Chapter 2  Sustainable construction – the debate

The issue of sustainable construction lies within a broader international debate on sustainable development. This debate has been hampered by the perceived ambiguity, and even contradictory nature of the concept and its associated terminology. Its all-encompassing nature and inherent complexity have also made the concept vulnerable to large-scale co-option by agencies within the international development community and multinational business arena. Agencies that very often use the term "sustainable development" for promoting activities that remain essentially based on an unsustainable development model that is polluting the ecosystem, increasing inequity and social exclusion, and consuming resources at a rate faster than nature can replace them.

This has given rise to considerable tension between the proponents of what has been described as weak sustainability, and those demanding a stronger approach, as well as between the developed and developing worlds. This chapter provides a brief introduction to the terminology used, the tensions within the debate, the impact of the construction sector, and the challenges of sustainable construction.

2.1  The terminology

The terms "sustainability" and "sustainable development" are the main sources of confusion. They are often seen as describing two different ideologies, with sustainability seen either as pure economic viability, or as an environmental concept advocating the maintenance and repair of current environmental conditions and, in the extreme, a return to some kind of noble savage state. In contrast, sustainable development is seen as the more progressive approach advocating the goal of sustaining current development (often interpreted as economic growth and improved standards of living). However, if one considers the motivation behind the concept of sustainable development, these interpretations are misleading and incorrect. Within the construction sector we also find terms such as "sustainable settlements/cities", "urban sustainability", and "sustainable construction" that need clarification.

2.1.1  Sustainability

The main motivation behind sustainable development is to sustain the species homo sapiens. The Rio Declaration, which forms the preamble to Agenda 21, states very clearly that "Human beings are at the centre of concern for sustainable development".

Humans are therefore the main focus of the sustainable development debate. The key concern is to keep planetary conditions favourable for human life at a global as well as local level. As we do not fully understand the complex interrelationships between the different components of the biosphere, a prudent approach is advocated, hence the call for biodiversity conservation and environmental protection.

Sustainability is thus the condition or state that would allow the continued existence of homo sapiens, and it is the goal we would like to achieve. Because of endlessly changing external and internal (societal) conditions, this is not a fixed state, but one of dynamic balance where we will have to continuously adapt to these changing conditions.

In order to achieve this state, we will have to meet certain requirements. Firstly, we need to balance the needs of humans with the carrying capacity of the planet, and with the need to protect that capacity so that the needs of future generations can continue to be met.
However, mere survival is not our goal. We want to be able to live in an environment that provides a certain quality of life — that meets our full hierarchy of needs. The most basic requirement for this is the ability of all to live a safe, healthy and productive life in harmony with nature and local cultural and spiritual values.

To get this, we need to achieve a measure of social and economic equity between individuals, as well as between communities, nations and generations. We have to find a way to equitably distribute wealth (in the form of access to resources and opportunities) and increase prosperity for all. This line of reasoning led us to the so-called three pillars of sustainable development — people (social development), the planet (ecological protection) and prosperity (economic development).

2.1.2 Sustainable development

Contrary to popular belief, sustainable development is not merely development that can be sustained, but rather the kind of development we need to pursue in order to achieve the state of sustainability. It is not the goal, but the process of maintaining a dynamic balance between the demands of people for equity, prosperity and quality of life, and what is ecologically possible. Development is also not just seen in its narrow meaning of growth, expansion and acquiring of knowledge, but as progress through improvement, evolution and the quest for wisdom.

While the scope of the term is still evolving as it is co-opted by more and more disciplines and advocacy groups, it is generally agreed to place certain demands on human activity in the three systems central to development.

The economic aspects of sustainable development require the development of an economic system that facilitates equitable access to resources and opportunities and the fair sharing of finite ecologically productive space, that enables sustainable livelihoods, and establishes viable businesses and industries based on sound ethical principles. The focus is on creating prosperity for all, not just profits for a few, and to do this within the bounds of the ecologically possible and without infringing on basic human rights.

The relationship between these terms can be explained as follows:

• The objective is to sustain the species homo sapiens. That is to support it and keep it alive.
• Sustainability is the condition or state which would allow the continued existence of homo sapiens, and provide a safe, healthy and productive life in harmony with nature and local cultural and spiritual values. It is the goal we would like to achieve.
• Sustainable development is then the kind of development we need to pursue in order to achieve the state of sustainability. It is a continuous process of maintaining a dynamic balance between the demands of people for equity, prosperity and quality of life, and what is ecologically possible. It is what we need to do.
• Sustainable human settlements are those cities, towns, villages and their communities that enable us to live in a manner that supports the state of sustainability and the principles of sustainable development.
• Urban sustainability is the broader process of creating sustainable human settlements, especially towns and cities. It includes sustainable construction, but also the creation of institutional, social and economic systems that support sustainable development.
• Sustainable construction means that the principles of sustainable development are applied to the comprehensive construction cycle from the extraction and beneficiation of raw materials, through the planning, design and construction of buildings and infrastructure, until their final deconstruction and management of the resultant waste. It is a holistic process aiming to restore and maintain harmony between the natural and built environments, while creating settlements that affirm human dignity and encourage economic equity.

Agenda 21 for Sustainable Construction in Developing Countries
The social aspects of sustainable development require that we enable the development of fair and just societies that foster positive human development and provide people with opportunities for self-actualisation and an acceptable quality of life.

The environmental aspects of sustainable development require that we find a balance between protecting the physical environment and its resources, and using these resources in a way that will allow the earth to continue supporting an acceptable quality of life for human beings.

It is highly unlikely that all of the sustainability principles implicit in the above statements can be upheld at all times, as they have conflicting requirements. Most of the time, decision-makers will have to make trade-offs and otherwise try to balance the different requirements to find a solution that is the optimum one for the greater good. These decisions need to be flexible and should be regularly reviewed against agreed-upon indicators to keep the three systems in dynamic balance and ensure that the one sphere is not developed at the expense of the others.

2.1.3 Sustainable human settlements

Sustainable human settlements are those cities, towns, villages and their communities which:

- enable us to live in a manner that supports the state of sustainability and the principles of sustainable development, and
- have institutional, social and economic systems that will ensure their continued existence.

Whether a settlement can be declared sustainable or not depends on the interaction of four different patterns:

- The physical structure – how the settlement sits within the natural environment and therefore responds to the topography; the spatial relationship between the different parts of the city; and the form of the built environment.
- The utilisation patterns – which are formed by the way the settlement uses its resources and which are described by the infrastructure and services provided.
- The social patterns – how people live, learn and work in, and relate to their settlement, and the opportunities provided by the settlement for meeting these social needs.
- The operational patterns – how the settlement functions and is managed.

Sustainable development holds certain very specific and often conflicting demands and conditions for the creation of these patterns. These conditions are also different within different economic, ecological, geographical, topographical and social contexts. It is therefore not possible to define a physical blueprint for sustainable human settlements.
settlements. However, through the Habitat Agenda an attempt has been made to create normative guidelines that could be applied to the creation of settlements everywhere.

2.1.4 Urban sustainability

Urban sustainability is the broader process of creating sustainable human settlements, especially towns and cities. It includes sustainable construction, but also the creation of institutional, social and economic systems that support sustainable development. The seven essential dimensions of urban sustainability can be described as:3

- A sustainable urban economy providing work and wealth;
- A sustainable urban society with social coherence and social solidarity;
- Sustainable urban shelter providing decent, affordable housing for all;
- A sustainable urban environment with stable ecosystems;
- Sustainable urban access through resource conserving mobility;
- Sustainable urban life – the liveable city; and
- Sustainable urban democracy through an empowered citizenry.

Urban sustainability is a multi-dimensional problem that requires a systemic approach. The decision-making processes of urban sustainability would therefore also be different from traditional approaches. In practice this means a move from hierarchical and sectoral decision-making to a more holistic, integrated and participative approach.

2.1.5 Sustainable construction

Sustainable construction is a holistic process aiming to restore and maintain harmony between the natural and built environments, and create settlements that affirm human dignity and encourage economic equity.

It should be recognised that mankind is locked into a highly dynamic relationship with the natural world and that the two are acutely interdependent. In addressing the complex problem of construction and the environment, efforts towards sustainable construction are fundamentally an attempt to put in place practices that restore the balance between the natural and built environments. It is a search for an ecological model that views both realms as fundamentally interconnected.
Sustainable construction is seen to imply holistic thinking as regards construction and management of the built environment, taking a lifecycle perspective. It implies not only new environmentally orientated construction designs, but also new environmentally friendly operation and maintenance procedures. Not only must construction materials and components be produced in a sustainable way, but their use must also answer to new requirements deriving from holistic environmental prerequisites. For example, there is no sense in producing cladding glass in an environmentally friendly way, if that sheet of glass is going to be used as a façade or roof in a Brazilian tropical climate.

However, just as the concept of environmental sustainability is still unfolding as our knowledge about the environment expands, so is the understanding of sustainable construction as a concept that extends beyond the biophysical impact of the built environment. Thus, the concept of sustainable construction now transcends environmental sustainability to embrace economic and social sustainability, which emphasises possible value addition to the quality of life of individuals and communities.

For many years there has been a tendency for sustainability studies in construction to give greater emphasis to the dimensions or aspects denominated as technical, i.e. ecological and geographical/spatial sustainability (as described by Sachs). As a result, this approach has often ended up neglecting the social contradictions making the environmental issue mainly – and in some cases exclusively – a technical one.

Thus, understanding of the non-technical aspects (i.e. social, economic and cultural sustainability), as well as the political, must be encouraged and practised in countries which have to fight against social exclusion as one of their priorities. This change of focus, or increased plurality of approach, should contribute towards helping developing countries to face up in a more productive way to the challenges presented by sustainable development within their reality, given that the social, economic and cultural contradictions are the true causes of their environmental problems.

2.2 The tensions

As said earlier, there are many tensions within the sustainability debate. The first set of tensions is mainly between the concerns of the North and those of the South, and is expressed in terms of the Brown and Green Agendas.

Another set of tensions arises from the time frame within which responses are planned. If we are dealing with the survival of the human species, can we afford to make decisions that will threaten that survival fifty or four hundred years down the line? Or do we limit our decisions to a time frame of twenty or thirty years and hope that technology will develop to mitigate the consequences of our actions at a later stage?

The third set of tensions can be found in Einstein’s question of whether we can really solve our problems from the same consciousness that created them. This poses the question of who should be responsible for formulating the sustainable development model. Should it be the North, which was responsible for creating most of the problems sustainable development attempts to address, and has a vested interest in trying to maintain current economic models and global power balances? Or should it be the South, which traditionally has a more value-orientated, community-based notion of development (although this is rapidly eroding)?

2.2.1 The "Brown" and "Green" agendas

The Green Agenda concentrates on reducing the environmental impact of urban-based production, consumption and waste-generation on natural resources and ecosystems, and ultimately on the world’s life-support systems. In
The Green Agenda, which focuses on the problems of affluence and over-consumption, is more pressing in affluent countries. The Brown Agenda, which focuses on the problems of poverty and underdevelopment, emphasises the need to reduce the environmental threats to health that arise from poor sanitary conditions, crowding, inadequate water provision, hazardous air and water pollution, and local accumulations of solid waste. The Brown Agenda is therefore more pertinent in poor, under-serviced cities or parts of cities. Table 1 illustrates the main differences between the Brown and Green agendas.

### Table 1: Difference between the Brown and Green agendas

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<thead>
<tr>
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<th>Brown</th>
<th>Green</th>
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<tbody>
<tr>
<td>Key concern</td>
<td>Human well-being</td>
<td>Ecosystemic well-being</td>
</tr>
<tr>
<td>Timeframe</td>
<td>Immediate</td>
<td>Delayed</td>
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<tr>
<td>Scale</td>
<td>Local</td>
<td>Local to global</td>
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<tr>
<td>Concerned about</td>
<td>Low-income groups</td>
<td>Future generations</td>
</tr>
<tr>
<td>View of Nature</td>
<td>Manipulate and use</td>
<td>Protect and work with</td>
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<tr>
<td>Environmental services</td>
<td>Provide more</td>
<td>Use less</td>
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The developing world is in a particularly difficult position as the interaction between the Brown and Green Agendas is further complicated by the need to address past inequities in service delivery in a manner that is socially acceptable to both rich and poor, that will enable the developing world to live within what is ecologically possible, given its small resource base relative to its population growth rates, and which minimises the negative environmental impacts associated with both Green and Brown agendas.

### 2.2.2 Weak versus strong sustainability

Depending on the willingness of stakeholders to accept and participate in change, efforts towards sustainability can be placed on a continuum between weak (false) and strong (true) sustainability, the key criterion being whether current development and consumption patterns will allow future generations to meet their basic needs.

Key to this intergenerational equity aspect of sustainable development is the question of how much we can use now and how much to leave for future generations. To enable us to measure our resource wealth, four kinds of capital have been identified:

- Natural capital: natural resources and the services provided to humans by the biophysical environment.
- Human capital: labour, education, skills, intelligence, culture and organisation.
- Manufactured capital: buildings, infrastructure, goods, information resources.
- Financial capital: Cash, credit, investments and monetary instruments.

**Weak sustainability** is the idea that different kinds of capital are fully interchangeable and that natural capital can therefore be used up as long as it is converted into manufactured capital of equal value. If this rule is applied it would, for instance, be justified to run down the environment provided the proceeds of environmental degradation were reinvested in other forms of capital.

"Only when the last tree has died and the last river been poisoned and the last fish been caught will we realize that we cannot eat money."

19th century Cree Indian Prophecy

**Strong sustainability** is the idea that there are certain functions that the environment performs that are essential for the welfare and survival of the human species, and which cannot be duplicated by humans. These ecological assets are called "critical natural capital" and cannot be
traded for any of the other forms of capital, as their depletion would endanger human survival. Examples are the ozone layer, the carbon cycle and the hydrological cycle.8

Thus, while it may seem perfectly rational to trade natural capital of a given value for human-made capital of equal or greater value within a static framework, this is not true within a dynamic framework – that is, modelling economic systems through time. Firstly, this is because we would be living off our irreplaceable and non-substitutable natural capital, instead of off the revenue derived from that capital, and, secondly, because the human-made capital with which we replace it will eventually depreciate in value, leaving us with nothing. Over the long term the sustainability of homo sapiens will therefore be threatened by the "weak" sustainability approach.

2.2.3 A new model of development

The model of social and economic equity, which underpins Agenda 21, is mainly based on the Western liberal democratic value system shaped by the previous millennium’s social revolutions in Europe. Increasing scepticism from the developing world suggests that sustainable development as promoted and practised by the international development agencies is just business as usual, and that despite its lip service to "harmony with local cultural and spiritual values" it often conflicts with the values held by the non-industrialised countries, or at best does not acknowledge the validity of other value systems. There is also scepticism about the ability of the West to provide the real solutions to problems that were essentially created by their development model.

It is felt unlikely that sustainable development and human settlements will be possible through the model of development espoused by the World Bank and the International Monetary Fund. Many of the problems experienced in the developing world are a result of the development models these institutions encouraged the developing countries to follow, not a divinely ordained process. Worldwide environmental crisis has been brought about by the economic model that favours expansion of the structures of mass production, with its predatory relationship to the physical environment and inherent social inequality manifested in a scenario of high concentration of private wealth and social exclusion. The strategies and processes that have been adopted in pursuit of economic growth and development have been very resource-intensive. These strategies and processes are themselves the products of habits and lifestyles that are constantly changing in ways that impose further demands on global natural resources.

From the Kauntan Declaration "Our cities, our homes: A citizens' agenda"

"This disturbing reality is in large part a legacy of the ideologies and institutions of the twentieth century and in particular of the dominant neo-liberal economic development model of unfettered economic growth, unregulated markets, privatisation of public assets and functions, and global economic integration that has become the guiding philosophy of our most powerful institutions. This model spawns projects that displace the poor to benefit those already better off, diverts resources to export production that might otherwise be used by the less advantaged to produce for their own needs, destroys livelihoods in the name of creating jobs, and legitimises policies that deprive persons in need of essential public services. The model advances institutional changes that shift the power to govern from people and governments to unaccountable global corporations and financial institutions devoted to a single goal: maximising their own short-term financial gains. We need a different kind of development which will give different kinds of cities."
Notions of what constitutes development, and the associated habits and lifestyles introduced by the various European colonisers, contributed greatly to the problems experienced by cities in developing countries. The question asked is whether the developing countries should continue pursuing this development model.

The developing nations are today following the developed nations’ policy of achieving economic growth through macro-industrial production, which revolves around the concept of large-scale production and high-consumption patterns. The consequent environmental and social impact is often overlooked. The adoption of the new Western "sustainable" construction methods and city patterns requires questioning to ensure these reflect the specific requirements of the developing nations and incorporate their value systems. Promoting a development model derived from Western values and growth patterns increases inequity, causes cultural alienation, loss of cultural wisdom and environmental degradation, irrespective of whether it claims to promote sustainable development or not. Therefore, changes to this development model are called for, or we require a completely new model of development that includes non-Western values. We need a different vision with different kinds of economics, growth, technology, energy, institutions, governance, and, of course, a different type of "development". We therefore need a new development model that would enable these changes to be made, that places more moderate demands on the earth’s resources, and that encourages their more equitable distribution. Both our benchmarks and goals must change. So must the measuring yardstick. Developmental problem-solving is not only about ensuring clean water, treating sewage and managing transport, but also about tackling the underlying forces and processes – changing "development" itself.

The biggest challenge of sustainable development comes from having to question and re-evaluate some of our fundamental assumptions regarding development. We need to rethink and redesign the dominant development models, we have to question the inevitability of urbanisation as we are currently experiencing it, and we need to go within ourselves and our cultural value systems to find a set of values and ethics that will encourage true sustainable development. Most importantly, we need to accept the magnitude of the change that will be required and start working towards that change.

Just as we cannot solve the problems we created with the same thinking that created them, we will not be able to effect these changes from within the current developmental paradigm. We need to make a mental shift equivalent to the one the human race had to make when it was proven that the Earth was not the centre of the universe.

However, the criticism levelled against a "sustainable" development model that requires the imposition of a Western value system on the developing world does not imply an outright rejection either of sustainable development or of Western values. Instead, in the words of Iba Der Thiam:

"[T]he way is simple. It does not mean exalting or restoring every bit of Africa’s social heritage… . Nor does it mean rejecting everything history brought us from Europe and elsewhere; It means examining our real culture for the permanent values which created the unity, stability, solidarity and cohesion of ancient societies … and to add to this canon selected values, not just from Europe … but from civilisations and cultures from all over the world." 9

It is clear, though, that inherent in this call for a new development model is the understanding that the success of the sustainability drive depends ultimately on the decisions people make regarding their behaviour. These decisions...
are driven by a value system, by an idea of what is "right" and what is "wrong". Development initiatives will not lead to tangible and lasting improvements in physical well-being without drawing on those universal spiritual postulates that give direction and meaning to life.

While science can offer tools and methods for promoting social and economic advancement, it alone cannot set direction; the goal of development cannot come from the process itself. A vision is needed, and the proper vision will never take shape if the spiritual (not religious) heritage and needs of humans continue to be regarded as tangential to development policy and programmes. We need to reinvent the relationship between people and their environment. For this we need to develop a new set of values and ethics that also acknowledges the values and traditions of the developing world.

2.3 The impact of the construction industry

Most human activities that impact on the environment have backwards or forward linkages to the construction industry, and their impact can be mitigated through changes in the practices of the construction industry. The industry’s environmental impact is the most measurable, but its socio-economic impact should not be negated.

Sustainable construction in the developing countries tends to focus on the relationship between construction and human development, often marginalising the environmental aspects. Biophysical considerations in the built environment have not been clearly articulated beyond the impact on environmental health. However, in light of the severe environmental degradation experienced by most of the developing world, the construction industry cannot continue to ignore the environment.

2.3.1 Environmental impact

The environmental impact of the construction industry as an industry sector is probably larger in developing countries than it is in developed countries. This is due to the fact that the developing countries are virtually still under construction and that they have a relatively low degree of industrialisation, making the construction industry one of the biggest factors impacting on the biophysical environment.

The physical environment and the construction sector are linked principally by the demands made by the latter on global natural resources, and this assumes huge environmental significance with the rapid growth in global population and the attendant implications for natural resources. This is especially the case with housing and infrastructure, which are very resource-intensive. The call and desire for sustainable construction is in realisation of the construction industry’s capacity to make a significant contribution to environmental sustainability because of the enormous demands it exerts on global resources.

The simplest point at which to begin evaluating the impact of the construction industry is to look at its consumption of energy and greenhouse gas emissions. The biggest culprits in terms of climate change are the materials that form the basis of modern construction – concrete and steel. Twice as much concrete is used in formal construction around the world than the total of all other building materials – including wood, steel, plastic and aluminium. Cement production is, after the burning of fossil fuels, the biggest anthropogenic contributor to greenhouse gas emissions. Cement kilns have been identified as a stationary source of nitrogen oxides, releasing more than 25 tons per year.10 Although cement makes up only 12-14% of the final concrete mix, further embodied energy comes from the transportation and extraction of aggregates and, in the case of reinforced concrete, the manufacturing of steel.
Steel is one of the most energy-intensive materials. Together, the production of iron and steel is responsible for 4.1% of global energy use.\textsuperscript{11} The manufacturing and final use of both these materials can also be very water-intensive. Construction activities, whether through the manufacture of construction materials, or through the operational activities of actual construction, also lead to a number of other environmental problems. These include noise pollution, dust, and hazardous contamination through toxic waste.

Apart from the energy embedded in building materials and products, and the associated greenhouse gas emissions, massive environmental pollution also occurs during processing of the raw materials and manufacturing of the product. Toxic gases and effluents are discharged into the environmental media with devastating effects on aquatic and marine life, as well as contributing to atmospheric pollution. The production of iron, steel and non-ferrous metals, as well as the production of other construction materials such as cement, glass, lime and bricks, is responsible for 20% of annual dioxin and furan emissions. This exclude emissions due to the production and use of PVC and other chlorinated substances used in the construction industry as paints, sealants, plastics and wood preservatives, for which specific figures are not yet available. Road transport infrastructure, especially road paving with asphalt, contributes a further one percent of annual dioxin emissions. The bulk of dioxin emissions (69%) come from the incineration of municipal waste. The incineration of treated waste wood, floor coverings and electrical wiring from demolition sites makes a significant contribution to this figure.\textsuperscript{13}

Construction and demolition waste is another important issue, as waste is often dumped illegally in dams, river courses and any available hollow. If left unchecked, dumping sites become breeding grounds for mosquitoes and vermin. High material consumption rates are due to high material wastage, both as waste and as material unnecessarily incorporated in the building. (Material wastage can be defined as the amount of material consumed in addition to the planned amount.) The highest rates of wastage are recorded for Portland cement and concrete and ceramic blocks, all materials which significantly contribute to climate change through their manufacture.

The building materials manufacturing industry is also responsible for the pollution of watercourses and filling up of landfill sites. The raw materials for building materials are often extracted from the rural hinterlands, where they cause degradation of land and ecosystems. The processing and production of these usually take place close to the city, where they produce air and dust pollution and consume a great deal of energy.

Any discussion on the environmental impact of construction would not be complete without the inclusion of the mining and mineral-related industrial sector. Pollution, land degradation and widespread disruption of natural terrain are direct impacts that are exacerbated by the lack of programmes and regulations regarding the rehabilitation of mining sites.
Furthermore, massive deforestation in developing countries can be attributed to the building materials industry – not just locally, but also for export. Timber for construction and related industries is often harvested from indigenous forests and only minimally replaced, causing soil erosion, siltation of watercourses, and reduced precipitation and its concomitant problems. These indirect impacts generate growing regional inequalities, impoverishment, and underemployment.

Site design and the impact of the actual construction process on the natural environment remain common problems. Without a proper investigation of the site, the natural environment ceases to be an integral part of design and construction implementation and is thereby compromised. As argued by Schaefer, architects, developers, builders and owners often overlook the site as one of the significant elements of sustainable development and construction. He further argues that development proceeds in a heroic mode – that nature is to be conquered, the rugged individual mastering and subduing the land for economic gain.

In many urban areas of the developing world, the construction of buildings, especially residential buildings, has been carried out to occupy the entire site. In the process, the natural green system has been destroyed and compaction has taken place to a level that prevents air movement in the soil, even after construction has been completed. The existing natural environment has in many cases been destroyed beyond repair. In South Africa, for example, new housing, especially in the state low-cost projects, has changed places of good natural vegetation into desert, with construction activity causing the removal of all the trees on site, rather than integrating them into the built environment.

The construction industry also has a huge impact on agricultural land. Soil erosion and other forms of land degradation now rob the world of 70-140 000km²/year of farming land. Urbanisation alone is responsible for the loss of 20-40 000km²/year. Again, the impact is most dire in developing countries with poor-quality soils, such as most African countries. Land is a costly commodity and the basis of many an economic activity on which survival rests. The development of land, especially where there is lack of stringent application of environmental standards and regulations, tends to disregard the quality of the built and natural environment in pursuit of maximum economic gain.

### 2.3.2 Social impact

Given that the products of the industry are used to underpin and facilitate all facets of socio-economic relations, it is possible to enhance social sustainability through the construction process. This is particularly the case with the labour-intensive nature of construction activities and the opportunities it presents for poverty alleviation. Construction also has social impacts in terms of its labour relations and business practices.

The construction industry (in its narrow definition) is the largest industrial employer in the world with 111 million employees worldwide. Of these, 74% are in the low-income countries. Since low-income countries produce only 23% of the global construction output, it is clear that the "employment intensity" of construction activities is much higher in low-income countries than in the high-income ones. The construction industry and its employment conditions can therefore play a major role in human development and improving the quality of life for the poor.
However, the construction sector has a reputation for greed, corruption, unfair labour practices and environmental destruction. In a recent international Gallup poll, the sector was perceived as even more corrupt than the arms and energy sectors. Corruption in the construction sector, leading to sub-standard construction products, was also partially held to account for the high death tolls in recent earthquakes in Turkey and India. A study by the International Labour Organisation (ILO) found that construction workers almost everywhere in the world do not view their employment in a favourable light and in many countries – both rich and poor – people work in construction out of necessity and rarely out of choice. Few would want their children to enter the industry.

The same study also found that among blue-collar workers high rates of gender discrimination and sexual harassment continue to limit the equal participation of women in the industry, despite government programmes to promote gender equality in the sector. While the situation is better for women in the built-environment professions, they too still deal with high, if more subtle, levels of gender discrimination and harassment.

According to the ILO study, the construction industry also has a very bad safety record, although reliable data on this is scarce, especially in developing countries where the rarity of workman’s insurance means that accidents often go unreported. This high accident rate is ascribed to lack of formal training and subcontracting to the unregulated informal sector.

The fluctuating nature of the industry, coupled with low profit margins and a high turnover of informal workers, is also contributing to the collapse of the apprenticeship system, and subsequently to a reduced national skills base.

2.3.3 Economic impact

The construction industry also has the potential to enhance economic sustainability through its structure, conduct and performance. In almost every country in the world, the built environment normally constitutes more than half of total national capital investment, and construction represents as much as 10% of GNP. The industry is also playing a substantial role in the creation of small, medium and micro enterprises (SMMEs). Ninety per cent of construction workers are employed in microfirms with fewer than ten people. The contribution of small and informal contractors to the economy should also not be underestimated. Most cement and paint is sold to smaller consumers. Small companies are also responsible for a large proportion of building material manufactured. In Brazil alone there are about 11 000 small companies manufacturing ceramic bricks and tiles. These companies promote local economic development in a way that the large national and multinational companies cannot do.
There is also a direct relationship between the economic sustainability of the sector and its environmental impact. An economically efficient construction industry enhances environmental sustainability by ensuring least-cost methods of construction that encourage optimal allocation of resources and discourage waste. Furthermore, economic sustainability within construction requires that social and environmental costs are internalised and reflected in the final product prices.

2.4 The challenges of sustainable construction

Sustainable construction poses certain challenges to developing and developed countries alike. Often, the only differences lies in the approach to finding solutions to these challenges that are appropriate to the specific contextual conditions, and the resources that are available to pursue these solutions. However, while these challenges are the main focus of sustainable construction in developed countries, in developing countries they merely constitute another layer in an already complex problem. Furthermore, while developed countries have made some progress in addressing the challenges of sustainable construction, developing countries are only now beginning to consider how to address these challenges from within the broader developmental challenges they are facing. This section briefly discusses the common challenges, while Chapter 3 provides an overview of the challenges particular to developing countries.

2.4.1 Internalising sustainability

Sustainability as a concept has only recently been introduced to the construction sector, and the development that is happening shows that sustainability and sustainable construction are not yet an integral part of decision-making and business practice. Sustainability is still seen as a "nice-to-have" addition to normal practice, and not as the main motivator that drives all business and development decisions.

2.4.2 Can "sustainable" be profitable?

The general perception is that the introduction of sustainable construction practices will increase costs and reduce profit. The need to make additional investments in machinery, equipment and training is very often an excuse not to comply with standards and practices based on principles of sustainability. The construction industry complains of lack of resources to invest in the technological changes required for the application of this concept and they are concerned that their level of profits will be reduced. The same arguments prevent the implementation of better employment conditions and training programmes.

While it is true that the change to more sustainable construction will incur some costs, there are also associated savings resulting from efficient resource use, higher productivity and reduced risk. The challenge is to find ways of capitalising on these benefits of sustainability to increase profitability.

2.4.3 Mobilisation of resources

One of the key challenges of sustainable construction is the mobilisation of resources in order to support research, technological changes and feasibility studies for the production and marketing of new materials and technologies. In many cases the issue is not the lack of resources, but the lack of coordination to manage them in a more efficient way. Converging resources from the different organisations could help to increase the impact of these resources.

Governments are not able to guarantee the necessary financial resources to support the above-mentioned activities. The private and academic sectors represent resources that can be tapped and directed towards initiatives in the
sustainable construction sector. Working together, the financing of research and educational activities, as well as the responsibilities to develop the sector can be shared by all parties. Costs can also be substantially reduced if the construction sector works together and shares responsibilities with government, universities and other private sector related industries and institutions. Furthermore, research partnerships among different countries will reduce the cost and time required to solve the main technical problems.

2.4.4 Public awareness

Sustainability is not only the responsibility of governments and the construction industry. Citizens need to get involved and be aware of the impacts of their behaviour and their use and misuse of resources. Individual participation of people is key to achieving decisions needed to secure changes in the consumption patterns of the majority of the population. It is important to develop campaigns that on the one hand inform the public regarding the benefits and opportunities of the use of environmentally friendly building materials and products and, on the other, encourage a change in consumer habits towards a more sustainable use of resources.

2.4.5 Improving the quality of the construction process and its products

Defects and inefficient processes are expensive forms of wasting environmental resources and pose a danger to both construction workers and the end-users of the product. Badly performing construction products also reduce the quality of life of those using these products. A first step towards sustainable construction is to improve the quality of construction products and the efficiency and safety of the construction process.

2.4.6 Reducing resource use

It is a priority for the construction sector to reduce its use of resources. This can be done by direct or indirect means, each posing a different challenge.

a) Reduction of building material wastage

Reducing material wastage has several benefits. It reduces global material consumption, the amount of construction waste and, in the long term, the amount of demolition waste. It also reduces construction costs, making houses more affordable.

Management, design and cultural practices have a great influence on the wastage rates. These can be changed through education, site planning, management and design practices, as well as the use of new technologies. Nature’s re-use and degradation technology needs to be incorporated where possible into modern-day construction processes. Where this is impossible, sustainable construction requires new and innovative methods of waste disposal and re-use.
b) Increasing the use of recycled waste as building materials
When properly done, recycling waste as building materials is a convenient way to reduce the environmental impact of the construction industry. Recycling has several potential environmental advantages:

- it reduces consumption of natural resources;
- it reduces the deposition of landfill;
- it can reduce energy consumption of material production and all its associated pollution; and
- it can result in more durable materials.

Waste recycling is still seen by many in terms of aggregates, fly-ash and steel re-use, but this viewpoint needs to be expanded to strategies that add much higher value to re-used or recycled materials.

c) Energy efficiency in buildings
This can be achieved through cutting down both consumption and embodied energy. Reducing energy consumption can be accomplished through education, the development of an energy code, improvement of systems (air-conditioning, heating, water heating), improvement of insulation, use of alternative energy sources and passive solar design improvements. Consumption can also be reduced through the redesign of appliances such as water heaters and lighting sources. There is furthermore significant room for improvement in the production of building materials, especially those produced by small companies.

d) Water conservation
A combination of user education and design and technical changes is required. Improved water metering systems, rainwater harvesting systems, re-using water, waterless technologies and low-flow, aerated and self-closing faucets are suggested. The use of water on construction sites and in the production of materials also needs to be reassessed.

e) Durability and maintenance
Increasing knowledge on the service life of the built environment, and the capability of generating and managing life data are certainly a major challenge for achieving a more sustainable construction industry. This should include the physical as well as functional durability of the constructed asset, as well as the optimisation of the service life in all phases of the building process. It also requires that building flexibility and capacity be upgraded. At present research on durability is almost completely limited to reinforced concrete structures, and it is necessary to extend research to all other technologies and construction materials.

Maintenance also needs to be considered during design, and life-cycle costs can be used to select more competitive technologies.

2.4.7 Innovation in building materials and methods
Sustainable construction can make a huge difference not only to global environmental sustainability, but also to socio-economic sustainability through the equitable sharing of the world’s resources as promoted by the Fair Shares concept. A recent study for the European Union on the implications of the Fair Share concept concluded that if the EU were to use only its fair share of the world’s resources, this would require an 85% reduction in use of cement, 87% of steel and 90% of aluminium. The Kyoto Protocol also requires a substantial reduction in greenhouse gas emissions. This will have serious implications for the construction sector, as the built environment is a substantial
The Fair Shares concept looks at the individual’s access to resources – both source and sink (the ability to absorb waste products). This is calculated on a country-by-country basis as a factor of the national population as a percentage of the global population, the amount of product produced, and the sink capacity or emissions produced, and is based on the premise that the total material input into world economy must be halved if we are to leave enough resources for future generations. It also includes the idea that we have to reduce our resource consumption not only because we will run out of resources, but also because of the environmental impact of extracting and using those resources.

2.4.9 Procurement procedures

The client has an important role to play in the sustainability of construction. By including sustainability criteria into the procurement policies and procedures of all large clients, including government, an enabling environment for sustainable construction, as well as a market for sustainable construction products, is created.

contributor to greenhouse gas emissions. Coping with these kind of restrictions will require an entirely new design paradigm, one more far-reaching than the move from brick and mortar to steel and glass at the beginning of the 20th century.

2.4.8 Environmental health and safety

As the materials used by the construction sector are responsible for a large percentage of the global toxic burden, more research needs to be done regarding the environmental and health impacts of manufactured building materials and finishes, and strategies for dealing with harmful materials like asbestos need to be developed and implemented. Further investigation is also needed regarding the environmental impact and health threats presented by activities on building sites, especially regarding the loss of topsoil and vegetation, as well as dust and noise pollution and the storage of harmful chemicals.