Final Version for publication, January 2003

Building Research & Information (2003) 31(3–4), 195–199

Editorial

Preparing the built environment for climate change

The last 15 years have seen the subject of climate change move from a question of science to one of global political, economic and technology policy. To the extent that the built environment community has engaged with climate change, its efforts have hitherto been focussed largely on reducing energy use and carbon emissions to mitigate change. The results of this work have been mixed. At its best, results have been dramatic, but they been neither widely replicated nor largely understood and in overall terms their impact has been small. Specific energy use (kWh/m^{2}a) in many industrialised countries has changed little since the 1980s while the stock of buildings has increased steadily. Energy use in the built environment as a whole has continued to grow.

However, the current scientific consensus is that climate change is no longer a hypothetical possibility, but that measurable change has occurred and that it will accelerate under the combined effects of historical and future emissions. Different scenarios have been formulated, from best to worst cases, for climate change over the next 50-100 years (IPCC 2001, Hulme *et al.* 2002). A significant new problem has been created which needs to be addressed by clients, practitioners, researchers and policy makers. This can be summarised:

> How can we develop both policy and practice to enable the built environment to accommodate expected primary (temperatures, wind speeds, water tables, floods, driving rain, extreme climatic events) secondary (ranges of flora and fauna, biological agents of disease) and

tertiary (social, behavioural and institutional) impacts of climate change, over the next 50-100 years?

This special issue records the early stages of the processes by which different countries are beginning to respond to the questions posed by the problem of adapting the built environment for climate change. A turning point has been reached where the need to limit future climate change through reducing carbon emissions has now to be complemented by the need to prepare the built environment to withstand a range of climate change scenarios. Although specific aspects of climate change (and accompanying scenarios) will have different regional impacts, the key questions are, what lessons can be shared from early policy and strategy development, what gaps remain to be filled by further research and where is future collaboration likely to be most useful?

Earlier forays into the field include the pioneering work of Graves & Philipson (2000), a paper in this journal from Camillieri *et al.* (2001) and the Tyndall Centre/CIB conference in April of last year. This is, however, the first time that *Building Research and Information* has devoted an entire issue to the subject. A serious problem for the pioneers in this field is the complexity both of climate change and of the built environment with its diversity of stakeholders including academic and professional disciplines, businesses, government departments and building users. This makes it difficult to comprehend the whole of the problem or to take effective ownership of it. Reflecting this, the early stages of research in all of the countries represented in this issue are characterised by a some reluctance to address strategic rather than specific questions and, on occasion, a (misplaced) embarrassment about lack of progress to date. There is also a scarcity of work from a number of countries that have hitherto played a major part in the formulation and implementation of responses to climate change.

The different perspectives of the authors of the papers in this issue provide insight into a number of areas. These include the relationship between adaptation and mitigation, the relative importance of adaptation in less developed countries, the importance of local context in determining the focus of adaptation efforts and the potential for medium and long term adaptation strategies to diverge.

The papers from Canada, South Africa, Norway and Japan all refer to climate change policy either still being seen, or until recently having been seen, exclusively in terms of mitigation. This also appears to be the case in countries not represented in this special issue, notably Germany and the Netherlands. It appears that much of the technical and policy-making community has been reluctant to address the problem of adaptation. This may be because they could see no immediate need for an adaptive response. However, as noted above, it may be that to do so would have been to admit that the political case for the development and world-wide implementation of vigorous and effective mitigation strategies would be much more difficult to win than many had, perhaps naively, hoped. An interesting variant on this position is present in some quarters in the US, where there is a reluctance to address the problems of adaptation because of an unwillingness to lend weight to arguments for migitation (or indeed for the existence of climate change itself). As Mills (2003) notes, this difference is manifest even at the linguistic level. However, the last two or three years have seen a growing recognition that strategies for adaptation will be needed, with actions to establish research networks or centres with responsibility for researching and developing adaptation strategies in at least three of the countries represented.

One of the most obvious ways of adapting to climate change is through regulation and design codes. The problem of how to adapt design codes against a background of quite profound uncertainty over the magnitude of climate change has proved to be a difficult one. In areas such as structural design, those responsible for drafting codes of practice have become used to treating climate as a set of stationary statistical phenomena, with well defined characteristics. The problem of determining design values for variables such as wind speed is therefore simply a matter of collecting sufficient historical data and undertaking the appropriate statistical analysis. As the understanding of the existing climate has improved, so the sophistication and subtlety of the codes of practice has increased. Climate change means that the phenomena of climate are no longer stationary. Sanders & Phillipson (2003) note that the current response of regulators in the UK and Europe to this problem is:

> "…[reluctance] to require significant improvements in the structural design of buildings, which will impose greatly increased costs on the construction industry, on the basis of very uncertain predictions."

However, requests for better predictions of future climate can only partially be answered by climatologists, since future climate depends on the success or otherwise of actions to mitigate climate change. Regulation has therefore, unavoidably, to take into account a wide and expanding range of future possibilities. Happily, uncertainty has always been a part of the regulatory process, and it should not be difficult to deal, if necessarily quite crudely, with our growing realisation of the uncertainty of future climate.

Two of the papers in this issue refer to a subtler problem associated with regulation (Lisø *et al.* 2003, Sanders and Philipson 2003). This is the fact that a significant proportion of wind and storm damage is caused by failures to apply existing regulation. It has, at times, been unfashionable to espouse the need for a strong and robust regulatory framework for the construction industry. But, as both Lisø *et al.* and Mills remind us, with reference to the differing experiences of California and Turkey in the earthquakes of 1989 and 1999, the absence of such frameworks can be catastrophic. Nevertheless, maintaining the public acceptability of regulation requires a careful balancing of interests. Simply raising performance standards as a response to climate change, without dealing with the issue of non-compliance with existing standards, may run the risk of undermining the legitimacy of regulation generally. Attention therefore needs initially to be paid to ensuring compliance of both new and existing building stock.

Regulation plays a crucial role in the anticipation and avoidance of risk. The other main mechanism for dealing with risk is through insurance. An extended discussion of the role of the insurance industry from Mills and contributions from Lisø *et al.* and Hertin *et al.* (2003) begin to reveal the complexity of the issues in this area and the intersciplinarity needed to deal effectively with them.

The importance of local context in mediating the impacts of climate change can be most clearly seen in the papers from the UK, Japan and Canada. Sanders and

Phillpson consider at length the impacts of wind, storm damage and driving rain, in contrast to Shimoda (2003) who deals almost entirely with warming in the urban heat island. The latter is understandable given the existing climate of Tokyo and other major Japanese cities. Incidentally, the data presented in Shimoda's paper show very clearly the way in which progressive increases in temperature lead to non-linear impacts – for example on health. Shimoda's paper also shows how tightly the issues of adaptation and mitigation are intertwined. The urban heat island is exacerbated by inefficient use of energy in urban areas, and many of the technical measures discussed by Shimoda. For example, the development air conditioning equipment with coefficients of performance[1] in the region of 6.0 simultaneously mitigate global climate change, reduce urban temperatures and allow cost effective adaptation at the level of the individual building.

This paper also hints at a possible divergence of medium term and long term adaptation strategies in its discussion of the effects of thermal insulation on envelope performance and energy use for cooling. One of the most important tasks of research in this area will be to identify and understand such divergences.

There are fascinating parallels between Steemers' (2003) discussion of the adaptive potential of buildings and people, and Shimoda's reference to the Kansai "summer eco-style campaign" to reduce the impact of the urban heat island by social engineering. For a wide range of existing climates, such social strategies have the capacity to offset a significant proportion of warming, at least over the next half century. Their application requires a subtle understanding of the nature of thermal comfort and human behaviour in the built environment, a fact that may explain both their enduring fascination for architects and others and their current, relatively modest impact on mainstream design. The problem of understanding the factors that determine the extent to which they are implemented is complex and worthy of further research.

---

[1] The coefficient of performance, or COP, of a cooling system is the ratio of the electrical input to the cooling output of the system. Typical values for current technology are in the range 2-3. The values reported in this issue for Japan appear to go some way to answering the request of another of the authors in this issue (Larsson) for the development of more energy efficient cooling equipment, and suggest that international collaboration in this area may be fruitful.

Further examples of the interactions between context and climate change are provided by Larsson's (2003) discussion of the impact of warming on the communities of Canada's far North and by Shimoda's brief but fascinating discussion of the interaction between earthquake risk and rising sea-level in coastal areas in Japan.

Most of the papers in this issue deal with climate change in industrialised countries. A welcome counterpoint to this perspective is provided by du Plessis *et al*. (2003). While South Africa is unique in the developing world in having many of the elements of an advanced industrial economy, this has had little impact on the lives of much of its population. The picture that emerges from this paper is profoundly challenging. While the costs of climate change are likely to be greatest and the need for adaptation most pressing in the developing world, other issues – the need for economic and social development, the battle against diseases such as AIDS - have much more immediate significance. The debate around climate change in the developing world presently appears to be a luxury that only the developed world can afford.

A number of questions are not comprehensively dealt with in this issue. These include the dynamics of climate change and human response, the potential for conflicts between stakeholders, the impacts of climate change on human disease and disease vectors and on other biological agents such as wood-boring insects, the robustness of adaptation strategies, and the need to integrate adaptation strategies with efforts to mitigate climate change.

To begin with the dynamics of change and response, the built environment is characterised by sub-systems with widely differing characteristic timescales. Sub-systems, such as the construction industry itself, can and do change dramatically over periods of just a few years – significantly shorter than the decades-long rate of most aspects of climate change. Most building services systems have replacement cycles of between one and two decades – still significantly shorter than the timescales for significant climate change. The sub-systems with the longest characteristic timescales are, in rough descending order but with significant overlaps, settlement patterns and transport infrastructure, building envelopes, energy systems and water supply and treatment systems. Interestingly, many of the soft sub-systems within the built environment (the structures of contractual and professional relationships, systems of regulation and education) can be among the most durable and long-lasting.

One implication of this is that not all climate impacts are equally important or urgent. Some impacts of climate change may indeed be major, but others are genuinely negligible. For certain categories of problem, wait-and-see may be the most sensible response. In other areas, for example flooding and coastal inundation, immediate action appears justifiable by the very long timescales associated with settlement patterns, despite necessarily imperfect information about future climates. One of the more important tasks of research into adaptation strategies for the built environment is to help us to tell the difference (Lowe 2001a).

Interactions between sub-systems can be strong. Transport systems – in particular air and road – are among the most important drivers of the design of commercial and domestic buildings in many countries, and represent a significant constraint on the implementation of natural ventilation or mixed mode strategies in urban and sub-urban environments. Implementation of vigorous mitigation measures in the transport sector would therefore have a significant impact on the selection of adaptation strategies and on building and urban design in general. Such inter-relatedness places a premium on whole-system thinking in the development of response strategies.

The problem of robustness is related to the dynamics of change and can be illustrated with reference to the assumption that widespread implementation of natural ventilation in buildings is an appropriate and effective adaptive strategy. The envelope within which this is the case is constrained by a variety of factors including individual and social behaviour, by the availability and affordability of alternatives (e.g. air conditioning) and by individual and collective expectations in a climate of economic growth. It appears likely that future climate change will significantly reduce this envelope, particularly in regions where natural ventilation is already marginal. Recognition of this forces us to consider the degree to which such buildings can continue to adapt to climate change throughout the coming century. More generally, there is a need for designers and the research community to identify and develop adaptive trajectories rather than once-and-for-all adaptations.

The problem of divergence of interests of different built environment stakeholders is touched on briefly by Hertin *et al.* One of the most obvious potential divergences is between the construction industry and owners and operators of buildings. The construction industry generally wishes to minimise its exposure to climate in the short-term, while owners and operators are interested in the impacts of climate change over much longer periods. One of the ways in which the construction industry can achieve its short-term objective is by increased use of pre-fabrication and the use of lightweight construction systems. Such systems may however be less comfortable in warmer climates, and may be more vulnerable to damage from flooding, fire and insects. Other divergences exist within the web of interests in the built environment – between the construction industry and the insurance industry, between the insurance industry and building owners/operators. Systematic understanding of conflicts and divergences of interest and of the interplay between different construction industry and built environment agendas is likely to be essential to the process of policy formation and implementation in this area.

One of the most important questions still to be tackled systematically is the relationship between adaptation and mitigation. Climate change mitigation and adaptation have significantly different characteristics and impose different requirements on stakeholders. Major components of adaptation strategies will be geographically fine-grained, dealing with risks such as riverine flooding and coastal inundation. Mitigation strategies are in contrast systemic, focusing on energy supply and end-use systems and technological solutions that are valid at the national, continental and in some cases global scales. Benefits of mitigation are, to first order, long term and entirely global, with no direct benefits to countries, companies or individuals involved. The implementation of mitigation therefore depends on the political task of constructing national and international consensus for action and implementing systems (such as energy taxation) which convert long-term, global, external benefits into privately realisable benefits. The fact that the benefits of adaptation accrue at all scales – national, regional, municipal, corporate and private – make it in principle easier to mobilise support for adaptation strategies than for effective mitigation strategies. As noted earlier, much of the work in this area has until recently been on mitigation. It would, however, be unfortunate if the pendulum of interest and research effort were to swing to the other extreme. The potential for both synergy and conflict between adaptation and mitigation measures and strategies requires the development of integrated rather than separate responses (Lowe, 2001a & 2001b).

It is clear that the study of adaptation is at an early stage in all of the countries represented in this issue. In some cases work has been under way for one or two years (although the underpinning thinking has clearly been under way for rather longer). In other cases, concerted programmes of work have not yet begun, and the resulting papers are genuinely exploratory. In all cases, the authors must be complimented for a willingness to tackle a subject at such an early stage in its development.

There is a need to move beyond the initial explorations summarised here, a need to establish contact, to share insights and experience and to move forward. It is hoped that the publication of this special issue will help to build momentum. The initiation and rapid early development of adaptation research in a number of countries suggests that there may be a need for a second special issue on the subject, perhaps in 2004. *BRI* will welcome both feedback on the papers presented in this issue and further papers on national and international initiatives in this area.

Robert Lowe
Guest Editor
Leeds Metropolitan University, UK

References

Anon. *Proceedings of Tyndall/CIB International Conference on Climate Change and the Built Environment*. UMIST, Manchester, 8-9 April 2002.

Camillieri, M., Jaques, R. & Isaacs, N. (2001) Impacts of climate change on building performance in New Zealand, *Building Research and Information*, 29 (6) 440-450.

Graves, H.M. & Phillipson, M.C. (2000) *Potential implications of climate change in the built environment*, Watford: BRE.

Hertin, J., Berkhout, F., Gann, D.M. & Barlow, J. (2003) Climate change and the UK housebuilding sector: perceptions, future impacts and adaptation, *Building Research and Information* 31 (3) .

Hulme, M., Jenkins, G.J., Lu, X. Turnpenny, J.R., Mitchell, T.D., Jones, R.G., Lowe, J., Murphy, J.M., Hassell, D., Boorman, P., McDonald, R. & Hill, S. (1998) *Climate change scenarios for the UK: the UKCIP02 Scientific Report*, Norwich: Tyndall Centre for Climate Change Research.

IPCC (2001) *Climate Change 2001. Adaptation. Contribution of Working Group II to the Third Assessment Report of the IPCC.* Cambridge: CUP.

Larsson, N. (2003) Adapting to climate change in Canada, *Building Research and Information* 31 (3) .

Lisø, K.R., Alfsen, K.H., Eriksen, S. & Aandahl,G. (2003) Preparing for climate change in the built environment in Norway, *Building Research and Information* 31 (3) .

Lowe, R.J. (2001a) *A review of recent and current initiatives on climate change and its impact on the built environment: impact, effectiveness and recommendations. CRISP Consultancy Commission 01/04 Final Report*, Leeds: Centre for the Built Environment. http://www.crisp-uk.org.uk

Lowe, R.J. (2001b) Really Rethinking Construction. A review of *Potential implications of climate change in the built environment* by H.M. Graves & M.C. Phillipson, *Building Research & Information* 29 (5) 409-412.

Mills, E. (2003) Climate change, insurance, and the buildings sector: technological synergisms between adaptation and mitigation, *Building Research and Information* 31 (3) .

Plessis, C. du, Irurah, D.K. & Scholes, R.J. (2003) The built environment and responses to climate change in South Africa, *Building Research and Information* 31 (3)

Sanders, C.H. & Philipson, M.C. (2003) Adaptation strategies and technical responses to the impacts of climate change on buildings in the UK, *Building Research and Information* 31 (3) .

Shimoda, Y. (2003) Adaptation Measures to Global Warming and the Urban Heat Island in the Japanese Buildings Sector, *Building Research and Information* 31 (3) .

Steemers, K. (2003) Towards a research agenda for adapting to climate change, *Building Research and Information* 31 (3) .