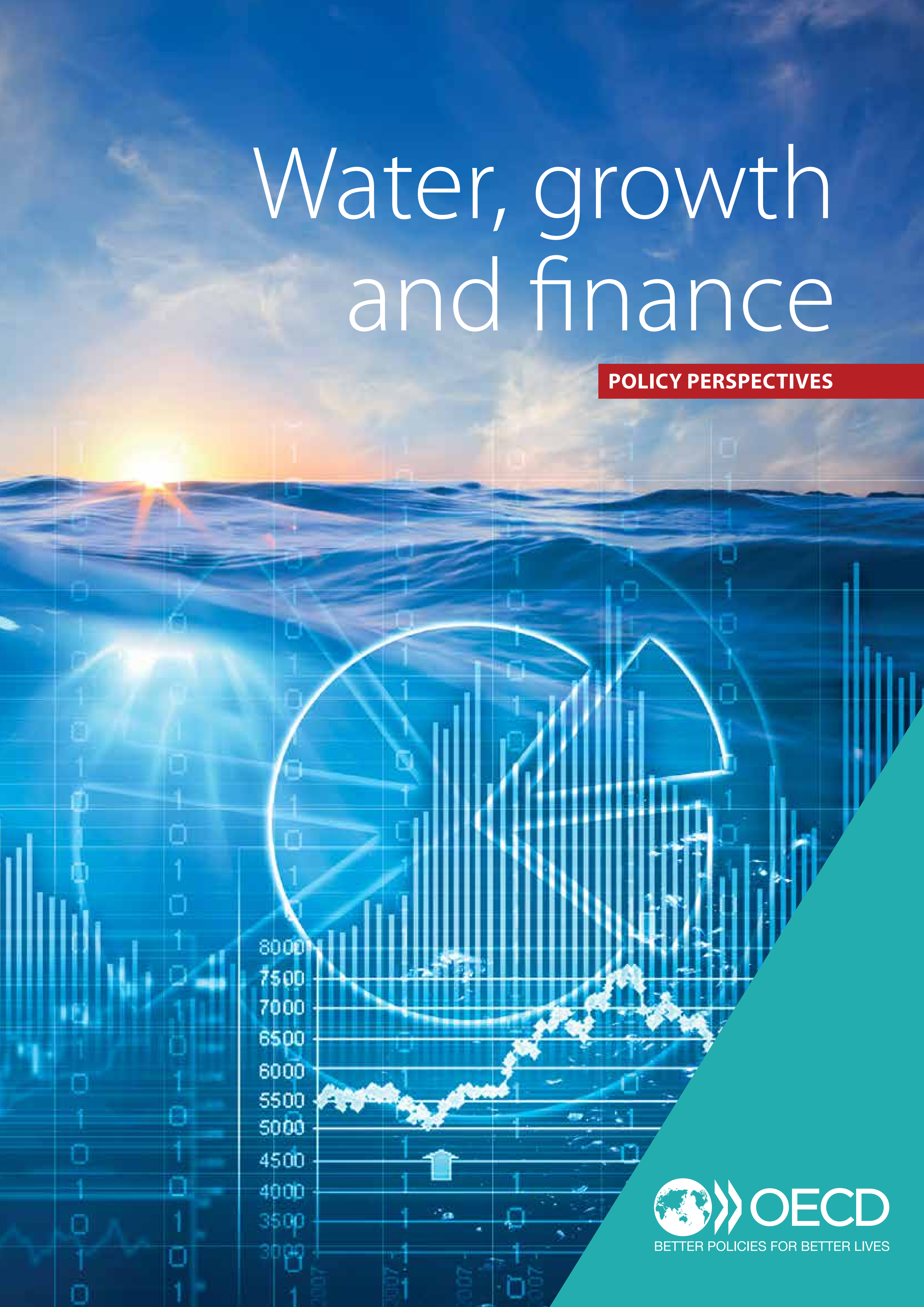
Water, growth and finance

POLICY PERSPECTIVES



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BETTER POLICIES FOR BETTER LIVES

"Investing in water security will drive sustainable growth. These investments must be well-planned, fit in with broader development agendas, benefit local communities and the environment, and be flexible enough to adapt to changing circumstances."

Angel Gurría, OECD Secretary-General

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BETTER POLICIES FOR BETTER LIVES

CONTENTS:

Why we need policies to foster investments in water security and sustainable growth

INVESTMENT IN WATER SECURITY HELPS TO DRIVE SUSTAINABLE GROWTH

The challenge of water security is global, and growing. As populations, cities and economies grow and the climate changes, greater pressure is being placed on water resources, increasing the exposure of people and assets to water risks and increasing the frequency and severity of extreme climatic events. Rising water stress and increasing supply variability, flooding, inadequate access to safe drinking water and sanitation, and higher levels of water pollution are creating a drag on economic growth.

Water security affects both developed and developing countries, with the greatest threats of water-related risks falling mainly on developing countries. Many poor countries face unreliable water supplies, and hence require greater investment to achieve water security. Although most developed countries are relatively water secure, they must continuously adapt and invest to maintain water security in the face of climate change, deteriorating infrastructure, economic development, demographic change, and rising environmental quality expectations.

Investments in water security and economic growth are interlinked. There are feedback cycles between vulnerability and exposure to water risks, and water-related limits to economic growth.

- Investing in enhancing water security protects society and sectors from specific water risks, and can have a profound positive effect on economic growth, inclusiveness, and the structure of economies. For example, enhancing water security can reduce the price, and the price volatility, of staple food crops, a key priority in the global economy.
- Economic growth can provide both increasing exposure to water risks, and opportunities for further investment in water security:
  - As economies and populations grow, so will the assets, economic activities and populations facing water risks. As such, investments should be developed in order to be robust to uncertainties; and to support adaptive management as risks, opportunities, and social preferences change.
  - Wealth creates a demand and opportunity for enhanced water services, greater protection from water risks, and improved environmental quality.
  - Wealth provides critical resources to mitigating water risks; as countries become wealthier, reducing water risks becomes more affordable. Economic growth can therefore facilitate opportunities for policy reform, strengthened institutions for water management, and financing for investments in water-related technologies, infrastructure and information systems.
  - Water-related risks increasingly affect stability and economic growth, public finances, poor and vulnerable social groups, and the environment, thus demanding urgent and concerted action. Drawing on recent OECD work on water, as well as the findings from two recent major international initiatives[1], this *Policy Perspectives* lays out the opportunities for investment and financing in water security for economic growth and wellbeing.

1. The Global Water Partnership (GWP) and OECD Task Force on Water Security and Sustainable Growth, and the World Water Council (WWC) and the OECD High Level Panel on Financing for a Water Secure World.

BOX 1: **WATER SECURITY DEFINED**

The OECD defines water security as achieving and maintaining acceptable levels for four water risks:

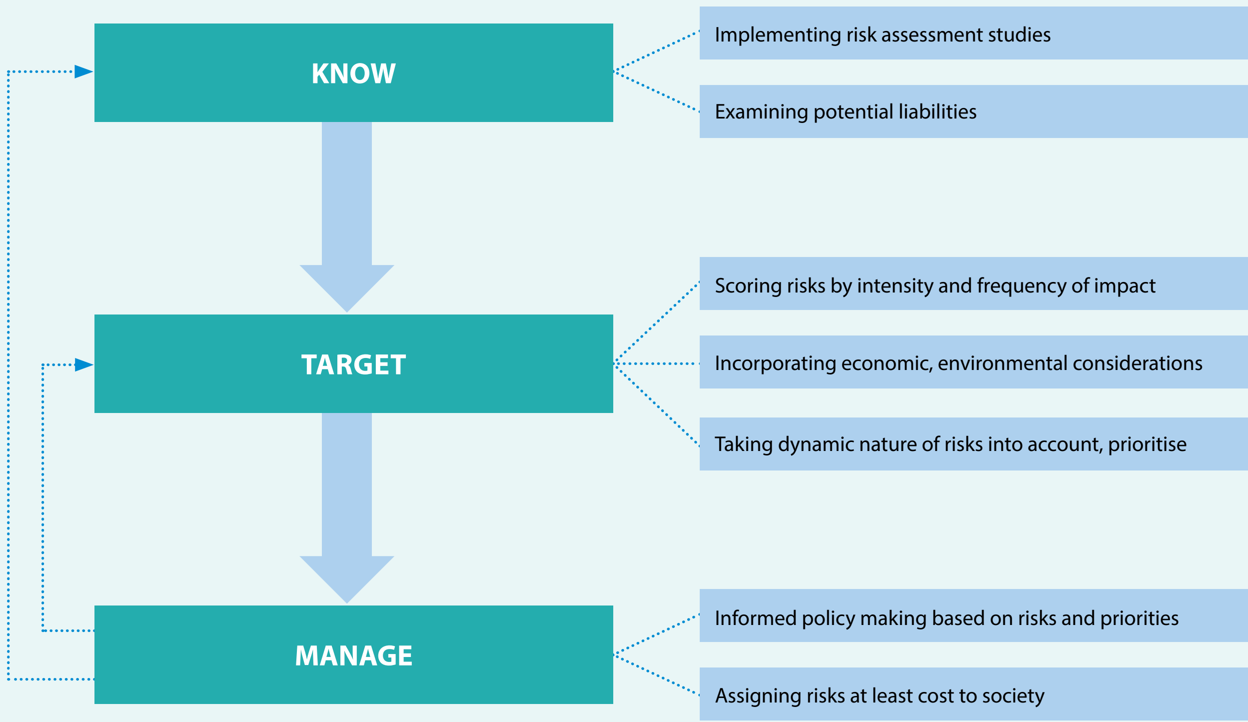
- **Too little water (including droughts)**: Lack of sufficient water to meet demand for beneficial uses (households, agriculture, manufacturing, electricity and the environment);
- **Too much water (including floods)**: Overflow of the normal confines of a water system (natural or built), or the destructive accumulation of water over areas that are not normally submerged;
- **Too polluted water**: Lack of water of suitable quality for a particular purpose or use; and
- **Degradation of freshwater ecosystems**: Undermining the resilience of freshwater ecosystems by exceeding the coping capacity of surface and groundwater bodies and their interactions.

These risks to water security can also increase the risk of (and be affected by) **inadequate access to safe water supply and sanitation**.

The water risks are inter-related. For example, floods and droughts both affect water quality, the provision of safe drinking water, and contribute to degradation of freshwater ecosystems. Polluted water resources, without treatment, are effectively excluded from human consumption and utilisation by industry and agricultural sectors, thereby increasing the risk of water scarcity. Climate change is exacerbating existing water risks, due to altered precipitation and flow regimes, more frequent and severe extreme weather events, altered thermal regimes, and sea level rise. Moreover, the inherent uncertainty in climate change projections makes it more challenging to assess how these risks will evolve in the future.

Investment in water security can help to safeguard growth against increasing water risks. Decision makers will need to innovate and adapt, without being limited to the solutions adopted in the past.

The **OECD risk-based approach** of "Know the risks", "Target the risks" and "Manage the risks" can assist in prioritising and targeting water risks, determining the acceptable level of risk, and designing policy responses that are proportional to the magnitude of the risk.



Source: Adapted from OECD (2013), Water Security for Better Lives, OECD Studies on Water, OECD.

BOX 2: **RELATIVE ECONOMIC IMPACTS OF WATER INSECURITY**

The Global Dialogue on *Water Security and Sustainable Growth*, a joint initiative by the OECD and the Global Water Partnership, examines the causal link between water management and economic growth.

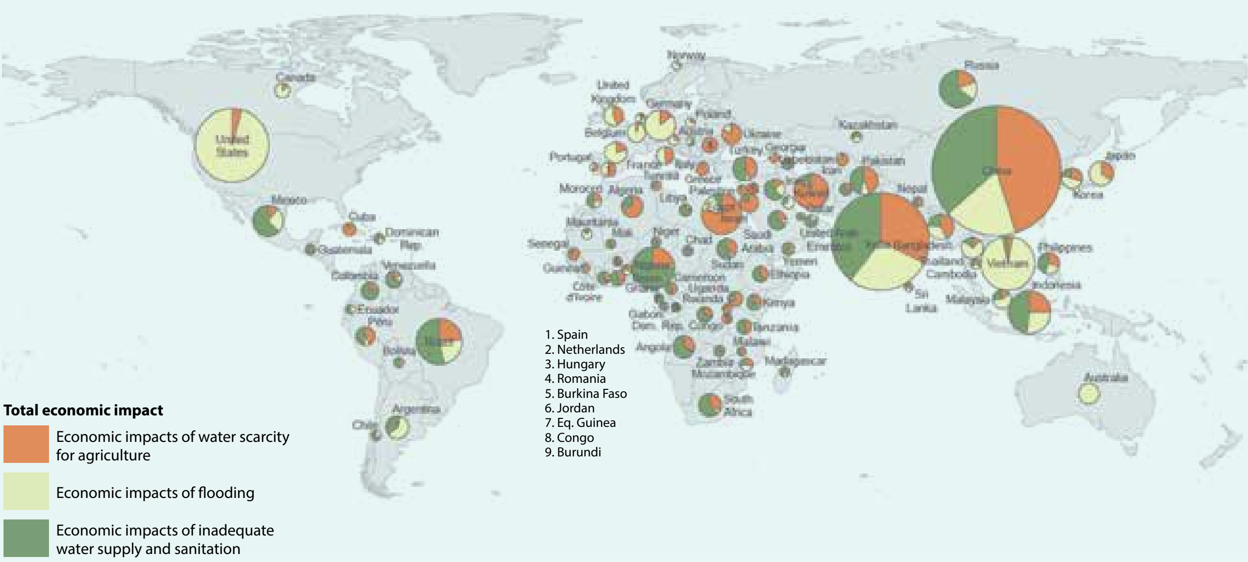
Different parts of the world are subject to different water risks, and many countries suffer from all water risks. Some countries are more vulnerable to water risks than others. A country's hydrology, the structure of its economy, and its overall level of wealth (and associated level of water infrastructure and institutional capacity), are all key determinants of its vulnerability to water risks.

The risk of **water scarcity** is concentrated in locations with highly variable rainfall and over-exploitation of relatively scarce resources. Given that the dominant use of water is for agricultural irrigation (global average is 70%), the economic consequences of droughts and water scarcity are most pronounced in agriculture-dependent economies.

The economic risks from **flooding** are increasing in all locations worldwide, due to increasing economic vulnerability, but are greatest in North America, Europe and Asia.

The greatest economic losses are from **inadequate water supply and sanitation**, and associated loss of life, health costs, lost time, and other opportunity costs. The losses are highest in Sub-Saharan Africa.

China and India suffer from the greatest total economic burden, and number of people at risk of water insecurity. They are subject to risks of water scarcity, floods, and inadequate water supply and sanitation.



Source: Sadoff et al. (2015), *Securing Water, Sustaining Growth:* Report of the GWP/OECD Task Force on Water Security and Sustainable Growth.

BOX 3: **WATER AND CLIMATE CHANGE ADAPTATION IN OECD COUNTRIES**

Climate change is projected to increase investment needs relating to water. In some regions, additional investment will be required to address less favourable hydrological conditions – declining rainfall and snowpack, increasing variability, and more floods and droughts. Even where conditions become more favourable, there may be transition costs in moving to water management systems that are fit for the new climate conditions. In addition, the unprecedented rate of change and potential novel changes outside of historical experience introduce a greater degree of uncertainty beyond what water managers have traditionally had to cope with. This increases the costs of water management, as systems have to be robust to a broader range of potential hydrological conditions.

Progress on adapting water systems to climate change has advanced rapidly in recent years and a significant number of efforts are currently on-going. Impacts on freshwater nearly always feature as a key priority on OECD national risk assessments or adaptation strategies.

The majority of efforts to date have focused on documenting the risk by building the scientific evidence base and disseminating information, but much more can be done to better understand what an acceptable level of risk is for a given population under specific circumstances, and to manage water risks in a changing climate.

In particular, only a handful of countries have begun to address the issue of financing adaptation for water systems. Of those countries that have started financing water systems adaptation, some are mainstreaming adaptation into existing budgetary mechanisms, while others are addressing adaptation via specific water programmes or projects, or tapping international financing mechanisms. A few countries have allocated dedicated funding to climate change adaptation in general, which typically includes measures for water.

Source: OECD (2013b), *Water and Climate Change Adaptation. Policies to Navigate Unchartered Waters,* OECD Publishing; OECD (2015e), *Climate Change Risks and Adaption: Linking Policy and Economics,* OECD publishing.

US$120 billion per year

global economic losses from urban property flood damages

Source: Sadoff C. et al. (2015), *Securing Water, Sustaining Growth:* Report of the GWP/OECD Task Force on Water Security and Sustainable Growth.

INVESTMENT NEEDS IN WATER SECURITY

Estimates of current investments in water security are often incomplete and difficult to compare due to different methodologies (an exception is the water supply and sanitation sector). At the international level, there is a lack of reliable information on who pays for what. Investments in large infrastructure projects can be traced, but operation and maintenance expenditure are not monitored with the same accuracy. In addition, we know little about how much users (i.e. farmers, industrial or domestic water users) invest on their own to secure the water they need and to protect against water-related risks.

Although not comprehensive, projections from independent groups indicate that global financing needs for water infrastructure are significant and increasing rapidly (see Winpenny, 2015, for a compilation). Global estimates range from USD 6.7 trillion by 2030 to USD 22.6 trillion by 2050. The figures do not cover the development of water resources for irrigation or energy.

Attempts to project infrastructure needs for, and investments in, water management highlight several important messages:

- **Investment needs for water management are large** (significantly larger than for telecommunications, land transport, or electricity transmission and distribution) (OECD, 2006).
- Although the benefits of investment likely outweigh the costs, it does not follow that these projected expenditures will be realised. Indeed, if past experience is any guide, such **investment needs will likely not be met** (OECD, 2006).
- The main reason **why investments in water security do not materialise is not a shortage of money**: money is available globally to finance investments in water security (Winpenny, 2015).

Source: World Health Organization and UNICEF Joint Monitoring Programme (JMP) (2015) *Progress on Drinking Water and Sanitation, 2015 Update and MDG Assessment.*

BOX 4: INVESTMENTS IN WATER SUPPLY AND SANITATION HAVE NOT KEPT PACE WITH AMBITIONS

Financial flows, outcomes and future investments needs in water supply and sanitation are relatively well-documented, in part owing to the United Nations Millennium Development Target on halving the proportion of the population without sustainable access to safe drinking water and basic sanitation by 2015. Progress towards achieving this target was notable. The Joint Monitoring report 2015 concluded that between 1990 and 2015, 2.6 billion people gained access to an improved drinking water source, with those having access increasing from 76% of the global population to 91%. Over the same period, 2.1 billion gained access to improved sanitation, with 68% of the global population currently with access to an improved facility.

UN-Water indicates that the progress made in improving access to water supply and sanitation has required significant investment. For example, 49 countries, representing 1.8 billion people, reported total annual national government spending on water, sanitation and hygiene in the order of USD 28 billion (UN-Water, 2014). According to OECD statistics, official development assistance commitments for water and sanitation have grown by 30% to over USD 10.9 billion in 2012 from USD 8.3 billion in 2010 (OECD-CRS).

However, investments in water supply and sanitation have not kept pace with the needs. The goal of halving the proportion of the population without access to sanitation was not achieved, and although the target for drinking water was met five years ahead of schedule, much remains to be done to ensure that the water supplied is safe to drink. Financing needs remain high, and funding is insufficient to achieve universal access to safe water supply and sanitation, resulting in rising inequalities.

The UN-water global analysis and assessment of sanitation and drinking water (GLAAS) report documents a huge financing gap between plans and budgets for water supply and sanitation, with 80% of countries indicating insufficient financing for the sector. One important gap in financing is operation and maintenance, which is critical to ensuring reliable and safe service provision. UN Water argues that, with 70% of countries reporting that tariffs do not cover the costs of operation and maintenance of water services, the quality of services and coverage levels are at risk of decline.

Although the risks of inadequate access to water supply and sanitation, and the associated investments needs, are concentrated in developing countries, OECD countries also have substantial financing shortages in the water supply and sanitation sector, as illustrated below.

France

The average network-renewal rate (quotient of the average line of supply network renewed over the past five years by the total length of the supply network) is 0.61 for water supply and 0.71 for wastewater collection and treatment, meaning that a full replacement of existing networks would take 160 years for water supply networks and 140 years for wastewater collection and treatment. The average renewal rate presents urban-rural disparities: services in high-density urban environments (≥200 habitants per km of network) have a significantly higher rate (1.31), signalling faster renewal. Even so, 80 years would be necessary to renew existing water infrastructures in densely populated areas that may have exceeded the infrastructure's design life.

Japan

Official estimates hold that significant future investment is required for water infrastructure in Japan (Ministry of Health, Labour and Welfare [MHLW], 2012), prompted by i) the renewal of the ageing water infrastructure, most of which will need replacing in 20 years; and ii) the need to strengthen the infrastructure to meet earthquake standards. The MHLW (2012) forecasts that the replacement cost of water supply facilities by 2050 will be 59 trillion yen (approximately USD 580 billion) and its annual average cost will be 1.4 trillion yen when being updated in accordance with the statutory useful life (approximately USD 14 billion per year, from 2009). In addition, Yane (2012) estimates that the renewal investment cost of water pipes per year will amount to 1.24 trillion yen (approximately USD 12 billion per year). These investment needs coincide with a projected decline in available financing, such that they will exceed the potential available funds for investment by 2025. Finding other sources of capital is therefore critical.

Source: OECD (2015), *Water and Cities. Ensuring sustainable futures,* OECD Publishing; The Ministry of Health, Labour and Welfare, Department of Health, Water Division (2012), "About Updating Water Supply Facilities in the Future", October; Yane, Shinji (2012), "Corruptible Water Infrastructure-The Amount of Renewal Investment for Aging Pipelines and its Water Charges-" Research Institute Bulletin of St. Andrew's University, Vol. 37, No. 3, pp. 151-172.

The United States

The estimated value of the infrastructure managed by the US Corps of Engineers has dropped from USD 237 billion in the 1980s to USD 164 billion in 2010. The funding gap over 2000-19 for clean watershed and drinking water capital, operation and maintenance costs is estimated at over USD 500 billion, excluding drainage costs. The investment capital required for the public water system infrastructure to continue to provide safe drinking water to the public over 2011-30 is estimated at USD 384.2 billion, excluding expenditures on raw-water dams and reservoirs, projects related to population growth, and the operation and maintenance costs of the water supply. These figures may need revising to account for climate change adaptation.

INCREASING PRESSURE ON WATER RESOURCES

Increasing pressure on water resources is a main driver of investment needs. The OECD projects that global water demand will increase by 55% between 2000 and 2050, driven by manufacturing (+400%), electricity generation (+140%) and domestic uses (+130%) (OECD, 2012). Other pressures relate to declining water quality, especially outside the OECD, driven by nutrient flows from agriculture, and poorly treated wastewater. The number of people at risk of floods is projected to rise from 1.2 billion to 1.6 billion between 2010 and 2050 as a result of climate change, but also due to individual and collective decisions, which result in the concentration of populations and valuable assets on coasts or in floodplains.

Energy depends on water – for hydropower generation; the extraction, transport and processing of fossil fuels; cooling of power plants; and the irrigation of biofuel crops. The energy sector is vulnerable to physical constraints on water availability, and the regulations that might limit access to it. Global freshwater withdrawals for energy production constitute approximately 15% of total withdrawals, and the IEA's New Policies Scenario projects an increase by 20% between 2010 and 2035 (IEA, 2012). The rise in energy-related water demand primarily results from the irrigation needs of the accelerating biofuels production worldwide, as well as the steeply increasing demand for cooling of thermal power plants (which exacerbates climate change and changes to the hydrological cycle).

Urban development puts more pressure on securing water supply, to serve growing populations. Urbanisation increases risks of flooding, when the extension of impervious surfaces augments and accelerates urban run-off in cases of heavy rains. Urbanisation also raises the value of assets and property at risk of flooding: the economic value of assets at risk of flooding is projected to grow by over 340% between 2010 and 2050 (OECD, 2012). Urbanisation puts more pressure on water quality as well, as urban run-off and wastewater need to be collected and treated before it can be safely returned to the environment or be re-used.

Thus, a number of related areas – energy, agriculture and urbanisation – influence water risks, and investment needs. Failure to account for how initiatives in related sectors affect water risks can generate further liabilities. However, they can also contribute to water security if investments in these sectors account and manage for water risks. Thus, an important part of investment in water security and sustainable growth does not need to be investment in the water sector *per se*.

Investment needs are further driven by social expectations. Economic growth and development lower public tolerance to risks, demanding a greater level of protection from risk, pushing up investment needs in water security (OECD, 2013). The Sustainable Development Goals (SDGs), which were adopted by the international community in September 2015, set a new ambition for investment in water security, not just in the water supply and sanitation sector, but for the management of other water risks including water scarcity, pollution and the protection of freshwater ecosystems.

BOX 5: **EXPERTS' VIEW ON FUTURE DRIVERS OF WATER INFRASTRUCTURE INVESTMENT NEEDS**

The Report of the High-Level Panel on financing infrastructure for a water-secure world (Winpenny, 2015) compiles what we know about future investment and water-related expenditures. The report acknowledges that predictions in this area are particularly difficult. A Delphi survey shed some light on the main drivers for future water infrastructure needs:

- Social perception of and responses to water-related risks (in particular droughts, floods, pollution);
- Increasing awareness of the value of ecosystems and biodiversity;
- Innovation in water services and infrastructure; and
- The impact of climate change on water availability and demand.

In that context, projections of future investment needs depend on a range of definitions and choices and these are difficult to compare.

Source: Winpenny J. (2015), *Water: fit to finance? Catalyzing national growth through investment in water security,* Report of the High-Level Panel on financing infrastructure for a water-secure world, World Water Council and OECD.

BOX 6: THE COSTS OF ACHIEVING UNIVERSAL ACCESS TO SAFE WATER SUPPLY AND SANITATION

Hutton and Varughese (2016) estimate the costs of meeting the United Nations Sustainable Development Target of achieving universal and equitable access to safe and affordable drinking water for all by 2030. Cost estimates cover those of capital investment, programme delivery, operations, and major capital maintenance. The costs include only those of extending services to the unserved in 2015, and exclude the costs of maintaining access for those already served by a given service level in 2015. The present value of the additional investment needed until 2030 is around 1.7 trillion USD.

The authors note that the costs of meeting the WASH-related SDG targets by 2030 will depend on the pathway for scaling up services. Three main findings derive from the projections:

- Current levels of financing can cover the capital costs of achieving universal basic service for drinking water, sanitation, and hygiene by 2030, provided resources are targeted to the needs. Extending basic WASH services to the unserved will cost $28.4 billion (range: $13.8 to $46.7 billion) per year from 2015 to 2030, or 0.10 percent (range: 0.05 to 0.16 percent) of the global product of the 140 countries included. This financing requirement is equivalent, in order of magnitude, to the 0.12 percent of global product spent needed to serve the unserved with improved water supply and sanitation during the MDG period. This hides wide variations across countries and income groups.
- The capital investments required to achieve the water supply, sanitation, and hygiene SDGs (targets 6.1 and 6.2) amount to about three times the current investment levels. The capital financing required to extend safely managed water supply and sanitation services to the unserved is approximately 0.39 percent of the global product of the 140 countries included (range: 0.26 to 0.55 percent), or a little over three times the historical financing trend of extending access to the unserved (0.12 percent globally).
- Sustained universal coverage requires more than capital inflows: financial and institutional strengthening will be needed to ensure that capital investments translate into effective service delivery. As the year 2030 approaches, the costs of operating the new infrastructure built will exceed the annual capital cost requirements to meet those remaining unserved. In order to ensure sufficient and quality spending on operations and maintenance, institutions and regulations need to be strengthened.

Source: Hutton G. and M. Varughese (2016), *The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water, Sanitation, and Hygiene,* WSP – The World Bank Group.

US$94 billion per year

global cost of water insecurity to existing irrigators

Source: Sadoff C. et al. (2015), *Securing Water, Sustaining Growth:* Report of the GWP/OECD Task Force on Water Security and Sustainable Growth.

BARRIERS TO INVESTMENT IN WATER SECURITY

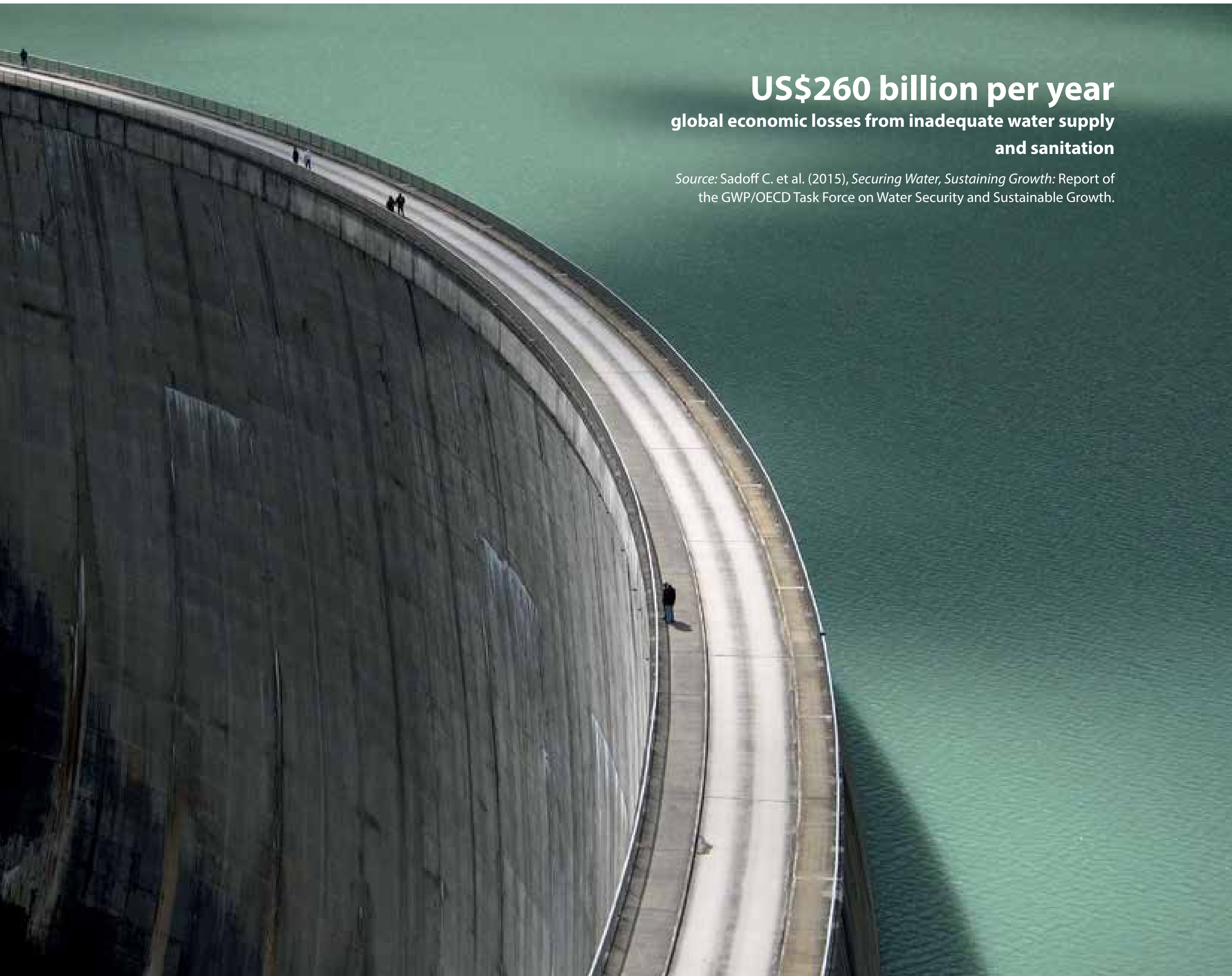
Investment in water security faces a number of barriers. Water infrastructure is typically capital intensive, long-lived with high sunk costs. It requires a high initial investment followed by a very long payback period. Investments in water security often deliver a mix of public and private benefits to diverse beneficiaries. Many of these benefits cannot be easily monetised, undermining potential revenue flows and thus the "risk-return" balance for potential investors.

In addition to the usual range of project risks, investments in water security face specific risks, such as financial risks arising from the heavy sunk costs involved or a poor record of cost recovery. The political sensitivity of water pricing makes the sector vulnerable to political interference and criticism from local groups, undermining policy makers' willingness to charge for water services or to impose taxes on pollution. In addition, hydrological risk is inherent in all activities dependent on water and is expected to increase and become more uncertain due to ongoing climate change.

Lack of appropriate analytical tools and adequate data to assess complex water security investments can deter financiers. Emerging approaches, such as green infrastructure, lack a clear performance track record needed to assess their risk-return potential.

Government policy can also raise barriers to investment in water security. A lack of policy coherence (across water-related domains, such as agriculture and urban development) can increase overall costs. Regulations can exclude private investment in public infrastructure.

Well-designed policies are needed to overcome these barriers to investment in water security and sustainable growth.



Fostering investment in water security and sustainable growth

AN ECONOMIC FRAMEWORK

Water security is complex and multi-faceted. Improvements in water security generate a range of public and private benefits in terms of reduced water-related risks for communities, business, and the environment. These benefits accrue to distinct sets of beneficiaries. At an aggregate level, investments in water security should seek to maximise social welfare. But determining how such investments should be financed requires an understanding of *what types* of benefits an investment generates, and *who* benefits from them. Such an understanding can help identify the parts of an investment that generate public goods, which could be publicly funded, and the parts of an investment that generate private goods and services, which could be monetised to generate a revenue stream. This can help to allocate the costs of providing the benefits of investments in water security to different sources of finance (public or private).

To attract investors, water projects need to provide an adequate risk-return profile, which requires:

- Identifying the **drivers** of water-related risks. These can be specific activities (e.g. industries that pollute a river), or general trends (economic growth or demographic changes). The drivers can be policies or decisions such as urban development in flood plains. Identifying the drivers can help trace who (if anyone) is accountable for additional water-related risks. *Policy coherence*, for instance between water and urban development, energy security or food security, can help minimise the impact on water security of these drivers.

- Measuring the **costs** of improving water security. The objective of a risk-based approach to water security is to achieve an "acceptable" level of water-related risks. That comes at a cost. The different categories of costs can be allocated to different stakeholders. For example, *the Polluter Pays principle* states that the polluter should bear the cost of measures to reduce pollution according to the extent of either the damage done to society or the exceeding of an acceptable level (standard) of pollution.

- Identifying the **benefits** of water security, in terms of reduced water-related risks. Some of the benefits accrue to the community. Others accrue to specific people or groups, such as farmers who irrigate. *The User-Pays Principle* is a variation of the Polluter-Pays Principle that calls upon the user of a natural resource to bear the cost of using natural capital. Water users are not the only beneficiaries of investments in water security. For instance, extension of flood protection can benefit property developers, whose property value will gain from investment in water security.

The Beneficiary-Pays Principle takes account of the high opportunity cost related to using public funds for the provision of private goods that users can afford. Both public and private benefits attached to investments in water security are inventoried and valued, beneficiaries are identified, and mechanisms are set to harness them to generate revenue streams.

- Considering the range of opportunities to devise **revenue streams**, to capture benefits and to internalise negative externalities. These include tariffs for water and sanitation services, abstraction charges, pollution taxes, land value capture taxes, taxes on impervious surfaces, and taxes on urban development in flood plains. **Equity** is essential, to harness revenue from those who increase the costs of water security, or benefit from investments in water security. It is also essential to address affordability issues, especially when water bills are disproportionate with stakeholders' capacity to pay.

Building on these considerations, financing investment in water security and sustainable growth combines four sets of actions:

1. **MAXIMISE THE VALUE OF EXISTING WATER SECURITY INVESTMENTS.** Investment plans can be optimised by improving the efficiency of existing infrastructure– for example, better operation and maintenance of infrastructure, demand management measures, and engagement with stakeholders can reduce water-related risks and investment needs.

2. **SELECT INVESTMENT PATHWAYS THAT REDUCE WATER RISKS AT LEAST COST OVER TIME.** This requires performing cost-benefit analysis on sequences (or portfolios) of projects and carefully considering how pursuing a specific project may foreclose future options. It requires investments not only in infrastructure, but also in institutions and information systems in order to maximise the benefits to society.

3. **ENSURE SYNERGIES AND COMPLEMENTARITIES WITH INVESTMENTS IN OTHER SECTORS.** A better alignment of policies and investments across urban development, food and energy sectors will enhance water security.

4. **SCALE-UP FINANCING THROUGH RISK-RETURN ALLOCATION SCHEMES.** Governments can help to attract new investors by enabling public and private actors to earn returns commensurate to the risks they take. Governments may consider providing risk mitigation to long-term investment projects where it would result in more appropriate allocation of risks and their associated returns.

These four actions will be discussed in further detail in the following sections.

1 Maximise value from existing water security investments

MAKE THE BEST OF EXISTING ASSETS AND CURRENT INVESTMENTS

A multidimensional definition of performance for water services – from basic physical condition to service quality, business risk and sustainability – can underlie methods to optimise the management of existing infrastructure.

Increased efficiency in operation and maintenance of existing water assets can be a cost-efficient way of improving water security and services. Urban utilities in developed countries increasingly rely on computer tools, inspection robots and geographical information systems to gain precise knowledge of the state and performance of their assets, particularly those buried underground (Box 8). This knowledge allows better planning of investments in maintenance and renewal to improve system reliability (especially by repairing damaged pipes). Innovative tools help enlarge the scale and scope of infrastructure monitoring, and extend the time horizon for asset management.

When the operator and water management authority have a clear vision of asset and renewal needs, as well as improved forecasts of water demands, they can rigorously plan operation, maintenance and investment. Moreover, when involving (public or private) service providers, they can sign precise and secure contracts that reduce information asymmetries and rent-seeking behaviour by either party. Finally, rigorous asset management entails precise depreciation, which in turn leads to improved self-financing capacities, reduced debt and access to cheaper loans (since the utility is more creditworthy).

BOX 8: ADVANCED ASSET MANAGEMENT: ILLUSTRATIONS FROM SELECTED OECD COUNTRIES

In New Zealand, the city of Auckland used geographical information systems to overlay actions and investments with a direct or indirect effect on freshwater quality, including those targeting:

i) Stormwater asset maintenance, renewal and development

ii) Cycleway and road construction

iii) Network infrastructure development (e.g. broadband rollout).

The city of Auckland also demonstrates how co-ordination across such sectors as road construction triggers additional benefits for water security and sustainable growth.

In the United States, the Massachusetts Water Resources Authority developed a predictive maintenance strategy based on condition monitoring, and the probability and consequences of failure of each component. The programme increased equipment availability to 99%; it achieved cost savings by eliminating unneeded and

low-value preventive maintenance work, and shifting the freed-up resources to predictive tasks and actual maintenance work. Predictive and probability-based maintenance illustrates a shift from zero-risk asset management (which translates into high degrees of infrastructure redundancy) to more-thorough risk analysis allowing more strategic and cost-effective asset management.

Source: OECD (2015), *Water and Cities: Ensuring Sustainable Futures,* OECD Publishing, Paris.

INNOVATE

Innovation can minimise the costs of water management. Water-related innovation is multifaceted:

- In agriculture, innovation is associated with the development of water-efficient irrigation, planting of less water-intensive crops, and the adoption of practices that reduce nutrient flows back to water bodies.

- In manufacturing, it deals with more water-efficient and cleaner production practices, appliances, and more effective treatment techniques. Similar opportunities are associated with water supply and sanitation.

- Innovation applies to storage techniques, monitoring of river flows and pollution loads, and the operation of infrastructure as well. Smart water technologies cut across these boundaries: they allow the users to monitor, manage and act on data relating to the part of the water cycle that is pertinent to their interests.

Water-related innovation is not limited to new technologies: non-technical innovations can also contribute to water security and sustainable growth. Innovative business models for water utilities are a good example. The revenues of most water utilities depend on the volume of water sold and of wastewater collected and treated. There are benefits in (at least partially) decoupling revenue from the volumes of water sold. This can be done through the development of well-designed water tariff structures, and opening up opportunities to derive additional revenue by enhancing environmental performance through performance-based contracts (where the utility receives a premium when it reaches certain level of performance regarding, for instance, leak detection, or the quality of effluents).

Water-related innovation may derive from dedicated policies. Several countries and states (Arizona, Australia, California, France, Israel, Korea, Malta, the Netherlands, and Ontario) have explicitly encouraged the development and deployment of smart water systems, either to address local issues, or to support a growing global business (OECD, 2015a). The challenge is to foster country collaboration and transfer innovations in water security to developing economies.

BOX 9: **OVERCOMING BARRIERS TO THE DIFFUSION OF INNOVATIVE URBAN WATER MANAGEMENT**

A series of factors continue to limit the diffusion of new approaches:

- Retrofitting is difficult, particularly in high-density areas;
- The lack of coherent policies often hinders the competitiveness of innovative solutions, e.g. when water prices fail to reflect the opportunity costs of resource use, or when land use and urban development do not reflect the risks of building in flood plains; and
- Regulations, funding mechanisms, or split incentives and responsibilities along the water cycle favour concrete infrastructures and incumbent urban water management practices over long-term sustainable practices. They often fail to recognise the capacity of users and the wider community to consider the pros and cons of alternative technologies.

Cities in OECD countries that have overcome these barriers are generally characterised by:

- A long-term vision of water challenges and opportunities for urban development;
- Business models for water utilities and land development that reflect water risks;
- Governance structures that co-ordinate urban water management with other dimensions of urban management and reach beyond city limits; and
- Information campaigns to raise city dwellers' awareness of water-related risks and the liability costs resulting from short-term visions.

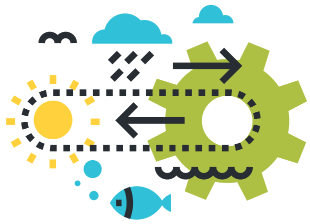
Source: OECD (2015). *Water and Cities: Ensuring Sustainable Futures,* OECD Publishing, Paris.

ENHANCE WATER ALLOCATION EFFICIENCY

Well-designed water allocation regimes allocate water and water-related risks so as to maximise social welfare. Water resources provide value to individuals, ecosystems, farms, firms and society in various ways – from the ecological value provided by supporting biodiversity, to the economic value derived from productive uses, to the existence value of iconic lakes and rivers. A robust allocation regime can facilitate the allocation of water to higher-value uses.

Improving water allocation regimes is often a more cost-effective option to reap greater benefits from water use, as compared to investing in new infrastructure to augment supply. There are ample opportunities to improve allocation regimes in both developed and developing countries, as prevailing regimes were not originally designed to perform efficiently in the context of intensifying competition to access water resources, and with rising uncertainties about water availability and demand due to climate change. Water allocation reform can be politically sensitive. However, OECD (2015b, 2015d) show how such reforms can reduce water security investment needs and draw lessons learned from countries that have successfully pursued reforms.

2 Select investment pathways that reduce water risks at least cost over time



BENEFICIAL INVESTMENTS IN WATER SECURITY AND SUSTAINABLE GROWTH SHARE THREE FEATURES:

1. **They have been proven to be cost-effective.** Assessment tools (cost-benefit analysis, in particular) help identify projects which generate more benefits than costs for the community. Methodologies have advanced considerably, but still face a number of complex issues related to the assessment of economic, social and environmental costs and benefits, and their combination at different scales (from local to basin, national, transboundary and global).

2. **They combine investments in infrastructures, information and institutions.** Well-designed infrastructures only deliver expected outcomes when they are backed by appropriate institutions (for project design, financing, management, accountability), and when they build on best available knowledge and information.

3. **They are consistent with water-wise, long-term development strategies** that are also dynamic and adaptive with respect to changing circumstances.

Financiers and governments usually focus on the first feature, while analytical tools to assess the last two features are lacking. It is not clear what tools are available to:

- Assess the costs and benefits of water investments for the economy and how water risks should be factored in development pathways.
- Value the flexibility (or closure of future options) that derive from specific projects and combinations thereof.
- Combine individual projects in sequences and compare the benefits of alternative investment sequences.

New work is required to develop the tools that can help policy makers and financiers pay attention to the second and third features.

BOOSTING INVESTMENTS IN GREEN INFRASTRUCTURE

Green infrastructure involves the use of natural or semi-natural systems that utilise nature's ecosystem services in the management of water resources and associated risks (OECD, 2015c). Green infrastructure is increasingly part of the response to all four water-related risks. For example, conservation or expansion of floodplains can increase water infiltration and reduce flooding risks to cities, while simultaneously supporting agricultural production and wildlife, and providing recreational and tourism benefits. Likewise, permeable pavements and the creation of green spaces can enable surface water to infiltrate the soil, replenish aquifers, and reduce polluted stormwater runoff. The equivalent grey infrastructure solutions include dams, dykes, artificial groundwater recharge, and wastewater treatment plants.

In certain cases, it has been shown to be cost-effective for cities to rely on green infrastructure (OECD, 2015a). Apart from having a lower environmental impact, investment in green infrastructure is generally less capital intensive; has lower operation, maintenance and replacement costs; avoids lock-in associated with grey infrastructure; and appreciates in value over time with the regeneration of nature and its associated ecosystem services (as opposed to the high depreciation associated with grey infrastructure). Green infrastructure can also avoid or postpone the costs of building new, or extending existing, grey infrastructure.

Although the benefits of green infrastructure for water security and sustainable growth are known, significant barriers hinder investors' allocation to green infrastructure:

- Due to limited data on river flows, as well as of evidence on the value of freshwater and terrestrial ecosystems, it can be difficult to design and assess the costs and benefits of green infrastructure. The estimation of benefits is especially complex as these may be hard to monetise. As a consequence, there is a lack of track-record for costs and benefits, technologies, markets and financial products associated with green infrastructure. The absence of available best practices and expertise for investors creates uncertainty related to bidding processes, timing for investments, transactions and underlying risks.

- Many investors have yet to conclude that green infrastructure investments offer a sufficiently attractive risk-return profile. A number of environmental, energy and climate policies and regulations still favour investments in grey infrastructure over green infrastructure. The competitiveness of innovative solutions is often hampered by lack of policy coherence; for instance, water prices that fail to reflect the opportunity costs of resource use; or land use and urban development that do not reflect the risks of building in flood plains. There is a need for support policies and funding mechanisms that price nature-based and ecosystem services in ways that encourage investments in green infrastructure.

- Green infrastructure is multipurpose by nature, thus contractual arrangements may be highly complex and vulnerable, exposing investors to risks and insecure returns.

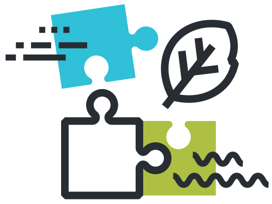
- The innovative practices associated with green infrastructure often combine different scales in urban water management, from individual buildings, to municipal and larger levels. Such combinations can be hampered by institutional arrangements, which split incentives and responsibilities along the water cycle.

- There are certain liability issues that cannot be addressed in the case of green infrastructure, due to the intrinsic characteristics of its components, which rely on natural ecosystems. There is great ambiguity related to the determination of who to hold accountable in case of failure, for example, when a floodplain ceases to deliver the services it is expected to provide.

The abundant literature and documentation of successful case studies can inspire policies in developed and developing countries. Issues remain regarding replicating or scaling-up experience with financing for green infrastructure that contributes to water security and sustainable growth.

Green infrastructure can be a cost-effective approach to improve water quality and help communities stretch their infrastructure investments further by providing multiple environmental, economic, and social benefits.

3 Ensure synergies and complementarities with investments in other sectors



Water-related risks are influenced by a range of investments and practices that extend beyond what is usually thought of as the "water sector". For example, urban development in flood plains affects exposure and vulnerability to flood risk; run-off from sealed surfaces or agriculture affects risk of water quality; growth of a water-intensive industry in a water-scarce location can increase competition for water resources and risks of water scarcity. Thus, improving water security requires that investments in a range of sectors (urban development, food security, energy security, etc.) are water-wise and avoid increasing water-related risks.

Policies outside of the water sector can stimulate water-wise investments when they factor in the costs of reduced water risks, and deter investments and practices that inadvertently increase water-related risks. Investments that impact water security, whether via the urban footprint of city landscapes or large water infrastructure projects, impose strong path dependency, which can be generate increasing risks in a changing climate. Hence, the importance of building resilience into water security investments. Designing modular, scalable investments, which minimise the cost of adjusting to changing conditions, is a smart approach in the context of growing uncertainty about future conditions.

BOX 10: **FUTURE ENERGY DEMAND AND WATER SECURITY**

The energy sector's growing water demand will have an impact on the availability of water for other sectors. Hence, water-wise investments are needed in order to keep this to a minimum. The IEA's New Policy Scenario projects that energy consumption will rise by as much as 85% between 2010 and 2035; however, the growth in the associated water demand can be limited to 20%, or even less, if investments are used to:

- Ensure greater reliance on renewable energy technologies that have minimal water requirements, such as solar PV and wind;
- Improve the efficiency of power plants, for instance by shifting from subcritical coal to supercritical coal or IGCC plants;
- Deploy more advanced cooling systems, including wet cooling towers, and dry and hybrid cooling;
- Give advantage to those biomass crops and locations that have the greatest water efficiency;
- Encourage the energy sector to exploit non-freshwater sources – saline water, treated wastewater, storm water and produced water from oil and gas operations – and adopt water re-use technologies.

Source: International Energy Agency (2012), *World Energy Outlook 2012*, OECD/IEA, Paris.

4 Scale-up financing through attractive risk-return allocation

Water infrastructure competes with other sectors for financiers' attention. The main criterion in that competition is the risk-return ratio: what return an investment can yield in light of the level of risk exposure. This depends critically on two factors:

- **A stable revenue stream, which requires governments to ensure effective use is made of pricing instruments;**
- **How the range of risks around the financing of water instruments are shared between public and private entities.**

MAKING THE BEST USE OF PRICING INSTRUMENTS

Economic instruments can play a key role in delivering water security at least cost for society and in providing a revenue stream for investments in water security and sustainable growth. Pricing instruments, in combination with other instruments (e.g. regulatory, voluntary or other economic instruments), can contribute to managing water resources (in particular water conservation), phasing out negative externalities (e.g. overuse, pollution) and improving the financial sustainability of water infrastructures and water services through cost recovery.

Well-designed water prices reflect the full cost of water supply, as well as the scarcity value of the resource. Water demand is relatively price inelastic, but not unresponsive to changes in price (Box 11).

Despite some reforms away from subsidised water towards pricing based on supply costs and the subsequent improvements in economic efficiency, water tariffs in many cases in the OECD area generally remain both inefficient and inequitable (OECD, 2013). More attention needs to be paid to the design of pricing instruments for water management and their combination with other instruments. Authorities that are considering pricing instruments for water security and sustainable growth would benefit from the considerations outlined in the four following subsections.

Table 1: **Possible economic instruments for water security and sustainable growth**

Water security issue	Recommended market-based instruments	Advantages of use
Water supply	Marginal social cost pricing, incorporating the scarcity value of water	Signals the optimum time to invest in water infrastructure so that supply is augmented efficiently
	International and regional water markets	Allows trade of water supply in areas of scarcity
Water demand	Regional water markets	Allows trade of water from low to high value uses creating incentives to use water efficiently and reduce demand
	Marginal social cost pricing, incorporating the scarcity value of water	Reduces demand for water during periods of scarcity
Water quantity	Buy-backs of water user's rights	Secures water for environmental flows and offsets economic losses
Water quality	Emission permit trading for point and nonpoint pollution	Allows pollution to be reduced from the lowest cost sources
	Emission taxes	Creates ongoing incentive for all sources to reduce pollution

Source: OECD (2013a), *Water Security for Better Lives*, OECD Publishing, Paris.

1. Set water prices, including water tariffs and abstraction charges for surface and groundwater, that reflect water scarcity and full supply costs

Despite the increasing use of volumetric charges and the move towards cost recovery, the focus of most water pricing schemes is on covering the long-run average cost of supplying water from existing water infrastructure (including up-front and O&M costs). The problem with such an approach is that it does not take into account the scarcity of water resources: prices do not reflect the full marginal social cost of using the resource. This leads to the inability of water prices to signal when new investments in water infrastructure should be undertaken. Thus, as noted by Grafton in OECD (2013), investments in infrastructure that determine the average cost of supply, and are made separately from the pricing decision, may be made inefficiently. As a result of inefficient pricing, imbalances between water supply and demand still arise, leading to water scarcity.

Table 2 depicts water abstraction charges in selected countries and regions. Most abstraction charges are based on the price per volume of water abstracted and charges are often differentiated according to type of user (e.g. agriculture, industrial, residential). In some cases, charges are also determined on the basis of other factors, including the scarcity of the resource or season.

The optimal economic solution is to implement volumetric pricing based on the scarcity of the resource, not the long-run marginal costs of supplying water, nor the cost of the next most affordable source of water. Thus, scarcity pricing allows water supply variability to be managed, allocating water efficiently, as well as signalling when new investments in water supply should be undertaken. Scarcity pricing can be supplemented by other price components, such as a fixed access fee, which can cover the investment and O&M costs of supplying water, the cost of insuring water quality, or the level of service.

An alternative option to manage water supply variability under a given level of investment, is to offer water users a portfolio of water contracts, with different levels of water security and prices: users who want to ensure reliable supply and avoid mandatory water use restrictions would opt for a higher price; users less concerned about availability would opt for a lower price. This option acknowledges that different water users value water and water security differently, and are willing to pay a price that reflects this value.

These options (a price that reflects scarcity, or a portfolio of water contracts) can be more efficient and equitable than mandatory restrictions of water use in cases of droughts as such restrictions ignore the heterogeneity in values attached to water and the capacity to adjust to periods of water scarcity.

BOX 11: **ELASTICITY OF WATER CONSUMPTION TO PRICES**

Pricing instruments can serve two purposes: i) generate revenue; and ii) change user behaviour by making water use more costly, thereby managing demand. Putting a price on water can signal water scarcity or the costs of providing water to users, or both (under some circumstances).

The literature indicates that residential water demand is relatively inelastic at current prices, meaning that it takes a large change in the price of water to reduce the demand for water. However, a lot of variables determine the price elasticity of water, including: the degree of water scarcity; water users awareness of their water charges; preferences for water use (e.g. indoor vs outdoor); the price of water from alternative water sources (such as private wells or wastewater reuse); season and time of the day (e.g. peak versus off-peak water demands); and the presence of other water conservation programmes. Changes in the behaviour of water users may also take time to materialise. For example, well-entrenched behaviour (such as long, high-pressure showers) or time lags in the uptake of water-efficient appliances may delay the consequences of changes in water prices on the behaviour of water users. The use of uniform tariff rates or increasing or decreasing block rate systems also turns out to be important. For example, price elasticities in East Los Angeles and South San Francisco were -0.39 to -0.22 under uniform rates and -0.44 and 0.43 under tiered rates, respectively (Lee and Tanverakul, 2015).

In the EU-28 countries, household water demand typically is estimated to be relatively price-inelastic, varying between -0.5 and -0.1 across countries. From a water demand management perspective, this means that should water prices rise by 10%, water consumption may drop by 1 to 5% (Reynaud, 2015). Similarly, a global review of the residential water demand management studies published between 2002 and 2014 shows that the mean of the elasticity estimates is –0.365 and the median is –0.291. In other words, a 10% increase in price generally results in a 3%–4% reduction in water use, implying inelastic demand (Sebri (2014). The review also found that elasticities tend to be differently estimated across various regions of the world, as well as between developed and developing countries (Sebri (2014).

In Central Florida, U.S., price elasticity of high residential water users (who over-irrigate and have high income) is very low, ranging between –0.07 and –0.14. Since water bills account for a small proportion of the total household budget for high-income households, these households can be less responsive to water price changes than low-income households, implying that significant price increases are required for price strategies to be effective in managing water demand (Ascia, 2016). Renwick and Archibald (1998) find that water demand of low-income users is five times more responsive to price changes than the demand of high-income users (with corresponding price elasticities of –0.53 and –0.11, respectively). Similarly, in Klaiber et al. (2014), price elasticities ranges from –0.13 to –1.93, and in Yoo et al. (2014), the estimated elasticities are –0.89 and –2.40, with high-income customers having lower estimated price elasticity.

In comparison to residential studies, there is a paucity of empirical studies on price elasticities for water demand in the industrial and agricultural sectors, primarily because of low pricing or free use of water resources. Where studies have been undertaken, the existing literature indicates that industrial price elasticity estimates for water tend to be higher than residential estimates and vary by industry (Olmstead, 2010). Irrigation water demand elasticities are also more elastic than residential water demand elasticities (Scheierling et al., 2006).

The long-run demand for irrigation water deliveries does respond to price, although demand is likely to be relatively price inelastic (Scheierling et al. 2006). An analysis in the U.S. suggests a mean price elasticity of –0.48, based on 24 U.S. agricultural water demand studies performed between 1963 and 2004 (although estimates varied widely). Elasticity was found to be higher for regions where water is scarce and prices are higher, and where changes in crops and irrigation technologies are options, irrigation water delivery demand is likely to be responsive to price (Scheierling et al. 2006). In Australia, the existing literature suggests that price elasticity of demand for water allocations in Australia ranged from –0.52 to –1.9 (Zuo et al. 2015).

A recent study in the southern Murray-Darling Basin, Australia, shows that price elasticities of demand of high-security water entitlements are relatively inelastic with respect to the current market price for water. The price elasticity of demand for lower-reliability water entitlements is more inelastic than high-security water entitlements (Zuo et al. 2015). The relatively irresponsive demand for water entitlements to price could be explained by the fact that irrigators usually employ long-term plans to buy or sell water entitlements, whereas it is a much more flexible and temporary decision for irrigators to buy or sell seasonal water allocations (Zuo et al. 2015). Farmers with longer-term investment in irrigation are also less responsive to changes in water prices. For example, horticultural industries, such as nurseries, vegetables, vineyards and fruit, have higher inelasticities than cropping industries such as grains, sugar and cotton; a reflection of the substantial longer-term investment by farm enterprises in horticulture (Bell *et al*. 2007).

In general, these studies highlight the following key points:

- The price elasticity of water depends on the local context and a number of variables. Water pricing and conservation policies must be tailored to specific groups of users. Solid estimates of the price elasticity of water demand are critical for the development of effective water pricing and conservation policies. Pricing strategies must be used effectively and fairly for different user groups to ensure social inclusion, particularly for household water use.

- Price elasticity increases with higher prices, because at higher prices, water charges account for a larger share of household expenditures or business/farmer profit. Peak-load and seasonal water pricing may be an effective tool for managing water demand, particularly in water-scarce basins.

- The long-term price elasticity of water demand is greater than short-term price elasticity. This calls for consistent water pricing policies over time.

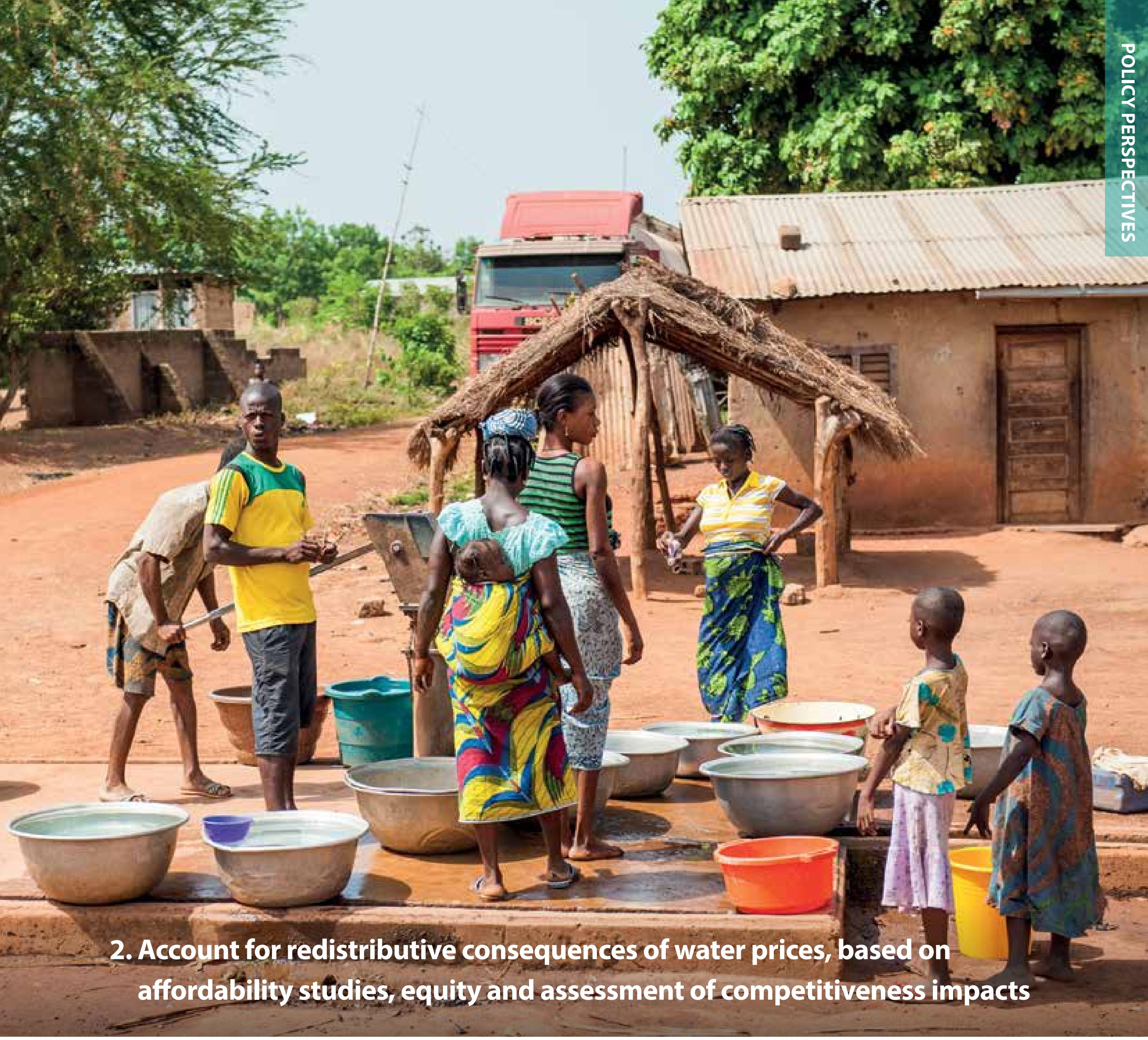
- A combination of price- and non-price strategies is needed to achieve significant water use reduction. Regulation, education, information campaigns and stimulation and uptake of innovation in water efficient technologies play important roles in water conservation policies.

Sources: Ascia, S., Borisovab, T. and M. Dukesc (2016), Are price strategies effective in managing demand of high residential water users?, *Applied Economics*; Bell, R., J. Gali, P. Gretton, and I. Redmond (2007), "The Responsiveness of Australian Farm Performance to Changes in Irrigation Water Use and Trade", 51st Annual Conference of the Australian Agricultural and Resource Economics Society, New Zealand, Queenstown, 14–16 February 2007; Dalhuisen, J.M., Florax, R.J.G.M., de Groot, H.L.F. and P. Nijkamp (2003), Price and Income Elasticities of Residential Water Demand: A Meta-Analysis, *Land Economics*, Vol. 79, No. 2, pp. 292–308; Gaudin, S. (2006), Effect of price information on residential water demand, Applied Economics, Vol. 38, pp. 383–393; Klaiber, H.A., Smith, V.K., Kaminsky, M. and A. Strong (2014), Measuring Price Elasticities for Residential Water Demand with Limited Information, *Land Economics*, Vol. 90, No. 1, pp. 100–113; Lee, J. and S.A. Tanverakul (2015), Price elasticity of residential water demand in California, *Journal of Water Supply Research and Technology—AQUA*, Vol. 64, No. 2, pp. 211-218; Olmstead, S.M. (2010), The Economics of Managing Scarce Water Resources, *Review of Environmental Economics and Policy*, Vol. 4, No. 2, pp. 179–198; Renwick, M.E. and S.O. Archibald (1998), Demand Side Management Policies for Residential Water Use: Who Bears the Conservation Burden?, *Land Economics*, Vol. 74, No. 3, pp. 343-359; Reynaud A. (2015), *Modelling Household Water Demand in Europe. Insights from a cross-country econonometric analysis of EU-28 countries*, JRC Technical reports, European Union; Scheierling, S.M., Loomis, J.B. and R.A. Young (2006), Irrigation water demand: A meta-analysis of price elasticities, *Water Resources Research*, Vol. 42; Sebri, M. (2014), A meta-analysis of residential water demand studies, *Environment, Development and Sustainability*, Vol. 16, pp. 499–520; Yoo, J., Simonit, S., Kinzig, A.P. and C Perrings (2014), Estimating the Price Elasticity of Residential Water Demand: The Case of Phoenix, Arizona, *Applied Economic Perspectives and Policy*, Vol. 0, No. 0, pp. 1–18; Zuo, A., Wheeler, S.A., Adamowicz, W.L., Boxall, P.C. and D. Hatton-MacDonald (2015), Measuring Price Elasticities of Demand and Supply of Water Entitlements Based on Stated and Revealed Preference Data, *American Journal of Agricultural Economics*, 1–19.

Table 2: **Features of water abstraction charges in selected countries and regions**

Country	Basis for charging	Charges differentiated by sector	Charges differentiated by other charectistics	Year of introduction	Ground water	Surface water
Belgium						
Flanders	Price per volume of water abstracted	–	Scarcity of the aquifer	1997	Yes	No
Canada						
British Columbia	Price per volume of water abstracted (with sometimes amount not to be exceeded) Price per license Price per MWh (electricity)	Yes	–	–	–	–
Nova Scotia	Price per volume of water abstracted Price for yearly license	Yes	–	–	–	–
China	Minimum price per volume of water abstracted	–	Location	2013	Yes	Yes
Czech Republic	Price per volume of water abstracted	Yes	–	1980	Yes	No
Estonia	Price per volume of water abstracted	Yes	Source aquifer	1991	Yes	Yes
France	Price per volume of water abstracted	Yes	Place of sampling in the environment and level of pressure on the aquatic environment	1977	Yes	Yes
Germany						
Baden-Wuerttemberg	Price per volume of water abstracted	Yes	–	1988	Yes	Yes
Hamburg	Fixed amount for agricultural and private use purposes Fixed amount and price per volume of water abstracted for commercial purposes	Yes	–	1989	No	Yes
Saxony	Price per volume of water abstracted	Yes	–	1992	Yes	Yes
Hungary	Price per volume of water abstracted	–	Region	–	Yes	Yes
Israel	Price per volume of water abstracted	Yes	Season	1959	–	–
Japan	Price per volume of water abstracted	–	Location	–	No	Yes
Korea	Price per volume of water abstracted	–	Source river	1999	No	Yes
Latvia	Price per volume of water abstracted	Yes	–	1995	Yes	Yes
Lithuania	Price per volume of water abstracted	Yes	–	1991	Yes	Yes
Luxembourg	Price per volume of water abstracted	–	–	–	–	–
Poland	Price per volume of water abstracted	Yes	Water quality and region	1990	Yes	Yes
United Kingdom	Price per volume of water licensed to be abstracted and not actually abstracted	–	–	2016	–	–

Source: OECD/EEA database on instruments for environmental policies.



2. Account for redistributive consequences of water prices, based on affordability studies, equity and assessment of competitiveness impacts

The experience of OECD countries with the use of pricing instruments for water services is diverse and growing. Several water pricing structures exist within the OECD: flat rates and volumetric ones; and increasing or decreasing block tariffs (OECD, 2010).

Affordability can be an issue for selected households in OECD countries. A number of measures can be implemented to reduce the burden of higher water prices on low-income households. These include: reduced water access fees, progressive tariffs, water vouchers, or lump sum transfers (OECD, 2010). An important message, based on both theoretical and empirical observations, is that trying to achieve equity and efficiency goals with a single instrument is likely to be ineffective (OECD, 2013). Better outcomes can be achieved if pricing is set so as to achieve efficiency goals, and subsidies are set independently of consumption to achieve equity goals.

Increasing block tariffs (IBTs) – where the volumetric rate increases with the volume of water consumed (blocks can be applied uniformly or differentially) - deserve particular attention. OECD (2010) notes that IBTs are becoming increasingly common among OECD countries. IBTs can theoretically be designed to allow free or low-cost water to low-income households who consume less water, and long-run marginal costs can be covered by higher tariffs for those who consume more (OECD, 2013). Such a tariff structure rests on the assumption that low-income households consume less water than high-income households. In reality, poorer households can be larger, and may end up consuming more water. Adjustments in the design of IBTs to account for the size of large poor households cannot completely overcome its shortcomings.

3. Set water pollution charges for surface and groundwater use, and pollution or charges for wastewater discharge, at a sufficient level to have a significant incentive effect to prevent and control pollution and enhance water use efficiency

Economic instruments are theoretically more cost-effective than direct regulation, which imposes the same controls on all polluters and does not take into account the heterogeneity of abatement costs. Pricing instruments also provide a dynamic incentive for additional pollution abatement, as polluters can reduce their costs by the amount of the emission tax for each additional unit of pollution abatement. This incentive effect can lead to significant investment in pollution abatement and technological innovation, thereby lowering the overall cost to society of meeting environmental targets (OECD, 2010). Table 3 illustrates features of water pollution charges in selected OECD countries and regions.

An operational challenge of pollution charges is that, in contradistinction with air pollution, the marginal costs of water pollution vary dramatically with the location of emissions. As a consequence, water pollution charges should vary according to each watercourse, and discharges in environments with a high-dilution capacity should be charged less than in areas with low-dilution capacity.

OECD countries have essentially managed water quality through regulation - ambient water quality standards, technology requirements, or bans on discharges into water bodies. Water pollution charges have been used in a number of countries for two purposes: i) reducing water pollution; and ii) raising revenues. For example, in the Netherlands, emissions taxes were set at a very high level in 1970 which led to a reduction in total organic emissions by 50% and industrial organic emissions by 75% by 1990. Likewise, high emissions taxes have been implemented in Germany, the Czech Republic, and Slovenia, in order to encourage behavioural change and reduce water pollution.

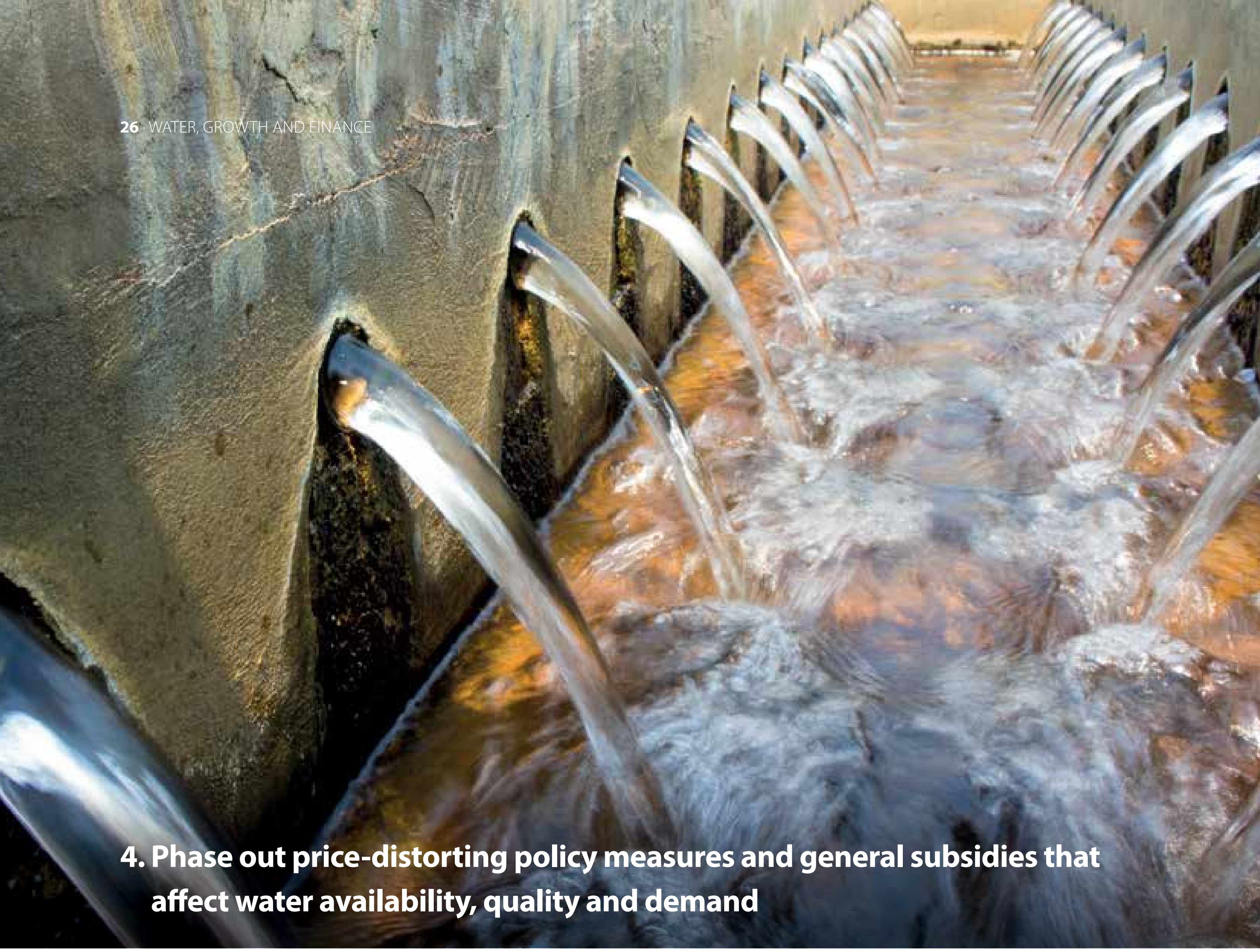
In the majority of countries where emissions taxes have been implemented, they have been set too low to induce behavioural change, and have primarily been used to raise revenues. However, they are increasingly being used to provide incentives for users to continuously reduce discharges, and in some cases they can be significant (see OECD, 2013, for a review and list of sources).

The OECD risk-based approach to water security (Box 1, page 2) argues that, instead of aiming to achieve the optimal level of pollution, planners, in consultation with stakeholders, can define an acceptable level and use taxes to reach it at the lowest possible cost.

Table 3: Features of water pollution charges in selected countries

Country	Name of instrument	Based on
Australia	South Australia -- Water effluent charge	Impact level
Austria	Wastewater charges	End-user (household, enterprises) For households: household size EUR 58 to 487 per year for an average source
Canada	British Columbia -- Charge on agricultural inputs	Volume of pesticides, EUR 0.8177 per litre
	British Columbia -- Charge on discharge	Pollution content, Weight
	Quebec -- Industrial wastewater charges and water effluent charges	Volume, Pollution content
China	Pollutant charge	Class (I, II), Volume (pollution equivalent)
Denmark	Charge on sewage discharge	Volume (water), Weight (pollutant)
	Duty on certain chlorinated solvents	Weight, pollution content
	Duties on nitrogen and pesticides	Weight
	Duty on waste water	Weight, pollution content
	Tax on mineral phosphorous in feed phosphates	Weight
Germany	Waste Water charge	Pollution load (noxiousness)
India	Tax for prevention and control of pollution	Pollutant content, sector, volume
Italy	Duty on pesticides	Percentage of previous year's turnover on the sale of pesticides
	Charge on water services	–
Japan	Wastewater user charges	–
Mexico	Water effluent charges	Quantity of wastewater in excess of permissible contents of COD and TSS, depending on carrying capacity of recipient body.
Netherlands	Levy on water pollution	Pollution unit, size of effluent
	Municipal sewerage charge	Number of members in the household
Spain	Andalucía - Tax on coastal wastewater discharges	Pollution unit, sector
	Castilla-La Mancha – Water treatment	Volume
	Tax on waste water discharges	Sector Volume
United States	Florida – Water quality tax	Pollution content Volume
	Maryland – Bay restoration fund fee	End-user Sewage disposal system (onsite, offsite)
	Washington –– Hazardous substance tax (Pesticides)	Percentage of wholesale value

Source: OECD/EEA database on instruments for environmental policies.



4. Phase out price-distorting policy measures and general subsidies that affect water availability, quality and demand

Reducing harmful subsidies is both a fiscally- and environmentally-sound contribution to water security. This requires phasing out price-distorting policy measures and general subsidies that affect water availability, quality and demand, to the extent possible, taking into account broader public policies and priorities. There are many types of water harmful subsidies, as demonstrated in the table below.

Table 4: **Types of water harmful subsidies**

Transfer mechanism	Example
Direct transfers of funds	Capital investment subsidies for water and sanitation providers
Foregone tax revenue	Inadequate environmental pollution charge, as well as special reductions or exemptions
Foregone user charge revenue	Inadequate water supply and sanitation tariffs Lack of abstraction charges Reduced electricity tariffs for irrigation pumps
Transfer of risk to government	Government compensation to households and firms for property damage due to water-related disasters
Induced transfers	Cross-subsidies for water supply and sanitation services (industrial vs. household tariffs)
Economic advantage due to unequal regulation or policy	Different regulations or charges for industry discharging pollutants to sewer systems or directly to water bodies

Source: OECD (2013e), *Improving the Use of Economic Instruments for Water Resource Management in Kyrgyzstan: the case of Lake Issyk-Kul Basin,* OECD Publishing, Paris.

ADDRESSING INVESTMENT RISKS

Attracting investors requires identifying principal financial risks (commercial, macroeconomic, construction, technology, environmental, political and regulatory risks), exploring tools to mitigate them (guarantees, public funds as seed money, etc.) and allocating residual financial risks to the party best able to address them - with the aim to minimise the Weighted Average Cost of Capital of the project concerned. Mitigation tools and financial risk allocation patterns define the particular risk-return profile of the investment. It has to be designed to match the profile of a particular type of investor.

Some of the main risks financiers face include:

- **Financial risk**. Commercial risk that arises when the revenues from the service are lower than expected, because the service is not appropriately charged, or the willingness to pay is too low, or the capacity to collect revenues is weak. Stable regulatory frameworks, robust business models, pricing schemes, and enforcement capacities help address this risk.
- **Foreign exchange risk**, when the money invested, and the revenues generated, are in different currencies. This risk can be addressed by developing domestic financial markets, which can generate financial resources to invest in water security and sustainable growth. Opportunities are growing as emerging economies develop.
- **Construction or technical risk**, when the technology is not mature, or the environment is uncertain. One option is to use public finance to cover the upfront cost of the project, and to harness private financiers once the project has demonstrated technical, commercial and financial sustainability. Refinancing can be an exit strategy for public financiers, allowing them to reallocate scarce financial resources to other projects.
- **Political risk**, which can be particularly acute in developing and emerging economies. Dedicated instruments can help mitigate these risks. Box 12 provides an example.

BOX 12: **COVERING POLITICAL RISKS: THE MULTILATERAL INVESTMENT GUARANTEE AGENCY**

Water security investments in emerging and developing economies may face political risks, such as expropriation, war and civil disturbance, breach of contract as well as currency inconvertibility and transfer restrictions. The Multilateral Investment Guarantee Agency (MIGA), parts of the World Bank Group, helps investors deal with these risks by insuring eligible projects against these types of risks. MIGA guarantees offer more than just the assurance that losses will be recovered, but also bring along a number of ancillary benefits. These include: deterring harmful actions, resolving disputes, helping investors obtain project finance, lowering borrowing costs and increasing the length of time until a loan is due, and proving environmental and social expertise.

Source: MIGA (2016) "Overview", www.miga.org/investment-guarantees [accessed 12 July 2016].

Governments can play a role in helping to attract new investors by enabling public and private actors to earn returns commensurate to the risks they take. Governments may consider providing risk mitigation to long-term investment projects where it would result in more appropriate allocation of risks and their associated returns.

Guarantees play a critical role in mitigating the risks financiers face. Similarly, public money can be used to cover parts of the risks that private financiers (debt or equity) are unable to take. In the United States, state revolving funds provide examples of a sustainable infrastructure financing model. Set up with 'seed money' from US Congress, the state revolving funds capitalise a state-administered financial assistance programme to build and upgrade wastewater treatment plants and drinking water infrastructure, as well as invest in other projects to improve water quality (such as measures to reduce diffuse pollution and water recycling) (Box 13). In doing so, the funds support a longer transition and ample flexibility to set up long-term financing to promote state and local self-sufficiency.

BOX 13: **STATE REVOLVING FUNDS FOR GREEN INFRASTRUCTURE IN PHILADELPHIA**

The City of Philadelphia signed a Green City, Clean Waters Partnership Agreement with the US Environmental Protection Agency (EPA) in 2011 (EFAB, 2014). The agreement set out to reduce stormwater pollution entering the city's combined sewer system by investing in green infrastructure (PW, n.d.). Over the course of 25 years, the Philadelphia Water Department will invest a total of USD 2.4 billion to retrofit about 10 000 impervious acres of public and private land, seeking to green any impermeable surface that channels storm-water into sewers and waterways during precipitation (PWD, 2011). Thanks to the green infrastructure, the stormwater will evaporate into the ground or the air, and in some cases be released, in a slowly and controlled manner, into the sewer system. The intent of the Green City, Clean Waters plan is to reduce stormwater pollution of waterways and sewers by as much as 85% within 25 years (EFAB, 2013; PW, n.d.).

In addition to drawing on public spending, Green City, Clean Waters seeks to leverage private investments by establishing a new wastewater pricing mechanism that incentivises owners of non-residential land to finance storm water remediation (EFAB, 2014). The plan sets a charge for stormwater removal services on the basis of impervious surface as a percentage of a property's total size, implying that the land owners' fee for stormwater services decreases with a decline in the impervious surface footprint. Hence, property owners are incentivised to invest in green stormwater infrastructure that costs less than the net present value of the service charge (EFAB, 2014).

Since the implementation of Green City, Clean Waters in 2011, more than 1100 storm water remediation tools have been added to the Philadelphian landscape, by the Philadelphia Water Department as well as by private developers (PW, n.d.) The stormwater remediation programme is projected to reduce the City's capital expenditure by USD 8 billion in traditional point source investment over 25 years, in addition to ensure the progressive transfer of the cost burden related to stormwater mitigation from the city authorities to private property owners (EFAB, 2014). The implementation of the programme facilitates the City of Philadelphia's compliance with the US Clean Water Act, as well as produces a financial benefit by shoring up existing bond credit ratings and budget estimates of future debt service costs (EFAB, 2014). The Philadelphia agreement can serve as a model for wastewater infrastructure gap closing measure on national level (PW, n.d.; EFAB, 2014).

Source: Environmental Financial Advisory Board (EFAB) (2014), "Environmental Financial Advisory Board ", https://www.epa.gov/sites/production/files/2014-04/documents/efab_report_srf_funding_for_greeninfra_projects.pdf ; Philadelphia Water (PW) (n.d.), "Green City, Clean Waters", http://www.phillywatersheds.org/what_were_doing/documents_and_data/cso_long_term_control_plan ; Philadelphia Water Department (PWD) (2011), "Amended Green City, Clean Waters", http://www.phillywatersheds.org/doc/GCCW_AmendedJune2011_LOWRES-web.pdf.

The Water Infrastructure Finance and Innovation Act (WIFIA) in the United States established a new financing mechanism for water and wastewater infrastructure projects to be managed by the Environmental Protection Agency. The Act provides low interest rate financing for the construction of large dollar-value infrastructure (at least USD 20 million) of national or regional significance. Credit assistance can be in the form of loans or guarantees. The programme attempts to fill a perceived gap left open by the State Revolving Funds by providing subsidised financing for large projects. It was modelled on a similar initiative for transportation projects, which has provided over USD 16 billion in assistance since 1999 to projects costing nearly USD 60 billion (see USEPA, 216, for more information).

Public-private partnerships can make the best use of the capabilities of the two sets of financiers. For example, London have established a novel Government Support Package, to attract private financiers and reduce insurance liabilities to deliver the Thames Tideway Tunnel project – a major construction undertaking to intercept London's combined sewer overflows for treatment to improve water quality of the River Thames (Box 14). Blended finance is a promising avenue, where development finance and philanthropic funds leverage private capital flows in emerging or frontier markets (WEF, OECD, 2015).

BOX 14: **A PUBLIC-PRIVATE APPROACH TO DELIVERING THE THAMES TIDEWAY TUNNEL, UK**

London's combined sewer system was constructed over the period 1859-75. Designed to serve a maximum of 4 million people, and to accommodate both domestic sewage and stormwater runoff, the significant increase in London's population to 8 million over the last 150 years means that there is no longer sufficient capacity in the sewer system during periods of rainfall. As a consequence, the combined sewer overflows (CSOs) discharge untreated sewage and stormwater to the River Thames, on average, once per week (in excess of 40 million tonnes of sewage each year).

In 2001, the private water utility (Thames Water), local and national government and regulators (the Environment Agency and Ofwat) commenced a joint Thames Tideway Strategic Study (TTSS) to consider options to tackle the problem of CSOs. The study (reported in 2005), found the most economically feasible solution was to build a new tunnel – the Thames Tideway Tunnel (TTT) – under the bed of the Thames, to intercept the CSOs, transferring wastewater to the Beckton sewage treatment works for processing.

BOX 14: *(continued)*

An economic cost-benefit analysis of the TTT estimates welfare benefits of GBP 7.4-12.7 bn for a whole-life project cost of GBP 4.1 bn (Defra 2015, Eftec 2015). However, despite the economic benefits significantly out-weighing the capital investment costs, the exceptionally high risk profile of the project (i.e. the unprecedented scale and major tunnelling work under one of the world's most complex cities) inflated the cost of borrowing and reduced the ability of Thames Water to secure finance for the project through the normal capital markets. Unique and exceptional risks which are conceivable when considering the TTT (for example, catastrophic scenarios such as flooding the London Underground or causing the collapse of significant public and other buildings through tunnelling works) are not easily insurable, which significantly affects the appetite of private investors to provide capital, and increases the risk premium attached to any funding. In addition, the inability to separate the TTT project from Thames Water's existing business and debt also placed severe constraints on the ability of investors to lend to Thames Water.

In response to the difficulty of attracting finance for the TTT, the national government, Ofwat and Thames Water put in place an innovative public-private arrangement to enable risks to be managed and underwritten to the point that private capital markets were prepared to finance the project on reasonable terms. The key principle behind developing a risk-sharing model for the TTT was that different parties have different capacities to mitigate and absorb different risks, which in turn affects financing costs and ultimately the feasibility of a project.

A novel Government Support Package (GSP) for the TTT project was constructed, which provided contingent public financial support under very specific circumstances. The GSP is provided for a fee and comprises five agreements:

- *Supplemental compensation agreement (SCA):* Government provides an insurance facility to the project for cover above the limits of commercial insurance, including if commercial insurance were available at the beginning of the project but subsequently becomes unavailable.

- *Contingent equity support agreement (CESA):* if the costs of completing the TTT are forecast to escalate beyond a specified point (the "Threshold Outturn"), the project will have the option of requesting that Government makes an injection of equity to allow it to be completed. If Government receives such a request, it is committed to provide this equity, subject to its right to discontinue the Project (see below).

- *Market disruption facility (MDF):* in the event that the project is unable to access debt capital markets as a result of a sustained period of disruption in these markets, Government would provide temporary liquidity.

- *Special administration offer agreement (SAOA):* if the provider should go into Special Administration and not have exited after 18 months, Government commits to either make an offer to purchase the provider (at a price at its discretion), or to discontinue.

- *Discontinuation agreement (DA):* Government will have the right to discontinue in a number of circumstances, in particular, in the event that the costs of completing the TTT are predicted to escalate beyond the Threshold Outturn and the project requests an injection of equity from Government or if insurance claims exceed a specified amount. Where Government opts to discontinue the Project, it commits to paying compensation to existing equity and debt investors. This agreement of the GSP acts to ensure that Government does not assume unlimited liabilities.

As a result of the public-private risk-sharing model and the Government Support Package, an Infrastructure Provider and a construction consortium have now both been appointed and construction of the TTT is proceeding and expected for completion in 2023.

Costs to the government have been carefully defined to only arise in very specific, low probability circumstances. In the absence of risks materialising, the cost to the government is zero, but the presence of the Government Support Package as a "backstop" gives comfort to the private sector and enables efficient private financing.

Source: OECD (2016, forthcoming), *Diffuse pollution in OECD Countries: Policies and Principles for Action, OECD Studies on Water,* OECD Publishing, Paris.

DEBT OR EQUITY?

Financiers have varying appetites for diverse risk-return profiles. Water-related investments can be financed by equity or debt, which are sources of repayable finance. These can cover upfront investments, and will ultimately be repaid through a combination of the 3Ts - tariffs, taxes and transfers (OECD, 2010). Financiers providing equity and debt have varying risk appetites which will determine the extent to which they will consider investments in water security (OECD (2015b).

Equity investors buy ownership (equity) in companies that provide various water services. Many such investors, notably ***private equity funds***, focus their investment on specific asset classes, and look for companies with good prospects for profit in order to minimise single-asset risk. Only a minority of water service providers globally meet the criteria of the private equity funds, and these are primarily located in OECD countries. A key advantage of private equity funds is that these can help reduce the liquidity risk of original investors or lenders in the water sector, by offering a re-financing, or a secondary market for infrastructure finance, and enabling the original investors to exit. This allows some municipalities to release capital tied up in water infrastructures in order to generate funds for spending on new projects (OECD, 2015a).

Some equity funds are ***specialised water funds***, which solely invest in the water sector. Hence, they are willing to take the risks associated with this sector, but do nevertheless expect high returns. The owners of specialised water funds are typically individuals of high-net worth, and the funds invested in listed securities (equities or bonds).

BOX 15: **WATER BONDS**

The green bonds market has been growing rapidly over the past decade, reaching USD 42.8 billion in annual issuances in 2015 and could be valued at USD 1 trillion by 2020. As part of the rapidly growing green bonds market, a standard for a "Water Climate Bond" has recently been developed by the Climate Bonds Initiative. The new standard is intended to provide investors with verifiable, science-based criteria for evaluating water-related bonds, and to assist issuers in the global corporate, municipal, sovereign and supra-sovereign markets in differentiating their green bond offerings. The standard aims to maintain credibility in the green bonds market. It can be used to evaluate projects as diverse as industrial water efficiency, reuse, catchment or watershed restoration and or large-scale water supply infrastructure development.

A number of recent green bond issues either target water projects or include water projects within their broader criteria. For example, HSBC's first EUR 500 million green bond, which was oversubscribed by a factor of four, included sustainable water management and climate change adaptation, among the qualifying projects. At the municipal level, the State of Connecticut (USA) recently issued its third green bond of USD 65 million. The proceeds of this bond will be used on high priority clean water projects aimed mainly at investments in wastewater treatment.

Sources: Climate Bonds Initiative (2016). "2015 Green Bond Market Roundup"; Climate Bonds Initiative (2015), "Water Climate Bonds Standard", Background paper to eligibility criteria, Water Technical Working Group, November 2015; Climate Bonds Initiative (2015), "Market update: roaring week in green bond market".

The engagement of ***institutional investors such as pension funds and insurance companies*** in water infrastructure is limited. Nevertheless, the steady flow of projects and the improved grasp of the risks associated with infrastructure lending are helping to draw institutional investors to investments that boast higher yields, as well as comparatively low default rates and better recoveries, than those similarly rated corporate debt, while also offering the asset-liability management that these investors need.

Debt financiers give loans to, or buy bonds from, water service providers. Many such investors have a low appetite for risk and expect high returns. ***Commercial banks*** can be attracted by low-return but low-risk water investments in developed countries. They will be less attracted by similar projects in developing countries, where risks are higher. They value short maturities, which allow them to adjust investment strategies over time.

International Financing Institutions (IFIs), offer favourable terms for debt financing and often will accept lower returns than commercial banks and insurance companies. The IFIs are used to deploy a range of products including advice and technical assistance, and do in many cases leverage funding from other market players. IFIs offer commercial terms in middle-income countries where they don't offer concessional loans; there, they face competition from other financiers, and must, to a growing extent, tailor their products to gaps in the market. More and more countries, notably middle-income countries, find it is easier to finance their infrastructure needs in private capital markets (e.g. ***bonds*** are gaining traction), rather than with loans from IFIs, due to the conditions set by the latter.

Many ***philanthropic funds*** also offer loans to the water sector. These funds are often managed by NGOs, and are notably invested in developing countries. Philanthropic donations or loans to development programmes are estimated to be of a similar order of magnitude to total overseas development assistance (ODA). Some philanthropic funds and IFIs also use grants as a funding instrument (Winpenny, 2015).

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