Towards a sustainable built environment prepared for climate change?

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Abstract

On a global scale, the Building, Construction and Property Services Sector is causally related to many of the climatic and other environmental challenges that we face today. Sustainable development requires an overall approach to create win-win situations — this has resulted in a change of expression in the sector, from 'green buildings' to 'sustainable built environment'.

Traditionally, from an eco-efficiency perspective, research and other initiatives concerning sustainable building have focused on two viewpoints: (i) How do buildings affect the environment, locally, regionally and globally, and (ii) how is the climate regime of today affecting structures, building enclosures and construction materials regarding utilisation, maintenance and extended lifetime? But now we have a third issue to contend with: What are the possible impacts of the anticipated climate change on the built environment?

Our goal of a sustainable built environment must accommodate these expected climate changes. How can policy and practice be developed to achieve this over the next 50-100 years? This will require three main measures: (i) development of adaptation strategies, (ii) larger societal and inter-sectoral adjustments, and (iii) improved understanding of the ways in which the building sector interacts with other sectors and political, environmental, social and economic processes at large. This is hindered today by a lack of appropriate codes and regulations.

Introduction

The Building, Construction and Property Services Sector is the world's largest sector, at least in industrialized countries. The built environment literally "houses" economic activities, individuals and families, as well as society's cultural heritage. Its purpose is to protect life, health and psychological and social welfare of its inhabitants, host economic activities and sustain aesthetic and cultural values.

On a global scale, this sector is related to many of the environmental problems we are facing today. For our ancestors, environmental concerns were a localized or regional affair. Now it is a major issue for us all. Just in the last decade we have received repeated signals of serious

impending changes in our global environment. We have realised, and even experienced first hand, that the changes can and will affect the built environment, and therefore our daily lives.

We have also realized that the issue of climate change and a sustainable built environment has expanded from a question of science to one of global political, economic and technology policy. And dealing with these issues involves different stakeholders, and requires development of adaptation strategies, together with larger societal and inter-sectoral adjustments. There are significant gaps in our scientific understanding, so we must continue to pursue research into creating a more sustainable built environment. The main question is: How can we develop both policy and practice so that our goal of a sustainable built environment accommodates expected impacts of climate change over the next 50-100 years?

Sustainability

In 1987, the Brundtland Report "*Our common future*" defined sustainable development as "*the ability of humanity to ensure that it meets the needs of the present without compromising the ability for future generations to meet their own needs*". It further stated that there are many dimensions to sustainability, including economic, social and environmental aspects. The term has now become a part of our everyday language. And more importantly, also governments, industry and non-governmental organizations have adopted the term, as it has been the subject of several international agreements and conferences, including the following:

- The *Montreal Protocol on Substances that Deplete the Ozone Layer*, agreed on in 1987
- The *United Nations Conference on Environment and Development* held in Rio de Janeiro in 1992, resulting in the Rio *Declaration On Environment And Development* and *Agenda 21*
- The second United Nations Conference on Human Settlements, *Habitat II* was held in Istanbul, Turkey in 1996. It resulted in *The Habitat Agenda*, and was intended as a global call to action at all levels, and a guide towards the achievement of sustainable development of the world's cities, towns and villages into the first two decades of this millennium.
- The *Kyoto Protocol* in 1997
- And lastly, The *World Summit on Sustainable Development* last year, held in Johannesburg, South Africa

It's now 15 years since the Brundtland-report was presented. For many years after this, the debate on sustainable development tended to focus on environmental aspects only, treating economic concerns and social aspects separately. We now better understand the complexity of sustainability issues, and now have come to realize that sustainable housing must include a construction perspective, a social and economic perspective and an eco-efficiency perspective.

Unfortunately, despite our efforts on international agreements and world summits, emissions of greenhouse gases have increased, and natural resources have been further degraded. The world's population doubled between 1960 and 2000, and is estimated to increase by a further 50% to 9 billion in 50 years. Worldwide consumption will increase even faster. Recently published research shows that, from the mid-80's up to today, humans started to exceed nature's ability to regenerate. Human consumption of natural resources today overshoots the Earth's biological capacity by about 20%. Looking at the world's ecological footprint, which

compares the consumption of renewable natural resources with nature's biologically productive capacity, we see that it would take 1.2 Earths to regenerate resources at the rate we are using them.

The gap between the rich and poor is widening and becoming more obvious. Sixty percent of the world's poorest live in ecological vulnerable areas, and these are the people who have the least opportunity to protect themselves from global warming and long-term changes in the climate system. Sustainable development is crucial for the world's poorest. The family that has to clear forest, to grow its food and find the fuel to cook, does not have the choice of living sustainably. The poorest have the least power to protect themselves from the effects of global environmental problems.

After Rio in 1992 the then UN head, Boutro Boutros-Ghali, proclaimed: "*One day we will have to do better*". He was right. To achieve sustainable development we need to further increase our knowledge for the interaction between:

- Economic growth in the form of industrialisation, urbanization and increase of prosperity,
- Conservation and enhancement of natural resources,
- Environmental impacts related to production and consumption of resources,
- and lastly, Social and cultural development, including the elimination of poverty.

We must believe in finding many paths towards the common goal of a sustainable future. Each one of us, representing different communities, ethnic and religious groups, regions, countries and human cultures, must search for our own unique approaches based on historical roots, technologies, population dynamics and specific natural conditions.

From 'green buildings' towards sustainable built environment

Sustainable building plays a pivotal role in sustainable development. Climate change caused by anthropogenic emissions of greenhouse gases (GHG) is considered to be of the most important threats of today, and a core issue in sustainable development. Approximately 40% of the global energy use is ascribed to the building sector, so there is a close link between building energy consumption and climate change.

Parallel to the events in the 1990's that saw an increase in public awareness of sustainable development, there was also considerable interest in the building and construction sector, starting with environmental assessment of buildings. One of the reasons for this interest was that both the research community and relevant government agencies view performance-rating and labelling systems as one of the most effective methods of market transformation — the wholesale improvement of building performance benchmarks to higher levels.

The interest in building environmental assessment in the 1990's, resulted in international activity and a number of methods worldwide to evaluate the performance of buildings and tools for documenting the environmental performance of materials and products. This has provided the building sector with important theoretical and practical lessons, and has encouraged better communication and interaction between the different actors within the building industry. Within the international standardizations system (ISO), work started in 1997, which I had the opportunity to initiate, with a study on sustainable buildings.

Today there are 5 ISO Committee drafts on:

- environmental assessment of buildings,
- environmental declaration of buildings products,
- sustainability indicators,
- defining general principles,
- and finally, a common terminology for sustainability in building construction.

In 1996, the project – *Green Building Challenge* (GBC) – successfully created an international agenda for environmental assessment of buildings. It has resulted, to date, in three conferences, starting with the GBC'98 conference, a major international event in Vancouver. Then, two *Sustainable Building* conferences, one in Maastricht in The Netherlands in 2000, and the other in Oslo in Norway in 2002. The acknowledgment that sustainable development requires an overall approach to create win-win situations has resulted in this change of expression, from 'green buildings' to 'sustainable built environment'. Through these three conferences, the design and research communities have joined forces to assess projects from participating countries and to organize major international conferences. And most importantly, this has lead to a focus on international dialogue, seeking a consensus from participants representing a variety of viewpoints, different cultural and social backgrounds, economic context, climatic and environmental conditions.

From the 2002 *Sustainable Building* conference, it was clear to see that progress in sustainable building is only incremental, especially in those countries with a large existing building stock. The progress will not be enough to meet Kyoto targets, to avoid severe problems in resource availability, in water supply, and social cohesion in urban settlements. We need new concepts, a radical change in the management of our resource cycles, and initiatives for providing shelter. And, in addition to preventing climate change, the building sector will have to withstand the anticipated effects of climate change.

Furthermore, there is still a strong emphasis on design and construction of new buildings. But, due to the sheer size of the existing building stock, and need for rehabilitation of whole neighbourhoods, this should be the starting point for the sustainable building and housing strategies.

The demand for energy in buildings is expected to continue growing in the future, and appropriate actions need to be taken to meet this demand. A new EU directive on the energy performance of buildings will be important for the introduction of stricter energy requirements. EU issued this directive in December 2002. The directive instructs that the energy use in buildings shall be evaluated on a holistic basis, where not only the space heating demand is to be taken into account, but energy use for cooling, lighting, appliances, fans, pumps, etc. as well. The directive also instructs that all buildings, including homes, that are to be sold or rented, shall have a valid certificate informing about its energy performance and the measures that could be taken to improve it.

Climate change and the built environment

Traditionally, from an eco-efficiency perspective, research concerning sustainable building has focused on the following viewpoints:

- Firstly, how do buildings affect the environment, locally, regionally and globally, both in the construction phase, and in use? Important aspects are: rational and efficient use of resources such as land, level of energy consumption, type of energy used, water consumption, emissions of substances, and impact on biodiversity.
- Secondly, how is the climate regime of today affecting structures, building enclosures and construction materials regarding utilisation, maintenance and extended lifetime?

Today, we face a third issue: the possible impacts of climate change on the built environment. Extreme weather events remind us of how vulnerable society is when faced with major climatic variations and severe weather conditions.

Observations increasingly point to global warming and other changes in the climate system. Different scenarios have been formulated, from best to worst cases, for climate change over the next 50-100 years. Climate change can be seen as having 3 spheres of impacts:

- *Primary* (temperatures, wind speeds, water tables, floods, driving rain, extreme climatic events),
- *Secondary* (ranges of flora and fauna, biological agents and disease),
- and, *Tertiary* (social, behavioural and institutional).

Global warming is likely to lead to changes in the local climate in several parts of the world, but several sources of uncertainties exist related to both scenarios for global climate change, and to the effects of global warming on regional-level climate. Regional scenarios should not be considered as forecasts in an absolute sense, but they offer insights into the likely range and nature of future weather scenarios.

Norway can be considered a highly exposed country due to its naturally extreme weather conditions. Because of the country's long coastline and steep topography, it is particularly vulnerable to extreme events like coastal storms, avalanches and landslides. Norway may be exposed to changes in autumn rainfall, and to an increase in the frequency and intensity of storms due to global warming. Many sectors of the Norwegian society can be affected by climate change. Impacts may be felt by economic sectors directly or indirectly, depending on climatic factors. The same is true for environmental and social sectors. In the energy and hydropower sector, increased precipitation and runoff may enable increased power production. At the same time, however, increased temperatures might reduce household space heating and energy demand.

Historically, large variations in local climatic impact in Norway have led to major variations in building practice, often well-suited to local climatic conditions. Extensive degradation and damage to the built environment occur every year due to the impacts of precipitation, wind, temperature and exposure to the sun. The question is: to what extent have we rejected sound building traditions and practice in our search for cost-effective solutions?

The understanding of how degradation and damage best may be reduced, is of significant importance in the design and construction of buildings. Future building materials, structures

and building enclosures, will need to withstand even greater climatic impact in parts of Norway than they do today. When designing building enclosures to resist wind actions, extremes are much more important than mean wind velocity values. For certain types of house facings the duration of rainy periods might be of greater importance than the maximum intensity of precipitation that occurs in the form of driving rain. For other types of external walls the intensity of driving rain may be the most important. The total number of freezing and thawing cycles is significant when the whole-life performance of masonry constructions is to be determined. For polymer materials, the sum of ultraviolet radiation may determine the lifetime of the products, rather than the yearly averages in temperature. Many parts of buildings' external enclosures are likely to be subject to faster degradation in parts of the country where there is increased ultraviolet radiation.

Potential implications of climate change in Norway might be moderate compared to what may be the case in other parts of the world. In the developing world, costs of climate change are likely to be greatest and the need for adaptation most pressing. However, other issues – the need for economic and social development, and the battle against diseases such as AIDS – have much more immediate significance. Presently, the debate about climate change in the developing world appears to be a luxury that only the developed world can afford.

Scientists in many fields are exploring the possible impacts of climate change. Until now, few studies have looked at the likely impacts of climate change on the built environment. A study by BRE concluded that an increase in wind speeds of 6% is likely to cause damage to 1 million buildings, with a cost of £1-2 billion. The study also addressed the impact of increased quantities of driving rain on of different types of building envelope, and the likely increase in maintenance costs due to more extreme weather in parts of England.

A study published by the Building Research Association of New Zealand highlights climate change impacts on building performance in New Zealand. The study concludes that the future performance of buildings in New Zealand may be significantly altered with regard to coastal and inland flooding, overheating, and wind damage and flooding associated with tropical cyclones.

Dealing with both sustainability and possible impacts of climate change, we see that different countries are beginning to respond to these issues and looking for ways to move towards a sustainable built environment, adapted for climate change.

Possible strategies towards a sustainable built environment prepared for climate change

How can we develop both policy and practice to ensure a sustainable built environment accommodated for expected primary, secondary and tertiary impacts of climate change over the next 50-100 years?

Through several international conferences, agreements and policy, we now understand better the complexity of the sustainable issues. We also know that sustainable housing include a construction perspective, a social and economic perspective and eco-efficiency perspective. A important challenge for the pioneers in this field is the complexity, both of climate change and sustainable built environment, with its diversity of stakeholders. The built environment encompasses both domestic housing, industry and business premises. The building sector involves several actors, including occupants of the buildings (individuals and families,

business, industry and the service sector), authorities who regulate the built environment, and the construction industry. And our global climate system is likely to undergo changes, but the full range of impacts resulting from these changes is still uncertain. This makes it difficult to comprehend the whole of this challenge and to take effective ownership of it.

Adaptation to climate change is necessary and inevitable within several sectors. For Norway, adaptation to the prevailing climatic conditions has always been crucial for the viability of the countries society, but future climate changes may expose Norway to new challenges. Indeed, within the climate impacts literature, there is growing emphasis on adaptation and the need to enhance adaptive capacity, both in developed and developing countries.

Adaptation can be described as adjustments in practices, processes, or structures to take into account changing climate conditions, to moderate potential damages, or to benefit from opportunities associated with climate change. Adaptation is thus justified as a way of reducing the negative impacts of climate change and of taking advantage of the opportunities created by it. While the physical exposure component of vulnerability can be targeted through emissions reductions, it is likely to persist if not increase with climate change. In order to effectively reduce vulnerability as a result of climate change, society's sensitivity and coping capacity must be targeted.

Important questions to answer are: What lessons can be shared form early policy and strategy development, what gap remains to be filled by further research, and where is future collaboration likely to be most useful?

To the extent that the built environment community has engaged with climate change, its efforts have until now been focussed on reducing energy use and CO_2-emmissons. The result of this work has been variable. Since the 1980s, there been minor changes in the specific energy use (KWh/m^2) in many industrialised countries, while the stock of buildings has increased steadily. And, it is shown that energy use in the built environment as a whole has continued to grow.

In addition to achieve energy improvements in buildings, a shift in the way energy is used in new and existing buildings is needed. Firstly, it is important that the demand for energy efficient and sustainable favourable buildings. The new EU directive will be important, but it is crucial that the European countries support the implementation of the instructions in the directive. Further on, we need stricter requirements in the building regulations to improve the environmental performance of new buildings and lastly, make sustainable improvements in the existing building stock more profitable for the different stakeholders.

For the improvements in buildings to be sustainable, the changing climate regime of today has to be taken into account. In order to do so, we need to learn more about the impact of different climate change scenarios on building performance and how society best can adapt to these changes. This requires qualifications and skills of professionals need to be further improved, e.g. by developing education programmes and courses to increase the competence, followed by guidelines described how sustainable solutions, prepared for climate change should be carried out in practice. An important factor in this is that the funding of research and development is prioritised. This will allow the building and construction sector to initiate demonstration projects and actively test out new solutions and demonstrate them for the trade and users.

By correctly applying knew knowledge in a sustainable context in planning and design, it will lead to a higher level of building reliability, extended lifetime, lower damage and maintenance costs, and administration. This requires more accurate criteria and Codes and Practice concerning building performance in different climates. Today there is a lack of such appropriate codes and regulations. But in order to do so, larger societal and intersectoral adjustments are necessary as well. This together with improving our understanding of the ways in which the building sector interacts with other sectors and political/environmental/social/economic processes at large.

Concluding remarks

We are facing a changing climate regime, which must be taken in to account when moving towards a sustainable built environment. We must develop effective codes and practices to meet this challenge.

Some parts of the world, such as Europe, have started this work, but a lot of research still needs to be done, and inter-sectional actions are yet to be taken. Unfortunately, not all parts of the world have the luxury to deal with this issue. The gap between the World's poorest and richest is widening, and we know that poverty and environmental problems often go hand-in-hand.

This requires a holistic perspective and strategy, where we must keep focus on the future challenges and act according to defined timetables and targets. Each country's needs and conditions must be taken into account when dealing with both sustainability and climate change. In this way it might be possible to achieve a conscious holistic policy, at least at national levels.

Thank you for your attention.

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References

Lowe (2003): '*Preparing the built environment for climate change*'. Editorial in Building Research & Information, Volume 31 Number 3-4 May-August 2003

Lisø, K. R., Aandahl, G., Eriksen, S., Alfsen, K., H. (2003): '*Preparing for climate change impacts in Norways's built environment*'. Building Research & Information, Volume 31 Number 3-4 May-August 2003

Plessis C., Iruah, D., K., Scholes, R., J. (2003): '*The built environment and 5climate change in South Africa*'. Building Research & Information, Volume 31 Number 3-4 May-August 2003

EC (2003): '*Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings*'. Official Journal of the European Communities L1, 46, pp.65: http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/1_001/1_00120030104en00650071.pdf

Myhre L., Pettersen T., D. (2003): '*Sustainable construction in Norway: Climate change and energy challenges*'. Special issue article in: The Future of Sustainable Construction – 2003.

McCarthy J., J. *et al.* (2001): '*Climate Change 2001, Impacts, Adaptation and Vulnerability*'. Cambridge University Press, Cambridge.

Loh J. (editor) (2002): '*Living Planet Report*'. WWF-World Wide Fund For Nature, Gland, Switzerland

The Research Council of Norway (2002): '*Fattigdom, utvikling og miljø*'. Report based on a national conference dealing with poverty, development and environmental isssues, hosted by Research Council of Norway.