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UN WATER

Report

The United Nations World Water Development Report 2016

WATER AND JOBS

United Nations Educational, Scientific and Cultural Organization

World Water Assessment Programme

Food and Agriculture Organization of the United Nations

International Labour Organization

UNDESA, UNECE, UNECLAC, UNESCAP, UNESCWA

UNEP

United Nations Educational, Scientific and Cultural Organization

UNIDO

World Meteorological Organization
Weather • Climate • Water

The United Nations World Water Development Report 2016

WATER AND JOBS

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FOREWORD

by Ban Ki-moon
Secretary-General of the United Nations

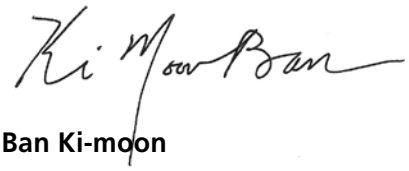
Sustainable development, human migration, conflict and natural disasters: water cuts across these and many other major issues on the global agenda. Employment is another key factor in population movements, civil unrest and environmental sustainability.

The 2016 edition of the United Nations World Water Development Report, which was coordinated by the United Nations World Water Assessment Programme of UNESCO in collaboration with UN-Water Members and other partners, illustrates how the connection between water and jobs holds the promise of inclusive and sustainable economic growth for all countries. Its findings can serve to help reach the Sustainable Development Goals, which are all interlinked, including Goal 6 covering water and sanitation for all, and Goal 8 addressing decent work for all.

Among its findings, this report shows that many jobs in the global workforce depend on water. It demonstrates that water stress and the lack of decent work can exacerbate security challenges. It also traces the link between scarce or poor quality water, damaged ecosystems and instability that can lead to forced migration.

The main message of the report is clear: water is essential to decent jobs and sustainable development. Now is the time to increase investments in protecting and rehabilitating water resources, including drinking water, as well as sanitation while focusing on generating employment.

I commend this report to all those interested in joining forces to realize our bold vision for sustainable development aimed at creating a future where all people live in dignity on a healthy and peaceful planet.



Ban Ki-moon

FOREWORD

by Irina Bokova
Director-General of UNESCO

Water and jobs are inextricably linked on various levels, whether we look at them from an economic, environmental or social perspective. This edition of the World Water Development Report breaks new ground by addressing the pervasive relationship between water and jobs to an extent not yet seen in any other report.

The report estimates that well over one billion jobs, representing more than 40% of the world's total active workforce, are heavily water-dependent. Such jobs are found in agriculture, forestry, inland fisheries, mining and resource extraction, power generation and water supply and sanitation, as well as in several manufacturing and transformation industries including food, pharmaceuticals and textiles. Another billion jobs, representing over one third of the world's total active workforce, are likely to be moderately water-dependent. Examples of sectors with moderately water-dependent jobs include construction, recreation, transportation and manufacturing/transformation industries such as wood, paper, rubber/plastics and metals.

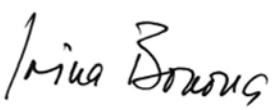
This means that nearly 80% of the jobs constituting the global workforce are dependent upon having access to an adequate supply of water and water-related services, including sanitation. As such, jobs in the water sectors themselves (including integrated water resources management and ecosystem restoration and remediation; building and managing water infrastructure; and the provision of water-related services, such as water supply, sewerage, waste management and remediation activities) help to create an enabling environment for the creation and maintenance of decent jobs across most other sectors of the global economy.

As competition for freshwater resources grows and climate change impacts supplies, it is increasingly critical that governments develop and adopt employment policies that take account of the limitations imposed by water availability, while fulfilling the human rights to water, sanitation and decent jobs, according to each countries' own resource base, potential and priorities. Achieving the appropriate sectoral balance, and generating the highest possible output of decent and productive jobs without compromising the support capacity of water resources and ecosystems, is essential to ensuring long-term social, economic and environmental sustainability.

An important part of the policy package for addressing water-related challenges consists in ensuring that a sufficient number of water experts and professionals are available to inform and assist the process of meeting these challenges. As this report highlights, addressing the current and growing human resources gaps in the relevant water-related sectors requires immediate consideration from policy-makers. Notably, the shift to a green economy in sectors such as agriculture, forestry, fishing, energy, resource-intensive manufacturing, recycling, buildings and transport is changing the range of tasks and required expertise associated with various jobs, as a result of new technologies, processes and practices.

It is everyone's responsibility, including States, the private sector, development banks and civil society, to partake in global and local efforts to improve the living conditions of millions through the sustainable management of water, and the provision of drinking water and sanitation and decent job opportunities for all. This report calls for concerted long-term integrated decision-making to address the water and jobs nexus. The international community is already showing the way, having given itself long-term goals with regards to water, sanitation, decent work and sustainable development.

We trust that building on the recently adopted Sustainable Development Goals and this report, policy-makers everywhere will rise to the challenge and act at the water-jobs nexus to maximize its benefits to society and avoid the costs of inaction.



Irina Bokova

FOREWORD

by Guy Ryder
Chair of UN-Water and Director-General of International Labour Organization

Water and jobs have many common denominators: water is central to human survival, the environment and the economy – decent work is the chief locomotive of development and better standards of living.

Both have the power to transform people's lives.

Last year, the United Nations adopted the 2030 Agenda for Sustainable Development. Now, we have an unprecedented opportunity to transform our world. We have committed to working tirelessly for the next fifteen years to eradicate poverty, strengthen universal peace and urgently shift the world on to a sustainable and resilient path that will leave no one behind.

For this to happen, we need to promote social justice in the world but also develop means of action and supporting policies. This report shows how almost half of the world's workers – 1.5 billion people – work in water-related sectors and how nearly all jobs depend on water and those that ensure its safe delivery.

Yet, these millions of people are often not recognized or protected by basic labour rights. This needs to change. A first step is recognizing these workers, changing their conditions and organizing the work.

The report shows how water affects workers' lives through its presence, its quality and its quantity. It shows how investments in water and sanitation can create paid and decent jobs and thereby contribute to a greener economy.

However, for all of this to happen, we need more qualified workers and for their work to be decent: that means dignity, equality, a fair income and safe working conditions. We need to help countries ensure access to water and sanitation for all, improve quality, increase efficient management, improve protection and expand cooperation.

In my capacity as the new Chair of UN-Water, I am proud of this year's World Water Development Report. It is my hope that it can help enhance the political understanding of how water and jobs create a crucial pillar to help support sustainable development when we work to transform our world.

Guy Ryder

PREFACE

by **Stefan Uhlenbrook**, WWAP Coordinator
and **Richard Connor**, Editor-in-Chief

As the third in a series of annually released theme-oriented reports, the 2016 edition of the United Nations World Water Development Report (WWDR) addresses a subject that has received only marginal attention, particularly at the international level: the relationship between water and jobs.

The fact that water underpins economic development and social wellbeing is widely recognized. Water is essential for food and energy production, and serves as a necessary and often irreplaceable input in a wide variety of industrial value chains. Jobs in these sectors are therefore clearly water-dependent. However, the water-job nexus does not stop there. In fact, that is only the beginning. Water is not so much a job 'creator' as a job 'enabler'. For example, access to safe water supply and adequate sanitation services, both at home and at the workplace, are essential for maintaining a healthy and productive workforce. The provision of these services depends on people with all sorts of jobs in water utilities. Likewise, jobs in water resources management and in the development, maintenance and operation of water-related infrastructure are equally necessary to ensure water is available for job creation in the various water-dependent sectors.

Describing the nature and extent of this circular relationship between water and jobs in comprehensive terms proved to be a challenging undertaking. In preparing this report, it quickly became apparent that very little information, and even fewer statistics, is available to examine and understand the linkages between water and jobs and the importance of that nexus for sustainable economic and social development. Fortunately, thanks in large part to the assistance and creativity of our staff and partners, we have managed to produce a comprehensive report that we will provide a solid basis for further study and analysis. Our hope is that this report will galvanize interest in filling this knowledge gap and raise awareness about the fact that sound management and forward looking policies related to the water and jobs nexus hold the promise of better lives and a better future for all.

Like its predecessors, the WWDR 2016 is primarily targeted at national-level decision-makers and water resources managers, as well as academics and the broader development community. It is hoped that this report will also be particularly well received by national employment ministries, labour organizations, business councils and other employment-focused people and institutions whose day-to-day decisions and actions impact – and are impacted by – water.

This latest edition of the WWDR is the result of a concerted effort between WWAP and Lead Agencies (FAO, ILO, UNECE, UNECLAC, UNEP, UNESCAP, UNESCO, UNESCWA, UNIDO, WMO), which all provided perspectives on water and jobs.

The report also benefitted to a great extent from the inputs and contributions of several UN-Water Members and partners, as well as from dozens of scientists, professionals and NGOs who provided a wide range of relevant material. The members of WWAP's Technical Advisory Committee were particularly active and generous in providing their guidance and knowledge to the production team. In line with the previous publications of WWAP, this report is gender-mainstreamed thanks to the support of UN Women, the WWAP Advisory Group on Gender and the UNESCO Division for Gender Equality.

We have endeavoured to present a fact-based, balanced and neutral account of the current state of knowledge, covering the most recent developments pertaining to water and jobs. It is our sincere hope that this factual report is received as a useful, informative and credible tool that will support and strengthen proactive discussions pertaining to our common future, and ultimately help to identify and adopt appropriate responses to challenges related to water and jobs, which as the report describes are often inseparable.

On behalf of WWAP Secretariat, we would like to extend our deepest appreciation to Lead Agencies, members and partners of UN-Water, and to authors, writers, editors and other contributors for collectively producing this unique and authoritative report. A special recognition goes to ILO, who provided outstanding guidance and support from the very beginning of the report's development through to the final editing process.

Our special thanks go to Irina Bokova, Director-General of UNESCO, for her crucial support to WWAP and the production of the WWDR.

We are profoundly grateful to the Italian Government for funding the Programme and to the Regione Umbria for hosting the WWAP Secretariat in Villa La Colombella in Perugia. Their contributions have been instrumental to the production of the WWDR.

We extend our most sincere gratitude to all our colleagues at the WWAP Secretariat, whose names are listed in the acknowledgements. This report could not have been completed without their dedication and professionalism.

Last but not least, our warm and heartfelt thanks to Michela Miletto, who served as WWAP Coordinator a.i. from September 2013 through October 2015, and who played a key role in the design and development of the report.

Stefan Uhlenbrook

Richard Connor

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The United Nations World Water Assessment Programme (WWAP) Secretariat would like to thank all the organizations, institutions and individuals who made the preparation of this report possible.

WWAP recognizes the valuable contribution, useful revisions and timely endorsements of UN-Water members and partners. Our special thanks go to ILO for their assistance and cooperation in developing the structure and main messages of the report, and for hosting the Developmental Workshop for the 2016 edition of the World Water Development Report (WWDR 2016) in Geneva, Switzerland.

WWDR 2016 benefitted from the significant reviews, comments and guidance of WWAP's Technical Advisory Committee.

We wish to express our earnest thanks to Irina Bokova, Director-General of UNESCO, whose support was instrumental in preparing the report.

We would like to acknowledge the support of Blanca Jiménez-Cisneros, Director of the Division of Water Sciences and Secretary of the International Hydrological Programme (IHP), and colleagues at IHP.

WWAP gratefully acknowledges the financial contribution of the International Labour Organization (ILO) for the translation into Spanish of the WWDR 2016, and the Swiss Agency for Development and Cooperation (SDC) for the translation in French. The printing in these languages was ensured by ILO, SDC and Itaipu Binacional.

We also would like to express our gratitude to numerous UNESCO Field Offices, various UN agencies and country partners as well as institutions for organizing national and regional promotional events to widely disseminate the report and its findings.

We greatly appreciate the generous help extended to us by the UNESCO Field Offices in Almaty, Beijing, Brasilia, Cairo and New Delhi for the translation of the Executive Summary into Russian, Chinese, Portuguese, Arabic and Hindi languages. Thanks to the valuable collaboration between the National Water Agency of Brazil and UNESCO Brasilia Field Office, the Portuguese language has been included in the translation series.

WWAP is grateful for the generous financial contribution of the Italian Government, and for the facilities provided by Regione Umbria.

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EXECUTIVE SUMMARY

Farmers planting rice near Yogyakarta (Indonesia)
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Water is an essential component of national and local economies, and is needed to create and maintain jobs across all sectors of the economy. Half of the global workforce is employed in eight water and natural resource-dependent industries: agriculture, forestry, fisheries, energy, resource-intensive manufacturing, recycling, building and transport.

Sustainable water management, water infrastructure and access to a safe, reliable and affordable supply of water and adequate sanitation services improve living standards, expand local economies, and lead to the creation of more decent jobs and greater social inclusion. Sustainable water management is also an essential driver of green growth and sustainable development.

Conversely, neglecting water issues runs the risk of imposing serious negative impacts on economies, livelihoods and populations with potentially catastrophic and extremely costly results. Unsustainable management of water and other natural resources can cause severe damages to economies and to society, thus reversing many poverty reduction, job creation and hard-won development gains.

Addressing the water-jobs nexus, notably through coordinated policies and investments, is therefore a prerequisite to sustainable development in both developed and developing countries.

Water jobs

Jobs in water sectors fall under one of three functional categories: i) water resources management, including integrated water resources management (IWRM) and ecosystem restoration and remediation; ii) building, operating and maintaining water infrastructure; and iii) the provision of water-related services including water supply, sanitation and wastewater management.

These jobs serve as the building blocks for a wide array of water-dependent job opportunities in sectors such as agriculture (including fisheries and aquaculture), energy and industry. Specifically, investments in safe drinking water and sanitation have been shown to foster economic growth, with high rates of return. Access to a safe and reliable water supply and sanitation services at home and the workplace, coupled with appropriate hygiene, is critical to maintaining a healthy, educated and productive workforce.

A number of ancillary jobs also enable employment in water-dependent sectors. These include jobs in regulatory institutions within public administrations, infrastructure financing, real estate, wholesale and retail trade, and construction.

Together, water jobs and ancillary jobs provide the enabling environment and necessary support to the activities or operation of numerous organizations, institutions, industries and systems, and the jobs they generate. By estimating the potential employment supported by investments in the conservation, treatment and delivery of water, governments can determine the investment and employment policies that will increase and improve jobs across the economy.

Water, economy and jobs

Failure to secure an adequate and reliable supply of water to support heavily water-dependent sectors results in the loss or disappearance of jobs (i.e. no water, no jobs). Floods, droughts and other water-related risks can also have economic and employment repercussions that can go far beyond the immediate affected areas.

In addition to jobs in agriculture and industry, sectors with heavily water-dependent jobs include forestry, inland fisheries and aquaculture, mining and resource extraction, water supply and sanitation, and most types of power generation. This category also includes some jobs in the health care, tourism and ecosystem management sectors. The analyses made in this report have allowed estimating that more than 1.4 billion jobs, or 42% of the world's total active workforce, are heavily water-dependent.

It is further estimated that 1.2 billion jobs, or 36% of the world's total active workforce, are moderately

water-dependent. These are sectors that do not require access to significant quantities of water resources to realize most of their activities, but for which water is nonetheless a necessary component in part(s) of their value chains. Examples of sectors with moderately water-dependent jobs include construction, recreation and transportation.

In essence, 78% of jobs constituting the global workforce are dependent on water.

Agri-food sector

Insufficient or erratic water supplies affect the quality and quantity of employment in the agri-food sector. They constrain agricultural productivity and compromise income stability with dramatic effects for the poorest households with limited assets and safety nets to cope with risks. Furthermore, agriculture plays a wide role supporting livelihoods, notably for the poorest, with an important self-consumption aspect. Agricultural production, which includes fisheries and forestry, is also a generator of jobs and self-employment in the supply of inputs, machinery and rural infrastructure, transformation of agricultural products and distribution to the end consumers. While agricultural investments often increase agricultural productivity and raise the quality of employment, it may do so at the expense of the numbers of available jobs. In such cases, appropriate policies are needed to limit the impacts on displaced workers.

Energy sector

The demand for energy is increasing, particularly for electricity in developing and emerging economies. The energy sector, with growing water withdrawal that currently accounts for about 15% of the world's total, provides direct employment. Energy production, as a requirement for development, enables direct and indirect job creation across all economic sectors. Growth in the renewable energy sector leads to growth in the number of green and non-water-dependent jobs.

Industry sector

Industry is an important source of decent employment worldwide and accounts for a fifth of the world's workforce. Industry and manufacturing account for approximately 4% of global water withdrawals and it has been predicted that by 2050, manufacturing alone could increase its water use by 400%. As industrial technology and understanding of the essential role of water in the economy and of the environmental stresses placed upon the resource improve, industry is taking measures to reduce its water use per unit produced, thereby improving industrial water productivity. Increased attention is being directed to water quality, particularly downstream. Industry is also putting efforts to reuse and recycle water, matching water quality to use and moving towards cleaner production, with possible benefits in terms of better paid jobs (for more highly trained employees) within industry as well as treatment equipment suppliers.

Global perspectives on water

Freshwater withdrawals have increased globally by about 1% per year since the 1980s, mainly due to growing demand in developing countries. In much of the world's highly developed countries, freshwater withdrawals have stabilized or slightly declined.

Accelerated urbanization and rising living standards, increased demand for water, food (especially meat) and energy from an ever-growing global population will inevitably lead to the creation of jobs in certain sectors (i.e. municipal wastewater treatment) and to the loss of jobs in others.

Water scarcity is likely to limit opportunities for economic growth and the creation of decent jobs in the upcoming years and decades. Unless there is sufficient infrastructure to manage and store the water, as is the case in many developed countries, water availability might vary significantly, leaving (parts of) countries 'water scarce' for extended periods. Water availability is also highly dependent on water quality. Poor quality water may not be fit for several uses and the cost of the required treatment may be a prohibiting factor, thus contributing to the burden of economic water scarcity.

Reduced water availability will further intensify competition for water among users, including agriculture, maintenance of ecosystems, human settlements, industry and energy production. This will affect regional water, energy and food security, and potentially geopolitical security, prompting migration at various scales. The potential impacts on economic activity and the job market are real and possibly severe. Many developing economies are located in hotspots of water-related stress, particularly in Africa, Asia, Latin America and the Middle East.

Climate change exacerbates the threats to water availability and is expected to increase the frequency, intensity and severity of extreme weather events. Climate change will inevitably lead to the loss of jobs in certain sectors. A proactive approach to adaptation via employment policies may offset some of these losses. At the same time, climate change is creating job opportunities of its own in terms of mitigation and adaptation activities.

Adopting an ecosystem-based approach to watershed management, including the economic valuation of ecosystem services, is one way of quantifying their benefits for livelihoods and employment. In that regard, the emerging market for payments for ecosystem services (PES) schemes can offer low-income populations the opportunity to create a new type of entrepreneurship (with its related jobs) that generates increased income while implementing restoration/conservation practices.

Investing in water is investing in jobs

Water investments are a necessary enabling condition for economic growth, jobs and reducing inequalities. Conversely, failure to invest in water management not only represents missed opportunities, but may also impede economic growth and job creation.

Assessing the relationship between water, economic growth and jobs is particularly challenging. It has however been shown that countries exhibit a strong positive correlation between water-related investments and national income, as well as between water storage capacity and economic growth.

Investments in infrastructure and operation of water-related services can provide high returns for economic growth and for direct and indirect job creation. Water investments can also lead to production systems that are more labour intensive. Notably, green development can increase employment opportunities through green jobs, more labour intensive practices and PES.

It is essential to plan water investments in conjunction with relevant sectors, such as agriculture, energy and industry in order to maximize positive economic and employment results. Within a suitable regulatory framework, public-private partnerships (PPPs) offer prospects for much needed investment in water sectors, including building and operating infrastructure for irrigation and water supply, distribution and treatment. With a view to promoting economic growth, poverty reduction and environmental sustainability, consideration must be given to methods that mitigate job loss or displacement and maximize job creation that may result from the implementation of an integrated approach to water management.

Regional perspectives

In Africa, the demand for jobs will be a major policy issue across a continent which is already experiencing high unemployment and underemployment, driving migration both within the region and externally. For Africa to be able to maintain its impressive growth rates of the last 10 years, the basic infrastructure of water and electricity are prerequisites. Without these, African economies could lose momentum, resulting in the loss of direct water jobs and jobs in the water-dependent sectors.

In the Arab region, unemployment trends have worsened in recent years as rural income fell due to low agricultural productivity, drought, land degradation and the depletion of groundwater resources. These trends have fuelled rural to urban migration, the expansion of informal settlements and social unrest. As water scarcity is prevalent in the Arab region, employment in many sectors is

water sensitive. Investments in water use efficiency and conservation present politically palatable avenues for governments that must weigh trade-offs between water sustainability and employment targets.

In Asia and the Pacific, most of the industries driving economic growth depend upon a reliable supply of freshwater for large parts of their production processes. Expanding economies will need increasing supplies of energy, which will in turn require access to more water. There is tremendous potential to create employment opportunities in the region by increasing access to water in the agricultural sector. There is also potential in the industry and service sectors to create and support water-dependent jobs, especially through the improvement of water efficiency, pollution control and wastewater usage.

In Europe and North America, among the developments that have markedly influenced employment in water management and water services as well as qualifications required are the following: in the European Union and North America, increased automation, use of remote sensing and standardization; in Eastern pan-Europe, investment in infrastructure, resource constraints and reforms of national administrations. Emerging employment opportunities reside in the undeveloped potential for hydropower (in parts of the region) and other renewables. The need to repair, modernize and construct different types of water infrastructure may also create different job opportunities.

Economies in Latin America and the Caribbean rely heavily on the exploitation of natural resources, including water, particularly for mining, agriculture, including biofuels, forestry, fishery and tourism. This demands constant attention from policy-makers in order to maximize the contribution of water to development and job creation, starting with strong, transparent and effective institutional arrangements for integrated water management and the provision of water and sanitation services. These actions protect public interest, promote economic efficiency, and provide the stability and flexibility necessary to attract investment to the development of water resources and related public utility services.

Human rights, sustainable development and gender

Human rights, green economy, sustainable development and gender are among the most salient legal and policy frameworks to be considered by policy-makers when addressing the water and jobs nexus.

The right to safe drinking water and sanitation is a prerequisite and integral to the realization of other human rights, most notably the rights to life and dignity, to adequate food and housing, as well as the right to health and well-being, including the right to healthy occupational and environmental conditions. The right to decent work is also an internationally recognized human right. A subset of economic, social and cultural rights, the right to work is enunciated in the 1948 Universal Declaration of Human Rights (UN, 1948), which states: 'Everyone has the right to work, to free choice of employment, to just and favourable conditions of work and to protection against unemployment.'

Despite these universally-recognized rights, there are 2.3 million work-related deaths annually. Work-related communicable diseases contribute to 17% of these deaths and, in that category, the main contributing and preventable factors comprised poor-quality drinking water, poor sanitation, poor hygiene and related lack of knowledge. These figures underscore the need for countries to accelerate efforts towards securing safe drinking water and sanitation for all, including in the workplace.

In September 2015, the international community adopted the Sustainable Development Goals (SDGs). Goal 6 aims to ensure the availability and sustainable management of water and sanitation for all, and Goal 8 addresses the promotion of sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. Water- and labour-related concerns are also of importance to several other SDG targets, notably Goal 1 on poverty and Goal 3 on health, and as such will be central to the realization of the SDGs.

Evidence from various economic sectors demonstrates the significant contribution women can make in formal positions at the highest levels, and qualitative analyses show that women's involvement in the management of water resources and water infrastructure can improve efficiency and increase outputs. Nevertheless, women continue to experience widespread discrimination and inequality in the workplace. In many parts of the world, women often occupy undervalued and low-paid jobs and still shoulder responsibility for most unpaid care work. A number of measures can be undertaken to improve women's participation in, and contribution to the water-related workforce, including: adopting equal opportunity policies and measures; improving sex-disaggregated workforce data sets; addressing cultural barriers, social norms and gender stereotypes; and expanding access to public services and investment in time- and labour-saving infrastructure.

Innovation

Innovation contributes to the continuous improvement of water management, with the related benefits to economic development and decent jobs. In addition to their potential efficiency, effectiveness, and performance improvements, innovations can have important implications for water-dependent and water sector employment opportunities in quantitative and qualitative terms. Innovation resulting from the shift towards a greener economy is changing the range of tasks associated with various jobs, as well as working conditions, due to new technologies, processes and practices. Innovation will change the number and nature of jobs and the required skill sets and competencies. Policy mechanisms need to be in place to draw on relevant research for capturing the job-creating opportunities in the field of water innovation and to ensure the required capacity for the generation and diffusion of water-related innovations.

Improving water efficiency and productivity

Both water-use efficiency and water productivity can contribute to improving socio-economic development and create opportunities for employment and decent jobs in water-dependent sectors, especially under conditions of water scarcity (where inadequate water supplies may impede development). New resource-efficient technologies as well as enhanced competitiveness and innovation are also generating shifts in employment and changes in the workforce worldwide.

Governments can create policy frameworks to enable, support and reward improvements in resource efficiency or productivity bringing increased competitiveness, resilience and security, and new sources of jobs and growth. By doing so, they can facilitate significant cost savings for different agents from improved efficiency and productivity, commercialization of innovations, and enhanced water management over the entire product life cycle. However, understanding and considering the trade-offs and synergies between water, energy, food, ecosystems and other issues at the proper scale is essential for wise management and to meet overall sustainability goals.

Opportunities for water source diversification

The increased demand for water in sites where the resource is scarce or where there is high competition for water creates the need for using so-called 'non-conventional sources' for water, such as low yielding wells and springs, rainwater, urban runoff, stormwater, and wastewater recycling. This will create jobs not only through technology development, but also because it enables new forms of small-scale intensive uses of water, such as cultivation of highly profitable crops in small plots, and but also in the operation and maintenance of treatment plants to reclaim water.

Provided that the health risks are adequately managed, wastewater (treated to 'fit-for-purpose' levels) offers opportunities for source diversification, especially in water scarce areas. It is estimated that between four million and 20 million hectares of land are irrigated with untreated wastewater. Not only does this practice provide livelihoods for farming families and those involved in marketing the products, but with its expected scaling up and

formalization, substantial job creation in this sector can also be expected.

Water source diversification will initially generate jobs at the research level, leading to new jobs being created for the operationalization, supervision, and maintenance and fine-tuning of smart systems. Beyond the jobs that water reuse will create within the water, agriculture and public health sectors, it is also likely to generate jobs in research, agricultural extension, produce marketing and the cultivation of non-food crops. These evolutions will require a different type of skill sets from workers and, consequently, stress the importance of capacity development and continuous professional development.

Addressing capacity development needs and improving dialogue

The skills, qualities and capacities of employed human resources are vital for the successful performance of the water sectors and for the sustained use, adaptation and development of scientific and technological innovations. This is particularly salient in view of the broadening fields of expertise that are needed for these sectors, which include water resources management, building and managing water infrastructure, and the provision of water-related services.

The lack of capacity and the challenges facing the water sectors require the design of adequate training tools and innovative learning approaches to enhance the competencies of staff as well as to strengthen institutional capacity. This applies to government and its agencies, river basin organizations as well as other groups including private sector organizations. Solutions to filling these gaps include: creating an enabling policy environment for collaborative frameworks between the education sector, sector employers (public, private, NGOs), trade unions and employees; developing incentives to attract and retain staff; strengthening technical and vocational training; and giving attention to human resources capacity development in rural areas. New and transversal skills also need to be instilled to respond to new needs.

Monitoring, assessment and reporting

Reliable and objective information concerning the state of water resources in terms of their quantity, quality and vulnerability at the local or basin level is often poor or lacking, as are specific metrics for water demand and use by different economic sectors. Globally, water observation and monitoring networks are in decline and improperly funded. Development of technology and increased use of remote sensing can help to fill gaps, but only to a point.

In terms of jobs and employment, few statistics reflect the current reality of work. They tend to simplify the core situation (often due to their objectives, measurement methods and conceptual frameworks), resulting in partial coverage, insufficient detail and an incomplete analysis of complex topics. One of the greatest challenges is gathering data and information concerning informal, part-time and/or unpaid work. Another challenge lies in identifying the level of 'water-dependence' of any given job.

Data from the World Input-Output Database (WIOD) could be analysed to derive evidence on how dependent the whole economy is on water supply and how many jobs are created when a government increases or improves water supply, estimating backwards and forwards linkages of water supply and related sectors to calculate total multiplier effects of potential investments in a given sector.

Policy responses

Critical relationships and essential linkages exist between the management of water and employment opportunities in countries at all levels of development. Sustainable water management, combined with access to safe and reliable supply of water and appropriate sanitation services, create an enabling environment for employment opportunities to develop and grow across economic sectors.

The political will to set and implement water-related policy objectives that mutually support sustainable development and job creation is essential. However, there is frequently a low level of appreciation of the high risks and serious impacts to which neglect of water issues can lead, often with catastrophic and extremely costly results. Improving knowledge and understanding, especially among politicians and policy-makers, of the pervasive role of water resources, infrastructure and services in the economy and in employment creation would enhance benefits in terms of generation of decent jobs, as well as serve the broader objectives of sustainable development.

Meeting these societal goals requires coherence and a shared vision, notably between water, energy, food, environmental, social and economic policies, ensuring that incentives are aligned for all stakeholders and that negative impacts are mitigated, for example in ensuring future employability of those displaced in sectors where employment may fall. In the coming years, governments and their partners will be required to develop and implement sustainable, integrated and mutually supportive water, employment and economic strategies in order to respond to the challenges arising from the risks and opportunities at the water and jobs nexus highlighted in this report.

It will be important for each country, according to its own resource base, potential and priorities to identify and promote specific and coherent strategies, plans and policies to achieve the right sectoral balance and generate the highest possible output of decent and productive jobs without compromising the sustainability of water resources and the environment. The international community is already showing the way, having set long-term goals for water, sanitation, decent work and sustainable development that offer an action framework for countries' development objectives.

The allocation of water resources and the provision of water services to different economic sectors will largely dictate the growth potential for high quality jobs at country and local levels. Focusing on the economic sectors that are most relevant for environmental sustainability and job creation will prove to be the ultimate key to success. Reaching these targets involves coherence and shared vision, notably between water, energy, food and environment policies, in order to ensure that incentives are aligned for the benefit of all stakeholders.

1

INTRODUCTION

WWAP | Marc Paquin
With contributions from Catherine Cosgrove and Katherine Manchester

Waterways for economic activity – Hamburg port (Germany)
Photo: © SergiyN/Shutterstock.com

This introduction frames the report by presenting the critical relationships between water, jobs and sustainable development of any country, underlining the importance that political and policy attention be paid to that nexus. The chapter also emphasizes the benefits of investing in water and jobs and avoiding costly inaction.

Water permeates all aspects of life on Earth. Like the air we breathe, water sustains human, animal and plant life. It provides vital services for human health, livelihoods and well-being and contributes to the sustainability of ecosystems.

Water is an essential component of our economies and required to create and maintain jobs in every sector of the economy: in the primary sector (e.g. agriculture, animal husbandry, inland fisheries, aquaculture, mining and extraction of other natural resources); in the secondary (e.g. heavy industry, processing of goods, electricity and fuel production); and in the services sectors (e.g. tourism and recreation) (UNDP, 2006; OECD, 2012a). Many of these sectors require large quantities of water at one or more stages of their value chain.

Half of the global workforce is employed in eight water and natural resource-dependent industries: agriculture, forestry, fisheries, energy, resource-intensive manufacturing, recycling, building and transport. Over a billion people are employed in the fisheries, agriculture and forestry sectors alone, the last two representing some of the sectors most threatened by freshwater disruptions (ILO, 2013a).

Sustainable water management in its broadest sense encompasses ecosystems protection and restoration, integrated water resources management (IWRM), as well as infrastructure development, operation and maintenance. Combined with access to a safe, reliable and affordable supply of water and adequate sanitation services, it creates an enabling environment for long-term employment opportunities, as well as development and growth across different economic sectors (UN-EMG, 2011; ILO, 2013a).

The basic provision of adequate water, sanitation and hygiene (WASH) services at home and in the workplace enables a robust economy by contributing to a healthy and productive population and workforce, with benefit-to-cost ratios as high as 7 to 1 for basic water and sanitation services in developing countries (OECD, 2011a and 2012a) (see also Chapter 11). Conversely, people who have the least access to water and sanitation are usually the most likely to have poor access to health care and stable jobs, thus feeding the cycle of poverty (UNEP, 2010 and 2012a). In this regard, equality gaps persist between urban and rural dwellers, across genders, and between the richest and poorest segments of the population (UNICEF/WHO, 2015).

> The shift to a sustainable, greener economy, in which the central role of water is fully recognized, leads to the creation of more jobs, an increase in the number of decent jobs and much greater social inclusion

1.1 Investing in water: A path to economic growth and jobs

While the dynamics of water, economic growth and employment are complex, and highly dependent upon specific physical, cultural, political and economic circumstances, sound public governance, together with public and private investment in water resources management and water infrastructure and services, can generate and support employment across all sectors of the economy. These opportunities range from full-time decent jobs[1] to more precarious informal ones – encompassing a wide range of skill sets (ILO, 2013a). When reinforced by appropriate measures governing working conditions, these can be decent jobs (ILO, 2007a). Furthermore, if they contribute to preserving or restoring a sustainable environment, these jobs will also support the greening of an economy (ILO 2013b; UNEP/ILO/IOE/ITUC, 2008; SIWI/WHO, 2005). In contrast, lack of good governance and failure to invest in water can lead to economic slowdown (ILO, 2012, 2014a).

[1] 'Decent jobs' or 'decent work' involve opportunities for work that is productive and delivers a fair income, security in the workplace and social protection for families. For a more detailed definition, see Chapter 3.1.

Indeed, the shift to a sustainable, greener economy, in which the central role of water is fully recognized, leads to the creation of more jobs, an increase in the number of decent jobs and much greater social inclusion (ILO, 2013a).

High returns for the economy and the environment are associated not only with investments in infrastructure – for water, agriculture and energy – but also with provision of services in these sectors (UNEP, 2012b). This includes employment in all water use sectors such as industry, energy, agriculture, tourism, recreation, research and development (R&D) and various public sector organizations, including municipalities, ministries, public research and management organizations as well as international organizations (UN-Water, 2014). 'While evidence is limited, it suggests that these jobs tend to be more qualified, safer and better paid than comparable jobs in the same or similar sectors' (ILO, 2013a, p. xiv). In addition, gains in eco-efficiency and access to new and growing markets can lead to higher profits, incomes and wages (ILO, 2013a).

In particular, infrastructure development for productive water uses (e.g. irrigation, hydropower and flood control) and investments made to upgrade, replace or decommission existing works create jobs (UN-Water, 2014).

In the irrigated agriculture sector, which represents 70% of freshwater withdrawals worldwide, the potential efficiency savings from increased water productivity could be as high as US$115 billion annually by 2030 (in 2011 prices). Moreover, the provision of more efficient water technologies to some 100 million poor farmers would generate an estimated direct total net benefit of US$100-200 billion (Dobbs, et al. 2011).

Investments in safe drinking water and sanitation have paved a path to economic growth. Such investments have high rates of return: for each US$1 invested, the World Health Organization (WHO) estimates returns of US$3-34, depending on the region and technology (WWAP, 2009). According to the United Nations Environment Programme (UNEP), investments in small-scale projects that provide access to safe water and basic sanitation in Africa could return an estimated overall economic gain of about US$28.4 billion a year, or around 5% of gross domestic product (GDP) (UNEP, n.d.). Another study found that in poor countries with better access to improved water and sanitation services, the annual economic growth rate reached 3.7%, while those without similar access to improved services had an annual growth of just 0.1% (WHO, 2001). In spite of obvious benefits, there are many areas worldwide that still suffer from underinvestment in such infrastructure.

The market potential of water and sanitation services, and related job creation, is expected to be significant in the coming decades. In Bangladesh, Benin and Cambodia alone, about 20 million people should gain access to rural piped water supplies by 2025, ten times the current number, representing a market worth US$90 million/year. On the sanitation side, a study in Bangladesh, Indonesia, Peru and Tanzania reveals a market potential for sanitation services of US$700 million annually (Sy et al., 2014).

1.2 A costly status quo

It is important to consider economic and thus employment losses that may result from the mismanagement or lack of investment in the water sectors. The high risks and serious negative impacts on economies, livelihoods and populations caused by neglect of water issues are frequently overlooked, often with catastrophic and extremely costly results. Unsustainable management of water and other environmental assets cause damage to economies and to society that have the potential to reverse global gains in poverty reduction, job creation and development (ILO, 2013a).

The cost of inaction may already be evident in government, corporate or household budgets. For instance, inaction results in heightened health spending as a result of water pollution, increased unemployment benefits for fishers or tourism operators and higher property insurance costs

around waterfront areas (OECD, 2008). For example, it is estimated that that the global annual cost of land degradation in irrigated areas could be between US$11 billion and US$27.3 billion due to decreased agricultural productivity, particularly from salinization (Quadir et al., 2014; Postel, 1999). Regionally, the World Bank estimates that degraded water quality costs Middle Eastern and North African countries between 0.5% and 2.5% of their annual GDP (World Bank, 2007a).

Socio-economic inequity and the effects of climate change are also exacerbating the impacts of disasters beyond societies' adaptation capacities and destroying livelihoods while intensifying inequalities. One looming cause of water disruption could be increased competition for water among uses and users. Global water demand is projected to increase greatly over the next several decades; at best, available resources will remain unchanged. This will put a direct strain on economic development, and indirectly through social unrest and unhealthy ecosystems. Decreasing water waste and increasing the productivity and efficiency of water use in agriculture, energy and industry will be paramount, with the added benefits of savings in production costs for businesses and reduced need for infrastructure expansion (UN-Water, 2014).

From 1992 to 2014, 'floods, droughts and storms … affected 4.2 billion people (95% of all people affected by disasters) and caused US$1.3 trillion worth of damage (63% of all damages)' (UN-Water, 2014, p. 9). It is estimated that Kenya's floods in 1997-1998 cost the equivalent of 11% of GDP, while the cost of its drought between 1998 and 2000 was equivalent to 16% of GDP (UN-Water, 2014). In the United States, Hurricane Katrina led to the loss of some 40,000 jobs in 2005, with African-American women the hardest hit; in Bangladesh, Cyclone Sidr disrupted several hundred thousand small businesses and adversely affected 567,000 jobs (ILO, 2013a). In many countries, droughts, floods and deforestation increase the unpaid time girls and women spend to retrieve water for household chores, leaving them less time for education or earning an income (ILO, 2013a; UNDP, 2014).

The sustainable management of water for economic growth and employment is not only a question of resource availability and money, but also a matter of sound policy frameworks and governance

Another growing concern is groundwater depletion, which may result from pricing schemes that inaccurately account for resource scarcity and the environmental impacts of abstraction, or water regimes that fail to incentivize sustained and equitable use. Globally, some 38% of irrigated areas depend on groundwater (Siebert et al., 2013), which has contributed to a ten-fold increase of groundwater abstraction for agricultural irrigation over the last 50 years. At the same time, almost half of the world's population depend on groundwater for drinking (Tushaar et al., 2007). Projected increased water demand, primarily from manufacturing, electricity and domestic use will generate further stress on water resources and possibly impact water allocation for irrigation (OECD, 2012a).

Estimates indicate that about 30% of global water abstraction is lost through leakage (Kingdom et al., 2006; Danilenko et al., 2014). Given the growth of urbanization and the rise of demand for water, improving the efficiency of water use and reducing leakages by maintaining and upgrading ageing infrastructures are critical. Once these measures are taken, they will generate jobs, most of which will require skilled employees.

Water management and development strategies play a central role in reducing the exposure and vulnerability of people and assets to such water-related extremes (UN-Water, 2014). Planning, preparedness and coordinated responses to mitigate the risks associated with natural water-related disasters have been shown to be particularly cost-effective, especially when combining structural and non-structural flood management approaches. In summary, 'well designed national

public employment programs using local resource-based work methods can have a large multiplier effect on vulnerable communities by combining the multiple objectives of employment generation, income support, asset creation and restoring the natural resource base' (UN-Water, 2014, p. 30). These economic benefits cannot be achieved without the sustainable management of the complete water cycle, from naturally available water resources, through its various uses and related services, to its ultimate return to the natural environment (OECD, 2012a; UN-EMG, 2011).

1.3 Water and jobs nexus

Water should be considered a fundamental driver of green growth (OECD, 2012b). The political will to set and implement water-related policy objectives that support sustainable development and job creation is essential (ILO, 2013a). Meeting these societal goals involves coherence and shared vision, notably between water, energy, food and environment policies to ensure that incentives are aligned for all stakeholders (OECD, 2012b). Studies have shown that any negative effect of environmental reforms (such as increased investment costs for upgrading and job losses in certain sectors) are offset by complementing environmental reform with labour market and social policies, and that its overall impact on employment is positive (ILO, 2013a).

The sustainable management of water for economic growth and employment is not only a question of resource availability and money, but also a matter of sound policy frameworks and governance, including the political, social, economic and administrative systems necessary to develop, manage and govern water resources, and the delivery of water services (Rogers and Hall, 2003; OECD, 2012b).

Water resources and the range of services they provide underpin economic growth, poverty reduction and environmental sustainability (UNEP, 2012a). As stated in The United Nations World Water Development Report (WWDR) 2015, 'addressing the challenges related to water requires changing the way we assess, manage and use our water resources. Progress calls for engaging a broad range of societal actors to take account of water in their decision-making processes and responses' (WWAP, 2015, p. 97).

Improved governance, technological innovation and capacity development for water productivity and management entail reforming institutions and building capacity of communities and individuals, including an adequate number of technicians and professional experts (UN-Water, 2014). Shortages of qualified workers are already hampering the shift to a greener economy in most countries and sectors (ILO, 2011a). This is also the case in the water services sector specifically, as discussed in Chapter 4. Strengthening water governance will require a concerted programme of education, knowledge and skills development, including a focus on youth and women (UN-Water, 2014).

Moreover, it should be emphasized that pursuant to the human right to water and sanitation, countries have an obligation to progressively provide safe drinking water and adequate sanitation services, including in the workplace. Countries also have the obligation to guarantee that the right to water is enjoyed without discrimination and equally between men and women.

Meeting this obligation will remove one of the major hurdles to women having the opportunity to go to school, obtain the appropriate education and training, and hold positions in the workplace, further adding to the economies' skilled human resource capacity. Clean, safe and readily available water in homes, schools and other training institutions is therefore another prerequisite to a healthy economy (OECD, 2011a). As such, investing in water is a winning proposition from economic, environmental and social standpoints.

A significant proportion of water-dependent jobs hinge on private initiative and sustained investment, and supported by predictable, reliable, secure and efficient water management, infrastructure and services. This requires long-term political commitment and planning engagement by and

on behalf of the community as a whole. Improved water resources management, WASH services, and wastewater management are prerequisites to enhanced employment opportunities and other related socio-economic benefits (UNEP, 2012b; OECD, 2012b).

Policies and strategies to support sufficient investments require mobilizing financing from a wide range of sources, which can include savings from cost reductions (from efficiency gains or cheaper service options), increasing tariffs, taxes and transfers and mobilizing loans (from market or public sources). Innovation in regulatory approaches and standards may be necessary to allow payments for ecosystem services (PES) or to ensure that polluters internalize the costs of pollution (UNEP, 2010; OECD, 2012b).

Funding for water infrastructure and services continues to come primarily from the public sector, which performs such vital functions as water rights allocation, price setting, systems maintenance, service delivery, and infrastructure and capacity investments. While privatizing government services is often linked with cost savings, research on such reforms is incomplete, and the results are mixed. In the case of Uruguay, a study shows that privatizing water services had little effect on access to sanitation, whereas the subsequent nationalization increased access for poor households and also improved the water quality (Borraz et al., 2013). The best-fit scenario is likely to be highly situational, and requires careful analysis of service costs, transaction costs and policy environment, including the competition aspect (Bel et al., 2008).

Increasing water scarcity presents not only a substantial risk, but in some cases also an opportunity for the private sector to stand out by investing in water efficiency innovation. By one estimate, improving water productivity to close the worldwide gap between supply and demand for water will cost US$50-60 billion annually over the next 20 years. With private sector investment comprising about half of that spending, positive returns could be expected in just three years (Boccaletti et al., 2009).

International institutions such as the World Bank continue to promote the value of public-private partnerships (PPPs), but stress the importance of considering countries' legal frameworks around the regulation of water tariffs and regulatory risks (World Bank, 2015). A 2010 World Bank review of PPPs in developing countries emphasized the importance of using private operators to improve efficiency and quality of service, rather than simply as a source of financing (World Bank, 2010). Importantly, the review found several PPPs involved substantial layoffs, particularly in Latin America, but that this was often due to over-staffing; several PPP arrangements were not associated with significant reductions in employees. In turn, private sector involvement can generate significant transfers of technology and know-how to the benefit of public utilities and users.

2

THE GLOBAL PERSPECTIVE ON WATER

River delta in Queensland (Australia)
Photo: © iStock.com/wosabi

This chapter provides an overview of the current state of the world's freshwater resources and how these are expected to evolve over the short and medium term as a function of external driving forces, with a special focus on climate change and ecosystem health.

2.1 State of freshwater resources

WWAP | Richard Connor
With contributions from Karen Frenken (FAO)

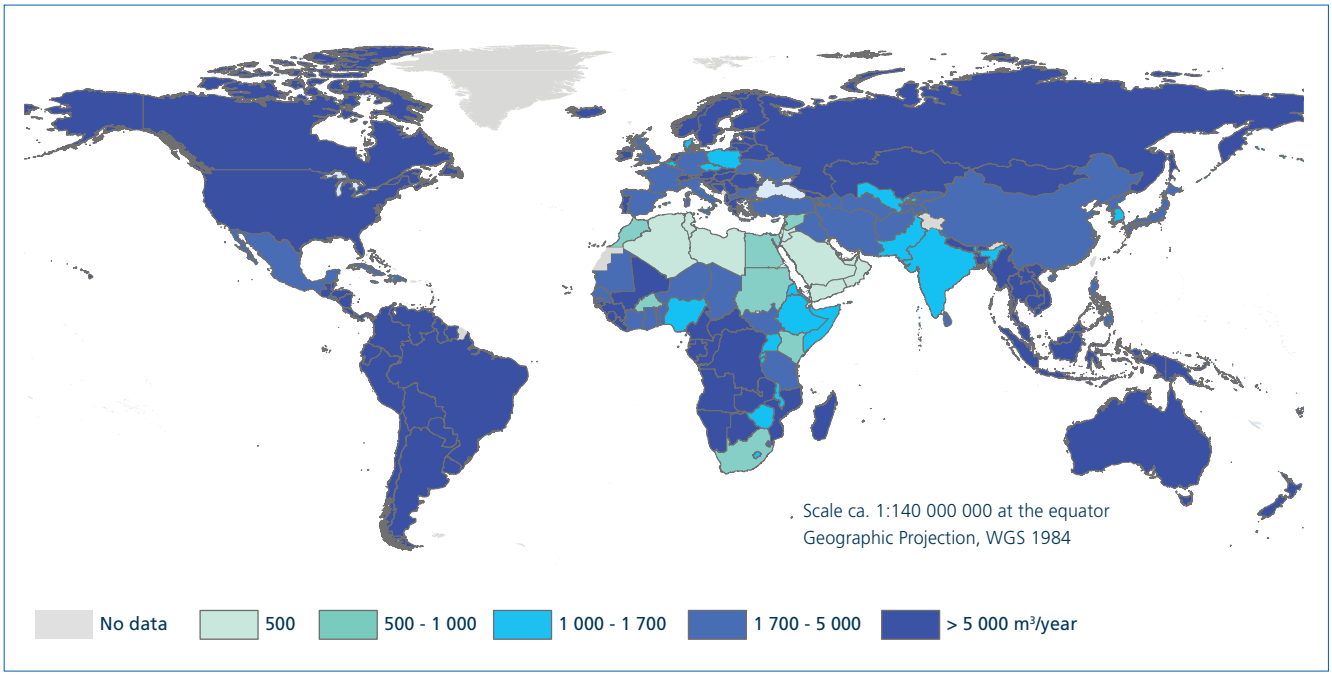
The world's freshwater resources are renewed through a continuous cycle of evaporation, precipitation and runoff – commonly referred to as the water cycle – that dictates their distribution and availability over time and space.

There are different ways of defining and measuring water scarcity and/or water stress. The best-known indicator of national water scarcity is per capita renewable water per year, where threshold values are used to distinguish between different levels of water stress (Falkenmark and Widstrand, 1992). An area or country is under regular water stress when renewable water supplies drop below 1,700 m^3 per capita per year. Populations face chronic water scarcity when water supplies drop below 1,000 m^3 per capita per year and absolute scarcity below 500 m^3 per capita per year. Using these thresholds, significant disparities exist between countries (Figure 2.1).

This crude approach to measuring water scarcity was primarily based on estimates of the number of people that can reasonably live with a certain unit of water resources (Falkenmark, 1984; FAO, 2012). Although useful, it oversimplifies the water situation of specific countries, ignoring local factors determining access to water, as well as the feasibility of solutions in different locations, among others (FAO, 2012).

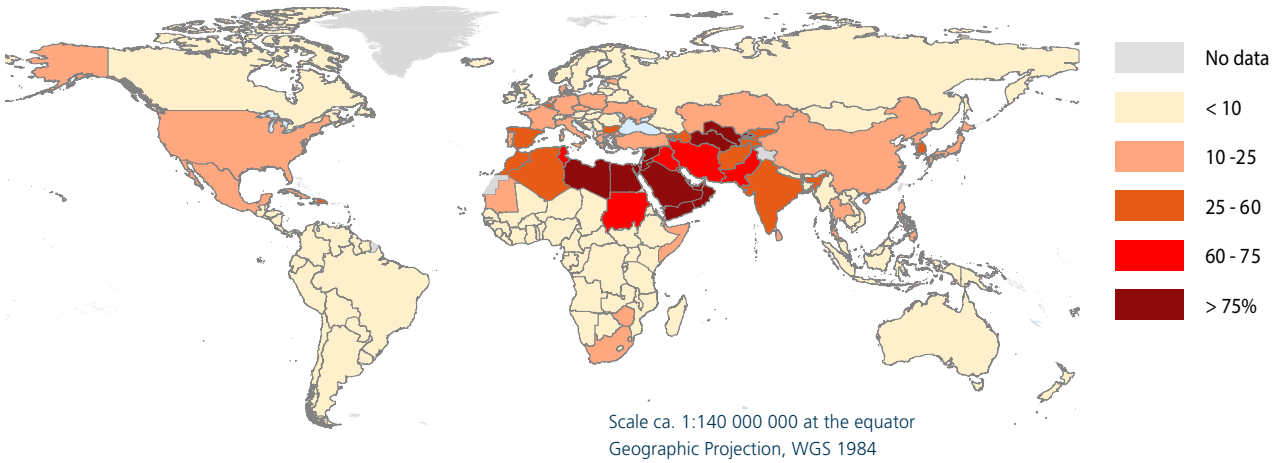
In an attempt to better capture the relation between supply and demand, the Millennium Development Goal (MDG) Water Indicator purports to measure the level of human pressure on water resources, based on the ratio between water withdrawal by agriculture, municipalities and industries over total renewable water resources (UNSD, n.d.) (see Figure 2.2). The higher the ratio-of-use to available water, the higher the stress on the supply system and the more difficult it will be to meet increasing demands.

FIGURE 2.1 TOTAL RENEWABLE WATER RESOURCES (CUBIC METRES PER CAPITA PER YEAR), 2014



Source: FAO (2015a, http://www.fao.org/nr/water/aquastat/maps/TRWR.Cap_eng.pdf).

FIGURE 2.2 PERCENTAGE OF RENEWABLE WATER RESOURCES WITHDRAWN

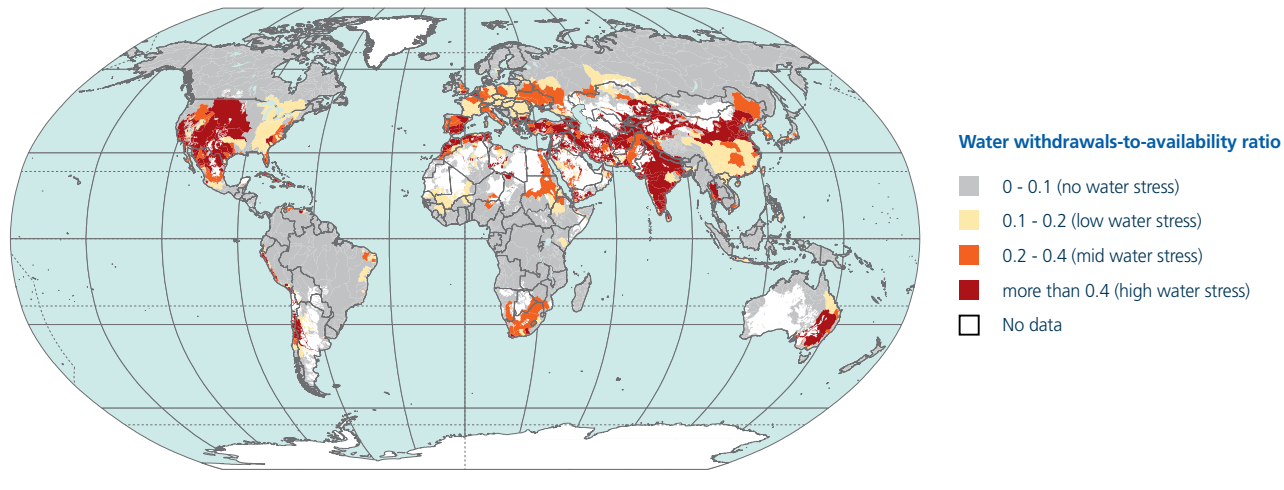


Source: FAO (2015a, http://www.fao.org/nr/water/aquastat/maps/MDG_eng.pdf).

A problem with national-level information is that for some larger countries, averaging water availability over their entire territory masks in-country variability; Australia, China and the United States provide prime examples. Another problem is the transboundary nature of water.

In addition to showing how water stress levels can vary significantly within larger countries, the basin-level analysis shown in Figure 2.3 also demonstrates the transboundary nature of water resources.

FIGURE 2.3 ANNUAL AVERAGE WATER STRESS BASED ON THE WITHDRAWALS-TO-AVAILABILITY RATIO (1981-2010)

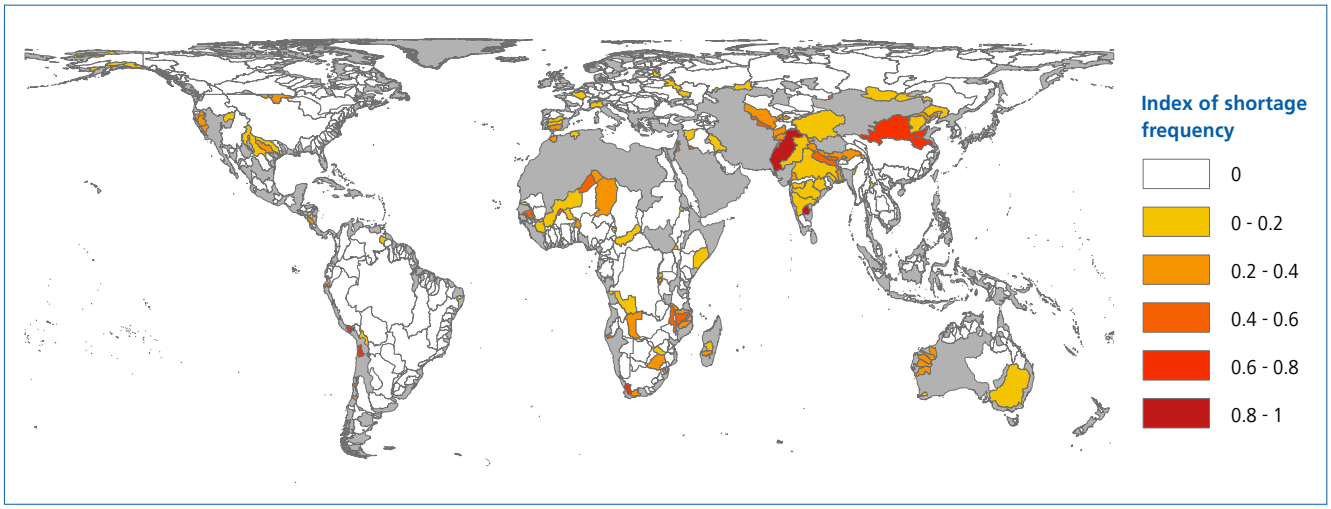


Note: Baseline water stress measures the ratio of total annual water withdrawals to total available annual renewable supply, accounting for upstream consumptive use. Higher values indicate more competition among users.

Source: Center for Environmental Systems Research, University of Kassel (Generated in December 2014 using WaterGAP3 model), based on Alcamo et al. (2007).

Variability in water availability over time can also be significant. Some areas of the planet experience dramatic changes in water availability over months, creating seasonal variation in supply and demand over wet and dry seasons. This seasonal variability, and the water stress that result from dry periods, can be masked by annual averages of water availability. Figure 2.4 illustrates the results of an aggregate model of water scarcity that operates on a monthly basis for every large river basin globally, taking into account the seasonal variation in supply and demand, and the buffering effect that storage provides (Sadoff et al., 2015).

FIGURE 2.4 INDEX OF FREQUENCY OF SHORTAGES OF WATER AVAILABLE FOR USE ON A MONTH-TO-MONTH BASIS



Note: The index shows how frequently reservoir levels are predicted to fall below 20% of the total storage, which the authors have taken as being the storage level at which, on average, restrictions on water use may be applied. Their analysis tracked whether there is enough water available from rivers, groundwater or reservoirs on a monthly basis to satisfy existing water use patterns.

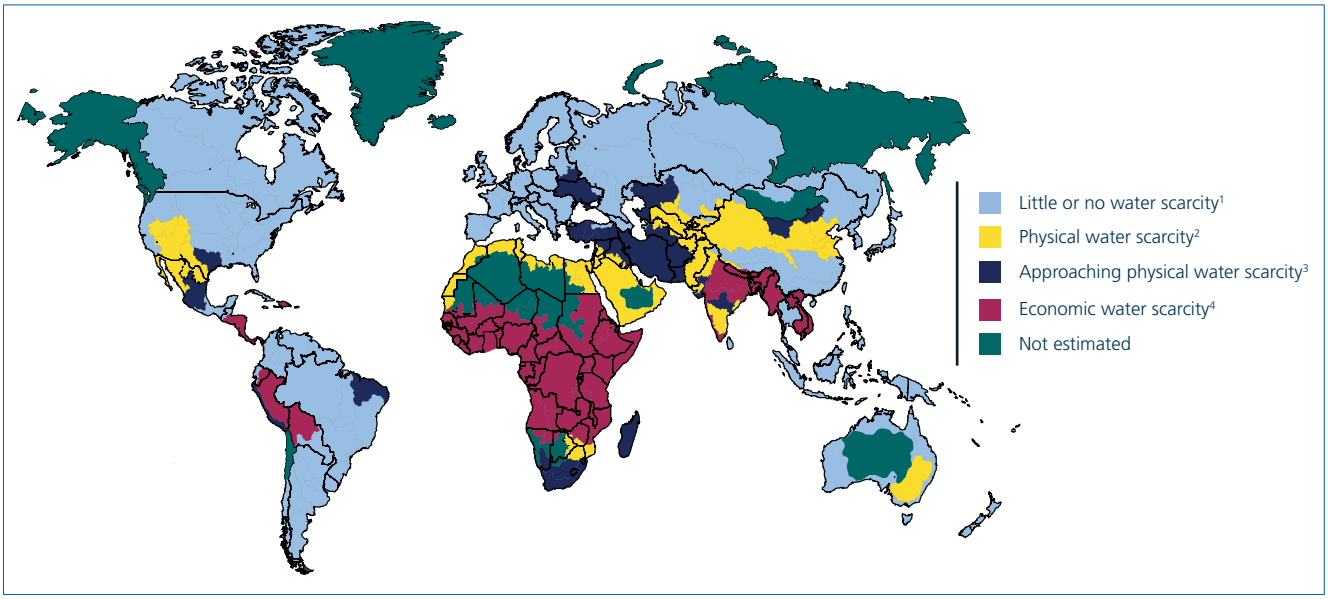
Source: Sadoff et al. (2015, Fig. 8, p. 77).

Water scarcity emerges from a combination of hydrological variability and high human use, which may in part be mitigated by storage infrastructure. According to Figure 2.4, while the risks of monthly water shortages are most severe in South Asia and northern China, some significant risks of seasonal water scarcity appear on all continents. However, since this analysis is based on river basins, it does not address the most arid parts of the world, such as North Africa and the Arabian Peninsula, through which no rivers flow (Sadoff et al., 2015).

Since the water cycle is principally driven by climate, increasing variability in precipitation and evaporation patterns due to climate change are expected to exacerbate spatial and temporal variations in water supply and demand (see Section 2.3).

The indicators described above refer to physical water stress and scarcity. However, low physical water stress does not automatically ensure ready access to water resources and water-related services. Water scarcity is the result of multiple causes, where three dimensions of water scarcity can be considered: (1) physical water scarcity (as above); (2) economic water scarcity, due to a lack of infrastructure because of financial or technical constraints, irrespective of the level of water resources; (3) institutional water scarcity, due to the failure of institutions in place to ensure reliable, secure and equitable supply of water to users (FAO, 2012). Figure 2.5 illustrates the global distribution of physical and economic water scarcity.

FIGURE 2.5 GLOBAL PHYSICAL AND ECONOMIC WATER SCARCITY



Notes:

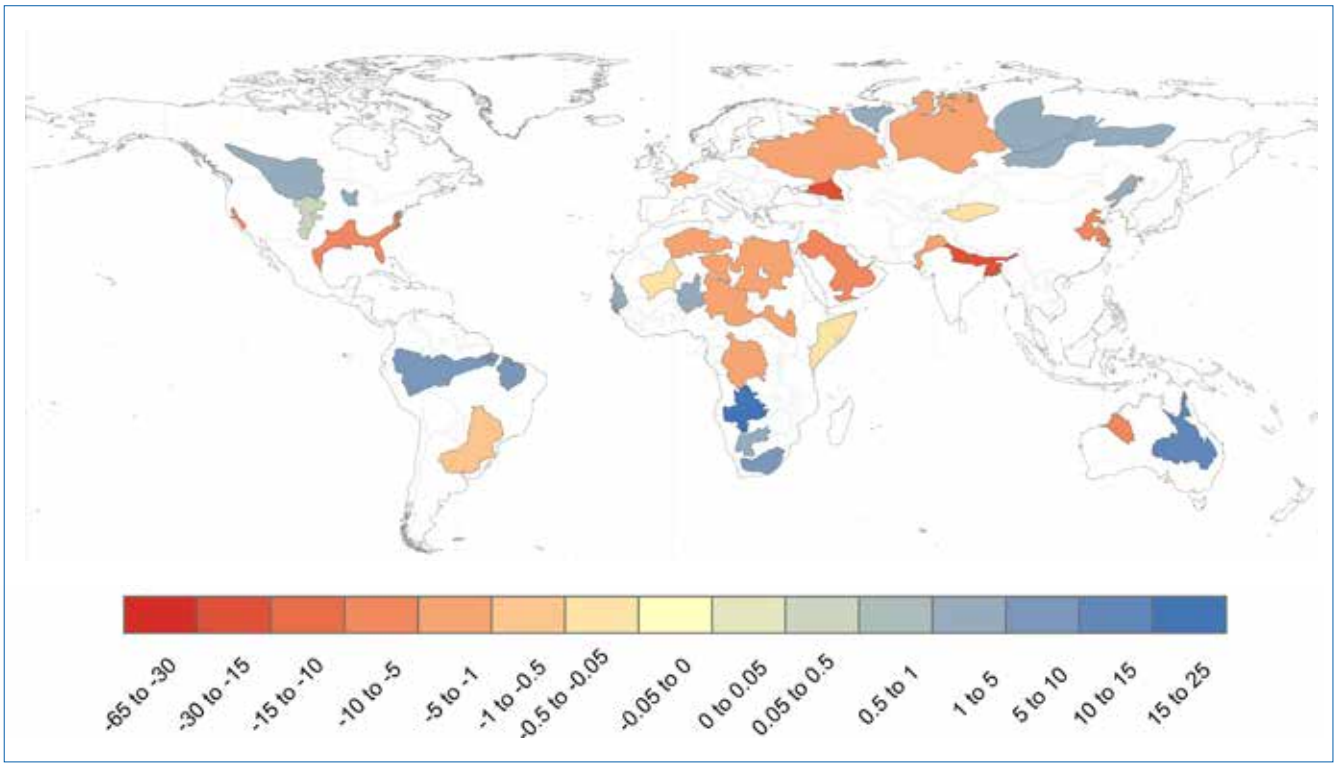
[1] Little or no water scarcity. Abundant water resources relative to use, with less than 25% of water from rivers withdrawn for human purposes.
[2] Physical water scarcity (water resources development is approaching or has exceeded sustainable limits). More than 75% of river flows are withdrawn for agriculture, industry, and domestic purposes (accounting for recycling of return flows). This definition – relating water availability to water demand – implies that dry areas are not necessarily water scarce.
[3] Approaching physical water scarcity. More than 60% of river flows are withdrawn. These basins will experience physical water scarcity in the near future.
[4] Economic water scarcity (human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands). Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.

Source: CAWMA (2007, Map 2.1, p. 63), reproduced with permission from the International Water Management Institute (IWMI).

To summarize, some basins and countries receive relatively abundant amounts of water over an entire year (Figures 2.1, 2.2 and 2.3). However, in some areas, rainfall can be highly concentrated during a particular wet season. Conversely, rainfall can be scarce in prolonged dry seasons that last many months (Figure 2.4). Unless there is sufficient human-made and natural infrastructure to manage and store the water that arrives during the wet season, parts of a country can remain arid for extended periods. This is precisely the case in many of the areas categorized under economic scarcity in Figure 2.5. The notion of economic scarcity in Figure 2.5 is not only due to a lack of available funding for infrastructure. It also reflects the need to build human and institutional capacity and/or legal and regulatory frameworks in order to ensure good governance in water resources management, described above as a third type of water scarcity, institutional water scarcity (see Chapters 12 and 18).

When withdrawn sustainably and recharged during periods of abundant surface water supplies, groundwater can provide opportunities for storage that can act as a buffer to compensate for times of drought (WWAP, 2012). However, this does not apply to fossil groundwater, a resource that can be several thousands of years old and is not naturally replenished. Groundwater resources are abundant in many parts of the world, but there is clear evidence that supplies are diminishing. An estimated 21 of the world's 37 largest aquifers are severely over-exploited in locations, from China and India to France and the United States (Figure 2.6). Globally, the rate of groundwater abstraction is increasing by 1% to 2% per year (WWAP, 2012). The areas under the most severe groundwater stress are in many of the same places where surface water is severely stressed.

FIGURE 2.6 GRACE*-DERIVED GROUNDWATER STORAGE ANOMALIES IN MILLIMETRES PER YEAR (AS AVERAGED OVER THE 2003-2013 BASE PERIOD)



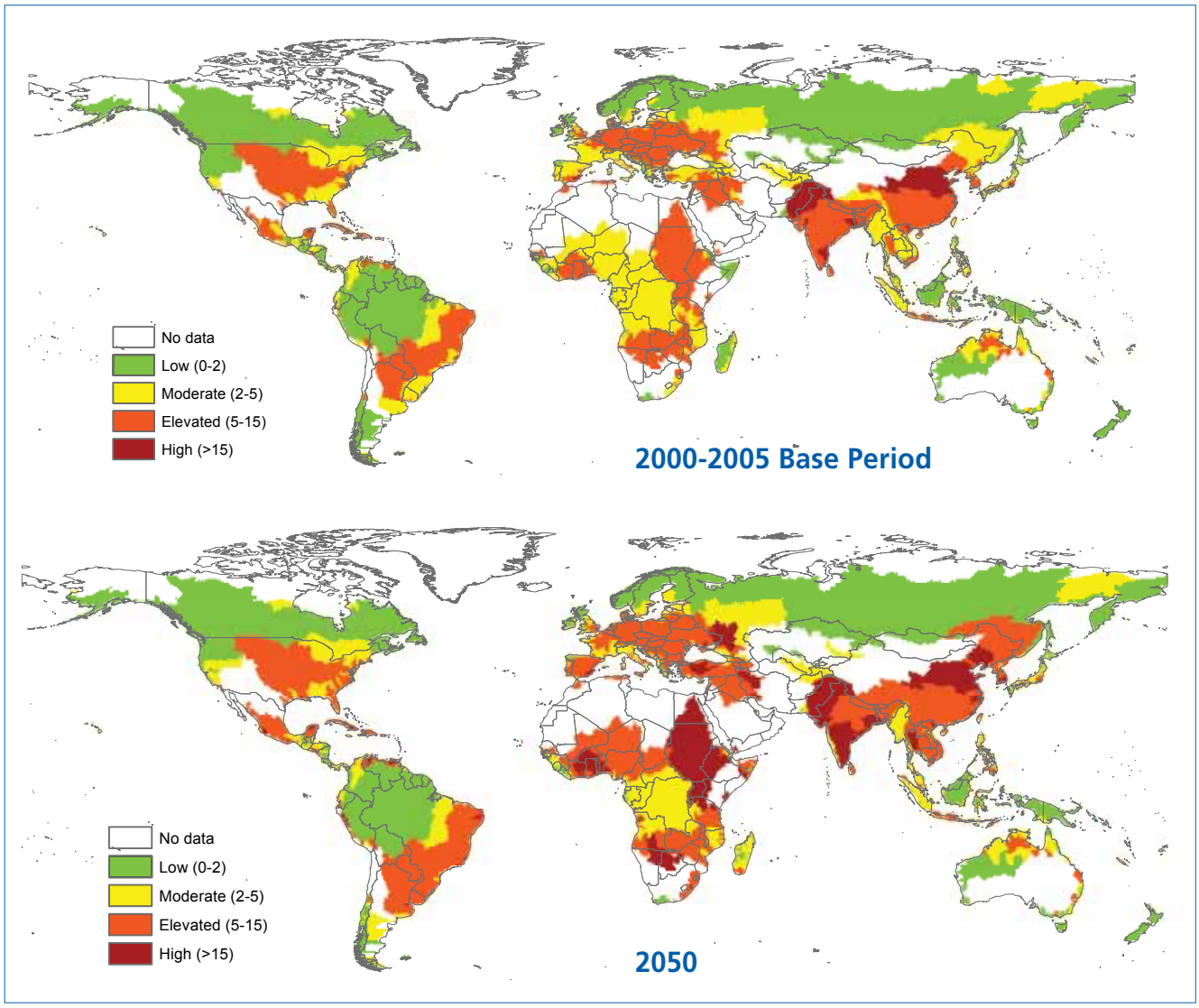
* NASA's Gravity Recovery and Climate Experiment (GRACE) satellites.

Source: Richey et al. (2015, Fig. 6b, p. 5228).

Water availability is also highly dependent on water quality. Poor quality water may not be fit for different uses and the cost of treatment may be prohibitive, thus compounding the burden of economic water scarcity. According to a recent study by Veolia and the International Food Policy Research Institute IFPRI (2015, p. 3): 'Water quality deterioration is projected to rapidly increase over the next several decades which, in turn, will increase risks to human health, economic development and ecosystems.' Industrial production, mining and untreated urban runoff and wastewater generate a wide range of chemical pollutants and pathogenic contaminants that tend to increase with unsustainable urban and industrial development. Nutrient loads from intensive use of fertilizers in agriculture (nitrogen, phosphorous and potassium), which are expected to increase through 2050 (Figure 2.7), contribute to the eutrophication of freshwater and coastal marine ecosystems.

It is estimated that the number of people living in environments with high water quality risks due to excessive biochemical oxygen demand (BOD) will affect one-fifth of the global population in 2050, while people facing risks from excessive nitrogen and phosphorous will increase to one-third of the global population over the same period (Veolia and IFPRI, 2015). As shown in Figure 2.7, projected changes in water quality risks vary at country and basin levels. The greatest increases in exposure to pollutants are expected to occur in low- and lower-middle income countries, primarily because of higher population and economic growth within these countries, especially those in Africa. Given the transboundary nature of most river basins, regional cooperation will be critical to addressing projected water quality challenges.

FIGURE 2.7 WATER QUALITY RISK INDICES FOR MAJOR RIVER BASINS DURING BASE PERIOD (2000-2005) COMPARED TO 2050 (N INDEX UNDER THE CSIRO*-MEDIUM SCENARIO**)



* Commonwealth Scientific and Industrial Research Organization

** This scenario takes into account a drier future (as projected by the CSIRO climate change model) and a medium level of socio-economic growth.

Source: Veolia and IFPRI (2015, Fig. 3, p. 9).

2.2 Increasing pressures and growing demand

WWAP | Richard Connor and Marc Paquin
With contributions from Karen Frenken (FAO) and Catherine Cosgrove

Between 2011 and 2050, the world population is expected to increase by 33%, growing from seven billion to 9.3 billion (UN DESA, 2011), and food demand will rise by 60% in the same period (Alexandratos and Bruinsma, 2012). Furthermore, it is projected that populations living in urban areas will almost double, from 3.6 billion in 2011 to 6.3 billion in 2050 (UN DESA, 2011).

Population dynamics and an ever-increasing global standard of living are driving production and consumption of goods and services to meet the escalating needs of a growing and richer population. Market demand for water-intensive products, such as

meat, tends to increase with economic development, thus dramatically raising the water demand from agriculture. The growth in energy demand, which is also water-intensive, is also expected to surge. Moreover, population growth amplifies the challenge of providing water and food to many more people and generating enough decent jobs, which in turn depend on economic development (UNEP, 2011a).

An estimated 663 million people lack ready access to improved[2] sources of drinking water, while the number of people without reliable access to water of good enough quality to be safe for human consumption is at least 1.8 billion (UNICEF/WHO, 2015), and possibly significantly more. More than one-third of the global population – some 2.4 billion people – do not use improved sanitation facilities; of these, one billion people still practice open defecation (UNICEF/WHO, 2015).

Water use (withdrawals and consumption)[3] by different sectors is generally based on estimates, rather than actual measurements. These estimates indicate that freshwater withdrawals increased globally by about 1% per year between 1987 and 2000 (FAO, 2015a), and available evidence suggests a slightly lower growth rate (0.6%) over the past 15 years. The growth rate over the 20th century is estimated at about 1.9% per year, with the highest growth rate of 2.5% per year between 1950 and 1980 (Shiklomanov, 1997). In much of the world's most highly developed countries, freshwater withdrawals have stabilized or slightly declined, due in part to a combination of improved water-use efficiency and increased importation of water intensive products, including food. It can therefore be deduced that the current increase in water use is occurring mainly in developing countries.

Regardless of the magnitude of future global, and more importantly local, water deficits, water scarcity is likely to limit opportunities for economic growth and the creation of decent jobs in the coming decades

Agriculture accounts for roughly 70% of total freshwater withdrawals globally and for over 90% in the majority of Least Developed Countries (LDCs) (FAO, 2011a). Developed countries generally withdraw less for agriculture and more for energy production and large industry, which account for 15% and 5% of global withdrawals, respectively. Fulfilling the water-related needs of households (for drinking water, sanitation, hygiene, cleaning, etc.), institutions (e.g. schools and hospitals) and most small- and medium-sized industries, municipal systems account for the remaining 10% of global freshwater withdrawals (WWAP, 2012).[4]

Without improved efficiency measures, agricultural water consumption is expected to increase by about 20% globally by 2050 (WWAP, 2012). Domestic and industrial water demands are also expected to rise, particularly in cities and countries undergoing rapid economic growth. Water demand for energy, and electricity generation in particular, will also grow significantly (WWAP, 2014), as energy demand is expected to grow by more than one-third in the period 2010-2035, with 90% occurring in non-OECD (Organisation for Economic Co-operation and Development) countries (IEA, 2012a).

The OECD's 2012 Global Environmental Outlook's Baseline Scenario (OECD, 2012a)[5] projects increasing strains on freshwater availability through 2050, with an additional 2.3 billion people (over 40% of the global population) expected to be living in

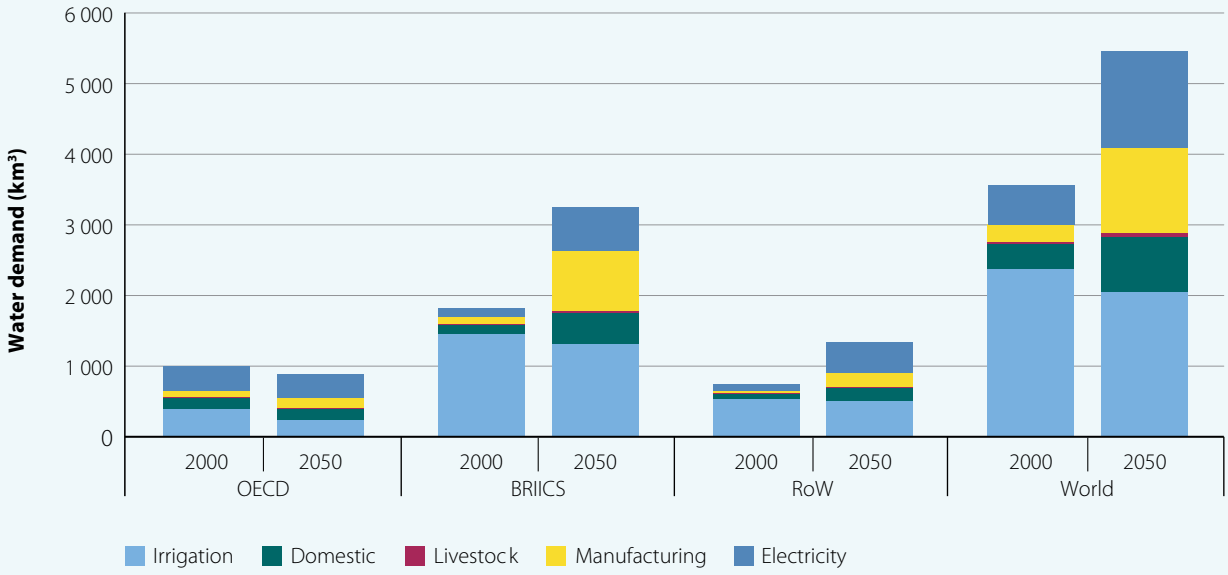
[2] An 'improved water source' is defined as one where human use is kept separate from use by animals and faecal contamination. However, water from an 'improved source' is not necessarily free of bacteria or other contamination and is not necessarily safe.

[3] Withdrawal is the total amount of water taken from a lake, river or aquifer for any purpose. Consumption is the fraction of withdrawn water that is lost in transmission, evaporation, absorption or chemical transformation, or otherwise made unavailable for other purposes as a result of human use.

[4] For a detailed description of water use by sector, see WWAP, 2012.

[5] The OECD's Baseline Scenario is a business-as-usual scenario that assumes linear growth rates in water demand trends and the absence of new policies that would affect these growth trends

FIGURE 2.8 GLOBAL WATER DEMAND (FRESHWATER WITHDRAWALS): BASELINE SCENARIO, 2000 AND 2050



Note: BRIICS (Brazil, Russia, India, Indonesia, China, South Africa); OECD (Organisation for Economic Co-operation and Development); RoW (rest of world). This figure only measures 'blue water' demand and does not consider rainfed agriculture.

Source: OECD (2012a, Fig. 5.4, p. 217).

areas with severe water stress, especially in North and South Africa and South and Central Asia. As shown in Figure 2.7, global water demand (in terms of freshwater withdrawal) is projected to increase by some 55% due to growing demands from manufacturing (400%), thermal electricity generation (140%) and domestic use (130%). Another report predicts the world could face a 40% global water deficit by 2030 under a business-as-usual (BAU) scenario (2030 WRG, 2009). As described above in Section 2.1, a number of countries and basins already face severe water deficits.

While the OECD projects a global decrease in future water withdrawals for irrigation, the Food and Agriculture Organization of the United Nations (FAO) (FAO, 2011a) estimates a 5.5% increase in irrigation water withdrawals from 2008 to 2050. Although OECD and FAO estimate are not necessarily contradictory – provided irrigation efficiency enables a larger proportion of water withdrawn to be consumed by crops in the field – they do, however, highlight the challenge of quantifying projected global water demand and associated water stresses.

Despite improved modelling and computing capacity, quantifying potential increases in water demand and resulting water deficits is extremely difficult due to uncertainties concerning future bio-physical, climatic, economic and socio-political conditions (WWAP, 2012). This is particularly true for rapidly evolving sectors such as industry and energy, and for smaller countries that experience high levels of seasonal and year-to-year variability in water availability. A review of 13 Water Demand Projections by Amarasinghe and Smakhtin (2014) concluded that current average per capita domestic water withdrawal already exceeds projections made by BAU scenarios for 2025 developed in the early 2000s.

Regardless of the magnitude of future global, and more importantly local, water deficits, water scarcity is likely to limit opportunities for economic growth and the creation of decent jobs in the coming decades.

2.3 Climate change and extreme events

UNESCO-IHP, WMO and IAHS | Wouter Buytaert, Anil Mishra, Siegfried Demuth and Blanca Jiménez Cisneros (UNESCO-IHP); Bruce Stewart and Claudio Caponi (WMO); and Christophe Cudennec (IAHS)

Climate change exacerbates multiple threats to water availability and may increase the frequency, intensity and severity of extreme weather events. There is high agreement among scientists that climate change will alter stream flow regimes, deteriorate water quality, and change spatial and temporal patterns of precipitation and water availability (IPCC, 2014). Furthermore, the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment projects that for each degree of global warming, approximately 7% of the global population will be exposed to a decrease of renewable water resources of at least 20% (Döll et al., 2014; Schewe et al., 2014). This will put an increasing portion of the global population under risk of water scarcity. Although the geography of these changes is highly variable and uncertain, regions that are currently arid and semi-arid are expected to be most vulnerable to increased drought risk.

Dry subtropical regions are specific hotspots for a significant reduction in renewable surface water and groundwater resources. More locally, hydrogeomorphological settings currently under water stress or overexploitation will, with increasing demography, become more vulnerable to drought, such as coastal plains, deltas, islands or high altitude areas.

Reduced water availability will intensify competition for water among users, including agriculture, ecosystem maintenance, settlements, industry (including tourism) and energy production. This will affect regional water, energy and food security, and potentially geopolitical security. Regions that have been identified as vulnerable to increasing water stress include the Mediterranean, parts of South America, Western Australia, China and sub-Saharan Africa.

Historic evidence shows changes in flood magnitude and frequency due to anthropogenic climate change. Moreover, future projections suggest that flood hazards will intensify, particularly in parts of South, Southeast and Northeast Asia, as well as tropical Africa and South America. Increased exposure and vulnerability of burgeoning populations will exacerbate socio-economic losses.

The potential impact of climate change on economic activity and the job market could be severe

The potential impact of climate change on economic activity and the job market could be severe. While climate change is creating an industry of its own in mitigation and adaptation, its effects will inevitably lead to loss of jobs in certain sectors. A proactive approach to adaptation via employment policies may enable offsetting some of these losses. An optimal use of these opportunities will require flexible infrastructure approaches, greater mobility of workforces, and capacity building and training across all levels, especially in LDCs.

Many of the world's developing economies are located in hotspots of water-related stress, in particular in Africa, Asia and the Middle East. Worldwide, the cost of water insecurity to the irrigation sector is estimated at US$94 billion per year, and the total cost of water insecurity to the global economy at US$500 billion annually (Sadoff et al., 2015). Including environmental impacts, this figure may rise to 1% of global GDP (Sadoff et al., 2015). Worldwide flood damage amounted to over US$50 billion in 2013 and is increasing (Guha-Sapir et al., 2014). The impacts of climate change are expected to lead to substantial unemployment across the global economy through employment cuts, and may amount to a reduction of 2% of jobs by 2020 (Jochem et al, 2009).

By far the most vulnerable economic sector is agriculture, which is globally one of the biggest in terms of workers and still drives economic development in many emerging economies. On a global scale, the impact of climate change on the growing conditions of major crops, such as wheat, maize and rice, are predominantly negative (IPCC, 2014). Even though positive impacts of climate change may occur locally, smallholder

Flooding in Steyr (Austria)
Photo: © Lisa S./Shutterstock.com

farmers in many emerging economies do not have the necessary capacity to flexibly adapt to these opportunities. Additionally, the increasing stress on water resources may inhibit adaptation efforts that rely on increased irrigation or at least maintaining current levels of irrigation. In those regions, a failure to adapt may have dramatic consequences for local employment, with potential follow-on effects to trade and migration.

Many water supply systems still incur large losses and inefficiencies. Even in developed countries the loss in water supply systems can be higher than 30%, with cities such as London reaching 25% (Thames London, 2014) and Norway 32% (Statistics Norway, 2015). Urban water supply systems are prone to leakage and spills, and irrigation practices are often dominated by low technology and inefficient methods such as basin and furrow irrigation. However, short- and medium-term adaptation activities could create jobs in the infrastructure sector. Adaptation policies should, therefore, focus on mobilizing the financial resources to accelerate improved infrastructure design and development. The construction and upgrade of flood defence schemes is essential to protect the most vulnerable, as well as the economic, social and cultural assets that are at risk. In some instances, it may be necessary to give consideration to additional catchment storage to protect against increasing intensity and frequency of droughts.

In the longer term, climate change will affect the biogeography and potential of agriculture in many regions. Inevitably, these changes will occur in a context of multiple other pressures, such as land use change, environmental degradation and economic development. Adapting to these interdependent changes will require a combination of scientific, engineering, economic and sociological knowledge and skills. But because of the inherent uncertainty in these changes, it will also be necessary to adopt flexible, 'no-regret' strategies. This will require moving away from hard infrastructure-based solutions to more intelligent and adaptive solutions, including green and multi-purpose infrastructure.

For instance, green roofs, wetlands, landscape features and intelligently managed sluices have the potential to provide increased buffering and storage capacity, and to increase the societal benefits well as the adaptive capacity of water resources and risk management. The design and implementation of such solutions will create jobs, with additional jobs for those systems that need continuous and proactive operation. Intelligent monitoring and control systems will be needed to guide the operation and maintenance of such structures. The development, implementation and operation of these systems also provide great opportunities for job creation. Even at present, it is estimated that already around 5% of all jobs in England are in the 'green space' sector (including public parks departments, nature reserves, botanical/zoological gardens, landscape services and architectural services) (Gore et al., 2013).

Together with novel infrastructure design, there is a need for the development, establishment and operation of new systems and approaches for monitoring, predicting, early warning, and risk assessment and management. Early warning systems improve preparedness and support response and recovery where impacts cannot be avoided. Improved risk assessment strategies, such as the development of weather-index-based agricultural insurance products (IFAD/WFP, 2011), allow for better mitigation of losses, optimization of supply chain resilience and a circular economy, among others. In particular, the Sendai Framework for Disaster Risk Reduction (2015-2030) calls for relevant UN agencies to strengthen existing and implement new global mechanisms to raise awareness and improve

understanding of water-related disaster risks and their impact on society, and to advance strategies for disaster risk reduction (UNISDR, 2015). These strategies would shift the way water resources are managed, especially in the context of high-impact and record-setting extremes in floods and droughts. Preparatory actions are required to decrease exposure to disaster risk and vulnerability when hazards occur and to increase societal resiliency when disaster strikes.

2.4 Ecosystem health

UNEP | Eric Hoa and Birguy Lamizana

Ecosystem health relies on environmental flows that ensure the sustainable and equitable distribution of and access to water and related ecosystem services. The quality, quantity and timing of water flows are essential to maintaining the functions, processes and resilience of aquatic ecosystems on which livelihoods and economic opportunities depend. A special case is ecosystems whose services are directly dependent on the groundwater system.

Since the 1990s, water pollution has worsened in almost all rivers in Latin America, Africa and Asia. The main causes include increases in untreated wastewater loadings to freshwater bodies (rivers and lakes) and unsustainable land use practices which enhance erosion and lead to increased nutrient and sediment loadings. This trend is driven by population growth, urbanization and the related increasing number of small-scale industrial and agricultural structures that are not always well-managed and generate untreated wastewater. In 2010, severe organic pollution (with monthly in-stream concentrations of BOD above 8 mg/L) is estimated to affect 6% to 10% of Latin American river stretches, 7% to 15% of African river stretches and 11% to 17% of Asian river stretches (UNEP, forthcoming).

The populations directly affected by organic pollution include poor rural people, who mainly rely on freshwater fish for protein, and low-income fishers and workers who depend on the freshwater fishery for their livelihoods. Inland capture fisheries are indeed an important source of livelihood in developing countries, providing employment for 21 million fishers (FAO, 2014a), as well as 38.5 million jobs in post-catch processing and other related activities (World Bank, 2012). Most activities take place in small-scale fisheries, with over half of the total workforce being women.

Although water pollution is serious and worsening in Latin America, Africa and Asia, there are great opportunities for reversing the trend. This entails taking action to mitigate further pollution, restore the degraded ecosystems (with rehabilitation measures such as reforestation) and adopt a holistic approach towards wastewater management. The latter includes the implementation of conventional and unconventional wastewater treatment schemes and the consideration of wastewater reuse (e.g. for irrigation and aquaculture) in line with health safeguards (WHO, 2006). The monitoring and assessment of water quality are also essential in order to understand the intensity and scope of the global water quality challenge and to implement proper corrective actions that sustain ecosystem health.

For freshwater bodies, the flow regime is an important determinant of the ecosystem services that are provided. Base flows maintain water table levels in the floodplain and soil moisture for plants, while large floods recharge floodplain aquifers. Therefore, it is crucial that, in water resources management plans, a certain volume of water, or environmental water requirements (EWR), is accounted for the maintenance of freshwater ecosystem functions and the services they provide to women and men. EWR required for maintaining a fair condition of freshwater bodies range globally from 20% to 50% of the mean annual river flow in a basin (Boelee, 2011).

On a global scale, there is significant momentum to incorporate environmental flows into policy making and watershed management plans. They are already addressed in international agreements, such as the Ramsar Convention or the UN Watercourses Convention (entered into force in 2014), regional frameworks such as the European Water Framework

> As competition for freshwater resources grows and climate change affects resource availability, it will become more difficult to meet socio-economic-based demands while maintaining ecosystem integrity and environmental sustainability

Directive and national water policies such as the South African National Water Act (Forslund et al., 2009).

Adopting an ecosystem-based approach to watershed management, including the economic valuation of ecosystem services, is one way of recognizing (and quantifying) the benefits of ecosystem services for livelihoods and employment. Ecosystems are part of the sustainable growth challenge and should be taken into account for broad policy- and decision-making contexts to ensure equitable share of benefits and contribute to poverty alleviation, especially in developing countries. In that regard, the emerging market for PES schemes may offer low-income populations the opportunity to create a new type of entrepreneurship (with its related jobs) and thereby, to generate increased income while implementing restoration/conservation practices.

2.5 The challenges ahead

WWAP | Marc Paquin
With contributions from Catherine Cosgrove and Lucilla Minelli

Considering the finite nature of water resources in any given region, unavoidable challenges in the form of trade-offs loom over the coming decades. As competition for freshwater resources grow and climate change affects resource availability, it will become more difficult to meet socio-economic-based demands while maintaining ecosystem integrity and environmental sustainability (UNEP, 2011b). A systemic approach is called for in this context, which requires overcoming multi-level governance challenges (OECD, 2011b).

One challenge is to ensure that decisions pertaining to water (and sanitation) are consistent with a country's human rights obligations. As noted in Chapter 5, States are required, to the maximum extent of their available resources, to take steps to progressively and by all appropriate means achieve the full realization of these rights. States are also required to gradually provide safe drinking water and adequate sanitation services to prevent, treat and control diseases linked to water, including in the workplace. In addition, States have the obligation to guarantee that the right to water is enjoyed without discrimination and equally between men and women (UN, 2003). In this context, decision-makers must prioritize the fulfilment of the human right to safe drinking water and sanitation over competing uses that could prevent the progressive realization of this right.

A second challenge is to ensure the sustainability of ecosystems as well as their water component. In order to guarantee continued access to sufficient and adequate water for people and the economy over time, it is imperative that decision-makers from the local level up assess the needs of water provisioning ecosystems and take the actions required to preserve, sustainably manage and, where necessary, restore the ecosystems based on available knowledge and datasets (WWAP, 2012; Ramsar Convention Secretariat, 2010). The key decisions involve the allocation of sufficient amounts of water to ensure the sustainable functioning of the ecosystems (Forslund et al., 2009). These necessary choices seek to maximize the socio-economic opportunities provided by healthy and sustainable ecosystems and lower the risks associated with vulnerable water resources. The adequate management of ecosystems also supports their resilience, and the resilience of those who depend upon them, to cope with stresses such as drought, extreme weather events and climate change (WWAP, 2012). A variety of concepts, approaches and tools, such as IWRM and valuation of ecosystem services, can be of assistance in this regard.

Other challenges can be tackled when the sustainability of water resources is ensured through adequate ecosystem protection and management, and the human right to safe drinking water and

sanitation, as well as the other human rights that depend on water, are prioritized in accordance with international law. This requires allocating remaining water resources to the competing socio-economic needs and requirements (e.g. drinking water and sanitation, agriculture, energy production, industry), in keeping with a community or country's social and economic development priorities and strategies (Speed et al., 2013).

Given that ecosystems may not hold enough water to sustain all the economic activities that rely on it (especially in a growth context), decision-makers, in concert with stakeholders, must arbitrate among competing demands. Policy decisions on the amount of water each economic sector (and each water consumer in these sectors) will be entitled to for its activities must therefore be made. For example, in terms of water availability, some regions will favour certain economic sectors (e.g. energy production or urban needs), while others will support different ones (e.g. agriculture). The decision to allocate more water to one sector rather than another can have tremendous consequences on the performance, and even the viability, of the affected sectors, with resulting impacts on income generation and jobs (SIWI/WHO, 2005). In this context, the shift to a green economy in eight key sectors (agriculture, forestry, fishing, energy, resource-intensive manufacturing, recycling, buildings and transport) can lead to significant benefits by supporting them in the adoption of greener and more productive practices (ILO, 2012; UNEP, 2011c).

Finally, a fourth challenge for policy-makers consists of addressing trade-offs to offset the negative impacts that may arise from the aforementioned water allocation decisions. Examples of such trade-offs include transitional assistance mechanisms and the provision of adequate compensation and adjustments for water surrendered, bearing in mind that those in the value chain can be affected by any fall-off in economic activity as a result of the reductions in water allocation (Speed et al., 2013; OECD, 2012a).

The water entitlement decision-making process is also an occasion to explore opportunities for maximizing the benefits of water allocation choices. Water can be a powerful vector for shifting a conventional economy towards a greener one through the reduction of pollution or waste and greater efficiency in the use of water, energy and materials that are likely to generate a small positive change in total employment in most instances (UNEP/ILO/IOE/ITUC, 2008).

Failure to meet these concurrent challenges may prove costly in many ways: declining ecosystems and ecosystem services, unsustainable economic development, social unrest and migration (see Box 2.1) resulting from water insecurity and compromised public health and resilience (OECD, 2008; Lant, 2004).

BOX 2.1 WATER STRESS, MIGRATION AND EMPLOYMENT

Climate change, water stress and environmental degradation are affecting large populations around the world and represent major threats to international peace, human security and wellbeing. There is a clear connection between water scarcity, food insecurity, social instability and potentially violent conflicts, which in turn can trigger and intensify migration patterns throughout the world. Many Asian, African and Middle Eastern nations as well as Small Islands Developing States are witnessing widespread migration flows exacerbated by adverse climate change effects and political volatility. Several studies estimate that by 2050 between 150 and 200 million people could be displaced as a consequence of phenomena, such as desertification, sea level rise and increased extreme weather events (Scheffran et al., 2012). However, environmental drivers are only a part of the equation as poor governance, political instability, economic and cultural issues also contribute to this multi-faced and complex phenomenon.

Water stress not only can underpin reasons for fleeing, but it can also turn into a consequence as migratory groups put additional pressures on the water resources of recipient countries. Employment is also affected on both sides of the coin: high joblessness rates and unrest are engines for migration, which in turn leave post-conflict countries without active workforce for reconstruction. On the other hand, increased request for jobs or subsidies represent a major challenge for hosting countries which dispose of inadequate established policy or legislation to deal with these pressures and address the needs and rights of 'environmental migrants'.[6]

The case of Bangladesh is an example of the water-migration-employment nexus: poverty is widespread, sea level rise is turning much of the country's fertile land into a saline desert and extensive flooding occurs regularly with increasing severity – all of which have led to a large, landless population. About 61% of the population of Bangladesh is of working age (15 to 64 years old). However, those who are employed in the formal labour market often work just a few hours a week at low wages. This context has favoured a predominance of economically-motivated international migration from Bangladesh. Even if these temporary movements[7] can positively contribute to the economy of Bangladesh, the country's migration stream comes with its own set of problems (MPI, 2011). In fact, the arrival of migrants in receiving countries can add burdens upon the local economy, social structure and ecosystems which need to be addressed in terms of the resilience of hosting communities.

Policy responses aimed at mitigating 'the stress associated with water scarcity and detrimental aspects of migration strategies have many opportunities to reinforce community resilience and maintain coping options' (Dow et al., 2005, p. 25). These may include: promotion of green jobs in the formulation and implementation of climate adaptation and mitigation strategies; improved access to water services; increased efforts towards women empowerment and education; fairer land tenure systems (vs land/water grabbing); investments in modern assessments and monitoring of water resources; awareness raising to reduce disaster risk; protection of cultural heritage and traditional knowledge; review of current international law and treaties on migration, refugees and displacement; and development of urban areas based on more equitable distribution of water resources and resource recovery approach, in addition to other region- and context-specific actions. Research and policy should look beyond the two-way relationship between water scarcity and migration as 'sustainable development efforts must engage with the complexity of local livelihoods and social structures through which water scarcity is understood and managed' (Dow et al., 2005, p. 26).

Contributed by Lucilla Minelli (WWAP).

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[6] The International Organization for Migration (IOM, 2007, pp. 1-2) defines environmental migrants as 'persons or groups of persons who, for compelling reasons of sudden or progressive change in the environment that adversely affects their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad'.

[7] Receiving countries authorize workers to work for legally specified periods of limited duration.

3

ECONOMY, JOBS AND WATER

Collecting salt in Sambhar Salt Lake (India)
Photo: © Iryna Rasko/Shutterstock.com

This chapter provides a lexicon of the terminology used in this report followed by an overview of global employment trends. It then describes the importance of water for economies and many of the jobs they support, with a special focus on the agri-food, energy and industrial sectors.

3.1 Terminology

WWAP | Marc Paquin and Richard Connor
ILO | Carlos Carrion-Crespo

For the purposes of this report, it is useful to define some of the terms used when discussing jobs in general and jobs as they relate to water in particular.

Jobs are an individual's set of tasks that will deliver the work within a single enterprise, farm, community, household, or other production unit, including self-employment (ICLS 2013, para. 12(b)). Jobs can be formal or informal. A **formal job** refers to a job that is, in law and in practice, subject to national labour legislation, income taxation, social protection or entitlement to certain employment benefits (advance notice of dismissal, severance pay, paid annual or sick leave, etc.). Conversely, an **informal job** refers to a job that is, in law or in practice, not subject to national labour legislation, income taxation, social protection or entitlement to certain employment benefits (ILO, 2003a).

Direct jobs result from investment in any given economic sector (e.g. jobs created at a recently-built water treatment plant). **Indirect jobs** are created when an investment in a sector leads to an increase in jobs in suppliers and distributors of that sector (e.g. jobs at a chemical plant that produces the required products to be used in a recently-built water treatment plant). The jobs resulting from direct and indirect employees spending more (and thus increasing consumption) will create a number of **induced jobs** (ILO, 2013c; IFC, 2013). **Growth-related jobs** refer to job creation through macro-benefits resulting, for example, from improved infrastructure, such as an increase in water supply that allows for additional production, leading to economic growth, and hence employment (IFC, 2013) (Figure 3.1).

Green jobs are decent jobs that contribute to preserve or restore the environment; they are in traditional sectors such as manufacturing and construction, or in new, emerging green sectors including renewable energy and energy efficiency (ILO, 2013b).

FIGURE 3.1 DIRECT, INDIRECT, INDUCED AND GROWTH-RELATED JOBS

Source: IFC (2013, Fig.6.1, p. 64, © World Bank. License: CC BY 3.0 IGO).

Work is meant as any activity performed by any person to produce goods or to provide services for use by that person or others, irrespective of its formality or legality (ICLS, 2013, para. 6). Work can be divided in two broad categories: paid and unpaid. **Paid work** describes work performed for others in exchange for pay or profit, whereas **unpaid work** refers to the production work for the person's own use, unpaid trainee work, volunteer work, unpaid work by prisoners and unpaid military or alternative civilian service (ICLS, 2013, paras. 28 to 39).

According to the International Labour Organization (ILO) (2007b, p. 4), '**decent work** sums up the aspirations of people in their working lives. It involves opportunities for work that is productive and delivers a fair income, security in the workplace and social protection for families. Decent work means better prospects for personal development and social integration, and freedom for people to express their concerns, organize and participate in the decisions that affect their lives. It entails equality of opportunity and treatment for all women and men.'

Persons in employment are defined as all those of working age who, during a short reference period, are engaged in any activity to produce goods or provide services for pay or profit. They comprise: (a) employed persons at work, i.e. who worked in a job for at least one hour; and (b) employed persons not at work due to temporary absence from a job, or to working-time

arrangements (such as shift work, flexitime and compensatory leave for overtime) (ICLS, 2013, para. 27).

Underemployment exists when employed persons have not attained their full employment level in the sense of the Employment Policy Convention adopted by the International Labour Conference in 1964. According to this Convention, full employment ensures that (i) there is work for all persons who are willing to work and look for work; (ii) that such work is as productive as possible; and (iii) that they have the freedom to choose the employment and that each worker has all the possibilities to acquire the necessary skills to get the employment that most suits them and to use in this employment such skills and other qualifications that they possess. The situations that do not fulfil objective (i) refer to unemployment, and those that do not satisfy objectives (ii) or (iii) refer mainly to underemployment (ILO, 1964).

For the purposes of this report, the following categories are used when discussing jobs as they relate to water.

Water jobs (or jobs in the water sectors, or water sector jobs) are the direct jobs in the water sectors, which are mainly comprised of: a) water resources management, including IWRM and ecosystem restoration and remediation; b) building and managing water infrastructure; and c) the provision of water-related services, which includes: water supply; sewerage, waste management and remediation activities (UN DESA, 2008).

Water-dependent jobs refer to direct jobs in heavily and moderately water-dependent economic sectors. Heavily water-dependent economic sectors consist of those requiring a significant quantity of water as a major and necessary input to their activities and/or production processes. Failure to secure an adequate and reliable supply of water to support these sectors results in the loss or disappearance of jobs (i.e. no water, no jobs). Moderately water-dependent economic sectors can be defined as those that do not require access to significant quantities of water resources for their activities, but for which water is a nevertheless an essential component in parts of their production chains.

> Agriculture is the primary employment sector in most developing countries and currently accounts for 60% of all jobs in sub-Saharan Africa, where women account for one half the sector's workforce

Ancillary water jobs are those that provide the water-related enabling environment and necessary support to the activities or operation of an organization, institution, industry or system. This encompasses, for example, legal and policy specialists, engineers, planners, financiers and hydrologists.

Finally, **water-related jobs** refer indiscriminately to any job whose essential tasks relate to water. These comprise mainly water sector jobs and ancillary water jobs.

3.2 Global employment trends

WWAP | Richard Connor with contributions from Laurens Thuy

ILO's employment statistics show that the global active workforce (i.e. paid work) increased from 2.3 billion people in 1991 to an estimated 3.2 billion in 2014 (Table 3.1), while the global population grew from 5.4 billion to 7.2 billion over the same period (UN DESA, 2001, 2015). The industry and services sectors account for this increase, while employment in the agricultural sectors (agriculture, forestry and fishing) experienced a slight decrease during this period (Figure 3.2). The male to female employment ratio has remained steady over the past 25 years, with women accounting for 40% of the global active workforce (Table 3.2).

TABLE 3.1 EMPLOYMENT BY SECTOR AND SEX, WORLD AND REGIONS (MILLIONS)

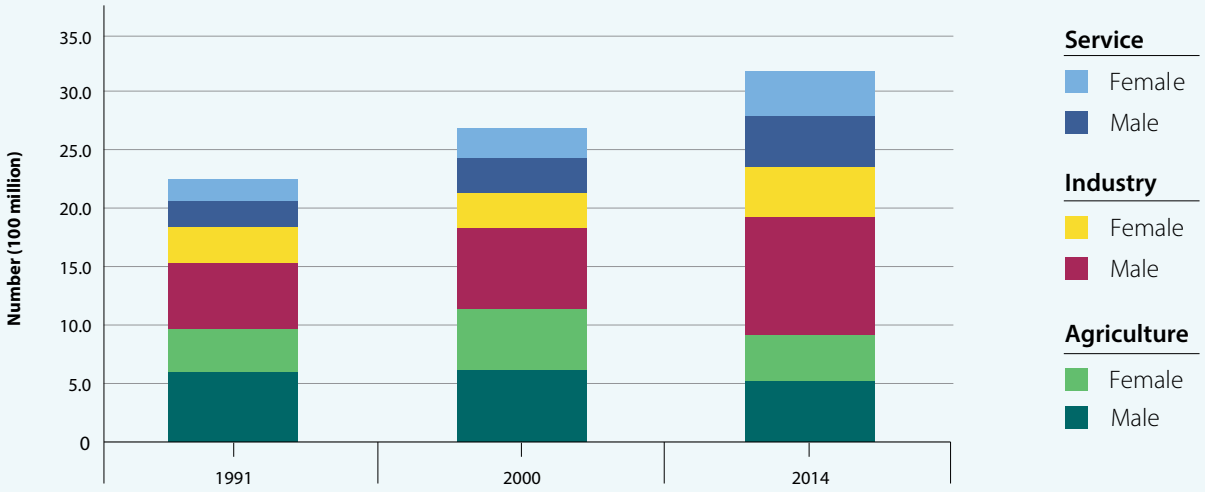
	AGRICULTURE					INDUSTRY					SERVICES				
BOTH SEXES	**1991**	**2000**	**2013**	**2014**	**2019***	**1991**	**2000**	**2013**	**2014**	**2019***	**1991**	**2000**	**2013**	**2014**	**2019***
World	966.8	1 057.9	932.3	929.3	894.8	870.8	1 009.5	1 399.9	1 425.3	1 540.1	420.7	545.4	814.3	836.3	953.5
Developed Economies and European Union	28.7	24.5	16.7	16.6	15.3	221.1	217.6	213.4	215.3	216.0	167.7	206.1	245.0	248.6	261.5
Central and South-Eastern Europe (non-EU) and CIS**	32.7	35.1	26.8	26.6	25.0	73.5	68.4	82.7	83.1	82.7	40.8	42.2	56.3	56.7	58.7
East Asia	355.8	361.9	203.6	194.0	150.3	269.4	315.2	478.8	486.4	510.8	46.8	72.2	145.9	152.3	180.6
South-East Asia and the Pacific	112.6	120.3	117.0	116.9	109.1	59.2	86.1	126.3	128.9	144.7	24.1	35.9	64.0	66.5	81.4
South Asia	259.7	302.2	299.4	300.7	294.7	113.1	148.0	240.9	248.0	289.8	46.6	58.3	90.7	94.2	117.4
Latin America and the Caribbean	41.9	43.2	42.0	42.5	42.6	74.3	94.5	129.6	131.1	141.9	50.3	70.3	107.3	109.2	121.8
Middle East and North Africa	20.8	24.1	27.5	27.9	29.3	26.5	35.4	59.9	61.3	68.7	18.8	26.2	43.0	44.0	50.6
Sub-Saharan Africa	114.7	146.5	199.5	204.1	228.5	33.6	44.2	68.3	71.1	85.5	25.6	34.3	62.2	64.9	81.5
MALES	**1991**	**2000**	**2013**	**2014**	**2019***	**1991**	**2000**	**2013**	**2014**	**2019***	**1991**	**2000**	**2013**	**2014**	**2019***
World	580.6	606.9	521.4	518.4	488.0	570.1	691.8	969.7	987.4	1 068.4	220.8	275.9	412.3	425.1	498.9
Developed Economies and European Union	17.6	15.2	10.9	10.9	10.1	148.4	147.7	146.4	147.9	149.9	74.0	88.9	101.5	103.1	109.0
Central and South-Eastern Europe (non-EU) and CIS**	17.3	19.1	12.9	12.9	12.8	46.3	43.3	54.4	54.7	54.5	16.9	18.0	23.9	23.9	24.6
East Asia	200.8	183.0	87.3	81.3	52.9	143.6	195.2	302.6	306.9	320.2	26.6	34.6	74.0	78.4	100.5
South-East Asia and the Pacific	62.7	66.1	63.0	63.3	60.2	37.2	54.9	81.3	83.1	92.6	13.0	18.9	32.0	32.7	39.6
South Asia	172.6	196.1	195.5	195.3	185.8	95.6	126.4	202.1	208.0	241.3	34.1	43.1	67.0	69.6	86.7
Latin America and the Caribbean	32.1	32.5	31.8	32.1	32.2	54.3	66.5	88.2	89.2	96.7	24.1	30.8	44.5	45.3	51.0
Middle East and North Africa	16.6	24.1	20.0	20.4	21.0	24.0	32.0	54.8	56.1	62.9	15.0	19.9	30.9	31.6	36.3
Sub-Saharan Africa	60.9	76.2	100.0	102.1	112.9	20.6	25.8	39.9	41.6	50.3	17.0	21.8	38.6	40.3	51.1
FEMALES	**1991**	**2000**	**2013**	**2014**	**2019***	**1991**	**2000**	**2013**	**2014**	**2019***	**1991**	**2000**	**2013**	**2014**	**2019***
World	386.2	451.0	411.0	410.9	406.8	300.7	317.6	430.2	437.8	471.7	200.0	269.5	402.0	411.3	454.6
Developed Economies and European Union	11.0	9.2	5.7	5.7	5.2	72.7	69.9	67.0	67.4	66.1	93.7	117.2	143.5	145.5	152.4
Central and South-Eastern Europe (non-EU) and CIS**	15.4	16.0	13.9	13.7	12.1	27.2	25.1	28.3	28.4	28.2	23.9	24.2	32.4	32.8	34.0
East Asia	155.0	178.9	116.3	112.7	97.4	125.8	120.0	176.2	179.5	190.6	20.2	37.6	71.9	73.8	80.1
South-East Asia and the Pacific	49.9	54.3	54.1	53.6	48.9	22.0	31.1	45.0	45.8	52.1	11.1	17.1	32.0	33.8	41.9
South Asia	87.2	106.1	103.9	105.4	108.8	17.5	21.6	38.8	40.1	48.5	12.5	15.2	23.7	24.6	30.6
Latin America and the Caribbean	9.7	10.8	10.2	10.3	10.4	20.0	28.0	41.3	41.8	45.1	26.2	39.5	62.8	63.9	70.8
Middle East and North Africa	4.2	5.5	7.4	7.6	8.3	2.6	3.4	5.1	5.2	5.8	3.8	6.3	12.1	12.4	14.3
Sub-Saharan Africa	53.8	70.3	99.5	102.0	115.6	13.0	18.5	28.4	29.6	35.2	8.6	12.5	23.7	24.6	30.4

* Projection ** Commonwealth of Independent States

Source: WWAP, based on the Supporting Datasets for the World Employment Social Outlook: Trends 2015 (ILO, 2015a).

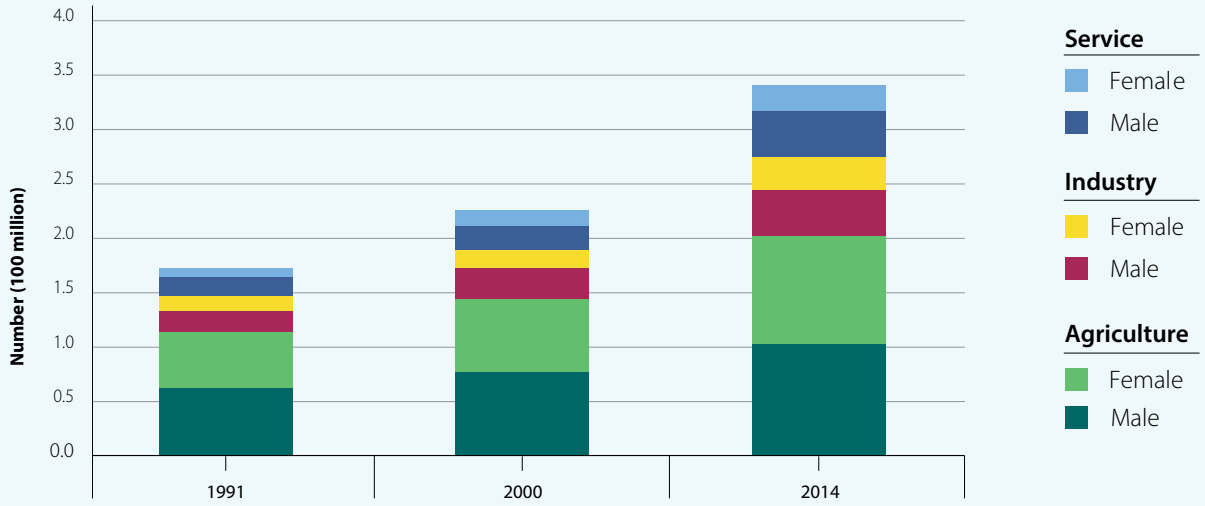
Employment in the agriculture sector dropped from just over one billion people in 2000 (when it comprised 40% of the active workforce) to 930 million in 2014, accounting then for slightly less than 30%. This trend can be seen for both sexes across nearly all regions and appears entirely decoupled from regional and global population growth. The notable exception to this trend is in sub-Saharan Africa where employment in the agriculture sector has increased significantly for both men and women (Figure 3.3). Globally, in 2014 roughly 520 million men and 410 million women were employed in agriculture, accounting for one third of all employed women. Agriculture is the primary employment sector in most developing countries and currently accounts for 60% of all jobs in sub-Saharan Africa where women account for one half the sector's workforce.

FIGURE 3.2 GLOBAL EMPLOYMENT TRENDS, BY SECTOR AND SEX



Source: WWAP, based on the Supporting Datasets for the World Employment Social Outlook: Trends 2015 (ILO, 2015a).

FIGURE 3.3 SUB-SAHARAN EMPLOYMENT TRENDS, BY SECTOR AND SEX



Source: WWAP, based on the Supporting Datasets for the World Employment Social Outlook: Trends 2015 (ILO, 2015a).

TABLE 3.2 EMPLOYMENT BY SECTOR AND SEX, WORLD AND REGIONS (%)

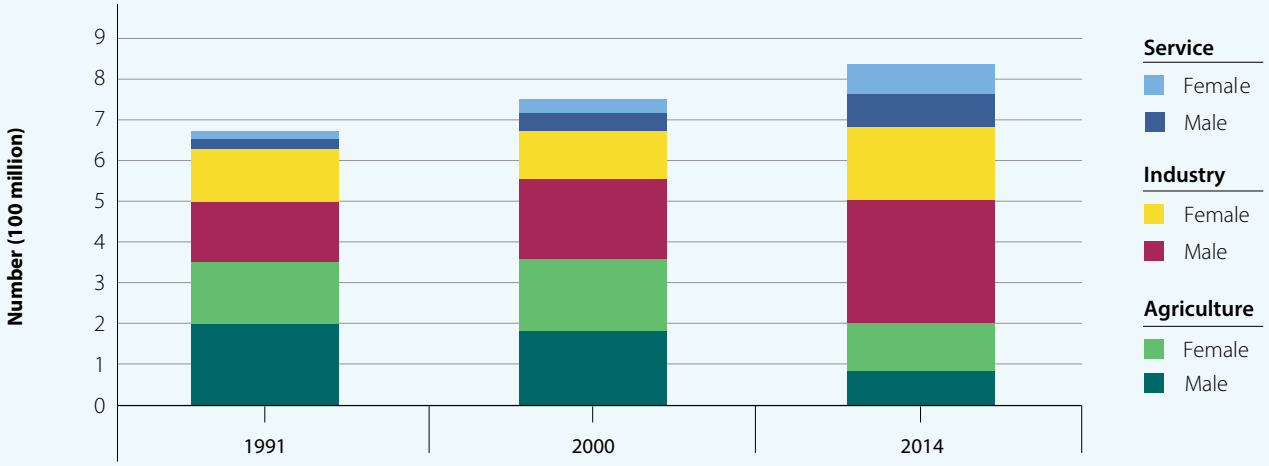
BOTH SEXES	AGRICULTURE					INDUSTRY					SERVICES				
	1991	2000	2013	2014	2019*	1991	2000	2013	2014	2019*	1991	2000	2013	2014	2019*
World	42.8	40.5	29.6	29.1	26.4	38.5	38.7	44.4	44.7	45.5	18.7	20.9	25.8	26.3	28.2
Developed Economies and European Union	6.9	5.5	3.5	3.5	3.1	52.9	48.6	45.0	44.9	43.7	40.2	46.0	51.6	51.7	53.1
Central and South-Eastern Europe (non-EU) and CIS**	22.3	24.1	16.1	16.0	15.0	50.0	46.8	49.8	50.0	49.7	27.6	28.9	34.1	33.9	35.3
East Asia	52.9	48.3	24.6	23.3	17.9	40.0	42.0	57.7	58.4	60.6	7.1	9.6	17.6	18.2	21.6
South-East Asia and the Pacific	57.5	49.7	38.1	37.4	32.5	30.2	35.6	41.1	41.2	43.3	12.2	14.8	20.8	21.4	24.3
South Asia	61.9	59.4	47.4	46.8	42.0	26.9	29.1	38.2	38.6	41.4	11.1	11.5	14.4	14.6	16.9
Latin America and the Caribbean	25.1	20.8	15.1	15.0	13.9	44.7	45.4	46.5	46.4	46.3	30.2	33.8	38.4	38.7	39.9
Middle East and North Africa	31.4	28.1	21.1	21.0	19.7	40.0	41.3	45.9	46.1	46.3	28.5	30.6	32.9	33.0	34.0
Sub-Saharan Africa	65.9	65.1	60.4	60.0	57.8	19.3	19.7	20.8	20.9	21.7	14.8	15.2	18.8	19.1	20.6
MALES	**1991**	**2000**	**2013**	**2014**	**2019***	**1991**	**2000**	**2013**	**2014**	**2019***	**1991**	**2000**	**2013**	**2014**	**2019***
World	42.3	38.5	27.4	26.8	23.7	41.5	44.0	50.9	51.1	52.1	16.0	17.5	21.8	22.0	24.3
Developed Economies and European Union	7.4	6.1	4.2	4.2	3.7	61.9	58.6	56.6	56.5	55.7	30.8	35.4	39.3	39.4	40.6
Central and South-Eastern Europe (non-EU) and CIS**	21.5	23.8	14.1	14.1	14.0	57.4	53.9	59.8	59.8	59.2	21.0	22.3	26.2	26.2	26.8
East Asia	54.1	44.3	18.8	17.4	11.2	38.8	47.1	65.3	65.7	67.6	7.2	8.4	15.9	16.7	21.2
South-East Asia and the Pacific	55.5	47.2	35.7	35.4	31.3	32.9	39.2	46.1	46.4	48.1	11.5	13.5	18.1	18.4	20.6
South Asia	57.1	53.6	42.1	41.3	36.2	31.6	34.6	43.5	44.0	47.0	11.4	11.7	14.3	14.7	16.8
Latin America and the Caribbean	29.1	25.0	19.3	19.3	17.9	49.2	51.3	53.6	53.4	53.8	21.7	23.8	26.9	27.2	28.4
Middle East and North Africa	29.9	28.1	19.0	18.9	17.5	43.0	45.4	51.8	51.8	52.4	27.1	28.3	29.4	29.3	30.1
Sub-Saharan Africa	61.8	61.6	56.0	55.5	52.7	21.1	20.8	22.3	22.6	23.5	17.2	17.6	21.6	21.9	23.8
FEMALES	**1991**	**2000**	**2013**	**2014**	**2019***	**1991**	**2000**	**2013**	**2014**	**2019***	**1991**	**2000**	**2013**	**2014**	**2019***
World	43.5	43.4	33.1	32.6	30.5	34.0	30.5	34.5	34.8	35.4	22.7	26.0	32.4	32.6	34.1
Developed Economies and European Union	6.2	4.7	2.6	2.6	2.3	41.0	35.6	31.0	30.9	29.5	52.8	59.6	66.4	66.6	68.2
Central and South-Eastern Europe (non-EU) and CIS**	23.2	24.5	18.6	18.3	16.3	40.9	38.5	38.0	37.8	37.9	36.0	37.1	43.6	43.8	45.8
East Asia	51.5	53.2	31.9	30.8	26.5	41.6	35.6	48.4	49.0	51.8	6.6	11.2	19.7	20.2	21.7
South-East Asia and the Pacific	60.2	53.0	41.3	40.2	34.2	26.5	30.4	34.3	34.5	36.5	13.5	16.8	24.4	25.2	29.3
South Asia	74.4	74.3	62.4	62.0	57.9	15.0	15.2	23.4	23.6	25.8	10.7	10.7	14.2	14.5	16.2
Latin America and the Caribbean	17.4	13.8	8.9	8.9	8.2	35.6	35.7	36.2	36.1	35.7	46.9	50.5	54.9	55.0	56.0
Middle East and North Africa	39.5	35.9	30.3	30.0	29.1	24.4	22.6	20.7	20.8	20.4	36.0	41.6	49.1	49.3	50.5
Sub-Saharan Africa	71.3	69.4	65.6	65.3	63.8	17.3	18.2	18.8	18.9	19.4	11.2	12.4	15.6	15.8	16.7

* Projection ** Commonwealth of Independent States

Source: WWAP, based on the Supporting Datasets for the World Employment Social Outlook: Trends 2015 (ILO, 2015a).

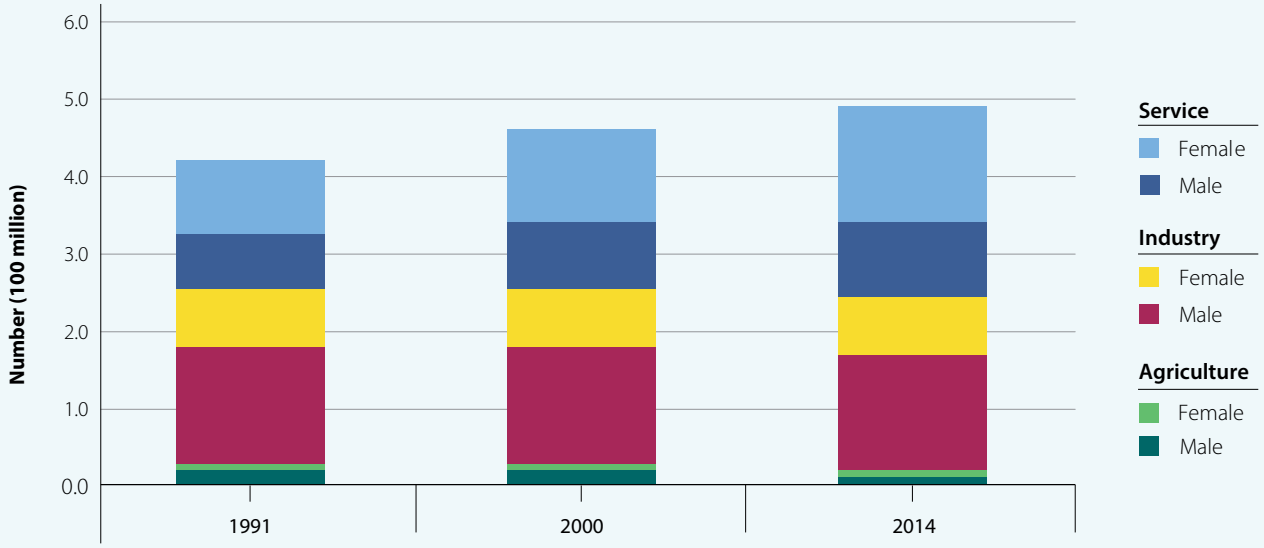
Employment figures for the industrial sector have grown dramatically in recent years, from 1 billion to 1.4 billion people between 2000 and 2014, accounting for just under 45% of the global active workforce. Led by South and East Asia (Figure 3.4), this growth has occurred across all regions with the exception of countries with developed economies (Figure 3.5). Men account for 70% of the global industrial workforce.

FIGURE 3.4 EAST ASIA EMPLOYMENT TRENDS, BY SECTOR AND SEX



Source: WWAP, based on the Supporting Datasets for the World Employment Social Outlook: Trends 2015 (ILO, 2015a).

FIGURE 3.5 DEVELOPED ECONOMIES AND EU EMPLOYMENT TRENDS, BY SECTOR AND SEX



Source: WWAP, based on the Supporting Datasets for the World Employment Social Outlook: Trends 2015 (ILO, 2015a).

Water-dependent jobs refer to direct jobs in heavily and moderately water-dependent economic sectors

Employment in the services sector grew by 50% between 2000 and 2014, increasing from 545 million to just over 835 million people, accounting for a little over 25% of the global active workforce. Globally, women account for slightly more than half of the services sector workforce (Figure 3.2), although the ratio differs from one region to another: in Latin America and the Caribbean, and in countries with developed economies (Figure 3.5), women hold nearly 60% of the jobs, whereas in South Asia, and in the Middle East and North Africa, women hold less than 30% of services sector jobs.

Figures 3.3, 3.4 and 3.5 also illustrate how employment breaks down into different sectors as a function of a region's level of economic development. In less developed countries in Sub-Saharan Africa (Figure 3.3), agriculture is the main employment sector by far, outpacing employment growth in other sectors. With several of its countries undergoing economic transition, East Asia has seen its share of employment in the agriculture sector drop significantly between 2001-2014, with industry taking over as the main sector of employment (Figure 3.4). Employment in countries with highly developed economies remained relatively stable between 1991 and 2014, with some increases in the services sectors; employment in the agricultural sector remained relatively marginal (Figure 3.5).

As described in the next section of this chapter, different economic sectors can have varying levels of water-dependency. In the case of heavily water-dependent sectors such as agriculture, water scarcity can pose a series of risks to the creation and maintenance of decent jobs. In comparison, the services sectors are generally much less water-dependent; thus, jobs in those sectors are not as vulnerable to risks associated with water scarcity.

3.3 Water-dependent jobs

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ILO | Carlos Carrion-Crespo

Water, from extraction to its return to the environment and its different uses in between, is essential for creating and supporting jobs, both directly and indirectly. When productive and decent, jobs contribute to sustainable development in fundamental ways.

Water jobs (discussed in Chapter 4) include jobs in a variety of sectors, such as water resources management, infrastructure, water supply and sewerage. As such, these jobs are fundamental to the various water-dependent sectors and to the jobs the sectors generate.

Water-dependent jobs (as opposed to water jobs) are comprised in economic sectors that are heavily or moderately water-dependent.

Sectors that are **heavily water-dependent** can be defined as those requiring a significant quantity of water resources as a major and necessary input to their activities and/or production processes. Failure to secure an adequate and reliable supply of water to support these sectors results in the loss or disappearance of jobs). Examples of sectors with water-dependent jobs include agriculture, forestry, inland fisheries and aquaculture, mining and resource extraction, water supply and sanitation, and most types of power generation, as well as a number of jobs in manufacturing and transformation industries such as food, pharmaceuticals and textiles. Other heavily water-dependent sectors include jobs in health care, tourism and ecosystem management. As such, it is estimated that 95% of jobs in the agriculture sector, 30% of jobs in the industry sector, and 10% of jobs in the services sector are heavily dependent on water. Applying this criterion to the data presented in tables 3.1 and 3.2 reveals that **1.35 billion jobs (42% of the world's total active workforce) are likely to be heavily water-dependent** (2014 est.).

Mining sludge
Photo: © Milos Muller/Shutterstock.com

Sectors that are **moderately water-dependent** can be defined as those that do not require access to significant quantities of water resources to realize most of their activities, but for which water is nonetheless a necessary component in part(s) of their value chains. Water-related risks to jobs can vary among different jobs and sectors, as a function of how much water the tasks and inputs associated with the job require, and whether or not access to an adequate and reliable water supply is ensured. Examples of sectors with moderately water-dependent jobs include construction, recreation, transportation (excluding inland navigation, which is heavily water-dependent) and manufacturing/transformation industries, such as wood, paper, rubber/plastics and metals, as well as a few specific types of jobs in education. As such, it is estimated that 5% of jobs in the agriculture sector, 60% of jobs in the industry sector and 30% of jobs in the services sector are moderately dependent on water. Applying this criterion to the data in Tables 3.1 and 3.2 reveals that **1.15 billion jobs (36% of the world's total active workforce) are likely to be moderately water-dependent** (2014 est.).

In essence, this means that 78% of the jobs constituting the global workforce are water-dependent.

Nonetheless, not every job in the various subsector categories is equally dependent on water. Water availability, or efforts to reduce water use and pollution, will inevitably impact some jobs more than others. For example, jobs on the production floor of a given manufacturing plant will often be more water dependent than those in the plant's administrative offices. On the other hand, losing or eliminating jobs on the production floor because of lack of water would likely render the office jobs superfluous.

In addition to the water jobs mentioned, a number of ancillary jobs **facilitate** the creation of water-dependent jobs. These include many jobs in regulatory institutions within public administrations, infrastructure financing, real estate, wholesale and retail trade, and construction. Such jobs provide the enabling environment and necessary support to the activities or operation of water-dependent organizations, institutions, industries or systems.

By estimating the potential employment generated by investments in the delivery, treatment and conservation of water, governments can determine the investment and employment policies that will increase and improve jobs across the economy. One way is to use, for example, input-output (I-O) analysis and social accounting matrices (SAMs)[8] which could help identify the most affected jobs, investment needs and adequate employment policies, and determine how water is used as an input by different subsectors. These tools further help quantify jobs created when a government increases or improves water supply.

3.4 Water and jobs in the agri-food sector

FAO | Marie-Aude Even with contributions from Elisenda Estruch, Thierry Facon, Valentina Franchi, Moujahed Achouri, Olcay Ünver, Karen Frenken, Turi Fileccia, Devin Bartley, Sally Bunning, Sara MarjaniZadeh and Karine Frouin (Independent consultant)

With contributions from Audrey Nepveu De Villemarceau (IFAD)

Jobs in the agri-food sector are difficult to estimate and go beyond jobs, as food production has multiple meanings for different people. Only 20% of people working in agriculture are considered

[8] The difference between I-Os and SAMs: While I-O tables provide a disaggregation of the system of production and can illustrate the interactions within it, SAMs go further by describing the interrelationships of income and transfer flows between different institutional units. Please refer to www.wiod.org for data on these analyses.

to be employed as waged workers (World Bank, 2005), and the remaining are self-employed or contribute family labour to around 570 million farms in the world. At least 90% of these farms are family farms. In low-income countries, farms up to two hectares occupy about 40% of the farmland and those up to five hectares about 70%, underscoring their fundamental contribution to food security (FAO, 2014b). Farm incomes and agricultural wages represent 42% to 75% of rural income in agricultural based countries, and 27% to 48% in transforming and urbanizing countries (see Table 3.3 for definitions) (World Bank, 2007b). The significance of agriculture, however, is higher relative to its income share as food production plays a wider role supporting livelihoods, notably for the poorest (World Bank, 2005), with an important self-consumption aspect.

There is also a wide diversity of farms, combining various production systems and livelihoods, including waged work in agriculture, with farming occupying different shares of time worked and income source (see Table 3.3) (World Bank, 2007b). In addition, agriculture often offers a safety net for those transitioning towards other employment sectors (Davidova and Thomson, 2013). Production is also the basis for further jobs and self-employment in the supply of inputs, machinery and rural infrastructure, transformation of agricultural products, and distribution to end consumers. It spawns activities in advisory and regulatory services, policy administration, specialized education, collective organizations, agribusiness finances, research and trade. Food preparation generates additional employment both in market and non-market economies. Such food-related activities cut across sectors and are rarely calculated together, but can increase the agricultural share of employment by half or more, notably in more developed countries (World Bank, 2007b), and by up to five times in some specific locations (Ferris, 2000).

The agricultural sector is often associated with low levels of income, poor and under-regulated working conditions, no or limited social benefits, and issues regarding child labour (FAO, 2014c and 2015b).

Increasing income and ensuring more decent work can improve employment quality, albeit sometimes at the expense of the quantity of employment. Therefore, parallel attention to opportunities outside agriculture is needed. Investing in the agri-food sector remains crucial, as agricultural growth can boost the incomes of the three poorest deciles 2.5 times more than growth in other sectors (World Bank, 2007b) and is the basis for employment creation in other sectors along the value chain.

3.4.1 Water, food and employment

This section explores first the impacts of water resources on the employment situation in the agri-food sector. It then highlights how investments in water can contribute to solving employment challenges.

All food production and utilization depends on water (Figure 3.6). Rainfed systems produce more than 60% of the world's crops (CAWMA, 2007) on 80% of the world's cultivated areas. Irrigated agriculture thus accounts for about 40% of the production on 20% of the world's cultivated areas. Irrigated agriculture accounts for approximately 70% of the world's total water withdrawals, with higher shares in some developing economies (FAO, 2015a and 2015c). An estimated 38% of irrigated land uses groundwater (Siebert et al., 2013). Livestock, food processing and preparation are heavily reliant on water as well (HLPE, 2015). Finally, inland fishery production relies fully on natural and modified water bodies (FAO, 2014a).

Water resources are under pressure, with water scarcity affecting around 40% of the global population (CAWMA, 2007). The root cause can be physical, economic or capacity-related (Section 2.1).

In addition, land and water resources are increasingly degraded by intensive agriculture, industrial development and growing cities (FAO, 2015b; HLPE, 2015) and subjected to increasing competition, within agriculture (e.g. crop and animal production) and outside (e.g. urban expansion). Increasing pressures to meet rising food demand and climate

TABLE 3.3 TYPOLOGY OF RURAL HOUSEHOLDS BY LIVELIHOOD STRATEGIES IN THREE COUNTRY TYPES

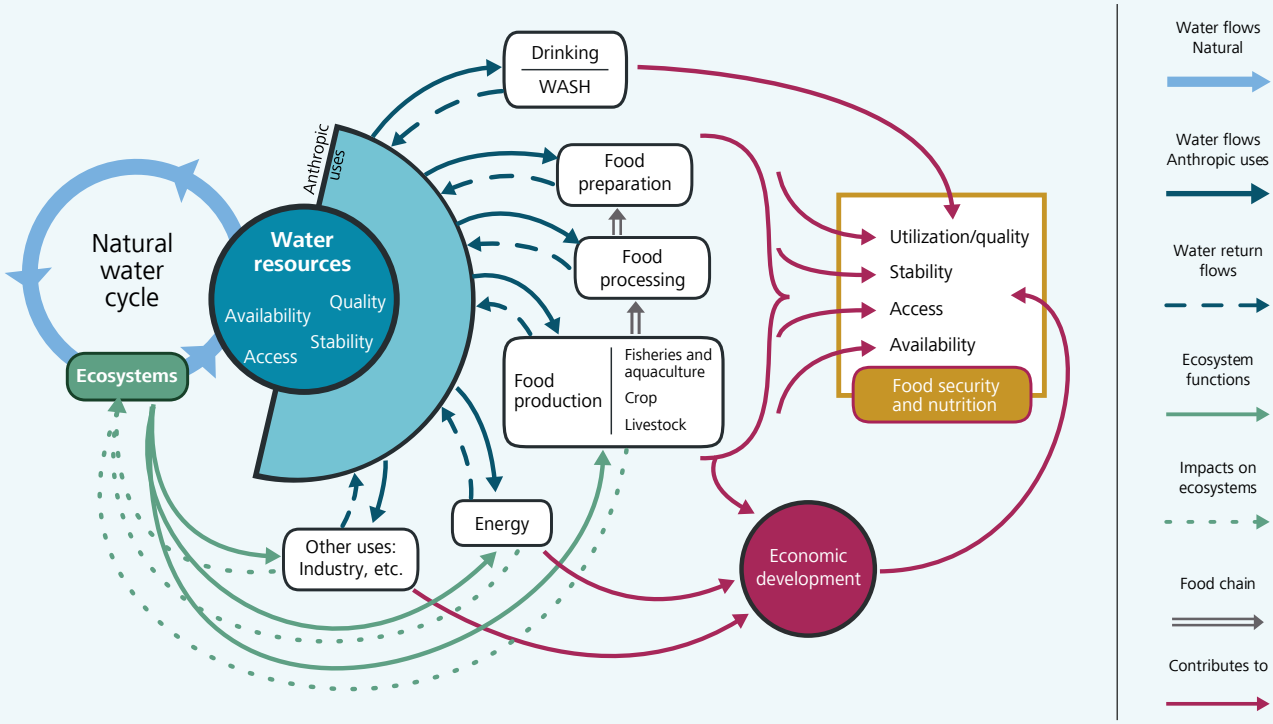
			Farm Oriented[1]						
			Market oriented[2]	Subsistence oriented[3]	Total	Labour oriented[4]	Migration oriented[5]	Diversified[6]	Total
	COUNTRY	YEAR	% of rural households in each group						
Agriculture-based countries*	Nigeria	2004	11	60	71	14	1	14	100
	Madagascar	2001	n.a.	n.a.	54	18	2	26	100
	Ghana	1998	13	41	54	24	3	19	100
	Malawi	2004	20	14	34	24	3	39	100
	Nepal	1996	17	8	25	29	4	42	100
	Nicaragua	2001	18	4	21	45	0	33	100
Transforming countries**	Viet Nam	1998	38	4	41	18	1	39	100
	Pakistan	2001	29	2	31	34	8	28	100
	Albania	2005	9	10	19	15	10	56	100
	Indonesia	2000	n.a.	n.a.	16	37	12	36	100
	Guatemala	2000	4	7	11	47	3	39	100
	Bangladesh	2000	4	2	6	40	6	48	100
	Panama	2003	1	5	6	50	6	37	100
Urbanized countries***	Ecuador	1998	14	11	25	53	2	19	100
	Bulgaria	2001	4	1	5	12	37	46	100

Notes:

[1] Farm-oriented household: More than 75% of total income from farm production.
[2] Farm, market-oriented household: More than 50% of agricultural production sold on market.
[3] Farm, subsistence-oriented household: Less than or equal to 50% of agricultural production sold on market.
[4] Labour-oriented household: More than 75% of total income from wage or nonfarm self-employment.
[5] Migration/transfers-oriented household: More than 75% of total income from transfers/other non-labour sources.
[6] Diversified household: Neither farming, labour, nor migration income source contribute more than 75% of total income.
n.a. = Not available
* Agriculture-based countries: Agriculture is a major source of growth, accounting for 32% of GDP growth on average – mainly because agriculture is a large share of GDP – and most of the poor are in rural areas (70%).
** Transforming countries: Agriculture is no longer a major source of economic growth, contributing on average only 7% to GDP growth, but poverty remains overwhelmingly rural (82% of all poor).
*** Urbanized countries: Agriculture contributes directly even less to economic growth, 5% on average, and poverty is mostly urban. Even so, rural areas still have 45% of the poor, and agribusiness and the food industry and services account for as much as one third of GDP.

Source: Adapted from World Bank (2007b, Table 3.2, p. 76, citing Davis el al., 2007; © World Bank. https://openknowledge.worldbank.org/handle/10986/5990 License: CC BY 3.0 IGO.).

FIGURE 3.6. THE MULTIPLE INTERFACES BETWEEN WATER AND FOOD SECURITY AND NUTRITION



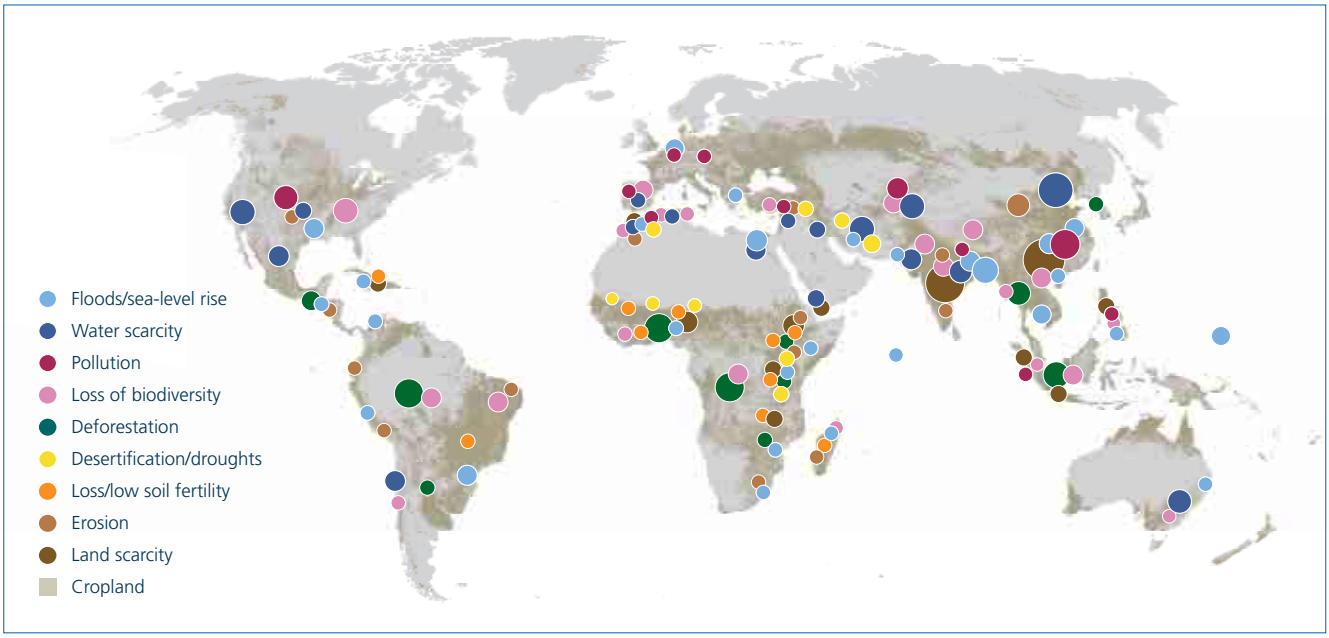
Source: HLPE (2015, Fig. 1, p. 27).

change will exacerbate such challenges. IFPRI points out that 'under business-as-usual scenario, 45% of global GDP, 52% of the world's population and 40% of grain production could be at risk due to water stress by 2050' (IFPRI, n.d.). FAO highlights specific farming systems at risk (Figure 3.7) 'constrained to a point where their capacity to meet current and future needs is seriously jeopardized' (FAO, 2011a).

Insufficient and erratic water supplies affect the quality and quantity of employment in the food sector. It constrains agricultural productivity and compromises income stability with dramatic effects for the poorest households with limited assets and safety nets to cope with risks (FAO/WWC, 2015). This limits rural inhabitants' capacities to accumulate the human capital and assets needed to sustainably lift themselves out of poverty (FAO, 2014c; HLPE, 2013). In India, for example, a 30-year analysis shows that wages are highly sensitive to rainfall shocks (World Bank, 2007b). Prolonged drought causes persistent unemployment, which often leads to migration as a coping strategy, notably when off-farm options are limited, and short- and long-term migration contributes to conflicts due to depleting natural resources (IOM, 2014). Furthermore, growing water scarcity is often associated with shorter cropping seasons, affecting labour demand and supply (HLPE, 2013). In Sahel countries, 80% of the agricultural population is only engaged in agriculture (productive work) during the three-month cropping season (CILSS, n.d.). Many inland fisheries dependent on seasonal floods and rainfall are also affected by pollutants in contaminated runoff (FAO, 2010a).

Improved and equitable water access is required to increase and stabilize income from agriculture (HLPE, 2015), intensify production, accumulate assets, invest in production and access credit. Such a virtuous circle can break the poverty trap, improve the quality of rural working conditions and generate wage labour opportunities (FAO, 2008), reducing distress migration.

FIGURE 3.7 SCHEMATIC OVERVIEW OF RISKS ASSOCIATED WITH MAIN AGRICULTURAL PRODUCTION SYSTEMS



Source: FAO (2011a, Fig. 3.4, p. 133).

Securing and stabilizing access to water involves investments in a long continuum of water management practices in both irrigated and rainfed systems. Irrigation systems enable farmers to produce all year round, creating up to a fivefold increase in the demand for agricultural labour (FAO, 2003). Improved access to fresh water is the basis for income generating activities in processing, gardening, fisheries and animal production (FAO, 2010b). Investments in predominant rainfed systems can benefit most and include water harvesting systems, water conservation practices and supplemental small-scale irrigation (FAO, 2011a). Practices improving rainfall use efficiency and storage are crucial, most often labour intensive and benefit both rainfed and irrigated systems (IFPRI, 2002; Rockström et al., 2007).

Water of adequate quality is needed for purposes of safe food production and human consumption as well as for protecting farmers and fisher folk against threats of water-related diseases and other adverse health impacts. In the absence of potable water supply, water from irrigation canals, although not meeting the adequate criteria, is often directly used for drinking and food preparation, with direct (health and productivity issues) and indirect (education, job retention and employment opportunities) impacts. Identifying the inter-linkages between agricultural water quality, food safety and WASH could help improve planning and investment in both sectors in order to respond to such challenges (HLPE, 2015).

3.4.2 Water investments and agri-food jobs

Agricultural investments often increase agricultural productivity, contributing to the quality of employment, but decreasing the quantity of jobs. While in some cases there may be a decrease in labour demand, these investments can contribute to economic transformations towards more diversified rural realities with less dependence on agriculture. However, such transformations occur at various rates according to countries and contexts (HLPE, 2013; Dorin et al., 2013). Different trajectories can be adopted by countries depending on their own specific needs and capacities. In a context of limited off-farm jobs and reduced migration opportunities, it is often crucial to pay specific attention to implications of water investments and their potential impacts on (quantity and quality of) employment, especially for youth and women.

Water investments have different implications on quality and quantity of jobs and can, therefore, play a role in shaping future transformations adapted to such national contexts. Investments may lead to production systems that are more labour intensive. Notably, green development can increase employment opportunities through green jobs (FAO, 2014d), more labour-intensive practices (UNEP, 2015) and payment for ecosystem services. High value production and inclusive value chain development models can create additional value and jobs (Pfitzer and Ramya, 2007). Reusing resources from waste in agriculture also offers various opportunities to reduce pollution, improve sanitation, create additional value and employment (Otoo and Drechsel, 2015)

In addition, better attention to equity and social impacts of water interventions is needed (FAO, 2008). Inequality weakens economic growth, while more equitable access to resources by the poor, including land and water, can generate better growth and reduce poverty more effectively (World Bank, 2005). Supporting the predominant small family farmers, fishers and processors can yield significant benefits (World Bank, 2007b; FAO, 2010a and 2014b; Belières et al., 2014). They can absorb the growing rural labour force by better managing labour intensive production while facilitating progressive transitions out of agriculture (Losch et al., 2012). However, women's access to natural resources and participation in decision-making is limited. Yet, they may represent as much as half of the population engaged in agriculture (FAO, 2015a), and even much more if the non-paid labour is considered, and 50% of the workforce in the inland fisheries sector (FAO, 2014a). Their overall involvement is difficult to measure and is underestimated (World Bank, 2007b), with limited sex-disaggregated data and unaccounted domestic activities (see Box 17.1).

Reducing gender inequality would accelerate poverty reduction strategies (FAO, 2011b). Similar issues pertain to youth, who are key actors for the future of agriculture. Hence, specific attention is required to propose land and water interventions which can

Insufficient and erratic water supplies affect the quality and quantity of employment in the food sector

meet the specific conditions and needs of different types of food producers, including the poorest, women and youth (Table 3.4) (WAW, 2014; Even and Sourisseau, 2015). Further interventions are often required, including on land and water rights, access to credit, extension, education, market and rural infrastructures and services.

In the context of limited water resources, countries need to focus on the efficient use and allocation of water to maximize economic, social and environmental returns, employment being a key element. In addition to examining the water and food situation, attention to a wider territorial context and on-going rural transformations is needed, with consideration given to the employment situation both on and off farm and future perspectives, including demographic ones. Basin approaches can help reconcile competing uses of water demands across sectors and the resulting interconnected impacts on employment. For example, draining wetlands for agriculture may reduce employment in the fishery sector; some agricultural investments may negatively impact customary access of pastoralists to natural resources, upstream irrigation development may reduce downstream water availability, etc. Water investments and policy can, therefore, be part of a broader and multi-sectoral dialogue on the future of farming to meet the aspirations of farmers and of society seeking sustainable and inclusive development in accordance with principles for Responsible Investment in Agriculture and Food Systems (FAO, 2014e; CFS, 2014).

With the lowest level of irrigated agriculture (5% of the cultivated area against more than 40% in Asia and a world average of just over 20%), and only one third of its potential in irrigation tapped, Sub-Saharan Africa appears to be a priority for investment in water and aquaculture (FAO/WWC, 2015). The region is subject to widespread poverty and a high yield gap; 195 million new entrants are expected to enter the

TABLE 3.4 TARGETING WATER INTERVENTIONS TO DIFFERENT TYPES OF FARMERS IN ASIA

Type of farmers	Typical interventions in water	Typical interventions in water
Large	Modernization of irrigation infrastructure and management, adoption of sustainable groundwater governance mechanism, disaster risk management	Facilitating market linkages
Medium	Conjunctive use of canal water and groundwater, investments in technologies and management models that contribute to improved water productivity	Facilitating market linkages
Commercial, small	Adoption of sustainable groundwater governance mechanisms, adoption of more effective management models in community-based irrigation schemes	Development of entrepreneurship skills, facilitating market linkages, promote linkage with large agribusiness, improved access to and quality of financial services
Subsistence, small	Rainwater management through intermediate forms of water control, access to groundwater, access to small-scale technologies to capture, store and distribute water	Access to basic services, rural infrastructure, diversification of income, social safety nets
Diversified	Multiple-use water services for domestic water and household gardens, livestock, atomistic irrigation	Rural infrastructure, training and support for non-farm activities
Women farmers	Empowerment: involvement in water users associations and decision-making processes, development of irrigation technologies adapted to their specific needs	Enhanced capacity and skills in farming, marketing, access to microcredit
Landless	Design of water services that consider the specific needs of the landless	Training to support non-farm activities

Source: FAO (2014d, Table 4.1, p. 80).

rural labour market by 2025 (World Bank, 2011) (see Chapter 6). Special attention may also be required in other regions, including in South Asia (FAO, 2014d) and northern Africa.

3.5 Water and jobs in the energy sector

UNIDO | UNIDO Industrial Resource Efficiency Unit and John Payne, John G. Payne & Associates Ltd

The strong interconnection between water and energy has recently received much attention and is well documented (WWAP, 2014). Most energy production, and particularly electricity, is either very dependent on cooling water or is generated as hydroelectricity by using water. Biomass, an increasingly important source of energy, is also heavily water-dependent. Water withdrawals for energy production were estimated for 2010 at 15% of the world's total and over 90% of this amount was for power generation. Electricity generation is expected to grow by about 70% between 2010 and 2035 (IEA, 2012b). However, the International Energy Agency (IEA) indicates that this increase is much greater than water withdrawal which, under its New Policies Scenario, is predicted to grow by 20%, reflecting in part the enlarged influence of renewables.

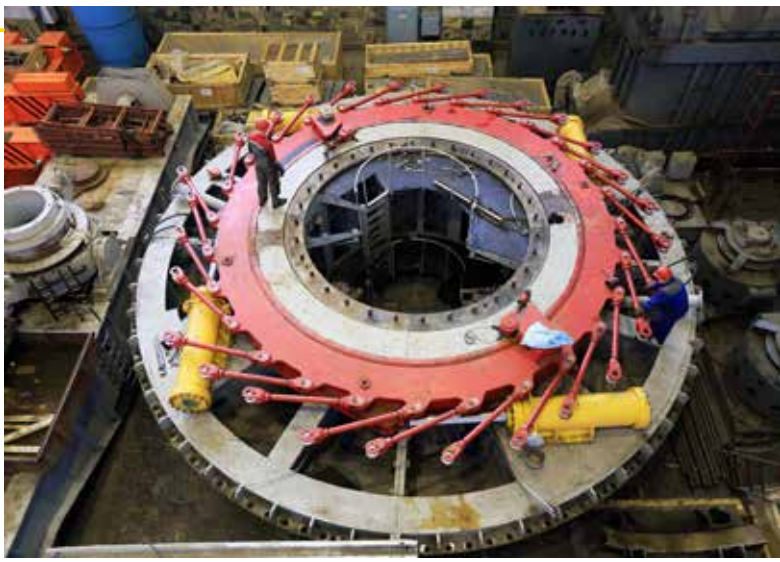
The energy-generating sector provides direct employment, and the electricity produced enables society to create the direct and indirect jobs in

Most energy production, and particularly electricity is either very dependent on cooling water or is generated as hydroelectricity

agriculture, industry and services that depend on power. The IEA predicts that about 7,200 gigawatts (GW) of capacity needs building to keep up with demand and replace existing facilities due for retirement by 2040 (IEA, 2014a). This observation is illustrated by the current almost non-stop construction of power plants in China, and should lead to many jobs in the engineering and contracting sectors with all their associated suppliers and sub-contractors as well as jobs to operate and maintain the installations.

Nevertheless, specific worldwide data about employment in the energy and power sectors is either generally lacking or the statistics may be included with other groupings. One analysis (Rutovitz et al., 2015) compared jobs predicted by IEA current policies projections (IEA, 2014b) with those of Greenpeace's Advanced Energy [R]evolution scenario (Teske et al., 2015) for low-carbon global energy supply up to 2030. The advanced Energy [R] evolution scenario assumes decarbonisation by 2050, and phases out coal, oil, gas and nuclear energy as fast as technically and economically possible using existing commercial technology. The scenario attains a renewable energy share of 42% in 2030, 72% in 2040 and 100% in 2050, including the power, heat and transport sectors. The only remaining use for fossil fuels (mainly oil) is in the non-energy sector, such as petrochemicals and steel production.

The report considered direct employment from electricity production such as jobs in fuel production, manufacturing, construction, and operations and maintenance. The results (Table 3.5) reveal that the reference scenario of the IEA shows an overall loss of one million jobs by 2030. In contrast, the [R]evolution scenario shows an increase of 10 million jobs by 2030, with nearly 20 million more energy sector jobs than the reference scenario, the main difference being in the renewable energy sector.



Hydroelectric machine hall in Naberezhnye Chelny (Russia)
Photo: © Vladimir Salman/Shutterstock.com

The IEA forecasts that between 2012 and 2040, the share of renewables, including hydroelectricity, in total power generation will increase from 21% to 33% and will supply almost half the growth in global electricity generation (IEA, 2014c).

With the increasing growth in renewable energy, there are new water/jobs dynamics as some types, such as solar photovoltaic (PV), wind and geothermal, essentially use no water, but show a growth in jobs. As is seen in Figure 3.8, wind and solar PV are predicted to show a steady increase in total (direct) jobs into the future and have more jobs per megawatt than biomass and conventional sources of energy.

The International Renewable Energy Agency (IRENA) (2015) paints an even more optimistic figure. It estimates that 7.7 million people worldwide were employed (directly or indirectly) in renewable energy in 2014. Solar PV was the largest employer with 2.5 million, followed by liquid biofuels with 1.8 million. Increased employment was noted across all types of renewable energy. In decreasing order, China, Brazil, the United States, India, Germany, Indonesia, Japan, France, Bangladesh and Colombia were the countries with the largest employment in the renewable sector. In addition, the report includes an estimate of 1.5 million (direct) jobs in large hydropower and 209,000 (direct and indirect) in small hydropower (IRENA, 2015). The development of small-scale hydropower near rural communities offers potential opportunities for job creation and the improvement of livelihoods (Box 3.1).

TABLE 3.5 WORLD EMPLOYMENT AND ELECTRICITY GENERATION BETWEEN 2010 AND 2030

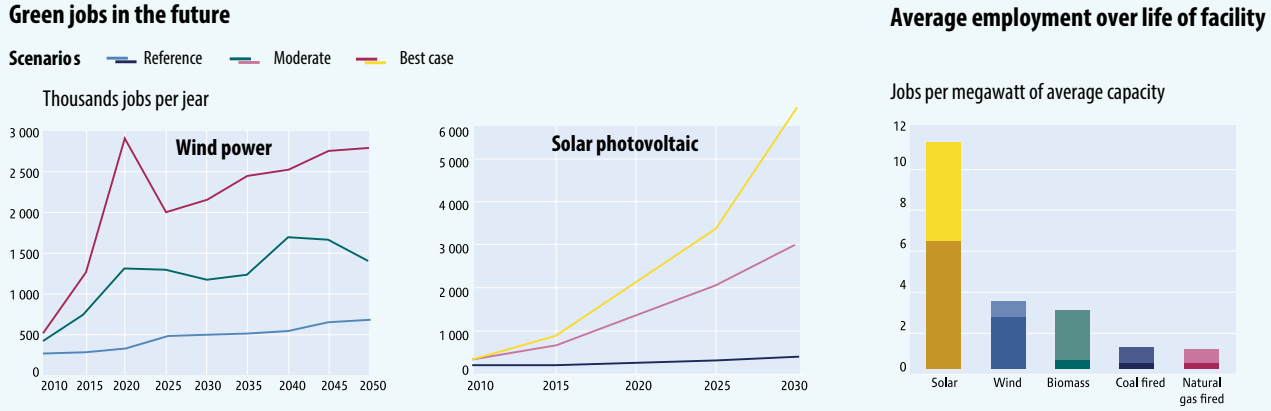
World	Reference scenario* (jobs in millions)			Advanced energy [R]evolution scenario** (jobs in millions)		
	2015	2020	2030	2010	2020	2030
Coal	9.7	9.6	7.6	9.68	4.78	1.96
Gas, oil and diesel	3.5	4.0	4.4	3.51	3.91	3.93
Nuclear	0.7	0.8	0.7	0.71	0.51	0.49
Renewable	14.5	15.2	14.6	14.48	26.28	39.76
Total Jobs	28.4	29.6	27.3	35.5	45.2	46.1

Notes:

* IEA (2014b)
** Teske et al. (2015)
Energy-efficient jobs included are only those over and above efficiency jobs in the reference scenario.

Source: Adapted from Rutovitz et al. (2015).

FIGURE 3.8 DIRECT JOBS IN RENEWABLE ENERGY



Source: UNEP/Grid-Arendal (n.d.).

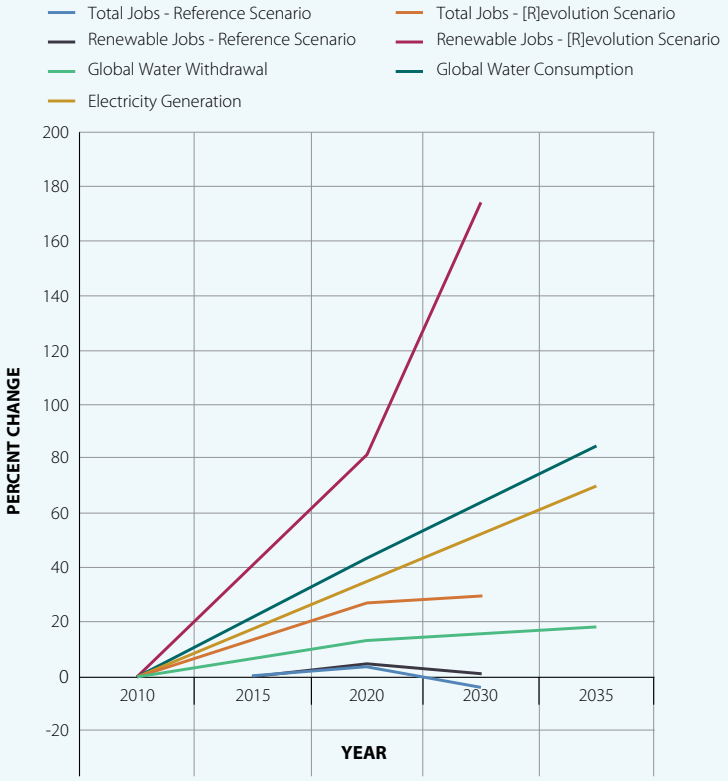
BOX 3.1 RURAL MINI-HYDRO – CLEAN ENERGY PROVIDING JOBS

Rwanda's efforts to reduce poverty and achieve greater economic growth are thwarted by a lack of electricity. The United Nations Industrial Development Organization (UNIDO) and the Ministry of Infrastructure (MININFRA) implemented a project to promote renewable-based energy development for productive uses, by providing access to affordable modern energy in rural areas through the establishment of mini-hydropower stations. Four pilot sites were selected and throughout construction, operation, maintenance and management of the facilities, UNIDO fostered the development of technical capacities and skills. The project provided 2,000 households, small businesses, cottage industries, schools and health centres with locally produced clean energy. The Government of Rwanda has decided to establish another 17 mini- and small-hydro sites; if replicated throughout the country, the additional stations would greatly contribute to employment creation and poverty reduction.

Source: Reproduced and adapted from UNIDO (2011).

The relationship between water, (direct) jobs and energy (electricity) based on data noted above are shown in Figure 3.9 (Rutovitz et al., 2015; IEA, 2012b and 2014b). They highlight that energy jobs will transfer into the renewable sector and that, while energy generation will steadily increase, water withdrawal will increase less and tend to level off, again reflecting the contribution of renewables that use less water. It is also interesting to note that water consumption will increase faster than withdrawal, mainly due to the move from once-through cooling to wet towers (closed loop evaporation) and the irrigation needs of biofuels (IEA, 2012b).

FIGURE 3.9 WATER, DIRECT JOBS AND ELECTRICITY



Source: Authors, based on Rutovitz et al. (2015), IEA (2012b and 2014b).

3.6 Water and jobs in industry

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Jobs and employment are frequently mentioned in the same sentence as industry, meant here to include large companies and small- and medium-sized enterprises (SMEs), comprising primary raw materials industries and manufacturing. It is good for business and for industry's profile to create direct jobs and this fits well into government agendas wishing to combat unemployment. Moreover, industry creates indirect spin off employment, as it requires suppliers and services (Box 3.2).

Industry, an important source of decent employment, provides almost 500 million jobs worldwide, which is about a fifth of the world's workforce (UNIDO, 2014). Within the OECD member countries in 2014, industry, including construction, employed 125.6 million people and manufacturing another 70.6 million (OECD, n.d.). Worldwide, some of the most water-intensive industry sectors employ great numbers of people: 22 million in food and drink (with 40% women); 20 million in chemical, pharmaceutical, and rubber and tyres; and 18 million in electronics (ILO, n.d.a.). Overall, industry (including energy) uses about 19% of the world's total water withdrawal (FAO, 2014f). In particular, according to the IEA (2012b), energy uses about 15% of the total, which implies approximately 4% for large industry

Controlling water quality in a waste water treatment plant
Photo: © Avatar_023/Shutterstock.com

and manufacturing. However, it is predicted that by 2050 manufacturing alone will increase its use by 400% (OECD, 2012c).

Industry's water-dependence ranges from the large users in food and beverage and the mining industry to SMEs. Water use is further expanded if the total water footprint (particularly the supply chain) of an industry or individual facility is considered. Water scarcity can have very serious effects on some major industrial sectors as noted in Table 3.6. Industry must have a reliable quantity of water of suitable quality for its use and has to manage it at least adequately, if not efficiently. In 2014, the Water Program of the Carbon Disclosure Project (CDP) reported that 53% of industrial respondents reported water risks in direct operations and 26% in supply chains (CDP, 2014).

Before any jobs materialize, a company must find a suitable location for its industrial investment. A number of factors are taken into consideration when an investment decision is made, and water and its possible scarcity, is one of them (others include local labour pools, raw materials, transportation, and potential markets). Any unsatisfactory factor can lead to the rejection of a location with the resulting impact of loss of future jobs. However, there is currently a lack of statistics to better understand the connection between water and jobs and the effect they have on one another.

Industry's water-dependence ranges from the large users in food and beverage and the mining industry to small- and medium-sized enterprises

Industry's continuing improvement in its understanding of the essential role of water in the economy, and of the environmental stresses placed upon the resource, has encouraged measures to reduce use and improve water productivity as value added per cubic meter of water (Grobicki, 2007). The change from supply to demand management in industry should, in theory, allow other sectors to grow using this saved water and generate more jobs as a result. If industry maintains production levels, the downside to increased water efficiency is potential job losses as high-tech equipment replaces parts the workforce. Conversely, based on the rebound effect (Ercin and Hoekstra, 2012), improved industrial efficiency may be utilized to increase production using the same amount of water, which may create more jobs. Statistics from Sweden (Box 3.3) show relationships between water abstractions, value added and employment in water-intensive industries where, interestingly, the level of employment has remained essentially constant, notwithstanding the decoupling (or not) of economic output from water use.

Attention is also being directed to water quality, particularly at the downstream end. In the worst case

BOX 3.2 CONSERVING WATER AND MULTIPLYING JOBS IN AFRICA

By 2020, SABMiller aims to 'reduce water use to three litres of water per litre of beer and 1.8 litres of water per litre of soft drink'. The company invested US$1.75 billion in its operations in Africa between 2008 and 2013, 'to create jobs, provide funding for infrastructure improvements and support a wide range of businesses up and down the value chain'.

An independent academic study found that SABMiller activities over the 2008-2013 period had the following impacts on jobs:

- In Ghana, the company directly employs 850 people, supporting 17,600 indirect jobs
- In Mozambique, at least 73,100 indirect jobs are supported
- In Uganda, each job at SABMiller supports over 200 indirect local jobs
- In Sub-Saharan Africa, 56 indirect jobs are supported for every direct employee, resulting in a total of 765,000 jobs.

Source: Reproduced and adapted from SABMiller (n.d.a., n.d.b and n.d.c).

TABLE 3.6 EFFECTS OF WATER SCARCITY IN MAJOR INDUSTRIAL SECTORS

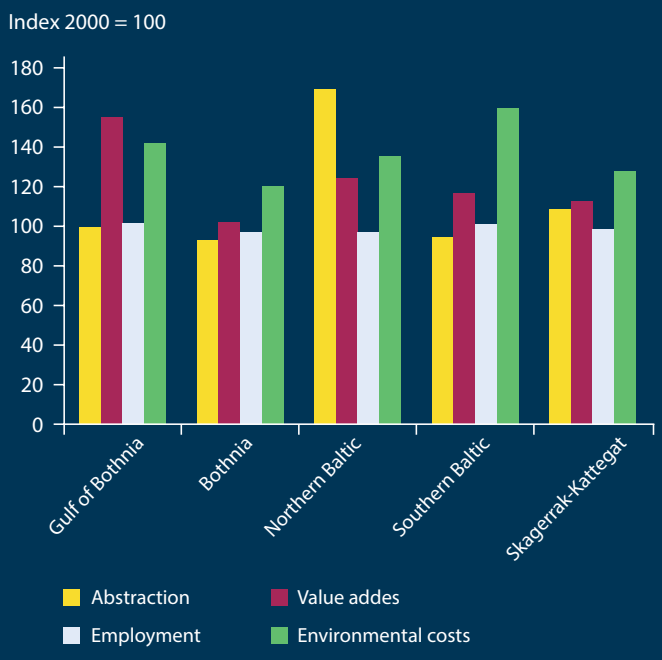
Sector	
Food and beverages	Manufacturing disruptions, higher commodity costs, higher power costs, loss of access to sources of bottled water
Manufacturing	Production disruptions, problems with discharge of liquid wastes
Semiconductor manufacturing	Production disruptions, higher costs for water purification, limits on expansion
Extractive industries	Potential restrictions on drilling, mining, use of slurry transport, and waste discharge

Source: Adapted from JPMorgan (2008, Table 2, p. 12, based on data from World Resources Institute).

scenario, severe effluent pollution could result in regulators closing a plant with all the attendant job losses. On the upside, efforts to reuse and recycle water, matching water quality to use and moving towards cleaner production, may lead to additional and likely better paid jobs (for more highly trained employees) within the industry, as well as outside for the manufacturers of the treatment equipment.

When considering the idea of decent jobs, a company or industry is likely to attract better-trained people and have a more productive workforce if it has a reputation of offering good workplace conditions. These factors should result in higher productivity. Higher profits could lead to increased investment in business, enabling beneficial water (and energy) saving technology. The reputational advantage of being seen as a green industry further compounds such benefits. Decent jobs are part of Inclusive and Sustainable Industrial Development (ISID), which is the cornerstone of UNIDO's work for sustainable economic growth, while safeguarding the environment (UNIDO, 2014).

BOX 3.3 EVOLUTION OF WATER ABSTRACTIONS, VALUE ADDED, EMPLOYMENT AND ENVIRONMENTAL COSTS IN WATER-INTENSIVE INDUSTRIES IN SWEDEN'S RIVER BASIN DISTRICTS, 2000–2005



- Water intensive industries achieved a clear decoupling of economic output from water use in the River Basin Districts of Gulf of Bothnia and southern Baltic. Water abstraction remained constant, and even decreased, while value added increased significantly. Decoupling can be seen to a lesser extent in the river basin districts of Bothnia and Skagerrak-Kattegat.
- By contrast, water abstraction increased significantly (60%) in the northern Baltic, while value-added increased by only 22%, indicating a continued strong link between water use and economic activity in the water-intensive industries there.
- Investments for treating and preventing environmental impact increased most in the southern Baltic.
- In all cases employment remained almost constant.

Source: Reproduced and adapted from EEA (2012, Fig. 4.9, p. 45, based on Sweden Statistics, 2007).

4

WATER JOBS

WWAP | Marc Paquin
With contributions from ILO, Kirsten de Vette, Robert Bos (IWA),
Archana Patkar and Emily Deschaine (WSSCC) and Catherine Cosgrove

Sewage treatment plant in Kavoor, Mangalore (India)
Photo: © Asian Development Bank

This chapter describes the different types of jobs found in traditional water sectors (water resources management, water infrastructure, and water services) and the related human resources needs.

4.1 Jobs in the water sectors

Overall, jobs in water sectors fall under one of three functional categories: a) water resources management, including IWRM and ecosystem restoration and remediation; b) building and managing water infrastructure; and c) the provision of water-related services, including water supply, sewerage, waste management and remediation activities (UN DESA, 2008).

Water resources management is critical for sustained economic development and aims at ensuring the protection, sustainable use and regeneration of water resources. This is the work of planners, managers, professionals, specialists, technicians and operators among others, whose work ranges from protecting ecosystems, rivers, lakes and wetlands to building the necessary infrastructure (e.g. dams and aqueducts) to store water and regulate its flow.

Building and managing infrastructure covers the provision and maintenance of water-related infrastructure (natural and man-made) for the management of the resource as well as for the provision of water-related services, including the management of floods and droughts. This requires planners, engineers, environmental specialists, and operators, to name but a few.

Water-related services for the provision of domestic water supply, wastewater management, sanitation and hygiene on one hand, and for economic uses on the other, such as in the energy, agriculture and industrial sectors, require jobs in many disciplines. These include legal, policy, institutional and regulatory frameworks, and functions addressing technical and financial planning, operation and maintenance, the construction of facilities, community mobilization, health promotion, and monitoring and evaluation.

Since water must be of sufficient quality to serve as an input for economic and non-economic activities and of adequate quality when it is returned to the environment, jobs related to the operation and maintenance of water and wastewater treatment plants are essential. Water supply and wastewater facilities operators employ about 80% of the workers in the water industry (UNESCO-UNEVOC, 2012). Although industry-wide numbers are not available on the global scale, the database of the International Benchmarking Network for Water and Sanitation Utilities (IBNET), an authoritative source for utility performance indicators worldwide and containing information from more than 4,000 utilities in 135 countries, estimates that the total professional staff in these utilities number about 623,000 (Danilenko et al., 2014).

Jobs in the water sectors serve as the building blocks for a wide array of water-dependent job opportunities linked to agriculture, energy, and the processing sector such as industrial and fuel production. These require substantial amounts of water, and in some instances they may also require water of a high quality (e.g. food transformation and production of pharmaceuticals).

4.2 Human resources needs

It is difficult to draw an accurate portrait of human resources demand in the water sectors, given that data concerning demand, capacity and availability in the sector is poor. Nevertheless, studies show an important human resources gap in the water services sector (IWA, 2014a). Information concerning human resources needs for water supply and sanitation is much better than for water resources management, mainly because of the assessments undertaken in response to the water and sanitation MDG. The more comprehensive Sustainable Development Goal (SDG) on water will provide an opportunity to examine human resources needs more closely in other water sectors.

A variety of countries, from Indonesia to the Netherlands, are faced with systemic issues such as staff attrition, erosion of experience and weak interest from new graduates to join the water sectors, and these will have an impact well beyond 2020. Across OECD countries in particular, the gap is increasing due to an ageing workforce (Wehn and Alaerts, 2013). Industry estimates indicate that 30%

to 50% of the current water utilities workforce in the United States is eligible for retirement by 2020 (Snow and Mutschler, 2012).

In lower- and middle-income countries, efforts to meet the water and sanitation MDG target to halve the proportion of the population without sustainable access to safe drinking water and basic sanitation has led to substantial investments in infrastructure, technological innovation and institutional reform. However, sufficient attention has not been paid to ensuring that the corresponding human resource base needed to design, construct, operate and maintain the services is in place, nor whether it would be adequate to carry longer-term efforts towards universal coverage (IWA, 2014b). Similarly, the growing needs for rehabilitation of ageing infrastructure in all countries face the challenge of closing financial and human resource gaps (United States Conference of Mayors, 2008a; WWC/OECD, 2015).

According to the WHO's biennial Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS), those gaps constitute a real threat to sustaining the achievements of the MDG's efforts. According to GLAAS, of the 67 countries that reported on systems operation and maintenance, only 27 countries had sufficient staff to operate and maintain their urban drinking water systems, and only 11 had the capacity to operate and maintain their rural drinking systems. Less than 20% of countries considered the supply of skilled labour and technicians sufficient to meet the needs in rural sanitation (WHO, 2014).

While more research is needed to further specify the nature and size of these gaps, another study, conducted in 10 countries (Burkina Faso, Ghana, Laos, Mozambique, Niger, Papua New Guinea, Senegal, Sri Lanka, and Tanzania) reveals a cumulative shortfall of 787,200 trained water and sanitation professionals in order to achieve universal coverage in water and sanitation (IWA, 2014a).

> Jobs in the water sectors serve as the building blocks for a wide array of water-dependent job opportunities linked to agriculture, energy, and the processing sector such as industrial and fuel production

Reasons for these gaps vary widely, but include: lack of financial resources for hiring and retaining staff (salaries and benefits), especially in the public sector; the difficulty of attracting skilled workers to live and work in rural areas; a mismatch between courses offered and job requirements; shortage of funding of educational institutions; cost of tuition; absence of continuous training systems in many countries; lack of government policies to create an enabling environment; image problems and a stigma associated with the sanitation sector in particular (UNESCO-UNEVOC, 2012; IWA, 2014a; WHO, 2014). In many regions, including West Africa, it is difficult to attract employees to work in sanitation facilities, often due to taboos related to issues like faeces (WaterAid, 2009).

WASH staff shortage in many developing countries is severe (IWA, 2014a), due to a variety of reasons ranging from reluctance to invest in this component, rigidly imposed government staff quotas, poorly targeted education, unattractiveness of the sanitation sector, and the absence of continuous learning and professional development.

Higher-income countries face different challenges in getting the numbers and qualification of their WASH personnel correct. Baby boomers who entered the sector in the 1970s will soon be retiring, with the risk of significant brain drain on the sector's knowledge base, experience and expertise.

The International Water Association (IWA, 2014a) identified a number of critical bottlenecks, based on analyses in some 15 countries in different developing regions of the world. A selection of findings includes:

- The human resources shortage is the largest in technical fields that are not specialized in water/ sanitation-mid-level technicians and engineers. The areas of work with the highest need are Operations and Maintenance, Monitoring and Evaluation and the social development disciplines (WHO, 2014). The latter is due to increased need for community mobilization, as well as increased participatory approaches (e.g. utility informal settlement departments);
- Qualification levels and critical numbers of professional capacity differ between rural and urban systems, especially in countries where piped supplies in rural settings are impractical or impossible. Rural areas rely more on informal workers, less complex technologies and or community-managed systems; urban areas rely on higher qualifications to handle larger volumes (especially in light of urbanization) and more complex technologies;
- The sector lacks incentives for workers (IWA, 2014a; WHO, 2014) in form of remuneration, benefits for working in rural areas or the sanitation sector. A general lack of human resource management, planning, development and evaluation of staff seemed to be non-existent in many countries; and
- Lack of coordination between industry needs and supply from education institutes (whether Academia/Technical Vocational Education and Training) result in a gap in skills required on the job.

Promoting adequate technical capacity to support water and wastewater management is an important part of the policy package for addressing water challenges in many countries (UNESCO-UNEVOC, 2012). Only one third of the 94 countries surveyed in the 2014 GLAAS report indicated that they have a human resource strategy in sanitation, drinking water and hygiene covering urban and rural areas (WHO, 2014). Solutions to filling these gaps include creating an enabling policy environment for collaborative frameworks between the education sector, sector employers (public, private and non-governmental organizations (NGOs), trade unions and employees; developing incentives to attract and retain staff; strengthening technical and vocational training; and giving attention to human resources capacity development in rural areas (IWA, 2014a, 2014b; Kimwaga et al., 2013; UNESCO-UNEVOC, 2012).

It is important to note, however, that lessons from past green jobs efforts show that when workers are specifically trained for occupations that are green and entirely new, they can be left with limited options for employment, unless their training also prepares them for more conventional occupations (Pacific Institute, 2013).

5

WATER, JOBS AND SUSTAINABLE DEVELOPMENT

Students wash their hands after using bathroom at Dima Guranda Primary School (Ethiopia)
Photo: © UNICEF Ethiopia/2014/Ose

This chapter tackles the most salient legal and policy frameworks (human rights, the green economy, sustainable development and gender) to be considered by policy-makers when addressing the water and jobs nexus.

5.1 The human right to safe drinking water and sanitation

WWAP | Marc Paquin
With contributions from Catherine Cosgrove

The right to safe drinking water and sanitation is an internationally recognized human right and integral to the realization of other human rights, most notably the right to life and dignity, to adequate food and housing, and to health and well-being, including the right to healthy occupational and environmental conditions. In spite of this, a very large proportion of the world's population does not enjoy this right in all its dimensions (sufficient quantity, quality, regularity, safety, acceptability, accessibility and affordability) (UNGA, 2010a). Stark disparities, notably across regions and between urban and rural areas, also remain (UNICEF/WHO, 2015).

Moreover, there are altogether 2.3 million work-related deaths annually (ILO, n.d.b.). According to ILO, work-related communicable diseases contributed to 17% of those deaths and, in that category, the main contributing and preventable factors comprised: poor-quality drinking water, poor sanitation, poor hygiene and related lack of knowledge (ILO, 2003b). Estimates indicate that poor occupational safety and health practices reduce global GDP by 4% each year (ILO, 2014b).

These figures underscore the need for countries to accelerate the pace of their efforts towards securing safe drinking water and sanitation for all, including in the workplace. Implementation of the post-2015 development framework and the SDGs call for a substantial acceleration in the pace of change in this regard.

In the words of the former UN Special Rapporteur, El Hadji Guissé: 'The Universal Declaration of Human Rights has arguably recognized implicitly the right to drinking water and sanitation in article 25 (1), which states that 'everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care …' (UN, 2004, p. 2). In 2010, the UN General Assembly confirmed this interpretation by affirming 'the human right to safe drinking water and sanitation is derived from the right to an adequate standard of living and inextricably related to the right to the highest attainable standard of physical and mental health, as well as the right to life and human dignity' (UNGA, 2010b, para. 4).[9]

For its part, the Committee on Economic Social and Cultural Rights states: 'The human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses' (UN, 2003, para. 3). The Committee further asserted that the water supply for each person must allow for personal and domestic uses, including drinking, personal sanitation, food preparation, personal and household hygiene. Moreover, ensuring that everyone has access to adequate sanitation is fundamental for human dignity and privacy, is essential for protecting the quality of drinking water supplies and resources (UN, 2003, paras. 2, 12 and 37).[10]

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[9] The right to water is also implicitly or explicitly recognized in a number of other international agreements and declarations such as: Human Rights Council Resolution A/HRC/RES/15/9 (UNGA, 2010c); International Covenant on Economic, Social and Cultural Rights. Adopted by the UN General Assembly resolution 2200 A (XXI) of 16 December 1966. Entry into force: 3 January 1976 (UNGA, 1966); Convention on the Elimination of All Forms of Discrimination against Women. Adopted by the UN General Assembly resolution 34/180 of 18 December 1979. Entry into force: 3 September 1981 (UNGA, 1979); Convention on the Rights of the Child. Adopted by the UN General Assembly resolution 44/25 of 20 November 1989. Entry into force: 2 September 1990 (UNGA, 1989); Convention on the Rights of Persons with Disabilities. Adopted by the UN General Assembly resolution 61/106 of 13 December 2006. Entry into force: 3 May 2008 (UNGA, 2006).

[10] Also note, the Outcome document of the high-level plenary meeting of the UN General Assembly known as the World Conference on Indigenous Peoples, which the UN General Assembly adopted on 22 September 2014, declared the right to equal access to water and sanitation (UNGA, 2014a). The plenary further committed to ensure 'high-level education that recognizes the diversity of the cultures of indigenous peoples and to health, housing, water, sanitation and other economic and social programmes to improve well-being, including through initiatives, policies and the provision of resources' (UNGA, 2014a, para. 11).

> The right to safe drinking water and sanitation is an internationally recognized human right and integral to the realization of other human rights

Draft guidelines were elaborated to assist government policy-makers, international agencies and members of civil society working in the water and sanitation sector to implement the right to drinking water and sanitation (UN, 2005).

5.2 The human right to decent work

WWAP | Marc Paquin
With contributions from Catherine Cosgrove

The right to decent work is an internationally recognized human right. A subset of economic, social and cultural rights, the right to work is enunciated in article 23 (1) of the 1948 Universal Declaration of Human Rights (UN, 1948), which states: 'Everyone has the right to work, to free choice of employment, to just and favourable conditions of work and to protection against unemployment.'

To ensure that work conditions are decent, article 7 of the International Covenant on Economic, Social and Cultural Rights further stipulates 'the right of everyone to the enjoyment of just and favourable conditions of work' (UNGA, 1966) that ensure, among others: remuneration that provides fair wages and equal pay for equal work and a decent living for the employees and their families; leisure and reasonable limitation of working hours; the right to form and join trade unions; and the right to safe and healthy working conditions.[11]

ILO Convention No. 122 (ILO, 1964), or Employment Policy Convention, which was ratified by 108 Member States, seeks to stimulate economic growth and development, raise levels of living, meet manpower requirements and overcome unemployment and underemployment. For that purpose, it requires ratifying states to pursue 'an active policy designed to promote full, productive and freely chosen employment' (article 1.1). Employment policies, however, 'shall take due account of the stage and level of economic development and the mutual relationships between employment objectives and other economic and social objectives, and shall be pursued by methods that are appropriate to national conditions and practices' (article 1.3). Therefore, social dialogue[12] between government, employers and workers are an important means to deliberate on the desired policy.

Under the Global Jobs Pact (ILO, 2009), the ILO's constituents, comprising governments as well as workers' and employers' organizations, agreed to put the aim of full and productive employment and decent work at the heart of the crisis responses (item 11). In this context, item 14 provides that 'international labour standards create a basis for and support rights at work and contribute to building a culture of social dialogue'. Furthermore, the preface to the pact underlines that 'respecting fundamental principles and rights at work, promoting gender equality and encouraging voice, participation and social dialogue are also critical to recovery and development. Adopted in an integral and coordinated manner, these policies can reduce social tensions, mitigate the negative impact of the recession on people, stimulate aggregate demand and reinforce both competitive market economies and a more inclusive growth process' (p. v).

It should be emphasized that human rights are all interrelated, interdependent and indivisible, and the improvement of one right facilitates advancement of the others, while the deprivation of one right adversely affects the others. (OHCHR, n.d.) Notably, the right to safe and healthy work conditions is incumbent on the fulfilment of the right to safe drinking water and sanitation in the workplace. Unsafe drinking water, poor sanitation and inadequate hygiene can have severe negative consequences for workers, including loss of ability to

[11] To implement these goals, the ILO has adopted Conventions Nos. 1, 30, 87, 98, 100, 111, 155 (ILO, 1919, 1930, 1948, 1949, 1951,1958 and 1981), and several others for safety and health in specific water-intensive economic sectors, including mining (No. 176) (ILO, 1995) and agriculture (No. 184) (ILO, 2001).

[12] Social dialogue consists of any form of information exchange, consultation or negotiation, with the intent of transparent and collaborative decision-making.

BOX 5.1 HUMAN RIGHTS-BASED APPROACH

The human rights based approach is a human development conceptual framework that is based on international human rights standards and directed to promoting and protecting human rights, such as the right to safe drinking water, sanitation and decent employment. This approach is also used to give legitimacy and strengthen the voice of those who are not usually heard, the excluded individuals and groups, particularly women, children and those who are discriminated against.

Source: de Albuquerque and Roaf (2012, p. 106).

work to secure a livelihood, poor health and loss of life. Fulfilling both of these rights is therefore part and parcel of the right to decent work (UN, 2004).

These linkages were evidenced in the 2014 report of the UN Special Rapporteur on the human right to safe drinking water and sanitation, which states: 'Violations of the human rights to water and sanitation frequently correlate with broader deprivations and other violations, including of the human rights to life, health, food, housing, education, work and a healthy environment ' (UNGA, 2014b, para. 6) (Box 5.1).

For economic social and cultural rights, such as the right to safe drinking water and sanitation and the right to work, states undertake, to the maximum of their available resources, to take steps to achieve progressively and by all appropriate means the full realization of these rights (UNGA, 1966, article 2).

Accordingly, State parties have an obligation to progressively provide safe drinking water and adequate sanitation services to prevent, treat and control diseases linked to water, including in the workplace. Similarly, they also have the obligation to guarantee that the right to water is enjoyed without discrimination, and equally between men and women (UN 2003, paras. 2 and 13). The human right to safe drinking water and sanitation often conflicts with existing water rights and/or other governance arrangements. Water rights systems that discriminate or prevent the progressive realization of the human right to safe drinking water and sanitation contradict State obligations and are in violation of that human right.

5.3 Job creation opportunities in a green economy

WWAP | Marc Paquin
With contributions from Catherine Cosgrove

The shift towards a greener economy is changing the range of tasks associated with various jobs, as well as well as working conditions, as a result of new technologies, processes and practices. The employment potential of the water sectors is likely to increase following 'green' restructuring within industry sectors, in a variety of countries (e.g. Estonia, France, India, South Korea, Spain and the United States) (ILO, 2011a).

Water planning and governance can be a powerful instrument to coordinate advances in many areas such as agriculture, energy, manufacturing, tourism and land settlements, while managing growing demands for limited water resources. This requires considering water management as a horizontal axis of economic public policy (UNW-DPC, 2012; OECD, 2012a). Chapter 11 of this report discusses in detail the considerable multiplier effect water jobs have on the economy and jobs in general.

Government decision-making plays a central role in such an approach, with investments and maintenance costs in the water sectors largely stemming from public sources. For instance, in developing countries large infrastructures are predominantly (75%) funded through government budgets and long-term finance from state banks. Moreover, about 90% of the total funding of catchment management and protection of aquatic

BOX 5.2 EXAMPLES OF NEW PROFESSIONS IN THE WATER SECTOR

Being an engineer in the water industry is a new profession in Australia. It entails technical skills in hydrogeology, water-sensitive urban design, flood-plain assessment and aquifer storage and recovery, management skills, knowledge of water trading, management of environmental flows, emerging and future water quality issues, salinity solutions. etc. Skills for wastewater management are also included.

A new profession in Spain is that of the desalination plant maintenance and operation manager who oversees the process of turning seawater into fresh drinking water (ILO, 2011a).

ecosystems in 2013 – estimated at US$9.6 billion – came from public funds (WWC/OECD, 2014). As such, it is not surprising that thematically the second largest proportion of green stimulus spending has been allocated to water and waste, after energy efficiency (ILO, 2011a).

In the United States, it is estimated that investments in traditional water infrastructure generate 10 to 26 jobs per US$1 million invested. In addition, some data suggest that investments in sustainable water projects, such as urban conservation and efficiency, restoration and remediation and alternative water supplies also generate large numbers of jobs, namely between 10 and 72 jobs per US$1 million invested (Pacific Institute, 2013).

Implementing sustainable water management requires a broad range of occupations some of which are quite new (Box 5.2). For instance, 136 occupations were identified by the Pacific Institute as being involved in achieving more sustainable outcomes in agriculture, urban residential and commercial settings, restoration and remediation, alternative water sources and stormwater management (Pacific Institute, 2013).

For green strategies to succeed, the timely identification of required skills is needed in targeted sectors (ILO, 2011a). Sustainable water strategies can create jobs in traditional occupations, which require no new skill sets (from truck drivers to lawyers); jobs in emerging occupations requiring vocational qualifications at upper secondary level, such as those dealing with the use and maintenance of technology; and less frequently, the strategies can create entirely new occupations that tend to require high-level qualifications (ILO, 2011a; Pacific Institute, 2013). This seems to hold true in developing, emerging and industrialized countries alike (ILO, 2011a).

Policy-makers, educational and vocational institutions as well as industry stakeholders must consider these elements in an integrated way and not in isolation from one another as they address the increasing and evolving demand in human resources.

5.4 Water, jobs and the Sustainable Development Goals (SDGs)

WWAP | Marc Paquin
With contributions from Catherine Cosgrove

In September 2015, the international community adopted the 2030 Agenda for Sustainable Development, which contains a set of SDGs. These goals, built on the foundation laid by the MDGs, seek to complete the unfinished business of the MDGs and respond to new challenges. They constitute a set of global priorities for sustainable development, break away from the restricted MDG vision of water that focused mainly on water supply and sanitation, and return to the essential full water cycle view. As opposed to the MDGs, the scope of the SDGs is not limited to developing countries.

The process of national, regional and global thematic consultations initiated by the UN to support member States in formulating a global development framework beyond 2015 was extensive in its scope and content. It engaged nearly one million people from countries in all regions, including representatives of employers and unions. Increased job opportunities

in water and sanitation were among the top priorities identified by the UN's MY World 2015 global survey for inclusion in the next agenda (UN, n.d.), together with education, health care, and honest and responsive governments. Job creation also emerged as a pressing need in nearly all the countries where the UN held national consultations, and it was among the key priorities identified by the UN Regional Commissions. The Future Goals Tracker by the Overseas Development Institute (ODI, n.d.), with about 150 proposals, revealed a similar pattern.

Goal 6 of the SDGs specifically aims to ensure availability and sustainable management of water and sanitation for all (Box 5.3)

Goal 6 is wide-ranging, setting objectives spanning from the protection and integrated management of water resources to access to safe and affordable drinking water and sanitation for all. It expands

> Water planning and governance can be a powerful instrument to coordinate advances in many areas such as agriculture, energy, manufacturing, tourism and land settlements

the agenda from WASH to cover the entire water cycle, including wastewater management and ambient water quality, water use and efficiency, water resources management and water-related ecosystems.

Water also percolates across most of the other SDG goals (Box 5.4). As stated in the WWDR 2015: 'Water's role in underpinning all aspects of sustainable development has become widely

BOX 5.3 ***SUSTAINABLE DEVELOPMENT GOAL 6*** – ENSURE AVAILABILITY AND SUSTAINABLE MANAGEMENT OF WATER AND SANITATION FOR ALL

- **6.1** By 2030, achieve universal and equitable access to safe and affordable drinking water for all
- **6.2** By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations
- **6.3** By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
- **6.4** By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
- **6.5** By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate
- **6.6** By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes
- **6.a** By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies
- **6.b** Support and strengthen the participation of local communities in improving water and sanitation management

Source: UNGA (2015).

BOX 5.4 WATER-RELATED SUSTAINABLE DEVELOPMENT GOALS

In addition to Goal 6, water has a bearing on, or is impacted by the following SDGs:

Goal 1 End poverty in all its forms everywhere

Goal 2 End hunger, achieve food security and improved nutrition, and promote sustainable agriculture

Goal 3 Ensure healthy lives and promote well-being for all at all ages

Goal 7 Ensure access to affordable, reliable, sustainable, and modern energy for all

Goal 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Goal 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 10 Reduce inequality within and among countries

Goal 11 Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations

Goal 12 Ensure sustainable consumption and production patterns

Goal 13 Take urgent action to combat climate change and its impacts

Goal 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Source: UNGA (2015).

BOX 5.5 *SUSTAINABLE DEVELOPMENT GOAL 8* – PROMOTE SUSTAINED, INCLUSIVE AND SUSTAINABLE ECONOMIC GROWTH, FULL AND PRODUCTIVE EMPLOYMENT AND DECENT WORK FOR ALL

[…]

8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services

8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value

8.8 Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment

Source: UNGA (2015).

There is inadequate sex-disaggregated data available related to the participation of men and women in water-dependent employment

recognized. It is now universally accepted that water is an essential primary natural resource upon which nearly all social and economic activities and ecosystem functions depend' (WWAP, 2015, p. 9).

Specifically, water is relevant to many aspects of SDG 8, which pertains to the promotion of sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all (Box 5.5).

Additional references to labour-related concerns are found in several other SDG targets. The question of social protection is a core target for action under the poverty and health goals (1 and 3) and is mentioned together with wage and fiscal policies as a means to address inequality. Technical and vocational skills are the topic of three targets under the education goal. Other references relate to rural workers, workers in the health and education sectors, unpaid care and domestic work, migrant workers, SMEs in value chains, resilience to climate-related hazards and economic, social and environmental shocks and disasters, discrimination, and fundamental freedoms.[13]

5.5 Bridging the gender gap

WWAP | Vasudha Pangare with contributions from Lesha Witmer, Richard Connor and Marc Paquin

The central role of women in the provision, management and safeguarding of water has been recognized at the international level, including at the 1977 United Nations Water Conference at Mar del Plata, Argentina, and at the 1992 International Conference on Water and the Environment in Dublin, Ireland. Agenda 21 (UNSD, 1992, Chapter 18, para. 18.9.c.) and the Johannesburg Plan of Implementation (WSSD, 2002, para. 25) also underlined the importance of women in water management. Furthermore, the International Decade for Action, 'Water for Life' (2005-2015), calls for women's participation and involvement in water-related development efforts.

Firefighter during a fire drill at Garantung village, Palangkaraya (Indonesia)
Photo: © Achmad Ibrahim/Center for International Forestry Research (CIFOR)

Evidence from various economic sectors demonstrates the significant contribution women can make in formal positions at the highest levels. A report by Catalyst (2011) stated that Fortune 500 companies with three or more women on their board showed a significant performance advantage over those with fewer women in these positions. Similarly, McKinsey & Company (2013) found that companies with a higher percentage of women on executive committees performed significantly better than their all-male counterparts. Qualitative analyses also show that women's involvement in the management of water resources and water infrastructure can improve efficiency and increase outputs (GWTF, 2006; van Koppen, 2002).

5.5.1 Exploring the gender gap

The gap in labour market participation between men and women has decreased only marginally since 1995. Globally, about 50% of women were working in 2014, compared to 77% of men. In 1995, these figures were 52% and 80% respectively (ILO,

[13] The findings of the ILO's World of Work Report 2014 (ILO, 2014a, p. xxiii) sustained the proposal to establish this goal: 'sustained development is not possible without making progress on the employment and decent work agenda. By putting in place policies and institutions that help create more and better jobs, the process of development will be facilitated. Conversely, economic growth is not sustainable when it is based on poor and unsafe working conditions, suppressed wages and rising working poverty and inequalities. In addition to their impact on economic growth, jobs, rights, social protection and dialogue are integral components of development.'

2015b). Women continue to experience widespread discrimination and inequality in the workplace. In many parts of the world, women often occupy undervalued and low-paid jobs and still shoulder responsibility for most unpaid care work. Unpaid work, which often goes unrecognized, can hinder women's active participation in paid employment. Many women lack access to education, training and recruitment, and have limited bargaining and decision-making power (ILO, 2015b). Affirmative action, the implementation of supporting policies and expanded access to public services and investment in time- and labour-saving infrastructure can help to speed-up the process of closing the gender gap (UN Women, 2015).

Women's role in making water available for the household is an important area of 'unpaid work' that negatively impacts women's participation in the formal labour market. Time spent fetching water (and fuel) reduces the time that can be devoted to generating livelihoods or remunerated work, whether in the formal or informal economy. Women (and girls) perform most unpaid water fetching work. About three quarters of households in sub-Saharan Africa fetch water from a source away from their home (UNICEF/WHO, 2012) and 50% to 85%of the time, women are responsible for this task (ILO/UNDP WGF, forthcoming). The likelihood of a woman being the responsible person also increases the more time is needed per trip (Sorenson et al., 2011). In South Africa, in poor rural households, women who fetch water and fuel wood spend 25% less time in paid employment (Valodia and Devey, 2005) (see Box 5.6).

Access to sanitation is also an important determinant to the participation of young girls and women in many spheres of life, including, most importantly, education and employment (Adukia, 2014; Pearson and McPhedran, 2012; World Bank, 2011; WaterAid, n.d.). Although this issue is more prevalent in developing countries, access to toilets in the workplace is something that women need in all parts of the world. By addressing women workers' menstrual needs, workplace practices and human resource manuals worldwide could achieve measurable productivity gains (Box 14.1). Lack of gender-segregated toilet facilities can also discourage girls from attending school during their menstrual cycles. The Commission on the Status of Women (CSW) at its 55th session underlined that

BOX 5.6 WATER FETCHING: ECONOMIC AND HEALTH IMPACTS OF WOMEN'S UNPAID WATER WORK

Carrying water appears to have direct detrimental impacts on the mental and physical health of the carrier, and his or her ability to participate in domestic, formal and informal work. Both children and adults link persisting pain or movement problems with water fetching (Geere et al., 2010a, 2010b; Lloyd et al., 2010) and the task may be an important factor in pain and disability linked to spinal musculoskeletal disorders and cervical compression syndromes (Evans et al., 2013).

In addition, water fetching can contribute to psychosocial and emotional distress, which can influence perceptions of general health, disability related to musculoskeletal disorders as well as work performance and satisfaction (Diouf et al., 2014; Stevenson et al., 2012; Wutich, 2009). Incidents and fear of physical and sexual violence is widely reported by women and children in relation to water fetching (Sorenson et al., 2011).

The effects of water fetching on women's health and abilities to work are more pronounced in low- and middle-income countries where a greater proportion of people are engaged in physically demanding, informal or poorly regulated work environments (Hoy et al., 2014). Furthermore, since economic, political and social inequalities are reflected in the access to drinking water (UNICEF/WHO, 2014), it is likely that marginalized groups suffer disproportionally from the negative economic and health impacts of water fetching.

Source: ILO/UNDP WGF (forthcoming).

BOX 5.7 WHERE THERE IS A WILL, THERE IS A WAY

In Uganda, the Directorate of Water Development (Ebila, 2006) measured the gendered levels of participation in water and sanitation committees and collected sex-disaggregated data on staff in different positions in the department. They found that the number of male staff was far greater than the number of women staff and decided to improve the gender balance in the water sectors by 30% in five years. To address this challenge, a gender working group was formed which included representatives from the Ministry of Gender, Labour and Social Development.

The 19th International Conference of Labour Statisticians (2013) adopted new international statistical standards that will refine the way in which countries measure traditional key headline indicators of the labour market, including labour force participation rates, employment to population ratios and unemployment rates. Importantly, a conceptual framework to separately measure all forms of work, paid and unpaid, was also introduced, aiming to address the growing demand for gender sensitive indicators to inform a broader range of economic and social policies. New measures of labour underutilization and access to labour markets will have strong implications for women and for gender equality.

the provision of drinking water and separate and adequate sanitation facilities as a factor of women's participation in the labour market which are rights germane to gender equality, and adequate standard of living and dignity.

5.5.2 Responses and opportunities

A number of measures can be undertaken to improve women's participation in, and contribute to, the water-dependent workforce.

Collect and disseminate a baseline of sex-disaggregated data related to the participation of men and women in the water-dependent workforce

There is inadequate sex-disaggregated data available related to the participation of men and women in water-dependent employment. The collection and dissemination of such data at global, regional, national and local levels would not only provide baseline information about men and women in the water work force, but also help in monitoring progress towards reducing the gender gap (Box 5.7). There is also a need to recognize the existence of social and cultural diversity among men and women in order to understand the differences in opportunities for employment that would be available to them.[14]

Address cultural barriers, social norms and gender stereotypes through gender sensitization

Social norms, perceptions and gender stereotyping often act as barriers to securing employment for men and women and limit the choices and opportunities available to them. Jobs can be stereotyped as being male or female and as a result influence not only job seekers but also employers (for example, employment opportunities in agriculture and fisheries value chains are often restricted by gender stereotyping). Boys and girls are also often steered towards education choices that are socially pre-determined.

In this respect, the importance of gender sensitization has been reiterated often and still remains a priority. More and better information on the existence of these social and cultural norms is required to understand the existing barriers to employment applicable to each sex and to identify ways to overcome them. The social acceptability of men doing unpaid work, which can free up women's time to take on paid work, would also benefit from focus gender sensitization.

[14] A list of priority indicators for data collection, methodology, guideline on how to collect the data and questionnaire for collecting the data is available from the UN WWAP UNESCO Project for Gender Sensitive Water Monitoring Assessment and Reporting at http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/water-and-gender/ (Seager, 2015; Pangare, 2015; WWAP Working Group on Sex-Disaggregated Indicators, 2015).

Adopt and support equal opportunity policies and measures

No effort at reducing the gender gap in employment can be successful unless proactive measures are put in place to remove the barriers preventing women's equal access to employment opportunities.

First, governments and employers need to design gender-sensitive recruitment and human resource policies and practices that take into account the often-distinct realities of men and women (Morton et al., 2014). Second, women must be given equal access to productive assets and resources, such as land and water, which are crucial in areas of self-employment such as in agriculture (FAO, n.d.). Third, the technical capacity of women needs to be developed. Many actors can contribute in this regard be it at the local or community level, either formally or informally. This is sine qua non to improve women's employability (see Box 5.8).

Through innovation and measures to green the economy, new job opportunities arise that present an opportunity for concerted efforts to raise women's employability for those jobs. Where new skills need to be developed, training and skill-building initiatives should be designed with women and men in mind. It is important to remember, however, that economic changes resulting from innovation or new priorities (e.g. greening the economy policies) can lead to both positive and negative impacts. From a gender perspective, it is important to make sure that women are in a position to secure the benefits that arise and that women do not disproportionately suffer from the negative consequences (see Box 5.9).

BOX 5.8 WOMEN WATER ENTREPRENEURS IN GHANA

Saha Global[15] has trained women to treat contaminated water from the local village sources with locally available technology to make the water safe to drink and then sell this clean drinking water to the local community. The organization has provided jobs to 178 women entrepreneurs in northern Ghana over a seven-year period. The women supplement their income from farming by selling water, earning an extra US$1-2 per week for five hours of work. For a family living on less than US$2 each day, the money they earn can be significant, and these resourceful women can use it to invest in the welfare of their children and communities. 'These women are empowered by the opportunity to use their skills and expertise to provide for their community. They are proud to give back, to help others and to create a better world for their children.'

[15] This blog post is part of the 'WASH and the MDGs: The Ripple Effect' blog series, in partnership with WASH Advocates, addressing the importance of WASH to global development. Available at http://www.huffingtonpost.com/kate-clopeck/empowering-women-entrepre_b_7058122.html

BOX 5.9 GREEN TECHNOLOGY CAN DISPLACE WOMEN'S MANUAL LABOUR IN AGRICULTURE

Direct-seeded rice (DSR) can significantly reduce the amount of water needed to grow the crop. According to the Indian Agricultural Research Institute (Foodtank, 2014), DSR eliminates the need for water for sowing seeds and reduces the amount of water required for growing rice by about 60%. The planting is sometimes done by machine, though more often by hand, especially in the developing world. Direct sowing can reduce labour demands necessitated by transplanting by up to 40% (Pathak et al., 2011). An IFPRI study (Paris et al., 2015) found that there was a 50% reduction in labour use when farmers used DSR, leading to a loss of income for poor women who work as hired agricultural workers for transplanting. The reduction in labour benefitted women from farming households that employ the workers.

6

AFRICA

WWAP | Stephen Maxwell Kwame Donkor
With contributions from Kalkidan Shawel

Work and childcare in Porto Novo (Benin)
Photo: © Anton_Ivanov/Shutterstock.com

This chapter focuses on the challenges and expected future developments related to Africa's water resources, policy frameworks, economy and jobs, with a focus on jobs in water-dependent sectors.

6.1 Challenges related to Africa's water resources

Africa has about 9% of the world's fresh water resources and 11% of the world's population. (World Bank, n.d.a.). Sub-Saharan Africa faces numerous water-related challenges that constrain economic growth and threaten the livelihoods of its people. African agriculture is mostly based on rainfed farming and less than 10% of its cultivated land is irrigated (World Bank, n.d.a.). There is very significant inter- and intra-annual variability of all climate and water resources characteristics. The impact of climate change and variability is thus very pronounced. The main source of electricity is hydropower, which contributes significantly to the current installed capacity for energy. Continuing investment in the last decade has increased the amount of power generated.

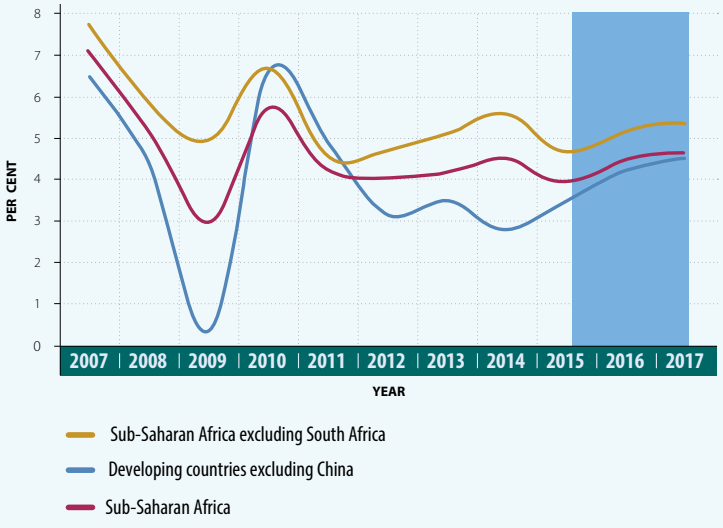
Solutions to the challenges of water for energy and food security are hindered by a big gap in water infrastructure and limited water development and management capacity to meet the demands of a rapidly growing population. This is compounded by the fact the Africa has the fastest urbanization rates in the world (Rafei and Tabari, 2014). Most significantly, water development and management is much more complex due to the multiplicity of transboundary water resources (rivers, lakes and aquifers). Around 75% of sub-Saharan Africa falls within 53 international river basin catchments crossed by multiple borders (World Bank, n.d.a.). This particular constraint can also be converted into an opportunity if the potential for transboundary cooperation is harnessed in the development of the area's water resources. A multi-sectoral analysis of the Zambezi River, for example, shows that riparian cooperation could lead to a 23% increase in firm energy production without any additional investments (World Bank, n.d.a.). A number of institutional and legal frameworks for transboundary cooperation exist exists, such as the Zambezi River Authority, the Southern African Development Community (SADC) Protocol, Volta River Authority and the Nile Basin Commission. However, additional efforts are required to further develop political will, as well as the financial capacities and institutional frameworks needed for win-win multilateral cooperative actions and optimal solutions for all riparians.

> The African fisheries and aquaculture sectors employed 12.3 million people in 2014 and contributed US$24 billion, or 1.26% of the GDP of all African countries

6.2 Water, jobs and the economy

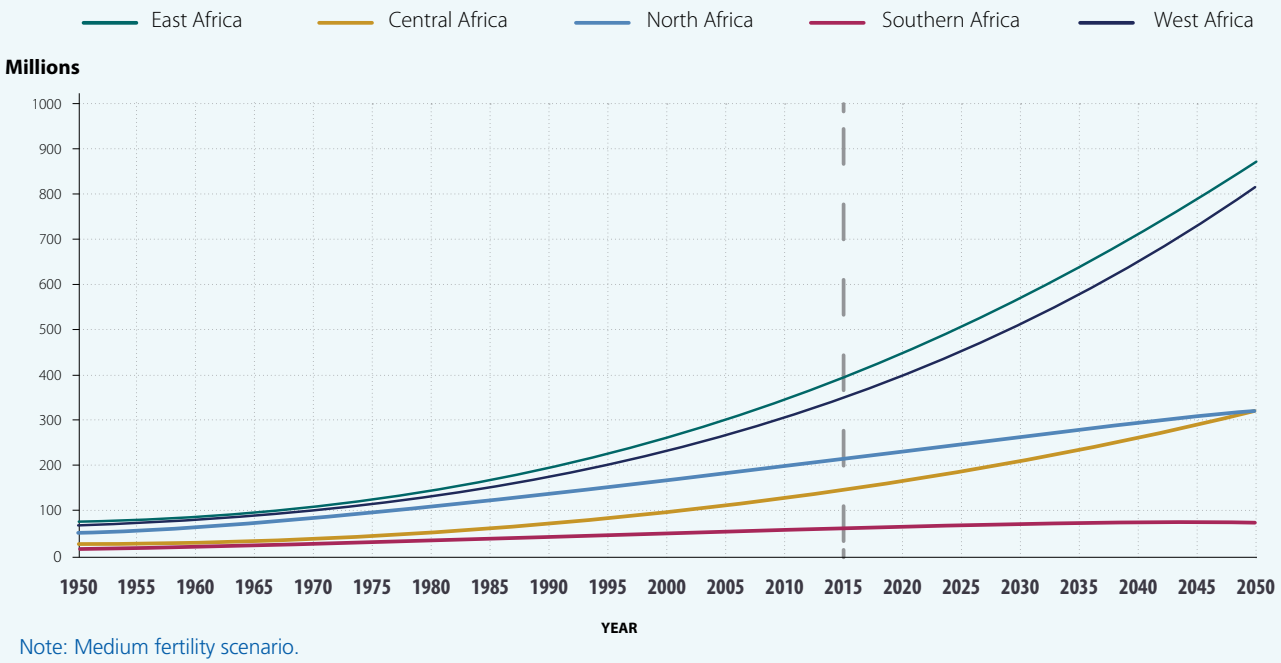
Africa has undergone the best decade (2005-2015) for economic growth since the post-independence period. The growth, however, has neither been inclusive or equitable. According to the World Bank, GDP growth in sub-Saharan Africa averaged 4.5% in 2014, up from 4.2% in 2013, supported by continuing infrastructure investment, increased agricultural production and buoyant services (Figure 6.1).

FIGURE 6.1 GDP GROWTH IN AFRICA AND DEVELOPING COUNTRIES, 2007-2017



Source: Chuhan-Pole et al. (2015, Fig. 1, p. 4, © World Bank. License: Creative Commons Attribution CC BY 3.0 IGO).

FIGURE 6. 2 POPULATION GROWTH IN AFRICA, 1950-2050



Note: Medium fertility scenario.

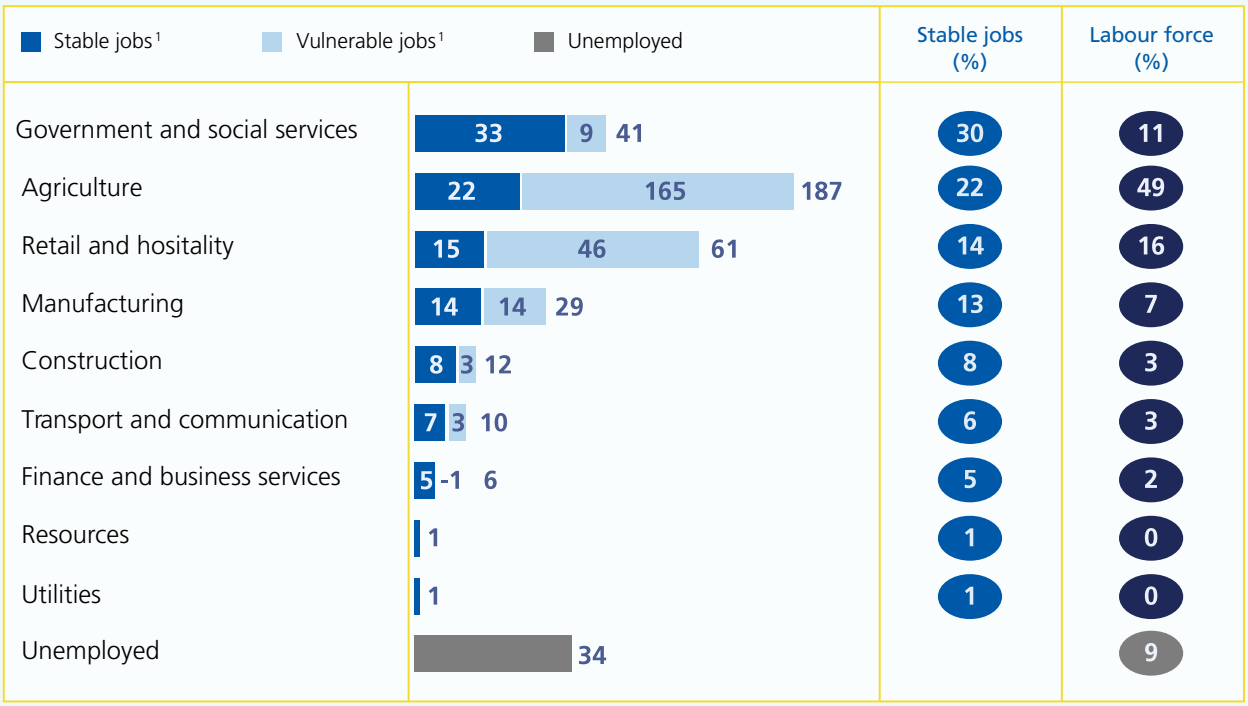
Source: AfDB/OECD/UNDP (2015, Fig.6, p. xi).

Africa's population surpassed the 1 billion mark in 2010 and is projected to double by 2050 (AfDB/OECD/UNDP, 2015). Demographically, it is expected to be the fastest growing region in the world with the growth varying depending on sub region. Furthermore, the growth is skewed to the young and that component of the population that will need jobs is expected to increase rapidly and comprise 910 million out of the projected two billion total population by 2050 (Figure 6.2). Most of the growth in workforce will be in Sub-Saharan Africa (about 90%). Hence, the demand for jobs will be a major policy issue across the continent, which is already experiencing high unemployment and underemployment; moreover, the latter is driving both migration within the region and emigration towards Europe and other regions.

Job creation for this anticipated growth in population is set to be the major challenge for Africa's structural economic and social transformation. It is estimated that in 2015, 19 million young people will be joining the sluggish job market in Sub-Saharan Africa and four million in North Africa. The demand for jobs is expected to increase to 24.6 million annually in Sub-Saharan Africa and 4.3 million in North Africa by 2030, representing two thirds of global growth in demand for jobs (AfDB/OECD/UNDP, 2015). Youth unemployment has been the trigger for uprisings, notably in North Africa, and has led to social and security instability.

The key water-dependent or related sectors with the potential for meeting part of the current and projected demand for jobs in Africa are social services, agriculture, fisheries and aquaculture, retail and hospitality, manufacturing, construction, natural resources exploitation (including mining) and energy production (including hydro, geothermal and expected fracking for oil and natural gas). All these sectors depend to a varying extent on the availability of, access to, and reliability of water resources. Irresponsible water use by some sectors can create short-term employment, but result in negative impacts on the availability of water resources and jeopardize future jobs in other water-dependant sectors. Climate change, water scarcity and variability have direct impact on the major sector outputs and thus ultimately on the overall economy of most African countries.

FIGURE 6.3 INDICATIVE JOB DISTRIBUTION OF VARIOUS SECTORS IN AFRICA (MILLIONS OF JOBS, 2010[2])



Notes:

[1] Stable employment includes wage and salary employees and business owners: vulnerable employment includes subsistence farming, informal self-employment, and work for a family member.

[2] Estimated using data for Algeria, Angola, Egypt, Ethiopia, Kenya, Morocco, Mali, Senegal, South Africa and Uganda.

6.3 Jobs in water-dependent sectors

Currently, the most important water-dependent sector in Africa is agriculture, which forms the bedrock of most economies of African states. Both rainfed and irrigated agriculture are important job providing sectors in all African countries. Figure 6.3 shows the following indicative job distribution for the various sectors in Africa.

6.3.1 Agriculture

The role of agriculture as the main source of employment is decreasing in many African countries as a sustained growth in many economies is leading to increasing standards of living, improved education and the occurrence of rapid rural-urban migration of educated youth in search of white collar jobs. However, for the foreseeable future agriculture will still be a major source of employment, especially in non-oil producing African states. There is a rising paradox of increasing unemployment in the rapidly urbanizing cities and towns of Africa: labour shortages in rural areas are leading to significant reduction in food production and increased dependence of many African countries on food imports.

Based on FAO statistics, agriculture was the source of employment for 49% of Africans by 2010 and is a reflection of a gradual decline from 2002 to 2010, which coincides with the period of sustained GDP growth in most African countries (FAO, 2014e). In spite of this decline, agriculture is expected to create eight million stable jobs by 2020 based on the trends from the McKinsey Global Institute (2012) analysis. If the continent accelerates agricultural development by expanding large scale commercial farming on uncultivated land and shifts production from low-value grain production to more labour-intensive and higher value-added horticultural and bio fuel crops (a good example is Ethiopia), as many as six million additional jobs could be created continent-wide by 2020 (McKinsey Global Institute, 2012). However, such estimates do not take account of the potential displacement or disappearance of existing jobs. These would need to be carefully assessed in terms of social, economic and environmental impacts in the overall context of responsible agricultural investment.

6.3.2 Fisheries

The African fisheries and aquaculture sector employed 12.3 million people in 2014 and contributed US$24 billion or 1.26% of the GDP of all African countries, which improved food security and nutrition. About half of the workers in the sector were fishers and the rest were processors (mainly women) or aquaculturalists (FAO, 2014g). Tables 6.1 and 6.2 show the contributions to Africa's overall GDP by fisheries and aquaculture and the employment generated by various fisheries subsectors.

TABLE 6.1 FISHERIES AND AQUACULTURE CONTRIBUTION TO GDP IN AFRICA BY SUBSECTOR

	Gross value added (US$ millions)	Contribution to GDP (%)
Total GDPs African countries	**1 909 514**	
Total fisheries and aquaculture	**24 030**	**1.26**
Total inland fisheries	**6 275**	**0.33**
Inland fishing	4 676	0.24
Post-harvest	1 590	0.08
Local licences	8	0.00
Total marine artisanal fisheries	**8 130**	**0.43**
Marine artisanal fishing	5 246	0.27
Post-harvest	2 870	0.15
Local licences	13	0.00
Total marine industrial fisheries	**6 849**	**0.36**
Marine industrial fishing	4 670	0.24
Post-harvest	1 878	0.10
Local licences	302	0.02
Total aquaculture	**2 776**	**0.15**

Source: FAO (2014g, Table 32, p. 41).

TABLE 6.2 EMPLOYMENT BY SUBSECTOR

	No. of employees (thousands)	Share subsector (%)	Share within subsector (%)
Total Employment	**12 269**		
Total Inland Fisheries	**4 958**	**40.4**	
Fishers	3 370		68.0
Processors	1 588		32.0
Total Marine Artisanal Fisheries	**4 041**	**32.9**	
Fishers	1 876		46.4
Processors	2 166		53.6
Total Marine Industrial Fisheries	**2 350**	**19.2**	
Fishers	901		38.4
Processors	1 448		61.6
Aquaculture Workers	**920**	**7.5**	

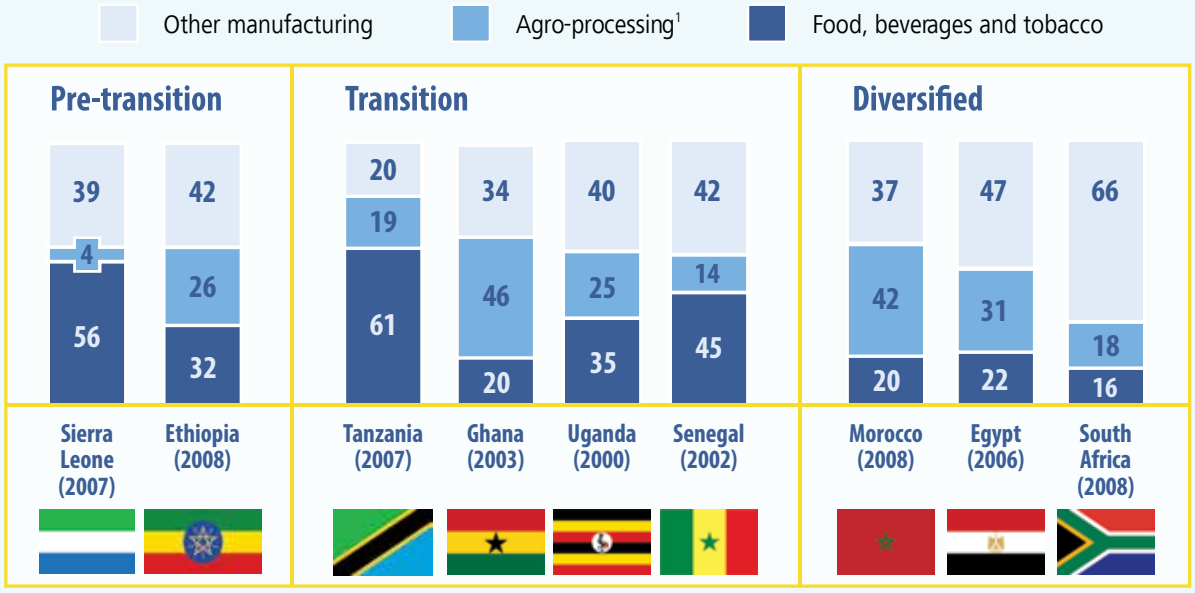
Source: FAO (2014g, Table 44, p. 54).

6.3.3 Manufacturing and industry

Many manufacturing industries in Africa are water-dependent. Figure 6.4 indicates the share of various manufacturing industries in job creation in Africa, based on the analysis of McKinsey Global Institute (2012), referring to INDSTAT4 of UNIDO for a sample of countries (UNIDO, n.d.). The share of jobs is lower than in agriculture, even though the industries cited are considered as water intensive.

> Solutions to the challenges of water for energy and food security are hindered by a big gap in water infrastructure and limited water development and management capacity to meet the demands of a rapidly growing population

FIGURE 6.4 JOB CREATION BY WATER-DEPENDENT MANUFACTURING INDUSTRIES IN SELECTED AFRICAN COUNTRIES (%)



Notes:

[1] Includes textiles, footwear and apparel, leather products, paper and wood products, and rubber products.

Numbers may not add up due to rounding.

Source: McKinsey Global Institute (2012, Exhibit 14, p. 33). © 2012 McKinsey & Company. All rights reserved. Reprinted by permission.

6.4 Expected future developments

For Africa to be able to meet the SDGs and maintain the impressive growth rates of the last 10 years, the basic infrastructures of water, electricity and transportation are prerequisites. Without these basics, the African economies will lose the momentum of the last decade, which will lead to not only loss of direct water jobs, but also jobs in all the other sectors dependent on water. An illustrative example is the case of Ghana which is often cited as one of the best examples of economic recovery in Africa (see Box 6.1).

6.5 African Water Policy Framework and impact on jobs

The African Policy Framework for the water sector comprise a series of high-level declarations, resolutions and programmes of action on the development and use of the continent's water resources for socio-economic development, regional integration and the environment. These include the African Water Vision 2025 and its Framework of Action (UNECA/AU/AfDB, 2000), the African Union (AU) Extraordinary Summit on Water and Agriculture (Sirte Declaration) (AU, 2004), the AU Sharm El

Sheikh Declaration on Water and Sanitation (AU, 2008), and most importantly, the Agenda 2063 – The Africa We Want (AU, 2014).

These policy instruments are underpinned by strategies and programmes, including the New Partnership for African Development Program (NEPAD), Program for Infrastructure Development in Africa (PIDA) and many others, which include the integrated development of Africa's water resources for socio-economic development and poverty alleviation and eradication.

The AU Agenda 2063, for example, aspires to a prosperous Africa based on inclusive growth and sustainable development. It specifically aims for an Africa that shall have equitable and sustainable use and management of water resources for socio-economic development, regional cooperation and the environment, and calls for the following action among others.

'Support Young people as drivers of Africa's renaissance, through investment in their health, education and access to technology, opportunities and capital, and concerted strategies to combat youth unemployment and underemployment. Encourage exchange and Pan-Africanism among young people through the formation of AU Clubs in all schools, colleges and universities. Ensure faster movement on the harmonization of continental admissions, curricula, standards, programmes and qualifications and raising the standards of higher education to enhance the mobility of African youth and talent across the continent by 2025' (AU, 2014, p. 17).

BOX 6.1 IMPACT OF LOW WATER LEVELS OF THE VOLTA RIVER ON GHANA'S ECONOMIC GROWTH

In 2011, Ghana's economy grew at 14% with the onset of its first production of oil (GSS, 2011). However, in 2015 the growth rate was expected to be only 3.9% (Okudzeto et al., 2015). This can be attributed to a great extent to the failure to provide the basic water and energy infrastructure to meet the needs of a rapidly growing economy. Ghana is mainly dependent on the Akosombo hydroelectric dam on the Volta River for electricity. Due to reduced inflows from low rainfall, the hydroelectric dam was operating merely at half of its capacity in 2015 (The Africa Report, 2015). This was exacerbated by disruptions mainly in geothermal plants. In June 2015, all electricity was being rationed at 12 hours on, and 24 hours off. Though this is extreme, it reinforces the need for water infrastructure to sustain production and jobs in the nascent African economies. Anecdotal evidence from Trade Unions and Employers in Ghana indicate that tens of thousands of stable jobs were lost in 2015 and the investment climate has turned sour, forcing Ghana to seek IMF macro-economic support again.

7

THE ARAB REGION

UNESCWA | Carol Chouchani Cherfane

This chapter focuses on water-dependent and water sector jobs in the Arab region as well as the situation regarding clean water availability in the workplace and at home, and education for better water-related jobs.

Racks of filters in a desalination plant
Photo: © Paul Vinten/Shutterstock.com

7.1 Background

Of an Arab population of approximately 348 million in 2010, an estimated 63% were of working age. Of these, 20% were youth between the ages of 15 and 24 years and 43% were adults between the ages of 25 and 64 years. Given the current youth bulge, it is expected that the adult working age population will represent over 50% of the national workforce by 2050, when the region's population is projected to reach 604 million (UNESCWA, 2013a). The Arab population was already estimated to have grown to 364 million in 2012. At the beginning of this decade, youth unemployment stood at 23% on average for the region, which is the highest level in the world (UNESCWA, 2013a). Unemployment trends have worsened in recent years as rural income has fallen in face of low agricultural productivity, drought, land degradation and depletion of groundwater resources. These trends have fuelled rural to urban migration and the expansion of informal settlements and social unrest. These stressors have been among the factors contributing to the civil unrest that has erupted across the region. Unemployment and water scarcity remain structural challenges that hinder sustainable development in the region.

7.2 Jobs in the water sectors

The public sector is the dominant employer in the region, and is largely responsible for the delivery of basic services, including the provision of water services. For instance, over 93% of Kuwaiti nationals work for the public sector (UNESCWA, 2013a). However, employment in the water sectors remains relatively limited. For instance, in Bahrain with a workforce of 977,812 people (UNESCWA, 2013a), an estimated 3,000 persons have water jobs at the Electricity and Water Authority (0.3%).[16] Similarly, out of a Jordanian workforce of four million,[17] an estimated 7,000 persons (0.2%) are employed in

> Investments in water use efficiency and conservation present more politically palatable avenues for governments that must weigh trade-offs between water sustainability and employment targets

the Jordan Valley Authority, which is responsible for supporting socio-economic development and environmental protection through sustainable water resources management. The Egyptian Holding Company for Water and Wastewater has over 100,000 employees and operates over 600 facilities (UNESCO-UNEVOC, 2012), which appears significant. These employees are responsible for delivering water services throughout Egypt but represented less than 0.002% of a workforce of over 55.4 million in 2010. Notwithstanding, there are also hundreds of thousands of water resource managers in Egypt responsible for irrigation, hydropower, water quality, agriculture, fisheries, regulations, research, policies and negotiations on transboundary water resources, so these figures are not fully reflective of the national workforce working on water. Nevertheless, more skilled human resources are needed.

The potential growth for jobs in the water supply and sanitation sector is particularly evident. The WHO/UNICEF Joint Monitoring Programme (JMP) figures show that approximately 55 million people in the Arab Region (15%) do not have access to improved drinking water, while 65 million people (18%) do not have access to improved sanitation (UNESCWA, 2015). However, Arab States suffer from intermittent access to safe drinking water (LAS/UNESCWA/ACWUA, 2015), dependency on desalinated water, high non-revenue water (NRW) losses and insufficient wastewater treatment (UNESCWA, 2013b). Furthermore, the global desalination market is estimated to grow at a compounded annual growth rate of 8.1% between 2014 and 2020 (GWI, 2015), with the largest plants coming on line in the Middle East. This will generate ancillary water jobs in engineering, law, finance and the environment.

[16] Personal communication with official at the Electricity and Water Authority of Bahrain, 14 January 2015.

[17] Personal communication with official at the Ministry of Water and Irrigation of Jordan, 14 January 2015.

7.3 Water-dependent jobs

As water scarcity is prevalent in the Arab region, employment in many sectors is water sensitive. Nearly 50% of the region's population is based in rural areas, with a large share formally or informally engaged in agricultural production or associated value chains. Thus, water scarcity, poor agricultural productivity and low levels of irrigation efficiency ranging from 30% to 40% in the region (AFED, 2011) affect job creation and retention in rural areas.

Because of this, some argue that the agricultural workforce will decrease over the coming decades (Richards and Waterbury, 2008; Chaaban, 2010). However, the recent turbulence in the region exposes the political imperative of supporting agricultural employment as a means of overcoming rural and urban dichotomies and ensuring social justice. Indeed, a recent report calls for the revitalization of the agricultural sector to increase agricultural employment and improve living standards, arguing that 10 million new jobs could be generated if more sustainable agricultural practices were pursued (AFED, 2011). Similar perspectives are observed at the national level. In Algeria, which is largely an oil economy, special measures to promote the agricultural sector through credit free loans, the write-off of farm debts and new government purchasing schemes led to a 17% growth in the sector in 2009 (UN-Habitat, 2012). Egypt has launched a massive one million feddan (420,000 ha) land reclamation project in Upper Egypt despite its dependency on external waters, while Somalia is digging new water channels to support pastoralists and its water-dependent livestock sector.

Similar trends are observed in the tourism sector, where governments continue to develop new facilities to generate revenue and employment, despite the strains posed on scarce water resources. Hence, investments in water-use efficiency and conservation present more politically palatable avenues for governments that must weigh trade-offs between water sustainability and employment targets.

7.4 Clean water for decent jobs and a healthy workforce

Insufficient access to reliable, accessible and affordable water resources in Arab States also affects the creation and maintenance of decent jobs outside the water sectors. Cost of environmental degradation studies in selected Arab countries have assessed labour productivity losses associated with waterborne illnesses, morbidity and child mortality. For instance, the cost of environmental degradation in the Upper Litani Basin of Lebanon is estimated to represent about 0.5% of the National GDP in 2012, with water resources degradation representing 77% of these total costs, including, in order of importance, water quantity, water-borne diseases and water quality (SWIM-SM, 2014).

The lack of access to adequate sanitation facilities particularly affects women and young girls and dissuades women from seeking employment in establishments and institutions that do not provide gender sensitive facilities (e.g. different washroom areas for women and men). This has been witnessed in some government ministries, sports facilities, schools and hospitals, and contributes to the already low participation rate of women and girls in national employment figures (UNESCWA, 2013a). Increasing pressures to create employment opportunities in face of the spillover effects of the Syrian conflict led the Jordanian Government to prepare a National Resilience Plan for 2014-12016. The plan aims to create job opportunities for poor and vulnerable groups (particularly women and youth), while also pursing heavy investments in water and sanitation services to enhance the capacity of host communities to meet the increased demand for these services (The Hashemite Kingdom of Jordan, 2014).

7.5 Education for better water-related jobs

There are an increasing number of universities offering first and second level degrees in water resources management and engineering, including programmes focused on water security and sustainability. Joint academic programmes are also offering specialized degrees, e.g. the German Jordan University launched a water and environmental engineering programme in 2009; the University of Jordan and Cologne University of Applied Science offer a joint IWRM Masters Programme; the Arabian Gulf University in Bahrain offers a professional IWRM certificate, while the water engineering programme at Cairo University is expanding at all levels.

Meanwhile, training and certification programmes for water operators have been launched by the International Institute for Water and Sanitation at the state-owned Office National pour l'Eau Potable (ONEP) of Morocco and the Arab Countries Association for Water Utilities in the Arab Region (ACWUA) based in Jordan. Such programmes target managers, supervisors, skilled workers and unskilled workers with the aim of upgrading skills and introducing new technologies to the water sector.

The programmes are being complemented by an increasing number of researchers working on water-related subjects, such as climate change, the water-energy-food nexus, transboundary water resources management and strategic R&D sectors related to desalination, co-generation and non-conventional energy sources. This is creating a new cadre of qualified job seekers and potential entrepreneurs and employers with expertise in the water sectors, which present a further opportunity for the creation of decent water jobs.

8

ASIA AND THE PACIFIC

UNESCAP | Aida N. Karazhanova, with substantial contributions from Joshua Goodfield, Ram S. Tiwaree and Donovan Storey
ILO | Lurraine Baybay Villacorta

Training for women plumbers (Timor Leste)
Photo: © AusAID

This chapter provides an overview of the current situation in Asia and the Pacific region, and highlights three approaches for generating water-dependent jobs in the region: i) addressing gaps of water and sanitation through the improvement of water infrastructure; ii) improving efficiency in water use to contribute to economic growth; and iii) transitioning beyond sectoral issues and demonstrating the short-, medium- and long-term values and benefits.

With 4.3 billion people, representing 60% of the world's population (UNESCAP, 2014a), the Asia and the Pacific region generates one-third of the world's GDP, with continuous prospects for 'thirsty' economic growth and the need to ensure safe and accessible water, to further address income inequality, poverty and unemployment.

Over 1.7 billion people in Asia and the Pacific continue to live without access to improved sanitation (UNICEF, n.d.) and over 85% of untreated wastewater create the risk of a 'silent disaster' (2nd APWS, 2013a, 2013b) from the pollution of surface and ground water resources and coastal ecosystems (UNESCAP, 2010). As a result of heightened climate change (UNESCAP, 2014b), more than 50% of the world's recent natural disasters occurred in Asia-Pacific affecting water supply infrastructure. Since 1970, more than 4,000 water-related disasters have been reported costing more than US$678 billion in economic losses. During the past 12 years, the regional coverage to the water supply and sanitation services grew by 0.5% and 0.7% respectively, thus improving productivity and livelihoods (UNESCAP, 2014a).

Traditionally, regional employment has been created through water resource management and water reuse. While some specific research has been conducted in the water-management sector, gaps persist in available regional data on water-dependent jobs in all the other sectors that rely on large quantities of water to perform basic operations and services (UNDP, 2006).

While between 60% to 90% of water is used for agriculture (UNESCAP, 2011), the employment rates in this sector are 39% in South-East Asia, and 44.5% in South and South-West Asia, respectively (ILO, 2014c). There is tremendous potential to create employment opportunities in the agricultural sector by increasing access to water and improving water-use efficiency in irrigation. Research and development for advanced technologies in agriculture can also foster employment opportunities in other sectors.

There is also potential in the industry and service sectors to create and support water-dependent jobs, especially through the improvement of water efficiency, wastewater usage and pollution control.

> Most of the industries that are driving economic growth across the region depend upon a reliable supply of freshwater for large parts of their production process

In South-East Asia alone, 41% of the labour force are in the industrial sector and 21% are in the service sector. In South and South-West Asia, 39% of the labour force are in the industrial sector and 15% are in the service sector (ILO, 2014c).

Hydropower accounts for the largest proportion of employment in the renewable energy sector. China alone accounts for half of the global employment in small hydropower (209,000) and in large hydropower (690,000) (IRENA, 2015). Employment in fisheries and aquaculture in the region supports approximately 10% to 12% of the world's population. In the fisheries and aquaculture industry, employment has grown rapidly since 1990, with 84% of the approximately 60 million jobs in this sector now based in Asia (FAO, 2014a).

The key regional responses for generating water-dependent jobs include addressing gaps of water and sanitation through the improvement of water infrastructure, increased efficiency in water use to contribute to economic growth, and a transition towards IWRM solutions demonstrating the short-, medium- and long-term values and benefits.

8.1 Addressing gaps in water and sanitation through the improvement of water infrastructure

While access to safe water sources in the region is improving, there are still disparities, particularly in urban areas, where the number of individuals without access to improved water is 97%, compared to 87% in rural areas (UNESCAP, 2014a). However, there are also disparities within urban areas. In Dhaka, Bangladesh, almost 60% of the city's slums lack effective drainage and are exposed to floods (UN-Habitat/UNESCAP, 2014). In such a case, water jobs and ancillary water jobs could be created through improved facilities and technology and respective enabling policy frameworks for

BOX 8.1 DECENTRALIZED WASTEWATER TREATMENT SYSTEMS

The Consortium for DEWATS Dissemination Society is working with South and South-West Asia to improve the state of the region's water. The organization has created jobs such as unit coordinators, sanitation trainers, documentation specialists, project engineers, capacity building programme assistants, urban planners, and executive management positions all working towards a common goal of better sanitation in water (India Water Portal, n.d.).

decentralized wastewater treatment systems (DEWATS) (Box 8.1) (UNESCAP/UN-Habitat/AIT, 2015), which are more flexible on technology, investment and operational choices.

Indonesia (FAO/Wetlands International/University of Greifswald, 2012), Nepal (UNESCAP, n.d.) and the Philippines (UNESCAP, 2012) are facing challenges in their efforts to provide an adequate water supply and sanitation services to their rural populations (UNESCAP, 2014a). Recent policies and activities carried out towards eco-efficient water infrastructure through participatory processes are focused on maximizing the value of water-related services, optimizing use of natural resources, and minimizing the negative impacts on ecosystems. On a smaller scale, investments in DEWATS in Indonesia have contributed to the environmental rehabilitation of peat lands, improved rural accessibility and enhanced rural livelihoods with more Indonesians employed in jobs to clean and restore the environment (FAO/Wetlands International/University of Greifswald, 2012). The policies on rainwater harvesting and DEWATS in Cambodia, Lao People's Democratic Republic and Viet Nam were developed to restore deteriorated river quality and to recycle and diversify water supply sources, which created a number of new jobs in financial and technical operations (UNESCAP/UN-Habitat/AIT, 2015). Increased public awareness and job creation has resulted in 94% access to public toilets in Viet Nam (UNICEF/WHO, 2008). The Philippines has started adopting an eco-efficient approach to water infrastructure (Box 8.2).

8.2 Improving efficiency in water use to contribute to economic growth

Less than half of China's 4,000 water treatment plants meet the national standard of the quality of the source water. The government plans to upgrade about 2,000 water plants during its Twelfth Five-Year Plan from 2011 to 2015, and build 2,358 additional water plants with a combined capacity of 40 million cubic metres per day, to meet the demands of urbanization. This plan provides a major opportunity for setting up water treatment equipment manufacturing and water plants, potentially bringing more employment in water sector (KPMG,2012).

The Green Jobs Assessment Methodology (ILO, 2013d) is a step-by-step approach applied in several countries across the region, such as Indonesia and Malaysia, to map green jobs in various sectors, including water. The mapping has revealed 9,960 green jobs, including the water services sector in Malaysia by 2012 (Figure 8.1). Of this total, 1,020 people are employed in the water equipment and chemicals industry, 4,120 in wastewater treatment and 4,820 in water utilities. Through policy support modelling, the methodology identifies job creation potential of policies/measures in different green jobs sectors, where employment growth rate is higher than in sectors using brown technologies. Malaysia's water management sector aims to transition towards a minimal pollutant operation. However, current sewage treatment plants are responsible for 49% of water pollution, with the manufacturing industry accounting for an additional 45% (ILO, 2014d).

BOX 8.2 ECO-EFFICIENT WATER INFRASTRUCTURE IN THE PHILIPPINES

Since 2011, the Philippines has taken a unique approach with the idea to construct eco-efficient water infrastructure and small-scale pilot projects such as the application of sustainable designs for green school development in Cebu. The objective is to develop an eco-efficiency education curriculum to emphasize past water-related shortcomings. Green schools inform the workers of tomorrow how to integrate efficient and sustainable practices into their future careers to ensure the longevity of water resources (UNESCAP, 2012).

BOX 8.3 'SOFT' INTERVENTIONS IN VIET NAM

To address the challenge of increasing environmental pollution associated with urbanization in large cities, the Viet Nam Urban Wastewater Review highlighted key recommendations for the establishment of a national strategy to apply IWRM principles (Australian Aid/World Bank, 2013), accompanied with 'soft interventions' of capacity building, institutional and financial arrangements. Of the seven urban field site interventions, 310,639 households have had their water supply improved, enabling employment. Sanitation coverage percentage ranged from a low of 56% in some areas of Sa Dec town and a high of nearly 90% in Thang town. Over 90% of Viet Nam's equipment installed for water and wastewater engineering systems created opportunities for local enterprises to manufacture pumps, pipelines, treatment packages, control systems and devices, and operations supports (WSP, 2012).

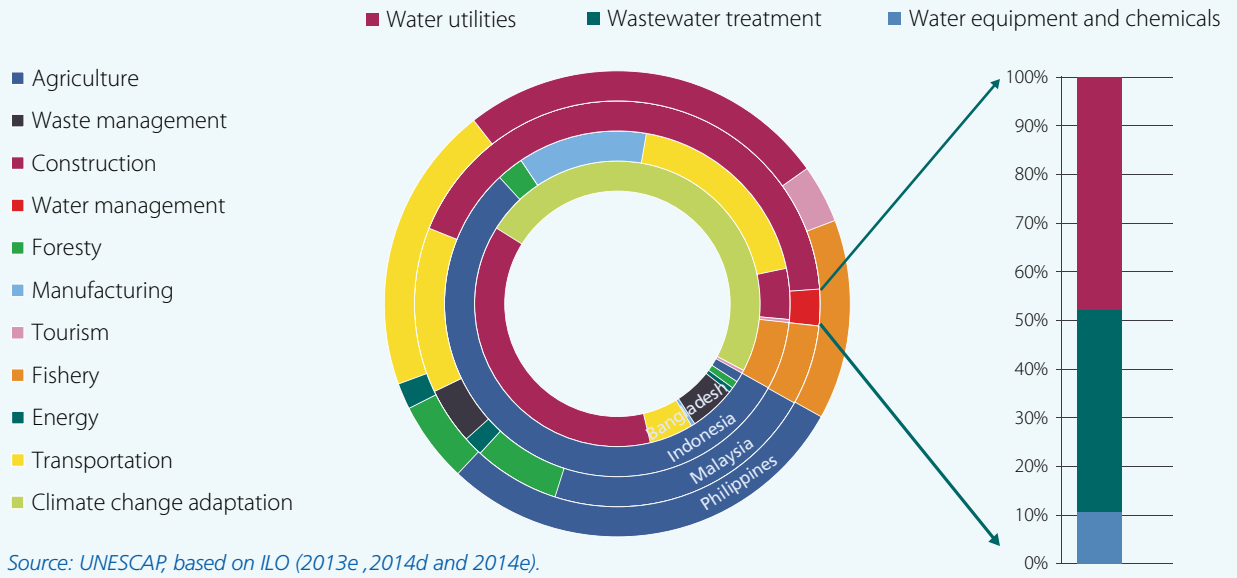
8.3 Transitioning beyond sectorial issues and demonstrating the short-, medium- and long-term values and benefits

Using inter-sectorial and inter-disciplinary approaches in planning, which envisions new market opportunities and enables more job and income (Rogers and Daines, 2014), the region is searching for appropriate technological solutions than can help improve water infrastructure and water-use efficiency in industry and agriculture. South-East Asia has demonstrated signs of smarter decision-making in an attempt to facilitate economic growth through IWRM solutions (Box 8.3).

Water management within the Mahatma Gandhi National Rural Employment Guarantee Act and the wage employment programme in India (using participatory rural appraisal methodology) provided productive green jobs to 52.5 million households in 2009 and 2010. The water sectors among others comprised jobs in water conservation, water harvesting, drought-proofing and irrigation canals (ILO, 2011b).

Sub-regional capacity to effectively manage water resources depend on national strategies, executive plans at the local levels (UNESCWA, 2007), and public employment programmes (ILO, 2014c). More practical options need to be further explored, promoted and up-scaled through enabling policies for PPPs (UNESCAP, n.d.). The options should create business cases, which empower communities and generate more water-related jobs. Government has a crucial role to play by creating a conducive environment and developing legislation and policy frameworks to improve opportunities for water-related employment that support sustainable water use and management.

FIGURE 8.1 ESTIMATED CORE ENVIRONMENTAL-RELATED JOBS THROUGH GREEN MAPPING STUDIES IN FOUR SOUTH-EAST ASIAN COUNTRIES (2010-2012)



Source: UNESCAP, based on ILO (2013e ,2014d and 2014e).

9

EUROPE AND NORTH AMERICA

UNECE | Annukka Lipponen and Nicholas Bonvoisin

Scientist makes measurements and calculations to analyze water quality in an oil field in Casper, Wyoming (United States)
Photo: © B. Brown/Shutterstock.com

This chapter focuses on the Europe and North America region, and offers an overview of employment in the water services and water-dependent economic sectors, as well as in water resources monitoring, and presents specific emerging employment opportunities.

Across most of the United Nations Economic Commission for Europe (UNECE) region, covering the pan-European area and North America, management of the nitrogen and phosphorous cycles, including handling of nutrients, has been identified as a major challenge (WWAP, 2015). However, in the European Union (EU), the most widespread pressure on a good ecological status of waters originates from hydromorphological changes to water bodies due to dams or other construction (EC, 2012).

Deterioration of water supply and sanitation infrastructure in Eastern Europe and Central Asia – exemplified by low quality and high levels of unaccounted-for water – calls for investment and the improvement of operation, with important implications for employment.[18] In the EU and North America, water infrastructure is more complete but ageing and thus repair and maintenance works are the focus.

Many countries in the Caucasus and Central Asia, in particular, face the challenge of reforming and developing labour- and water-intensive irrigated agriculture.[19] In the EU, increasing resource efficiency (including water) and focusing services on green growth more explicitly aim to achieve a sustainable recovery from the recent economic crisis and to respond to pressures on the environment (EC, 2012).

A number of developments can be observed in the UNECE region that have strongly influenced employment and education in the field of water management and water services, as well as research. Some examples according to subregion are provided in Table 9.1. In most of the UNECE region, promotion of standardization and mutual recognition of professional certifications is an on-going trend, resulting in a more mobile workforce.

TABLE 9.1 SELECTED TRENDS BY SUBREGION THAT HAVE RESULTED IN CHANGES IN JOBS IN WATER MANAGEMENT OR WATER SERVICES

North America	European Union	South-Eastern Europe, Eastern Europe	Caucasus, Central Asia
Increased use of automation and of remote sensing. Monitoring less labour-intensive but specialized job niches have developed.	Adoption of the Water Framework Directive has transformed assessment of water resources, increasing the role of public consultation, economics and biological parameters of water quality. Increased EU-wide standardization contributes to exchange of experience and mobility of the workforce between EU member States.	Investment in water management and services infrastructure. Postponement of key water infrastructure repairs and of resulting public health benefits from improved hygiene and environmental health. In the recent EU accession countries, implementation of the Urban Wastewater Directive required major investments.*	Reduced resources led to both degraded monitoring infrastructure and reduced staffing. Reforming national administrations and an increasing use and modernization of technology allow more to be done with limited resources.

* This progress comes with significant EU investment support, amounting to EUR 14.3 billion between 2007 and 2013 (EC, 2013a).

Source: UNECE, and cf. EC (2012) and OECD (2007).

[18] For an overview of the situation, see OECD (2007).

[19] With the exception of Kazakhstan, the share of agriculture of total annual water withdrawal in the Central Asian former Soviet republics is around 90% or more (FAO, 2013).

There is still an enormous need to repair, modernize and construct different types of water infrastructure in Eastern Europe, the Caucasus and Central Asia, as well as in parts of North America

9.1 Employment in water services and water-dependent economic sectors

The water services sector is a significant provider of employment in the UNECE region. In the EU, it includes 9,000 SMEs and 600,000 direct jobs in water utilities alone (EC, 2012). In recent decades, the number of people employed by water supply and wastewater treatment facilities has consistently decreased, while the level of education and specialization of personnel has increased. In Finland in the mid-1980s, the public water and wastewater works employed some 8,500 people; in 2002 their number had decreased to 5,000 and by 2011 to 4,000 (Katko, 2013). In Eastern Europe and Central Asia, there are nine staff per 1,000 connections, which is more than an order of magnitude higher than that observed in the best-performing quartile of utilities worldwide (< 0.6) (Danilenko et al., 2014; based on IBNET database). In the United States, the job market outlook for water and wastewater treatment plant and system operators is positive, with employment projected to grow by 8% from 2012 to 2020 (US Bureau of Labor Statistics, n.d.). A significant proportion of 'green' jobs in France are water jobs (Box 9.1)

Some countries suffer from the severe constraint of skilled workers not willing to live and work in rural areas (i.e. Serbia), a lack of skilled graduates (i.e. Tajikistan), a lack of financial resources for staff costs (i.e. Azerbaijan) or the absence of a human resource strategy (i.e. Lithuania) (WHO, 2014). UNECE work with water services operators in Portugal demonstrates how a focused effort to improve the awareness and skills of personnel improves the performance of utilities while contributing to the realization of the Human Right to Water (see Box 12.3).

BOX 9.1 GREEN JOBS IN FRANCE

In France in 2010, some 140,000 persons (or 0.5% of the workforce) worked in 'green' jobs, and a significant share is linked to water: four-fifths work in the management or treatment of wastewater or solid waste (36%), or in the production and distribution of water and energy (45%). The remainder were in posts related to environmental protection or treatment of pollution, or were environmental technicians or specialists.

Source: French Ministry of Ecology, Sustainable Development and Energy (2010).

Irrigated agriculture employs significant numbers of people in Central Asia and in the Caucasus. In Central Asia, agriculture accounts for between 26% (Kazakhstan) and 53% (Tajikistan) of national employment (World Bank, n.d.b.). Farmers and employees are ageing; young people tend to look for opportunities in other sectors. Low salaries further intensify the migration from the countryside. Guest workers from the Russian Federation returning to Central Asia as a result of the economic downturn have put pressure on the countries to find acceptable solutions for their employment.

In contrast, in the EU, where industrialization and intensification of agricultural practices have transformed the agriculture sector, around 10 million people are employed in agriculture, representing 5% of total employment. At the same time, some 25 million people were regularly engaged in farm work in the EU during 2010. Behind this difference in numbers is – beyond statistical divergences – the pursuit of agriculture as a part-time activity and as seasonal work, among other factors (EC, 2013b). More environment-friendly practices are being required in agriculture and this has implications for the skills required. Support is therefore needed for a new generation of farmers with different attitudes and abilities.

9.2 Employment in the monitoring of water resources

Employment and skill requirements in the monitoring of water resources have been changed by cuts to in situ monitoring, development of technology and increased attention to biological parameters.

In Central Asia and the Caucasus, in particular, monitoring degraded significantly after the break-up of the Soviet Union. In the past decades, improvements have been made through site-specific projects, but long-term sustainability of these projects remains a concern (UNECE, 2011).

Remote sensing is increasingly contributing to operational monitoring, partially filling some gaps. For example, the Idaho Department of Water Resources developed a LANDSAT imagery based application for monitoring aquifer depletion caused by the pumping of groundwater for irrigated agriculture. While some ground-truth data is necessary, illustrative calculations suggest the costs to be approximately 10 times less than using power consumption co-efficients and site energy records, or more than 40 times less costly than using flow meters (Morse et al., 2008).

In hydrological monitoring in North America and Europe, there are indications that the average number of hydrologists per organization has not changed since 2002, although the share of women employees has increased and the education level of the workforce is higher (Aquatic Informatics, 2012).

9.3 Specific emerging employment opportunities

Renewable energy:[20] There is undeveloped potential for hydropower and other renewables, especially in South-Eastern Europe, Eastern Europe, the Caucasus and Central Asia. Given that many sources of renewables are intermittent, a corresponding need for pumped storage provides new employment opportunities. Based on the modelling of the heat and electricity markets, the Energy Community assessed the costs and other implications of the 2020 EU Renewable Energy Targets for Albania, Bosnia and Herzegovina, Croatia, Montenegro, Serbia, the former Yugoslav Republic of Macedonia and Kosovo.[21] In addition to the savings in CO_2 emissions, potential employment benefits were predicted, primarily in the electricity sector, at between 10,000 and 22,000 additional full-time jobs. Significantly, more jobs would be created in a scenario involving development of wind and hydropower (IPA-Energy and Water Economics, 2010).[22]

Construction, extension, repair and maintenance of water infrastructure: Even though investment has increased and water sector reforms have transformed the provision of services, there is still an enormous need to repair, modernize and construct different types of water infrastructure in Eastern Europe, the Caucasus and Central Asia, as well as in parts of North America. The investment need is particularly great in wastewater treatment. Should the necessary resources for investments into basic water and sanitation infrastructure be made, these would translate into both employment opportunities and favourable effects on public health. Smart metering, technical and non-technical innovations, international benchmarking and private sector participation are among factors that shape further the water services sector. In other areas of water infrastructure, growth-representing jobs in construction works and increased activity could be achieved in inland waterway transport, if the bottlenecks of low capacity or non-passable points between major rivers and canals were to be invested in (UNECE, 2013).

[20] See for example UNECE, 2009; UNECE, 2014a and 2014b.

[21] United Nations administered territory under Security Council Resolution 1244 (UN SC, 1999).

[22] The actual job creation (or loss) would depend on the local manufacturing percentages for each generating technology. Indirect employment will also be created in secondary industries.

10 LATIN AMERICA AND THE CARIBBEAN

UNECLAC | Andrei Jouravlev, with comments from: Eurípides Amaya, David Barkin, Andrea Bernal, Mario Buenfil, Caridad Canales, Gonzalo Delacámara, Axel Dourojeanni, Marcelo Gaviño, Daniel Greif, Juan Justo, Terence Lee, Emilio Lentini, Humberto Peña, Franz Rojas, Carlos Serrentino, Miguel Solanes, Claudia Vargas and Gabriel Zamorano

This chapter focuses on the Latin America and the Caribbean region, and provides an overview of the importance of water in the economy of the region and of the various aspects to address in order to maximize the contribution of water to development and job creation.

Command room of Itaipu dam on Parana River on the border of Brazil and Paraguay
Photo: © Matyas Rehak/Shutterstock.com

The Latin America and Caribbean region has abundant water resources, but they vary significantly across the area. These play a strategic role in regional socio-economic development and in job creation. Regional economies rely heavily on the exploitation of natural resources, particularly on mining, agriculture (including biofuels), forestry, fisheries and tourism. Droughts are frequent in the region. Severe droughts can lead to a noticeable increase in unemployment, particularly among the rural population. Increasingly, droughts affect not only agriculture, but also the urban population, hydroelectric power generation and industries which use water in their production processes (UNECLAC, 1987).

In general, there is strong labour demand in water-related economic activities. The region is highly dependent on hydropower which provides over 60% of electricity generation, in comparison with the world average of less than 16%, and it still has significant (74%) undeveloped technical potential (IEA, 2014b). Although irrigated land is not a large proportion of arable land (13%), it accounts for almost 67% of total water withdrawals (FAO, 2015a). In several countries (e.g. Argentina, Brazil, Chile, Mexico and Peru), irrigation is responsible for a major part of agricultural production, particularly for export. It provides important employment opportunities for rural populations, as well as in backward- and forward-linked industries. On the whole, however, rainfed agriculture accounts for most of crop production (including biofuels) and employment. Jobs are shifting from agriculture to services, with industrial employment remaining stable (ILO, 2014f).

The economies of most countries are export-oriented and highly dependent on international commodity prices. Since the beginning of the 2000s, the boom in international demand for primary goods (minerals, hydrocarbons and agricultural commodities) has been instrumental to strong macroeconomic performance and job creation. The region enjoyed high and labour-intensive economic growth, leading to an increase in the employment rate, rising real wages in the formal sector, an extension of social protection systems and a reduction in unemployment (UNECLAC, 2014a). Rapid job creation in medium- and high-productivity sectors and advances in labour formalization resulted in an improvement in the quality of employment. In addition, they were instrumental in increasing household consumption and reducing income inequalities. However, largely because of negative external conditions, economic growth has slowed since 2011, as has labour demand.

Most of the regional export products, and related employment, are water intensive, either because they use water in the production process (particularly, irrigated agriculture and mining, food, pulp and paper, petrochemical and textile industries), depend on it (as much of the tourism, which represents over 30% of GDP in some of the countries of the region) or because they use water as a key component of their final products (i.e. the bottled water industry is important in a number of countries, mainly because of deficiencies in water supply services, in terms of coverage, and especially because of poor service quality). Although the region has about a third of the global water supply, the high water intensity of regional economies and their dependence on natural resources and international commodity prices pose important challenges for economic growth and job creation, such as:

- The pattern of water use is influenced greatly by the concentration of the population, urban agglomerations and economic activities in dry and sub-humid areas. This results in intense competition for scarce water resources in concentrated areas or specific seasons, unsustainable practices of water use, growing water pollution, not only by sewage but also increasingly by agriculture and mining, and the destruction of watersheds. The main threat to employment and job creation is that these trends are undermining the environmental sustainability of economic development. Climate change will also intensify pressure on water resources. Its effects are already seen in agriculture, water availability, forests and biodiversity, coastal areas, tourism and public health (UNECLAC, 2014b);
- There are signs that economies that are heavily dependent on natural resources, especially in combination with low productivity growth, could

be generating greater relative demand for low-skilled workers and reducing the education wage premium, thereby discouraging educational pursuit and skill development (UNECLAC, 2014c); and

- Water management institutions are weak in most countries, their capacity for implementation is extremely limited and rules and norms are rarely effectively enforced (Solanes and Jouravlev, 2006). At the same time, with rising incomes, the emergence of the middle class and democratization, people are demanding that more attention be given to environmental conservation, to the protection of the rights of indigenous communities and local public interests. This is accompanied by increased consumption of water-intensive products and services. Both factors have led to the proliferation of socio-environmental conflicts, most of them water-related, which block many large infrastructure and natural resources development projects, particularly in mining (Martín and Justo, 2015), that could contribute to economic development and job creation.

The regional experience permits the identification of the following key elements that demand constant attention in order to maximize the contribution of water to development and job creation (Solanes, 2007; Solanes and Jouravlev, 2006):

- Developing strong, transparent and effective institutional arrangements for integrated water management and the provision of water and sanitation services that protect public interests and promote economic efficiency, as well as provide the stability and flexibility necessary to attract investment to the development of water resources and related public utility services;
- Increasing the capture of rents from natural resources and ensure their investment in human capital, including education and training, social protection, infrastructure, and science and technology. In addition, there is a need to institutionalize long-term mechanisms for the stabilization, saving and investment of income from the extractive industries, and to build the institutional capacity to manage socio-environmental and labour conflicts associated with the development of these sectors;
- Ensuring that accurate, objective, reliable and timely information on water supply and use (including the magnitude and distribution of costs and benefits) is available to the public, stakeholders and decision-makers;
- Preventing water governance from being captured or manipulated by special interest groups;
- Improving water planning and careful assessment, based on objective criteria, of the economic, social, labour and environmental impacts of water policies, publicly financed projects, fiscal subsidies and government guarantees;
- Protecting the ecological integrity and sustainability of water sources, including the maintenance of environmental flows; and
- Guaranteeing basic human needs are satisfied, including the protection of the human right to water and sanitation and the rights of indigenous peoples.

Other important aspects of the role played by water resources in relation to employment include the contribution of water services to health and labour productivity and employment in the water sector.

Regarding health, the existing levels of provision of drinking water supply and sanitation services achieved in the region compare favourably to those in other developing nations. The focus of public policies remains firmly on these services: the region has reached the MDGs for water supply, and it missed the target for sanitation only by a very small margin. It has now started to work on the post-2015 development agenda, including the materialization of the human right to water and sanitation. This means continuing the expansion of water and sanitation coverage, especially reducing the deficits in rural and peri-urban areas, the improvement of service quality (particularly drinking water quality control) and major investments in wastewater treatment. These efforts are an important contribution to employment, both directly (in the water and sanitation sector itself), and particularly indirectly (in other economic activities), through the reduction of morbidity and mortality, of work and school absenteeism and the burden of

unpaid work of water collection, especially for women and girls, and an increase of the time available for work (Hantke-Domas and Jouravlev, 2011). They also promote social stability and create advantageous conditions for the development of irrigated – particularly export-oriented – agriculture, tourism, coastal and inland fishing. In addition, they reduce the cost of installing new businesses, help maintain or improve labour productivity, and facilitate access to export markets, generating more and better jobs across the economy (see Box 10.1).

Employment in the water sector remains characterized by extensive political interference in employment decisions. Politically motivated nominations and needless staff rotation (particularly of staff with management responsibilities) undermine efficiency orientation, retention of qualified personnel and the application of technical criteria. It is essential to avoid political appointments and unnecessary rotation, as well as to manage conflicts of interest, control corruption and capture, and encourage professionalization. There has been a move to facilitate flexibility in operations, particularly in water supply services, by removing staff from the controls of civil service under administrative law and employing them by contract and under private law. This trend is a cause of concern because of its potentially negative impact on accountability and contradictory incentives for efficiency (Bohoslavsky, 2011). The most interesting advances are related to the creation of independent water authorities and autonomous regulatory agencies (Solanes and Jouravlev, 2006). Regional experience suggests, however, that their effectiveness depends more on the general political culture and governance than on the letter of the law.

> Although the region has about a third of the global water supply, the high water intensity of regional economies and their dependence on natural resources and international commodity prices pose important challenges for economic growth and job creation

BOX 10.1 IMPACTS OF WATER SUPPLY AND SANITATION ON ECONOMIC DEVELOPMENT AND EMPLOYMENT

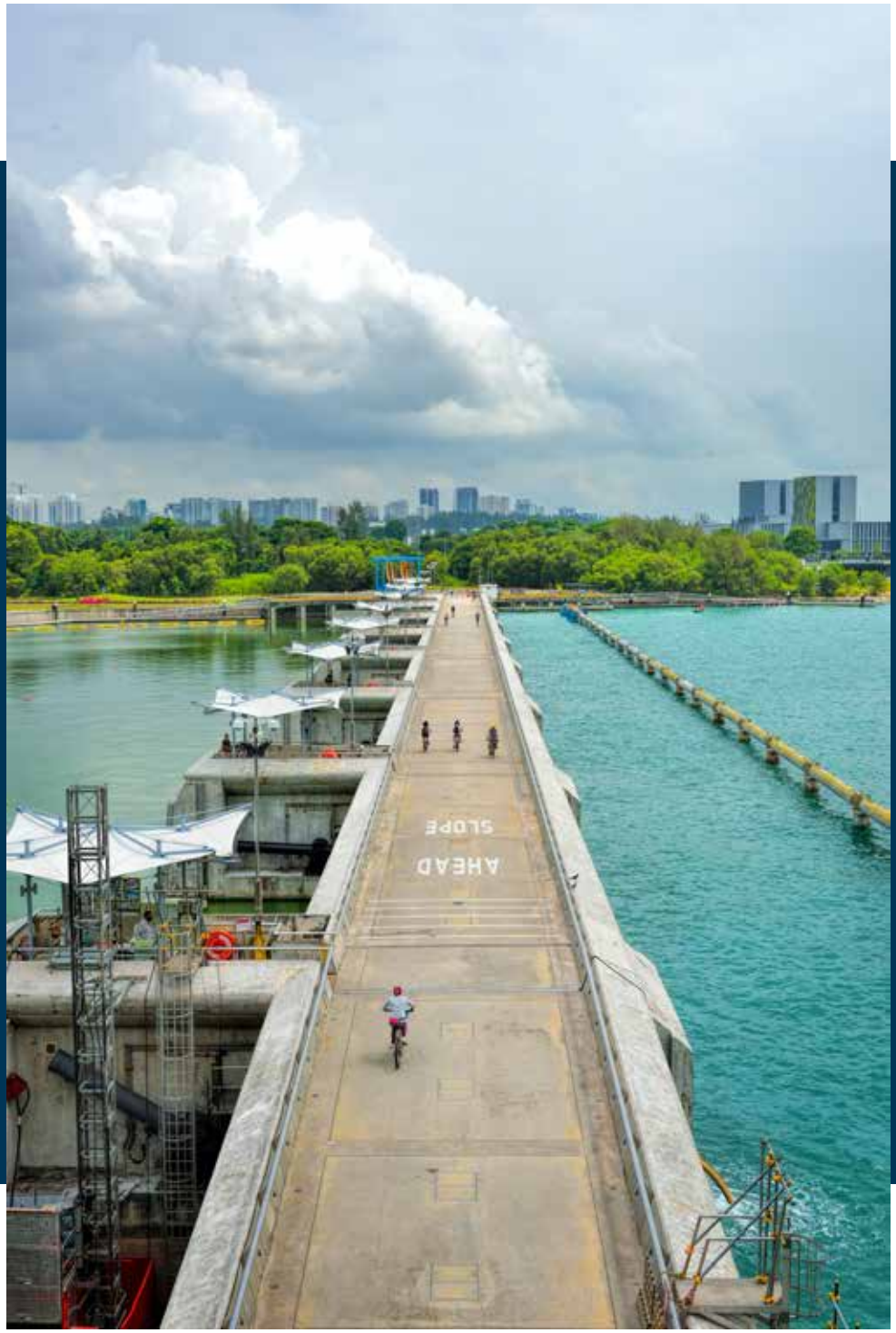
The cholera epidemic that affected the region in 1991 was closely related to the deterioration in water supply, sanitation and health services influenced by the economic crisis of the 1980s. The epidemic caused serious losses in employment and economic activity in tourism, agriculture, fishing and exports. The need to protect access to external markets was one of the factors that motivated important investments in urban wastewater treatment. For example, in the words of a former President of Chile: 'If we continued irrigating with wastewaters we were going to have serious problems in placing our ... agricultural products [in external markets]'. As a result, wastewater treatment coverage in the region doubled from 14% to 28% in the last decade. In particular, in Chile, all urban wastewater discharges currently receive treatment. Many countries (e.g. Argentina and Peru) are making important investments in water supply and sanitation services. The benefits of these investments are often presented not only in terms of public health, quality of life and protection of the environment, but also as positive effects on the economy and employment. For example, the expansion of wastewater treatment is expected to make it possible to irrigate more land with clean water; to promote the tourist industry, because of clean water bodies; to reduce export risk due to possible complaints in relation to wastewater irrigation; to promote the qualities of pollution-free products in external markets; and to generate more employment associated with exports and the tourist industry.

Source: Jouravlev (2004 and 2015).

11

INVESTING IN WATER IS INVESTING IN JOBS

WWAP | Marc Paquin
With contributions from Katherine Manchester and Catherine Cosgrove



This chapter underlines that water-related investments are necessary for economic growth, jobs and reducing inequalities. Failure to invest not only represents missed opportunities but also may impede economic growth and job creation, effectively resulting in job losses.

The bridge of Marina Barrage, a government-commissioned dam built across the mouth of Marina Channel (Singapore)
Photo: © Tristan Tan/Shutterstock.com

Water is a crucial and pervasive input for all major types of production – so much so that estimating its relationship with economic growth and jobs is particularly challenging. Countries exhibit a strong positive correlation between water-related investments and national income, as well as between water storage capacity and economic growth (Sadoff et al., 2015). As discussed in Chapter 1, water investments are a necessary enabling condition for economic growth, jobs and reducing inequalities. Failing to invest in water management not only represents missed opportunities but may also positively have the reverse impact and impede economic growth and job creation, effectively resulting in jobs loss.

Insufficient local investment can have far-reaching economic impacts. For example, the 2011 floods in Thailand affected the country's primary industries (automotive and electronics) and were also detrimental to the national economy and to select global supply chains (Haraguchi and Lall, 2014). In São Paulo, Brazil, frequent flooding as well as the severe drought in 2014-2015 had an impact on the city's growth and restricted local competitiveness in domestic and international markets (Haddad and Teixeira, 2015).

Whether looking at water investment through the lens of risk reduction (e.g. flooding, drought, disease) or growth potential (i.g. expanding agriculture, industry or recreation), the highest returns require proactive policies that make the most of an increasingly in-demand resource, particularly given the uncertainties resulting from climate change. When making these policy considerations, it is important to keep in mind that water investments providing benefits for human well-being may not necessarily translate into national economic statistics. For example, improved water access can shift the time that households spend collecting water to more productive activities (see Box 5.2), but those gains may not be measured in the context of an informal economy (Sadoff et al., 2015). Despite the complexity of accurately projecting costs and benefits beyond the project level, these estimates are critical for maximizing the returns of water investments.

Investments in infrastructure and operations of water-related services can provide high returns for economic growth and for direct and indirect job creation

Investments in infrastructure and operations of water-related services can provide high returns for economic growth and for direct and indirect job creation (Box 11.1). In terms of direct job creation from water investments, the results are highly context-dependent but may entail some significant returns. One study found that investing US$1 billion in water supply and sanitation network expansion in Latin America would directly result in 100,000 jobs (more than equal investments in coal-powered energy or rural electrification) (Schwartz, et al., 2009). Another study in Peru found that villages with a rehabilitated irrigation infrastructure hired 30% more agricultural workers than comparable villages, with greater benefits accruing to poor farmers (IFC, 2013).

An analysis of ILO data by the International Finance Corporation (IFC) found that about 1% of the labour force in both developed and developing countries work in the water sectors (Estache and Garsous, 2012). While jobs in the water sector may sometimes represent only a minor share of the total employment opportunities, they are a prerequisite to a large number of other jobs.

As indicated in Chapter 1, poor countries with greater access to safe water and improved sanitation have experienced much higher annual GDP growth, compared to similar countries with lower levels of access (SIWI/WHO, 2005). Infrastructure increases growth and decreases income inequality, while bringing water access into the analysis is particularly effective for reducing inequality (Calderon and Servén, 2004 and 2008). Thus, targeted water investments may contribute towards reaching growth and poverty alleviation goals more effectively.

BOX 11.1 DIRECT EMPLOYMENT GENERATED BY INFRASTRUCTURE PROJECTS

At times, infrastructure projects – including water projects – have been intentionally designed for high job creation. For instance, the Mahatma Ghandi National Rural Employment Guarantee (MGNREG) programme in India, which provides work opportunities to some 25% of rural households, has largely focused on water projects, such as water conservation and harvesting, irrigation and flood, and drought protection (Government of India, 2012).

Another example is South Korea's Four Rivers Restoration Project, which directed some US$86 billion towards the creation of thousands of jobs in water management following the economic crisis (Ministry of Environment/Korea Environment Institute, 2009).

The benefits of water investments – for employment, economic growth and well-being – can be remarkable. The US Department of Commerce's Bureau of Economic Analysis found that each job created in the local water and wastewater industry creates 3.68 indirect jobs in the national economy (United States Conference of Mayors, 2008b). Investing US$188.4 billion, the amount needed to manage stormwater and preserve water quality in the United States, could generate US$265.6 billion in economic activity, create nearly 1.9 million direct and indirect jobs (e.g. in manufacturing to supply equipment and machinery) and result in 568,000 additional (induced) jobs from increased spending (Green for All, 2011). Furthermore, traditional water infrastructure is estimated to generate between 10 and 26 direct, indirect and induced jobs per US$1 million invested (Green for All, 2011; Pacific Institute, 2013).

Moreover, investments in sustainable water practices are estimated to generate: between 10 and 15 direct, indirect and induced jobs per US$1 million invested in alternative water supplies; between five and 20 direct, indirect and induced jobs per US$1 million invested in stormwater management; between 12 and 22 direct, indirect and induced jobs per US$1 million invested in urban conservation and efficiency; and between 10 and 72 direct, indirect and induced jobs per US$1 million invested in restoration and remediation (Pacific Institute, 2013).

From the global health perspective, one of the greatest water-related challenges is inadequate WASH, which is associated with global economic losses of US$260 billion every year, largely related to lost time and productivity (WHO, 2012). While costly to address, the estimated rates of return on water supply and sanitation investments are striking: every US$1 invested in WASH could have a return of US$3-34, depending on the region and technology involved (Hutton and Haller, 2004).

Investment in agriculture also contributes to alleviating unemployment and the on-going fight against poverty. Agricultural growth can increase the incomes of the three poorest deciles 2.5 times more than growth in other sectors (World Bank, 2007) and is the basis for employment creation in other sectors along the value chain. As noted in Section 3.2, employment in the agriculture sector accounted for roughly 30% of the global active workforce in 2014, but for 60% in sub-Saharan Africa (Table 3.2). In general, water investments and policy need to be part of a broader and multi-sectoral dialogue on the future of farming to meet the aspirations of the farmers and of society (FAO, 2014d), seeking sustainable and inclusive development in accordance with principles for Responsible Investment in Agriculture and Food Systems (CFS, 2014).

For any water-related investment, obtaining the highest return will be highly context-specific, and its appropriateness will depend on a multitude of economic, social and environmental factors and their relative benefits and trade-offs. Public-private partnerships provide possible solutions to investment needs. Despite mixed results, PPPs offer the prospect of much needed investment in water sectors, including building and operating infrastructure

for irrigation and water supply, distribution and treatment. However, in many developing countries, the assistance of the international donor community may be necessary to catalyse public-private collaboration, and to promote the inclusion of relevant social and environmental safeguards (Rodriguez et. al, 2012).

The strategic planning and management of water resources at the basin or watershed level is essential for sustainable economic development and jobs. In this context, consideration must be given to ways that maximize job creation and mitigate job losses or displacement that may result from the implementation of an integrated approach to water management, with a view to promote economic growth, poverty reduction and environmental sustainability.

The transition may entail negative consequences for specific groups or individuals as a result of investment choices, new sets of policies, technological innovations, and shifts in business strategies (ILO, 2015c). For example, a lack of investment to prevent or mitigate flood and drought disasters can lead to drastic displacements, especially among agricultural populations. In the forestry sector, it is sometimes necessary to reduce deforestation to avoid water shortages or excess water flows with negative impacts on a region, resulting in lay-offs in the industry. In other instances, excessive water withdrawal can lead to the loss of a resource base, and destroy a region's industry (e.g. inland fisheries and aquaculture) and related employment. In turn, imposing mandatory water-use restrictions to mitigate the impact of prolonged drought conditions on an entire population can also lead to economic downturns in some economic sectors, with employees losing their jobs.

Therefore, it is essential that decision-makers and planners be cognizant of these potential impacts and make concerted efforts to consult the various stakeholders. Provisions must also be made to assist those negatively impacted by the changes, notably through retraining to seize the new opportunities water investments generate.

Moreover, in order to maximize positive economic and employment results it is necessary to plan water investments in conjunction with relevant sectors, such as agriculture, energy and industry. For instance, almost two-thirds of the companies that provided information to the Carbon Disclosure Project (CDP) Global Water Report 2015 reported an exposure to water risk, including from water scarcity. Conversely, more than 70% of reporting companies indicated that water offers operational, strategic, or market opportunities. This indicates that when it comes to water, businesses share common interests with governments and communities. This convergence of interest provides an opportunity for synergistic water investments beneficial, inter alia, to local economies and job creation (CDP, 2015).

12

ADDRESSING CAPACITY DEVELOPMENT NEEDS AND IMPROVING DIALOGUE

UNESCO-IHE | Uta Wehn and Maarten Blokland
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Students from Tailulu College (Tonga) making the most of new high-speed broadband services
Photo: © Tom Perry/World Bank

This chapter explores policies and actions that will help develop the capacity and skills required to meet the various water challenges, thus creating an enabling environment for employment opportunities in general.

The challenges faced by developing countries in their struggle for economic and social development are increasingly related to water. Many countries are shifting their attention to the city level as the locus for sustainable development. Companies are measured in terms of their social and environmental performance and are under public pressure to deliver services at affordable prices, while consumers are beginning to understand that they, too, have a role and may need to become more responsible consumers. Revisiting frameworks such as IWRM in order to resonate with these new complexities will be essential. Moreover, stronger and better-interlinked institutions are required to handle the increased level of complexity. While new knowledge, datasets, analytical tools and consistent data need to be developed, capacity development and social learning will be critical to keep up with the evolving challenges (Indij and Gumbo , 2012).

12.1 Changing capacity needs

The skills, qualities and capacities of the human resources employed are vital for the successful performance of the water sector and for the sustained use, adaptation and development of scientific and technological innovations (see Chapter 16). This is particularly salient in view of the broadening of the fields of expertise that are needed for this sector, which includes water resources management, building and managing water infrastructure, and the provision of water-related services (see Chapter 4). For example, classic water treatment and network operation skills, such as management, chemistry, automation, accounting, laws and human resources, are still paramount, but the scope of expertise needed nowadays includes other topics such as biodiversity assessment, nexus issues (e.g. food and energy) as well as modelling, information and communication technologies (ICTs). Human rights-based approaches and dialogue with stakeholders are emerging as crucial imperatives. This issue is further compounded by the rapid sophistication of the majority of the domains, especially in legal and regulatory matters, which are more complicated and superimposed on customary law and practice.

Moreover, in order to reflect the cross-cutting nature of water, there is a need to broaden academic curricula, e.g. providing courses on energy and agriculture to water professionals, and on water resources management and water operations to science and engineering students in other fields of study. Furthermore, awareness-raising activities are needed to help inform and sensitize decision-makers outside the water community (e.g. agriculture, energy, health and safety, and finance) about water-related challenges and their implications for and interrelations with these sectors.

Aside from the skills, knowledge and competences of professionals and civil society, organizational and institutional capacity is also lacking in many countries (Wehn and Alaerts, 2013). Such capacity can consist of several layered and nested levels: the capacity of individuals, organizations, the enabling environment and civil society. While the process of strengthening capacity at one or more of these levels – capacity development – is the inherent responsibility of people, organizations and/or society (OECD, 2006), external sources can also play an important supporting role in addressing capacity needs. These have to be adjusted in sync with emerging challenges.

Lack of capacity and the challenges facing the water sector require design of adequate training tools and innovative learning approaches to enhance the competencies of staff as well as strengthen institutional capacity. This applies to government and its agencies, river basin organizations as well as other organizations, including those in the private sector.

12.2 Approaches for addressing capacity development needs

There is a great need for capacity development in the water sector, as identified by the IWA among others; this demand is no longer for doing more of what is already being done, but is a question of achieving more in a different and more efficient way.

Traditionally, individual staff development has taken the shape of apprenticeships, practical training, induction training for new staff, mentoring and

succession planning. E-learning opportunities increasingly have a supporting or complementary role to play. While individual staff development is certainly necessary, in most cases, it is not sufficient by itself; therefore, capacity development increasingly would entail more comprehensive approaches that extend to other levels of capacity. Organizational capacity development aiming for organizational or systemic change may take place within and between water sector organizations.

Larger water operators that operate through a variety of PPP models in different municipalities and countries have developed approaches and systems that ensure the accumulation of lessons on knowledge and capacity development so that lessons learned at one location are shared, adapted and transferred to other locations (see Box 12.1).

Water operators may engage in various forms of collaboration at local, national and international levels

Water operators may engage in various forms of collaboration at local, national and international levels. The collaborative instruments include voluntary benchmarking, twinning and water operator partnerships (WOPs) (see Box 12.2). In addition, there are learning and knowledge-sharing events organized by professional associations and other bodies, as well as thematic webinars.

BOX 12.1 TRAINING APPROACHES BY PRIVATE OPERATORS

At the beginning of a performance improvement contract, a private operator usually starts with an in-depth audit that covers the strategies, organizational structure, business processes, organizational performance and the workforce and managers. The findings usually show that training and organizational reforms are required to achieve necessary performance improvements. Such reforms may include a change of corporate culture, enhancement of key processes and working routines, as well as a change of work ethics and attitudes, and an injection of skills and technology into management and the labour force. In-depth reform is often undertaken through a multi-year change management programme that is developed in extensive consultations and negotiations with the local contracting authority and the workers unions.

These change programmes include a specific training component that runs the entire length of the contract. All staff and management levels receive appropriate training, including on the job, classroom training and mentoring. Larger private operators make use of international standards and practices, and have in-house networks of specialists, campuses, web-based training schemes, as well as partnership with local knowledge institutions. They aim to continuously develop employee skills through formal training programmes leading to diplomas, certifications and professional licenses (AquaFed, 2015).

Contributed by Jack Moss (AquaFed).

BOX 12.2 WATER OPERATORS' PARTNERSHIPS (WOPS)

A WOP is a not-for-profit peer support arrangement between water and sanitation utilities. WOPs are an increasingly common mechanism for building the capacity of public utilities, with over 200 WOPs on record. These solidarity-based partnerships make use of the knowledge and experience of staff in strong utilities to support the development of staff in other utilities that need help. In contrast to technical assistance programmes that rely on external experts to get the job done, WOPs represent more recent thinking on capacity development: they focus on strengthening the capacity of local water and sanitation utility staff memberswho will still be there years down the lineproviding services to local populations. WOPs build the skills of those who work within water and sanitation utilities and improve the way that employees work together. Partners in WOPs employ a range of learning approaches to strengthen utility employees'capacity to tackle technical and managerial challenges. Going beyond one-off classroom training, WOPs apply practical job training and ongoing informal mentorship to help operators anchor and apply newly acquired skills. In addition to boosting capacity, in studied cases, WOPs have contributed to improved staff motivation, safer working environments and improved labour-management dialogue.

Contributed by Julie Perkins (GWOPA).

In the case of profound organizational reforms, it is necessary to foster collaboration and obtain concurrence and support beyond water sector organizations, including user organizations, workers unions, investors and core governance institutions at the country level. This kind of social dialogue can be organized at the workplace, or at local and national levels, serving to promote water reforms and efficient water management as an enabler of employment generation by increasing wide ownership and information sharing (cf. Ratnam and Tomoda, 2005). Strong social dialogue, effective coordination among ministries (including policy coherence), and improved communication between employers and training providers are vital for turning the vicious circle of inadequate education, poor training, low-productivity jobs and low wages into a virtuous circle in which improving the quality and availability of education and training for women and men fuel innovation, and the growth of not only more but also better jobs and social cohesion (ILO, 2008).

In the water sectors worldwide, profoundly new and transversal themes need to be addressed. These include water integrity (see Box 12.3), human rights-based approaches, water diplomacy, water economics, gender, regulation and the use of technology. When merged together, they require embracing a new kind of knowledge configuration combining the natural sciences and engineering with social science disciplines, as well as bridging sectors and multi-stakeholder collaboration.

Raising public awareness about job opportunities in the water sector and creating attractive working conditions are vital in order to avoid brain drain to other sectors. Open, demand-responsive, locally-based and flexible networks are proving to be drivers for constructing the new social capital that the water sector is demanding (see Box 12.4). Interdependence and horizontal relations have grown in importance, partly as a consequence of the wide diffusion of ICTs. These approaches are able to foster peer-to-peer (individual and institutional) knowledge transfer among water institutions from different countries, including NGOs, private sector, unions, river basin agencies, water operators, communities and universities.

BOX 12.3 NEW THEMES FOR CAPACITY DEVELOPMENT

Promoting water integrity

The African Water Vision 2025 named inappropriate governance and institutional arrangements as core human threats to sustainable water management. The vision called for fundamental changes in policies, strategies and institutional arrangements for the adoption of participatory approaches, as well as for openness, transparency and accountability in decision-making processes. Specific attempts to promote water integrity with a coherent approach were taken during the implementation of the Capacity Building Programme on Water Integrity in the Western African subregion. The participants from 12 countries – Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, The Gambia, Ghana, Liberia, Mali, Niger, Nigeria, Sierra Leone and Togo – who attended the five regional training workshops organized in the subregion stemmed from all segments of society (government, business, members of parliament, representatives of civil society organizations and representatives of the media and river basins authority). At the end of each workshop, participants drafted a national water integrity action plan to be submitted for refinement, enrichment, validation and endorsement to a wider group of stakeholders at the national level.

Even more profound reforms concern the need to enhance the quality of governance in the water sector as a whole and the need to combat corruption in the water sector in particular. Insufficient understanding of roles and responsibilities leads to blurred accountability lines and procedures that can easily be captured by corrupt groups. The institutional fragmentation of the sector exacerbates corruption risks. To effectively promote integrity in such a context, a comprehensive approach is required that focuses on creating an enabling environment that fosters transparency, accountability, participation and anti-corruption.[23]

Contributed by Françoise-Nicole Ndoume (WIN), based on UNECA/AU/AfDB (2000) and UNDP WGF (2014).

Achieving the human right to water and sanitation

UNECE work with the Portuguese Water and Waste Services Regulation Authority (ERSAR) on improving equitable access to water and sanitation has shown the crucial role of building capacities of water and sanitation operators to contribute to the achievement of the human right to water and sanitation. In 2013, ERSAR coordinated the self-evaluation of the equity of access to water and sanitation services in Portugal, applying the Equitable Access Score-card, developed in the framework of the activities implemented under the UNECE-WHO/Europe Protocol on Water and Health. The outcomes of this assessment demonstrated the need to focus efforts on improving awareness and skills of personnel as a contribution to the realization of the human right to water and sanitation. ERSAR is currently developing recommendations for practitioners on how to implement these rights in the Portuguese water sector. ERSAR is also developing a simulator of social tariffs for water and waste services, which aims to help each Portuguese water and waste utility to find the best-adjusted solutions regarding the mandatory adoption of social tariff by these utilities.

Contributed by Álvaro Carvalho (ERSAR) and Chantal Demilecamps (UNECE).

[23] Transparency, Accountability, Participation and Anti-Corruption, often abbreviated as TAPA, are the key elements of Integrity.

12.3 National strategies for capacity development in the water sector and beyond

Despite many capacity development efforts, in practice, it remains challenging to strengthen knowledge and capacity across the board, in multiple government institutions, civil society, the private sector and knowledge institutes (Wehn and Alaerts, 2013). One of the main outcomes of events[24] held at UNESCO-IHE taking stock of the situation in 2013 was a call for 'national strategies for water sector capacity development'. This call was echoed by IWA's report on Human Resources Capacity Gap covering 15 countries in Africa (IWA, 2014a).

Such sector-wide capacity development strategies can help to ensure that the knowledge and skills to maintain water services and water resources are strengthened where needed (i.e. locally), and that new system expansions avoid the failures of the past when focus was entirely on infrastructure. Some countries have already embarked on developing and implementing such strategies (i.e. Uganda) (see Box 12.5), while others are only beginning to deliberate on their necessity (i.e. Indonesia). In some countries, capacity development strategies are (at least in principle) integrated in their national IWRM Policy (i.e. Colombia), but their implementation remains challenging. Lessons with the conceptualization, as well as the implementation, of such sector-wide strategies are starting to emerge.

Besides individual skills and capacity, the organizational capacity needs of various sector actors also constitute a key focal area of such water sector capacity development strategies. These can benefit from a concerted effort following agreed procedures and combined resources (see Box 12.5). Such dedicated water sector capacity development strategies provide a useful framework for strengthening water-related capacity and skills in a coherent and coordinated way through a comprehensive and harmonized approach. In the process of devising and implementing these strategies, they can also serve as a platform to foster dialogue between the many relevant actors in the water sector, and beyond.

[24] Once such event was the 5th Delft Symposium on Water Sector Capacity Development in May 2013 and a two-day Expert Workshop on Knowledge and Capacity Development leading up to the Symposium.

BOX 12.4 CAP-NET: NETWORKS FOR CAPACITY DEVELOPMENT

More than 10 years of work experience in the Cap-Net UNDP global framework shows that networks are bringing an important added value for capacity development in water.

This has been proven possible as networks can: (i) create a multi-disciplinary knowledge base necessary for the introduction and support of complex approaches, such as integrated water resources management; ii) combine scattered strengths of institutions into a critical mass; (iii) maximize use of local skills; iv) share knowledge and expertise through communication and collaboration; and (v) enhance the impact of capacity development activities by coordinating and making use of members' capacity, skills and experience. Due to their decision-making and operational frameworks, networks enable capacity development in line with the basic principles of green economy: resources efficiency, social inclusiveness and low carbon emissions.

Contributed by Kees Leendertse and Damian Indij (Cap-Net UNDP), based on Indij and Gumbo (2012); Indij et al. (2013).

BOX 12.5 UGANDA'S NATIONAL STRATEGY FOR WATER AND ENVIRONMENT SECTOR CAPACITY DEVELOPMENT

In order to help overcome the problem of disparate, overlapping or discontinued capacity development efforts, the Ministry of Water and Environment in Uganda was supported by the German Development Cooperation Agency (GIZ) and other donors in the process of devising a national strategy on capacity development for the water and environment sector. Based on a number of consultation events, brainstorming and evaluations of ideas at national level, followed by regional, district and local consultations, the national capacity development strategy was produced in October 2012. The main objective was for the water and environment sector to generate the capacity to increasingly meet its targets and undertake its mandate benefitting from a better understanding of its capacity demands: more effective means of delivering capacity in response to the needs and an increasing ability to positively influence the enabling environment. With a corresponding institutional structure in place, the strategy is now being implemented by making use of scarce resources. Focusing on the urban water supply and sanitation sector first, methods and templates for capacity development plans at the organizational level are being developed centrally. Next, they will be tested by the actors of this sub-sector before being rolled out and applied to the remaining five sub-sectors covered by the national capacity development strategy: rural water supply and sanitation, water for production, water resources management, environment and natural resources and climate change (Government of Uganda, 2012).

Source: UNESCO-IHE.

13

IMPROVING WATER EFFICIENCY AND PRODUCTIVITY

UNEP DTIE | Maite Aldaya and Elisa Tonda
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Irrigation system in raised garden bed
Photo: © Floki/Shutterstock.com

This chapter addresses the importance of improving water efficiency and productivity with a special focus on rural and urban areas as well as industry. It explores how policies and actions can boost water efficiency and productivity in order to minimize water use and mitigate impacts on ecosystems, thereby improving opportunities for socio-economic development and decent jobs, especially under conditions of water scarcity.

Water efficiency and productivity have different nuances in different economic sectors. Broadly, water-use efficiency is the ratio of the water input to the useful economic/product output of a system or activity (m^3 water per product units) (UNEP, 2012a). Increased efficiency implies using less water to achieve the same or more goods and services. It involves getting the most not only out of scarce water resources but also out of other natural, human and financial resources (GWP, 2006). Such an approach has four interrelated concepts: technical efficiency, productive efficiency, product-choice efficiency and allocative efficiency (GWP, 2006).

Water productivity refers to the ratio of the net benefits to the amount of water used in the production process (product units per m^3 water) (GWP, 2006). Increased water productivity means increasing the amount of benefit from a unit of water input. When the output is monetary it is referred to as economic water productivity (US$ per m^3). This has also been used to relate water use in agriculture to nutrition, jobs, welfare and the environment (CAWMA, 2007).

Increasing both water-use efficiency and water productivity can contribute to improving socio-economic development and create opportunities for employment and decent jobs in water-dependent sectors, especially under conditions of water scarcity (where water supplies may be a limiting factor to development).

In the broadest sense, productivity reflects the goal of producing more food, income, livelihood and/or ecological benefits while minimizing the use or deterioration of resources at every stage of the value chain. In the real world, however, there are generally trade-offs between water-use efficiency and the provision of other (non-hydrological) ecosystem services, which may become less significant if appropriate policies and IWRM are in place. Understanding and considering the trade-offs and synergies between water, energy, food, ecosystems and other issues at the proper scale is essential for wise management and meeting overall sustainability goals. A recent World Bank Group review (Scheierling, et al., 2014) suggests that most studies presented in the agricultural productivity and efficiency literature either analyse field- and basin-level aspects but focus only on a single input (water), or they apply a multi-factor approach but do not address these factors with a basin-level context.

Water-use efficiency improvements are considered instrumental to address the projected 40% gap between demand and supply and mitigate water scarcities by 2030 (UNEP, 2011d). Improving efficiency, particularly in agriculture, could lead to making available substantial volumes of water for reallocation to other sectors and uses, reduce conflicts among competing water users and facilitate the attainment of other development targets. Increasing the productivity per unit of water can help improve opportunities for economic diversification and growth, for employment, income generation and improved nutrition (CAWMA, 2007). However, there is no global data on the relation between water-use efficiency and jobs considering net impacts; most studies of this kind focus on green economies as a whole (UNEP, 2011d, 2015).

Governments can create a policy framework to enable, support and reward improvements in resource-efficiency bringing increased competitiveness, resilience and security, and new sources of jobs and growth. By doing so, they can facilitate significant cost savings for different agents from improved efficiency, commercialization of innovations and enhanced water management over the entire product life cycle. Timely action at the appropriate level can be enabled if national policies set clear targets, eventually building on existing standards; establish measures to advance towards appropriate water pricing and subsidy reform; invest in hard, soft, natural and man-made infrastructure and establish financing incentives to those who help increase efficiency, including R&D funds for the sharing of suitable technologies; and support scaling up and replicate best practices through PPPs.
A significant proportion of these jobs depend on private initiative and investment that will only take place if predictable, reliable, secure and efficient water

Increasing both water-use efficiency and water productivity can contribute to improving socio-economic development and create opportunities for employment and decent jobs in water-dependent sectors, especially under conditions of water scarcity

management and services are in place. Nevertheless, the short-term risk and profit analysis characteristic of the private sector, the increasing expectations of shareholders, coupled with concerns about safeguarding intellectual property, might impede the flow of capital into resource-efficient investments. The private sector expects that governments and international organizations will provide reliable signals and create a robust, predictable, coherent, fair and flexible framework within which businesses can operate (UNEP/ILO/IOE/ITUC, 2008). Proactive business engagement in public policy processes and with the local communities can help mitigate contextual risks in the value chain (CEO Water Mandate, 2010). To be meaningful, such engagement is oriented toward shared water goals and public interest outcomes.

13.1 Improving water efficiency and productivity in rural areas

It is widely recognized that improved efficiency and productivity produces secondary benefits for the economy at every level through multiplier effects on opportunities for employment and income generation (CAWMA, 2007; UNEP/ILO/IOE/ITUC, 2008; UNEP, 2011d). However, while increased agricultural productivity may raise the quality of employment, it may also decrease the quantity of jobs in that sector (see Section 3.4.2).

In the agricultural sector, numerous studies show that investments in irrigation have an overall multiplier effect on the economy estimated between 2.5 and 4 (CAWMA, 2007; Bhattarai et al., 2007; Hussain and Hanjra, 2004; Lipton et al., 2003; Huang et al., 2006). Investments in water management and savings, such as canal lining or micro irrigation, require a workforce for producing, installing and maintaining necessary equipment (UNEP/ILO/IOE/ITUC, 2008). This can be a relevant source of employment for the rural poor (CAWMA, 2007). Increased farm output also stimulates demand for farm labour in terms of number of workers and length of employment. For instance, annual labour use per hectare in the Ganges-Kobadak irrigation system of Bangladesh is about 100 days more than that in nearby non-irrigated areas (CAWMA, 2007). Increasing the value derived per unit of water, especially the opportunities for employment, income generation, nutrition and women empowerment, can be important for poverty reduction (CAWMA, 2007; FAO, 2011a; Polak, 2003). This can be achieved with a combination of agronomic and water management practices to raise grain yields in high-potential areas, strategies aimed at increasing the value per unit of scarce water, or reducing vulnerability to drought, polluted water, or loss of water allocations (CAWMA, 2007) (Table 13.1).

However, policies aimed at increasing local water-use efficiency alone may unintentionally stress water supplies at a broader basin scale and result in a rebound or take-back effect (WWAP, 2015). A rebound effect (or take-back effect) occurs when the water savings obtained from improved water-use efficiency are reinvested to increase production. Therefore, although the process may be more efficient, total water use does not decrease (WWAP, 2015). This is the case of the irrigation modernization process in some areas in Spain, where switching from traditional surface irrigation to modern sprinkler systems in the Alto Aragón increased crop evapotranspiration and non-beneficial evapotranspiration (mainly wind drift and evaporation losses) (Lecina et al., 2010). This shows how efficiency improvements lead to larger water consumption.

Green economy studies in Africa reveal that organic agriculture, which uses less energy and synthetic inputs (fertilizers, herbicides and pesticides), is more labour-intensive and creates more employment. The reallocation from chemical to organic inputs also results in lower negative impact on soil quality in the medium- to long-term and sustained higher productivity (UNEP, 2015) (Figure 13.1).

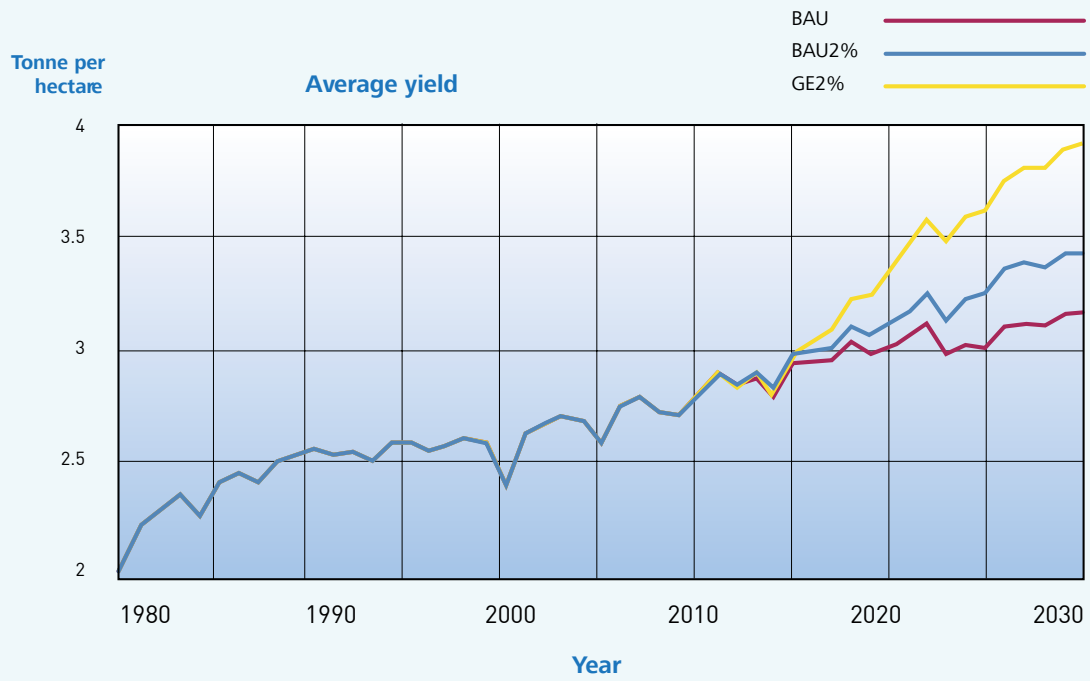
TABLE 13.1 THE IMPACTS OF POTENTIAL AGRICULTURAL WATER MANAGEMENT INTERVENTIONS IN PRODUCTIVITY AND EMPLOYMENT

Potential agricultural water management interventions	Production/ productivity	Employment	Consumption and price	Backward linkages and second-round output effects	Non-farm rural output and employment impacts	Income stabilization	Nutritional impacts	Multiple use	Socio-economic effects	Environmental and health impacts
1. New systems										
Large-scale public surface irrigation	High	Medium	High	High	High	Medium	Medium	High	Mixed*	Mixed*
Diffuse forms of irrigation: communal or private operated systems, groundwater, etc.	High	High	Medium	Medium	Medium	High	Medium	High	Mixed*	Mixed*
Fisheries and aquaculture	Medium	High	Low	Low	High	High	High	High	Medium	High
Multiple use systems: production plus, domestic plus	Low	Medium	Low	Low	Low	Low	High	High	High	Medium
Integrating livestock	Medium	Medium	Medium	Low	High	High	High	High	Medium	Mixed*
2. Maintaining ecosystem resilience	Low	Low	Low	Low	Medium	Low	Medium	High	Low	High
3. Improving existing systems										
Improving agricultural water productivity	Medium	Medium	Medium	High	Medium	High	Medium	Low	Mixed*	Mixed*
Reversing land degradation	Medium	Low	Medium	Medium	Medium	High	Medium	Low	Low	High
Management of marginal-quality water resources	Low	Low	Low	Low	Low	Medium	Mixed*	Low	Mixed*	Mixed*
4. Rainwater management	Medium	Medium	Medium	Medium	Medium	High	Medium		High	Medium
5. Water policies and institutions	Medium	Low	Low	Low	Low	Medium	Low		High	Medium

* Mixed positive and negative impacts.

Source: CAWMA (2007, Table 4.3, pp. 166-167, reproduced with permission from IWMI).

FIGURE 13.1 KENYA: AVERAGE AGRICULTURAL YIELD UNDER GREEN ECONOMY AND BAU SCENARIOS



Notes: Scenarios are projected to 2030.

BAU: Business-as-usual scenario.
BAU2%: Business-as-usual 2% scenario allocates an additional 2% of GDP per annum as investments to the current BAU investment path.
GE2%: Green Economy 2% scenario assumes an additional 2% of GDP per annum as green investments to the baseline.
GETS: Green Economy Target Specific scenario aims at identifying whether policy-makers can achieve the medium- to long-term targets following green economy interventions in the prioritised sectors.

Source: UNEP (2015, Fig. 11, p. 31).

Adjusting the concept of 'more crop per drop' to include 'more added value per drop' in agriculture

Simply increasing the physical value of production per unit of water is not enough. Policies for enhancing the value of water used in agriculture involve not only increasing yields, changing from low to high-value crops, reallocating water from low to higher value sectors or lowering the cost of inputs. They should also optimize the creation of quality jobs and related environmental aspects. For instance, policies should achieve more livelihood support per unit of water (more jobs, nutrition and income for the same amount of water), while increasing health benefits and the value of ecological services of agriculture (CAWMA, 2007).

Targeted water interventions are fundamental to ensuring that the benefits reach the poor and are not only captured by more powerful or wealthier users. These interventions enable the poor and marginalized people to gain access to water and manage it effectively (CAWMA, 2007; De Stefano and Llamas, 2013).

Access to water and water-efficient technologies, such as rainwater harvesting or water-saving irrigation techniques, allow smallholders to produce high-value crops such as vegetables or fruits. Particularly in regions with low or erratic rainfall, promoting on-farm soil, water conservation and water-harvesting structures can greatly improve the 'efficiency of rain'. Supplemental irrigation and water-saving localized irrigation techniques at all scales can also increase productivity. Microcredit schemes and private investments are essential to help smallholders enhance efficiency while lifting people out of poverty.

Industry has been investing in improving water-use efficiency and hence has had a relevant role in terms of job creation

Effective cross-sectoral and multi-level coordination mechanisms are needed to ensure that policies and objectives are mutually consistent and do not undermine each other. Innovative policies and technologies are necessary to address overall resource productivity and tackle the difficult challenges of social and environmental sustainability interlinkages (UNEP, 2012a).

13.2 Improving water efficiency and productivity in urban areas

Improving water-use efficiency in cities provides opportunities to address water and job challenges. For instance, cities can create jobs in low-water intensive sectors such as solar, wind energy, wastewater treatment, reuse and recycling.

Key success elements include (UNEP, 2012c):

- Smart urban logistics and spatial planning. Resource-efficient and low-footprint design of buildings and infrastructure are essential elements of successful urban design, such as dry toilets, use of solar PV, wind and geothermal energy for power generation, while at the same time rehabilitating aging water networks and infrastructure;
- Smart design, finance, technology and skills transfer and development. Price mechanisms such as incentives, tariffs, and subsidies can also be utilized instrumentally to stimulate the uptake of green technologies and processes. Volumetric charging through water meters is an effective means of incentivizing efficient water use (UNEP, 2011d). Pricing approaches have limitations, and should not be seen as an ultimate panacea;
- Maximized utility of freshwater. One method is reusing the wastewater generated by one process in another process with a lesser quality requirement (UNEP, 2011d). Alternatives can be also provided to piped water supply, such as rainwater harvesting for non-drinking purposes;

Modern urban wastewater treatment plant
Photo: © hxdyl/Shutterstock.com

- Awareness raising and education of local service providers. One of the keys to success is developing appropriate educational and awareness raising tools by local water and sanitation service providers and supporting institutional capacity, while enhancing competences and networks of government, business and civil society to support innovation-based measures;
- Participatory governance processes. The incorporation of bottom-up participatory governance processes in programmes and projects is essential; these will rely on the identification of local needs through social dialogue, including workers, operators as well as the participation of indigenous peoples in the case of water infrastructure schemes (see Box 13.1); and
- Rights to use water and the allocation of water to users. The formal definition of rights to use water and its allocation to users and the environment is also very important. Given that the majority of freshwater is used by agriculture, allocative water efficiency between cities and agriculture should be considered, i.e. in some cases, cities can buy water rights from farmers.

13.3 Increasing industrial water-use efficiency

Industry has been investing in improving water-use efficiency and hence has had a relevant role in terms of job creation, through the adoption of eco-innovation, cleaner and safer production and sustainable products development, extending their influence beyond the company gates to supply chains (see Box 13.2).

BOX 13.1 SOCIAL DIALOGUE IN THE MAYNILAD WATER DISTRICT, PHILIPPINES

In the Maynilad Water District, the management, unions and workers have successfully cooperated to reduce the high volume of NRW, defined as the difference between the amount of water put into the distribution system and the amount of water billed to consumers, thereby increasing water productivity (UNW-DPAC, 2011). The achievement of reducing NRW was converted into a mutually beneficial arrangement for both workers and the utility, and also resulted in significant environmental and social benefits. These include reduced NRW by 28% (from 66% in 2007 to 48% in 2011), which is equivalent to 560 million litres of treated water saved and redistributed (UN-Water, 2011). Social dialogue served to smooth potential conflicts during the privatization of the water utility and continues to provide a platform for the discussion and resolution of disputes between the management and the unions (UNW-DPA, 2011). The utility has ensured ongoing employment for workers, employing 87,000 people since 2007, including those hired by contractors and suppliers that rely on Maynilad as their major client. The company itself employs 2,123 workers (UN-Water, 2011) and has offered new skills and training to implement leak detection strategies (UNW-DPAC, 2011). This example is now being used in the Metro Cebu Water District, the largest in the country.

Source: UNW-DPAC (2011); UN-Water (2011).

The private sector has been playing an important role in the dissemination of the knowledge, techniques and skills and in scaling up water-use efficiency approaches. Nestlé Viet Nam's Farmer Connect Programme currently supports over 12,000 coffee farmers, providing them technical assistance and training to increase their productivity and secure jobs (see Box 13.3).

New resource-efficient technologies as well as enhanced competitiveness and innovation are generating shifts in employment and changes in the workforce worldwide. Increases in employment originate from new markets being created, such as waste management and recycling, and from resource-efficient value chains, such as the renewable energy ones. This leads to the creation of indirect jobs upstream and downstream as well as induced effects through increased demand (UNEP, 2012d). Recent studies across eight countries in Africa (Burkina Faso, Egypt, Ghana, Kenya, Mauritius, Rwanda, Senegal and South Africa) demonstrate that green economy policies will be an important source of new jobs. Investments in low water-intensive options such as solar and wind capacity can bring employment benefits. For instance, in Senegal, these energy options are projected to create between 7,600 and 30,000 additional jobs by 2035 (UNEP, 2015).

BOX 13.2 BUSINESS EVIDENCE 'DOING MORE WITH LESS'

There is evidence on how enhancing water-use efficiency and productivity is helping businesses reduce costs by minimizing wasteful practices. For instance, in 2014, Diageo Plc (a beverage company in the United Kingdom)reduced the volume of its water withdrawals by nearly 1 million cubic meters and estimated the cost savings associated with this reduction to be approximately US$3.2 million (CDP, 2014). It may also allow improved access to water for marginalized communities. In some cases, irrigation modernization coupled with water savings provides opportunities to expand these schemes to supply water to local communities (FAO, 2011a). Irrigation modernization improves water and agricultural productivity, which increases farm incomes, generates on-farm employment, lowers food prices, and has income and employment multipliers beyond the farm. However, the intensification brought by this modernization may have negative impacts on the ecosystems unless corrective actions are taken.

Source: CDP (2014); FAO (2011a).

Recycling makes an important contribution to reducing land requirement for landfills, as well as water and energy consumption for goods and services production, and associated pollution, while generating employment (Table 13.2). Recycling is expected to contribute to decent employment creation. However, it is worthwhile noting that in some countries, recycling jobs are often dirty and hazardous (UNEP, 2015).

Research and development in water-efficient and eco-innovative technologies can have spillover effects in other areas of the economy. For instance, more efficient modes of urban wastewater treatment and farm water use will have an impact on the energy component (Hardy et al., 2012).

A macroeconomic analysis of the German industry demonstrated that even if only half of the existing material efficiency potentials were realized, there would still be an increase in GDP and creation of new business areas of employment (Stiftung and Beys, 2005, cited in UNEP, 2011e).

TABLE 13.2 SELECTED EMPLOYMENT ESTIMATES IN THE RECYCLING SECTOR

	Country	Number of jobs (millions)
All recycling	China United States Brazil	10 1.1 – 1.3 0.5
Aluminium-can recycling	Brazil	0.7
Electronics recycling	China	0.7

Source: UNEP/ILO/IOE/ITUC (2008, Table E-S4, p. 18).

BOX 13.3 NESTLÉ VIET NAM'S FARMER CONNECT PROGRAMME

Value to Nestlé

Water is currently recognized as the most critical issue for sustainable coffee growing in Viet Nam, and Nestlé purchases roughly 20% of total Robusta coffee produced in Viet Nam for its global activities. Adoption of efficient water practices helps ensure a sustainable and secure supply chain.

Value to society

Nestlé implemented a number of best practices within its Farmer Connect network of 12,000 farmers working with other key local stakeholders for wider dissemination and scale up. Adoption of best practices allows improved water-use efficiency, generation of higher income for farmers through cost reduction linked to labour and energy, and higher yields, compared to the current average. Hence, farmers reap direct positive impacts on local sustainable drinking water availability.

Source: Nestlé (n.d.).

14

EMPLOYMENT IN SUPPORT OF WATER, SANITATION AND HYGIENE

WWAP | Marc Paquin and Richard Connor
With contributions from Kirsten de Vette and Robert Bos (IWA); and Archana Patkar and Emily Deschaine (WSSCC)

Builder laying sewage pipe on site
Photo: © iStock.com/ezza116

This chapter explores the financial and institutional mechanisms, and related job creation and human resources development considerations, necessary to the achievement of universal access to domestic water supply, sanitation and hygiene (WASH), as well as appropriate wastewater management. It also underlines the importance of a people-centred approach in this regard.

14.1 Financial and institutional mechanisms for universal access

Universal access to WASH contributes to increased productivity, to a life of dignity and equality, and to the creation of livelihoods and decent jobs. Achieving universal access requires financial and institutional mechanisms that foster coordination, cooperation, solidarity and accountability, and that provide incentives to invest in human resources for WASH. Ultimately, such investments pay off through their positive impact on a population's health status (see Chapters 1 and 11).

Policy frameworks that support these financial and institutional mechanisms need to be evidence-based. The adoption of the SDGs provides an opportunity for governments to review and adjust their national policy frameworks, including their water (notably WASH) and human resources policies and strategies. For WASH, this is also the opportunity to better reflect the obligations under the human right to safe drinking water and sanitation within these policies and strategies.

In most countries there is a dearth of information on the quantity and quality of human resources for WASH services, but whatever little evidence there is suggests a growing deficiency (see Section 4.2). It is in the best interest of governments to commission the necessary research, from their own resources or with external support, to strengthen the evidence base before consolidating new policies. Extrapolating from the limited information available in some low- and middle-income countries, new WASH policies should: support financial flows that rebalance investment in new infrastructure and services with those in operation and maintenance (O&M) and other recurrent expenditure; put a greater emphasis on sustainable sanitation services (including decentralized wastewater treatment in urban conglomerations); and ensure the WASH focus to shift to development in rural and peri-urban areas. It is essential that policies include targets and indicators that are measurable.

> Putting people at the centre of development solutions is an essential element of the process towards achieving sustainable universal access

The implications for job creation and human resources development need to be integrated into WASH policies and strategies, and these should be compatible with the general human resources development policies and strategies at the national level. It should thus 'take due account of stage and level of economic development and mutual relationships between employment objectives and other economic and social objectives' (ILO, 1964, Article 1). On the one hand, this will require a deployment of human resources to different services at all levels of government that is fit for purpose. In this context, there is a strong need to ensure that policies of decentralization include the authority for local decision-making (and related accountability) regarding the size and composition of the human resource base for WASH. On the other hand, human resources development must be guided by clear criteria that ensure an optimal balance between professional staff, technical staff and skilled labour, a rational representation of staff addressing different technical areas, and a recruitment policy that takes into account equality and non-discrimination aimed at achieving, among a number of goals, a just gender balance.

These changes require, in the first instance, an evidence-based, equitable and responsive reallocation of existing resources. In most low-income countries, such resources are very limited and once a reallocation has been complete, an increase of additional financial flows to WASH human resources will have to be pursued. Any increased investments in human resources should translate into expanded coverage and higher service levels, and should include incentives to improve the stability of the workforce, the decent nature of jobs and increased productivity through flexibility in deployment (see Box 14.1).

BOX 14.1 MANAGING MENSTRUATION IN FACTORIES

In Bangladesh, about 80% of the factory workers are young women, and a study by Business for Social Responsibility (BSR) concluded that 60% of the women workers were using rags from the factory floor as menstrual cloths. Since these were chemically charged and often freshly dyed, infections were common, resulting in 73% of women missing work for an average of six days a month. Women had no safe place to purchase cloth or pads or to change or dispose of them. When women are paid by the piece, these six days lost present a huge economic challenge to them and also to the business supply chain. An intervention to change this reportedly saw absenteeism drop to 3%, resulting in significant economic gains for workers and the factory owner. This scenario can be reproduced in farms and factories, homes and offices around the world. By addressing women workers' menstrual needs, workplace practices and human resource manuals worldwide could achieve measurable productivity gains.

Contributed by Archana Patkar and Emily Deschaine (WSSCC).

The handbook by the UN Special Rapporteur on the human rights to water and sanitation provides guidance on the principles, frameworks, financing and justice system underpinning the rights, which effectively apply to human resource policies, strategies and regulations (de Albuquerque, 2014). The IWA Manual on the Human Rights to Water and Sanitation provides more detailed guidance to utilities, operators and regulators of water and sanitation services, including detailed guidance on the human resources aspects (IWA, forthcoming). Corporate human resource and health and safety policies and procedures should be harmonized with the broader policy frameworks established by government and ensure that their own operations have safeguards in place that guarantee employee access to WASH. The World Business Council for Sustainable Development's (WBCSD) 'WASH at the workplace Pledge' is a tool that companies can use to ensure that their operations are in line with national legislation and best practice on WASH at the workplace.[25] The IWA Lisbon Charter for Public Policy and Effective Regulation of Drinking Water Supply, Sanitation and Wastewater Management Services lists among the responsibilities for regulators: '… to facilitate … the development of human resources with suitable technical and professional training, fit to carry out essential functions, thus ensuring increased autonomy of the [drinking water supply, sanitation and waste water management] services' (IWA, 2015, p. 11).

Institutional structures will have to provide the framework within which human resources for WASH can be optimally managed. With drinking water and sanitation responsibilities spread over a number of public sectors, the private sector and, in many low- and middle-income countries, the informal sector, it is crucial to establish effective institutional arrangements. Institutional mandates should be clearly defined, but not in a way that sustains silo-formation, and with incentives to work across sectoral boundaries. In public sectors, job security may be relatively good, but mechanisms to (re-)deploy human resources at levels and in positions where they can address the greatest needs, emerging issues or the most vulnerable segments of society are weak. The private sector often has more flexibility in staff deployment, but may enhance its contribution to universal coverage by shifts in the trade-offs between profitability, coverage expansion, service level increases and career opportunities for staff.

14.2 Accelerating universal access through people-centred approaches

Putting people at the centre of development solutions is an essential element of the process towards achieving sustainable universal access. Users of WASH services and facilities can provide an insight into what

[25] As of August 2015, 30 multinational companies had signed the World Business Council for Sustainable Development (WBCSD) WASH Pledge, and signatories are taking concrete steps to align their internal health, safety and environment (HSE)/sustainability reporting systems with best practice on WASH at the workplace.

Women have traditionally been the primary custodians of collecting and managing domestic water

WASH options are socially acceptable, affordable and technically feasible in their specific socio-economic context. Sustainability cannot be ensured without participation from communities, and especially women, the main users of domestic water supplies and water managers at the household level (UNICEF/WHO, 2012).

Due attention to users/clients is one essential element of a people-centred approach. Investing in the on-going career development of professional and technical staff through in-service training is another. WASH service providers should invest in improved human resource management practices, to plan for, attract, recruit and retain the most talented professionals and technicians. They should also ensure labour conditions that include opportunities and incentives for staff to continuously acquire new knowledge and develop new skills, including much-needed skills to participate in multi-disciplinary teams.

The speed and level of success by which the range of foreseen changes in WASH service delivery will take place critically depends on the way the human resource base evolves. Trends in the education and training of young professionals and technicians score high as key determinants. A successful inflow of appropriately trained young professionals into the WASH sector will depend on the development of curricula that respond to functional needs, are targeted to meet sector demand, and include the development of skills to work across disciplinary and sectoral boundaries. Consultative curriculum planning must address the specific needs of the WASH sector, reflect these in the objectives, scope and focus, and ensure that qualifications match the needs. It must also: consider the diversity of needs linked to environmental and social aspects in different geographical regions, and to emerging issues; concentrate on curricula responding to WASH market demands and be responsive to changes in those demands; and consider the capacity needs to perform the essential teaching functions effectively with quality teaching staff, facilities and equipment (IWA, 2014a).

In addition to professional training, the role of Technical and Vocational Education and Training (TVET) for WASH human resource capacity development should be purposefully expanded. The WASH sector should take the lead in this initiative, taking into account the specific needs for well-trained human resources for the WASH sector.

Women have traditionally been the primary custodians of collecting and managing domestic water and they are often responsible for managing and making payments for water. Yet, they have been consistently excluded from entering the sector in a professional or technical capacity: 15 national human resources assessments found an average of 17% of staff to be female (IWA, 2014a). Women's positive role in decision-making in rural water and sanitation projects is well documented and more evidence is expected to come to light through the Women Professionals in the Urban Water Sector project (IWA, n.d.). Therefore, gender-focused equal opportunities and affirmative action must be consistently included in WASH projects (see Section 5.5).

Creating conditions that help promote community participation is essential, especially for rural and peri-urban settings. However, community participation cannot be imposed and should take into account the opportunity costs incurred on individual community members by their voluntary involvement in, for example, infrastructure work, as frequently promoted through pro-poor measures in water utilities.

Many communities have proved to be sufficiently strong to develop their own initiatives to better meet their needs. In various parts of the world, communities have thus initiated provision of WASH services in a range of different ways. For example, they have started SMEs, set up water

kiosks or, where the community had been actively engaged in infrastructure development, they have taken over asset maintenance and management (see Boxes 14.2 and 14.3). Such arrangements frequently function outside of a formal institutional setting and the associated jobs may not be recognized as formal employment.

BOX 14.2 VOLUNTEERING SCHEMES IN THE PHILIPPINES

Local Government Units in the Philippines have extensive volumes of personnel engaged in advocacy, information, communication and promotion campaigns on positive practices for water stewardship, water conservation, household and community hygiene, environmental sanitation and community mobilization. The Department of Health's (DoH) provincial, city and municipal offices have about 600 health officers active in rural provinces and more than 3,000 in urban provinces. A large network of volunteers works under the auspices of the DoH. This includes the volunteer network of barangay health workers (around 212,000) and sanitary inspectors.

Source: IWA (2013).

BOX 14.3 SMALL-SCALE PRIVATE OPERATORS – *FONCTIONARES PRIVADOS DO AGUA* (FPA) IN MOZAMBIQUE

FPAs are small private providers who invest in boreholes and small distribution networks. They are mainly found in urban and peri-urban areas that are often underserved by the water utility network. The FPAs have worked diligently and consistently for over 20 years to respond to increased consumer demand, particularly in urban areas, where FPAs are critical to service provision. They are also an important source of livelihood for those who have made the initial investments in equipment and other assets.

Source: USAID-SUWASA (n.d.).

15

OPPORTUNITIES FOR WATER SOURCE DIVERSIFICATION

Aerial view of a sewage treatment plant
Photo: © iStock.com/Mariusz Szczygiel

This chapter examines the economic and job opportunities of developing and using alternative water sources, including wastewater, for productive activities, especially in areas experiencing water stress as a result of limited supply, excessive demand, or both.

15.1 Alternative water sources

UNESCO-IHP | Wouter Buytaert, Blanca Jiménez Cisneros, Anil Mishra and Siegfried Demuth

The increased demand for water in sites where the resource is scarce or where there is a high competition for water creates the need for using so-called 'non-conventional sources'[26] for water, such as low-yielding wells and springs, rainwater, urban runoff, stormwater and greywater[27], among others.

Various emerging technologies based on new developments in biological and physiochemical processes including membrane processes facilitate the use of such alternative water sources. This will create jobs not only through technology development, because it enables new forms of small-scale intensive uses of water such as cultivation of highly profitable crops in small plots, and but also in the operation and maintenance of treatment plants to reclaim water. The use of greywater and municipal wastewater along with the recycling of water within industries, as well the recycling of industrial wastewater, are increasing worldwide.

Use of municipal wastewater can represent up to 35% of the total water extracted for use in some countries (Jiménez Cisneros and Asano, 2008a). The reuse of water for irrigation is the most common strategy for recycling wastewater, especially in China, Mexico and India. Without treatment, wastewater use often incurs health risks. Nevertheless, low cost options exist for pathogen reduction or for procedures to applying used water while maintaining the nutrient content, which may hold promise for farmers in low-income regions (Drechsel et al., 2010). Other examples are the use of wastewater for sylviculture and the booming application of urban wastewater in peri-urban horticulture.

Ideally, the required level of treatment of used water is tailored to the application, instead of defaulting water treatment to standards set to protect the environment. Compounds considered as pollutants, such as nitrogen, phosphorus and organic matter, can even be beneficial for their fertilizing effects or for improving soil properties. For example, in Brazil, sugarcane is commonly irrigated with effluent from ethanol distilleries containing a high content of non-toxic organic material. In Mexico, the non-treated wastewater of Mexico City is used to irrigate around 90,000 hectares of agricultural land, which benefits around 70,000 farms in an area with limited job options (Jiménez Cisneros and Asano, 2008a). In the Mezquital valley close to Mexico City, land with access to wastewater is rented at a rate two to three times higher than land without it.

The use of rainwater harvesting, green roofs and other green infrastructure is gaining interest in some urban environments. This has a direct impact on reducing water consumption, in addition to reducing flood risk through increasing and decentralizing storage, reducing energy consumption through evaporative cooling, and improving the urban environment.

New technologies for water extraction and purification will enable the use of new water sources, such as fog interception (Vince, 2010), rainwater harvesting and desalinisation. The use of potentially less reliable sources of water, such as ephemeral streams and small groundwater aquifers, offer interesting avenues for further exploration.

The distribution of water from a larger variety of sources to various end-users, including internal and external recycling, can be made more efficient and intelligent. Continuous monitoring of water resources, in combination with weather forecasting systems, allows for a better forecasting of water

[26] Conventional sources of water are those that in principle are of high quality and low cost to exploit. Historically, surface water (river, lakes and dams) and shallow freshwater from the subsoil have been considered as the conventional sources for water, making the ocean, brackish water from subsoil or estuaries, rainwater, water from irrigation drainage, storm water and very deep aquifers, as the non-conventional sources for water (Jiménez Cisneros, 2001).

[27] Greywater refers to all wastewater generated in households or office buildings from streams without faecal contamination (e.g. used water from baths, sinks and laundry).

supply. This makes it possible to influence demand, for instance, by promoting temporarily less water intensive activities (i.e. conventional power generation instead of hydropower), or to prioritize those water uses with highest societal or economic benefit. New methods to optimize the use of natural resources, such as benefit-sharing mechanisms and ecosystem services assessments, will be instrumental in establishing those priorities.

The use of new water sources will create jobs initially at the research level because of the need to develop new technologies and methodologies, promoting the efficient use of resources while stimulating economic growth in various sectors. Once these technologies are operational, new jobs will be created for the operationalization, supervision, and maintenance and fine-tuning of smart systems.

It is clear that these evolutions will require a different type of skill sets from workers. There is a tendency for water resources and risk management to become more data intensive, and to evolve from using static infrastructure, to more dynamic, real-time controlled, observation-based systems. Training the future workforce to be prepared to assume such responsibilities will therefore be paramount.

15.2 Wastewater as a resource

WWAP and IWA | Kirsten de Vette, Robert Bos, Marc Paquin and Richard Connor

Clearly, there is value in used water. Consisting of 99.5% water, used water can also contain energy (i.e. heat and organic matter), nutrients (i.e. nitrogen and phosphorous), and other minerals of which some qualify as rare earths (Meda et al., 2012, cited in IWA, 2014c). Responding to environmental, economic and ecological challenges, resource recovery from used water has gained in popularity in both research and applications.

Considerable research is being carried out on novel forms of abstraction of resources from used water as highlighted, for example, in the Resource Recovery Compendium (IWA, 2014c). The research on wastewater management that has been put into practice includes water recovery, energy generation (i.e. biogas), extraction of inorganic/organic compounds that can be used as fertilizer, and extraction of rare earth and high-value materials. Research is also underway to develop models for scaling up wastewater use in agriculture, which in low- and some middle-income countries remains an informal, small-scale enterprise on the periphery of large cities. Sanitation safety plans (SSP) – an emerging framework on integrated risk assessment and management for improved wastewater management – can be used to investigate hazards, assess the associated risks and design remedial or mitigating measures, be aimed at optimizing safety in the use of wastewater, excreta and grey water in agriculture and aquaculture (Stedman, 2014).

Examples on practices of recovering resources can be found in many developed countries and more are emerging. Singapore has been very successful in implementing their 'NEWater' solution (PUB, n.d.), while Canada recovers nutrients from municipal and industrial water streams and transforms them into a slow release, eco-friendly fertilizer (Water World, n.d.).

In many developing countries, however, resource recovery practices remain limited. With most wastewater being dumped directly back to water bodies in many countries, there is an obvious impact on the health of people and ecosystems. Emerging economies, such as China, have seen the urgency and importance of wastewater treatment and recovery, and the government has made huge investments, which in turn created new job opportunities. Low-cost and small-scale solutions are more suitable for countries in development. One example can be turning sludge into biogas through anaerobic digestion.

Globally, it has been estimated that between four to six million hectares (Jiménez Cisneros and Asano, 2008b; Keraita et al., 2008) and 20 million hectares (WHO, 2006) of land are irrigated with untreated wastewater (Drechsel et al., 2010). Not only does the practice provide livelihoods for farming families

and those involved in marketing the products, but with its expected scaling up and formalization, it can also create substantial jobs in this sector. The important occupational health aspects related to the use of wastewater in agriculture will also require more regulators and public health personnel. Beyond the jobs that water reuse will create within the water, agriculture and public health sectors, it is also likely to generate jobs in research, agricultural extension, produce marketing and the cultivation of non-food crops.

Nonetheless, in order to accelerate innovations and push the paradigm shifts on resource recovery, there will be many important actions to consider, such as creating an interlinkage between research and market needs; changing public perception (e.g. towards direct potable reuse); ensuring proper regulation and governance; and tackling the high investment needs required to accelerate these innovations. Among others, these include creating an interlinkage between research and market needs; changing public perception (e.g. towards direct potable re-use); ensuring proper regulation and governance; and tackling the high investment needs required to accelerate these innovations. The public health hazards and risks related to untreated/partially treated wastewater in agriculture can be overcome if addressed through strict regulations applying an integrated risk assessment and management approach along the chain, from wastewater source to produce consumption (WHO, 2006).

16

SCIENTIFIC AND TECHNOLOGICAL INNOVATION

UNESCO-IHP, UNESCO-IHE, WMO and IAHS | Uta Wehn, Wouter Buytaert, Anil Mishra, Siegfried Demuth, Blanca Jiménez Cisneros, Leonardo Alfonso, Bruce Stewart, Christophe Cudennec and Claudio Caponi

Rainwater treatment plant
Photo: © Cylonphoto/Shutterstock.com

This chapter discusses how innovation impacts water management, water services and water-dependent sectors as well as water-related employment opportunities in quantitative and qualitative terms.

Innovation comprises scientific innovation, technological innovation (enabling new products, services and processes) as well non-technological innovation (at the organizational, financial, management and cultural levels). All these different forms of innovation contribute to the continuous improvement of water management, in terms of efficiency and effectiveness, with the related benefits of economic development and decent jobs. Scientific and technological innovations in the water sectors offer particularly interesting opportunities. Technological and non-technological innovations (i.e. those inventions that successfully make it to operational usage) are changing the direct management of water resources, the provision of water services, and water-dependent sectors. In addition to their potential efficiency, effectiveness and performance improvements, these innovations can have important implications for employment opportunities in quantitative and qualitative terms in water dependent and water sectors. The number and nature of jobs are likely to change, but also the required skill sets and competencies. These implications need to be better understood so that appropriate action can be taken at policy levels. This is particularly important for developing countries where innovations may often be imposed or introduced from abroad. This may increase the risk for a mismatch with locally available skills. Recently, policy-makers have become more aware of the importance of water-related innovations, as is evident by the increasing inclusion of water innovation in policy and research agendas and international fora (Wehn and Montalvo, 2015) as well as from the increasing efforts to facilitate interactions between relevant actors (see Box 16.1).

Innovation in the water sectors is highly diverse. On the one hand, new technologies may improve existing methods and processes and make them more efficient and cost-effective. On the other hand, disruptive technologies may fundamentally change the way that water is used. The latter, in particular, will require significant investments in R&D. These technologies are often part of a transformation from the current 'predict-and-control' paradigm in water resources to a more adaptive and flexible approach (characterized by self-organization, adaptation, heterogeneity across scales and distributed control (Pahl-Wostl et al., 2011).

On the water supply side, biological and physiochemical processes for water treatment have a lot of scope for technological improvement. Current techniques are time and energy intensive and difficult to apply within production systems and the built environment. Similarly, the distribution of water is energy-intensive and can be driven down by using low-friction materials, intelligent pumping systems and energy recovery. Improving system reliability will require intelligent sensor networks, as well as data processing and control systems.

On the water demand side, technological breakthroughs will be needed to increase the efficiency and productivity of industrial and agricultural water use, to achieve financial and economic efficiency, and to minimize long-term cumulative negative environmental impacts. For instance, new crop varieties are required that are more resistant to drought, more water efficient and able to survive on lower quality (i.e. saline) water. Industrial production needs to pursue further innovations in water recycling and recovery, and in the use of water of lower purity grades. For some applications, such as cooling systems, renewable energy and transport, it may be possible to substitute the use of water entirely.

At the household level, the field of sanitary engineering underwent a major refocus in the 1970's with the introduction of environmental engineering, which also dealt with water issues. Now environmental and sanitary engineering are further advancing with technological innovations, such as the provision of smart sanitation for slums and informal settlements, emergency sanitation provision following natural and anthropologic disasters, resource-oriented decentralized sanitation and faecal sludge management.

Nevertheless, new technologies may also change the way that the entire water distribution system is managed. Intelligent monitoring networks,

BOX 16.1 ACCELERATING WATER INNOVATION – CASE STUDIES

Ontario, Canada

The Government of Ontario created the Water Technology Acceleration Project (WaterTAP) in 2011 to help connect companies with the resources they need to successfully enter water technology markets by facilitating the demonstration, commercialization and adoption of innovative water solutions through knowledge sharing, attracting investment and developing innovative financial models. Established as a non-profit organization, WaterTAP champions and supports Ontario's status as a world water technology hub. It promotes close cooperation between Ontario's public and private water industry institutions and businesses and consists of 100 technology incubators, accelerators and programs. In this 'knowledge mobilization' process, Ontario's water-related research organizations collaborate closely with university researchers, government agencies, municipalities and the water industry. Specific water technology clusters cover biogas energy generation and nutrient recovery from wastewater and stormwater management and treatment to counteract the heavy rainfall events of climate change, buried pipeline infrastructure inspection, monitoring and rehabilitation, and 'smart' technologies involving the collection and processing of real-time data. Ontario has a strong track record in producing water-related patents, where the water industry holds some 22,000 jobs in 100 water-related research organizations, 300 start-ups, 700 established companies and more than 750 water and wastewater treatment facilities.

Europe

Like other European innovation partnerships, the European Innovation Partnership on Water (EIP Water) was initiated by the European Commission (EC) to accelerate water innovations, with a specific focus on those that serve to address societal challenges, foster the EU's competitiveness and support the EC's overarching goal of creating jobs and stimulating economic growth. The EIP Water is intended to create market opportunities for these innovations (inside and outside of Europe), remove barriers by advancing and leveraging existing solutions, and initiate and promote collaborative processes for change and innovation in the water sector across the public and private sector, NGOs and the general public. The implementation of the EIP Water started in May 2013, and its primary vehicles are voluntary, multi-stakeholder Action Groups (almost 30 registered in 2015) and an online Market Place on the EIP Water online platform.

African cities

Commissioned by the Dutch Ministry of Foreign Affairs to run initially from 2014-2017, VIA Water is a programme that aims to identify innovative solutions for water problems facing cities in seven African countries: Benin, Ghana, Kenya, Mali, Mozambique, Rwanda and South Sudan. It connects 'curious researchers and creative entrepreneurs, innovative NGOs and progressive policy-makers'. VIA Water financially supports small-scale innovations at the start of the supply chain through the VIA Water Fund and provides matchmaking between potential partners from the seven VIA Water countries. The programme shares and enriches the knowledge obtained along the innovation process through its VIA Water Learning Community.

Contributed by Uta Wehn (UNESCO-IHE), based on WaterTap (n.d.); EIP Water (n.d.); Viawater (n.d.).

combined with powerful forecasting and optimization algorithms, may help improve water distribution as a function of spatiotemporal variations in the supply and demand. Computer models, simulation tools and other ICT solutions will be necessary to anticipate changes in supply and demand, and to manage storage and distribution more proactively. Lastly, integration of local technology and knowledge may allow for better tailoring of solutions to local conditions and improve uptake (i.e. through so-called citizen-science) (Buytaert et al., 2014).

Indeed, ICT-based innovations are already being introduced in many aspects of water security (ADB, 2013). Examples include improved forecasting systems for floods and drought; smart sensors to reduce water consumption in households, business and municipalities; asset management; demand management; water reuse; and energy saving (Box 16.2).

ICT-based advances support various facets of water supply and demand. These developments have implications for water-related employment in terms of quantity (i.e. reduced number of staff for specific tasks) as well as quality (e.g. relevant knowledge, skills and capabilities, particularly ICT-related skills), potentially changing the size and shape of the capacity 'gaps' (see Chapter 12). Specifically, water-related employment is therefore likely to be directly focused on people with STEM (Science, Technology, Engineering and Mathematics) backgrounds, raising the entry-level qualifications for professionals in water sectors. At the same time, new job opportunities are being created through efforts in R&D and for a broad range of ICT-professionals and/or ICT-versed water professionals who will benefit from new employment opportunities in water organizations.

Innovations can have important implications for water dependent and water sector employment opportunities in quantitative and qualitative terms

In summary, innovation originating in or benefitting the water sectors can both destroy and create jobs, albeit not always in tandem and affecting differing levels of competences. Policy mechanisms need to be in place to draw on relevant research for capturing the job-creating opportunities in the field of water innovation and to ensure the supply of required capacity for the generation and diffusion of water-related innovations. Such policies should also address the risk of technology development and data sources being monopolized, which could potentially widen the knowledge gap between (and among) actors in developed and less-developed regions.

BOX 16.2 BENEFITS OF INFORMATION AND COMMUNICATION TECHNOLOGIES

Over the last decades, ICTs have triggered a number of water innovations that address a broad range of problems in the water sector as well as sectors relying upon water as a resource. For example, in the agricultural sector, the combination of remote sensing of crop and soil characteristics with high-resolution weather forecasts drives the development of data-intensive applications for precision agriculture, aiming at improved and better-targeted use of irrigation water, fertilizer and other agrochemicals. In developing regions, the increasing availability of weather data allows for the development of weather-index based insurance products, which enable farmers to pursue higher risk strategies that provide higher gains on the long term. Mobile telephony is a strong example of fast ICT adoption, enabling farmers' access to weather forecasts, as well as market data, and information about better farming practices such as disease control, thus safeguarding their livelihoods.

The following examples present other areas of ICT-enabled 'smart' water management that are emerging which will affect working conditions and require upgrading of staff skills and competencies to implement these solutions. At the same time, they imply job losses through increased management efficiencies in water organizations while increasing job opportunities for ICT professionals or ICT-versed water professionals.

Case: Attracting youth into agriculture

ICTs are changing the image of farming from a back-breaking, hardly remunerative, labour-consuming task to a much more profitable and decent source of income. ICTs not only improve the farming sector in general but also the status of young persons using it. According to recent research into three projects located in Western Kenya (Eldoret, Kakamega and Kisumu), youngsters who used to see farming as a type of last resort source of income without much perspective now regard the sector as a potentially strong source of rewarding business. Aside from being able to obtain information about the best market prices, ICTs also provide young farmers with access to new farming practices and agricultural (including irrigation) technologies, information on pest and disease control as well as communication with other farmers. Early adopters of ICTs for farm management receive recognition from family and community members for their technical knowledge and higher incomes that inspire others to follow suit in the adoption of ICTs for farming.

Case: WeSenseIt project

The WeSenseIt project explores the concept of citizen water observatories in which citizens and communities become active participants in data capturing, information evaluation and decision-making processes related to water such as flood risk management. Citizens capture hydrological data using Apps and physical sensors that can connect to portable devices such as smartphones and tablets. Relevant data is also extracted from the interactions of citizens via social media (Wehn and Evers, 2015). While water management can become more participatory in this way, new demands are also being placed on water organizations to integrate ICT-based interactions with citizens in their workflow, procedures and protocols.

Source: Uta Wehn (UNESCO-IEH), based on IICD (n.d.); WeSenseIt (n.d.).

17

MONITORING, ASSESSMENT AND REPORTING

WWAP | Richard Connor
ILO | Carlos Carrión-Crespo

Soil testing at the source of the Tana River (Kenya)
Photo: © Georgina Smith/International Center for Tropical Agriculture (CIAT)

This chapter identifies: the needs and opportunities for data monitoring, assessment and reporting on water availability quantity, quality and use in the context of declining hydrometeorological networks; indicators for monitoring progress on the SDGs; economic costs and benefits of water-related activities and investments; tracking improvements in water productivity; and employment statistics in water-dependent economic sectors.

17.1 Challenges

Monitoring the availability and use of water resources represents a daunting challenge, especially given their variability over time and space (see Section 2.1). Reliable and objective information concerning the state of water resources in terms of their quantity, quality and vulnerability at the local or basin level is often poor or lacking, as are specific metrics for water demand and use by different economic sectors. Globally, water observation and monitoring networks are in decline and inadequately funded. Moreover, traditional statistics assessing the relative water intensity of major water use sectors (agriculture, energy, industry and domestic) are often unsatisfactory for purposes of wisely allocating local or basin-level water resources to specific users. These include sizeable irrigation schemes, thermal power plants or large industrial installations. Some local studies and national-level assessments can provide a useful snapshot of the state and use of water resources at a given time and place, but these rarely deliver a detailed picture of how the different dimensions of water are evolving over time in different parts of the world.

Water resources monitoring can be costly, often requiring rather large instrumentation that can literally be 'washed away' during extreme flow events. Some encouraging progress is being made thanks to technological advances like NASA's GRACE satellite that has been monitoring changing groundwater levels across the planet (see Figure 2.5). However, while remote sensing is proving to be a useful tool, it will never substitute ground-truth.

The 2030 Agenda for Sustainable Development, with a dedicated SDG for water and sanitation (see Section 5.2), provides a new impetus for monitoring the entire water cycle. It expands the MDG agenda of drinking water and sanitation to now cover more aspects related to water resources, including wastewater treatment and water quality, water use and efficiency, IWRM, and water-related ecosystems. The agenda also includes targets on the enabling environment for water and sanitation interventions, such as international cooperation, capacity building and participation of local communities.

> Economic policy-makers and leaders in the private sector now recognize that water as a resource can have a significant influence on national economies

It is clear that countries themselves play a pivotal role in monitoring progress towards the SDGs, which in many countries will require both funding and institutional capacity building. For global monitoring of water and sanitation, the UN System is building on its experience from MDG monitoring and by integrating other existing monitoring efforts in the water sectors (including the JMP, GLAAS, AQUASTAT, GEMS/Water, and the IWRM reporting mechanism) and establishing new/adapted monitoring and reporting mechanisms, thus expanding its capacity to cover the entire SDG for water and sanitation.

The SDGs also create opportunities to leverage new technologies and approaches to increase the quality, frequency, scale and accessibility of traditional data collection. In addition to Earth observations, examples of new data streams include mobile networks, remote sensing data, smart meters and citizen science campaigns supported by an ever-growing capacity to store and process large amounts of data. 'The applications of this "data revolution" include robust weather monitoring systems that decrease the vulnerability of farmers as they plan ahead, early warning systems to help prepare for and adapt to water-related natural disasters, river monitoring advancements that improve decisions on water release to ensure endangered fish can move upstream to spawning areas, and smart metering of agricultural irrigation that improve water allocation across large watershed systems, especially in times of extreme events like droughts' (UN-Water, 2015, p. 2).

Many economic policy-makers and leaders in the private sector now recognize that water as a resource can have a significant influence on national economies and the vulnerability of industrial development. Indeed, water development spills over into the entire economy over the long term (WWAP, 2015). As described in Chapters 1 and 11 of this report, nearly all the data and information regarding the cost-benefit ratios of water interventions, such as

universal access to water and sanitation and water saving methodologies and technologies, show that water development is indeed cost-effective and essential for sustainable development. However, this information remains sparse and there are few metrics available to assess the value-added of investments in water management or the broader economic performance of allocating water to different sectors. For example, data are needed to assess the productivity of water, in terms of GDP per unit water used, to enable monitoring of the policy objective of decoupling economic growth from resource use (WWAP, 2012).

In terms of jobs and employment, few statistics reflect the current reality of work. They tend to simplify the core situation (often due to their objectives, measurement methods and conceptual frameworks), resulting in partial coverage, insufficient detail and an incomplete analysis of complex topics.

One of the greatest challenges is gathering data and information concerning informal, part-time and/or unpaid work. This type of employment situation occurs in developed and developing economies alike, but tends to be greatest among the poorest and more marginalized groups, of which women are disproportionally represented. Although the global and regional employment statistics presented in Section 3.2 are sex-disaggregated, these data do not include informal employment that account for hundreds of millions of people in highly water-dependent sectors such as agriculture (see Box 17.1).

> It is clear that countries themselves have to play a pivotal role in monitoring progress towards the SDGs, which in many countries will require both funding and institutional capacity building

Another challenge lies in identifying the level of 'water dependence' of any given job. As described in Section 3.3, it is somewhat easier to establish a level of water dependence of a given sector than for a given job. In essence, not all jobs in water-dependent sectors are necessarily water-dependent jobs.

BOX 17.1 DIFFICULTIES AND SPECIFICITIES OF EMPLOYMENT MEASURES IN THE AGRICULTURE AND FOOD SECTORS

The employment dimensions of the agriculture and food sector are difficult to measure. Most of it is done through informal self-employment in smallholdings that may not provide a full time source of employment. An important share of production is self-consumed by the family and its in-kind contribution may be underestimated. Therefore, employment may be overestimated by data on agricultural holdings, but underestimated by population census that takes into account the primary occupation or source of income of people. The problem is especially acute in the fishery sector where many people are involved in part-time or seasonal fishing activities that are often not recorded in agriculture or fisheries censuses (FAO, 2010b). On the other hand, waged work is often informal and casual, undertaken as complementary activity and underestimated in population census (World Bank, 2007b). Waged worker are often also poor farmers and therefore the figures tend to overlap. Finally, agriculture generates much indirect work along the food chain but along different sectors, rarely aggregated to offer the employment picture of the food sector. Another key difficulty relates to disaggregating employment data according to gender, age, ethnicity and type of households. For instance, women's involvement in agriculture often remains underestimated (World Bank, 2007b) due to the limited availability of sex-disaggregated data, and the situation is even worse when one wants to evaluate their access to water and land resources.

Source: FAO (2010b).

For example, whereas water can be an essential input in sectors such as agriculture and power generation, water is not necessarily essential for many tasks undertaken by workers in those sectors, such as administrative or clerical tasks. To date, no research examining or comparing the 'water intensity' of certain jobs has been undertaken.

Chapter 18 of this report provides further suggestions on increasing knowledge and innovation to be able to make decisions based on robust metrics.

17.2 Opportunities

Input-output (I-O) analysis and social accounting matrices (SAMs) identify how water is used as an input by different subsectors, and seek to quantify the jobs created when a government increases or improves water supply. This would help develop a comprehensive mapping of the linkages between access to water and sanitation and decent jobs that underscores: (i) the extent and full range of interactions and (ii) the significance of feedback effects. This can be used to build a strong case for an integrated approach to coordinated employment policies (both at national and local levels). It can also be used to show the multiplier effects that will result from better coordination.

Data from the World Input-Output Database (WIOD) can be analysed to derive evidence on how dependent the whole economy is on water supply and how many jobs are created when a government increases or improves water supply, estimating backwards and forwards linkages of water supply and related sectors to calculate total multiplier effects of potential investments in a given sector. These investments have several spillover effects, since they seek not only to improve distribution of water as a component of national wealth and well-being but also to increase labour productivity and reduce diseases and related costs.

Statistical systems are moving towards measuring new 'work' standards, and different forms of work and labour underutilization indicators (ICLS, 2013). This should also serve to facilitate construction of water-dependent decent work indicators: National statistical systems could combine water-related variables and data from all available/potential sources (i.e. regular/ad hoc/special modules), such as census, labour force surveys, household income and expenditure surveys, demographic and health surveys. Building statistical baseline data provides impetus to advocate for government investment in and commitment to developing and maintaining the public water system. Indicators for water and indicators for jobs and employment have something in common: both need to be appropriate for collection by a regular, national statistical data collection programme and for the generation of comparable time-series analysis (even if infrequent, i.e. every five years).

As previously mentioned in Chapters 4 and 14, there is a dearth of information on human resources for WASH services (IWA, 2014a). Commissioning the necessary research (from their own resources or with external support) to include numerical and skills gaps would allow governments to strengthen the evidence base before consolidating new WASH policies. The process to help states build a human resource/skills/capacity building strategy into a coherent national WASH strategy can thereby focus on the demand side by identifying sectoral value chains, core occupations, skills requirements and cross-occupation analyses.

18

POLICY RESPONSES

WWAP | Marc Paquin and Richard Connor

Knowledge learning workshop at the European Parliament
Photo: © Jean-Luc Flemal/European Parliament

In conclusion, this chapter summarizes the report's policy implications that arise from the water and jobs nexus. In order to achieve sustainable development based on a healthy environment and dependable water resources, along with a sound economy that offers opportunities for decent jobs, countries need to plan, regulate and invest – financially and otherwise – to ensure the sustainability of their water resources and ecosystems; help develop, operate and maintain water infrastructure; and plan, build and manage human resources' capacity. Countries will thus also continue to be innovative while increasing their knowledge and building expertise.

As this report demonstrates, critical relationships and essential linkages exist between the management of water (in its broadest sense) and employment opportunities in countries at all levels of development. Water plays a key role in generating and sustaining direct employment opportunities across a large array of sectors and in unlocking the potential for indirect employment creation through its multiplier effect.

> The political will to set and implement water-related policy objectives that support sustainable development and job creation is essential

Sustainable water management in its broadest sense embraces sound decision-making and policy, ecosystem management, through infrastructure development, operation and maintenance, down to the home, office, factory or field, then to its ultimate return to the natural environment. Combined with access to a safe and reliable supply of water and appropriate sanitation services, this creates an enabling environment for employment opportunities to develop and grow across economic sectors. Such opportunities range from full-time decent jobs to precarious informal ones – across a wide range of skill sets. Long-term planning and investment for improving water resources management, WASH and wastewater management are therefore required before enhanced employment opportunities and other related socio-economic benefits accrue.

The political will to set and implement water-related policy objectives that support sustainable development and job creation is essential. However, there is frequently a low level of appreciation of the high risks and serious impacts to which neglect of water issues can lead, often with catastrophic and extremely costly results. Improving knowledge and understanding, including among politicians and policy-makers, of the central role of water resources, infrastructure and services in the economy and in employment creation, could lead to increased benefits in terms of generation of decent jobs, as well as serve the broader objectives of sustainable development.

Meeting the described goals in the coming years requires a coherent approach and a vision shared by governments and their partners. In this process, developing water, energy, food, environment, social and economic policies that are complementary is a key requirement to a sustainable, integrated and mutually-supportive water, employment and economic strategy. The proposed approach could help respond to the challenges arising from the risks and opportunities at the water and jobs nexus highlighted in this report. This ensures that incentives are aligned for all stakeholders and that impacts are mitigated, for example, in ensuring future employability of those displaced in sectors where employment may decrease.

Indeed, managing water for economic growth and employment is not only a question of resource availability and money, but also a matter of good, effective and efficient governance. As such, strategically increasing investments of their financial and other resources at the water-job nexus enables countries to:

- Ensure the sustainability of water resources and ecosystems;
- Develop, operate and maintain water infrastructures;
- Plan, regulate and build capacity of human resources and institutions; and
- Build knowledge and facilitate innovation.

18.1 Ensure the sustainability of water resources and ecosystems

Population growth and the resulting increase in water demand for household uses (drinking and sanitation) and productive uses (e.g. energy and food), urbanization, and changing demographics and consumption patterns will put additional stress on water resources and ecosystems and the services they provide. This, in turn, will require governments and others to invest time and energy in strategically managing water resources.

> The allocation of water resources and the provision of water services to different economic sectors will largely dictate the growth potential for high quality jobs at country and local levels

Investment in sustainable water resources and ecosystems management is a prerequisite to a solid economy and expanding employment opportunities in water-dependent sectors, such as agriculture, fisheries, forestry, energy, industry, tourism and health, as well as, indirectly, in other economic sectors. Social dialogue between government units, water operators, water workers and users can help develop locally-adapted approaches, plans and indicators to ensure sustainable use of and access to water.

18.2 Develop, operate and maintain water infrastructure

Vibrant economies, and resulting employment opportunities, rely on effective water infrastructure. Investment in and support for the development, operation and maintenance of water infrastructure is needed in order to support the development of sustainable economies and employment opportunities. Infrastructure that ensures access to safe and reliable water supply and sanitation services, coupled with appropriate hygiene, is critical to maintaining a healthy, educated and productive workforce.

Therefore, government and stakeholders must recognize that investment in water infrastructure is essential for economic growth and that greater and more reliable water access is a prerequisite to seizing the growth and employment-creation potential of agricultural and other water-intensive sectors.

18.3 Plan, build and manage capacity of human resources

Economic activities necessitate water, but they also require a sufficient number of skilled individuals. As discussed in this report, important human resources gaps exist and are widening, either in terms of quantity (i.e. staff shortages as a result of an ageing workforce) or in quality (i.e. skills gap). These growing disparities underline the need for national strategies for water-related jobs.

Through appropriate national employment policies, countries can link growth and economic strategies to decent (and green) employment creation and the preservation and improvement of existing jobs. International commitments, most notably those pertaining to sustainability (i.e. SDGs) and the human rights to water, sanitation and decent employment, should guide the development of these employment policies.

Since water is an enabler of economic activity leading to more and potentially better employment, the effective management of water supply and use chains, including wastewater management, represents a key element to incorporate into national employment policies and strategies. A water-focused employment strategy should also promote the river basin/aquifer approach as a tool to assess employment prospects and trade-offs. In addition, it must take account of costs/benefits, risks/opportunities and recognize the political trade-offs involving jobs and water: short-term gains (be they in economic growth or creation of jobs) have to be weighed against longer-term losses (pollution, unsustainable use of resources, jobs abolition, etc.).

Solutions to filling the quantitative and qualitative human resources gaps include creating an enabling policy environment for collaborative frameworks between the education sector, sector employers (public, private and NGOs) and employees; developing incentives to attract and retain public sector staff; strengthening technical and vocational training; and giving attention to human resources capacity development in rural areas. In addressing

the human resources gaps, decision-makers must be specifically cognizant of the issues raised by youth unemployment, an ageing workforce, notably in the WASH sector, leading to a shrinking labour supply, and weak interest from graduates for jobs in water sectors.

18.4 Increase knowledge and innovate

In order to ensure greater coherence of policy objectives, action plans and funding at the water-jobs nexus, governments need to be able to make their decisions on sound knowledge based on robust metrics, including information on the:

- Availability and status (quality and vulnerability) of water resources and their variability over time (seasonal and year-to-year, including long-term climate projections);
- Water requirements and allocation frameworks, including the demands and actual usage (and abuse) of different water use (and major employment) sectors;
- Level of reliable access to safe water supply and effective sanitation services;
- Performance (and shortcomings) of existing water-related infrastructure (financing, operation, maintenance) and the additional needs (current and future) in terms of resource management, service delivery (water supply and sanitation) and wastewater management;
- Formal and informal employment situation in the water sectors;
- Potential for employment generation through water-dependent activities; and
- Status of the WASH and other water sectors' human resource base.

In addition to investing in the collection and analysis of relevant data, countries would benefit from improved change and innovation management and R&D investment in order to seize the full potential of their resources, both human and water, and address potential negative consequences. For example, in a context of limited water resources to be shared among sectors and countries, innovation should lead to improvements in the efficient use of all water sources and to the design of water allocation strategies that maximize the economic and social returns, while enhancing the water productivity of all sectors. Innovation in water efficiency and productivity also has the potential to lower costs and allow for the use of unconventional sources of water. Higher productivity, in turn, is a key driver for improvements in job quality associated with poverty reduction, falling shares of vulnerable employment and growth in the developing world's emerging middle class.

While progress is occurring, additional R&D efforts will be needed for:

- Development, establishment and operation of new computational systems for monitoring, predicting, early warning, and risk assessment and management;
- Development of databases and information systems, modelling;
- Monitoring: Improved analytical capacities, remote sensing, expanding use of biological quality parameters, which enhances water security and resistance to water-related disasters;
- Water and wastewater services: Smart metering, international benchmarking, increased private sector participation; and
- Green, flexible, multipurpose infrastructure: provision of smart sanitation for slums and informal settlements, emergency sanitation provision following natural and anthropologic disasters, resource-oriented decentralized sanitation and faecal sludge management.

18.5 Conclusion

This report calls for concerted long-term decision-making to address the core trends and inter-linkages affecting the water and jobs nexus. The international community is already showing the way, having set long-term goals regarding water, sanitation, decent work and sustainable development that offer an action framework for countries' development objectives.

It will be important for each country, according to its own resource base, potential and priorities, to identify and promote specific and coherent strategies, plans and policies to achieve the right sectoral balance and generate the highest possible output of decent and productive jobs without degrading the environment and compromising sustainability of water resources.

In this respect, the allocation of water resources and the provision of water services to different economic sectors, combined with higher water-use efficiency, productivity and value added, will largely dictate the growth potential for high quality jobs at country and local levels. Focusing on the economic sectors that are most relevant for environmental sustainability and job creation will prove to be the ultimate key to success.

Revisiting frameworks such as IWRM to resonate with these new complexities will also be important. Moreover, stronger, better and more efficient interlinked institutions will be required to handle the increased level of complexity.

To effectively achieve these social and political goals, a comprehensive approach that fosters integrity, transparency, accountability, participation and anti-corruption is required. Setting up participatory and accountability mechanisms such as community monitoring, social or community auditing, with an emphasis on gender parity represents a sound approach to ensuring that implementation of water and employment actions result in sustainable and shared benefits.

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ABBREVIATIONS AND ACRONYMS

2030 WRG	2030 Water Resources Group
AfDB	African Development Bank
ADB	Asian Development Bank
AU	African Union
BAU	Business-as-usual
BOD	Biochemical oxygen demand
CAWMA	Comprehensive assessment of water management in agriculture
CDP	Carbon disclosure project
DEWATS	Decentralized wastewater treatment systems
DSR	Direct-seeded rice
EC	European Commission
EIP Water	European Innovation Partnership on Water
ERSAR	Water and Waste Services Regulation Authority
EU	European Union
EWR	Environmental water requirements
FAO	Food and Agriculture Organization of the United Nations
FPA	Fonctionares privados do agua
GDP	Gross domestic product
GLAAS	Global Analysis and Assessment of Sanitation and Drinking-Water
GRACE	NASA's Gravity Recovery and Climate Experiment
ICT	Information and communication technology
IEA	International Energy Agency
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IPPC	Intergovernmental Panel on Climate Change
ILO	International Labour Organization
I-O	Input-output
IOM	International Organization for Migration
IRENA	International Renewable Energy Agency
IWA	International Water Association
IWMI	International Water Management Institute
IWRM	Integrated water resource management
JMP	WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation
LDC	Least developed countries
MDG	Millennium Development Goal
MW	Megawatt
NGO	Non-governmental organization
NRW	Non-revenue water
OECD	Organisation for Economic Co-operation and Development
PES	Payment for ecosystem services
PPP	Public-private partnership
PV	Photovoltaic
R&D	Research and development
SAM	Social Accounting Matrix
SDG	Sustainable Development Goal
SMEs	Small and medium-sized enterprises
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNECE	United Nations Economic Commission for Europe
UNECLAC	United Nations Economic Commission for Latin America and the Caribbean
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCWA	United Nations Economic and Social Commission for Western Asia
UNGA	United Nations General Assembly
UN-Habitat	United Nations Human Settlements Programme
UNIDO	United Nations Industrial Development Organization
UNISDR	United Nations Office for Disaster Risk Reduction
WASH	Water, sanitation and hygiene
WaterTAP	Water Technology Acceleration Project
WBCSD	World Business Council for Sustainable Development
WFP	United Nations World Food Programme
WHO	World Health Organization
WOP	Water operation partnership
WWAP	World Water Assessment Programme

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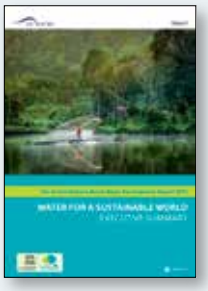

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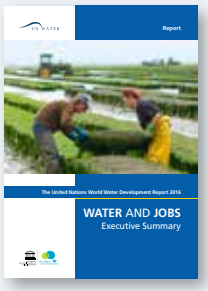

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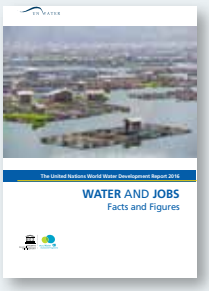

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United Nations Educational, Scientific and Cultural Organization

World Water Assessment Programme

WWDR 2016

UN-WATER REPORTS

UN-Water is the United Nations (UN) inter-agency coordination mechanism for freshwater-related issues, including sanitation. It was formally established in 2003 building on a long history of collaboration in the UN family. UN-Water is comprised of UN entities with a focus on, or interest in, water-related issues as Members and other non-UN international organizations as Partners.

The main purpose of UN-Water is to complement and add value to existing programmes and projects by facilitating synergies and joint efforts, so as to maximize system-wide coordinated action and coherence. By doing so, UN-Water seeks to increase the effectiveness of the support provided to Member States in their efforts towards achieving international agreements on water.

PERIODIC REPORTS

World Water Development Report (WWDR)

is the reference publication of the UN system on the status of the freshwater resource. The report is the result of the strong collaboration among UN-Water Members and Partners and it represents the coherent and integrated response of the UN system to freshwater-related issues and emerging challenges. The report production coordinated by the World Water Assessment Programme and the theme is harmonized with the theme of World Water Day (22 March). From 2003 to 2012, the WWDR was released every three years and from 2014 the report is released annually to provide the most up to date and factual information of how water-related challenges are addressed around the world.

- ✓ Strategic outlook
- ✓ State, uses and management of water resources
- ✓ Global
- ✓ Regional assessments
- ✓ Triennial (2003-2012)
- ✓ Annual (from 2014)
- ✓ Links to the theme of World Water Day (22 March)

UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS)

is produced by the World Health Organization (WHO) on behalf of UN-Water. It provides a global update on the policy frameworks, institutional arrangements, human resource base, and international and national finance streams in support of sanitation and drinking water. It is a substantive input into the activities of Sanitation and Water for All (SWA).

- ✓ Strategic outlook
- ✓ Water supply and sanitation
- ✓ Global
- ✓ Regional assessments
- ✓ Biennial (since 2008)

The progress report of the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP)

is affiliated with UN-Water and presents the results of the global monitoring of progress towards access to safe drinking-water, and adequate sanitation and hygiene. Monitoring draws on the findings of household surveys and censuses usually supported by national statistics bureaus in accordance with international criteria and increasingly draws on national administrative and regulatory datasets.

- ✓ Status and trends
- ✓ Water supply and sanitation
- ✓ Global
- ✓ Regional and national assessments
- ✓ Biennial (1990-2012)
- ✓ Annual updates (since 2013)

UN-WATER PLANNED PUBLICATIONS 2016

- UN-Water Analytical Brief on Water Efficiency
- UN-Water Analytical Brief on Water Quality Monitoring
- UN-Water Analytical Brief on the Water and Sanitation Interlinkages across the 2030 Agenda for Sustainable Development
- UN-Water Country Briefs

More information on UN-Water reports at: http://www.unwater.org/publications

The United Nations World Water Assessment Programme (WWAP) is hosted and led by UNESCO. WWAP brings together the work of 31 UN-Water Members as well as 38 Partners to publish the United Nations World Water Development Report (WWDR) series.

The annual World Water Development Reports focus on strategic water issues. UN-Water Members and Partners — all experts in their fields — contribute with latest findings on a specific theme.

This edition of the World Water Development Report focuses on 'Water and Jobs' and seeks to inform decision-makers, inside and outside the water community, about the importance of the water and jobs nexus for the social and economic development and environmental sustainability of countries, rich and poor.

The importance of 'water for jobs' across economies is such that this report could be subtitled 'No water - No jobs'. Indeed, a great majority of jobs are dependent upon water, and therefore increasingly at risk under conditions of water scarcity. This report also shows the importance for countries to have sufficient and an adequately trained water-related workforce in order to seize development opportunities and maximize benefits.

The first of its kind to address the multiple aspects of the water and jobs nexus, this report further reveals the need for additional research and analysis to gain a better understanding of the complex interactions between water, jobs and development to support decision-making pertaining to the sound management of water, employment policy and the achievement of the Sustainable Development Goals.

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