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The Impacts of Construction and the Built Environment

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Introduction

Around half of all non-renewable resources mankind consumes are used in construction, making it one of the least sustainable industries in the world. However, mankind has spent the majority of its existence trying to manipulate the natural environment to better suit its needs so today our daily lives are carried out in and on constructions of one sort or another: we live in houses, we travel on roads, we work and socialise in buildings of all kinds. Contemporary human civilisation depends on buildings and what they contain for its continued existence, and yet our planet cannot support the current level of resource consumption associated with them.

Estimate of global resources used in buildings [1]

Resource	(%)
Energy	45–50
Water	50
Materials for buildings and roads (by bulk)	60
Agricultural land loss to buildings	80
Timber products for construction	60 (90% of hardwoods)
Coral reef destruction	50 (indirect)
Rainforest destruction	25 (indirect)

Estimate of global pollution that can be attributed to buildings [2]

Pollution	(%)
Air quality (cities)	23
Climate change gases	50
Drinking water pollution	40
Landfill waste	50
Ozone depletion	50

Buildings are long-lived, and cities have even longer lives: their impacts will stretch into the lives of many generations of our ancestors; into a future of unknown resources, pollution and unstable climatic conditions. Clearly, for the good of the environment and the survival of the planet, its myriad of interwoven and interdependent ecosystems and mankind, something has to change, and construction companies have a leading role to play in that change.

But that is only part of the story. The buildings we construct create wealth. Half of all fixed capital formation annually is vested in buildings, which, taken together with the inherited assets of buildings, represents about 75 per cent of all UK wealth [3]. The long-term asset value of a building depends on its ability to satisfy user needs, cope with the changing environmental conditions and survive the evolving expectations of design quality.

Naturally lit and well ventilated buildings, that utilise alternative energy sources and those that are designed to offer attractive whole life performance to consumers are more likely to be sound wealth investments than those which are over-dependent on fossil fuels or which ignore the fundamental human need for a healthy and engaging environment. The typical ratio of economic costs of commercial building over a 50-year period is:

Cost of design and construction:	Operating costs:	Staff costs
1	2	10

It is therefore prudent to address environmental issues at the outset; otherwise our created wealth of the constructed asset will be significantly undermined.

The main impacts of the construction and use of our built environment can be grouped as follows:-

Energy Use, Global Warming and Climate Change

In the last hundred years the Earth has warmed by about 0.5^{o}C [4]. There is strong evidence that this is due to an increase in the concentrations of certain trace greenhouse gases. Principal amongst these is carbon dioxide which is produced whenever fossil fuels are burnt to obtain energy. Globally,

energy use, and the associated carbon dioxide emissions, has been rising rapidly over the past few decades. The main consumers are the developed countries who enjoy standards of living to which the developing countries aspire. The consequences of the continuing growth of energy use which this implies are potentially catastrophic. The developed countries must improve their energy efficiency as a part of ensuring that the problem is brought under control. Construction industry related energy use accounts for approximately half of national energy use in the UK. The use of fossil-fuel-derived energy in the production of materials, during the construction process, and by the occupants or users of the building or structure throughout its lifetime is a source of significant quantities of carbon dioxide. Though not the most potent of the so-called greenhouse gases, it is the one produced in the greatest quantities. These climatic changes themselves may necessitate changes in construction practice.

Resource depletion, waste and recycling

The construction industry is a conspicuous user of resources. Materials are derived from numerous sources and suppliers, and minimisation of waste presents particular problem. Although many of the materials in use are common to most sites, the fragmented nature of development constrains the practical extent of recycling. Furthermore, despite the long life of its products, their eventual demolition or redevelopment can produce significant waste for land disposal unless re-used.

The mass of resources used in the UK construction industry is dominated by stone and primary aggregates: sand and gravel extraction of these primary resources implies major environmental impact from loss of habitat and ecosystem, damage to the landscape, potential subsidence problems and release of methane. Noise and dust and heavy transport through populated areas confer local nuisance and contribute to restricted award of extraction licences by local authorities. The same issues arise in the disposal or processing/recycling of waste.

Construction also has a major impact on the environment in its consumption of energy, both directly and embodied in the materials that it uses. The large bulk of materials used consumes a great deal of energy for transport. Taking into account both direct use and embodied energy, the construction industry consumes about 4.5% of the national total as a consequence of this energy consumption, construction generates over 40 million tonnes of carbon dioxide which contributes to global warming from the greenhouse effect [4]. Acid gases and oxides of nitrogen (NO_2) are also produced, contributing to acid rain and photochemical smog production.

The links between water and energy are gradually becoming more evident. Generating energy uses a lot of water for cooling and a lack of water has already led to power cuts where nuclear power stations have been shut down during droughts. Likewise, treating and pumping drinking water and waste water uses a lot of energy with the UK water industry accounting for around 1% of UK CO_2 emissions [5]. In our homes domestic water heating is responsible for 5% of UK CO2 emissions, and 25% of your household energy bill [5]. The construction of a house, using a combination of methods, requires about 6 million litres of water [5].

Throughout the construction cycle, and especially at the end of a structure's life, large quantities of waste are produced. Significant quantities of waste are also generated by the construction process itself. Much of this wastage is avoidable on site, but inattention to design detailing, inappropriate material, dimensions, late variations, over-ordering, etc. also contribute to waste.

Pollution and hazardous substances in the natural and built environment

Pollution can be defined in many ways: that arising from the built environment (sewage, waste etc.); pollution caused during the manufacture of materials and products; pollution and hazards from the handling and use of materials or from the site itself; and other construction and operationally-related activities. The design and construction phases involve the specification of materials, and the use of plant, processes and techniques. Most also involve extensive disturbances to the existing environment, whether on green field or previously developed sites.

Each of these activities poses a risk of introducing pollutants into the environment which can affect the workers on site, the neighbourhood, or the local ground, water and air quality. Similar impacts can occur during the operational phase of the development. Such disturbances can also upset the

equilibrium between the ground, water and air and introduce the risk of pollution.

In the developed world, human beings spend approximately 90% of their lives within buildings [6]. They are exposed to a range of chemicals arising from furnishing and finishes. Other practices which take place within the building also affect their physiological and psychological reactions. Increasingly, the design and layout of buildings necessitate active measures to maintain conditions which ensure the health and general well-being of their occupants.

The problems of poor internal environment tend to be neglected because the effects are long term and, with a few exceptions, not immediately life threatening. In addition the causes have not been clearly defined; hence solutions are not self evident. One result of this in the UK is failure to treat the issue seriously. Limited research work has been carried out, so uncertainty of causes prevails with little quantitative data available.

Planning, land-use and conservation

There is a wide range of environmental issues concerned with the interaction of the land use, planning system and the construction industry. Almost all development undertaken by the construction industry requires planning permission.

The biodiversity on particular sites can be devastated by developments and through mineral extraction for the construction industry. However, a wide range of nature conservation initiatives and area designations have been developed to protect habitats.

Construction related activity has a significant impact upon transport movements. Considerable pressure can be placed on the local road network and neighbouring uses by quarrying operations. In addition, completed developments and their interrelationship with other land uses can influence the propensity to travel and modal choice. In turn these factors can impact upon the levels of energy used along with the pollution and emissions created.

The interaction between the built environment and the natural environment also has a significant impact on the hydrological system. The combined effect of urban expansion and agricultural intensification has exceeded the capacity of the land to absorb exceptional levels of rainfall. At the same time, rainfall has become more intensive, concentrated and erratic due to global climate change. This negative interaction is highlighted by an increasing rate of severe flooding witnessed in the UK, Italy, Germany, Cambodia, Vietnam and India in the period 2000–8. The spatial planning system and the design of buildings and landscapes therefore has a role to play in absorbing the new rainfall peaks, and thereby reducing stress on our engineered drainage systems and river systems.

It is estimated that construction related energy consumption, including both direct and indirect activities, amounts to around 50% of national energy use [7]. Land use planning can make a contribution to energy consumption through the configuration and location of buildings as the location of developments initiated by the client and built by the construction industry is largely controlled by formal planning procedures. However, the success of the development in integrating with, and the acceptability of the way in which it modifies and interacts with, the surrounding natural and built environment, cannot be ensured wholly by regulations.

While the above categorisation provides a convenient framework to discuss the issues, few of the issues can be considered in isolation, and due consideration must be given to the numerous interactions and interdependencies which exist between:

- the media of land, water and air;
- the internal and external environment;
- the local, regional and global consequences arising from certain activities;
- behavioural changes (e.g. traffic patterns) and other secondary impacts.

Some of these interrelationships are illustrated in Figure 1.

Figure 1: Some interrelationships between the built environment and environmental issues

ISSUE	Energy use, global warming and climate change	Resources, waste and recycling	Pollution and Hazardous substances	Internal environment
Planning, land-use and conservation	• Transport implications • Sea level rise • Overheating • Increased UHI effect • Passive heating/cooling • Thermal standards for refurbished buildings • Urban form and configuration • Flooding • Biodiversity • Water quality	• Minerals extraction • Disposal of spoil • Recycling derelict land • Re-use of existing buildings • Resources used for major infrastructure projects	• Pollution effect of built environment • Waste disposal • Maintenance of environmental quality objectives • Ecosystem conservation • Biodiversity conservation • Contaminated land register • Estate maintenance • Pesticides etc.	• Orientation daylight and passive heating • Rn-222 • Electromagnetic radiation
Internal environment	• Energy use, heating, appliances etc. • Flooding • Thermal efficiency • Reduced ventilation rates/less occupant control	• Gas from recycled sites • Reduced off-gassing from recycled products	• Indoor pollution/ Off-gassing from materials • Effect on pollution levels of reduced ventilation rates • Smoking • Noise from external and Internal environment • External air quality • Rn-222 and landfill gases	
Pollution and hazardous substances	• Energy related greenhouse gases • Other greenhouse gases • Ozone depletion • Ozone creation • Acidification • Ecotoxicity • Wastes and pollution from power generation	• Pollution during manufacture • Waste production • Pollution of primary resource • Recycling contaminated land		
Resources, waste and recycling	• Energy in transport • Energy in recycling • Use of sustainable resources (e.g. timber)			

Conclusion

Our built environment and its interactions with the natural environment are complex and have a massive impact on the world around us. Hence sustainability is a complex concept which encompasses not just energy but all the resources needed to support human activity. A large part of building sustainably is concerned with addressing the global warming that is driving climate change; using energy conservation and techniques such as life-cycle assessment to maintain a balance between capital cost and long-term asset value. It is also about enhancing biodiversity, creating spaces that are healthy, economically viable and sensitive to social needs. Rather than constantly battling against the natural environment, we need to start respecting natural systems and learning from ecological processes: creating a better balance between human need and the wider environment.

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Other suggestion reading:

Securing the Future

Procuring the Future

Capitalism, As if the World Matters – Jonathon Porritt