1 Introduction

1.1 The context

In the closing years of the 20th century, big business had a rude awakening to the fact that its obsession with the profit curve was causing environmental crises, which was affecting the curve itself. Commenting on the results of CDP Global Water Report 2014 (CDP, 2014), CEO Paul Simpson says 'The availability of water poses a strategic risk to a large and growing number of companies.' Industries are facing competition in regions of water scarcity, and as a consequence public grievances are beginning to force cancellation of licences to operate. It has taken the shape of a global phenomenon because the underprivileged are becoming more and more aware of their right to water. Additionally, global warming (even though the underprivileged are not well informed on climate change) looms larger with time. In short, the profiteering tendency of big business is being directly challenged by (1) resource depletion, (2) non-delivery of the social responsibilities, (3) management crises in the value chain (4) rising costs of water, (5) climate uncertainties, and (6) political and social pressure.

In the past, industries were considered in isolation, that is, as entities separated from the ecosphere although, in fact, industrial dynamics is dependent on information flow between the industry and its environs (Odongo, 2014) because they share common resources with other user sectors (see Figure 1.1). The underlying concept is simple: Industries depend on services provided by the ecosystem; consequently, an industrial system should be viewed as a subsystem that impacts the biosphere, hydrosphere, and lithosphere.

Industries often act upon the idea that they are free to operate merely by complying with Environmental Protection Agency guidelines and the water laws of the country in which they operate. But simply complying with guidelines is not enough to sustain a business, especially in areas known for water

Industrial Water Resource Management: Challenges and Opportunities for Corporate Water Stewardship, First Edition. Pradip K. Sengupta.

Figure 1.1 Industry and agriculture, sharing the same resource.

crisis (Aghababyan, 2006). Industry's own way of fulfilling social responsibilities often fails to convince the people when both industry and people confront severe resource depletion. Given below is a case in India that has given rise to newer questions on water stewardship delivered by industries.

1.1.1 The story of Coca-Cola in India

Mehdiganj near Varanasi in Uttar Pradesh (India) is mainly an agricultural belt. In 2003, with temporary permission to operate with a production target of 20,000 crates per day, Coca-Cola started its bottling plant, which increased its production to 36,000 crates per day by 2009 (India Resource Centre, 2014). In 1999, Mehdiganj was declared a safe category block[1] by the Central Groundwater Authority. By 2004, after only a few years, it turned into a critical block in terms of the groundwater resource. A report published on 19 June 2014 states that (The Ecologist, 2014) in pursuance of a Supreme Court ruling the 'local authority has passed an order to evict Coca-Cola.' The Coca-Cola Company, however, has published documents in defence against the charges drawn against them (Coca-Cola India, no date) claiming that the charges are nothing but myths and that they have abided by the laws and statutes.

The court verdict against Coca-Cola is a clear demonstration that big corporate houses have to look beyond profiteering and proactively participate in broader catchment-level resource management. Formulating or practicing their own policies and simply abiding by the terms of their legal licence will not suffice. Industries will lose the social licence (Lassonde, 2014) if resources begin to get endangered by their activities. The Mehdigunj case underscores the responsibility of multi-national companies to respect societal needs alongside protecting shareholder's

interest (Sengupta, 2014). Goods produced to cater to the desires of the privileged class may have to confront questions such as how ethical it is to make use of scarce resources that are supremely essential for the larger underprivileged population for the sake of producing something, rendered non-essential by another group. The difference between the concepts of 'need' and 'want' must be emphasised to the society. The derivative of this question is also equally important to manufacturers because consumers, of such products as are deemed non-essential in the world at large, do not like to see their brand manufacturers falling foul of the law. The bottom line is a fundamental question: Can the corporate sector be allowed to secure their production requirements only on the basis of complying with local or national statutes? Clearly not, as exemplified in the aforesaid court verdict. Big business has to factor in safeguarding the rights of the underprivileged to remain in business.

Manufacturers are thus accordingly awakened to their responsibility to the two most powerful factors that have the power to affect business sustainability: (1) accountability to shareholders and consumers, who feel affronted if the manufacturer is punished by the court of law; and (2) preventing people from protesting in the area of their operation by following the law both in letter and spirit. In the context of water stewardship, for example in the beverage industry, manufacturers have to keep a keen eye on the water they are exporting from catchment vis-à-vis effectiveness of their replenishment plans so that the total water reserve is not irreversibly damaged or severely depleted. Manufacturers are trying to compensate withdrawal by providing rainwater harvesting installations to the community. The question is how these two are balanced. Herein rests the importance of source-water assessment, which is vital to balancing resource extraction and input—a balancing act vital to avoid possible confrontation between business and society.

Coca-Cola is merely one example; it is by no means unique. The corporate sector is facing popular resistance throughout the world. A few more examples are given in Box 1.1

BOX 1.1

Corporate-society conflict over water

- In July 2012, residents of Shifang in the southwestern province of Sichuan, China, protested against a proposed USD 1.64 billion molybdenum copper plant, fearing negative impact on the environment and their health. The protest turned violent, and 17 people were injured. Ultimately, local officials announced that the project would be halted (Economy, 2013).
- In 2004, a Peruvian gold mine had to suspend its production due to people's protest about their water concerns (Walton, 2016).
- In 1999, the people of Cochabamba in Bolivia protested against privatisation of water in favour of industries, and the conflict led to violence (Otto and Böhm, 2006).
- In Jakarta, popular protest against privatisation and corporate control over water won a legal battle on the grounds that the Public-Private Partnerships (PPP) were negligent in fulfilling the people's right to water (The Transnational Institute, 2015).

The essence of modern-day water management requires balancing sustainability and economic growth. Coca-Cola is one of the leading companies among those who profess to propagate and apply the concepts of water stewardship. Despite resources and experiences that Coca-Cola invested in the water problem, they failed the Mehdinagar test. But *why*? A fuller understanding needs a deeper look into the problem.

We shall seek the answer to the italicised '*why*' in this book and try to identify the drivers, risks and opportunities of water stewardship within the framework of industrial water management.

1.2 Water goals in the 21st Century

The 'twentieth century has witnessed an unprecedented rise in human population, from 2.8 billion in 1955 to 5.3 billion in 1990 and is expected (Mary, 2016) to reach between 7.9 and 9.1 billion by 2025' (Gardner-Outlaw and Engelman, no date). This phenomenal population growth demands an increase in production rates from mines, power plants, beverage industry, and so on. Paradoxically, the industrial growth rate is higher in developing countries in comparison to developed countries, the simple reason being the industrialists' preference for such countries that easily provide them with cheap labour and weak/flexible environmental laws.

The United Nations World Development Report 2015 under the United Nation World Water Assessment Programme (WWAP, 2015) states that during the 19th and 20th centuries, development of water resources was largely driven by rapidly increasing demands for food, fibre and energy. A growing middle class, with improved living standards and increased purchasing capacity, boosted industrial growth that led to sharp increases in water use, which inevitably culminated in worldwide alarm cries against unsustainable growth rates. The crisis is more pronounced in places where water use is wasteful, distribution is inequitable and management is poor.

Increased meat consumption, building larger homes, using more motor vehicles, gadgets and appliances caused an increase in water consumption. While this may sound unconnected, it holds true, because, every product and service has its own virtual water content, and increased consumption increases the water footprint.

Savenije, Hoekstra and Zaag (2014) are of the opinion that the natural distribution of the freshwater resource on the face of the earth 'has changed as a result of human intervention and efforts to manage water'. Though changes are viewed in terms of utilising water for industrial growth and production of energy, the direct hydrological impact is seen as a diversion of natural water flow to facilitate supply to urban areas, industries and for agriculture. River basins have suffered a loss of perennial flow, depletion of resources and contamination from point or diffused sources. Such changes have also affected the global climate, biodiversity, land cover change and serious depletion of quality freshwater.

The science of water, or hydrology, is relatively new because it was developed in response to the recent population boom and the consequent rapid industrialisation. Diversion of river courses for harnessing hydropower was made possible by 'increasing knowledge of water engineering, large-scale water supply, flood mitigation and irrigation' (Savenije, Hoekstra and Zaag, 2014). But there is no such thing as a free lunch; the question arises, who is paying for the unregulated industrial use and how? 'Unregulated industrial use' is a euphemism for depriving marginal people of their meagre needs of fresh water. When pushed to the wall, the invisible and silent majority of marginal people join hands in large enough numbers to show up on the radar of the media, and the government is eventually forced to introduce regulatory acts. Interdisciplinary water management, where scientists, engineers, ecologists, decision-making managers, politicians, sociologists and the media work in tandem has emerged as a post-colonial paradigm; it is termed Integrated Water Resource Management (IWRM).

IWRM recommendations actually gathered momentum in 2002 from a far more serious problem that remained unnoticed in the 1970s, namely environmental degradation. This hitherto unrecognised problem came into focus in the Global Environmental Summit (United Nations, 1992b) where the Millennium Development Goal was proposed. In the proposal, unprecedented scarcity of water and other resources, skyrocketing food prices (KPMG, 2012), and escalating energy security issues were emphasised in light of projected population growth. Some key indicators of development were proposed in Agenda 21 of UN 1992, and Section 30.3 (strengthening the role of business and industry) stated that the highest priority should be given to 'environmental management' by society in general and by the corporate sector in particular. The role that big business must play in sustainable development is the crux of the matter discussed in Section 30.

In the context of water, the aforementioned UN document highlights 'responsible care' as the key element in water stewardship. Participating governments drew from IWRM recommendations in their approach document, which was presented in the 2002 World Summit on Sustainable Development (WSSD) held in Johannesburg. One hundred and ninety-three countries agreed to the Johannesburg Plan of Implementation (JPOI), in which Article 25 calls for 'the development and implementation of IWRM and water efficiency strategies, plans and programmes at national and regional levels with national-level IWRM plans to be developed by 2005' The salient features of Article 26 of JPOI are (United Nations, 1992a):

a Develop and implement national/regional strategies, plans and programmes with regard to integrated river basin, watershed and groundwater management and introduce measures to improve the efficiency of water infrastructure to reduce losses and increase recycling of water.

b Employ the full range of policy instruments, including regulation, monitoring, voluntary measures, market and information-based tools, land use management and cost recovery of water services, without cost recovery objectives becoming a barrier to access to safe water by poor people, and adopt an integrated water basin approach.

c Improve the efficient use of water resources and promote their allocation among competing uses in a way that gives priority to the satisfaction of basic human needs and balances the requirement of preserving or restoring ecosystems and their functions, in particular in fragile environments, with human domestic, industrial and agriculture needs, including safeguarding drinking water quality.
d Develop programmes for mitigating the effects of extreme water-related events.
e Support the diffusion of technology and capacity-building for non-conventional water resources and conservation technologies, to developing countries and regions facing water scarcity conditions or subject to drought and desertification, through technical and financial support and capacity-building.
f Support, where appropriate, efforts and programmes for energy-efficient, sustainable and cost-effective desalination of seawater, water recycling and water harvesting from coastal fogs in developing countries, through such measures as technological, technical and financial assistance and other modalities.
g Facilitate the establishment of public-private partnerships and other forms of partnership that give priority to the needs of the poor, within stable and transparent national regulatory frameworks provided by Governments, while respecting local conditions, involving all concerned stakeholders, and monitoring the performance and improving accountability of public institutions and private companies (Source: Sustainable Development Knowledge Platform, United Nations. Printed with permission from the United Nations.)

IWRM was accepted as a paradigm and 'particularly recommended in the final statement of the ministers at the International Conference on Water and the Environment in 1992 (called the Dublin principles).' The fundamental objectives under IWRM are: (1) Social equity, (2) Economic efficiency, (3) Ecological sustainability (*Integrated water resources management*, 2015).

These two world summits on environmental degradation emphasised water management plans especially with regard to industrialisation. The points of emphasis were:

1 Development of a national strategy or vision on water.
2 Implementation of regulations by letter and spirit on water withdrawal, use and discharge.
3 Pro-poor prioritisation of industrial water needs.
4 Promoting awareness among stakeholders and civil society towards industrial water management. This concept is crucial to areas of chronic water shortage to avoid conflict between people and industry.

How industries should look upon the water, therefore, becomes a big question. The United Nations in its document *WWDR 2014* has specifically outlined a visionary recommendation for water-intensive industries (see Box 1.2). Byers *et al.* (2002) observed that industry today is constantly striving to operate more efficiently. Most successful plants claim to be sincere in their search for safe, socially responsible, economically profitable and environmentally sustainable methods. While this is true in some isolated

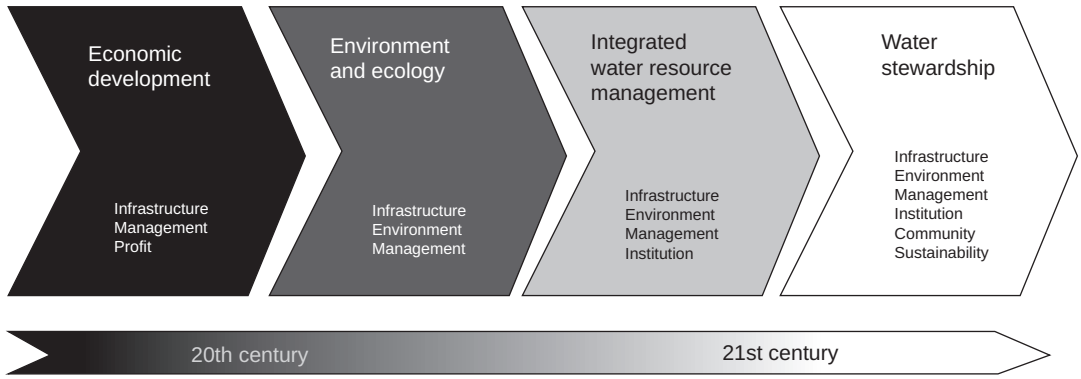

Figure 1.2 Paradigm shifts in water management.

instances, by and large, industries are focused on profits and merely pay lip service as a smoke screen to avoid the additional expenditure necessary for the implementation of IWRM guidelines.

Industries, as a rule, are more focused on short-term profit as opposed to the long-term assessment of economic growth vis-à-vis the environmental cost, a focus which is suicidal in a way because environmental degradation never fails to claim its pound of flesh. Small-scale industries in developing nations, which generally face step-motherly treatment from the government, therefore, feel justified in turning a blind eye to the pollutants they release into the environment.

However, there is also a bright side. Big businesses are shifting their focus from mere profit-making activities towards more sustainable business models that can be beneficial for both economic development and social well-being. The 20th-century economic development model is being metamorphosed into a more sustainable water stewardship model that the 21st century will witness. See Figure 1.2.

1.3 Water ethics

'Water is not a commercial product like any other but, rather, a heritage that must be protected, defended and treated as such.' EU Water Framework Directive (Bloech, 2010).

The water crisis of a country is assessed by various indicators, which have found that water and poverty are interlinked (Sullivan, Meigh, and Fediew, 2002). The indicators used for examining the extent of water crisis are water availability (surface and groundwater), demand (domestic, agriculture or industrial), access (distance to source and legal rights), institutional capacity (human and financial capacity to manage the system), price and affordability of water and environment (hydrological functions of ecosystems), vulnerability to water-related disasters and water quality improvement.

Water infrastructure and provisioning of water are indicators of both economic and institutional capacity of a country.

Big business generally considers water as a raw material while the ethical value of water is often ignored. The question of water ethics comes to mind only when faced with development projects dependent on water, such as hydroelectric projects, river linking, trans-boundary water transfer and the like, all of which are planned for the benefit of stakeholders in keeping with the interests of the silent majority. People who are dependent on the river basin are not factored into the planning of business development projects. This deliberate oversight borders on criminal negligence, because even a single deep tube well installed for industrial use adversely affects the drinking water security of local people. That being said, the scale of impact of large-scale businesses, comprising factories, offices and residential quarters, is left to the imagination of the reader. Admittedly, big projects recruit some local people for menial jobs, but their numbers constitute a minute percentage of people whose water security is compromised.

Ethical conceptualisation of water evolved alongside social changes brought about by technology. Hassan (2011) identified eight modern day paradigms: (1) spiritual and religious, (2) aesthetic-recreational, (3) ethical, (4) scientific, (5) ecological, (6) technological, notably hydraulic engineering, (7) financial and economic, and (8) management policies. The paradigm shifts that have taken place from ancient to modern times follow the path of modernisation of society. In the course of further evolution of water ethics, many modern societies have discarded some of the values listed above for reasons of practicality and have focused on the more scientific, technological, economic and managerial considerations.

The sub-commission COMEST, a committee appointed by UNESCO to examine the question of water ethics, has identified some fundamental principles. It states that water is a fundamental pillar that 'human dignity' rests on. The COMEST (2005) document clearly states that all individuals including the poorest are entitled to 'participate in the water planning and management'. The other principles of entitlement such as 'solidarity', 'human equality', 'common good' and 'stewardship', 'transparency' (UNESCO, 1999) and the right to information are also important in that data-sharing process. The disclosure of water-related information empowers the poor by making them aware of their rights to water. The document also advocates educating stakeholders who can influence water management (Liu *et al.*, 2011).

Consider the case of river-linking projects in India (Bansal, 2014). The defining character of India is not just its territorial vastness and the pressure of a vast population. India cannot be understood if the varied hydro-ecological zones and the consequent ethnic diversity are not included in its description. Rainfall is unevenly distributed, so that there is a chronic drought in some parts while another part of the country enjoys the world's highest rainfall. Both surface and groundwater resources are thus unevenly distributed. The government of India has taken a policy decision to link the river basins through canals and transfer water from one basin to another to feed the water-deficient regions of India.

Let us examine the ethical base of the proposal. Controversies arise when human enterprise causes irreversible destruction of natural habitats and attendant extinction of species. The use of the plant and animal kingdoms as a substrate for economic growth at the cost of life forms becoming extinct is challenged by conservationists fighting to protect animal rights, but they are vastly outnumbered by the champions of industry who continue with widespread habitat destruction behind a facade of sustainable growth. Animal-rights controversies make headlines when the media deem them newsworthy. The trouble is that there are also people sharing water and other ecosystem services of river basins targeted for linkage (interestingly tribal cultures have shared that space with local flora and fauna for millennia without disturbing ecological balance; this remarkable coexistence is not an example of sustainability for the policy makers of sustainable development).

According to Groenfeldt (2013), it is not wise to add further stress on an 'already depleted water ecosystem' by constructing new infrastructures without factoring in the environmental cost into the projected profits from development. One would have expected the internet-savvy third-millennium urban population to be alert to the environmental cost of their lifestyle. I, personally, am aghast at the amount of campaigning required to sensitise big business and its beneficiaries to the enormous losses caused by environmental degradation. To shorten a long story, decision makers need to balance environmental cost, ethical value and economic gain. Hopefully time, the great healer will restore the balance someday.

There are several tools and methods to support the knowledge base of decision makers (notably, historical water-related databases, consumptions pattern and practice, geographical information system (GIS) software, flownet analysis tools, and water-assessment tools). These tools are mostly technical in nature and require quantification (of such parameters as groundwater resource estimation, minor irrigation census, industrial water demand assessment tools, etc.). Decision makers must necessarily be conversant with these tools to reinforce and justify their decisions. The only drawback of such tools and methods is that they do not factor in local people and their water culture, a drawback subsequently addressed in the newly formulated policy of 'water stewardship'. In the absence of water stewardship guidelines, decision makers have traditionally applied their uninformed ideas (read self-serving interests), which were often found woefully short in ethical content leading to conflicts.

Since water stewardship is still in its infancy, it faces various unresolved ethical issues at various stages of big project implementation. For effective water stewardship, managers should focus on ethical values instead of lopsided arguments highlighting the economic value of big projects. Not all ethical issues merit prioritisation. The rural population is not intellectually incapable of appreciating development. They are flexible enough to readjust or even replace antediluvian water-intensive rituals to accommodate development plans in their ancestral lands, provided of course that the drive for development does not literally drive away the poor from their rural habitat to cities to make a living as domestic helpers

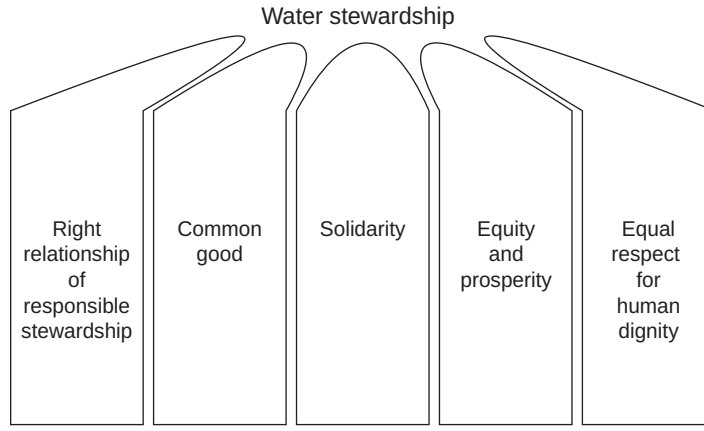

Figure 1.3 Ethical framework of water stewardship. Adapted from Jennings, Heltne and Kintzele (2009).

or exploited and underpaid daily wage labourers or even as beggars. Prevention of exodus from rural India to cities is arguably the greatest challenge to water stewardship.

With these ethical orientations and practical considerations in mind Jennings, Heltne, and Kintzele (2009) have suggested five principles of water ethics, which have the potential to elevate water stewardship from a mere strategy to a socially redeeming force. See Figure 1.3.

1.4 Value of water

The value of water is closely related to water ethics, that is, how a person is using water and how water is related to his identity. Water has different values to different persons or entities. In the context of water management for industries, water is seen in terms of economic value; whereas for a fisherman or a sailor water is as valuable as his own life.

Indian philosophy considers water as an economic, environmental, social and spiritual good, but water is not evaluated separately in each of these valuation concepts. Indian philosophy, like similar philosophies throughout the world, considers it as the most valuable natural resource to be shared and cared for. In the Indian way of thinking, both standing and flowing water have always been considered as the most vital common property to be shared by all that inhabit the region around a particular water source. Water has often been valued on par with livestock in ancient India. It has been stated, 'Water is equivalent to the cattle wealth' (Rig Veda, 10/19). The value of water evolves along with the changing economic system in an evolving society. Table 1.1 shows the value of water for different entities.

Table 1.1 Value of water.

System	Value	How valued
Ecosystem	The most essential fluid necessary for sustenance.	Valued as a natural asset and invaluable resource, hence it needs protection. The cost of conservation.
Human society	Water has a great social and entertainment value. It is also essential for religious activities. Ownership of a source of water is also an asset.	The value in terms of price or the cost of making it available for use, such as revenue paid to the municipal water supply or the cost of installing a personal tube well, pump and distribution system and cost of maintenance. The price of bottled water.
Farmers	Water for irrigation is essential for farming. Farmers value water in terms of crop production.	A commodity, irrigation has a cost. Valued as the cost of lifting or purchasing water from the irrigation authority or from the private irrigation service provider.
Business	Considers water as an economic good and natural capital.	Water has a cost; it can earn revenue and enhance brand value. The cost assessment at every stage of the business value chain is essential.

1.4.1 Water valuation

The Dublin Statement on Water and Sanitation Development pays attention to the economic value of water (United Nations, 1992a). Principle 4 states:

> Water has an economic value in all its competing uses and should be recognised as an economic good. Within this principle, it is vital to recognise first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognise the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources.

Water value is not a simple generic term, but a term that has different meanings for different people. Water value changes not only with time and space but also with social and political changes. Industries are more concerned with the economic, rather than the social and ethical values of water, a fact which might turn into a costly liability to business. If such values, apparently abstract, are neglected or treated with little seriousness, society itself becomes a threat to the project. For example, a site selected for water withdrawal from a river may be a place of worship, which can interfere with business plans.

Morgan and Orr (2015) have proposed a balance-sheet approach to water valuation. In their model they have included (a) on to the asset side, corporate water-related-built capital for both green and grey infrastructure, ownership of water reserves, community goodwill, brand value, social value and assets created through operation; and (b) on the liability side, water-related social and legal liabilities.

The move from 'water management' to 'water stewardship' includes the consideration of values in an upstream supply chain, industrial operations, and downstream product use (Sarni, 2015). The business world looks upon

water as a form of a commodity that needs an appropriate valuation. At every stage of operation, capital investment and recurring costs are involved. The World Business Council for Sustainable Development (WBCSD) defines water valuation (WBCSD, 2013) as the amount an individual is willing to pay for it, regardless of whether it is for social or economic purposes. In industry, the value of water is understood to be the expenditure incurred to procure it, cost for conservation, and cost for implementing water-related programmes under corporate social responsibility, maintaining a trade-off between the corporate body and stakeholders. These costs are measurable in terms of money and the volume of water purchased.

Another method of valuation is based on the cost of water productivity in USD for each kilolitre of water consumed. This valuation varies from one country to another depending on geographical and climatic conditions (e.g. temperature and evaporation), the cost of raw materials, market conditions and willingness to pay by the market (which is, of course, sensitive to USD exchange value in the country concerned). In most countries, the true value of water is not tagged with the product, and its cost is not recovered from the market. This practice can be greatly improved by adopting water stewardship and technological advancements in extraction and recycling of water.

Valuation of water, either as product or service is calculated according to the value it carries in its life cycle. The valuation is calculated with three variables; namely cost, value and price. Cost involves manufacturing or procurement expenditure. For example, the cost of production of one litre of bottled water sourced from a lake involves expenditure on withdrawal, purification and bottling, which amounts to USD 1.2 which is then sold at USD 2.5 to generate revenue and is price-tagged accordingly. In other words, the value of that one litre of bottled water is the purchase price. Such valuation based on production cost and selling price is not applicable to cultures that inhabit arid regions, where there is little difference between water and blood. Among the three aforementioned parameters, the value of water can only be appreciated from the lifestyle of people that inhabit climatically water-starved regions, such as the Kalahari.

1.4.2 Application of water valuation

One must note however that there is more to the world than the Kalahari. Globally, water valuation has several applications in industries as indicated by the WBCSD (2013) document on water valuation. Efficient water stewardship builds upon how an industry values its water resources in improving its business, delivering essential services to society and building a reputation for effectiveness in resolving problems. Water valuation helps industries to consolidate its relationship with both community and regulatory bodies. The main drivers in water valuation are:

a The role of water in proposed investments.
b Application of new technologies in water treatment, use, reducing loss and tracking unaccounted water consumption. This will generate more value per unit volume of water consumed.

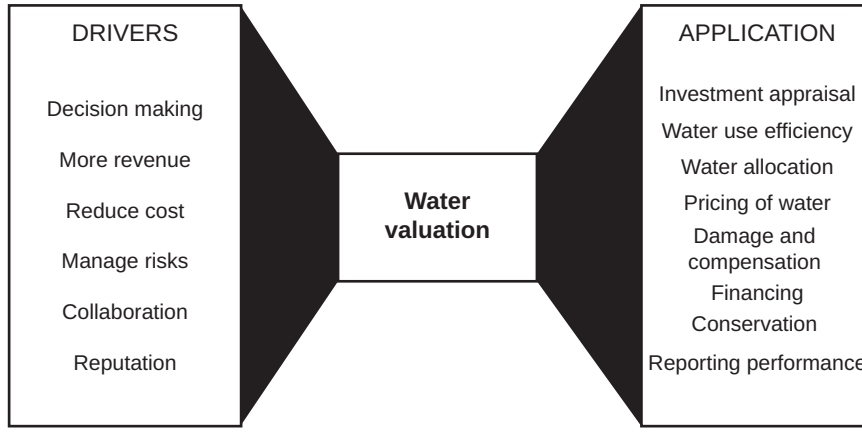

Figure 1.4 Drivers and applications of water valuation. Adapted from WBCSD (2013)

c Quantified need-based water allocation to different sectors of business.
d Water valuation is vital to quantifying the cost of domestic water consumption against revenue earned by water consuming industries (Porter and Kramer, 2011).
e Water valuation determines the pricing of domestic water usage, water services and products.
f Governments are known to charge users for polluting or damaging the environment (Wabunoha, no date). Water evaluation is essential for calculating damage compensation.
g Help in sustainable financing to create enabling environments (United Nations, 2014b).
h Water valuation is helpful in the assessment of impacts, where businesses must take conservation actions to offset degradation (Kreitler *et al.*, 2015).
i Water accounting and disclosure requires water valuation.

The drivers and application of water valuation in business are shown in Figure 1.4.

1.5 Water and energy nexus

Water and energy are closely related and interdependent. Availability and predictability of water resources can directly affect energy systems. Energy is required to withdraw water from wells, bodies of water, rivers or any other sources or storage. Without energy, water can neither be drawn nor transported from the place of collection to the point of use. The energy input may be mechanical, electrical or manual. The household perception of water transportation is from ground-level storage to the overhead tank, for which a one horsepower pump will generally suffice. 'Each kilowatt-hour (kWh) of thermoelectric generation requires the

withdrawal of approximately 25 gallons of water' (US-EPA, 2016a). Outside the cosy world of household needs, water transportation is enormously energy intensive; irrigating a wheat field, for instance, consumes a lot of power. It takes about 3.5 kW to lift 4000 gallons or 20 kilolitres of water from a low duty deep tube well in India. Torcellini, Long and Judkoff (2003) in a report of the US Power Department states, 'Eighty-nine per cent of electricity in the United States' is produced from thermal power plants. Thermal power plants use water for cooling. On an average, '1.8 litres of fresh water is evaporated per kWh of electricity production' and is considered fit for consumption. In hydroelectric power generation, water evaporates from the reservoir surface. 'In Arizona, for example, 7.85 gallons is lost to evaporation per kWh of power consumed' (US-EPA, 2016a). The power generation–water supply system may sound tautological because water is crucial to power generation and power is crucial to the water supply.

Needless to say that the tautology is broken by the fact that power generated by water usage is much more than the power required for water supply, but the tautology nevertheless highlights two very important points:

1. Water loss in either stage, i.e. during power generation or water supply, puts pressure on the water source, which in turn through a circuitous route puts pressure on the pocket. And most importantly,
2. Integration of agencies responsible for water-energy policy formulation with planning management agencies.

Resolving water and energy-related issues, and conservation of both in a complementary way has been put on the priority list by many industries in advanced countries. Big industries are trying to conserve water by investing in technologically advanced cooling systems, and by recycling and reusing treated effluence. A beginning has been made. But, the key question is whether corporate social responsibility (CSR) and water stewardship are functioning at par with the scale of the problem created by the corporate sector? Clearly not, as is plainly evident in the familiar picture of thousands of dead fish floating belly up in polluted rivers. Even more shocking is the post-modern phenomenon of farmer suicide in India in water-starved regions; strangely, the phenomenon started contemporaneously with economic reforms in 1990. World trade has brought together the affluent 'Global North' and its poor country cousin the 'Global South' to an interdependent platform. This interdependence has to expand beyond profit making and include sustainable use of water. That is the essence of water stewardship.

Water constraints lead to energy constraints. The vulnerabilities may arise from a depletion of quality and quantity of source water. Climate change can lead to water crises resulting in a reduced river flow or depressed groundwater levels. The water allocation policy of the government can do much to help in this direction. For example, the government of Chile is very strict regarding water allocation rights to the mining companies. A few years back, a copper mine, Xstrata's Collahuasi, was directed to reduce

water extraction from 750 litres per second to 300 litres per second (McKinsey, 2009). The company was forced to invest in alternative technologies to adapt to the reduced supply.

Population growth, consequent rise in food production and especially, urbanisation, with its wasteful water consumption habits, put enormous stress on water and energy requirement. There are several scenarios conceived by scientists and planners to reduce the stress.

The International Energy Agency (IEA, 2014) has modelled the world water withdrawal and consumption in a country-wise manner from 2010 to 2035. Taking 2010 as the baseline, it is estimated that the water withdrawal may increase by 0.7% in 2035 whereas consumption of water will reduce by 1.2%. The reason for reduced consumption is attributed to the development of water conservation technologies. In European industries, water withdrawal and consumption are estimated to decrease by 0.9% and 1.4% respectively; whereas in the USA both withdrawal and consumption may increase by 0.1% and 2.5% respectively. Industrial growth in India will result in an increase in both withdrawal and consumption by 1.6% and 3.5% respectively. At present, industrial water consumption in China is almost 2.5 times higher than that of India; water resources in China are likely to be further stressed by a 3.5% increase in consumption. The world figure of water withdrawal and consumption is shown in Figure 1.5.

Clearly, water consumption in relation to global energy demand is increasing at an alarming rate and firmly heading towards the limit of sustainability. Some large industries are trying to conserve energy to minimise their water requirement. The US Department of Energy has identified six strategic pillars to provide the necessary support to water-energy nexus.

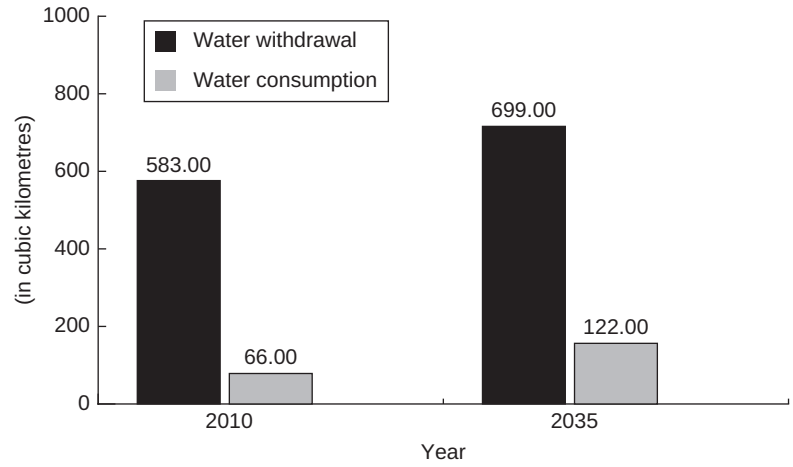

Figure 1.5 Predicted change in water withdrawal and consumption for industries from 2010 to 2035. Based on Shiklomanov (2000).

1.5.1 Impact of energy production on water resources

Hydroelectric power

Hydroelectric power plants utilise the potential energy of upstream water in reservoirs to drive turbines; the water then returns to the river downstream. Thus, hydroelectric power generation per se does not consume water (Davies *et al.*, 2009). But, by the construction of dams, reservoirs and diverting the natural flow, hydroelectric power plants do affect the natural order, notably by increased evaporation from reservoirs and submergence of vast areas in the upstream tract.

Thermal power

Thermal power plants, on the other hand, consume water in the cooling towers. Water consumption can be reduced by investing in improved cooling technology, but there is another factor involved. The higher temperature of water discharged from cooling towers increases ambient temperature causing thermal pollution of the environment.

Bio-fuel

Bio-fuel production sounds environment-friendly, but it needs large quantities of water.

Bio-fuel was initially championed as an environment-friendly alternative, but switching from fossil fuel to bio-fuel did not go down well with the automobile industry. Additionally, bio-fuel production is a big consumer of water. Consumption of water per litre of bio-fuel production is estimated by FAO (2008) as 2000 litres for sugarcane, 1357 litres for maize, 2364 litres for oil palm and 3333 litres for rapeseed; 30 to 50 litres of water is required per Giga Jule (GJ) energy yield. Also to be taken into consideration is water contamination caused by fertilisers and pesticides in bio-fuel crop cultivation. But, for all that, bio-fuel remains a formidable contender to replace fossil fuel, awaiting design improvements in internal combustion engines and improved agriculture.

Mining

Water use in energy and mineral mining is also an important factor in understanding the water-energy nexus since a good deal of water pollution also happens in mining. Water use in mines and attendant pollution are given below:

- **Oil and gas:** Water is used for drilling, hydraulic fracturing, oil-sand mining and in refineries. Secondary and enhanced oil recovery also consumes a substantial amount of water. Water pollution takes place from seepage and the produced water, contaminating both groundwater and surface water.
- **Coal:** Coal mining is a big user of water. Mechanical cutting of coal and related dust suppression need water. Water is also required in coal washing. Mining drainage and produced water are the main contaminants.

1.6 Global water stress

Annual water resource (AWR) and the need for improved technology are facing water-related stress trying to keep pace with population growth. The problem is global, but the magnitude of the problem is specific to each country. The human development report of the United Nations (UNDP, 2006) reveals that water overuse is the main cause of environmental degradation. As a result, major river basins are suffering from widespread and intensive agriculture development. Large river basins in China, India and North America are victims of rapid urbanisation and industrial growth. Most of the rivers in China are polluted by industrial waste; the scale of pollution can be appreciated from the fact that over 26 billion tonnes of wastewater was discharged into the Yangtze River in just one year (Aiyar, 2007). Hydrologists and social scientists define water stress in many ways and have tried to classify countries according to the stress on freshwater resources. Therein lies the communication gap. Evaluating freshwater depletion rate and contamination levels can only be measured in numbers, which do not make sense to the poor people from rural areas who are always positioned at the receiving end of the water problem. What the rural poor do understand is the fundamental truth, and, as opposed to numbers, they understand it from increasing physical hardship in everyday life as a consequence of the degraded environment. It is a world divided by scientific elitism. For effective water stewardship, it is incumbent upon social scientists to build a language bridge between the rural poor and scientific water conservation.

One of the popular indicators of water stress and scarcity is the Falkenmark indicator. It is perhaps the most widely used measure of water stress. Under this index, countries are categorised into no stress, stress, scarcity, and absolute scarcity areas (Table 1.2). The index thresholds 1,700m^3 and 1000m^3 per capita per year are used as lower limits of water-stressed and scarce areas, respectively (Falkenmark, Lundquist, and Widstrand, 1989).

The renewable freshwater resource of a country derives from the geographical, geological and geomorphological character of the territory, and as such the renewable freshwater resources of a country are more or less fixed. But the demand is ever increasing due to growth in different sectors.

Table 1.2 Water barrier differentiations.

Index (m^3 per capita)	Category/condition
>1,700	No Stress
1,000–1,700	Stress
500–1,000	Scarcity
<500	Absolute scarcity

Source: Falkenmark, Lundqvist and Widstrand (1989)

Shiklomanav (2000) estimated the renewable freshwater resources of various countries and calculated the per capita availability in each of the countries. His data was based on 1995 statistics.

Another scarcity index has been proposed, which compares annual water withdrawals relative to total available water resources (White, 2012). Using this approach a county is called water-scarce if annual withdrawals are between 20–40% of annual supply, and severely water scarce if they exceed 40%'.

A third approach to measuring water scarcity has been proposed by IWMI, which considers the water infrastructure, consumptive use and adaptive capacity of a country (White, 2012) as guiding factors. Using this approach, countries are classified into four groups (Seckler *et al.*, 1998) based on the growth percentage of water withdrawal (between 1990 and 2025). Group 1 consists of countries where water withdrawal is higher than 50% of the annual resource. Countries belonging to Groups 2 to 5 have water withdrawal less than 50%. Countries rated between 2 and 5 have been further classified on the basis of growth percentage. According to the development rate, countries that fall under Group 2 have more than 100% growth, Group 3 has 25 to 99% growth, Group 4 has growth below 25%, and Group 5 are countries having no, or negative, increase in projected water withdrawals.

Luo, Young and Reig (2015) measure water stress in terms of total annual water withdrawal (municipal, industrial and agricultural) expressed as a percentage of the total annual available blue water. Higher values indicate more competition among users. The classification is shown in Table 1.3.

Figure 1.6 shows the world map with countries classified according to the stress index.

'Aqueduct' is a water-related data portal that accumulates and disseminates water information by country. These data and information are also available as GIS-based interactive maps, which are very helpful to decision makers at the country level. Aqueduct utilised spatial aggregation methodology that projects sub-catchment level data onto the country level. The scope for modelling with Aqueduct enables the user to score 167 countries under the 'business-as-usual', 'pessimistic' and 'optimistic scenarios' for the years 2020, 2030 and 2040.

Table 1.3 Water stress index.

Score	Value
0–1	Low (<10%)
1–2	Low to medium (10–20%)
2–3	Medium to high (20–40%)
3–4	High (40–80%)
4–5	Very high (>80%)

Source: Luo, Young and Reig (2015) Printed under CC BY 3.0 licence.

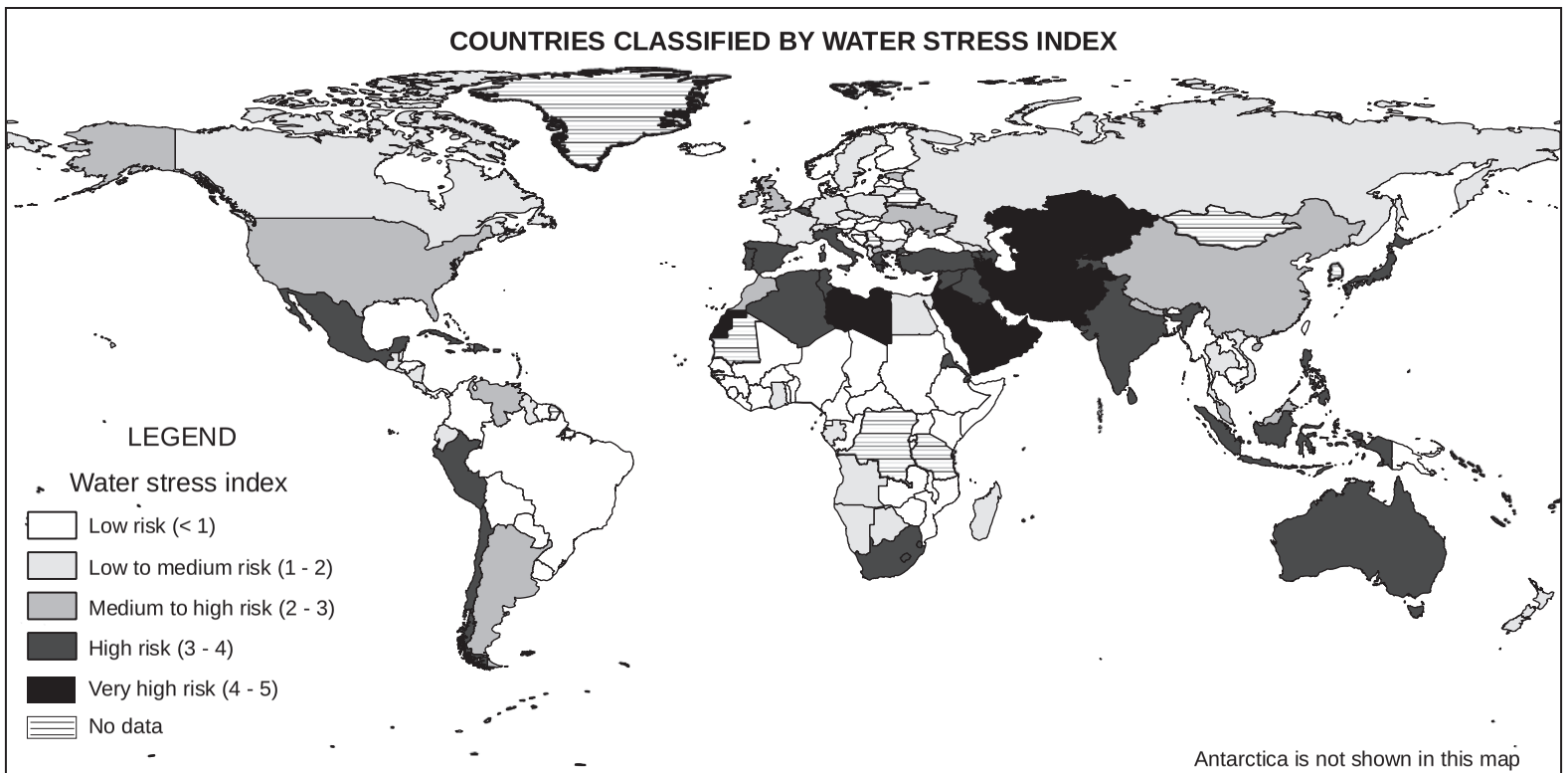

Figure 1.6 Map of countries classified according to the stress index. Data source: Luo, Young and Reig (2015).

1.7 Industrial impact on water resource

Industrial activities in a watershed have water-related impacts that a company needs to address in all stages of its value chain. These operations are as follows.

1.7.1 Impact on the quantity of the source water

One of the most challenging local water issues that arise from industrial modification of surface cover and high water withdrawal is the depletion of the quantity of water in natural ecosystems. For instance, high growth in the brown sector economy (tourism, hotel, power generation) in Kathmandu Valley has covered a large part of groundwater recharge zone of the valley by 'impervious roads and buildings for commercial and residential purposes' which has already posed a threat to the groundwater. Groundwater level, as a consequence, has dropped from 9 metres to as deep as 68 metres within a couple of decades as observed in 2001. The issue will develop social, ecological or regulatory challenges when companies will have an increasingly difficult time accessing water and may face reduced and/or unreliable water allocations.

1.7.2 Hydro-morphological impact

Hydro-morphological impact (Eleftheria *et al.*, 2004) is defined as a set of impacts on the land surface due to the creation of water infrastructures that change the direction, volume and hydrological activities of a flowing water resource. The morphological impact is also visible when modified river courses increase either erosion or deposition in its channel. A classic example of an adverse impact of constructing dykes on the embankment of a river can be given: The embankment on the Tista River has increased deposition on the river bed, thereby raising both the river bed height and the flood level. The river is now flowing at a height much above its original floodplain.

Over-exploitation of groundwater often triggers geomorphological changes like land subsidence. For example, 'in the United States, more than 17,000 square miles in 45 States, an area roughly the size of New Hampshire and Vermont combined, have been directly affected by subsidence' (USGS, 2016).

1.7.3 Quality impact

Industrial activities do change the water quality of the environment. In 2011, the Chinese government monitored water quality of rivers and found that 43% of rivers are so polluted that they are dangerous for human contact (Hays, 2013); needless to say, rivers so polluted have caused irreversible

changes in the ecology in terms of species extinction. Contamination of surface water (and groundwater) by industrial effluents is a well-known killer as evident in the news of thousands of dead fish floating belly up in ponds, lakes and rivers.

1.7.4 Impact on the access to water by the stakeholders

Allocation of water resource as a whole is a point of serious concern for the community. The leasing out of rivers for industrial use deprives common people of their traditional water sources. In March 2007, the Chhattisgarh government was taken to court 'for allowing a private company to appropriate the waters of the Sheonath river' (Putul, 2012) because the people were not allowed access to the river for their daily water needs.

1.7.5 Affordability of water

Depletion of water resources has an adverse economic effect on the poor, especially on communities in water-stressed regions. The affordability issue develops into a socio-political conflict when the poor are compelled to search for alternative sources, which are either costlier or labour intensive. In the face of such hardship, the poor continue to grapple until their backs are against the wall, giving rise to conflicts.

1.8 Water sustainability

Water is an integral part of the environmental sustainability since it plays a vital role in the survival of nature, which includes not only our planet Earth but also the human enterprises that thrive on water sustainability. Whether the human enterprise is sustainable or not can be understood from certain indicators which are explained by US-EPA in *A Framework for Sustainability Indicators at EPA* (Fiksel, Eason and Fredrickson, 2014). Sustainable business enterprise rests on the harmonisation of three components: (1) The environment, as a source of water and other natural resources; (2) the society, which shares water and other natural resources with business enterprises, more often than not grudgingly because environmental degradation it causes; and finally, (3) business enterprise itself, which is profit-driven and draws equally from both environmental nature as well as human nature for its economic potential.

'Sustainability is based on a simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. To pursue sustainability is to create and maintain the conditions under which humans and nature can exist in productive harmony to support present and future generations' (US-EPA, 2016b). US-EPA has proposed a taxonomic system for resource flow indicators, with

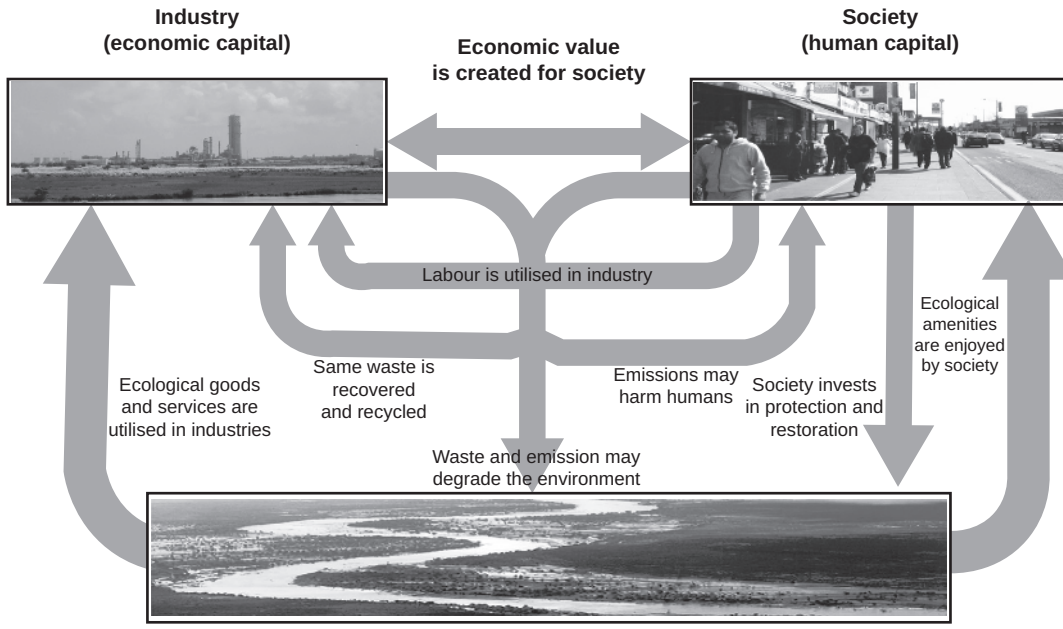

Figure 1.7 System taxonomy for resource flow indicators, with examples of specific metrics for material intensity, recovery and impact. Adapted from Fiksel, Eason and Frederickson (2010).

examples of specific metrics for material intensity, recovery and impact. See Figure 1.7.

The essential conditions for achieving a state of 'comfortable business' are continuous assessment of opportunities and risk, maintaining efficient water stewardship and compliance with all regulatory statutes. The risk-opportunity matrix in water sustainability is given in Table 1.4.

Sikdar (2003) has described sustainability as a function of (1) the economic aspect, (2) social aspect, and (3) environmental aspect. Where economic and social aspect are functioning then only socio-economic sustainability is achieved. See Figure 1.8.

Apart from economic, social and environmental aspects, two other aspects that are essential for consideration are the political and technological aspects. In several cases, especially in developing countries, political interventions account for multiple hindrances for maintaining smooth business operations. For example, a company has conducted a socio-economic survey in its area of operation and decided to extend a drinking water facility under a CSR scheme in selected villages. However, this move might not be politically approved, and political interventions may compel the corporation to modify its decision.

Technological advancement is often counted on for achieving sustainability through tools, data and instruments for resource estimation and environmental impact assessment. Remote-sensing data and advanced mapping tools can be of great help in finding suitable resources and estimating the capability of the resource to cater to the projected requirement. For example, (a) installation of meteorological observation systems on the company

Table 1.4 Risk and opportunity matrix in sustainable business.

Risk	Opportunities	Response
Deterioration of source-water quantity and quality	Re-creating business value of water	• Rainwater harvesting • Source-water protection measures
Rising cost of water	Investment in improved engineering and management solution in the value chain	• Water audit and water conservation measures • Reduction of water footprint
Change in water allocation status	Advocacy and lobbying with the authority	• Adapt to the new condition
More stringent government regulations	Improving water accounting and disclosure systems	• Engagement of experts • Training of staff
Stakeholders' resentment	Stakeholders engagement in water stewardship	• Promoting the wellbeing of the local workforce by providing better water and sanitation in the communities surrounding the factories (WSUP, 2015) • Engage employees to deliver on water goal

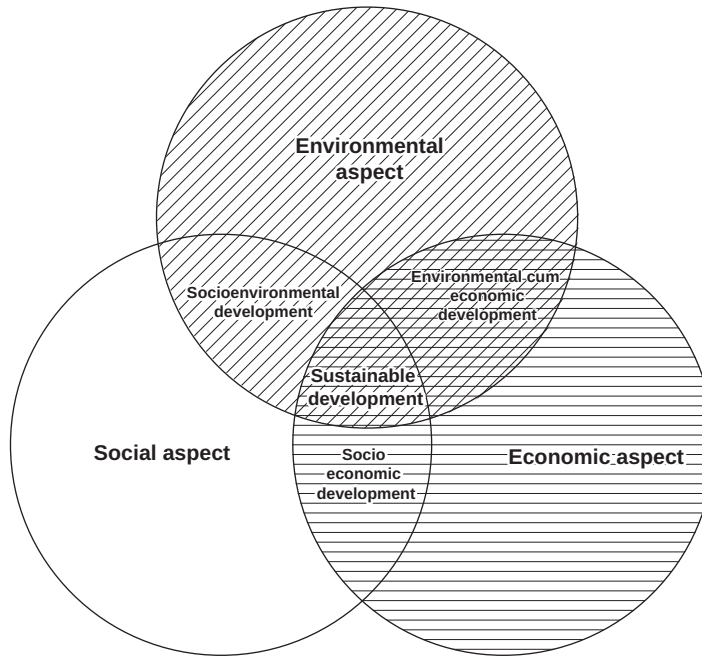

Figure 1.8 Three-dimensional pillars of sustainability. Adapted from Fiksel, Eason and Frederickson (2010).

premises will empower management with valuable weather data, and (b) an observation well in the company's area will help to monitor the fluctuation of groundwater level, which will further help them to decide groundwater withdrawal plans.

1.9 Impact of climate change

The US-EPA (2013) has defined climate change as 'substantial change in measures of climate (such as temperature or precipitation) lasting for an extended period (decades or longer).' Climate change is a naturally recurring phenomenon connected with variations in solar radiation. The earth has gone through several cycles of ice age followed by warm climate over the last couple of million years. This is known from shreds of geological evidence. The US-EPA definition of 'climate change' derives from alarm bells that scientists have been ringing since the 1980s; scientists believe that the climate change we are witnessing now has more to do with unregulated industrial activity than the periodicity of solar activity.

The present-day climate change is manifested in several phenomena, such as a rise in average global temperature, sea level rise, warming of oceans, retreating glaciers and shrinkage of ice caps. Extreme climatic events like drought and flood are on the rise because of global warming. The print and electronic media and, of course the internet, is rife with 'pop science' articles on global warming caused by greenhouse gases, notably CO_2. Scientists estimated that since the Industrial Revolution, atmospheric CO_2 has gone up by 40% from 280 ppm in the mid-18th century to 407 ppm as of 2016. The present concentration is estimated to be the highest in the last 800,000 years. The CO_2 increase is largely due to the burning of fossil fuels and deforestation. There are scientists who are critical of the alarmist approach to global warming, which they consider lead to hasty conclusions founded upon inadequate or misinterpreted data. But the majority believes, me among them, that it is better to err on the side of caution and take preventive steps. Blessed is he who sits on a pin for he shall rise again—a little moderation in programmed power consumption worldwide will go a long way in reversing the anthropogenic causes of global warming. Consider, for instance, the millions and millions of marginal people inhabiting coastal regions and low-lying countries (e.g. Bangladesh) who live under the threat of being rendered homeless by inundation because the sea level is rising at the rate of 3.38 mm per year (NASA, 2016). They may not drown after all, but what good can scientific integrity, critical of alarmists, do to relieve them of the anxiety of drowning?

The world climate is a chaotic phenomenon; that is, it is delicately balanced on the interdependence of multiple variables, all of which are so far beyond accurate measurement-capacity of present-day technology that the climate is extremely unlikely to become a deterministic phenomenon in the foreseeable future. What science does conclude at its present level of understanding is that even local problems can have ripple effects and cause catastrophic changes in the hydrological cycle, which in turn affect the monsoon cycle. And, adverse effects on the monsoon cycle can wreak havoc on water-dependent economies. Indeed, Mr Pranab Mukherji, the former Finance Minister (and now the President) of India, once said in his budget speech in Parliament that 'the monsoon is the real Finance Minister of India.' That statement sums up the scale of the problem water shortage can cause. Suffice it to say that any water crisis is creating problems within and between countries, and these problems will get deeper by the day if not brought under the umbrella of water stewardship.

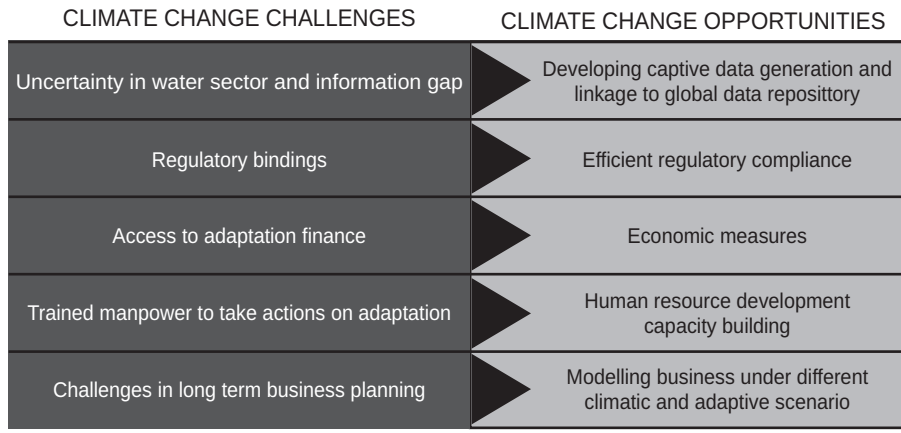

Figure 1.9 Climate adaptation framework for business. Adapted from United Nations (2015).

Industries are now aware that any water crisis cannot be mitigated without addressing climate change. 'Just as business operations are important, it is imperative to consider the impact of climate change on business operations, and potential impacts on sustainability', says ICIMOD (2016). Countries under the framework of the United Nations discussed water crisis in a convention on climate change in 1997. In that convention, an agreement named the Kyoto Protocol (United Nations, 2014a) was signed by the parties to agree on internationally binding emission-reduction targets. This protocol entered into force in 2005. This protocol is mostly binding on the industries.

If the climate change impact is not properly understood, business will face challenges as never before. The major challenges they will face are uncertainty in water availability and extreme climatic conditions like flood and drought. It is the right time for industries to address climate change in their business policy and business models.

The impact of climate change and the binding rules imposed by different regulatory authorities have a direct impact on business and have the potential for managing both challenges and opportunities. Corporate adaptation to climate change can make business more sustainable and socially responsible (Four Twenty Seven, 2012). Responsible corporate adaptation to climate change is a function of several parameters in the business environment. Climate adaptation framework for business is shown in Figure 1.9.

1.10 Dimensions in industrial water management

The famous remark of Mahatma Gandhi bears repeating in this context: 'The world has enough for everyone's need, but not enough for everyone's greed' because the quest for sustainable development rests on the nexus between government and big business promoting competitive consumerism, and the nexus rests fundamentally on the frenetic pitch of media advertisements. Manifestly, the combined wisdom of governments and big

business believe in brinkmanship. The nexus works on the principle of blurring the difference between credit society and inclusive economy. Nothing illustrates the ills of advertisement-promoted consumerism like the phenomenal growth in the sale of, and, misuse of android phones among rural youth. What we are witnessing now is a paradigm shift from the invisible hand to water conservation, gradually tightening its grip on economic growth, a shift balanced on the introduction of water stewardship. Water stewardship is not about crippling economic growth by cutting off the water supply to industries; rather, it is about harmonising all end users of water across economic boundaries. As things stand now, it is more or less a rule of thumb that rich countries will reduce water stress by technological intervention without remedying underlying causes (Vörösmarty *et al.*, 2010), and, technologically deficient poor countries will continue to suffer. It is an extreme form of the false science of Social Darwinism because it justifies denying the poor (80% of the world population) of something as fundamental as water. Water stewardship is a multidisciplinary science that aims to correct the disparity in water availability.

The paradigm shift in water withdrawal from pro-growth to pro-ecology is taking only baby steps due to the constant efforts of pressure group researchers and activists. Pioneers of the pro-ecology movement fought for reform because they believed that the destruction of forests, fertile soil, wildlife and water resources would lead to the downfall of society (Chapman, 2010). During the 1970s, the face of environmentalism shifted to civil action with special-tactical groups forcing environmental issues onto the national agenda. After several global conferences on the environment and three major environmental summits, protection of water resources, maintaining the quality of runoff and protection of soil quality became major conservation issues.

Although the environmental movement started with the participation of focus groups from the educated middle class during the 1980s, local environmental groups draw their members from a broad cross section of class and occupational categories (Freudenberg and Steinsapir, 1991). Not only in America but also in the developing countries, movements against water pollution and environmental degradation were launched by heterogeneous organisations comprising activists, science clubs and, most importantly, local people.

Another major driver of the environmental movement was the blossoming of *Not in My Backyard* or the NIMBY campaign (Freudenberg and Steinsapir, 1991). Industries became the major target of environmental activism. The case against the Sundarban Fertiliser Company is an example of an environmental movement initiated by common people. The movement started in the mid-1980s before the establishment of industries in a thickly populated village in South 24 Parganas district of West Bengal (Dutta Banik, Basu and De, 2007). The movement was organised to protest against the construction of the proposed factory, stating that it was (1) close to thickly populated villages, (2) impinging on agricultural land, (3) close to an important waterway in the integrated network of Sundarban, and (4) within a mile of a deep tube well, which was the main source of drinking water for the entire area. The business

community must recognise that resources must be conserved with utmost care and business expansion should be restricted to the extent of ecological limit (WBCSD, 2010).

Gleick (2000) has proposed 'two approaches' in water management, which include an increase in efficiency, both to meet the current needs as well as to develop the water allocation system. This may demand new sources of water supply, which can be met by innovative approaches and small projects in water sourcing. Best results will come from capacity-building in the corporate sector in terms of internal water management and source-water management. Both hydrological and engineering knowledge-bases are necessary to meet the requirements for efficient water management.

The major focus areas in corporate water management are summarised below.

1.10.1 Global perspective

There are companies which have factories and production centres distributed across many countries. Moreover, in their supply chain, they procure products from many countries. These industries must recognise that the impact of their activities on water resource is not a local issue anymore. It has to be addressed in a global perspective as well as with mitigation programmes at every point of the operations. Assessing local and global water situations along with political and regulatory issues is very important for multinational companies. This will help them to take informed decisions on how and where interventions are required to improve the machinery, management, relations with stakeholders and community, and vision towards corporate water stewardship.

1.10.2 Water accounting

This is one of the major tasks the industries should perform periodically. In developed countries, water accounting has been mandated through several business codes of conduct and methodologies. Water-footprint study will also help industries in assessing their impact on global and local water situations, both quantitatively and qualitatively. In developing countries, the concept is just emerging. For example, in India some of the major companies like Lafarge, Tata Motors, Tata Chemicals and extracting industries like Essar have started water audit and water footprint study. The minister of railways, India, has ordered water audits to be performed in all railway stations (*Deccan Chronicle*, 18 November 2014). Through water audit within the facilities and ancillary infrastructure, the risks of water loss can be assessed. An industry can benchmark its water use for processing, cooling and housekeeping. The water footprint is a tool to assess the amount of real and virtual water use in the supply chain, product life cycle and the environmental impact of discharge in terms of grey-water footprint.

1.10.3 Water stewardship

Corporate water stewardship is an approach of the companies to identify and manage water-related business risks especially, in the context of shared water. Protecting water resources in a sustainable way comes under the purview of corporate stewardship. In a water-intensive industry when public water governance cannot ensure water security, corporate stewardship can play a big role in achieving the water sustainability of the locality with the participation of stakeholders. Throughout the supply and production chain, water plays a pivotal role. Thus, conservative, judicious and time-specific actions are crucial to successful businesses, and so they have to set specific goals to eliminate, as far as possible, water wastage by modernisation of machinery, capacity building among staff and the setting of targets for water-related CSR activities, all of which are to be periodically checked by success indicators to determine the progress of water management.

1.10.4 Adaptive management

Adaptive management of water is a new paradigm that refers to a complete system of water management which includes all interconnected systems (Pahl-Wostl *et al.*, 2007) like water withdrawal, purification, allocation, licence, consumption, discharge and so on. It fulfils a complete set of social and economic functions. Adaptive management also includes social behaviour, legal requirements and institutional arrangements. It deals with both the organised sector and the unorganised sector. Adaptive management of water use is an inclusive management that covers three components related to water. These are (1) human components that actually pursue water-use solutions through engineered and social methods, (2) physical components that regulate water availability in time and space through the water cycle, and (3) biological and geochemical components. According to Pahl-Wostl (2006), the idea of adaptive water management refers to a systematic improvement of water management, policies and practices by learning from the experience gathered from the present system of management.

1.11 Green growth and green business

The term *green growth* was adopted in the *G20 Seoul Summit Leaders' Declaration* (2010). Green growth is a strategy of quality development, enabling countries to leapfrog old technologies. International cooperation in technology transfer and capacity building were also among the major issues, discussed in the summit.

The term *green growth* is used in the policy statement of a government or a business to describe a path of economic growth that uses natural resources in a sustainable manner. The term is used globally to provide an alternative to economic growth through ecologically destructive industries. Different

global-level organisations have defined green growth in different ways, but all of them have advocated three basic points: (1) it is a policy, (2) it aims at the well-being and improvement of humankind coupled with steady economic growth, and (3) it fosters social equity.

The concept of green growth is applicable to every sphere of human activity starting from a single individual to the level of the national government, in which the role of the former can hardly be overemphasised given that the world population is in excess six billion people. Needless to mention, domestic water wastage is, in most cases, an act of the privileged population. For example, reused water draining out from the kitchen sink or an unplugged bathtub used for gardening is, in a microcosm, a green growth model. On a larger scale, green growth policy requires big businesses to adopt production methods that do not affect the needs of marginal people and protects ecologically sensitive locations. According to the usual scenario, green growth, at this stage of economic growth and business, has to face many challenges.

1.11.1 The challenges of green growth

The most impacting challenges of green growth are discussed below.

Fund

Retrofitting existing technology for improved water and energy conservation needs a good amount of capital investment. A successful application of policy must pay it back within a reasonable time.

Government policy

Government support to green growth should be based on *suo moto* policy framing (as opposed to being a consequence of public agitation). It may well require constitutional amendments in a country. For example, Ecuador has included in its constitution a clause establishing the 'Right of Nature' which is a radical improvement over regulatory laws and empowers green growth drives (Global Alliance for the Rights of Nature, 2016).

Business policy

Corporate sectors should also include green growth proactively in their business policies and involve their employees, supply chain and stakeholders to subscribe to those policies.

Natural capital

Water is one of the major natural capitals of business. Conservation of natural capital is a major challenge in business intended for green growth.

Climate

Climate change or climate impact may have serious effects on water resource and hence, on business.

Green growth is a concept that embraces stakeholders of almost every sphere of the society. The government will act as the maker of policy and law, and remain vigilant about the implementation of the laws. The potential risks in implementing green growth policy are inefficiency, corruption and poor accountability at government level. This may lead to excessive environmental degradation in many countries (Barbier, 2011).

1.11.2 Natural capital concept

According to Dasgupta (2007), the ecosystem, like road, bridge and other infrastructures, is to be viewed as a capital asset but it differs in three ways: (1) depreciation of natural capital is frequently irreversible (or at best the systems take a long time to recover); (2) except in a very limited sense, it is not possible to replace a depleted or degraded ecosystem by a new one; and (3) ecosystems can collapse abruptly, without much prior warning. Mining of minerals, oil and so on is an example of depreciation of natural capital.

Increasing costs associated with diminishing natural capital assets are not reflected in the market. The price of any product, whether it is coming from a managed or degraded ecosystem does not carry any indication of the environmental impact caused by its production. The idea is to give the brand's conscious consumer, a choice. If a green product (i.e. where the manufacturing process is eco-friendly) is labelled suitably to indicate its eco-sensitive manufacturing as brand value, consumer preference will directly incentivise green growth.

1.11.3 Green growth policy fundamentals

A green growth policy of a country must ensure:

1. Strong and efficient governance that considers the ecosystem as natural capital and remains vigilant that the natural capital is exploited in such a way that environmental recovery is amenable to natural processes.
2. Every developmental project of the corporate sector must recognise that the impact of development is not local; it affects the ecosystem as a whole. In addition to local effects, business planning must act as a crucial factor in effects on the river basin as a whole.
3. Economic factors should be considered in a manner that accommodates the full spectrum of interests (*Water and green growth*, 2012).
4. Active public participation in water stewardship and ecosystem restoration.
5. Ensure availability of potable water for every member, as a part of their fundamental rights. See Figure 1.10.

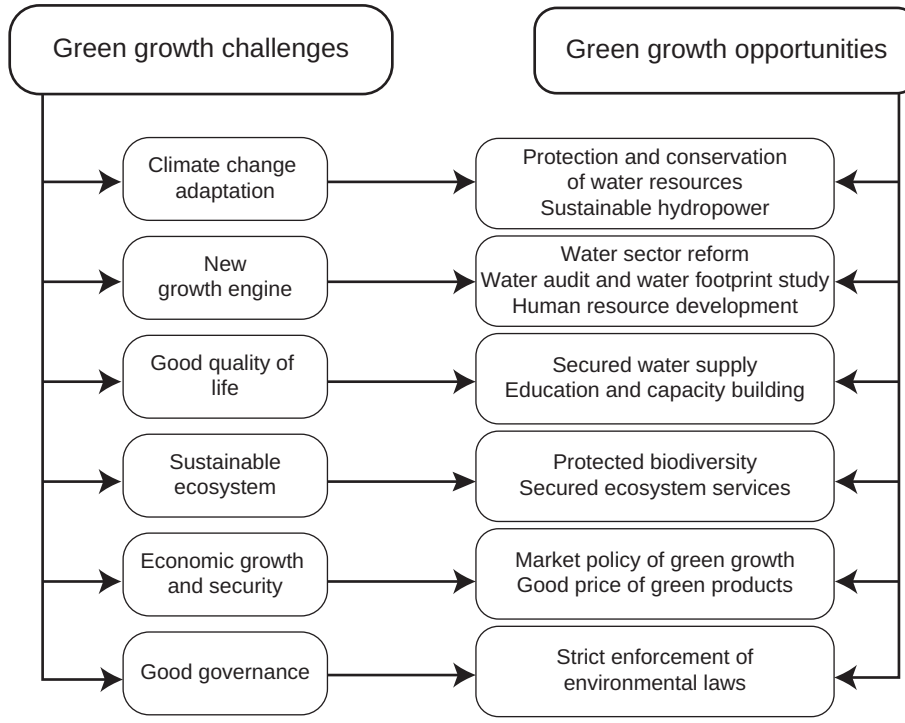

Figure 1.10 Water and green growth. Adapted from K-water Institute and World Water Council (2015).

1.11.4 Indicators of green growth

Researchers in Korea have developed a set of indicators—Environmental Sustainability Indicator (ESI), Environment Performance Indicator (EPI) and Environmental Vulnerability Index (EVI)—which they have termed the Water and Green Growth Index (WGGI). It includes different dimensions of green growth in water management (Kang *et al.*, 2012).

The OECD (2011) has identified four groups of indicators: (1) environmental and resource productivity indicators that monitor the use of natural products in the value chain, (2) natural asset-base indicators that monitor how the environment is functioning as environmental service provider and as a resource pool, (3) environmental quality of life indicators, and (4) economic opportunities and policy response indicators, which include policies, measures, opportunities and the function of corporations in investment, innovation, trade, training and so on.

1.12 Conclusion

Water is now a precious raw material for industries, especially in power generation, which demonstrates, with greater emphasis, the fact that water has a price and an ethical value. Industrial growth suffers if the environmental

and societal values of water are ignored. Sustainable industrial development is now linked with IWRM and is crucial to green growth. Effective application of green growth, in turn, is crucially dependent on water literacy. It is, therefore, incumbent upon the corporate sector to adopt IWRM and spread water literacy among the management and stakeholders for its own wellbeing.

Challenges notwithstanding, green growth is an emerging and inescapable reality for the good of mankind. Powerful agencies of diverse kinds, such as reputable thinkers, scientists, engineers, elected governments and their opposition, are all aware of the economic returns of green growth, even though the idea of green growth is only in a nascent state of application today. These agencies are also well aware of and in agreement with those long-term economic returns of green growth—far in excess of beneficial effects visible today. The only spanner in the works for green growth is the corporate sector because of its obsession with short-term gains. The blindness of the corporate sector, compounded by clout, to the enormous growth opportunity embedded in green growth substantiates the two-and-a-half century old idea of the invisible hand which still remains valid. This is perhaps just as well because nothing will kill the idea of invisible hand more effectively than the idea of green growth.

Note

1. In India groundwater is assessed under groundwater-assessment units of land, which are equivalent to lower-level administrative units, called blocks. *Safe block* means groundwater development/withdrawal is not more than 70% of annual renewable groundwater resource.

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