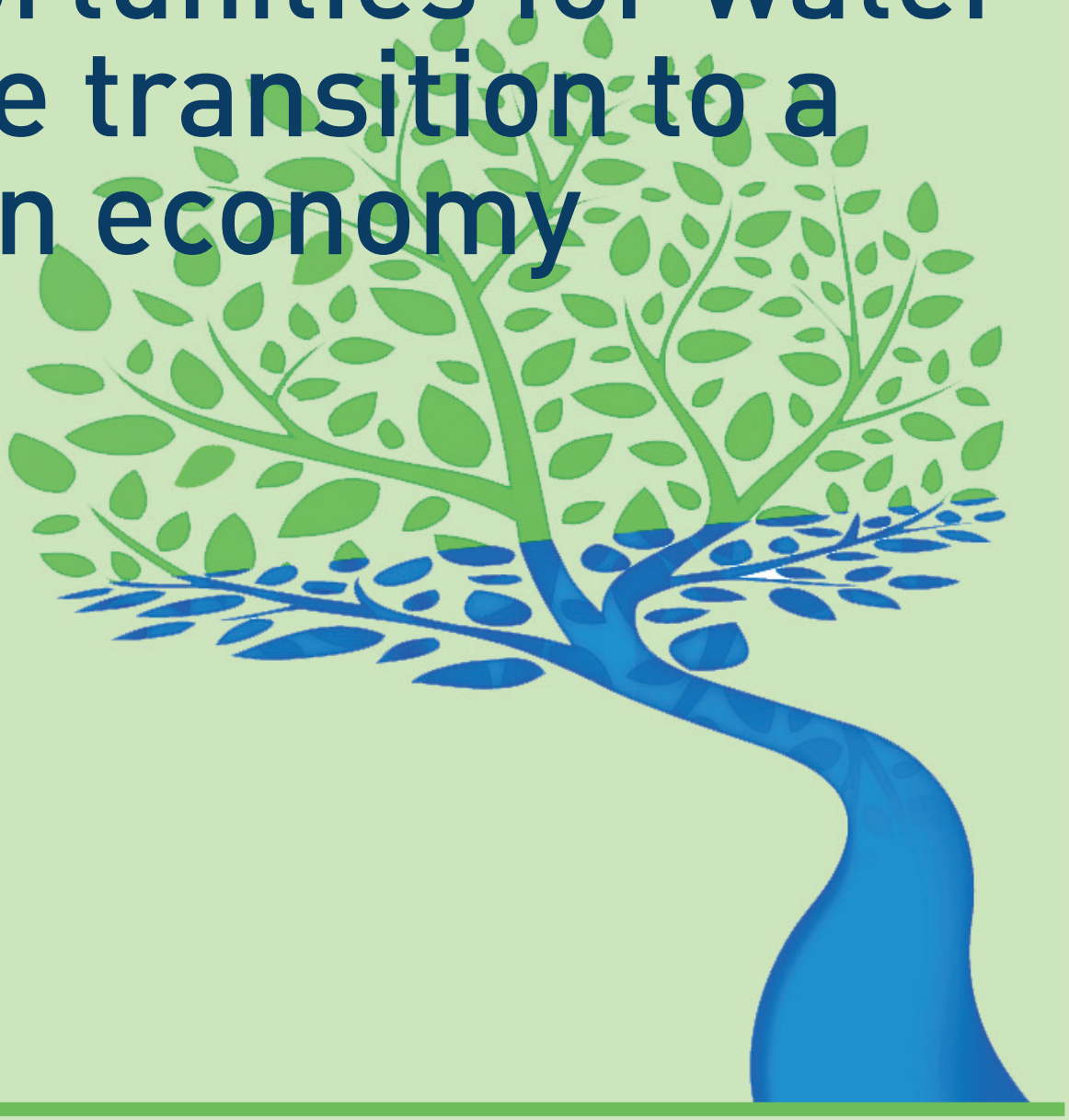
UN WATER

Chapter 2: Challenges and opportunities for water in the transition to a green economy



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Chapter 2

Challenges and opportunities for water in the transition to a green economy

Making the shift to the green economy requires that all economic sectors work towards the three-part objective of accelerating economic growth, reducing poverty and inequities, whilst aligning these advances with improvements in the environment. With regards to water, sustained efforts are needed to address the challenges and harness opportunities in agriculture, industries, cities and watersheds. These are discussed in turn below.

1. Challenges

The challenges for water and agriculture

> **"**Irrigation has made a crucial contribution to feeding the world. Over the last 50 years, the Earth's population doubled and the global food system responded remarkably to the increase in food demand. This was achieved through a modest growth in total cropland – not more than 12 percent. What really made the difference was mainly the intensification of agricultural production, i.e. an increase in yield and cropping intensity, unimaginable without irrigation. However, a lot needs to happen in terms of how we irrigate. Old, rigid systems of water distribution in large irrigation schemes will need to be replaced by much more flexible ones, offering more reliable water supply, and therefore allowing for progressive, higher value crops diversification. In such modernised systems, drip irrigation will play an important role in boosting water use efficiency and productivity. The focus must be on getting "more crop per drop," by adopting farming techniques that harvest more rainfall, conserve soil moisture, reduce waste in irrigation and – in some cases – by making changes in dietary choices to favour crops and foods that use less water. Finally, much more should be done to reduce waste. It is estimated that just about one third of the food produced is actually consumed, the rest being lost in storage, distribution and at consumer's level.**"**
>
> Mr. Alexander Müller, **Food and Agriculture Organization of the United Nations (FAO)**

Agriculture and food production rely heavily on natural resources such as water. Agriculture accounts for 70% of global water withdrawals and four out of ten people around the planet work in the agriculture sector. Currently, the world produces enough food to feed all of its inhabitants. However, if no fundamental changes are made, there will be insufficient resources available to feed a burgeoning population with higher income levels and

increasingly water-demanding dietary habits. To feed the increasing global population, food production will have to double within the next 40 years.

The challenge is not just about increasing agricultural production to meet the aspirations of a growing population and global economy. While the world currently produces enough food to feed everyone, 925 million people go hungry because they cannot afford to pay for it. Paradoxically, economic progress and advances in alternative energy threaten to worsen the situation for the poorest. These developments drive up basic food prices, divert efforts towards producing more valuable goods such as biofuels and eventually undermine food security and efforts to eradicate poverty in least developed countries.

Small-scale farmers, occupying about half a billion small farms in the world, provide the majority of the global food supply. However, these farmers account for the majority of South Asia's and sub-Saharan Africa's poor and roughly half of the developing world's undernourished.

In many developing countries, opportunities for progress depend on the availability of water and on irrigation systems. Small-scale farmers often occupy marginal land and depend mainly on rainfall for production. This makes them highly sensitive to climate variability and change, and extreme events such as droughts and floods.

Water and agriculture facts

- *With no change in dietary habits or in the food chain, and with no improvements in land and water productivity, the global water consumption for agriculture will need to increase by 70-90% in the next 40 years.*
- *In developing countries, people spend 50-80% of their income on food, mostly on raw foodstuffs such as flour and legumes.*
- *Roughly one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year.*
- *The food waste per capita of consumers in Europe and North-America is much higher (95-115 kg/year), than in Sub-Saharan Africa and Southeast Asia (6-11 kg/year)*
- *In many developing countries, irrigation accounts for 90% of the water used.*
- *Water consumed in agriculture is typically less than 50% of the water withdrawn due to efficiencies and losses in the system.*

Since 2007, commodity prices in world markets have fluctuated dramatically and have experienced global spikes in 2007-2008 and in 2010-2011. These spikes caused political and economic instability and led to food riots in several countries. Food prices today remain high, and are expected to remain volatile. For farmers, this results in large income fluctuations for which they have little or no recourse, such as savings and insurance. Not only do macroeconomic factors in conjunction with changes in supply and demand contribute to price volatility; speculative behaviour in organised futures markets may also contribute to volatile food prices.

The challenges for water and industry

"The ultimate aim is to de-link economic growth from increase in resource use and environmental impact, or, to put it simply: improve quality of life and health with less resources and waste. Green Industry is a two-pronged agenda for achieving this. Firstly, it aims to reduce resource consumption and environmental impact of all industries (or greening of industry, in particular through Resource Efficient and Cleaner Production). Secondly, it sets out to develop a vibrant and innovative supply of environmental goods and services, from green industries, that deliver for example waste management and recycling services, develop and market clean technologies and renewable energy systems and safe chemicals. As industry and sustainable development must go hand in hand, the influences of water on industry and industry on water are central to progress."

United Nations Industrial Development Organization (UNIDO)

The industrial sector uses about 20% of global freshwater withdrawals. This includes water for hydro and nuclear power generation, industrial processes and thermal power generation.

The annual quantity of water used by industry is rising and industry will increasingly be competing over limited water resources with growing urban and agricultural water demands. If no radical change is be brought about, the United Nations estimates that the annual water volume used by industry will rise from 752 km^3 per year in 1995 to an estimated 1,170 km^3 per year in 2025, i.e. about 24% of total freshwater withdrawals.

One of the major challenges for industry today is to effectively address the unsustainable exploitation and contamination of freshwater resources around the world**.** Pollutants make water non-potable and contaminate and kill fish, which provide an important source of protein for many people, particularly the poor. Contaminated water also risks the transfer of contaminants (including bio-magnifying compounds) to the food chain through its use in agriculture and its uptake by plant and animal life.

Water and industry facts

- *Global material consumption is projected to triple from 50 to 160 billion tonnes per year by 2050.*
- *In developing countries, 70% of industrial waste is dumped untreated into waters.*
- *Industry discharges about 300-500 million tons of heavy metals, solvents, toxic sludge, and other wastes each year.*
- *In low-income countries industry accounts for about 5% of water withdrawals, compared to up to 86% in some high-income countries such as Germany.*
- *Decoupling refers to the ability of an economy to grow without corresponding increases pressures on the environment.*

To meet the needs of present and future generations, industries' production systems will have to become more sustainable. This requires a coordinated strategy to increase efficiencies in the use of resources. Many enterprises use more resources than their production processes require due to the continued use of outdated and inefficient technologies and failure to adopt proper management systems.

In many countries industrial development goes hand in hand with environmental degradation and resource depletion, which threaten opportunities for sustainable economic

growth. But the technologies and expertise do exist to avoid the industrial pollution and environmental deterioration typically associated with intermediate stages of economic development. Developing countries need support to help overcome the barriers to adopting a green economy strategy, including lack of knowledge on the current challenges and lack of skills to deal with these challenges, the absence of an adequate industry support system to assist enterprises, short-sighted development policies which neglect environmental considerations, and difficulties in accessing finance.

The challenges for water and cities

"The central tenet of the green economy is that environmental sustainability and economic growth can develop harmoniously. Cities are crucial to leveraging this mutually-supportive opportunity by reducing the spatial footprint of development and allowing for shared infrastructure which itself reduces emissions and resource use. By harnessing the advantages of concentrated populations in metro areas, cities give great economies of scale and opportunities for efficiency to infrastructure development, including water, sewerage and sanitation services."

Mr. Joan Clos, Executive Director of the **United Nations Human Settlements Programme (UN-Habitat)**

Half of humanity now lives in cities, and within two decades, nearly 60% of the world's population will be urban dwellers.

Cities cannot be sustainable without ensuring reliable access to safe drinking water and adequate sanitation. However, institutions have shown a limited ability to anticipate and support the expansion of cities with the provision of water services. Although worldwide the proportion of people with access to water and sanitation gradually increases, in 2008 there were more urban dwellers without access to improved water sources (114 million more) and basic sanitation (134 million more) than in the year 2000. Not only global economic expansion, but also the rising number of consumers, desire for higher levels of service and changes in consumption patterns contribute to increased water demand.

Water and cities facts

- *Half of humanity now lives in cities.*
- *In urban areas **94%** of people have access to improved drinking water sources compared to 76% in rural areas.*
- *Urban growth is most rapid in the developing world, where cities gain an average of **5 million** residents every month.*
- *Worldwide, **828 million** people live in slums, lacking many of life's basic necessities*
- ***62%** of sub-Saharan Africa's urban population and 43% of south-central Asia's urban population live in slums.*
- *The number of people living in slums is expected to grow by **6 million** each year to reach a total of 889 million by 2020.*
- *A slum dweller in Nairobi (Kenya) pays **5 to 7 times** more for a liter of water than an average North American citizen.*
- *The city of Jakarta, with a population of 9 million, generates **1.3 million m³** of sewage each day.*

Many new urban dwellers lack life's basic necessities: safe drinking water, adequate sanitation services, access to health services, durable housing and secure tenure. Slums or informal settlements are often built on unstable slopes, or in other areas of high risk. Natural disasters such as floods and droughts form a major challenge for cities, especially for slum areas. The frequency of natural disasters is expected to increase in the future as a result of climate change.

Pollution poses another major problem for cities. Urban settlements are the main source of point-source pollution. In many fast-growing cities, wastewater infrastructure is non-existent, inadequate or outdated. Water storage, treatment and distribution systems are often poorly maintained. Moreover, in many countries of the developing world, water losses due to technical leakage and water theft, often exceed 40-60% of the total water distribution.

The challenges for watersheds

> "Integrated approaches to water resources management are being implemented and are having impact on the ground. A recent global survey on water resources management shows that most governments have made progress with water sector reform to adopt principles of integrated management of water resources and are working through the process from policy to laws, strategies and plans. However progress with national implementation does take a long time and some countries have difficulty moving beyond the first political steps. Whether getting the enabling environment right or rolling out national systems to manage water resources on the ground, it is rare for there not to be problems slowing down or even stalling progress. Whether due to inadequate consultation, political priorities, resistance to change or fear of losing benefits these are natural obstacles that have to be overcome. Some countries are already demonstrating that better water management can be achieved while others may need more support and shared lessons to move forward at a faster pace. There is no alternate vision for better water management so national and international leaders have to demonstrate their commitment for the long haul."
>
> **United Nations Environment Programme (UNEP)** for the UN-Water Zaragoza Conference on Water and the Green Economy in Practice

Human well-being therefore depends critically on the health of freshwater ecosystems. This is particularly the case for the world's poor, as they often depend directly on water and other ecosystem services provided by rivers, lakes and wetlands for their livelihoods.

Current unsustainable patterns of development and production are leading to overexploitation of aquifers and rivers, environmental degradation and the loss of inland and coastal wetlands. Protecting freshwater ecosystems requires recognising the special characteristics of water; a change in one part of a catchment necessarily has consequences elsewhere. For example, any alterations to a river's flow – such as through building large dams or diversion for agriculture and industry – inevitably have impacts elsewhere in the system. These impacts may be of a scale that outweighs the economic benefits expected from the alteration to the river. In all cases, comprehensive impact assessment is needed.

Overexploitation of aquifers in some areas is causing land surface levels to sink, increasing vulnerability to surface-water flooding and intrusion of salt water. There is an urgent need to bring groundwater to a sustainable level.

Adapting to climate change represents another major challenge for the management of watersheds and aquifers. As a result of climate change, the hydrological cycle is expected to accelerate as rising temperatures increase the rate of evaporation from land and sea, leading to increased variability in rainfall and runoff and more frequent droughts and floods. Water-stressed semi-arid and arid areas of the world will generally become even drier and hotter.

The transition towards a green economy will only be possible if the value of natural capital is properly recognised and incorporated into decision making. A growth strategy that focuses too heavily on water resources development and obtaining short term benefits may go at the expense of long term welfare and result in the degradation of natural assets.

Water distribution facts

- *Less than **3%** of the world's water is fresh; the rest is seawater and undrinkable.*
- *Groundwater represents about **90%** of the world's readily available freshwater resources.*
- *In some cases up to **90%** of the 'GDP of the poor' is linked to nature or natural capital such as forests and freshwater.*
- *The current rate of loss of freshwater biodiversity is more rapid than at any time in human history and shows no indication of slowing.*
- *Nearly a third (**31%**) of freshwater species assessed for the 2009 IUCN Red List are already threatened or extinct.*
- *In 2030, an estimated **47%** of the world population will be living in areas of high water stress.*
- *Climate change will increase biodiversity loss, affecting both individual species and their ecosystems.*

2. Opportunities

Opportunities for agriculture in the transition to a green economy

Agriculture can play an essential role in achieving a green economy since it accounts for 70% of global water withdrawals and provides employment for 40% of the global population. Furthermore, GDP growth generated by agriculture is up to four times more effective in reducing poverty than growth generated by other sectors. Green growth requires that in the coming decades enough food is provided for an expanding population (mostly in the least developed countries and especially in Sub-Saharan Africa), of which a proportion will be increasingly affluent in Least Developed Countries (LDCs) and Developed Countries (DCs).

A green economy requires the achievement of food security, but by using fewer natural resources. This could be achieved through improved resource efficiency, substantial investments and innovations. It implies increasing crops that ensure a higher efficiency in terms of nutrition per drop of water.

Smallholder farms are essential in the transition towards a green economy. They can contribute to economic growth, poverty reduction and food security. However, without the means to control and effectively manage water, poor farmers are unable to turn agriculture from a subsistence activity into an income-generating enterprise. Water is not the only constraint to improving crop production and nutrition, but if farmers do not have reliable access to water, interventions to address the other constraints will fail. For example, reliable access to water gives farmers the security to invest in inputs, such as fertilizers and improved seeds, and enables them to grow higher-value crops, such as fruits and vegetables.

The following approaches for transitioning to the green economy have been highlighted by the organisations participating in the conference.

Agricultural practices

- Efficiency of smallholders can be achieved by both push (access to techniques) and pull mechanisms (access to markets).
- Agroecosystem approach. This approach views agriculture as a set of human practices embedded and part of its own ecosystem that has certain ecosystem needs, functions and services and that interacts with other ecosystems. Agroecosystem management is then the management of natural resources and other inputs for the production of food and other provisioning, cultural, regulatory and supporting ecosystem services.
- Layered agricultural systems, such as the rice and fish culture in China, where fish are raised in rice fields, either concurrently with the rice crop or in rotation with rice.
- At farm and larger landscape level, the integration of crop, tree and livestock production can lead to resource recovery in the form of manure for soil fertility and crop residues and tree fodder for feed. For instance, in savannah woodlands, farmer-managed natural regeneration helps increase tree cover.
- Cultivation of local plants, desert-adapted plants, silvopastures and perennial grasses have the potential to capture benefits from infrequent and erratic rainfall and control

erosion in areas too dry to support traditional field crops.

- Use of innovative technologies that improve crop yields and drought tolerance; more efficient ways of using fertilizer and water, as well as new pesticides and non-chemical approaches to crop protection; and technologies that reduce post-harvest losses and more sustainable livestock and marine production.
- Upscaling of successful local solutions (from small-holders).
- Promotion of urban agriculture, since it has the advantage of reducing the transmission chain between soil and mouth.
- Capture and reuse of phosphorus. In both urban areas and in livestock farming, the phosphorus content of human and animal wastes must be recovered for return to the soil.

Food production chain

- Efficiency improvements throughout the value food chain*:* from the resources used and recycled during production, through waste minimisation during post-harvest handling, processing, retailing and consumption, to distributional equity and fair trading.
- Food loss reduction. Food waste in industrialised countries can be reduced by raising awareness among food industries, retailers and consumers. There is a need to find a beneficial use for safe food that is presently thrown away.
- Attention to the interdependencies between water, food, energy and climate. There is a need to align plans, strategies and programs dealing with elements of that nexus and recognise potential tradeoffs between land and water use, biodiversity, green house gas emission reduction, soil, etc.

Markets

- Farmers in developing countries (mostly smallholder) need better access to markets to make their small business more profitable. Generating more income enables greater investment in improving productivity.
- Use of soft technologies such as mobile phones to get information on market prices may help improve the profitability of farmers.
- Ensure that well-functioning markets provide the right signals*:*
  - Prices reflect the scarcity value of natural resources as well as the positive and negative environmental impacts of the food and agriculture system will contribute to resource use efficiency.
  - Further integration of domestic and global markets, bearing in mind the impacts of production trade on the environment and of environmental policies on production and trade.
  - Application of the polluter pays principle through charges and regulations.
  - Provision of incentives for the supply of environmental goods and services.

Land management

- Improvement of land use efficiency. Awareness-raising of challenges and available options, and leadership to adapt the best practices at all levels.
- Joint assessment of land and water productivities for optimisation of natural resources use.
- Establishment and enforcement of well defined property rights. Property rights help ensure optimal resource use, in particular for marine resources, land and forests, greenhouse gas emissions, and air and water quality. When resources are essentially free to private participants it can encourage over-exploitation, resulting in environmentally and socially sub-optimal outcomes.

Water management practices

- Improvement of irrigation efficiency in agriculture. Consider rain fed agriculture including small dams and water harvesting.
- Small scale irrigation technologies (e.g. treadle pumps, drip irrigation techniques). Investments in 'green' irrigation models (drip irrigation) can help address the increasingly unsustainable water withdrawals for irrigation.
- Measures to increase water productivity in agriculture and reduce the gap in water productivity between farms in different areas (supply).
- Account for volumes of water in the food supply chain. Currently the food supply chain is water value blind.
- Shift in focus from supply-side to demand-side approaches to agricultural water management. The current focus on physical infrastructure-based 'supply-side' solutions should shift towards a greater emphasis on the sustainable use of water and 'demand-side' economic solutions.
- Combination of new technologies and improved land and water management practices, such as efficient collection of runoff and soil-based storage of moisture, to increase water productivity in cropped areas and restore degraded rangelands.
- Decisions based on impact assessments to ensure water management is sustainable.
- Separation of pollution streams at source.
- Promotion of localised wastewater treatment techniques.
- Energy can be saved by optimising the use of gravity water supply, while reducing the need for pumping and conserving water quality across the basin.
- Adoption of new filtration technologies (such as nano-technology) to reuse grey-water (waste water from the urban sector) for agriculture.

Improving knowledge, building capacity

- Consumer education and public awareness on water efficiency, water quality concepts

and certification in order to change consumer behaviour and build a green society.

- Learning and knowledge-sharing on management practices such as conservation agriculture, nutrient management, integrated pest management, groundwater management and irrigation scheduling.

- Involvement of local people – both men and women- and creation of local economic opportunities. Building of local capacity for planning, implementation and management of forestry and replanting programs. There is a need for education and information on how to make best use of forests and how to cultivate crops sustainably.

Water governance

- A dialogue between water managers, agricultural planners and stakeholders is needed to identify and properly implement solutions.

- A holistic water governance framework is required whereby water is managed across sectors, with appropriate institutions that have the authority to take this holistic approach.

Opportunities for industry in the transition to a green economy

Industry can play a leading role in making water practices more sustainable by addressing overexploitation and contamination and improving water infrastructure and management. To reach these goals, industry must do '*more with less*', ideally moving toward a goal of zero discharge, for example by utilising a closed-loop production system.

UNIDO launched the *Green Industry Initiative*, which is a two-pronged strategy for decoupling resource use and pollution from industrial development and promoting the growth of sustainable productive sectors and entrepreneurship in developing and transitioning countries. According to UNIDO, this will lead to the creation of new green jobs, new business ventures, and will drive technology development and innovation. The initiative is especially designed to support developing countries and transition economies, enabling them to benefit from the opportunities associated with sustainable industrial development and the growing global demand for greener products and services.

Industry, as the prime manufacturer of the goods and services that societies consume, has a critical role to play in creating more sustainable production and consumption patterns. In the transition to a green economy, the environmental services sector offers opportunities for industries, as it can assist them in assessing, measuring and managing their environmental impacts, as well in the management and safe disposal of pollution and waste. Examples are cleaner production services and waste recycling. Recent statistics suggest that this industry is worth around USD 300 billion annually in the developed countries alone.

Many types of products with an environmental 'brand' offer opportunities for entrepreneurs. For example, in the renewable energy sector there are potential markets for solar water-heaters for commercial or residential use, or for solar cookers for use in rural areas. Through environmentally sound product design, enterprises can assist in bringing about a broader decoupling throughout societies. At one level, enterprises can redesign their products so that

they contain fewer materials (dematerialisation). At another level, they can redesign them to consume less (e.g. energy, water, detergents) during their use.

The current economic and financial crises can also provide an opportunity for industries to become more sustainable. The large public spending programs being touted as a means to revive economies are an opportunity to place our economies on more sustainable pathways of growth. The much needed green public investments, as well as the necessary policy changes to encourage green private investments, could well 'jump-start' our economies and place them on more sustainable paths of economic growth.

The main approaches to enhancing sustainability in industry are as follows:

- Experts and international institutions emphasise the importance of closing gaps in the normative framework. Global trading will increasingly require enterprises in the developing countries to comply with environmental product or process standards and certify that they do so. A normative framework is required allowing enterprises to obtain certifications of compliance with local environmental standards. A normative framework to encourage the growth of the recycling industry. Establishment of new environmental laws and regulations and enforcement of existing ones.

- Awareness-raising amongst entrepreneurs can promote opportunities for new green businesses responding to demands for technologies; infrastructure; or specialized consulting, laboratory or other services. Access to training, knowledge and technology, so that water-friendly industry in the green economy generates opportunities that benefit all. Enhancement of technical and managerial knowledge and skills throughout the industrial sector.

- Improvements in water use and energy efficiency along the value chain of industrial processes (production, transformation, marketing, consumption, recycling) via government and market incentives and regulations/standards and consumer campaigns. Measurement and assessment of water footprints and water risks in operations and supply-chains.

- Cleaner production and sustainability practices contribute to the transition toward zero effluent discharges. Industries should work to convert wastewater streams into useful inputs for other processes, industries and industrial clusters. Improved management of chemicals (storage and handling) to prevent accidental spills and leakages that negatively impact surface water and groundwater.

- Support to the development of small and medium enterprises (SMEs) and local green industry (goods and services) in the transition to a water-friendly economy. Promotion of good practices of corporate social responsibility around water, including for SMEs in developing countries. Proper sitting of enterprises. For example, locating small and medium enterprises (SMEs) of similar industrial sectors in industrial zones allows for common wastewater treatment and waste-management operations, which individual enterprises might not be able to afford. It can also enable groups of enterprises to practice industrial ecology, whereby wastes from one enterprise are fed to another enterprise as raw materials.

- Improvements to the financial support structure. It is important that the banking sector

in the position of being willing and able to support green investments by the private sector, or to invest directly in required infrastructure such as wastewater treatment plants and waste-management plants (these can be the green investments in stimulus packages). A different price structure for industrial water use which requires industry to pay more per unit of water than the public and increases the unit price with increasing water use. This promotes increased water use efficiency, since industries aim to keep costs low. Currently, many developing countries' industries pay a fix 'tax' for water which is unrelated to the amount used. Establishment of loan markets for small and medium enterprises (SMEs), municipalities, water users associations and domestic consumers.

- An integrated and strategic science and technology system that encourages green innovation as well as the transfer, development and adaptation of cleaner process technologies, recycling technologies, renewable-energy technologies, and other environmentally sound technologies. This makes it easier for enterprises to green themselves. Eco-industrial clusters and technological parks can increase efficiency and generate environmental benefits at the regional level.

Opportunities for cities in the transition to a green economy

With the majority of the world's economic activity and now over 50% of its population concentrated in urban areas, cities have a central role to play in the realisation of a green economy. How cities develop has far-reaching effects on economies, energy use and climate change. Furthermore, a green economy thrives on innovation and many of the more ambitious and sustainability-oriented innovations have emerged within cities; in the density of institutions, people and infrastructure.

As centres of social interaction and economic activity, cities are the critical spatial platform for the formulation and implementation of policies across sectors. It is in cities that economic growth and decent jobs can feasibly be balanced with an environment liberated from the risks of climate change and ecosystem degradation. Cities can catalyze an efficiency shift by targeting investment at well-planned greener transport infrastructure. Along with integrated transport planning, low-carbon fuels and electrification of transport, these innovations will help meet sustainability targets.

Urban densification – when sensitively planned and supported by sustainable infrastructure – allows for more efficient and sustainable patterns of development. Compact cities reduce the spatial footprint of development and shared infrastructure reduces emissions and resource use. By harnessing the advantages of concentrated populations, cities can reduce dependency on transportation and infrastructure and provide basic services with greater efficiency. Creative planning for compact and dense urban development that incorporates parks and green spaces can reduce commuting distance and energy consumption in buildings, while contributing to climate stabilisation and biodiversity.

The transition of cities to a green economy requires a combination of sustainable urban development, protection of urban ecosystems, effective management of waste water and pollution, efficient water use and improved governance.

Sustainable urban development

A key principle is the promotion of compact cities and planned extension of urban areas. Land mosaic patterns that provide for large green patches and more sustainable urban development. Two urban patterns, the 'compact concentric zone' and 'satellite cities' models, can best provide for both human and ecological systems. These patterns preserve a greater number of large patches of land within which nature can thrive, whereby flooding and landslides can be prevented, while at the same time allowing for population and economic growth.

Another key principle refers to a balance of strategic facilities with diversified local economic opportunities. As an urban centre grows, the range and number of the functions that it supports generally increases. Facilities such as good harbours, an international airport, universities and a financial centre strengthen the competitiveness of a city-region and support value chains throughout the area. At the same time, diversifying local economic opportunities diminishes the demand for mobility, hence reducing energy use.

Moreover, the following concrete approaches can contribute to sustainable urban development:

- Expansion of network infrastructure while getting the most out of existing networks.
- Construction of 'greener' built environments that use water and energy efficiently. Both regulatory approaches (e.g. strengthened building codes) and incentive-based strategies (e.g. green building rating tools, green mortgages) can promote green buildings.
- Technologies such as 'green roofs' can reduce runoff, reduce the heat island effect in cities and so reduce cooling demand, and remove pollutants from the air.
- Clusters of green industries and jobs. Decision-makers can support the growth of clusters of green industries and green jobs, e.g. through three-way linkages between universities, business and local authorities.
- More efficient intra-urban resource flows, for example by establishing urban growth boundaries to limit urban sprawl, incentives for car-free developments, and density bonuses for developments that support city-wide sustainability.

Ecosystem services

Protection of valuable ecosystem services and biodiversity hotspots in urban areas while increasing resilience to natural disasters. Safeguarding ecosystems involves conserving blue-green patches and corridors accordingly.

Governance

- Strong and consistent political leadership to ensure that cities and their green economies are successful. This leadership is needed to enable structured progress and a coordinated approach.
- Generation of political will to realise green initiatives and implement green policies.
- Partnerships between government, industry and communities to create and implement green policies and regulatory reforms.

Sustainable urban water management

- Integrated urban water management (IUWM) to facilitate the multi-functional nature of urban water services in order to optimise the outcomes of the system as a whole. This involves managing freshwater, wastewater, and stormwater as linked within the resource management structure, using an urban area as the unit of management.
- Integration of land and water management. Land use planning and building regulations have proved in some areas to be highly effective ways of promoting sustainable urban water management.
- Simple solutions, such as water loss reduction and regular operation and maintenance, can give big results that often surpass heavy investment in hard infrastructure.
- The 'Cities of the Future' programme of the International Water Association focuses on water security for the world's cities. Cities – and the water management, treatment and delivery systems that serve them – could be harmonised and re-engineered to minimise the use of scarce natural resources and increase the coverage of water and sanitation in lower- and middle-income countries.
- Provision of water and sanitation to informal settlements.
- Use of techniques for domestic water reuse for toilet flushing, garden watering, etc.
- Technological development for urban water production: nanotechnologies to reduce pollution and accelerate filtration.

Management of wastewater and pollution

- Separation of pollution streams at source.
- Use of grey water.
- Making water conservation and reuse possible and affordable.
- Campaigns for pollution abatement.
- Techniques for establishing sustainable drainage systems **(**SUDS) in high density cities (>15,000 people per km^2).
- Protection of infrastructure used to treat and transport water (including sources, treatment plants and distribution systems) to ensure safety for public health and the environment.

Economic instruments

- Price regulation for water suppliers and wastewater managers that promotes sustainable water use.
- Practical tariff systems for consumers whose income is low as well as variable.
- Incentives and regulations in the building and construction sector offer opportunities for cities and local governments to leverage their authority through the promotion of

green building materials and construction technologies, mandatory investments in energy efficiency and the installation of renewable energy technologies in buildings.

- Remittances for investment in water services.

Raising awareness

- Involvement of end users, particularly women, in water management to optimise benefits from water projects. Water managers can work with the users of water and sanitation services to find out their needs and identify appropriate solutions.

- Effective household demand management campaigns (e.g. Copenhagen, Denmark; Zaragoza, Spain).

- Education can raise awareness of the need for sustainable water use. Water, sanitation and hygiene education is also important for ensuring the integrity of both human and environmental health.

Watersheds in the transition to a green economy

There is a recognised link between poverty alleviation and the benefits that people derive from ecosystem services – especially those provided by freshwater ecosystems. The protection and sustainable management of these ecosystems can therefore play a critical role in poverty reduction strategies, by securing the continued cost-effective delivery of the water, food and other services that poor people rely on.

Recognising the valuable, less visible and non-monetised benefits of conserving ecosystems represents an opportunity to recover sustainable growth, fairness and poverty reduction paths while improving and protecting natural assets.

Sustaining or restoring the water-related services provided by ecosystems is at the heart of achieving water security for both people and nature. There is already solid evidence that ecosystem-based solutions to water-related problems are not only viable but can be very attractive in terms of investment returns. Water-related economic interests are already driving major shifts towards the wiser use of nature and biodiversity in the business, public and national policy agendas in many countries, including major developing nations.

Biodiversity conservation

- Biodiversity conservation can be a useful tool for managing nutrient uptake and storage; in certain freshwater ecosystems rapid vegetation growth can be used to remove excess nutrients from water, reducing the need for conventional water treatment plants. Maintaining both the physical and biological diversity of watercourses helps to buffer ecosystems against nutrient pollution.

- One of the key ways that water managers and those interested in conserving biodiversity have collaborated is through the setting up of investments and fiscal measures that provide incentives for the sustainable management of ecosystems. One of the most widely implemented approaches during the last 5 to 10 year is Payments for Ecosystem Services.

Ecosystem services

- Environmental flow assessment is becoming an influential decision-support tool. Environmental flows describe the quantity and timing of water needed to sustain freshwater ecosystems and the services they provide. The implementation of policies to restore and protect environmental flows ensures the maintenance of ecosystems services which people and economies rely upon.

- Sustainable provision of ecosystem services can be achieved through changes in land-use practices and incentives for farmers that are both equitable and targeted at maintaining or enhancing livelihoods.

- A programme of public awareness can sensitise stakeholders to upstream–downstream environmental linkages and the economic significance of the ecosystem services management carried out by watershed owners/managers. This can enhance willingness to pay on the part of users, and willingness to adapt land/water management practices by service 'suppliers' – or at least willingness by both groups of stakeholders to engage in dialogue.

- It may be better to 'start small' and to 'scale up' rather than to try to implement a fully fledged financial mechanism from the beginning. This can be done, for example, by targeting a specific land/water management practice – and the drivers underlying it – that influences a specific ecosystem service (e.g. deforestation driven by the need for fuel wood, causing increased runoff, erosion and sedimentation of water courses).

- The way in which ecosystems are valued has to be reconsidered. Water is usually only priced at the point of consumption, but in order to improve decision making and protect ecosystems, valuing the multiple benefits of water is essential.

Aquifers

- Development of mechanisms to ensure that decision making of water users sharing an aquifer is based on the capacity of the aquifer to meet their long-term water demands. Cooperation and sharing the benefits of a well-protected aquifer is always better than the competitive the race to the bottom dynamics that have led to the depletion of aquifers.

Integrated management

- Shift in focus towards a systemic approach to water management which takes into account ecological considerations.

- Management of catchments as systems, considering water usage within the catchment as a whole.

- Shift from 'fixing' point challenges to systemic solutions. Individual action within a catchment can be promoted to enhance overall catchment performance, e.g. in the provision and maintenance of ecosystem services.

- Integration of land and water management instead of treating them as separate problems or allowing land management to drive water management.

- Reallocation of resources from low-value to higher-value uses.

Managing climate variability and change

- Build resilience, adaptiveness, and adaptability, learning from past mistakes.
- Managing variability as a whole instead of treating different stages in that variability (i.e. droughts, resource, and floods) as separate problems. Actions which reduce runoff do so in drought periods as well as during periods of heavy rainfall.
- Due to the inherent uncertainty of future climate change projections, water management needs to be flexible and able to cope under a range of possible futures.

Management of wastewater and pollution

- Reduction of pollution through catchment-based strategies and action plans for more sustainable land use – especially agriculture – and working with industry (public and private sectors) to reduce water use and pollution.
- Investments in wastewater treatment facilities to reduce pollution from organic chemicals, pesticides, nitrates, heavy metals and waterborne pathogens.
- Water reuse, such as making use of grey water in peri-urban agriculture.