution charge and tax levels. Some requisites for diffuse pollution allocation and for the design of water quality markets are summarised in Table 4.6.

Table 4.6. **Some requisites for diffuse pollution allocation and water quality markets**

Requisite	Explanation
Clear objectives and a stringent cap	Clearly state the objectives of a pollution cap, what it aims to achieve and why. The goal could be to ensure that freshwater ecosystems are restored/protected, and that water of sufficient quality is available over time for its highest value use (economic, environmental and social). Determine a cap at the catchment scale, informed by robust data and calibrated and validated modelling. Consider the assimilative capacity of water bodies, and the level of water quality required to maintain ecosystem functioning when setting a cap. Account for urban, industrial and rural sources of pollution (diffuse and point source) within a cap.
Identify allocation approaches	Identify allocation approaches (e.g. grandparent, catchment average, auction, natural capital - see Table 3.1). Consider including differences in the land resource as an integral part of sustainable water policy (see sub-section below). Foster stakeholder agreement on the principles of equity to use.
Assess the efficiency and equity implications	Estimate the catchment revenue impacts and benefits of each allocation approach to assess the relative efficiency. Evaluate the distributional impacts and opportunity costs of each approach for each land use. Account for abatement potential of the different land uses.

Table 4.6. **Some requisites for diffuse pollution allocation and water quality markets** *(cont.)*

Allocate pollution allowances	Select an allocation approach that best achieves efficiency and equity requirements. Allocate pollution allowances within the cap to all polluters in the catchment. Obligations related to complying with pollution allowances and monitoring and reporting should be unambiguous.
Compensate (if necessary)	Reflect the polluter pays principle where possible. Identify compensation mechanisms, if necessary, for those who face the highest costs or have the fewest mitigation options. Considerations for compensation should account for the abatement potential of different land uses, the ability to pay or farmer income, and lost opportunity costs.
Provisions for water quality trading	Allow polluters to trade pollution allowances both short term (within a season) and long term (for the duration of a permit) within a catchment to improve efficiency in allocating abatement reduction effort. To avoid potentially negative impacts of trade arising from changing the location of pollution, pollution allowances and trading arrangements must be consistent with the pollution cap. State clear rules from government to facilitate transactions. Provide for voluntary forfeiture of un-used pollution allowances. Keep transaction costs as low as possible relative to the anticipated nutrient prices and improvements in water quality. This requires limiting trading costs to administrative costs that are unavoidable and also limiting third party interference in individual transactions. Foster stakeholder engagement to create buy-in to the concept of trading.
Enable synergies with other policy sectors	Enable synergies between water quality and climate change mitigation and adaptation policies to fully benefit from complementarities and to minimise the risk of conflicts. For example, allowing stacking of nutrient credits with carbon credits in an emission trading scheme can further encourage innovation and co-benefits that reduce greenhouse gases and nitrogen pollution of water bodies at the same time.

Include differences in the land resource as an integral part of water policy

In setting policy for tackling declining water quality associated with diffuse pollution, policy makers need to consider the implications of water quality policy for economic growth and land use options into the future. The natural capital approach illustrated in Chapter 3 provides an alternative approach to allocating diffuse pollution limits based on current land use activities (such as grandparenting or sector average approaches), which have the potential to reward existing polluters and constrain future growth opportunities.

By recognising that land, like water, is a finite and critical resource, and that land differs in its productive potential and capability to filter and retain water and nutrients for plant growth, the policy driver can be changed from a resources efficiency use to one that recognises the necessity to add greater flexibility to landscapes that have little natural capital and/or lack versatility in either land use options and/or pollution mitigation strategies. In the long-term greater nitrogen reductions, water retention, productivity and therefore economic growth can be achieved by encouraging intensive land use activities on highly versatile soils, while phasing out intensive land use on poor quality soils. The higher the pollution reduction target, the more difficult it is to achieve improvements in water quality if intensive land use activities continue on lower quality soils. In essence, linking pollution allocation to soil characteristics will encourage over time a better match between inherent capability and use. In the short term, the approach can be costly if large investments in intensive farming activities have been made on poor quality soils. Pathways forward are required to manage the challenges associated with the transition to such a policy, in a similar way to which stranded assets in the climate sector need to be managed. Water quality trading can assist in making this transition.

The concept of adding ecological boundaries (e.g. a cap nitrogen losses to limit the impact on receiving environments), within which land use must operate, moves the analysis from managing land to managing a landscape connected to water. The ability to include ecological boundaries within which resources should be managed will be a feature and capability that analytical farm system frameworks will require in the future to reach the full economic potential of natural resources and provide multiple ecosystem services for a range of desired outcomes beyond just economic growth and water quality.

A role for central government

Central government will play a critical role in the transition to more effective management of water quality. Attention is shifting to the control of diffuse pollution, which has proven more challenging to monitor and regulate. The attainment of the following recommendations may expedite success:

- **Overarching national policy guidance and a strong direction** on water quality improvements is required to send the right signals to local authorities, stakeholders and investors. Distribute responsibility to achieve minimum water quality standards to local government and communities, which each have unique water quality issues, desired outcomes and capacities to respond.
- National policy guidance should be backed up by **regulatory frameworks and enforced minimum water quality standards** for setting the benchmark for better performance, and initiating innovations and investments in improving water quality. For example, minimum standards provide a benchmark, over and above which economic instruments can be used for water quality trading or payment for ecosystem services. Placing harmful chemicals on a watch list can encourage the innovation of more environmentally-friendly products. The amount of investment needed to meet new regulations should be considered when minimum water quality standards are developed. Without suitable funding, regulations cannot be met and their practical usefulness is limited.
- **Creating a space for stakeholder and community engagement** is necessary to manage perceived and actual risks, and reach solutions in partnership. Box 4.3 outlines some requisites for successful stakeholder engagement. Government transparency, accessibility of government services and information, and the responsiveness of government to new ideas, demands and needs are considered as the three building blocks to support an improved evidence base for policy making, strengthened integrity, lower corruption and higher trust in government (OECD, 2005).
- **Giving notice of policy changes and providing multiple options for implementation** of minimum standards is necessary to pave a way forward and reduce objections from stakeholders.
- **Providing government seed funding and allowing space for experimentation** (by relaxing regulations in such circumstances and distributing responsibility to local governments) can stimulate the diffusion of innovative technical and policy approaches that minimise the cost of water quality management. Examples may include pilots for wastewater reuse, water quality fit for purpose, decentralised systems, new approaches to manage and reduce diffuse pollution (e.g. nitrogen inhibitors, new cultivars, precision agriculture, constructed wetlands), and resource recovery from wastewater (i.e. energy and nutrients).

Box 4.3. Requisites for stakeholder engagement on water quality

Stakeholder engagement is necessary to achieve common objectives on water quality management. It identifies stakeholder preferences and desired outcomes, provides a constructive means for collective decision-making about sharing the risks, costs and benefits, and encourages buy-in and compliance with implemented policies. Stakeholder engagement is also required for policy integration, harmonisation, and governance to build synergies and generate co-benefits across sectors and public–private partnerships.

The success of collaborative approaches depends on:

- A national process/framework to ensure the appointment of collaborative groups reflect a balanced range of the community's interests, values and investments. Principles to guide stakeholder governance frameworks are provided in the table below.
- Having sound and transparent processes that encourage stakeholders to freely supply their knowledge and opinions, and encourages them to negotiate honestly. Some stakeholders may withhold important information and negotiations may not reach sufficient agreement, irrespective of the soundness of the facilitation process. Regardless of the quality of the collaborative process, some or all stakeholders may still be critical of the final policy design.
- Providing stakeholders with a clear understanding of the policy design task and process, and with knowledge of the requisite design tools and skills. How policy design proceeds, and the tools used in that process, then becomes the shared territory of the collaborative parties and the decision-making authorities.
- Honest "knowledge brokers" or creating a space for the brokering, where there is competing science and/or entrenched views that block action and policy development.
- Sufficient funding to compensate employers whose staff may be chosen to represent community interests. Funding should also be supplied to secure independent experts for technical scientific investigation to inform decision-making.
- Tools to evaluate, track and report on the progress of collaborative governance in line with the OECD principles.

OECD Principles on stakeholder engagement in water governance

Principle	Description
Inclusiveness and equity	Map all stakeholders who have a stake in the outcome or that are likely to be affected, as well as their responsibility, core motivations and interactions
Clarity of goals, transparency and accountability	Define the ultimate line of decision making, the objectives of stakeholder engagement and the expected use of inputs
Capacity and information	Allocate proper financial and human resources and share needed information for result-oriented stakeholder engagement
Efficiency and effectiveness	Regularly assess the process and outcomes of stakeholder engagement to learn, adjust and improve accordingly
Institutionalisation, structuring and integration	Embed engagement processes in clear legal and policy frameworks, organisational structures/principles and responsible authorities
Adaptiveness	Customise the type and level of engagement as needed and keep the process flexible to changing circumstances.

Sources: Kaine and Boyce (2015); OECD (2015b).

Note

1. Fertiliser taxes can cause an additional burden on horticulture production while making livestock production more profitable. They may also provide unintended incentives to increase livestock levels, leading to greater manure production through more intensive protein feeding, larger acreages devoted to nitrogen-fixing plants and reorganisation of crops in favour of those with less nitrogen consumption, but not necessarily less nitrogen surplus (OECD, 2010).

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