

# Air pollution assignment

[Environment](#), [Air](#)



This paper has two purposes. First, it attempts to identify the principal ways in which construction contributes to environmental stress, and to quantify the contribution of construction where possible. Secondly, it considers the means available to reduce these environmental impacts, through improved technology, design or changed practices; and it suggests ways in which governments can take action to promote these changes. Sustainability is now a key concept in development thinking at all levels.

Over the last two decades there has been a growing understanding of the world and its inhabitants as a single system, and of the need to combine two key global aims in the development of human activities: to accelerate human development, particularly in the poorest countries, and to remove the gross inequities present in the world today; while at the same time avoiding the depletion of the resources and biological systems of the planet to such an extent that future generations will be impoverished.

The idea of sustainable development was well summarized by the report of the World Commission on Environment and Development, – which starts with the premise that Humanity has the ability to make development sustainable – – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs”.

The report acknowledges that there are limits which are imposed by the ability of the biosphere to absorb the effects of human activities, but states a belief that widespread poverty is no longer inevitable, and that technology and social organization can be both managed and improved to make way for a new era of economic growth.

In spite of differing perceptions about the precise meaning of the term sustainable development, it is now generally agreed that development in the poorer nations must proceed in parallel with a general global application of new \*This paper is a revised and updated version of a Paper presented to the First Global Consultation on the Construction Industry, organized by U N C H S , which took place in Tunis in May 1993. 279 280 Robin Spence and Helen Mulligan technologies which are both less resource-intensive and less environmentally damaging.

Although the means to achieve this balance are far from being agreed, the ROI Declaration resulting from the 1992 World Conference on Environment and Development now gives international approval to a set of principles for sustainable development, e A very detailed review of the state of these planetary assets and the general global environment was recently assembled by the World Resources Institute in collaboration with U N E P and UNDO. 3 This report presents a gloomy view of the deterioration of the planetary environment.

It shows data which indicate that the resource base of the planet has reached a critical stage of degradation in three areas: erosion of the global soil base, reducing the world's capacity for food reduction as populations rise; loss Of forests and wildness leading to loss of biodiversity, threat to indigenous cultures, and degradation of slopes and watersheds; accumulation of pollutants and greenhouse gases in the atmosphere, leading to local hazards to soils, vegetation and human health, and the threat of global climate change.

Although less immediately critical, the study also points to serious depletion of the world's mineral and fossil energy resources, which will ultimately restrict their continuing use. These factors are not independent, but interlinked and mutually reinforcing. As a result the WRIT asserts that "the world is not now headed towards a sustainable future, but towards a variety of potential human and environmental disasters". If this is the case, it is crucial for all development activities to be examined to identify what part they play in the current unsustainable development path, and how sustainability could be achieved.

**THE CONSTRUCTION INDUSTRY AND ENVIRONMENTAL STRESS** The construction industry is involved in creating the physical assets which are the basis of virtually every aspect of development, and thus in the creation of much of the world's man-made capital. But the industry, together with the alluding materials industries which supply it, is also one of the largest exploiters of natural resources, both mineral and biological. Its activities cause irreversible transformations of the natural environment; and it adds to the accumulation of pollutants in the atmosphere.

The construction industry thus contributes significantly to each of the areas of environmental stress identified above. Construction activity contributes to the loss of soil and agricultural land in several ways. Agricultural land is often lost through the activities of quarrying and mining for the raw materials used in construction; it is lost when agricultural land is converted to other uses, whether for arbitration, for retrograding, dams or other civil engineering projects; and it may also be degraded as a result of the local pollution or

waste generation associated with construction and building materials production.

Construction similarly contributes to the loss of forests and wilderness by their conversion to other uses; it contributes to the loss of forests by the unsustainable use of forests for building timber, bamboo and other raw materials for construction; by the use of timber to provide energy for building materials production; and indirectly by the atmospheric and water pollution consequences of construction and building materials production activities. Further, construction contributes to air pollution at all levels.

It creates air pollution at a local scale through emissions of dust, fiber, particles and toxic gases. Sustainable Development and the Construction Industry 281 from site activities and building materials production processes. It contributes to regional pollution through emissions of nitrogen and sulfur oxides in building materials production. And it contributes to pollution on a global scale in two important ways. By the use and release of chlorofluorocarbons (CFCs) in buildings contributing to the depletion of the atmospheric ozone layer, and by the emission of carbon dioxide and other greenhouse gases.

Finally, the construction industry is a major user of the world's non-renewable energy sources and minerals. Apart from its share of fossil fuel use, the construction industry is a heavy user of several metals which have limited remaining exploitable reserves, notably lead, copper and zinc. It is clear that a continuation and acceleration of construction activity along existing lines will intensify all these areas of environmental stress, some of

which are already critical. But it does not need to be assumed that future construction will inevitably continue present patterns.

There are many ways, which will be discussed, in which the construction industry could adapt its practices in such a way as to reduce substantially the resulting environmental impacts. Indeed, because of the diversity of construction methods in use, there is already much experience in all these matters which can be used as a guide. But changes in practice which are desirable in relation to environmental goals are often avoided through lack of appropriate policy guidance or government regulation, or through the resistance of commercial interests. The purposes of this paper are twofold.

First, it attempts to identify in detail the ways in which construction contributes to each of the three major areas of environmental stress.

Secondly, it will consider the means available to reduce the environmental impacts through improved technologies, through design or modified practices; and it will make recommendations for action at industry and national levels to promote sustainable development. CONSTRUCTION AND DETERIORATION OF THE PHYSICAL ENVIRONMENT Rising populations and the consequent exploitation of the natural environment has placed heavy pressure on both global soil resources and tropical forests.

New studies show that the condition of both resources is declining more rapidly than was previously thought. According to WRIT 3 an area approximately the size of China and India combined has suffered moderate to extreme soil degradation caused by agricultural activities, overgrazing, deforestation and land conversion over the last 35 years. This area, 1. 2

billion hectares, represents almost 11% of the Earth's vegetated surface. Most of this land is agricultural or forest land which has suffered moderate degradation, i. e. lost some of its productivity. But about 300 million hectares (3% of the total) shows severe degradation, while 9 million hectares has suffered extreme degradation, i. e. it is unrecoverable and beyond restoration. There are five principal causes of soil degradation: overgrazing, accounting for 35% of all degraded land; deforestation and land conversion, including arboriculture, accounting for 30%; agricultural activities, accounting for 28%; overexploitation for firewood, accounting for 7%; and industrial pollution accounting for about 1% of the total.

The vast majority of the seriously degraded land is located in Africa and Asia, where a large proportion of the world's poorest inhabitants live, where nutrition levels are currently least adequate, and where population growth rates are also highest. Because of their essential part in the planetary carbon cycle and their biodiversity, the loss of tropical forests is a matter of particular concern. Recent OAF studies have shown that the rate of tropical deforestation has increased dramatically during the last decade.

In 1991, OAF found the rate of deforestation to be about 17 million hectares per year, an increase of 50% since the early 1980s. And this does not include forest which has been logged and allowed to regrow, which often leads later to complete deforestation. W R P also points to severe environmental stress to the world's freshwater resources and coasts, caused by farming forestry, industry and human settlements. In several areas water

and coastal pollution has reached disastrous proportions, but in many other areas it is increasing without control.

Construction contributes to all of these areas of environmental stress. Gross construction output constitutes typically around 8-12% of GDP in many national economies, in both developing and industrialized countries, and construction is the destination of many of the materials whose production causes loss or deterioration of land and water resources. Construction plays a substantial part in the loss or conversion of agricultural land, both by the extension of human settlements and by the increase in the quarrying and mining used to provide raw materials for construction.

And the construction industry worldwide is the principal user of the tropical hardwoods and their products, contributing thereby very substantially to the loss of the tropical forests. The extent to which the responsibility for each of these areas of environmental stress can be allocated to the construction industry cannot be easily assessed, as no relevant data exist. Nor in many cases, can the subdivision of responsibility between the demands and activities of local construction and those of international trade be quantified.

There is a need for further research in these areas. Rough estimates made on the basis of global statistics however, suggest that quarrying of mineral resources may add to the global land loss of about 1.5 million hectares per year through deforestation, and that sawn wood production for construction may contribute as much as one-third of the FAO estimate of total worldwide loss of tropical broad-leaved forest. There are many detailed case histories of environmental stress caused by logging, minerals extraction, and the



extension of human settlements. , 7 Means to reduce deterioration of the physical environment There are many ways in which the nature of current construction activity can be changed to make it less environmentally damaging, without reducing the useful output of construction. These include improving land-use and pollution emission legislation and control, prescription environmental impact appraisals, and extending the life of and reuse of existing buildings. But perhaps of greatest significance within the industry itself would be to increase the use of mineral, agricultural and demolition wastes in construction.

The potential benefits Of greater utilization Of mineral and agricultural wastes as inputs to the construction industry have long been realized. Not only would this reduce the impact of construction on the natural environment by educing the need for quarrying, mining or logging; it would at the same time reduce the undesirable environmental impacts associated with the disposal of those mineral wastes. Considerable research and development work has been devoted to finding ways to utilities these wastes, both in developing and industrialized countries, and some progress has been made. -H) Some of the materials often available as sources of secondary aggregates include colliery and mining wastes, fuel ash and demolition wastes. However, the degree of utilization of wastes is still very far short of the potential, making this one of he most fruitful ways forward for the construction industry. Mineral wastes tend to be less available in developing countries than industrialized countries, because of lower industrial output. However, developing countries frequently generate

comparatively large quantities of organic waste from agriculture and forestry.

These are often suitable for further processing for use in construction. There has been considerable experimentation with agricultural wastes in national and regional laboratories, and some successful processes have emerged. Among the more promising developments are use of natural fibers as reinforcement in concrete roofing; construction boards from organic wastes; secondary timber species utilization; rice-husk ash cement and asphalt sheets for roofing.

Nevertheless a number of factors hinder the take-up or further utilization of these and similar processes. It is likely that, in the case of both agricultural and mineral wastes, economic incentives could have some effect in increasing their utilization. But in order to achieve a greater take up of organic wastes a package of additional actions would be needed, including financial support for industrial search and development into new techniques, and the development of standards for production and utilization of new building products.

**USE OF FOSSIL FUELS IN CONSTRUCTION** The world's commercial energy production has increased globally by 14% in the last decade. In 1989, over 95% of the world's commercial energy was produced by the burning of fossil fuels – oil, gas and coal – while only the remaining 5% was primary electricity produced from geothermal, hydro- electric and nuclear sources. Thus to the extent that the construction industry uses commercial energy,

whether in the form of direct fossil-fuel burning or the use of electricity, it is contributing to the depletion of fossil fuels.

The construction industry is responsible for the consumption of commercial energy in two principal ways: through the consumption of energy in the production of buildings and other constructed facilities, and through the consumption of energy in the subsequent use of these buildings and facilities. The energy in the production of buildings is used by the construction and building materials industries, whereas that consumed subsequently is controlled to a large extent by the eventual user.

But the design of buildings can also have a major impact on the degree of their subsequent energy use; for example, a building designed for air-conditioning usually requires to be air-conditioned throughout its lifetime. In general it has been found that energy consumption in the production of buildings is a relatively small part of the total lifetime energy use, perhaps 10-15%.<sup>13</sup> But much of this lifetime energy use, particularly in developing countries, is in the form of cooking energy, over which the initial design has little effect.

And even those aspects of the lifetime energy consumption which designers can influence, such as heating and lighting, are controlled by the way the building is used, and can be altered subsequently to some degree. The energy used in the production, the so-called embodied energy, is however totally within the control of the construction industry, the designers, builders and building materials producers. Embodied energy is important for this

reason. But the question of embodied energy has a special urgency in many of the poorer developing countries which are in a process of rapid urbanization.

The change from rural to urban settlements is often accompanied by a rapid change from the use of almost zero-energy renewable building materials such as earth, stone and thatch to higher-energy factory-made permanent materials such as brick and concrete. New factories for the production of these materials are now being established in large numbers in the developing countries, with the result that national energy consumption in the building materials sector (particularly of high-grade fuels) is rising rapidly.

As a part of the same process, building materials manufacture is increasingly concentrated in fewer, larger-scale production plants, to take advantage of economies of scale, thus increasing the transportation component of the energy cost. There are alternative materials which make use of local raw materials, use relatively little processing energy, and could be manufactured locally with low resulting transport costs. Thus, there is considerable potential for limiting the growth of consumption in fossil fuels by careful choice of technology.

Means to reduce fossil fuel use in construction The energy use in the production of building materials accounts for over 75% of the total embodied energy in buildings, and thus improvement of energy use in production processes is a crucial part of any overall strategy for energy conservation in the built environment. As so much of the energy use in building materials takes place in the manufacture of a few extensively used materials which involve high temperature kiln processes, notably iron and steel, cement, clay

bricks and tiles and glass, energy saving strategies should concentrate on these processes.

Strategies for energy saving in building materials manufacture include: improved energy efficiency in kiln processes; using cheaper or non-premium fuels in kiln processes; use of recycled materials in production processes; use of low- energy additives or extenders. Such strategies have already been successfully applied over a period of years in many industrialized countries, bringing down energy costs per unit output significantly. But capital costs of change are considerable and there is still a lot that could be done, especially in the developing countries. 3 On-site construction activity accounts for a small but important proportion of the embodied energy in buildings, ranging from about 15 to 25% of the embodied energy. A large part of the energy use in construction is related to the use of mechanical plant for site operations; improvements in efficiency of this plant are often possible. Construction efficiency also to some extent affects the total amount of embodied energy in the building, since inefficient site management can result in considerable materials wastage.

The decisions of the builder may also dictate the sources of supply of the materials used in a building and hence determine the transportation energy component of the embodied energy. In addition to the contributions made by improving the energy-efficiency of the production of building materials and the construction process, there is a major opportunity available to reduce the embodied energy used in building by appropriate choice of materials and technologies in design.

Designers can contribute to the reduction of the total energy use in the built environment through strategies such as : the use of less materials; selection of low-energy materials and structural systems; design of low-rise buildings in place of high-rise buildings; selection where possible of waste or recycled materials; design for recycling, long life and adaptability to varying requirements. These strategies will not always be consistent with strategies for saving energy consumption in the use of a building.

In such cases it is necessary to examine the total energy consumption over a building's lifetime to determine which is the optimum energy-saving strategy. Energy is used in buildings for cooking space-heating and cooling and lighting and also for productive activities. The patterns of energy use within buildings varies according to use and location. In residential buildings urban and rural patterns tend to be very different; household income and climate have a major influence both on energy sources and end use patterns.

Numerous local studies have been carried out to identify these variations. 4 Because of its prominence in energy demand and the widespread followed crisis, considerable attention has been paid to the development and dissemination of energy-efficient stoves and other equipment in developing countries 1 5 and to alternative sources of energy. -6 These strategies are important, but not directly in the control of the building designer. Alternative strategies with a considerable potential for energy saving are, however, available through building design and construction.

Two important options are: reduction of heating energy demand through improved standards of insulation of new and existing) buildings; -7 use of ‘ passive solar’ design approaches to reduce heating loads and or eliminate the need for mechanical ventilation and air-conditioning, is Active solar appliances can also make a significant contribution, particularly in provision of domestic hot water. 16 CONSTRUCTION AND ATMOSPHERIC POLLUTION Atmospheric pollution is today perhaps the most pressing environmental concern at a global level.

Growth in the atmospheric concentrations of several gases has already had severe environmental consequences at regional scales, and the evidence suggests that further regional and global damage is likely, leading to probable regional climate changes. 3 In spite of new international agreements among the nations producing most of these pollutants to limit their emissions, global emissions are still rising steeply at the present time. World carbon dioxide emissions from fossil fuel consumption and cement manufacture increased nearly four-fold from 6, 000 tones per year to 22, 000 tones between 1950 and 1989.

Construction, particularly the manufacture of energy-intensive materials, makes a significant contribution to carbon dioxide emissions. An estimated 8-20% of these emissions in different countries are due to construction and building materials production activities, and a further 2. 5% globally results from the chemical reactions taking place in cement and lime production. Estimates for four selected countries are shown in Table 1 . A further enormous contribution to global emissions results from the energy

consumption of buildings In use, up to as high as 50% in northern industrialized countries.

Construction also contributes significantly to the ozone-depleting gases, 19 as well as to unsustainable levels of other forms of coal and regional atmospheric pollution.