Agenda 21 for Sustainable Construction in Developing Countries

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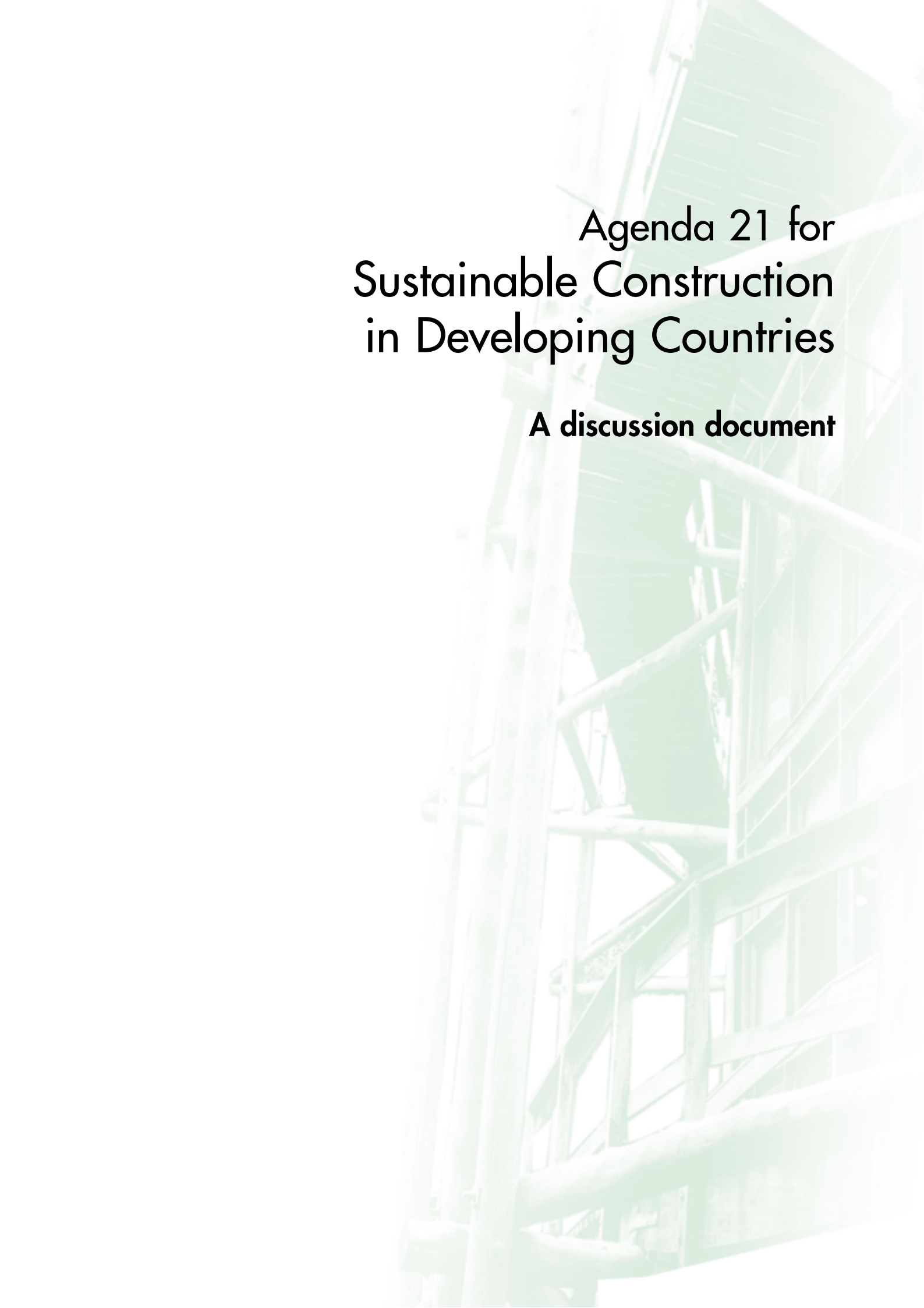
A discussion document



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Agenda 21 for Sustainable Construction in Developing Countries

A discussion document

The International Council for Research and Innovation in Building and Construction
CIB

and

United Nations Environment Programme
International Environmental Technology Centre
UNEP-IETC

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Table of Contents

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Foreword

This discussion document Agenda 21 for Sustainable Construction in Developing Countries represents both a sector response and a developing country response to the challenge of sustainable development. It builds on the principles of the UN Agenda 21 formulated at the Earth Summit in Rio and is published as a contribution to the Johannesburg World Summit on Sustainable Development.

The release of this discussion document coincides with the renewed commitment of developing countries to take leadership for social and economic development. This commitment is reflected in initiatives such as the New Partnership for Africa's Development (NePAD), conceived by African Heads of State to place the continent on a path of sustainable growth and development. The support of UNEP-IETC and the CIB to institutions and people of "the South", who have developed this contribution, is a concrete expression of such partnership.

The construction industry is central to how we shape our future, and to the sustainability of this future. The delivery of appropriate and affordable infrastructure underpins the competitive performance of almost every facet of a country's industrial, technological and commercial base, as well as the welfare of households and people. The industry impacts on almost every aspect of the realization of human settlements and the creation of infrastructure that supports development.

In the developed world, the built environment generally constitutes more than half of the total national capital investment, accounts for up to half of all the raw materials taken out of the earth's crust by weight, and consumes between 40% and 50% of a country's energy. The built environment consumes substantial financial and natural resources, and generates considerable waste streams.

While the built environment provides homes, employment, recreation and dignity to billions of people, many remain substantively excluded from these benefits and the potential of humankind to benefit into the future is dependent on a path of change that must be taken today. This document is an important step on the distinctive path that developing countries will have to follow, moving from a very different present, encumbered by exploitation and underdevelopment of the recent past.

The present drags the past in its wake. For developing countries, the objectives of future sustainability are inexorably bound together with the pressing need to attain a sustainable present grounded in economic growth. The enhanced capacity of governments, innovation, the formation of domestic skills and construction capability are all fundamental to the infrastructure that will unlock economic growth and an attack on poverty, hunger and disease.

The fabric of sustainability will be woven also from the rich cultural and environmental diversity that presents unique opportunity for the developing countries to demonstrate leadership on an alternative path to the common future.

Agenda 21 for Sustainable Construction in Developing Countries sets out an R & D agenda and a strategy for action for the developing world in partnership with the developed world. The Construction Industry Development Board (CIDB) is proud to be associated with this initiative and commends the authors. Established by government as a public/ private partnership to drive the national vision for transformation and development of the South African construction industry, the CIDB will continue to cooperate with UNEP-IETC, the CIB, the CSIR and all interested parties to advance this agenda.

Spencer Hodgson
CEO: Construction Industry Development Board
South Africa

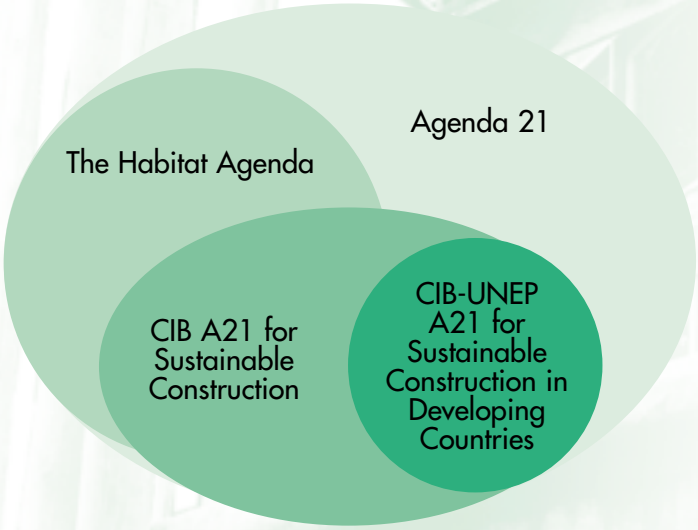
Preface

Since the 1992 Earth Summit in Rio, when Agenda 21 was formulated as the international blueprint for sustainable development, all sectors of society have been in the process of interpreting and pursuing sustainability and sustainable development within their specific contexts. Chapter 7 of Agenda 21 specifically refers to the role of human settlements in sustainable development. The ability to meet most of our basic human needs relates in one way or another to the creation of human settlements and their performance. Therefore, in 1996 a second international action plan, The Habitat Agenda, was formulated specifically to address the role of human settlements in sustainable development. The construction sector has a major role to play in terms of the sustainable development of human settlements, as is highlighted in Chapter 4, Section C of The Habitat Agenda. The construction industry and its activities are responsible for a substantial amount of global resource use and waste emissions. It also has an important role to play in socio-economic development and quality of life. Thus the need for an internationally agreed Agenda on Sustainable Construction was highlighted early on, and in 1999 the International Council for Research and Innovation in Building and Construction (CIB) published its *Agenda 21 on Sustainable Construction* (CIB Publication 237) after an extensive collaborative research process.

This first Agenda for the construction sector was intended as a global intermediary between the broader international Agendas, and national/regional Agendas for the built environment and the construction sector. Its main objectives were to create a global framework and terminology that would add value to all national or regional and sub-sectoral Agendas, and to provide a source document for defining R & D activities related to sustainable construction. The document provided a detailed overview of the concepts, issues and challenges of sustainable development and sustainable construction, and posed certain challenges to the construction industry. The full document can be downloaded from the CIB website www.cibworld.nl

However, creating a sustainable built environment in the developing world requires a different approach from that taken by the developed world, and this is not often clearly understood and discussed. The problems and their scale, the development priorities, the capacity of the local industry and governments, as well as the skills levels found in developing countries are often radically different from those found in developed countries. There are also certain cultural and worldview differences between the developed and developing world countries that impact on the understanding and implementation of sustainable development and construction.

Therefore, a special *Agenda 21 for Sustainable Construction in Developing Countries* was commissioned as part of the action plan for the implementation of Agenda 21 on Sustainable Construction, and to further the CIB's proactive approach on sustainable construction. This project has been undertaken in partnership with UNEP-IETC, CSIR Building and Construction Technology and the Construction Industry Development Board of South Africa. As the Agenda is continually evolving, your further contributions to the discussion are welcomed.



Chapter 1 Introduction

The developing world has very little time left in which to decide the future of its settlements. It can choose to blindly follow the model laid down by the developed nations, or it can choose to opt for a more sustainable model of development. There is no doubt that large-scale development is needed to address issues such as adequate housing, rapid urbanisation and lack of infrastructure. However, these problems need to be addressed in a way that is socially and ecologically responsible. Due to the rapid rate of urbanisation experienced in developing countries and the increasing pressures on what are often limited resources, there is great urgency to make sustainable interventions now, while these built environments are being created, rather than try and change things after the fact.

While the level of underdevelopment in developing countries may be cause for despair, it also provides an opportunity for development in these countries to avoid the problems currently experienced in the developed countries. Developing countries need not go through the same process of development as that followed by developed countries. Instead these countries can choose to base all future development on the principles of sustainability.

This document is the culmination of a process initiated in December 2000[a]. The aim of the process was to better understand the challenges of sustainable construction in developing countries, and formulate a research and development agenda and strategy for action that would ensure that the contribution of the construction sector to the physical development of developing countries supported the principles of sustainability. While the process highlighted the many barriers and developmental problems faced by developing countries, the aim of this Agenda is not to solve these issues, but to make sure that the role-players within the broader construction sector who are working on solutions to these developmental issues have what they need to make sure that their solutions support sustainable development.

The R & D agenda outlined in Chapter 4 of this document therefore not only looks at the technological enablers that will be necessary, but also at what would be required to provide an enabling environment for the implementation of sustainable construction practices in developing countries. This entails the development of a variety of institutional enablers, as well as the formulation of a value system for the construction sector that supports sustainability and the tools that would be needed to facilitate the adoption of this value system.

However, sustainable development and construction is the responsibility not only of researchers. It requires concerted action by all stakeholders involved in the creation and use of the built environment. Clients need to demand a more sustainable built environment, professionals need to adopt and promote sustainable construction practices through their work, the construction industry needs to commit to following sustainable construction processes, and regulatory bodies need to encourage, enable and enforce sustainable construction. If all these stakeholders are to fulfil their roles, the educational sector has to provide them with the necessary training and with educators who themselves are committed to sustainability. These educators will need the knowledge that is being developed by the researchers as part of the proposed R & D agenda. For the researchers to develop this new knowledge, they will need the participation and support of clients, contractors, professionals, governments and regulators.

Therefore, sustainable construction can happen only if all the necessary elements – both technological and contextual enablers, as well as stakeholders – are developed and work together at local, national, regional and international levels.

[a] This process is fully described in Addendum 1.

This document is especially significant as it represents an important step in the empowerment of developing countries, providing as it does an agenda that was prepared entirely by experts from developing countries to answer to the specific needs and challenges of developing countries. That is, to provide developing country answers to developing country problems. However, in an interconnected and interdependent world, the Agenda 21 for Sustainable Construction in Developing Countries does not concern developing countries alone, but also offers guidance to developed countries in their pursuit of sustainability, as well as opportunities for mutually beneficial partnerships.

1.1 Objectives

The aim of this document is to provide a research and development agenda and strategy for action for sustainable construction in developing countries. The objectives of this R & D agenda are to provide a common framework that can be used to:

- Guide international and national investment in research and development in developing countries.
- Stimulate debate and encourage the exchange of learning on sustainable construction within the developing world, thus drawing the developing world into the international debate as an equal partner.

1.2 Scope of the study

It is important to note that Agenda 21 for Sustainable Construction in Developing Countries restricts itself to issues that can be addressed through sustainability initiatives in the built environment. However, one must recognise that this is a highly simplistic view, which is based on the assumption that several other macro-scale factors are appropriately addressed. Four such factors, which will not be covered directly, are:

- Political stability. Political instability greatly undermines sustainable construction among other facets of socio-economic life. Besides, people, buildings and settlements are often the first targets of political violence, which in turn:
    - Renders people homeless. A growing refugee population increases the demand for emergency shelter and settlements.
    - Reduces the lifespan of buildings, either through actual destruction or lack of care and maintenance.
    - Reduces incentives to invest in property development and maintenance.
    - Reduces incentives for research and training, while contributing to the exodus of existing capacity.
- Transparent governance. Absence of transparent governance also translates into a situation where the construction industry becomes tainted with unfair practices, especially corruption in bidding, tendering and contract awards, as well as throughout the construction process.
- Economic growth and the redistribution of wealth.
- Meaningful integration and participation in the global economy, as well as meaningful political and economic cooperation among developing countries on a regional basis.

While the HIV/Aids pandemic and natural disasters also have significant implications for the construction industry in developing countries, which will need specific strategies, these fall outside the scope of this Agenda.

1.3 Structure of the document

Chapter 2 aims to provide an overview of the sustainable construction debate. It clarifies the sustainability terminology used, discusses some of the tensions, briefly describes the impact of the construction sector on the environment and society, and outlines some of the challenges of sustainable construction. Chapter 3 describes the developing world context within which this Agenda will have to be implemented. Chapter 4 outlines the actual R & D agenda proposed, while the strategy for action in Chapter 5 provides a framework of actions required from the various role-players responsible for supporting and implementing both the R & D agenda and sustainable construction. Chapter 6 describes the way forward for the implementation of the R & D agenda.

1.4 Definitions

1.4.1 Developing countries

For the purposes of this project, developing countries were defined as those countries outside Europe with a per capita GNP of less than US$7 000. Although this is the measure used by the World Bank, it must be commented that the use of GNP as a measure of development is coming under severe criticism. Not only is it based on consumption (and therefore not conducive to sustainability), it also disallows other, more qualitative measures of development that may be a more accurate measure of sustainability. These countries are also generically referred to as "the South", despite the fact that many fall in the northern hemisphere. The term "the North" is used for Europe, North America and high-income countries in Asia and Oceania. Despite its geographical inaccuracy, the north-south terminology is increasingly preferred in development circles, as the UN terminology implies that countries in Europe, North America and Australasia are superior ("developed") to other ("developing" or "less developed") countries.[1]

1.4.2 Construction

In the context of this Agenda, four meanings of construction are used:

- Construction as site activities that lead to the realisation of a specific building. In this regard construction is viewed as a specific stage in the project cycle described below.

- Construction as the comprehensive cycle of a building project, covering key stages such as feasibility, design, build, operation, decommissioning, demolition and disposal.

- Construction as a sector of the economy, which is in turn linked to allied sectors and industries in material production and distribution, as well as service sectors such as transport and finance. In Latin America, the term construbusiness has been coined to denote this broadest interpretation of construction.

- Construction as the broad process/mechanism for the realisation of human settlements. This entails the land-identification, planning, design and implementation processes for human settlements.

Construction is the broad process/mechanism for the realisation of human settlements and the creation of infrastructure that supports development. This includes the extraction and beneficiation of raw materials, the manufacturing of construction materials and components, the construction project cycle from feasibility to deconstruction, and the management and operation of the built environment.

Each of the four variations in meaning has different implications for the relevant sustainability issues to be addressed. The sustainability implications of construction as a site process aim only at minimising the environmental and worker-related impacts. Any broader concerns with sustainability in the built environment need to be addressed at stages in the project cycle earlier or later than at the construction stage. This leads to the second level of meaning of construction, considering construction as the comprehensive project cycle. This entails the pre-construction stages, as well as feasibility, site identification, design/technical documentation and contract award, as well as the actual building works and the post-construction stages, such as occupation/operation and demolition. Although this definition provides a more comprehensive framework for integrating sustainability issues in the built environment, it is still limited. This is mainly because the life cycle (and related impacts) of most construction materials/components begins well before the conventional project cycle begins, and ends well after the project cycle is over. This necessitates the third level of definition – construction as a sector of modern economies. In this respect the sector is viewed as a critical link in a chain of events originating with the extraction of raw materials (mining and harvesting) through processing and distribution of components, assembly of components on site, and building occupation followed by decommissioning of buildings, demolition and disposal of resultant waste. With this approach the range of sustainability issues and opportunities broadens significantly.

The key limitation of the above three definitions is that they tend to focus on the biophysical and economic considerations of sustainability in the built environment, while ignoring the human dimension (adequate provision for basic needs such as shelter, poverty, threat to cultural values and inequalities – gender, generational or regional). This has led to the broader view of construction as the process/mechanism for the realisation of human settlements. Sustainable construction in this context focuses on providing human settlements (urban and rural) that reaffirm human dignity rather than undermine it. The role of human settlements in reducing crime and enhancing the psychological/spiritual well-being of the inhabitants then becomes a critical issue.

A "sustainable construction industry" no longer means simply that the industry is able to continue its business and grow, but also that it supports the principles of sustainable development – which may mean that in some cases it needs to stop growing, or grow in different ways.

As "sustainability" has come to denote a meta-concept linked to the principles of sustainable development, the meaning of the term in relation to the construction industry has also changed. The next chapter provides some background on the sustainable construction debate, which will clarify the terminology and explain the importance of broadening the definition of construction to include this systemic view of the entire process of settlement creation.

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".

"Sustain: to support, to keep alive, to keep going"

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.

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.

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.[2]

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 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.

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs… As such it requires the promotion of values that encourage consumption standards that are within the bounds of the ecologically possible and to which all could reasonably aspire."
> Our Common Future, WCED, 1987

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.

> "Human settlements mean the totality of the human community – whether city, town or village – with all the social, material, organizational, spiritual and cultural elements that sustain it. "
> Vancouver Declaration on Human Settlements, 1976

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. 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]

Vision of the Forum Cities for Life (Foro Ciudades para la Vida), Peru

"We want cities for life that reflect the expression of sustainable development and that offer an adequate quality of life to their inhabitants. This is to be achieved through equal opportunities for a healthy, safe, productive life with solidarity and in harmony with nature and its rural surroundings, and the cultural conditions and spiritual values adapted to the diversity of the country. We want cities for life in which their inhabitants identify themselves with its development, in which they are proud of their culture and the natural beauty of the place they live in; and where they cooperate and demonstrate solidarity, while being competitive."
Forum Cities for Life, National Action Plan, 2000-2005

- 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[4]). 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

	Brown	Green
Key concern	Human well-being	Ecosystemic well-being
Timeframe	Immediate	Delayed
Scale	Local	Local to global
Concerned about	Low-income groups	Future generations
View of Nature	Manipulate and use	Protect and work with
Environmental services	Provide more	Use less

Table 1: Difference between the Brown and Green agendas.[6]

general, 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.[5] Table 1 illustrates the main differences between the Brown and Green agendas.

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:[7]

- 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.

Sustainability will demand fundamental and far-reaching changes in the world economic order and power relationships, development models, production practices, attitudes to resources and ways of living.

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.[11] The manufacturing and final use of both these materials can also be very water-intensive. Construction activities, whether through the manufacturing 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.[13]

Material	KWh/Kg	KWh/m3	Coal (Kg)
Sawn timber	0.7	350	0.8
Cement	1.4	1 750	260
Concrete	0.3	700	25
Bricks	0.8	1 360	140
Steel	5.9	46 000	1 000
PVC Plastic	18.0	24 700	1 800
Aluminium	52.0	141 500	4 200

Table 2: Energy consumption in the production of construction materials in Brazil.[12]

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.

In Cerro de Pasco city, Peru, 100% of the population have lead particles in their lungs from mining activities. The second cause of death in the city of Ilo is cancer caused by the sulphur dioxide emissions from the copper processing by the Southern Copper Corporation of Peru.

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.[14] 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 000km^2/year of farming land. Urbanisation alone is responsible for the loss of 20-40 000km^2/year.[15] 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.

Fig. 1: Soil erosion in new housing development, Mooirivier, South Africa.

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.[16] 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.[17] 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.[18] 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

Fig. 2: Workers in cooperative making compressed earth blocks, Buffalo City, South Africa.

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.[19] 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.[20] 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.

Fig. 3: Creating unnecessary demolition waste.

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.[21] 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.

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.

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.

Chapter 3 The developing world context

Why a separate Agenda for developing countries? While there are many similarities between developed and developing countries, the differences are even larger, the scope of the problems more extreme, and the resources to deal with them considerably fewer. Furthermore, the level of underdevelopment in developing countries may be cause for despair, but it also provides an opportunity for development in these countries to avoid the problems experienced in developed countries, by following a more sustainable development path.

There is therefore a sense of urgency about introducing sustainable construction practices into the developing world. Firstly, the developing world is still largely under construction and every minute means the construction of a building, road or dam that will in all likelihood not be sustainable. Secondly, the pressures on resources in these countries mean that they cannot afford to make mistakes and have to make sure that what is being constructed now will be sustainable.

However, sustainability is still a relatively new concept for the construction industry in the developing world, and it is not yet receiving sufficient attention. Societies and governments faced with the extreme survival issues prevalent in the developing world tend to adopt a crisis-management approach to development, with little regard for the long-term impact their actions will have on both the environment and society. In regions marked by poverty and economic problems, it is very difficult to establish environmental sustainability as a national priority. Consequently sustainability actions are focused on poverty, democracy, improving infrastructure, and nature conservation to support eco-tourism, and the construction sector's role in these areas remains underrated. Only the socio-economic considerations of sustainability have benefited in terms of articulated policies and implementation programmes, and the role of construction in poverty alleviation, women and children's rights, and community empowerment are growth areas in research. The biophysical considerations of construction have tended to remain research exercises to be addressed by research and academic institutions, and biophysical sustainability issues are rarely taken beyond the need for better household health through improved indoor air quality and water and sanitation provision.

Awareness of human rights with respect to basic needs such as shelter and related services has translated into communities and households demanding housing and infrastructure intervention. However, while the demand for shelter and services is high, the response from government and industry is still extremely limited and rarely considers the implications of both lack of service delivery and type of services delivered from a sustainability perspective. This then is the context within which the construction sector in developing countries has to operate.

3.1 What developing countries have in common

The developing countries have very different climatic, cultural and economic conditions, yet they have many conditions and issues in common. This document will focus on the commonalities, while recognising this diversity and the fact that solutions can only be appropriate if arrived at on a local level. The following are some of the conditions common to developing countries:

- The main sources of foreign income for most developing countries remain agricultural products and raw materials, and with the value of these commodities showing a steady decline over the past few decades, these countries find it increasingly difficult to access the financing necessary to move towards industrialisation and a knowledge economy.

Fig. 4: Global corporations and informal settlements living cheek-by-jowl in São Paulo, Brazil.

- There are high levels of inequity within developing countries, with many countries having developed a dual economy with a wealthy elite that has consumption patterns equal to those in developed countries, and the majority of the population living in abject poverty.

- The developing world is further characterised by a lack of infrastructure and basic services. Often these countries even lack the capacity and resources to improve and maintain existing infrastructure, let alone cope with the demands of rapid urbanisation. For example, in the poorest region of the developing world, Africa, only 62% of households in urban areas have access to safe drinking water, and this mostly means having access to a communal tap. Rapid urbanisation and high levels of urban poverty mean that the resources often do not exist to improve and operate this level of service.

- The rapid growth of most cities in the developing world, coupled with a lack of funds for urban investment, is the main reason behind the developing world's most pressing need – delivery of adequate and affordable housing and infrastructure.

- The majority of developing countries have a colonial past that imposed certain norms, standards and bureaucratic procedures on the development of settlements and, by implication, on the construction industry. These were often inappropriate in the local context, but destroyed existing built environment traditions.

- While the developing world consumes far fewer resources, and releases far less greenhouse gasses than the developed world, the environmental degradation experienced has a more direct and visible impact and present a more immediate threat to the survival of the poor.

- The majority of developing countries have only recently become aware of gender issues, and discrimination and even abuse against women is still part of local cultures. This extends to women's ability to be equal participants in the creation and ownership of the built environment.

- Developing countries still have strong traditions of cooperative society and have developed sophisticated methods of conflict resolution and reaching common agreement.

- There is strong grassroots ability for innovation in the use of building materials, settlement development, and institutional structuring that can be regarded as one of the most important resources in developing countries.

3.2 The main issues

Developing countries also have a number of key developmental issues in common. While these issues may cause

different problems in different regions and even countries, they are the main developmental concerns in developing countries.

3.2.1 Urbanisation and rural development

Developing countries are experiencing urbanisation at a rate unprecedented in human history. Since the 1950s the global population has more than doubled, and most of that growth has taken place in the developing world. The majority of the world's megacities are in developing countries where there is not sufficient urban investment to keep pace with the high rate of demographic growth.[22] Much of this growth therefore happened without proper planning and infrastructure investment, and in many of the largest cities, 20-30% of this growth happens in the informal sector. In Lima, the capital city of Peru, 54% of the population lives in informal housing.

Fig. 5: Favela (informal settlement) in Rio de Janeiro, Brazil.

There are many reasons why people move to the cities. They are pushed off their ancestral lands by environmental degradation, over-population, civil war, ill-conceived development programmes and government taxes. But mostly people move to the cities to try and improve their lot. Subsistence farmers are forced to enter the cash economy in order to pay medical and education bills and taxes, and to purchase the tempting array of consumer goods making their way to the villages. However, agriculture is no longer profitable for any but the largest farmers using mechanised processes and expensive fertilisers, scientifically developed cultivars and special animal feeds and supplements. In contrast, the city with its diverse economy promises a much better opportunity for survival.

Evolving appropriate sustainable city strategies for developing, as well as developed, countries requires a re-examination of modern day frameworks of the city as well as its components. Cities have always developed in tandem with economic and technological resources. In other words, as long as there is ample, expendable money, as well as access to technological resources that enable physical growth, most cities have rapidly developed with little consideration for their natural environment and long-term sustainability. This has been a feature of cities since the days of Ur, and many historical cities have paid the ultimate price for this shortsightedness. However, modern cities come with specific spatial characteristics that further increase their unsustainability.

Cities in developing countries are particularly vulnerable to the negative impacts of modern-day planning frameworks. Past colonial segregation planning systems, the modern movement's monofunctional zoning system that shaped the post-colonial cities of the developing world, the emphasis on industrialisation as engine for growth, and modern social exclusion practices such as security estates have combined to form and reinforce the disjointed and fragmented character of developing country cities.

The spatial form resulting from these factors has been observed to deepen poverty, widen inequality, increase exclusion, promote wasteful consumerism, destroy the environment, deplete natural resources, tilt investment balance in favour of

cities and in particular to big cities, and cause cultural alienation, thereby seriously damaging people's capacity to find solutions rooted in their cultures, social norms, value systems and traditional wisdom. How the developing world copes with these forces and factors will largely determine how humane, liveable and just its cities will be.

Developing world cities also have to deal with two sets of sustainability problems. It is a fact that urban poverty creates structural and strategic problems for sustainable development. Urban underdevelopment leads to high levels of indoor air pollution, pollution of watercourses, increased vulnerability to communicable diseases and social problems such as gang-related crime and problems associated with overcrowding.

However, the intense focus of sustainability efforts on adequate and affordable housing and service delivery in the developing world leaves the impression that the higher-end formal residential and commercial sub-sector has no serious sustainability problems to be addressed. The settlements and buildings in this sector therefore often fail to actively pursue a sustainability agenda.

While the higher-end built environment sector (residential, commercial and industrial) reflect higher standards of socio-economic sustainability than the informal settlements and low-cost housing schemes, they too suffer from biophysical unsustainability, as well as unresponsiveness to opportunities or strategies for addressing the socio-economic deprivations manifested in the poorer areas.

At the building unit level, failure to address energy and water conservation, the re-use and recycling of components and materials, targeted job creation and the use of local resources, as well as issues of gender inequality, are some of the unsustainability outcomes of this sub-sector. The biophysical unsustainability is characterised by heavy environmental impacts throughout the project cycle and the cradle-to-grave cycle of materials and components. In the project cycle, these impacts include:

- Increased water pollution due to greater runoff from hard paved surfaces and waste/pollutants generated through urban use such as motorised transport, soil erosion from excavation sites and uncollected solid waste.

- Heavy consumption of resources for inputs to production of virgin components. Most of the materials used involve high levels of embodied energy through their cradle-to-grave cycle, and then end up on landfills after demolition due to the absence of systems for re-use and recycling of construction waste.

- The operation phase of such buildings means inefficient consumption of energy and water due to an absence of conservation strategies or initiatives to exploit renewable energy sources. Absence of strategies for the recycling of water and solid waste further translates to excessive levels of consumption and pollution.

- High dependence on mechanised construction and factory-based production of components increases embodied energy intensities while minimising job and entrepreneurial opportunities in the cradle-to-grave and project cycles of the sub-sector.

- Inefficient land use and urban sprawl, especially through development of residential suburbs, office parks and shopping malls.

- Short economic lifespan of buildings.

- Minimal opportunities for re-use and recycling of components and materials.

- High levels of solid waste generation.

This sub-sector therefore poses different sustainability challenges compared to the informal and low-cost housing sub-sector. However, these are often the "invisible" challenges that hardly attract attention. The absence of appropriate legislation or incentives, as well as the incapacity of local authorities and central governments in implementing the existing ones, has meant that the middle/high income residential and commercial sub-sector have totally ignored the need to address the biophysical issues. The market-driven sector is likely to continue ignoring socio-economic and biophysical considerations unless there is a significant change in legislation/incentives and the capacity of governments to implement them. The challenge of sustainable construction has therefore remained unanswered. It is also evident that the resources of most stakeholders in construction will continue to be directed towards socio-economic considerations, and ways will have to be found to achieve a balance of investment between socio-economic and environmental sustainability, exploiting the synergies between the sectors.

Linked to urbanisation are two further issues: rural development and its links to urbanisation, and the issue of land.

a) Urban-rural linkages

The development strategy of industrialisation, in which the construction sector plays a large part, focuses most of its activities in urban centres, causing labour in rural areas to migrate for employment. Gordon[23] is of the opinion that industry has succeeded neither in achieving economic development for most countries, nor even in providing employment for all the hopeful job seekers. It has been found, though, that a small increase in the number of jobs available may stimulate migration to such an extent that unemployment actually increases as a result. Therefore it is necessary to reconsider current infrastructure and industrialisation investment strategies in terms of their spatial location and the resultant effect on migration.

It is clear that urban and rural problems are closely interlinked. Linkages between cities and their rural hinterlands are critical to the functioning of both. Programmes for the revitalisation and redevelopment of transportation networks and infrastructure between cities and rural areas have attempted to address this. Transportation in many ways provides a vital lubricant for trade and permits the advantages of geographical specialisation in production to be more fully exploited. However, in many of the developing countries there is a widespread transportation crisis. This crisis is not always one of quantity – many countries have extensive road and rail networks – but rather the quality of the infrastructure. These countries therefore face problems of both quantity and quality in transportation, which in turn impact on the viability of rural economies and their attractiveness to jobseekers. Tourism is also playing an increasingly large, and not always beneficial, role in rural development in the developing world. To understand the construction industry in relation to tourism, one needs to understand the models and types of tourism developed in most developing countries. Until recently, most foreign investment in tourism was coupled with foreign architectural concepts and imagery and the destination became a replication of high-density Western architecture. This is amply illustrated by the proliferation of Western-style high-rise hotels in countries such as Turkey and Thailand. The appropriateness of such structures, the aesthetic quality of the architecture and their impact on the local environment and society are questionable in terms of their contextual responsiveness. Investment in tourism is meant to encourage a self-sustaining economy. However, the international tourism industry, because of the economic power held by foreign investors, imposes a pattern of development which exacerbates dependency on developed countries.[24] This trend can be observed in many developing-country tourist destinations, especially in their

architectural expression, imagery, usage of materials and construction procurement systems. Tourism development has also caused irreversible environmental and social damage in many countries, and tourism development projects need to be approached with caution and wisdom.

Fig. 6: Rural housing, Limpopo Province, South Africa.

In short, visible and sustainable rural development strategies should form an integral part of fashioning a new urban future. The inherent sustainability advantages of rural living – lower energy consumption, lower waste production, lower pollution, small size, cyclic metabolism and in some cases more direct governance, combined with the urban environmental backlash, could lead to a reassessment of our priorities. There may be a place for Ghandi's village republic system, after all.

b) Land

Land is the basic matrix of life and all development activities generate on or from it. The traditional relationship to land ownership is one of the major differentiating factors between developed and developing countries. Land values and land ownership are considered synonymous with progress, but this perspective needs to be re-examined. Traditional practices, for example the Artha Shastra in India, and tribal law in many African countries, propagated a system very different from today's practices. In Ghana, for instance, land is seen as belonging to the ancestors and it is kept in trust for future generations, thus no one can own land.

> "But how can you buy or sell the sky? The land? The idea is strange to us. If we do not own the freshness of the air and the sparkle of the water, how can you buy them? We have not inherited the Earth from our forefathers, but borrowed it from our children."
> Chief Seattle, 1858

The values attributed to a product are frequently unrepresentative of its real value, as a result of various market and credit systems. The manner in which land is valued is a typical example that has far-reaching effects. It can lead to speculation (and inflation) without creating any real value or product. Furthermore, if the owner has to pay a high price just for the land, he will often compromise on the quality of the building itself. Logically, it is the asset on the land that can be bought and sold, and not the land itself. Most developing countries are suffering from the ill effects of unsustainable land- and credit-related financial policies. Over the years we have linked value to land and made this a transactable commodity with astronomical value, perpetuating the lack of integration of the poor into the city's economical and social opportunities. Presently, there is widespread inequity with regard to access to land in most developing countries.

The fact that you can trade in land is by itself the core of the problem. There are three areas that need critical examination:

- The commodification of land, which is a major contributor to inflation.
- Credit against land as a mortgageable asset, which in turn leads to inequity.
- Lack of access to credit because of inequitable access to land, and therefore of collateral.

Besides the need to reformulate the financial and legal aspects of land issues, we also need to reconsider how we use, distribute and manage that land. Planning land use and where we build needs to be integrated with the planning of water supply systems and roads, as well as drainage, sewage and the disposal of waste. Development strategies that are based on natural resource planning are often relegated to the background, and instead political considerations are allowed to dictate regional plans. This results in the misuse of land, inequitable growth and extensive degradation.

At urban level formal developments still thrive on the perception of abundance of cheap land, as is evident from the single-purpose land usage. This results in heavy land take as most such properties are developed at very low densities. This in turn poses a major threat to other land uses such as agriculture, forestry, and nature conservation. Urban sprawl also contributes significantly to loss of bio-diversity and impairment of water catchments areas. Urban sprawl is supported by private motorised transport. However, while it is clear that developing countries have far lower demand for private motor vehicles, infrastructure continues to be planned for projected vehicle ownership that equals that in Europe or even North America, instead of focusing on the development of more efficient public transport systems.

Fig. 7: Sprawling low-cost residential development in South Africa.

3.2.2 Sustainable housing

The integrated concept of housing as part of the urban tissue of a city is not often contemplated by the construction industry, yet it is one of the most pressing problems of the developing world. Housing is far more than just shelter and is only one of the building blocks of human settlement. For housing to be sustainable, housing programmes have to adopt a holistic perspective and include issues such as urban design, urban greening and the provision of social infrastructure such as schools and clinics. The problems of sustainable housing concern both formal and informal housing provision, as well as the policies that regulate housing provision. Housing is also often seen as a product to be fabricated and delivered, instead of as an enabling and empowering process.

Urban housing, especially low-income housing, in the majority of developing countries is characterised by the following:

- Rapid growth of slums and unauthorised settlements (between 20-30% of new growth in cities).
- Overcrowding.
- Deteriorating quality due to poor maintenance and neglect.
- Declining rental stock.
- Sluggish supply rate of formal housing.
- Unaffordable land and housing prices compared to income and savings levels.
- Strained physical infrastructure and social services.
- Shortage of skilled labour.
- Insufficient attention to social, environmental, cultural and climatic factors in planning and design.

Although sustainability at human settlement scale has received great attention so far in most developing countries, it still remains the most glaring challenge in terms of its demand on resources and expertise. The demand at human settlement level (especially for affordable housing) has become so much that there is hardly any spare capacity to be directed to the other levels of sustainability, especially with respect to the impacts and opportunities of the formal construction sector. On the other hand it is at settlement level where the developing world's contribution to sustainable construction becomes more effectively demonstrated, especially in terms of the community-based delivery processes that characterises low-cost housing projects from South America to South East Asia. In many developing countries family members themselves are building a significant number of houses, normally with help from family and friends.

a) Informal housing

The informal sector is the biggest producer of housing stock in most developing countries. Most of it is illegal and built through self-help construction processes. The sector is characterised by insecure tenure, poor-quality environments, small units, high density, inadequate physical and social services, and the unavailability of finance and credit. On the other hand it is affordable, and presents not only problems, but also solutions.

There is possibly no better starting point for the sustainable construction agenda in the developing world than the shack. This building type, which is predominant in all cities of the developing world, is a highly paradoxical phenomenon. Although it is clear why informal settlements and shack housing have been identified as among the most pressing sustainability issues in cities in the developing world, it is rarely recognised that the shack and its related informal settlement types have extremely unique sustainability qualities which need to be enhanced. On the one hand, the shack epitomises that pinnacle of resource efficiency that even developed countries are still struggling to achieve – full re-use and recycling of building materials and components. A conventional shack can consist almost entirely of re-used components or materials sourced close to the site. Since they are self-built, shacks exploit the most abundant skills and technology available within the household and community. This enhances resource conservation and affordability while providing a channel for household employment and investment. The shack is also quite low in embodied energy and very easy to deconstruct and reassemble as required. Its production, operation processes and layout also provide opportunities for the development of cohesive communities and settlement structures which have proved difficult to replicate through formal upgrading and new formal settlement development.

Fig. 8: Re-use of materials - shacks in Cape Town, South Africa.

Key amongst these strengths are labour-intensive construction methods, locally sourced materials, and highly structured, internally networked and mutually supportive communities. The communities also contribute to the general recycling of resources from the waste stream, not only for their own use but also for supply to the conventional recycling stream. Failure to recognise these sustainability qualities often leads to these qualities being disregarded during housing interventions aimed at improving socio-economic sustainability.

On the other hand, the shack epitomises a lot of what is unsustainable about construction and the built environment. This is characterised by the following:

- Lack of tenure –- most shack dwellers are squatters who occupy land illegally, often at very high densities.
- Inadequate shelter (poor construction and inadequate size for the number of occupants).
- Poor indoor air quality, especially due to inadequate ventilation and use of fossil fuels or biomass fuels.
- Major contribution to water and outdoor air pollution.
- High vulnerability to both natural disasters and man-made disasters such as fire.

b) Formal housing

Public sector housing programmes are characterised by doubtful quality, generally unimaginative planning and design, low market image, high client dissatisfaction, poor land management records, low land costs and low expectations of profit, offset by organisational inefficiency. In the rush to provide better housing and improved services, communities are sometimes relocated to remote sites that inhibit the social processes that facilitate cohesive communities and settlements. In Africa, single-purpose land use, low densities, long distances from work centres and inadequate public transport are some of the urban level unsustainability issues related to such interventions. In Asia and Latin America, issues such as a lack of formal low-income housing schemes in some countries, and the high population densities in housing schemes, create a different set of problems.

Although affordable housing has been pursued as the most critical agenda for sustainable construction in the developing world, one can conclude that most of the interventions have not been carried out in a sustainable way from both socio-economic and biophysical considerations. It is therefore clear that the delivery of sustainable and affordable housing/settlements still remains as one of the most critical agendas for sustainable construction in developing countries. The large projects initiated to improve the housing conditions of the urban poor are not motivated by improvements in the overall sustainability of the city, but rather by the need to improve the economic indicators of employment generation through construction activities, and meet the targets set by political agendas.

The Brazilian experience

The current state of Brazilian cities is due to the absence of public or private housing programmes capable of financing or promoting the production of housing and urban infrastructure on a large scale. Thus the housing deficit today is characterised as one of the biggest problems faced by the population and a major challenge to the construction industry. Poor distribution of income is the main cause of the housing deficit. This deficit can be subdivided into two different concepts: quantitative deficit (the number of dwellings that need to be built to meet the demographic demand), and qualitative deficit (the number of dwellings considered inadequate because of a lack of or poor infrastructure and excessive overcrowding). Self-construction in peripheral areas or high-risk areas such as steep slopes or flood plains has seen the creation of the "illegal" city. These clandestine self-constructed shantytowns are still the main source of housing production in Brazil.

The South African experience

At the house design and construction level, many low-income housing schemes show minimal improvements to the shack. Inadequate size, poor thermal and structural performance, use of costly and highly processed materials and technologies, a short economic life span with high maintenance requirements, as well as inadequate community/owner participation in the intervention are some of the inadequacies of the housing delivered.

It is not uncommon to see subsidence, the cracking of walls and unbearable indoor temperatures, coupled with wrong foundation and construction material choices yielding unhealthy environments and high maintenance costs. This is because little site planning and assessment takes place and factors such as climatic conditions, orientation, hydrology, geology and ecology is rarely considered.

These housing interventions are also implemented with little or no public participation and seldom make provision for adequate social services. Non-occupation, pilferage, waste and corruption are further common problems that can be highlighted.

The challenges differ from region to region, and some regional perspectives are discussed in the accompanying boxes. However, the problems of quality, exclusion, social sustainability and environmental impact are common to all the regions.

As the term often implies, low-cost housing interventions aim at low initial cost per unit delivered, with minimal consideration for the life cycle cost of the housing provided to the owners, the communities and society in general. The properties also hardly get integrated into the conventional property market, as they are perceived to be of inferior quality and constituting high financial risk. During the last twenty-five years, various housing practices considered to be "alternative" have shown themselves to be the only programmes capable of reaching the poorest sections of the population. Among these are the popular housing cooperative, and alternative methods of production based on the collective and organised efforts of the community. John Turner pointed out in the 1970s that a participative system for housing production would bring benefits for all. On the one hand, the users themselves decide on the planning, administer the resources efficiently, and guard the built environment against degradation. On the other hand, the quality of the resulting buildings and the personalisation of the product help to reduce instances of default on payments and promote the financial sustainability that the traditional programmes had been losing.[25]

The most effective of these participative systems have proved to be self-managed popular cooperatives, where the community has financial control of the project, including purchasing, hiring, payments and keeping of accounts. For the development of the building project and its execution, technical consulting services – which do not belong to any public organ – are contracted. In popular cooperatives in Peru, the total indirect costs of building are some 45% less than the total cost of conventional construction. Besides the cost factor, the quality of the construction produced by popular cooperatives can be higher than that achieved in conventional enterprises. The low level of material wastage and the diversity of the architectural and typological solutions resulting from the participation of the cooperative workers in the planning and execution can explain the higher quality of construction found in cooperative schemes.

However, due to the resistance from consumers and the companies providing the service, it is very difficult to imagine that the demands for sustainable housing and better services can be satisfied with alternative clean technologies. The self-help tradition of poor families does not guarantee the use of these technologies, because they tend to copy medium and high-class construction concepts with a misunderstood concept of progress and modernity.

c) Rural housing

A shift in socio-economic patterns from traditional agriculture to monetary based agriculture and later to manufacturing industry has changed the planning patterns and construction systems in developing countries in urban as well as rural areas, as the adopted planning laws, building codes and regulations from the West often discourage, if not forbid, housing development based on traditional concepts. However, in some cases rural housing still provides good examples of an alternative and perhaps more sustainable model of development and construction.

Fig. 9: Traditional house, Himachal Pradesh, India.

The following factors influence the production process and product quality of rural housing:

- Increasing monetisation and commercialisation of rural economy.
- Changes in social systems and relations that have traditionally encouraged/facilitated use of communities' internal skills and resources in construction of houses/buildings on a self-help, mutual sharing basis.
- Declining access to materials such as mud, thatch, bamboo, wood, stone and cow dung, with which villagers use to construct houses.
- Increasing alienation from the traditional natural building materials due partly to the "urban" influence of modernisation, and party to the "unsatisfactory" performance of these materials.
- The gradual disappearance of traditional wisdom and knowledge of building science and materials.
- The exodus of skilled labour to cities/ other countries.
- Underdeveloped housing credit systems and institutions; expensive and exploitative informal credit; and scarce formal institutional credit for individual customers.
- Legal status and insecurity of tenure, as well as depleting common property resources, are problems for poor households.
- A scarcity of professional services, especially locally based services.
- The non-availability of credit for repairs, upgrading and extensions.

d) Housing policy

In many developing countries there are no clear-cut policies to support housing and urban planning, and there is a definite lack of norms and specific legislation that promote sustainable construction. While there have been regulations regarding Environmental Impact Assessments (EIA) for industrial sectors like mining, fishery and forestry for a while now, these requirements rarely exist for the construction of big infrastructure projects and large urban development projects.

According to Turner, one of the main barriers that needs to be removed by governments regarding the housing issue is the traditional institutional approach in terms of programmes and packages – that is to say, imposing standardised sets of goods and services for categories of people, made up of pre-selected options.[26] This administrative, cultural or merely geographical divergence between those who decode, control and make projects on one side, and those who need, use and pay on the other, has already resulted in many unsuccessful experiments in housing in economic, technical, aesthetic, environmental and social terms. Too often government presents itself as The Great Provider without the financial and institutional capacity to make good on its promises.

Political changes in the developing world from colonial to post-colonial times have also meant changes in government policies in areas such as housing and other development spheres that have an impact on sustainable construction. Due to urbanisation and population growth, with the resultant acute shortage of housing, many governments have provided housing – among other national needs. Housing policies were often geared towards delivery of low-cost housing on a large scale or, following the enabling approach of providing a core or starter house, a site with services, or a capital subsidy. However, there are several challenges that have resulted from large-scale housing provision. The one is that the race to complete large quantities of housing in a relatively short timeframe prompted the emergence of unscrupulous contractors with relatively limited experience in the construction sector, whose standards of workmanship and project management were poor. Beneficiaries of such housing have been unable to achieve consolidation on account of low incomes and lack of access to economic opportunities and credit. In the area of skills transfer, the scale at which women have benefited has also been limited.

3.2.3 Education

Ignorance, lack of access to information, and education on environmental topics, especially those related to sustainable construction, are present at all levels. Raising public awareness on environmental and equity issues is indispensable for sustainable development. For successful implementation of comprehensive and appropriate development issues, it is essential to educate the public, governments, social and technical institutions and business groups about comprehensive sustainability issues. Just as an individual understands the implications of his daily financial decisions, similarly he should be cognisant of the social and environmental implications of his actions.

Two main problems exist in the current education system. The first and most important one is a lack of integration of these efforts within the education system, since development as well as research in the field of sustainable human settlements and construction is not linked to the academic institutions. At best, any change and development work continues to remain one of many pilot projects or "alternative" options. Their propagation at a mass level is hindered by the lack of appropriately trained professionals within the profession, government agencies and amongst the educators themselves. This lack of awareness also exists amongst the general public. This shortage of professional skills can be ascribed to the following reasons:

- Lack of awareness and exposure to sustainability issues in a holistic manner.

- The inability of the faculty to guide and support students in these efforts due to the requirements of working within the conventional framework, as well as the faculty's own lack of understanding of sustainable construction.

- There is no organised feedback of research and development in sustainable design and construction into the professional institutions. The system remains static in the absence of a discerning coterie to advocate the necessary change.

The creation of better mechanisms to allow the transference of knowledge from research institutions to the market, bridging the gap between theory and practice, is crucial. To bridge this gap will require intervention at all three levels of education, continued education programmes for both professionals and technicians and a concerted public education programme.

High on the agenda would be to develop modules that become part of the regular school curriculum. Just as Mathematics and other sciences are part of the basic school curricula right from the primary level, the subject of Sustainability must be taught so as to become a part of one's daily thought processes.

Sustainable construction will also require professionals with better environmental knowledge. This, in turn, will require environmentally orientated education in fields like building materials and building systems. Furthermore there is a shortage of qualified workers and an insufficient amount of specialised workers, especially in alternative and clean technologies. Within the curricula of schools and tertiary institutions there are often no courses that include the problems and requirements of sustainable construction.

3.2.4 Gender equity

In many of the developing countries, women are still considered second-class citizens. It is important that the role of women as legitimate owners, users and producers of housing is recognised. In its report entitled "Shramshakti", the National Commission appointed by the Government of India on self-employed women and women in the informal sector notes that all poor women share some important characteristics. These can be summed up as fewer and poorer opportunities to work; greater impact of unemployment, under-employment and casual nature of work; greater vulnerability because of lack of skills and education; lesser mobility; heavy responsibilities; a system of social practices underrating the value of women's work; and lack of access to better technologies, tools and productive assets.

Fig. 10: Women being taught how to build with rammed earth, Johannesburg, South Africa.

Women construction workers face instability and insecurity of work, poor remuneration, and discrimination in the payment of wages. Tools, equipment and technologies used by skilled and unskilled workers are not designed for women's physiology, and women are also often the last in line when skills like masonry and carpentry are imparted. Conditions on construction sites also do not take into account women's need for privacy and security.

3.2.5 Financing and procurement

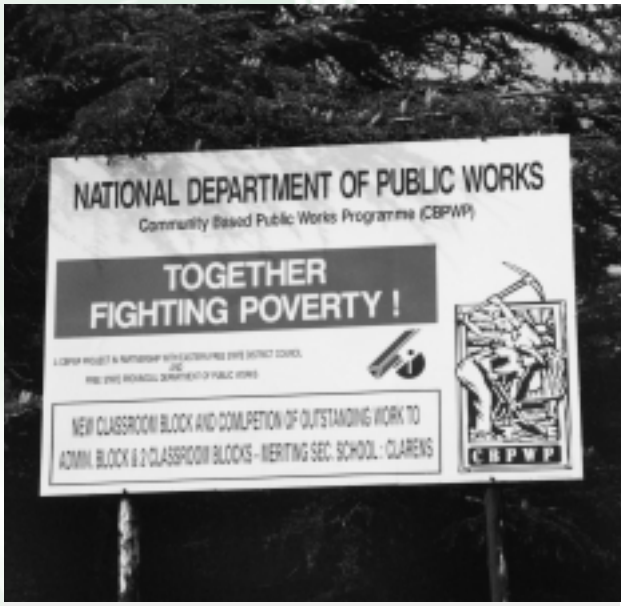


Fig. 11: Construction projects funded as part of poverty relief programme, Clarens, South Africa.

There is tremendous scope for achieving sustainability through the use of government expenditure as a procurement instrument, especially given that the government is one of the major clients of construction firms in the formal sector. It is possible and appropriate for the government to demand sustainable construction practices. However, this possibility is also limited to various factors. Dwindling government income and a limited revenue base may limit the uses of government expenditure as a policy instrument for achieving sustainable construction. In the face of other competing demands, less emphasis may be put on measures and processes likely to lead to sustainable construction, especially if these mean additional costs. This would particularly be the case with regard to the use of government grants and subsidies as incentives for adopting sustainable construction processes.

Most developing country governments favour large turnkey projects and "build, operate, and transfer" projects. Among the problems associated with these procurement systems is the fact that only large companies are able to participate effectively in this kind of project, as proof of available bridging finance, large capacities and long standing experience in similar projects is often required. This means that foreign companies often win such project bids.

There is also little finance available to introduce environmentally appropriate and sustainable interventions, and existing financial avenues are resistant to the use of new technologies (e.g. photovoltaic energy sources) and materials such as earth or straw bale. One of the major challenges would be to develop financing mechanisms that enable and encourage the use of sustainable technologies and level the playing field for local contractors.

3.2.6 Governance and management: institutional sustainability

The combination of economic and regulatory measures by which sustainable construction can be encouraged would be difficult to implement in the developing world. This is because of the absence of the necessary government and private institutions to facilitate the process. In the particular case of sustainability initiatives, the role of institutions as a necessary prerequisite to successful implementation of sustainable policies and processes is well documented.[27] Perhaps more significant are the constituents of the institutional problems cited in the developing countries as impediments to sustainable development. Commonly identified institutional problems in the developing world include inadequate skills and personnel, poor monitoring, corruption, lack of coordination, lack of political will and limited public awareness of the concept of sustainability, and inadequate legislative frameworks.

These problems are especially acute in sub-Saharan Africa. The dearth of institutions necessary to enable the formulation and implementation of effective policies to drive the process of sustainable construction makes a mockery of the call for sustainable construction on the continent. Unless these institutions are in place to facilitate and implement appropriate policies, efforts at achieving sustainable construction in sub-Saharan Africa remain unrealistic.

The significance of institutional sustainability as a necessary prerequisite to environmental sustainability is often ignored, especially in the case of the developing countries, where it is assumed that functional institutions exist. This assumption often encourages the formulation of policies that are largely incongruent to the peculiarities of these countries. Policies that give no recognition to the dearth of financial, human and institutional capacity are openly advocated for the developing world. As the experiences of developed countries show, the structure, conduct and performance of the construction industry is crucial to the sector's ability to respond to policy initiatives and development strategies.

When it comes to policy instruments for implementing sustainable construction, the scope is limited by numerous factors. If we take economic policies and instruments as an example, the fact that a huge proportion of the population in developing countries operates outside of the mainstream economy drastically reduces policy activism and effectiveness. For instance, in the majority of sub-Saharan African countries, most medium to small construction industry operatives are not registered in the tax system and do not pay taxes, making it very difficult or impossible to subject them to any fiscal discipline or influence.

At local government level, the local authorities in charge of the provision of construction permits, the regularisation of informal buildings, the provision of good quality public spaces and the control of urbanisation, are not equipped with the necessary financial and technical resources to provide these services adequately, let alone include criteria for sustainability. While there are many tools available to assist local authorities with environmental management, they are not accompanied by the necessary capacity and the financial resources for their application.

3.3 The barriers to sustainable construction

3.3.1 Lack of capacity of the construction sector

The most critical barrier to sustainable construction is the lack of capacity of the construction sector to actually implement sustainable practices. This lack of capacity is a factor both of the number of human resources and the skills levels of these resources. There simply are not enough professionals, tradesmen and labourers who have been trained to support sustainable construction. In fact, the capacity of the construction sector in many developing countries can barely deal with the demands of routine construction. The vast majority of construction firms are small enterprises that rely on outsourcing personnel as required. This has severely affected skills training and the retention of expertise in the industry as construction workers become highly mobile, walking in and out of the industry, depending on performance in other sectors of the economy. The impact can be seen in the rigid adherence to management techniques and construction practices handed down from colonial times which, as a result of inadequate skills and capacity, have remained unchanged and irrelevant to the requirements of sustainable construction.

3.3.2 An uncertain economic environment

In developing countries the private sector has a very narrow market base and the formal construction industry overly relies on the government for work. However, government construction orders fluctuate with income, especially multilateral and unilateral financial assistance, which often facilitate the foreign exchange devoted to imports, including construction materials.

There has also been a reduction in public spending as services previously provided by governments are privatised because of fiscal prudence, or simply because governments are bankrupt. Often reductions in public spending are

a precondition for financial support from the World Bank or International Monetary Fund. For example, in Kenya public building activity in 1995 was only 3% of what it had been in 1982.[28]

This helps perpetuate the informal approach to construction activities, as fluctuations in construction activity discourage long term strategic planning, which in turn hinders access to investment capital. Usually, detailed investment appraisal is required by financial institutions to grant business loans, which is impossible in an uncertain economic environment brought about by the huge variations in construction demand. As a result, a vicious circle emerges where uncertainties prevent access to capital investment, making it difficult in turn to maintain and procure plants and equipment and train personnel to deal with new requirements such as sustainability.

Delays with interim and final payments, as well as onerous contract conditions faced by construction firms, can also impose huge constraints on the industry. Many construction firms have suffered financial ruin and bankruptcy because of delays in payment, which are common with government contracts. This is further compounded by the political instability that prevails in developing countries, where new regimes often refuse to honour the contracts issued by their predecessors.

The construction industry in developing countries is also often very dependent on the importation of construction components and materials. There is a direct relationship between natural resource depletion and foreign exchange earnings, which are used to facilitate imports, including construction materials and expertise. Thus, achieving reductions in construction-related imports through a sustainable construction process would assist in reducing the environmental impact of related activities such as mining and deforestation. This is particularly the case given the negative terms of trade between primary commodities and manufactured products.[29] This means that as import prices increase and primary commodity prices fall, as is often the case, real resources are constantly transferred from the developing countries to the developed countries by having to export more primary commodities for less manufactured products.

3.3.3 Poverty and low urban investment

The cities of the developing world show a low rate of urban investment against a high rate of demographic growth. This has evolved into the accelerated degradation of the urban quality of life. This process affects not only the urban poor and their surrounding environment, but has a negative impact on the city as a whole. Even with efforts by national governments and the private sector to promote urban investment and reduce environmental degradation, the benefits have been able to reach neither the lowest income population nor the city as a whole.

Within this generalised shortage of resources – not only of people, but also of institutions – construction alternatives with new and sustainable technologies struggle to find the necessary space to develop into mainstream technologies. Any technical solution that increases the total capital cost of housing or infrastructure will probably face opposition, especially if aimed at low-cost housing.

3.3.4 Lack of accurate data

Accurate data and information is critical to achieving effective sustainable construction processes and policies. Information is needed on current "green" building materials that are available, including the types of materials, how they are employed and the resources consumed over their life cycle. Similarly, it is also important to have accurate information about the number of construction operatives, their mode of operation and the sector in which they operate.

In the developing countries the paucity of even baseline population data is well acknowledged, imposing further constraints on effective planning. Although there are government institutions charged with the tasks of gathering statistical information, they often exist only in name. Those that have had to contend with development issues would acknowledge that it is not unusual to seek statistical information from government offices in sub-Saharan Africa and be referred to the local offices of the United Nations. Indeed, in many African countries, it has not been possible to execute a population census, and the figures commonly used are projections from the colonial era. Statistical information for the construction sector is often either unavailable or unreliable.

Data and information on the health effects and risk of unsustainable construction activities are also not very reliable and often insufficient. To date it is very difficult to prove the connection between certain illnesses and environmental pollution, even though these links are well known. The lack of data about the exact connections makes decisions on interventions difficult.

3.3.5 Lack of interest in the issue of sustainability

There is a general lack of interest in the issue of sustainability – and especially biophysical sustainability – by the construction sector, its clients and other stakeholders. This neglect is experienced differently through the various stakeholders, as illustrated below:

- Politicians: Biophysical sustainability issues rarely constitute agenda-differentiation of parties or political leadership, except when they can be directly linked to gender and poverty.

- Manufacturers: Environmental responsiveness rarely constitutes a criterion in materials or product specifications, or in their marketing.

- Local authorities: Biophysical sustainability rarely constitutes a criterion or drives requirements for plan approvals, land use or land sub-division.

- Built environment professionals: Sustainability considerations rarely make it to the brief, design criteria or specifications. Related training institutions have negligible capacity for training in these issues.

The construction industry is traditionally very difficult to change, especially when it comes to the construction methods and building materials used. Companies follow the consumption patterns of clients who normally worship modernity and the development model of developed countries with its vices and problems. Furthermore, the construction sector is dominated by companies that are not interested in technology changes that involve risks and extra costs.

One of the reasons for the lack of interest by the private sector to develop sustainable products that are accessible to the various income groups of the population, is the lack of alternative financial and micro-credit mechanisms to encourage changes in present practices. Developers/financers and contractors also do not recognise sustainability as a means to competitiveness in local or foreign markets.

3.3.6 Technological inertia

Fig. 12: Traditional earth house, Free State, South Africa.

Another barrier is the unquestioning application of building codes and planning concepts from Western countries introduced during the colonial period. These regulations favour the use of construction materials such as brick and reinforced concrete, and discourage any alternatives to these building materials and types of services. To introduce any new technologies or use a broader spectrum of technologies, including some traditional technologies, is incredibly difficult. This results in technological inertia – where few new technologies are introduced and adopted – and ultimately in technological dependency on the developed world from which many developing countries have to source the materials and technologies that comply with the inherited practices.

There is no such thing as apolitical technology. Technological dependency hinders the autonomous development of dependent countries in developing their own technologies, and makes poorer countries subject to an agenda designed to favour the economic and financial aims of large international groups. Developing countries need knowledge and technology that is better adapted to their own natural resources than that which they obtain from industrialised countries. There is also a more insidious legacy of this colonial technology imposition. So insistent have the colonial powers been that their technologies and criteria for development are far superior to anything found in the colonies, that there is a general lack if confidence in home-grown solutions and traditions, and these are actively discouraged.

For instance, in Malaysia the traditional planning and construction system using timber has been discouraged since major fires occurred in 1826 and 1881. In South Africa it is almost impossible to get council approval and financing for earth construction, despite the fact that the technology has a long history of use in the country and that more than 10% of the population live in traditional housing constructed mainly of earth.

However, even if these technologies were allowed, they have been so vilified as symbols of primitivism, sub-development and poverty that people would rather pay a fortune for an imported product or technology than make use of a more appropriate and affordable local version. Even those who naturally make use of these techniques in the countryside reject them when they migrate to the city, preferring their new residences to be constructed from conventional materials, as a symbol of their social ascent, material advancement and stability.

The lack of national technological policies supportive of traditional technologies creates favourable conditions for the reproduction of the technological models adopted in the developed countries, models not suited to the reality of the developing world. In many developing countries energy sources are also particularly scarce and associated with high import cost. Scarcity of energy has therefore impacted on the local production of these imported materials, especially high-energy materials such as aluminium, steel, plastic, glass and cement. An added problem is the use of old manufacturing plants and equipment whose energy consumption and costs are often high relative to similar plants in developed countries.

While the regulations help to control standards of housing development, they have made housing minimally feasible for the poor. The regulations should provide opportunity rather than restriction in order to encourage the discovery of new solutions or adaptation of traditional solutions without endangering people's safety and health.

3.3.7 Lack of integrated research

Another problem is that much of the research in building technologies and planning is not done in a holistic manner. The research institutions, development agencies and other organisations address each issue individually and independently of other issues to which it is linked. For instance, agencies involved with building technologies focus on specific technologies such as Ferro-cement or soil blocks as isolated elements, while others deal with pollution, transport planning, environment or social issues. Co-ordination and cross-sectoral work between these agencies is lacking and thus development activities related to the design and management of human settlements do not take place in a holistic manner. Funding for holistic research projects, instead of projects focusing on one specific aspect such as energy efficiency, is also difficult to find.

While there is a consensus in the discourse, this comes undone in the proposals for dealing with the problem. This lack of integrated research planning and dissemination between the theoretical and practical spheres is a further obstacle to sustainable construction.

3.4 Opportunities

The developing countries also offer some opportunities for sustainable construction that are not common in the developed world.

3.4.1 Innovation in materials and technologies

In developing countries the availability of conventional construction materials will fall considerably short of their demand, despite improved productivity, and several alternatives for them are being developed. R & D institutions in India have developed a number of technologies for production of new building materials that are cost-effective and eco-friendly with special attention to utilisation of industrial and agricultural waste. However, most of these technologies are still in the experimental or demonstration stage. In South America, experts are experimenting with renewable materials such as sugar-cane straw panels and bamboo, and innovative construction-waste recycling experiences have delivered interesting results for the generation of different construction aggregates to be used in new construction processes. In Malaysia research is focused on marrying modern production methods with traditional building practices.

Large-scale, centralised production and consumption lead to large distances for transportation of raw materials and end products, high marketing costs and other add-ons. Macro-production essentially leads to a centralised economy and imbalanced growth, while micro-production facilitates distribution of wealth and power. There is a need to differentiate between products that need to go into macro-enterprise production and those appropriate for micro-enterprise. Technologies that are appropriate at a national level must also be segregated from those that are appropriate for local consumption. This would distinguish technologies that need to go into macro-industrial production from those suited to micro-enterprise. Appropriate technologies are those that respond to the local environment, resources and economic needs. The development of new materials and technologies needs also to take into account the fact that the majority of the population is poor with very limited investment capacity.

Fig. 13: Informal house built with old bottles, Free Sate, South Africa.

Furthermore, efforts must not only be concentrated on sourcing new and environmentally friendly construction materials, but attention must also be given to innovative recycling and re-use. This would require, as part of the strategy, a practice of producing buildings and materials with a longer life-span, and which are easy to recycle and can be disposed of at minimal environmental cost. Thus, the adverse impacts of construction activities and products on the physical environment would only be effectively minimised through efficient use of natural resources, especially non-renewable resources.

Modernising traditional Malay architecture

The Industrial Revolution introduced the idea of mass production with components manufactured by a single purpose machine. The ability of industries to offer components with regular sizes and dimensions helped to speed up housing construction and reduce costs, but the system constricts design and planning to a limited pattern. This application ignores the surrounding regional identity, since all places are regarded as the same in the design strategy of exploiting mass-produced components. The outcome is a homogeneous building identity, which tends to erode existing landscapes and disregard the essence of the place, culture, tradition and existing geography. Today, the technology has developed through the application of a computer-based approach. This has created batch industry technology, which is far more flexible and can be practically adopted for eco-friendly design. It is now possible to create a versatile and multi-purpose factory, which can provide a variety of building components or batch products as opposed to a single product.

Traditional Malay architecture relies heavily on pre-fabricated elements. The concept of assembled components using batch technology provides a way to reintroduce the traditional building patterns in a cost-effective way. Instead of being produced manually by traditional builders, the components can be fabricated at the factory. These batch-produced materials will help to cope with the demands of the housing industry. The positive aspect of batch-produced components is that they are available at reasonable prices according to individual requirements. The number of traditional craftsmen is decreasing, as there is no place for them in the modern construction industry. The application of construction methods based on a combination of traditional techniques and computer technology in the manufacturing industry saves the profession of the traditional craftsmen. Today's craftsmen, though, would most likely be university graduates doing research and designing prefabricated components in various forms, sizes, designs and styles. This move to automation will not necessarily result in job losses as a large number of workers will still be needed to work on the house construction itself.

3.4.2 Re-evaluating the traditional

The concept of sustainable development as seen within the environmental movement was well understood by the early traditions in human civilisation. The indigenous people of developing countries have practical experience of the fact that humans are dependent on the earth's life support system and traditional cultures have practised sustainable resource use for millennia. Traditional communities have always used the natural materials of their immediate environments for construction and the resultant buildings have been well integrated into the natural environment. Such indigenous architectural precedents, using different materials in different circumstances, can be found across the developing world. Traditional building materials have the additional advantage of being cheap and easily accessible. Such materials have been proved also to be climatically friendly, as demonstrated in studies by Fathy[30], Guidoni[31] Scwelferger[32] and Prussin[33].

For decades the frequent adaptation of buildings and invariable re-use of earlier materials or materials close at hand, or those drawn from abandoned or collapsed buildings, has further supported sustainability. This also provided a natural solution to the problem of construction waste. Where sound building materials survived, they

would be re-used or even adapted to suit a new design. The rest of the building materials (clay walls or grass roofs) were left to be gradually reabsorbed into the environment. While this form of natural degradation may still be possible in rural areas across the developing world, where use of rudimentary building materials and technologies are common, one has to question its workability in an urban setting where the size of construction volume and construction waste prevent a gradual deconstruction process, and the use of materials that do not lend themselves to natural degradation is the norm. However, in South Africa several pilot projects with stabilised earth block construction, and the issue of two Agrément certificates for different types of stabilised earth blocks, have shown that there is room for improved traditional technologies in the formal construction market.

Fig. 14: New Gourna mosque, Luxor, Egypt. Designed by Hassan Fathy and built with sun dried earth blocks.

However, traditions provide us not only with examples of more sustainable construction patterns, but also with examples of processes for social sustainability in the creation of the built environment. Emergent construction activities are often based on the principles of sustainable construction in terms of usage of materials, environmental friendliness, procurement systems geared towards embracing community methods of construction, and management practices found in the local culture and traditions.

a) Co-existence, community and collaboration

One of the strengths of the developing countries is the strong culture of solidarity, mutual aid and people's capacity to work together. These values can still be seen in rural areas and in the informal settlements in urban areas where the population must work together in order to improve their living conditions. It is also practised among poor municipalities which depend on such strategies to achieve results.

There are also precedents for more transparent and direct local government, for example the Panchayati Raj system used in India. This system is typically depended on the wisdom of the five headman of the village to look after the day-to-day problems of the village by dealing with a problem at the first level. It was only the residual problems that were taken to the next level of decision-making where the individual representatives went to the decision-making body of the group of villages.

La Mita - Peru

"Due to the scarce State funding, the city of Ilo has developed a co-financing system for the implementation of community infrastructure that has a great social impact. This system makes use of an ancient tradition of community work called "la mita". In this system it is the responsibility of each citizen to give one day of work per week for the community. Through this system investments of approximately 10 million dollars have been generated in communal works between 1990 and 1997. Additionally, with the introduction of the "tributary compensation programme" the neighbours with economic difficulties are allowed to pay the municipal service fees and taxes to the municipality through days of communal work."
Doris Balvin, Ilo Report, HIS-BID

b) Traditional building methods

This is another area where there is much opportunity in the amount of innovative experiences and research already done in relation to appropriate building materials and technologies. There is very valuable experience

Fig. 15: Traditional house and sun dried earth blocks, Limpopo Province, South Africa.

that can be drawn from work done by local experts in various regions, experimenting with traditional practices and materials. It is understood that the development of traditional building practices cannot be successful by simply copying a prototype of the traditional house, because the existing prototype is obsolete in a contemporary context. Furthermore, the regionalist approach is not a development of architecture which recalls a lost vernacular; it must adhere to the context of contemporary technology, topical adaptation and cultural responses. However, the traditional house and the technologies used to create it can be utilised as a springboard for research into more sustainable technologies.

In the search for alternatives which meet the expectations of the population, as well as housing and environmental requirements, the technologies which use raw earth, timber from sustainable managed sources and other organic products, such as straw and bamboo, as raw materials present great potential. Although there is currently much resistance to the utilisation of these materials, they have been used in the developing countries since time immemorial. Some of these techniques are deeply rooted in the culture of different regions, and if they were to be used in a technically correct and economically viable way, it would be possible, through successful experiments, to restore the confidence of government, industry and users. Earth construction techniques went into disfavour mainly due to the technological changes brought on by the Industrial Revolution and the consequent new demands of the consumer market. It remains one of the major problems that traditional rural construction methods, which are often more environmentally friendly, are mostly abandoned in cities because of a false idea of "modernity".

Fig. 16: "Modern" house built with compressed earth blocks, Buffalo City, South Africa.

It is known that any technological change normally requires at least one generation to consolidate. For example, in Peru the transition from mud bricks and quincha to the wrongly named "noble" materials was a process which took from 1930 to 1950 to gain momentum and then up to the 1970s to get established and be included within the national norms systems. This was done at the same time that mud construction and traditional systems were forbidden. This prohibition ended at the end of the 1980s, but the technological change was already incorporated, and it may take another generation or two before the traditional technologies become acceptable again. However, as the example from Malaysia shows, there are many benefits in taking a new look at old technologies.

Traditional housing in Malaysia

In Malaysia and other South East Asian countries, the traditional 'house on stilts' provided a far more ecologically friendly footprint than the imported terrace houses or high-rise residential blocks. It developed with the landscape and its pattern evolved with the landscape.

The traditional construction system made use of prefabricated timber components that were assembled on site. Timber is the most suitable material for the humid climate and high rainfall. Most settlements are built along the river in wetlands, as this area is most suitable for paddy cultivation - the main traditional agricultural activity. This has influenced the form of the traditional house which is built on a series of piles, with the floor elevated several feet above ground level. This compensates for any rise of the water level, while not inhibiting the flow of the water. The foundations are simple and no intensive site clearing is required. The design of the floor aids in the ventilation of the house. The house is built by a communal effort, with the men doing the heavy work and the women making the thatched walls and roofs. Through the benefit of prefabrication, the traditional house is capable of enlargement. The basic type forms a 'core' house built according to what the occupant can afford. When finance increases, so does the opportunity to extend the size of the house.

The layout of the village is based on the result of mutual agreement among the villagers. It represents the adjustment of physical and social parameters to environmental factors. When a villager wants to build a house, he seeks advice and permission from the community through the leader of the village. Traditional house construction is guided by the whole community, especially through the ceremony to select the site. The villagers commonly share most activities ranging from mutual economic aid to house construction. Often the boundary between individual, family and community responsibility is difficult to identify. This type of social unit is important because it signifies the only solution to the problem of survival. Each family is dependent on the others.

Traditional patterns offer a variation of house size for all income groups while the grouping arrangements encourage social interaction. Various house sizes are located in one group incorporating all income levels. The size of the house accords to the owner's means and avoids segregation of income levels. The use of wood makes pre-fabricated systems possible that can easily be used by semi-skilled labour in cooperative schemes. All of this supports social sustainability.

c) Ethical values for construction and settlement planning

It was the endeavour to provide for sustainable human settlements that led man to introduce guidelines for social and value-based controls so that the entire interdependent system was respected. These values and guidelines were often encoded in religion, either through propagating the sense of brotherhood and interdependence, or through myths around the elements, specific plants, and animals, aimed to ensure what we today understand as sustainability. It was the responsibility of the architect or the planner of human settlements to ensure that the principles of inter-dependency were respected. This linking of religious and social codes with architecture and human settlement planning is found in both Asian and African societies.

Traditional architecture in the Asian region was more than just the built form and its symbolism. The town-planning methodologies, the symbolism and the architecture all combined to provide a total formula for sustainable human settlements described in mystical[b] codification linked to religion. Though designated the leader of the team, the architect/planner worked in close coordination with the religious head, who was responsible for overseeing that the social aspects were well integrated in the planning and implementation stages to provide for sustainable development with social cross-checks.

[b] Mystical, or mystification is used in its sense of inducing a sense of the sacred. Thus mystifying planning controls would be to declare them as sacred and part of the spiritual and/or religious doctrine.

Vastu Vidya

The Vastu Vidya — the traditional Indian texts containing the fundamental principles of planning and building for human settlements, is the parallel of the Feng Shui in the Far East. Though propagated through myths and religion, if analysed logically it is a complete builders manual of do's and don'ts. These texts have a strong understanding of climatology, the behaviour of building materials and their appropriate application, respect for the natural elements and, most importantly, the control of human aspirations. The texts are region-specific and several versions exist, but the fundamental logic of living with nature is the common thread that holds all the versions together. These texts were revered by King and citizen alike, and propagated by the religious heads through the planners and designers of settlements.

This rationale is contained in the ancient Sanskrit text, the *Vastu Vidya*. Studying and demystifying the precepts contained in this text will provide one with human settlement patterns that are environmentally sustainable, whilst at the same time respecting the social fabric of the citizens that the settlements were designed for.

African societies also have a very strong cosmological rationale to the design and layout of settlements, and there are specific rules and taboos surrounding the creation and use of the built and natural environment to encourage peaceful coexistence and harmony at all levels of life.

So rapid was the transformation during the Industrial Revolution that all the wisdom of the past regarding governance, traditional values, customs and cultural practices were buried, and with it the traditional values of coexistence. Western science also considers these traditional practices with suspicion because of their association with religious or spiritual practices, and many Western scientists reject outright any mention of this rich heritage. However, within their context, these traditions provide a sound basis for a value system that encourages more sustainable practices in the societies of their origin. They also provide some practical guidelines for the implementation of certain aspects of sustainability from which the rest of the world can learn. By dismissing these traditions because of their religious links, we are dismissing thousands of years of accumulated wisdom. As the pharmaceutical industry is doing with traditional herbal lore, and Heinrich Schliemann did with the legend of Odysseus, we (as individuals and as creators of the built environment) also need to separate the superstition from the underlying knowledge and wisdom in order to find the hidden gold.

d) Cultural tourism

Fig. 17: Makalali Game Lodge, Mpumalanga, South Africa.

The synthesis of tradition and modernity found in the many luxury game lodges in Africa is another example of how cultural tourism can be used to reinvigorate the traditional building heritage. This approach re-uses traditional architectural vocabulary, imagery and form, which are defined through construction techniques and materials, but applies modern, scientific understanding of construction and maintenance problems. The emphasis is not only on the aesthetic quality, but rather on pragmatic architectural solutions to indigenous methods and construction processes. These methods are region-specific and embrace the indigenous type of architecture and society that has established a long tradition in terms of image, technology, appropriate traditional materials and functions. The architects and construction team involved in tourism-related design have a responsibility to blend the traditional and modern polarities, without turning it into a theme park.

Chapter 4 A future R & D agenda

4.1 Introduction

Chapter 3 provided the context within which built environment practitioners, researchers and educators have to work in developing countries. As can be seen, there are numerous barriers and challenges for sustainable construction, but also some opportunities. It is also clear that, to improve the quality of life for people in developing countries, a number of critical issues such as access to adequate housing and infrastructure, rapid urbanisation, informal settlement and institutional incapacity have to be addressed. However, in following an issue-driven approach in formulating this research agenda, it would have been easy to get trapped in the enormity of the developmental challenge and end up with an unfocused wish list that lost sight of the original purpose: making sure that the development that is necessary and happening already will be according to sustainability principles. Therefore, a different approach was followed that, firstly, steered clear of old sectoral divisions (e.g. energy, water, waste, etc.) and attempted to introduce a more holistic approach, and secondly focused not on the development that is needed, but on what would be necessary to make sure that when development happens, it would be sustainable.

As could be seen from Chapter 2, the international community has more or less reached agreement on the descriptors of sustainable development – that is, the requirements that a sustainable development path is going to place on our relationship with the biophysical environment and with each other, and on the economic models we choose to facilitate these interactions. The challenge now lies in meeting these requirements. For this, a number of enablers are required.

In preparing this document, the focus was on identifying these enablers and the actions that would be necessary to ensure their use. The enablers are interdependent and multi-dimensional, following a systemic approach, as opposed to the usual sectoral approach. They are also bound to the actions in Chapter 5, both driving certain actions and requiring specific actions for their development and implementation. Thus the enablers and the actions together provide a comprehensive, long-term framework for the furtherance of sustainable construction. Because of the great diversity in developing countries, and the different levels of progress on sustainable construction within different countries, the R & D agenda has been left at a visionary, and therefore generic level, identifying specific research areas, not necessarily research projects. Implementation of the agenda should take place within the context of the sustainability principles and the developing world challenges. Thus, where capacity building of the private sector is suggested, this implies building the capacity of the private sector to deal with the requirements of sustainable development. Technologies for the future means the development of technologies that are appropriate to developing countries and support sustainable construction, while the areas suggested under benchmarking and assessment require the collection of data specific to developing countries.

Developing the necessary enablers requires an approach that operates simultaneously at various scales, as well as different time horizons. In terms of scale, enablers need to cover a range of needs from the urban level right down to the level of components and materials. In terms of time frames, there are certain immediate enablers that have to be developed to provide a sound basis from which to work. Concurrently with these immediate enablers a set of medium term and long-term enablers also have to be developed. The immediate enablers relate to the creation of an enabling environment and the collection and sharing of information for benchmarking and assessment. The medium term enablers relate to the mitigation of impact and actual implementation of sustainable construction, while the long-term enablers relate to the creation of a totally new and more sustainable built environment paradigm.

Enablers can be technological or institutional, or they can come from the value systems we subscribe to. While it is a rather simplistic division, for the purposes of this document these three categories of enablers have been used to identify specific research areas for a future R & D agenda.

4.1.1 Technology enablers

Development is supported by technology, not only through the provision of physical infrastructure, but also through the tools and knowledge that aid decision-making. The socio-economic goals of development cannot be met without the use of technology. However, the technology used must also support the environmental and socio-economic principles of sustainable development. Technology enablers can be divided into "hardware", "software" and know-how.

- Equipment, industrial processes, materials and physical infrastructure are all examples of technological "hardware" necessary for development.

- "Software" includes systems, mental models and those tools (ICT-based or otherwise) that support decision-making and monitoring and evaluation, and assist with knowledge and information management.

- Know-how is the information (blueprints, benchmarks, databases, etc.) we have and the knowledge and experience that is available through specialist expertise and indigenous knowledge systems.

For technology enablers to be successful, processes for technology transfer and management are required, as well as access to those technologies. This requires the presence of functioning institutional enablers. Furthermore, specific value system enablers are necessary to bring about the successful uptake of technologies that are conducive to sustainable development.

4.1.2 Institutional enablers

Without functioning and supportive institutions, sustainable development will not be possible. As with technology, the institutional enablers come in both "hardware" and "software". The hardware is the range of institutions involved in developing and using institutional enablers. These include national and local government, planning and implementing agencies, supporting agencies (such as financial institutions), academic and research institutions, professional associations, and non-governmental and community-based organisations of various descriptions. For sustainable development to become a reality, the following requirements are placed on these institutions:

- That they truly understand and support the principles of sustainable development.

- That sustainable development becomes a seminal aspect of policy, legislation and governance.

- That the capacity to implement sustainable development initiatives be developed through developing the required skills base, financial mechanisms, and partnerships.

- That an integrated approach and the precautionary principle be followed.

The software is what is necessary to help the institutions meet the above requirements. They fall into at least five categories:

- Policy and strategy: Giving guidance on what should be done, and how it should be done.

- Education: As sustainable development requires continuous adaptation, educational enablers are needed that reaches almost from cradle to grave, across all sectors of society, teaching people not only the what and why, but also the how of sustainable development, and updating this knowledge as new knowledge and understanding becomes available.

- Financial mechanisms: These can range from financing mechanisms to encourage the uptake of more sustainable technologies or encourage resource efficiency, to finding new ways of determining professional fees to allow for new demands and changes in working patterns.

- Regulations and legislation that can act as either incentives or disincentives for more sustainable practices, and which allow for new technologies and ways of doing things.

- Mechanisms for good governance: These can be new processes, specific performance indicators, or a new political (or corporate) value system.

4.1.3 Value-system enablers

Sustainable development is not just a way to ensure that human needs will continue to be met. In its deeper meaning the concept has ethical connotations that require attitudinal and behavioural changes. The success of sustainable development will ultimately depend on the decisions individuals and groups make regarding their own behaviour. Adopting new technologies and institutional processes requires that we make specific decisions to do so. These decisions are based on our personal value system. The value system enablers to support sustainable development can be found in those traditional values that encourage harmony, tolerance, respect and compassion between humans and their physical environment. Examples are the African concept of "Ubuntu" or the South American "La Mita", which are both based on the recognition of broader familial and social relationships and obligations, and acknowledgement of the fundamental interconnectedness of all creation.

From the above, the following can then grow:

- Personal codes of conduct that encourage the individual to take responsibility for his or her actions, as well as for the well-being of the community, and the community to take responsibility for the well-being of the individual.

- Community behaviour that supports a shared ethical system and follows a common vision of sustainable development.

- A society that encourages and enables creativity and innovation, and actively embraces change and difference.

4.2 Technology enablers – the key R & D areas

While there is considerable international research regarding the immediate technology enablers for sustainable

development and construction, several gaps remain in developing countries, where different conditions not only require different solutions, but also mean that the benchmarking information drawn from developed countries is seldom applicable. Further, information pertinent to developing countries is often not disseminated widely or effectively. Because of this gap, the technologies used to mitigate the impact are drawn from developed countries and do not provide the optimum answer for developing countries. For example, imported solutions often reduce local employment opportunities, instead of creating them and thus meeting a key requirement for sustainable development in developing countries. Lastly, both developed and developing countries have to take the third step – developing radically new technologies that reinvent the way we construct and use our built environments. This last gap offers an opportunity for developing countries to race ahead of the developed countries with their vested interests in old materials and technologies.

The critical areas in which research on technology enablers is necessary are described below. The immediate work has to be focused on benchmarking, assessment and knowledge sharing. This will then support the medium-term enablers of mitigation, as well as the long-term enablers that create both the technologies and a construction industry for the future. However, work on these enablers needs to be done concurrently, although the time frames within which it needs to happen can be divided into short, medium or long term, with the weight of investment gradually shifting from the immediate to the long term enablers.

4.2.1 Benchmarking and assessment

The first step would be to establish the current state of affairs in developing countries (on a country-by-country basis) in respect of the impact of the built environment, the broad construction process, the capacity of the construction industry (including the built environment professionals), and the life-cycle properties of existing technologies used in these countries.

a) Establish the impact of the construction industry in developing countries

The data from developed countries indicate that the construction industry has a considerable environmental impact. As much of the developing world is effectively still under construction, this impact could be significantly larger in developing countries, as would be the socio-economic impact of the industry. The availability of a package of country-specific data on energy and water consumption, the generation of waste and pollution, job creation, employment conditions and economic contribution of the industry is crucial to advocacy, awareness raising and education, as well as to future monitoring and evaluation of the industry. However, to understand the full impact of construction, it is also necessary to look at the impact of the built environment once it had been created.

b) Establish the impact of the built environment in developing countries

The range of built environment types in developing countries is far broader than that in developed countries, covering a range from ultra-modern skyscrapers to different types of informal settlement, and down to deep rural traditional settlements. Each of these has a different socio-economic and environmental impact that needs to be determined. Unlike in developed countries, it is also necessary to determine the impact of underdevelopment of the built environment.

c) Establish the capacity of the broader construction industry

Central to sustainable construction is a viable and skilled industry that is able to meet the requirements of sustainability. It is therefore necessary to understand the available skills levels, capacity and other

restrictions of the local industry and its associated built environment professionals in order to identify the gaps and challenges, and determine an appropriate strategy for addressing these.

d) Develop an expanded life cycle analysis for existing technologies

Little work has been done regarding the life-cycle analysis of specific construction materials, technologies and infrastructure options in developing countries, making it difficult for designers and specifiers to make informed choices, and for buildings and other construction projects to be assessed. It is also essential that analysis methods be expanded to include issues such as job creation, child labour, human rights and local economic development potential.

e) Develop a vulnerability index

Developing countries are most at risk from natural disasters and environmental degradation, as well as economic crises. A vulnerability index that identifies potential areas of risk and disaster and monitors the possible impacts of climate change will assist in the planning of settlements and infrastructure choices and reduce the impact of future disasters.

In many countries research has already been done on aspects of the above research areas. However, for a number of reasons it is very difficult for developing country researchers to widely disseminate the knowledge and information that has been developed. Often even researchers working in the same country remain unaware of each other's work, and the available information is not packaged in a way that is accessible and useful to industry and the broader public. Thus, together with the development of the above information packages, it is also necessary to look at how this knowledge will be shared.

4.2.2 Knowledge sharing

For sustainable construction practices to become widely accepted, the sharing of knowledge has to happen at four levels:

- between researchers themselves;
- between researchers and educational institutions;
- between researchers and the industry; and
- between researchers and the decision-makers (governments, developers, and the public).

To facilitate knowledge sharing the following is required:

- a global survey on relevant studies done in developing countries that can be kept in a national or international databank;

- an inventory of internationally available design and assessment tools and technologies for sustainable construction that are appropriate for use in developing countries;

- the collection and publication of best practices that illustrate inter alia the application of tools and technologies, and approaches in support of capacity building; and

- development of a knowledge-sharing strategy for each of the above levels that make use of a variety of media, from dedicated journals, to websites and even radio.

4.2.3 Technologies to mitigate impact

A number of technologies and construction practices that concentrate on mitigating the environmental impact of the built environment and its construction have been developed in both the developed and the developing countries. However, the environmental impact of the built environment is not the only concern of sustainable construction. It is also necessary to develop and use technologies and practices that will mitigate the social impact of construction and empower people through job creation and entrepreneurial opportunities, without placing their health at risk, as well as technologies that deal with the immediate impact of poverty in human settlements. Again, much work has already been done in this regard. The main challenge is to:

- identify, and if necessary adapt, the technologies and practices that are appropriate for developing country conditions and affordable, as well as acceptable, for low-income communities;
- promote technology transfer between developing countries, as well as between developing and developed countries;
- find ways of introducing these technologies into mainstream building practice; and
- identify and fill the remaining technology gaps.

4.2.4 Technologies of the future

Mitigating the impact of the construction industry is like treating a disease by reducing the symptoms. Ultimately, if a cure is to be found, it will be necessary to address the root cause of the disease. Thus, while we are doing damage control, it is crucial that we start thinking about alternatives to current practices and technologies that will steer the way we build and live towards a more sustainable model. The research in this regard is long term, with long turnaround times in investment, and it requires skills and resources that are not readily available in developing countries. Nonetheless, if these problems can be addressed, these technologies can become an important driver for the future economic growth of developing countries. The following interlinked topics are the main future focus areas for sustainable construction in developing and developed countries alike. Development in this area should strive to meet the sustainability criteria of resource efficiency, use of renewable resources, minimising pollution and waste, economic empowerment, health and safety, and human development. In addition, it is crucial for developing countries that the technologies developed also factor in the creation of livelihood opportunities.

a) Ecosystemic buildings and infrastructure

The most sustainable approach to the creation of the built environment would be to mimic natural processes and designs to provide services such as heating and cooling or waste management. This approach needs to be explored at all levels from the manufacturing of materials to the planning and management of cities.

b) The renewable revolution

Much emphasis has been placed on renewable energy, and this research needs to continue, with emphasis on making these technologies reliable and cost-effective. However, little attention has been paid to an equally important area: the use of construction materials from renewable resources. These can be used directly – for example wood, straw bales and bamboo – or indirectly through the development of new materials from renewable resources such as plant oils and fibres.

c) Biotechnology

Historically, changes in the built environment have been led by changes in technology, which in turn were driven by scientific revolutions. Biotechnology is the next scientific revolution that can play a major role in changing our built environment. Because of its current attractiveness to investors, it is also the future research area where the possibility of funding is the greatest. Biotechnology can be used to develop more sustainable replacements for energy-intensive, polluting, poisonous or non-renewable construction materials, as well as in the provision of services such as sanitation and energy.

d) Recycling

The current trend is to focus on the re-use and recycling of construction and demolition waste. To this must be added the possibility of creating construction materials and components from recycled materials from a range of waste streams.

e) Rethinking the traditional

The fact is that many developing countries will not be able to provide the newer sustainable technologies to low-income communities for a long time. However, these countries tend to have a long tradition of construction that is more sustainable and better suited to local conditions than that introduced by the colonial powers. Therefore, another key area for research is to identify these construction practices and materials and develop them further to provide an improved standard of living, while providing low-income communities with the opportunity to construct their own shelter, create liveable settlements and maintain their cultural heritage.

4.2.5 Changing the construction process

It is also crucial that the construction process be changed to allow for a more holistic and sustainable approach to the creation of the built environment. This would mean, inter alia, the development of:

- processes and tools that allow the integration of planning, design and implementation processes;
- tools that encourage a synergistic and more ecologically responsible approach to infrastructure and service delivery at city level, as well as at building level; and
- construction and deconstruction processes that minimise environmental impact while maximising job creation and local prosperity.

4.3 Institutional enablers – the key R & D areas

A huge gap remains between the development of sustainable technologies and their implementation. This gap is caused by an imperfect understanding on the part of the various stakeholders regarding their roles and responsibilities; the poor communication between researchers, educational organisations and implementers; lagging or non-existing regulatory and implementing mechanisms; and a general lack of awareness regarding the need for change and its urgency, as well as how to implement the necessary change.

4.3.1 Clarification of roles and responsibilities

The first area that needs clarification is to understand the institutional power relationships and their drivers, as well

as how each of these institutions (financial, educational and research institutions, government, and professional and industry bodies and associations) will drive the changes necessary for sustainable construction.

The second area that needs clarification is within the construction process itself, where the different role-players tend to pass responsibility for the introduction of more sustainable practices to each other. It is necessary to clearly outline the responsibilities, and necessary actions of each of the members of the professional team, the actual construction team, the client and the local authority or other relevant government bodies, as well as the relationship between these various roles and responsibilities.

In many developing countries, the roles of traditional governance systems and leadership offer a third area where clarification is necessary. Through the inclusion of these structures, a bridge can also be built between new technologies and traditional practices that support sustainable development.

4.3.2 Education

In order to meet the need for built environment practitioners skilled in the additional requirements of sustainable construction the following steps are necessary:

- Curricula and training programmes need to be revised to reflect the centrality of sustainability requirements in the creation of the built environment. Coupled with this is the need to develop new methods of teaching that will equip students to work within a multi-dimensional, multi-disciplinary and interdependent problem-solving framework.

- Gaps in the education of clients, the public, decision-makers, professionals and other implementers need to be identified and programmes developed to fill these gaps.

- Training programmes need to be developed for continued professional education, as well as for a range of new built environment professionals such as impact assessors, sustainability raters, etc.

- Methods of rating and auditing curricula and educational institutions for adherence to sustainability principles need to be developed.

4.3.3 Advocacy and awareness

Coupled with the educational drive is the necessity to raise public awareness about the need for and benefits of sustainable construction, and to introduce new technologies to the public, the industry and political decision-makers. This can be done through the development of pilot projects, best-practice databases, and monitoring and evaluation of these best practices to illustrate the benefits that can be achieved through sustainable construction.

4.3.4 Cooperation and partnerships

To strengthen sustainable construction in developing countries it is necessary to enable more cooperation between developing country researchers. Therefore new cooperative partnerships between umbrella bodies within developing countries and active research networks need to be established and systems put in place to facilitate the interaction between members of these networks and partnerships.

4.3.5 Linking research to implementers

It is crucial that knowledge and tools for sustainable construction be transferred to the people who have to use them. However, it is also crucial that the people who have to use these tools are involved in the development of tools and technologies. It is therefore necessary to establish partnerships with industries, local governments, communities and other possible end-users of a product in the development of that product. Linking research to identified problems within a specific industry or community can also strengthen the interaction between researchers and implementers. Systems to link researchers with possible non-research partners therefore need to be developed.

4.3.6 Develop regulatory mechanisms

The introduction of more sustainable technologies and practices will require strong regulatory support. To achieve this support it is necessary to:

- review existing policies, legislation and regulations to identify gaps, shortcomings and conflicts;
- update existing regulations (e.g. national building regulations) to include new technologies and introduce sustainability criteria, and deregulate where regulations are creating blockages;
- develop regulatory tools, e.g. incentives or disincentives, to encourage sustainability;
- identify problems with the enforcement of regulations and develop more effective enforcement measures through cooperation and partnerships between stakeholders; and
- develop more progressive benchmarks for standards and regulations.

4.3.7 Strengthening implementing mechanisms

In developing countries the capacity of implementing agents is one of the key barriers to sustainable construction. While this can partly be addressed through education and training, problems such as lack of manpower, equipment, access to financing or even basic services further reduce the capacity of implementing agents. It is therefore necessary to determine the capacity, skills levels and levels of infrastructure support of the construction industry, built environment practitioners and their government counterparts, and from this develop a strategy for filling the gaps.

To support such a strategy, it is necessary to develop mechanisms for releasing financial resources for sustainable construction. Such mechanisms would include those that encourage innovation and demonstrate such innovation, as well as encourage and enable the use of more sustainable practices. It is also necessary to develop procedures such as sustainability rating systems for capturing and using benchmarks to assess projects and individuals.

A further barrier to implementation is the current fee structure of built environment professionals that is based on project cost. Alternative fee structures that encourage or reward professionals for paying more attention to sustainability need to be developed and accredited.

4.3.8 Using institutions as drivers

Education, research and government institutions can play a powerful role in driving sustainable construction through setting an example of best practice. To assist institutions in this role, systems have to be developed that enable and monitor the use of procurement as a driver. In addition, it is necessary to develop mechanisms for the auditing and accreditation of institutions, companies and professionals as providers of sustainable construction services.

4.3.9 Regional centres of excellence

Establishment of regional and local centres to train future professionals in the areas of appropriate building technologies and sustainable planning strategies can help to develop a corps of sustainable habitat advocates operating within the mainstream. These centres can also be used for awareness raising, information and technical support to professionals, contractors, interested citizens, institutions, business and industry, and should also be available at centralised points in a comprehensive manner. These centres could be linked internationally to promote the exchange of information and ideas.

4.4 Value system enablers – the key R & D areas

The values of sustainability are being introduced into a context of conflict, inequality, materialism and lack of concern for the biosphere and for collective survival. For sustainability to become a key criterion for decisions made by individuals, corporations and governments, humanity will need to redefine its value systems. This includes the ethical or moral codes we adopt, the value we assign to an action and its outcome, and the rewards we seek and award. The construction sector could play a decisive role in the success or failure of the drive for sustainability. However, this would require that the sector critically examine the value systems on which it is currently based, and make the necessary changes. To assist with this, the following is required.

4.4.1 Mapping the route and landmarks of change

The construction sector is particularly resistant to change and therefore needs clear indications of the changes in the external environment and how these increase the urgency for changes in the sector, as well as the measures of success that have already been achieved and the benefits of these. Mapping the landmarks of change, both in terms of real threats such as climate change or toxic pollution, and in terms of the successes that have been achieved, such as the reduction in use of CFCs, and the improvements in energy efficiency achieved by some countries, can help to encourage change within the construction sector.

4.4.2 Re-evaluating heritage and tradition

It may not be necessary to invent a new value system to support sustainability. Cultural heritage in developing countries provides many of the elements that are needed. However, for these to be adopted, developing countries will first have to accept that their heritage is valuable and relevant in the twenty-first century, and secondly that their cultural heritage also includes elements that is contrary to the principles of sustainable development. It is therefore necessary to re-evaluate the cultural heritage of the developing world in terms of the contribution it can make to sustainable construction by providing technological, institutional and value enablers.

4.4.3 Understanding what drive current value systems

Value systems develop within a specific context for specific reasons. In order to change the current value systems to values supportive of sustainability, it is necessary to critically examine the value systems in the construction sector and find out what is driving them. By addressing the driver, and not the value, the construction industry may discover that there are more sustainable options to meet the same needs.

4.4.4 Develop a new way of measuring value and reward

Currently, the value of something, be it a plant, object or person, is measured in monetary terms, as is the means through which people are rewarded. However, we are rediscovering that most things in life that determine quality of life (as opposed to standard of living) have an intrinsic value far greater than their monetary value. This understanding is central to the value system that underlies sustainability. We need to learn to value of the environment and the community of life also for the non-material wealth they provide. Companies are also discovering that money alone is not a sufficient reward. Employees tend to be more loyal to companies with a strong value system and sense of social responsibility, and which reward their employees through means that acknowledge them as people; for instance, extra time to spend with their family, a sabbatical to pursue a particular passion, or even the freedom to choose the colour of their office walls.

The enabler that is needed here is not a list providing a means of comparing the monetary and intrinsic values of, for instance, employing more people versus buying a machine to do their jobs. Rather it is a process through which companies can, together with their staff, develop a common set of values and a shared ethic to which all can subscribe, and which acknowledges the intrinsic value of our natural and built environment and of mutually beneficial social relationships.

4.4.5 Develop codes of conduct based on a shared ethic

Sustainable construction requires that the construction sector operates from a shared ethical statement – something similar to an Earth Charter[c] specifically for the construction sector. Once the sector has a shared vision and commitment to support that vision, the various industry sectors and professional organisations involved in the broad construction process have to develop their own internal codes of conduct.

4.4.6 Corporate social responsibility reporting for the construction sector

The shift towards sustainable development requires that the focus of social responsibility shift from the external (charity) to the internal –- integrating certain principles of responsibility and compassion into the day-to-day actions and decisions of both individuals and companies. Corporate social responsibility reporting is becoming an important market differentiator in all industry sectors and the construction industry is not excluded from this. While some companies have already developed their own reporting mechanisms based on indicators drawn from the company's value statement and code of conduct, it is necessary to develop a reporting mechanism for the construction sector that can be used to measure a company's performance on a comparative basis.

[c] See www.ecocouncil.com

Summary Table: A future R & D agenda			
	Technology enablers	**Institutional enablers**	**Value enablers**
Immediate	**Benchmarking and assessment** • Establish the impact of the construction industry in developing countries. • Establish the impact of the built environment in developing countries. • Establish the capacity of the broader construction industry. • Develop an expanded life cycle analysis for existing technologies. • Develop a vulnerability index.	**Clarification of roles and responsibilities** • Institutional power relationships and how these will drive change. • Roles of players within the construction process. • Role of traditional governance systems.	**Mapping the route and landmarks of change** • Plotting changes in the possible threats. • Mapping the successes.
	Knowledge sharing • A databank of relevant developing country studies. • A knowledge-sharing strategy. • Inventory of appropriate technologies.	**Education** • Revise curricula and training programmes. • New methods of teaching to reflect new complexity and integration of processes. • Identify gaps in learning for role-players and stakeholders. • Continued professional education training programmes. • Methods of rating and auditing curricula, as well as institutions.	**Understanding what drives current value systems** • Understand the drivers behind decisions and identify more sustainable options that satisfy these drivers.
		Advocacy and awareness • Pilot projects. • Best practices databases. • Monitoring and evaluation tools and systems.	**Re-evaluating heritage and traditional** • Identify the contribution tradition and cultural heritage in developing countries can make to the development of enablers.
		Cooperation and partnerships • Establish research networks. • Partnerships between developing country institutions.	

Summary Table (continued): A future R & D agenda			
	Technology enablers	**Institutional enablers**	**Value enablers**
Medium term	**Technologies to mitigate impact** • Identify and adapt the appropriate technologies. • Promote technology transfer between developing countries. • Find ways of introducing these technologies into mainstream building practice. • Identify and fill he remaining technology gaps.	**Linking research to implementers** • Partnerships between research and industry or other non-research partners.	**Develop a new way of measuring value and reward** • Process for companies to develop a common set of values that acknowledge the intrinsic value of social and environmental relationships.
		Develop regulatory mechanisms • Review existing policies, legislation and regulations. • Update existing regulations to enable sustainable construction. • Develop regulatory tools (e.g. financial incentives) to encourage sustainable construction. • Identify enforcement problems and develop more effective enforcement mechanisms. • Develop more progressive standards.	**Develop codes of conduct based on shared ethic** • Develop a shared vision and ethical statement for the construction sector. • Develop internal codes of conduct for professional organisations and industry sectors based on this shared vision.
Long-term	**Technologies of the future** • Ecosystemic buildings and infrastructure. • Renewable energy and materials. • Biotechnology for construction. • Recycling resources. • Rethinking the traditional.	**Strenghening implementing mechanisms** • Determine gaps incapacity and skills levels and develop a strategy to address these. • Financial mechanisms (including incentives and disincentives) to encourage and enable innovation and sustainable construction. • Rating schemes to assess projects and practitioners. • Rethink professional fee structures.	**Corporate social responsibility reporting** • Develop a common corporate social responsibility (CSR) reporting mechanisms for the construction sector.
	Changing the construction process • Processes and tools to allow the integration of planning, design and implementation. • Tools that encourage a synergistic and more ecologically responsible approach to infra structure and service delivery in cities and in buildings. • Construction and deconstruction processes that minimise environmental impact while maximising job creation and local prosperity.	**Using institutions as drivers** • Systems and tools to enable and monitor the use of institutional procurement as a sustainability driver. • Mechanisms for auditing and accreditation of institutions and practitioners.	
		Using institutions as drivers • Establish regional centres for training, technical support, information capturing and knowledge-sharing.	

Chapter 5 A strategy for action

5.1 Elements of the strategy

As stated in Chapter 1, the purpose of this document is to provide an understanding of what would be necessary to ensure that the contribution of the construction sector to the physical development of developing countries supports the principles of sustainability. This can only be possible if all the different stakeholders cooperate in the implementation of a clear strategy that involves specific supportive actions by all role-players, as well as the development of new knowledge and technologies that can assist the different role-players to perform these actions. Chapter 4 identified a number of key knowledge and technology areas that have to be developed. However, research and development happens within a specific context, and it is the responsibility of the various stakeholders to create an enabling environment for the kind of research and development that supports sustainability, as well as for the uptake and implementation of the results from such research. This chapter provides a strategy for action that will create such an enabling environment.

This strategy is built around the following elements:

- Capacity building
- Access to funding
- Partnerships and cooperation
- Internal housekeeping
- Encouraging and supporting implementation
- Monitoring and evaluation.

As the R & D agenda and strategy for action are interdependent, there may be certain overlaps between the two, as well as between the actions identified in this chapter for the various role-players. While the R & D agenda identifies the enabler that needs to be developed through research, the role-players have to support, accept and implement these enablers through the actions described in this chapter.

This strategy is also based on the understanding that action is required at individual, organisational, local, national, regional and international levels.

5.2 Actions for the research and education sector

It is necessary that sustainability becomes the central point of departure in determining research projects, the content of curricula, and educational methods. To achieve this, issues such as funding, internal capacity, knowledge-sharing and partnerships will also need to be addressed. These institutions can also play the role of independent watchdogs to monitor and evaluate the performance of other sectors. However, to be accepted in such a role, institutions will themselves have to practise what they preach.

5.2.1 Capacity-building

While elements such as energy efficiency and the development of alternative construction materials and services have been studied and taught for many years, sustainable construction as a holistic concept is less than ten years old. This means that most of the built environment practitioners currently in practice know very little about the concept and how it relates to their activities. The same can be said for most educators and researchers. Therefore,

there is very little capacity to train the next generation of practitioners to be fully aware of their role in sustainable construction and be capable of actually implementing sustainability principles. It is essential that this gap be addressed through the following actions:

a) Build internal capacity

Research and education institutes have to commit to a programme of internal capacity-building that will result in staff with the necessary level of understanding and skills regarding sustainable construction. These institutions also have to ensure the continuity of organisational learning and areas of expertise that have been developed. In other words, they have to develop mechanisms to retain the capacity that has been developed.

b) Expand learning offerings

Educational institutes need to expand the scope of their offerings to include continued professional education programmes specifically focused on sustainable construction, courses for the emerging sustainability professions, as well as training programmes for blue-collar workers in the construction industry that will equip them to deal with a new approach to construction and the new technologies that are being introduced.

5.2.2 Access to funding

Funding for research and development remains a critical issue in developing countries. Funding for research in construction and the built environment is even scarcer. Many developing countries, keen on catching up with the West, are concentrating their research funding on areas such as biotechnology and information and communications technology (ICT). The lack of funding for developing country researchers in this field to participate meaningfully in international collaborative efforts and knowledge exchanges severely limits the development of research in developing countries, as well as the ability of these countries to contribute to the debate on sustainable construction.

Overseas development funding for built environment research tends to focus on issues that are considered priorities in the developed world with its mature construction industry, modern infrastructure and high standards of living. The obligatory partnerships with developed country partners also mean that the bulk of funding usually returns to the funding country via expensive human resource costs. The conditions attached to these funding streams also structure research projects in such a way that the developed country partner plays the senior role, with developing country partners relegated to a supporting role. This system limits the empowerment and development of researchers in developing countries, and makes these countries even more dependent on imported technology. While North-South collaboration has an important role to play, the development of South-South opportunities for research collaboration is becoming increasingly important.

A further problem with the current conditions of overseas development funding is that many of these funding mechanisms require that researchers should be able to carry some or all of the costs upfront and then have the bridging finance available to wait until the funding organisation's lengthy internal processes have been completed. Many developing country research organisations simply do not have the financial means to do this and thus remain unable to access this funding.

Having said that, it should be acknowledged that some funding is available, but that developing countries have also not developed sufficient expertise in accessing or creatively harnessing the available funds. More can also be done to lobby for internal and external funding, as well as for better funding conditions and the allocation of funding specifically for research in sustainable construction. Research institutes therefore have to undertake the following steps:

a) Identify and access appropriate funding streams

While there may be limited funding available for large research projects between developing country partners, there is often internal governmental funding available for local projects, as well as funding for exchange programmes made available as part of bilateral science and technology agreements between countries. Partnerships with industry may also open further funding streams. Research organisations need to find out what funding is available within their own countries, and identify the funding processes of international funding agencies.

b) Be creative in using existing funding streams

The next step is to use this funding creatively to leverage further funding or resources, or to use local funding to fund local projects that link with larger developing country research projects.

c) Actively lobby for funding

Research organisations also need to actively lobby funding institutions for a larger funding share for sustainable construction, given the tremendous impact that the construction sector has on the environment and the socio-economic benefits that can grow from sustainable construction.

5.2.3 Partnerships and cooperation

Research and education does not happen in a vacuum. There is a direct circle of influence between research, education, industry, government and community that has to be considered when introducing change. The establishment of partnerships and practical cooperation between these sectors plays an important role in introducing meaningful change. It is also necessary to establish closer cooperation between research and educational institutions in developing countries, as these institutions often have more in common with each other than they have with their traditional developed world partners. Therefore, the following actions also need to be taken:

a) Establish cross-sectoral exchange programmes

It is necessary to establish networks and programmes to exchange staff and knowledge between research organisations, academia, government and industry to expedite the transfer of learning between these sectors, ensure the continued relevance of research and education to industry and government, and help industry and government to be more responsive to new demands placed on them as a result of sustainable development.

b) Establish an effective South-South network of researchers and educators

For various reasons, there has been little collaboration between researchers from developing countries outside their own regions. However, within the different regions, various networks do exist that can be linked into an umbrella network of developing country researchers. Such a network can then be used to share knowledge, identify project partners and candidates for staff exchange, and leverage funding for South-South cooperation.

c) Clarify issues of knowledge-sharing

To make the most effective use of the limited resources available for research in developing countries, it is necessary that information and knowledge be shared freely among researchers working within these countries. However, there are issues regarding intellectual property rights and accessibility of knowledge that have to be clarified beforehand.

d) Pursue research and educational partnerships with other sectors

The fact that sustainable construction is such a new concept means that everyone is still learning. The urgency of the matter means that opportunities for learning have to be innovatively pursued. Establishing research and educational partnerships with industry sectors, non-governmental organisations (NGOs), community-based organisations (CBOs) and government increases these opportunities for learning and places them directly at the coalface, thus ensuring that research remains relevant to the local context, and that sustainability becomes a central driver for other development. Research organisations and universities can also act as the laboratories for industry and government, as well as provide independent monitoring and evaluation services.

5.2.4 Internal housekeeping

a) Revise existing curricula

Educational institutions will have to commit to the development and implementation of new curricula and training methods suggested under Section 4.3.2 of the R & D agenda described in Chapter 4.

b) Practise what is being preached

The best way to teach is by example, and research organisations cannot expect the public to accept new technologies if the organisations that developed these technologies are not prepared to use them. Therefore, both research and educational institutions have to review and, if necessary, change their day-to-day activities to ensure that these support the principles of sustainability and provide examples of what is being advocated. These institutions also need to participate in the relevant sustainability reporting and assessment schemes that are developed under the R & D agenda outlined in Chapter 4.

5.2.5 Encouraging and supporting implementation

While the main role of research organisations is to develop the necessary enablers, they also have a responsibility to facilitate the implementation of these enablers through technology transfer and advocacy. Educational institutions also have an advocacy responsibility, as well as a significant role in raising awareness about the importance of sustainable construction and the enablers that are available to implement it.

a) Technology transfer

Technology transfer has to happen in several directions: between developing countries, between developed and developing countries, between industry and research organisations, and between research organisations and communities, sometimes via industry or government. As many of the technologies being developed for sustainable construction are new, the importance of pilot and demonstration projects to assist with technology transfer should not be underestimated.

b) Raising awareness

The most effective way that educational institutions can raise awareness is by including the principles of sustainable construction in their curricula. In partnership with the research organisations, they can also raise awareness by means of seminars and workshops with members of the professions and industry, and through community outreach programmes. These institutions also have to explore ways of disseminating knowledge through more popular platforms such as trade magazines, television and radio.

c) **Advocacy**

Through their alumni, universities have a powerful advocacy resource that can be used to introduce the principles of sustainability and sustainable construction into the marketplace and the agendas of decision-makers. Research organisations can also play an advocacy role through their often close links to government and involvement in policy development.

5.2.6 Monitoring and evaluation

Apart from developing the appropriate mechanisms and tools, research and education institutions have two further roles to play in terms of monitoring and evaluation.

a) **Provide independent monitoring to the private sector and government**

Their very nature makes universities and other research organisations the obvious candidates for providing independent monitoring and evaluation of the performance of the private sector and government according to the mechanisms suggested in Section 4.3.5 and 4.3.7.

b) **Introduce mechanisms for own monitoring and evaluation**

If research and educational institutions are to monitor, evaluate and assess the performance of other sectors, these institutions themselves should also be accountable. Section 4.3.7 suggests the development of appropriate mechanisms for auditing, accreditation and assessment of these institutions. Research and education institutions have to commit themselves to introducing these mechanisms in their management processes.

5.3 Actions for the private sector, utility companies and other service providers

Stakeholders in this section include built environment practitioners, contractors, developers, manufacturers of construction materials, components and tools, the financial sector that provides funding for construction and property development, certain government functions and the utility companies.

5.3.1 Capacity-building

One of the major barriers against the implementation of sustainable construction practices is that those who have to implement these practices do not have the necessary knowledge, skills or even understanding of what is required. Building the capacity of these implementers to deal with the demands of sustainable construction is therefore an essential action for this sector.

a) **Enable continued organisational learning**

The requirements of sustainable construction will demand new skills and continuous learning. For the private sector to remain competitive, its members will have to enable and encourage continued learning within their organisations. This can be done through developing in-house training programmes or through partnerships with research and education institutions. The main goal is to make sure that everyone within the organisation acquires the necessary knowledge and understanding that will help him or her to further sustainability.

b) **Support the development of external capacity**

As part of their corporate social responsibility programmes, the private sector can fund (or otherwise support) a range of capacity building programmes to support sustainable construction, from training and

skills development programmes for blue-collar workers and emerging contractors to the internal capacity-building programmes at educational institutions.

5.3.2 Access to funding

The private sector is one of the key avenues for research funding. While most of this funding is directly related to increasing the competitiveness of the organisation that has provided the funding, a certain amount of funding is also required for research that is for the common good, but will not have a direct impact on the organisation's profit margins. It is therefore suggested that a percentage of the organisational budget for corporate social responsibility is earmarked for this kind of general research. This funding can then be pooled to fund joint research projects of the kind suggested in Chapter 4.

5.3.3 Partnerships and cooperation

The private sector and other service providers are important stakeholders in the development and implementation of sustainable construction. Their cooperation with research organisations is essential to the success of the R & D agenda described in Chapter 4. Partnerships between different industry sectors and the resultant synergies and pooling of resources will benefit all parties, as well as speed up the development of those enablers necessary for sustainable construction. Therefore the following actions are suggested:

a) Cooperate on implementation of the R & D agenda

The private sector's cooperation is essential if researchers are to determine the impact of the construction industry and the built environment and establish benchmarks for the monitoring of progress, as well as for developing life-cycle analysis databases and monitoring and evaluation mechanisms. The process requires that private-sector role-players are prepared not only to divulge sensitive information, but also to actually capture the relevant data for their own organisations and appoint an external, independent party to perform the relevant assessments.

b) Partner for R & D

There are several ways in which the private sector can partner with the research institutions. The private sector can work with the research organisations to adapt or replace existing practices to achieve greater efficiency and improve sustainability. A partnership between research organisations and the private sector can also assist with the commercialisation of new products and processes developed in the research organisations.

c) Form industry coalitions

In the initial phases of benchmarking, developing strategies and pre-competitive research, coalitions between different industry role-players will help to develop integrated solutions and enabling mechanisms, and pool resources for mutual gain.

5.3.4 Internal housekeeping

One of the main barriers to sustainable construction is the reluctance of the private sector to fully commit itself to sustainability and make the necessary adaptations in its business practices. However, the context within which businesses operates is changing and placing increased pressure on the private sector to support sustainability. It has therefore become necessary for the private sector to take the following actions:

a) Assess risk and benefits

The worldwide shift towards corporate social responsibility and sustainable development is changing investment drivers, procurement criteria and notions of accountability. Role-players in the construction sector have to determine how vulnerable they are in this new environment, and what benefits can be drawn from a change in business practice towards more sustainable methods and processes.

b) Devise strategic plans for different industry sectors

While this document provides a general outline of the actions that are necessary, each of the different industry sectors (e.g. steel manufacturers, contractors' associations and professional bodies) has to develop its own, sector-specific strategy on how to address the requirements of sustainable construction and development. This needs to happen at national and international level.

c) Change organisational values

Change will also have to take place at an organisational level, with businesses adopting their own internal codes of conduct to reflect the different values required for a sustainable world.

d) Improve resource efficiency and reduce environmental impact

The first step towards a more sustainable construction industry is to foster more efficient use of resources and reduce the environmental impact of the industry. Businesses can contribute in three ways: Firstly, by changing their work environment to be more resource-efficient (for example, by changing light fittings in offices and introducing recycling policies for office waste); secondly, by changing manufacturing and construction processes to reduce and recycle waste and use less energy and water; and thirdly, by planners and designers basing their designs and specifications on principles of resource efficiency and ecological responsibility.

5.3.5 Encouraging and supporting implementation

The private sector will largely be responsible for the implementation of sustainable construction practices. This it can do through the following actions:

a) Assist with the incubation and mentoring of emerging-market niches

Sustainable construction is leading to the development of entirely new market niches in terms of services, materials and tools. The private sector can assist with the commercialisation of these new services, materials and tools, and help their originators to create viable businesses.

b) Create a demand

By virtue of its spending power, the private sector can create a demand for more ecologically and socially responsible construction materials and services, as well as more efficient and healthier buildings, and can pressurise financing institutions to accept alternative, more sustainable materials and technologies.

c) Use new technologies and processes

Finally, the private sector can use more sustainable technologies and processes in its own business activities – for example, using zero-emission industrial clustering in the manufacturing of materials and components, specifying more sustainable materials and services, designing more resource-efficient buildings, using more labour-intensive construction methods, or managing the deconstruction process for maximum recovery of materials.

5.3.6 Monitoring and evaluation

a) Develop and adopt corporate social responsibility reporting systems

Ideally, all businesses should develop an internal system for corporate social responsibility that is in line with international reporting initiatives. Corporate social responsibility is measured according to an organisation's performance in terms of its purpose and values; how it treats its workforce, how ethically it deals in the marketplace; its impact on the environment; its involvement in the community; and its commitment to human rights – all the requirements of sustainability.[34]

b) Participate in certification schemes

All industry role-players should actively seek certification under ISO 9 000 and 14 000, and any new sustainability standards that are developed. Developers, designers and contractors should also apply for certification of their products according to rating schemes such as BREEAM, LEED, Green Buildings for Africa, and other eco-rating and assessment schemes.

c) Capture information for monitoring and assessment

In order to monitor the progress of the construction sector, it is necessary that the indicators used to benchmark industry impact be regularly updated. It is therefore important that organisations commit to capturing indicator information regarding their own performance on a regular basis. Capturing this information will also help organisations to measure the impact and benefits of their sustainability policies, and provide an early warning system regarding future problems and risks.

5.4 Actions for clients

The question most often asked by service providers in the construction sector is whether there is a market for sustainability. It is the role of clients – from the individual buying a wood-treatment product to the government putting out tenders for infrastructure development – to demand products and services that support sustainable construction and thus create this market. For this, clients have to become informed customers, adopt mechanisms that will release funding for possible additional costs, form partnerships to leverage change, change their procurement systems and monitor the impact of their choices.

5.4.1 Capacity-building

To create a market for sustainable construction, clients will have to develop their understanding of what sustainability means, how it relates to their lives and businesses, how it should change their procurement briefs and policies, and the benefits of demanding more sustainable options.

5.4.2 Access to funding

Opting for a product or service that supports sustainability may require higher capital costs. However, these higher capital costs can be offset by reduced running and maintenance costs, reduced risks, increased productivity, a happier, healthier and more loyal workforce, and an improved public image that can result in an increased market share and improved shareholder appeal. Clients can use these savings, reduced risks and added value to leverage the additional capital costs.

5.4.3 Partnerships and cooperation

There are two ways in which clients can use partnerships and collaborative effort to support sustainable construction.

a) Partnerships for learning

Client groups can form partnerships with research organisations to help them identify the possible benefits of sustainable construction for their specific operations, and to identify and develop ways of leveraging funding to cover the additional costs. Similarly, partnerships must be developed with educational institutions to assist clients in educating themselves on the need for and requirements of sustainable construction.

b) Consumer lobbying

It is difficult to choose sustainable construction products and services if these are not yet on offer. Clients can guide this process by forming consumer blocks that actively lobby service providers and manufacturers to develop and provide the kind of services and products that are required.

5.4.4 Internal housekeeping

The most important contribution clients can make is to change their internal procurement systems to support ecologically and socially responsible service providers. By doing this, governments, businesses and other clients not only reduce their own negative impact, but also actively assist in developing a market for services and products that support sustainability. Further, clients themselves have to become ecologically and socially responsible by sourcing labour and materials locally, choosing ecologically responsible materials and services, and using their procurement policies to assist with skills development and empowerment within local communities.

5.4.5 Encouraging and supporting implementation

Clients support the implementation of sustainable construction by actively demanding sustainable services and products from the construction sector and withdrawing their support from businesses that do not follow sustainability principles. In many developing countries, government remains one of the construction industry's biggest clients, and even where it is not a direct client, it often continues to play a role in determining the tender conditions and awarding of infrastructure projects. By changing its tender criteria and providing special conditions for service providers who support sustainability, government can use its considerable buying power and influence to leverage the adoption of sustainable construction practices.

5.4.6 Monitoring and evaluation

Monitoring the costs, savings and other benefits and impacts resulting from purchasing and using more sustainable services and products can help to determine the benefits and possible problems of this approach. This information can be used to motivate other clients to adopt procurement systems that demand sustainable construction, and thus expand the market. It can also be used to develop more efficient purchasing and procurement systems, as well as solutions to any problems that are blocking the market uptake of sustainable construction products and processes.

5.5 Actions for government and regulatory stakeholders

The stakeholders included in this area are national and local government, regulatory bodies such as standards organisations and those bodies responsible for regulating the professions and the industry sectors.

5.5.1 Capacity-building

While many developing country governments and regulatory bodies face serious capacity problems in terms of personnel, equipment and finances, this section focus specifically on the capacity of these bodies to deal with the demands of sustainable construction. The following actions will assist with creating this capacity.

a) Create an advisory stakeholder council

Government or a coalition of the relevant regulatory bodies should convene an advisory stakeholder council that can formulate guidelines for sustainable construction, liaise with other sectors and advise government regarding appropriate policy and legislation.

b) Raise awareness among government officials and politicians

The majority of politicians have a very limited understanding of sustainable development and its implications for the development paths and infrastructure choices they promise to their electorate. However, if politicians were to fully understand and support sustainability, they would be a very powerful force for advocacy and raising awareness amongst the public. Government officials tend to have a similarly low understanding of sustainable development and the role that the construction sector can and should play.

It is necessary to raise the level of understanding among both officials and politicians and build their capacity to bring about the changes in policy, legislation and implementation that sustainable construction will require.

c) Introduce compulsory continued professional education

In the developing world, with its rapid urbanisation and limited resources, there is a great urgency to make sustainable interventions now, while these built environments are being created, rather than try and change things after the fact. Developing countries cannot afford to wait for the next generation of professionals to be educated and come into power before sustainable construction is introduced into the mainstream of practice. Waiting for the market to drive this change in professional capacity will also take too long. Drastic measures are called for, and this includes compelling the current generation of built environmental professionals to re-educate themselves to be able to deal with the challenge, and to continue updating their knowledge.

5.5.2 Access to funding

a) Reconsider scope of own funding programmes

Sustainable construction has been largely left out of the research budget of most developing countries, which tend to be skewed in favour of the glamorous areas of information and communications technology and biotechnology – areas which are of limited relevance to the developmental priorities of developing countries and which, unlike sustainable construction, promise a comparatively small return on investment in terms of local job creation and an improved quality of life for the citizens of developing countries. However, the contribution that sustainable construction can make in terms of real changes on the ground, as well as the opening up of previously unexplored opportunities for economic development, such as

carbon trading with the developed countries, and technology transfer between developing countries, justifies a larger share of the national R & D budget.

b) Negotiate better terms and access to funding with Overseas Development Agencies (ODAs)

Governments are largely responsible for negotiating the overseas development assistance that a country receives, and the terms on which it is made available. While most ODAs have a specific funding portfolio in terms of types of projects and areas of research that are being funded, these are not cast in stone, and developing country governments can negotiate for a change in these funding portfolios and terms to better reflect local conditions and priorities.

c) Provide funding to support emerging businesses and innovative technologies

While there are many technologies being developed in developing countries to support sustainable construction, there is often no funding and other support available to help the inventors of these technologies to commercialise them and set up viable businesses. Yet these technologies not only provide more sustainable options to the established technologies, they also provide several spin-off benefits such as improved human and environmental health, opportunities for economic self-empowerment of the poor, and possible sources of foreign income. These additional benefits mean that it is in the interests of the government to support the development of these businesses and technologies.

d) Provide funding for training and education

As explained in Section 5.2.1 and 5.3.1, it is critical that the skills of all members of the construction sector have to be upgraded. Professional organisations, in partnership with government and the private sector, should set up funding schemes for training blue-collar workers, professionals and educators. These can include subsidisation of training courses, providing scholarships to those who cannot afford the costs themselves, and setting up incentive and reward schemes.

5.5.3 Partnerships and cooperation

a) Include the informal sector

In many developing countries, the informal sector of the construction industry is as big as, if not bigger than, the formal sector. It is therefore crucial that industry umbrella bodies and professional organisations include the informal sector as well when setting up partnerships for the implementation of sustainable construction.

b) Bring traditional governance systems on board

In many developing countries, especially in Africa and Asia, traditional systems of governance are still alive and play a vital role in the development of especially rural areas. Traditional leaders have an influential role to play in determining the acceptance of new technologies into communities. As sustainable construction has to happen within the local cultural context, it is necessary to include traditional leaders into partnerships for research and implementation. Their collaboration in developing strategies for awareness-raising and dissemination of information, as well as the development of codes of conduct that support sustainability, is also critical to the success of sustainable development and construction in the areas where they are in control.

c) Partner with local government

The most direct link between government and the construction sector is often through local government. The buy-in and support of local government will be critical to the acceptance and implementation of more

sustainable construction technologies and practices. It is therefore necessary to set up partnerships with local government to build their own capacity, to assist in the implementation of the R & D agenda identified in Chapter 4, and to manage and regulate the technology transfer from research programmes to pilot projects and further.

5.5.4 Internal housekeeping

a) Lead by example

National and local governments need to lead by example, greening their own facilities and practices and following their own policies and regulations.

b) Adopt a regulatory framework for sustainable construction

Government, the professional regulators and industry representatives have to formulate and adopt a regulatory framework for sustainable construction that clearly outlines the roles and responsibilities of the various role-players and the performance indicators according to which they will be measured.

Professional and industry regulatory bodies need to formulate their own internal codes of conduct in relationship to sustainable construction, while national government has to facilitate the creation of regulatory bodies for the range of emerging professions such as impact assessors, energy raters, etc.

c) Comply with international agreements and frameworks

Government should provide an enabling and encouraging framework for all role-players, including itself, to comply with those international agreements and frameworks to which the country is a signatory.

d) Change professional fee system

Current professional fee systems, based on a percentage of the contract value, do not encourage the use of more sustainable construction practices, and may in fact discourage their use. The bodies and government sectors responsible for regulating the professions need to develop alternative fee structures that more accurately reflect the demands placed on built-environment practitioners by the requirements of sustainable construction.

5.5.5 Encouraging and supporting implementation

a) Change standards and regulations to support sustainable construction

Many existing standards and regulations were developed to meet totally different priorities and needs than those required by sustainable construction in developing countries. As such, they may no longer be relevant, or may even provide obstacles to the creation of a more sustainable built environment. National and local government have to review policies, legislation and regulations on a continuous basis, and deregulate or develop new regulations as our understanding of sustainability grows.

Standards organisations have to review their methods and criteria to allow for the new technologies and services that are being developed, while local governments have to review their by-laws and regulations to accommodate the changes brought about by sustainable construction practices.

b) Provide effective incentives and disincentives

Through incentives such as tax breaks, preferential procurement and bridging finance for retooling, government can provide incentives for the construction sector to adopt sustainable construction practices.

Similarly, tougher environmental and labour legislation with severe penalties for infringement will encourage manufacturers and contractors to clean up their act.

c) Enforce regulations

Government and professional and industry bodies have to set up systems to make sure that regulations are enforced, and set up appropriate dispute-resolution mechanisms.

5.5.6 Monitoring and evaluation

a) Set up legal structures for monitoring and evaluation

Government and the regulatory bodies need to set up legal structures for monitoring, evaluating and assessment, even if the responsibility for their management is to be delegated to other organisations.

b) Participate in monitoring and evaluating schemes

Government, at both local and national level, needs to participate in the various monitoring and evaluation schemes that will be set up.

5.6 Role of NGOs and CBOs

The last stakeholder group comprises the non-governmental organisations (NGOs) and community-based organisations (CBOs). These organisations are at the front line in terms of technology transfer for sustainable construction, awareness-raising and advocacy. They also have an important watchdog role to play, and can take over some of the monitoring and evaluation roles described in this chapter. Their close links to the communities within which they operate means that these organisations are critical partners for the research organisations in the development and transfer of new technologies.

Summary Table: A strategy for action				
	Actions for the research and education sector	**Actions for the private sector and utility companies as service providers**	**Actions for clients**	**Actions for government and regulatory stakeholders**
Capacity building	• Build internal capacity. • Expand learning offerings.	• Enable continued organisational learning. • Support the development of external capacity.	• Develop own understanding of sustainability and the benefits of more sustainable choices.	• Create an advisory stakeholder council. • Raise awareness of sustainable construction among government officials and politicians. • Introduce continued professional education.
Access to funding	• Identify and access appropriate funding streams. • Be creative in using existing funding streams. • Actively lobby for funding for sustainable construction.	• Provide funding for R & D for own benefit. • Through corporate social responsibility (CSR) budget contribute to funding for research for the common good.	• Use the savings, reduced risks and added value resulting from sustainable construction to leverage the additional capital costs required for its implementation.	• Reconsider scope of own funding programmes. • Negotiate better terms and access to funding with overseas development agencies (ODAs). • Provide funding to support emerging businesses and innovative technologies. • Provide funding for training and education.
Partnerships and cooperation	• Establish cross-sectoral exchange programmes. • Establish an effective South-South network of researchers & educators. • Clarify issues of knowledge sharing. • Pursue research and educational partnerships with other sectors.	• Cooperate on the implementation of the R & D agenda. • Partner with research organisations. • Form industry coalitions to fund pre-competitive research and development of enabling mechanisms.	• Form partnerships for learning with research and education institutions. • Form consumer lobbying groups to demand more sustainable services and products.	• Include the informal sector. • Bring traditional governance systems on board. • Partnerships between local government and research and education institutions.
Internal housekeeping	• Revise existing curricula. • Practise what is being preached.	• Assess risk of non-compliance and benefits of compliance. • Devise strategic plans for different industry sectors. • Change organisational values. • Improve resource efficiency and reduce impact.	• Rethink own internal procurement systems.	• Lead by example. • Adopt a regulatory framework for sustainable construction. • Comply with international agreements & frameworks. • Change professional fee systems.
Encouraging and supporting implementation	• Technology transfer. • Raising awareness. • Advocacy.	• Assist with the incubation and mentoring of emerging market niches. • Use new technologies and processes. • Create a demand.	• Use government influence to drive the market.	• Change standards and regulations to support sustainable construction. • Provide effective incentives and disincentives, e.g. tax breaks. • Enforce regulations.
Monitoring and evaluation	• Provide independent monitoring to private sector and government. • Introduce mechanisms for own monitoring and evaluation.	• Adopt corporate social responsibility (CSR) reporting systems. • Participate in certification schemes. • Capture information for monitoring and assessment.	• Participate in monitoring and evaluation schemes. • Monitor cost benefits achieved.	• Set up legal structures for monitoring and evaluation. • Participate in monitoring and evaluation schemes.

Chapter 6 Conclusions and the way forward

6.1 Conclusions

We are beginning to realise the impact of our developmental actions on the planet and its people, and can appreciate at an intellectual level that the current state of the world is not its optimum condition. But are we, as users of the built environment and as members of the construction sector, fully aware of our culpability in this state of affairs and prepared to internalise the changes that will be needed? In developed and developing countries alike, the formal construction sector and its clients persist in thinking that construction can continue as before; all that is needed are a few tweaks to the construction process to improve resource efficiency. The interventions most often suggested are what other industries call "end-of-pipe" solutions. In terms of the mind shift that is necessary, they amount to rearranging the deckchairs on the Titanic. At most they are the interim solutions that are buying us time to formulate, accept and implement a strong sustainability model of development with its accompanying values and ethics. Internationally, the construction industry and its clients have not even begun to realise the scope of the innovation that will be required.

The change required is far greater than the shift made at the beginning of the 20th century, moving from bricks and mortar to steel and glass. The construction industry needs to be completely reinvented, from the materials used and how they are manufactured, to how performance is viewed and the criteria set for it.

In a way, this shift would be easiest for the developing countries. Not only do they in many cases still have a living memory of existing in another paradigm with other values, they are, by nature of the survival challenges experienced, used to innovation, adaptation and doing more with less. It may be that, through their cultural heritage, innovative home-grown solutions and adaptability, the developing countries are holding one part of the key to sustainability. However, we have to remember that both developed and developing countries hold knowledge and values that can contribute to a new vision for development, as well as the practical know-how needed to make it work.

The ultimate aim of Agenda 21 for Sustainable Construction in Developing Countries is to facilitate this shift in thinking and doing, from exploitation and degradation of the planet and its people to a development model where the built environment and the natural environment are in harmony with each other and where people can live safe, healthy and productive lives in harmony with nature and local cultural and spiritual values. To this purpose an R & D agenda has been formulated that is aimed at developing the technological, social and value enablers that will make the shift possible. To support this R & D agenda, a strategy for action is suggested. This strategy describes the actions expected from the research and education institutions, the private sector, clients, government, and the professional and industry regulatory bodies in support of sustainable construction and the implementation of the R & D agenda.

The title of this document suggests that there is a difference in sustainable construction between developed and developing countries. However, if one looks at the headings in the R & D agenda and strategy for action, these can in most cases apply equally well to developed countries. The question can therefore be asked: How is Agenda 21 for Sustainable Construction in Developing Countries different from an agenda that would have been formulated from a developed-world perspective? The differences lie in the scope of the Agenda and the context within which its recommendations have to be applied.

The developed world, which owes its wealth and high standard of living to its commitment to technological development, would naturally emphasise technology in an R & D agenda that concerns itself with sustainable

construction. The developing world, however, comes from a people-centred view of development, which recognises that ultimately it will be the behaviour and choices of people that determine the success or failure of sustainable development and construction, not only the availability of sustainable technologies. While technology is important, we also need to provide an institutional environment that encourages and enables people to change their behaviour, as well as giving them reasons for changing their behaviour. The scope of the Agenda was therefore expanded to include the development of institutional and value enablers. These three sets of enablers are seen as equally important for the promotion and implementation of sustainable construction.

There are as many contextual differences between developing countries as there are between developing and developed countries, and many of the similarities are superficial at best. Thus, while it is agreed that we share a common goal – achieving a state of sustainability – the developing world, with its great diversity of cultures, realises that there are different ways of defining and meeting this goal, and that these ways can best be determined at local level. The R & D agenda therefore merely provides a loose framework of areas in which research is needed, and places the emphasis on developing enablers that are situated within the local context, whether these are technologies that respond to local climates and skills levels, or the use of value systems derived from the local cultural heritage. Similarly, the suggested actions have to grow from local initiatives, making use of local strengths and addressing local barriers. The value of the strategy for action lies in providing a global strategy that can be used by local champions to encourage action within their own communities.

6.2 The way forward

To take Agenda 21 for Sustainable Construction in Developing Countries forward is an enormous undertaking that will require plenty of innovation and commitment from all concerned. Both the R & D agenda and the strategy for action have identified tasks for immediate attention, as well as tasks for the medium and long term. The immediate tasks are those concerned with capacity-building, raising awareness, finding access to funding, building networks and partnerships, and providing benchmark information relevant to developing countries. This is where the bulk of work needs to focus in the next five years, as these areas present the critical obstacles that are holding back further development. However, it is vital that work continues at the same time on the medium term and long-term tasks of developing tools and technologies and other enablers to lessen the impact and lead the construction sector into a new paradigm.

> The only way to eat an elephant is bite by bite.
> African proverb

Due to contextual differences, it is envisioned that this Agenda needs to be taken forward at both the local and international level. The R & D agenda has been structured in a way that allows countries to work independently from each other according to their own priorities, while contributing to the development of an international body of knowledge. It therefore provides a framework for common research projects that can be executed in partnership with research teams of other developing countries, or as independent, country-specific studies that fill some of the knowledge and technology gaps. However, the ideal is that the R & D agenda will provide a structured opportunity for South-South partnerships and technology transfer, as well as for renegotiation of existing North-South partnerships to empower researchers in developing countries and expand research capacity in these countries.

To start this process it will be necessary to actively lobby for support of the Agenda within the different developing country regions, as well as at international level. To coordinate and facilitate this process, a formal structure is required. It is therefore proposed that a special programme be set up, under the umbrella of an organisation such as the CIB, with the explicit purpose of managing and promoting the implementation of the Agenda. In response to

the different priorities and conditions in the regions, as well as the language gap between Latin America and the largely English-speaking African and Asian networks, it is suggested that an initial three regional champions be appointed to take the Agenda further in their respective regions. These champions could also act on a rotating basis as the champion responsible for the international coordination of the process and setting up the umbrella network.

The duties of these champions will be to:

- Lobby the various regional stakeholders and role-players to get their support for and commitment to the Agenda and its strategy for action.

- Identify existing regional research and education networks that operate in the field of construction, and lobby them to form a regional network of networks, which will then all be linked to the global research network.

- Identify possible sources of funding for research collaboration within their regions.

- Start an awareness-raising process on sustainable construction within their own countries or regions.

Over time, the structures set up by these champions could then form the basis of regional centres of excellence. It should also be acknowledged that the three main regions could be further divided into sub-regions. Africa alone can be divided into six or seven distinct sub-regions. The ideal is to ultimately set up a series of sub-regional network hubs that are all linked to the global network, but which can focus on specific sub-regional issues.

The duties of the international champion are envisioned as follows:

- to negotiate with international agencies for funding of collaborative research projects on a South-South, as well as North-South basis;

- to build links with relevant international networks and bodies;

- to build the international developing country research network; and

- to facilitate collaboration and knowledge-sharing between research organisations in the developing world, as well as between researchers and role-players in the industry.

Finally, the implementation of this Agenda is not the responsibility only of the research and education institutions. More active involvement of government, industry, non-governmental organisations and professionals is needed if sustainability is to become a generally accepted driver for change. The circle of discussion and dissemination thus needs to be widened. At national level a strategic alliance between the different levels of government, the broader construction industry and universities and research centres could work as an effective mechanism to boost the importance of the topic and to encourage coordinated action. At international level, cooperation and concerted advocacy can play an important role in influencing governments and the construction sector in developing countries to give the necessary attention to issues related to sustainable construction.

Most importantly of all, we have to acknowledge that people are at the centre of sustainable development. In its deeper meaning sustainability has ethical and moral connotations that imply attitudinal changes and value reorientation. Therefore, the success of the sustainability drive will ultimately depend on each individual's conscious choice to adopt or reject the principles of sustainable development. There are countless examples where development projects have unexpectedly failed, usually because aspirations, cultural practices and values, and real needs were disregarded.[35] Studies in South Africa have shown that when people are asked to rate the key performance indicators for their built environment, it is often not the quality that is important, but that the correct process has been followed in determining what gets built, and that this process takes cognisance of social and cultural needs and their priorities.[36] Sustainable construction in developing countries will therefore only become feasible if it meets the needs and requirements of the people in these countries, and does not conflict with their culture and values. At the end of the day, it is the client who will determine whether sustainable construction will be adopted by the industry as the best way forward.

Addendum 1

The process

Phase 1 (funded jointly by CIB and CSIR)

Nine expert position papers were commissioned, three each from Africa, Asia and Latin America. These papers provided comment on the following:

- The different regional understandings of sustainable construction.
- The issues and challenges facing the regions.
- The impact of the construction industry on the economy, the environment and society in the regions.
- The barriers to sustainable construction.
- The strengths and opportunities presented by the cultures and traditional practices of the regions.
- Suggested actions for the research community, governments and the construction industry.

From these papers, a first discussion document was prepared to act as a common starting point for further debate. This document, as well as the position papers, was made available on the following websites:

http://www.cibworld.nl:600/pages/begin/A21SCDC.html
http://www.sustainablesettlement.co.za

Phase 2 (funded jointly by UNEP-IETC and the CSIR)

Through articles in the publications "Open House International" and "Sustainable Building", as well as through CIB newsletters and a targeted e-mail campaign, interested parties were invited to use the First Discussion Document as a basis from which to identify the key priorities for action regarding the creation of sustainable built environments in developing countries, as well as concrete suggestions for the way forward. This broader consultation process was open for a year. Finally, a small expert workshop was convened to formulate the structure of the research and development agenda, the strategy for action and a concrete way forward for the Agenda. From this workshop, the final draft was prepared.

Phase 3 (funded jointly by UNEP-IETC and the CIDB)

A draft Agenda was prepared and submitted electronically for final comment to the regional expert working group comprising of those invited to the workshop, as well as the original contributors to the First Discussion Document, parties identified by UNEP-IETC and a selected group of 50 international experts within the CIB, as well as within other stakeholder groups. Taking into account the comments received from this final round of consultation, the final Agenda was readied for publication and its launch at the World Summit on Sustainable Development in Johannesburg, as well as the Sustainable Building'02 Conference in Oslo.

Chapters 2 and 3 of this document are based on the discussion papers, while Chapters 4, 5 and 6 are based on the results of the expert workshop.

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