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Sustainable Development in Asia Pacific and the Role of Civil Engineering

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For the last four decades, Asia Pacific countries have achieved some of the most intense economic growth in the world. Following the mechanical and electronic industry success of Japan in the 70s, a wave of GDP growth has swept across South Korea, Taiwan, Southeast Asia, and now China and India. Industrial growth has been accompanied by huge investments in infrastructure and general construction. Yet, sometimes the results, in terms of the newly built environment, have been far less successful than the economic achievements and, in the process, damage has been caused to the environment. In many cases, both the construction activity itself and the management of the products have been clearly unsustainable.

Traditionally, the aims of sustainability have been social, economic and environmental, with each being given a rather equal weighting. The climate change crisis has now pushed the environmental aspect to the top of our collective sustainability consciousness. We are now faced with the difficult task of controlling climate change while still ensuring prosperity and welfare in our societies.

Civil engineers are responsible for developing shelter, energy, transportation and water supply to support modern societies. Constructing and operating this infrastructure is also the main threat to a sustainable planet. The well-known definition of our profession in the Institution of Civil Engineers Royal Charter as being '…the art of directing the great sources of power in Nature for the use and convenience of man….' has surely never been more apt. It is us who need to direct both the technology and policy behind infrastructure and energy provision in a manner that the planet can sustain.

This paper reviews the economic and environmental data for several countries in the Asia Pacific region in parallel with construction activity data. An attempt is made to identify trends and to try to quantify degrees of sustainability, whether it is economic, environmental or social. These trends are then used to suggest a framework for future development in the region.

The countries that are studied are those within the Asia Pacific region that have ICE representation. Russia is also included although it is usually considered part of the ICE European region. Figures for the United Kingdom are shown, where available, for comparison purposes.

A detailed review of Japan's experience is presented. The massive expansion in the highway and high-speed rail network in the 80s and 90s has now been replaced by quasi-recessive construction activity with private housing developments possibly the only area of growth. Amongst these trends, there have also been many white elephant projects that have only enjoyed a few years' use before abandonment and demolition.

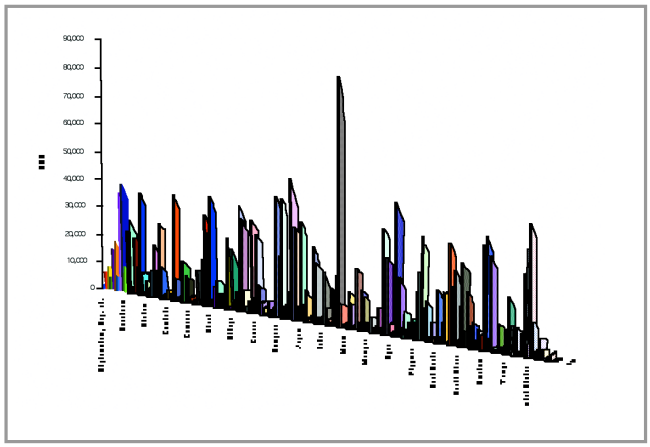

Figure 1: World Per Capita GDP by PPP

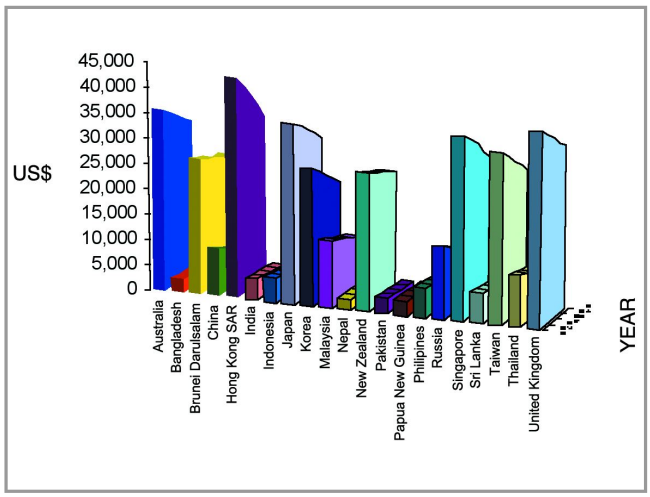

Figure 2: Asia Pacific Per Capita GDP by PPP

Nevertheless, on a person-kilometre basis, Japan's transportation infrastructure is very efficient and environmentally benign. The energy to run it also leaves a low carbon footprint because of the high proportion of nuclear and hydroelectric generation. In terms of land use, Japan is relatively 'green' thanks to dense habitation, modest residential aspirations and extensive forestation.

After looking at the situation in Japan, the view shifts back to the regional and, indeed, global focus of setting one country's contribution in the wider context of sustainability of the planet. Is it perhaps possible to give countries a 'sustainability damage index' that may help us shift the collective will away from the ever-more intense free trade and financial greed toward a responsibility to avoid cheating future generations?

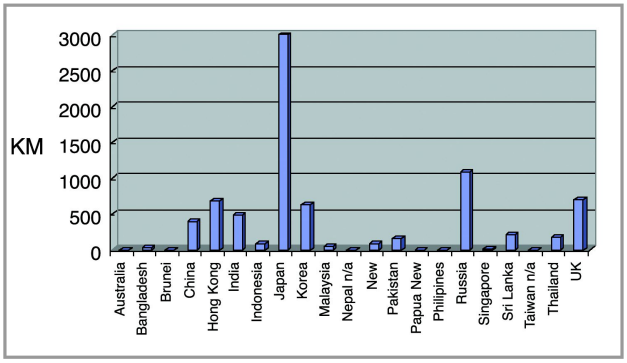

Figure 3: Rail Transport KM Travelled Per Capita Per Year

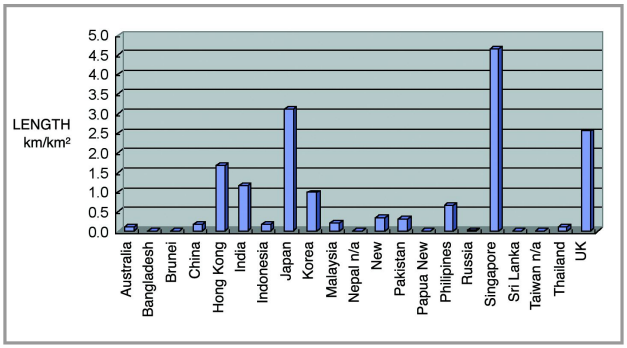

Figure 4: Road Length Per Square Kilometer Land Area

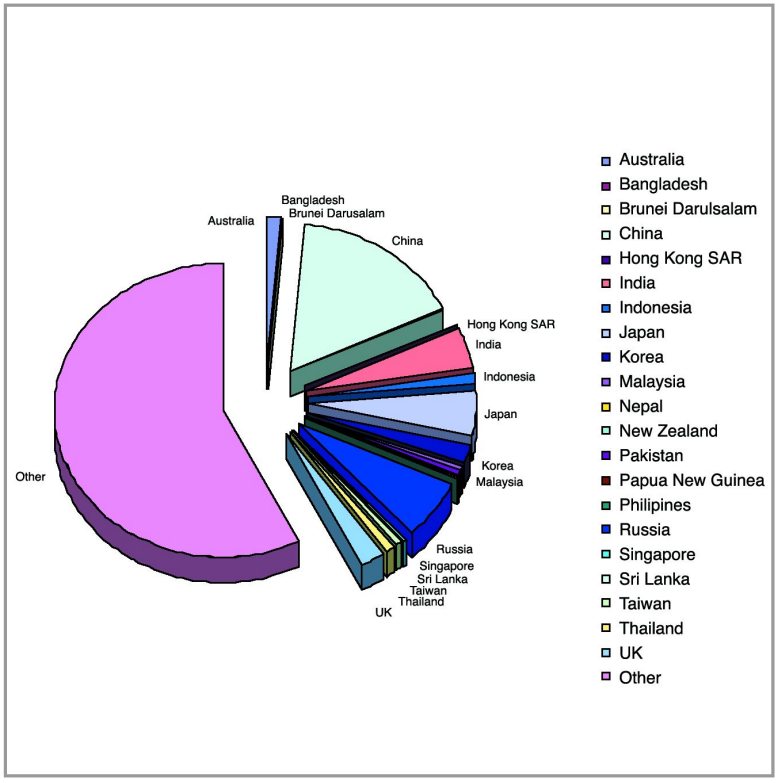

Figure 5: World and Asian Pacific Co_2 EMission 2003

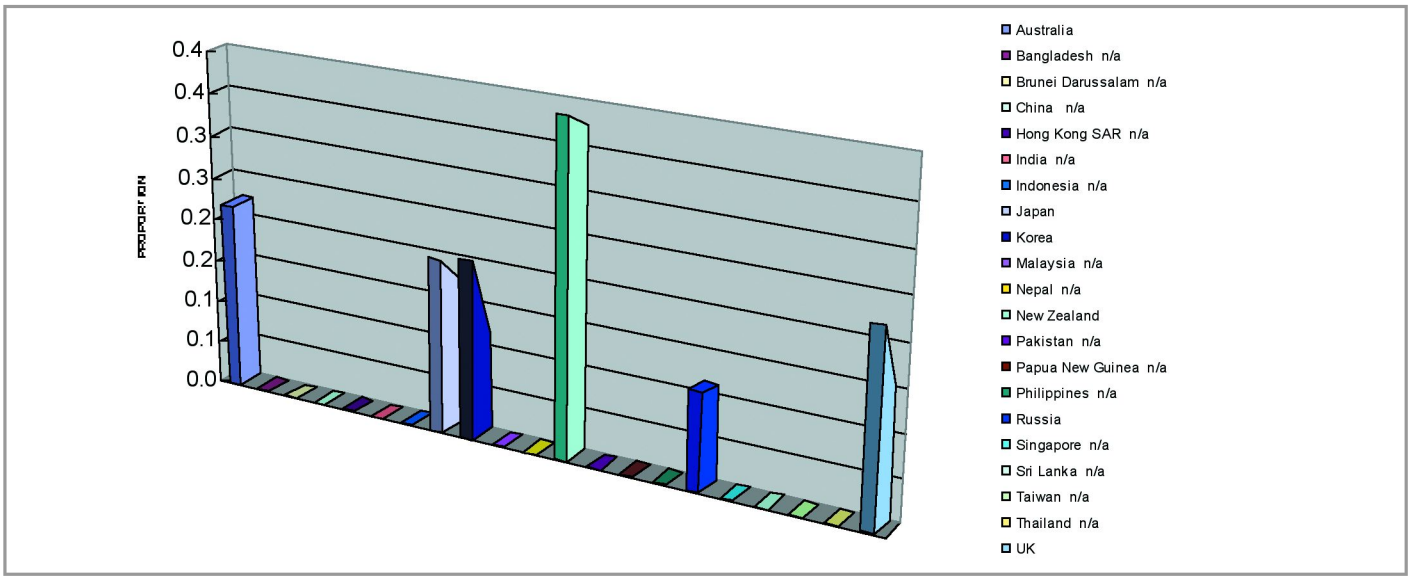

Figure 6: Transport Em Mission As Proportion of Total

THE ECONOMIC ENVIRONMENT

Across the region, the results in purely economic indices show considerable variation. The current world GDP levels in Figure 1 shows that on, a per capita basis, many countries in the Asia Pacific remain well below the world average. Disparities within the region are, if anything, actually increasing. Figure 2 demonstrates that the growth in the countries with the lowest GDP is low or zero, while those with the highest GDP show the highest growth, notably Hong Kong and Singapore. As a region, this is both an undesirable and unsustainable economic situation.

A reverse of this trend such that the developing countries' GDP converge with those of developed countries is clearly desirable. Until there is stabilisation at a level with low deviation from the mean level, we cannot really say that economic sustainability has been achieved.

Economic development is intricately linked to each country's social, historical and geographical setting. From the civil engineering perspective though, the provision of an efficient and economical transportation system is a vital component for success. Some correlation can, in fact, be seen between transportation

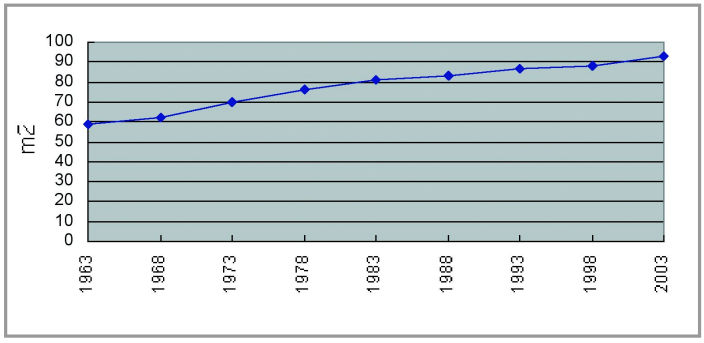

Figure 8: Average Japanese Housing Unit Area

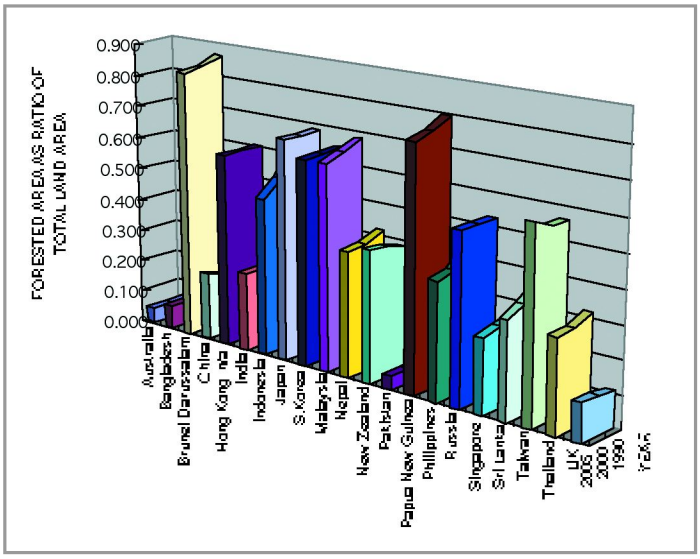

Figure 7: Asia Pacific Forestation Ratio

provision and economic performance. Figures 3 and 4 show the degree of passenger rail use and length of road by country over the past decade. Each of the most economically successful countries has either a high rail use ratio (Japan, in particular, is uniquely high), or high road development per land area. After energy provision, rail and road infrastructure are perhaps the most direct physical contribution that civil engineering can make towards economic prosperity.

IMPACT OF INFRASTRUCTURE ON THE CLIMATE

The downside of providing transport and other infrastructure is that, along with other industrial activities, greenhouse gases are produced. It is an unfortunate fact that about 40% of gases contributing to global warming are produced by countries in the Asia Pacific region (Figure 5). Both during construction and once a transport infrastructure is commissioned and operating, it creates a significant amount of these gases. Methods to reduce the greenhouse gas footprint from transportation are essential if we are to succeed in containing our climate change problems.

The use of more efficient transport is one obvious and immediately achievable approach. Better train networks, more electrification, more buses, and better emission regulations for cars – all are possible with current well-established technology. Figure 6 shows that where data is available, little progress has been made in this area over the past 20 years. Unfortunately, the ratio of harmful emissions produced by the transport sector has

generally increased or, at best, stayed the same at around 20% from the period 1980 to 2002.

Approaching the problem from the opposite direction, engineers can have a great influence on the location and density of infrastructure and building projects. The prevention of deforestation is a key component in our effort to reduce CO_2 concentrations. Although still not allowed as a Carbon Emission Reduction factor under the Kyoto Protocol, preventive deforestation is clearly a good thing for the environment.

Forestation data for the region is shown in Figure 7. Land use is not something that can be changed quickly, so the trend of change in the absolute ratio of forested land is important. Indonesia, the Philippines, Malaysia, Sri Lanka and Papua New Guinea are deforesting at a rapid rate whilst China and Taiwan are reforesting. For a country like Indonesia, where the total land area is very large, it is important that they reach a stable level of forestation as soon as possible.

INFRASTRUCTURE AND LAND USE IN JAPAN

Japan is well-known for its highly urbanised plains and fully forested mountains. Although some problems with overcrowding in towns and a lack of biodiversity in the forests remain, the infrastructure and land use pattern does seem to

Figure 9: Example of green roofing

Figure 10: Small-scale wind and solar power

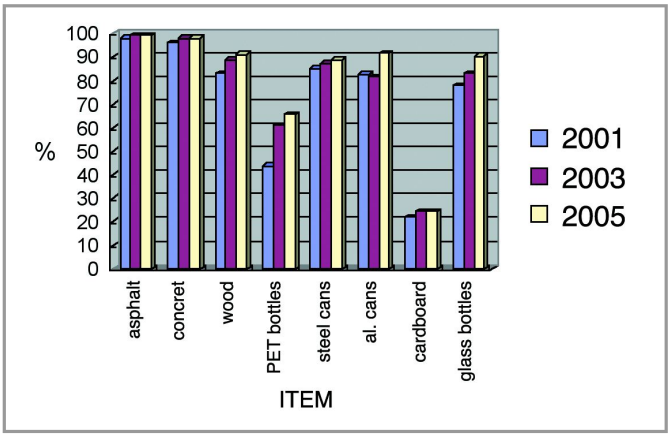

Figure 11: Japanese Recycling Performance

have reached a stabilised state that, for Japan at least, is 'sustainable'. Urbanised land has been stable at about 22% of total land for the past 30 years. The rail and expressway networks are essentially complete, with possible over-provision in some areas. Housing is adequate in number, and the trend now is for replacements to improve the overall standard. Total housing area has changed little, and the average Japanese residential unit area is rising slowly (Figure 8) and remains under 100 square meters per household.

Although not at the level of some European countries, much more emphasis is now being placed on maintaining and renewing the physical stock of the country in a more sustainable manner. In urban areas, efforts are being made to green-plant the roofs of buildings to reduce heat island effects, improve insulation and act as CO_2 sinks (Figure 9).

Energy production in Japan has benefited from the heavy investment in nuclear and hydroelectric power generation. About 23% of total energy production is via nuclear and 10% via hydroelectric. This has helped to make the rail system even more environmentally-friendly through the use of 'cleaner' electricity (70% of all lines are now electrified). On the other hand, investment in renewable energy such as wind and solar has been rather weak compared with other developed nations. In the past few years though, there are signs of more widespread use of compact wind and solar generators to power street lighting and signage (Figure 10).

Great attention has been paid to separating domestic refuse for many years, but this effort is now being extended to many areas of industry including construction. A selection of data showing the percentage of items recycled is given in Figure 11. ■

Note:
This is the end of Part 1 of a two-part article. Part 2 of this article will be published in the future issue.