Recent trends in material flows and resource productivity in Asia and the Pacific




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UNEP Division of Early Warning and Assessment
United Nations Environment Programme
Regional Office for Asia and the Pacific
U.N. Building 2nd floor, Rajdamnern Nok Avenue
Bangkok 10200, Thailand
Tel: +662-288-2617/1133, Fax: + 662-280-3829
E-mail: uneppub@unep.org
Web: www.unep.org/roap

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The report was written by James West and Heinz Schandl of CSIRO Ecosystem Sciences, who also compiled and analysed the underlying data.

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List of acronyms related to material flows and resource efficiency

DE Domestic Extraction – Materials domestically extracted from the environment which are subsequently used in economic activity

DMC Domestic Material Consumption (= DE – PTB)

GDP Gross Domestic Product

MI Materials Intensity (= DMC / GDP)

PTB Physical Trade Balance (Net Imports – Net Exports)

I Impact (environmental), in IPAT analysis terminology. In this report, the environmental impact considered for the IPAT analyses is extractive pressure, so I = DMC

P Population

A Level of Affluence of the population

T Technological coefficient, in IPAT analysis terminology. This is a measure of the environmental impact (I) generated per unit of income generated. For this study, T = DMC /GDP, and so is equivalent to MI

1 Introduction

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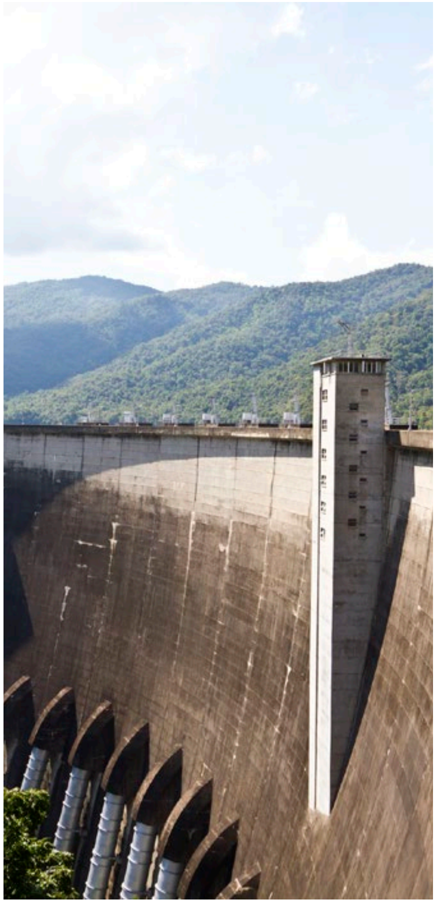

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This report presents an update of a previous report on material flows and resource productivity in Asia and the Pacific (UNEP 2011), and brings together data extending the latest reported year up to 2008 and the onset of the Global Financial Crisis (GFC).

The update shows that very rapid growth in materials consumption by the Asia-Pacific region's population giants continues apace, and as a consequence the region's dominance of world material flows continues to grow. One objective of this update is to focus more on those relatively few countries which account for the vast bulk of the region's materials consumption, as it is the material flows trajectories of these countries that are of greatest importance for the region, and the world as a whole. The set of ten countries examined in detail was determined accordingly, taking the ten greatest aggregate consumers in 2008, rather than trying to provide an overview of different types of economies and sub-regions as done in the previous report.

There has been some revision of the methodology used to compile statistics and perform analyses here, but the methods remain generally consistent with the approach used for the earlier report (UNEP 2011). Where significant changes have been made these are duly noted either in the text or in footnotes, while the updated Technical Annex to the (online) database at www.csiro.au/AsiaPacificMaterialFlows provides a full guide to the current methods. For this report, the number of countries was reduced to those countries for which more reliable data is available, removing numerous issues associated with the availability and continuity of time series data.

2 Main Messages

The Asia-Pacific region continued to assert its dominant position in world material flows, up to and including the onset of the Global Financial Crisis in 2008. The stagnation in growth in materials consumption registered for the rest of the world (ROW) in 2008 was reflected in only a slight moderation within the region.

Asia and the Pacific continues to catch up rapidly in per capita material use terms, with the regional average now being 86% of that of the rest of the world.

The transition of regional economies away from biomass based to minerals based continued, with further contractions in biomass share in both regional population giants, China and India. Construction minerals extraction continued to increase into 2008 underlining the large investment into building cities and infrastructure in the region.

The updated data indicates that the Asia-Pacific region is reverting towards a higher greenhouse gas emitting fuel mix, a trend that was not so clear in the first report (UNEP 2011). This is occurring despite the rapid increase in total tonnage terms of natural gas and increased production of renewable energy.

The physical trade balance of the region continued to show a trend towards increasing and accelerating net imports indicating that exploitation of the resource base within the region is no longer sufficient to support the fast growing economic activity and emerging new lifestyles in the region.

The efficiency with which materials are used has declined further. The fact that material intensity (MI = domestic material consumption/GDP), has continued to increase at the regional level, is cause for concern. MI needs to decrease at a rate roughly comparable to the rate of increase in GDP just to stabilize extractive pressures on the environment. On current trends, extractive pressures on the environment will increase even more rapidly than the region's rapid rate of growth.

Increasing materials intensity has been identified as a much stronger driver of extractive pressures than originally estimated in the earlier report (UNEP 2011). A reworked analysis of driving forces indicates that, rather than moderating the environmental pressures imposed by increasing populations and affluence, changing technology is interacting with the regional redistribution of production activities to accelerate materials consumption at the regional level.

Population growth is now the least important driver of growing extractive pressures on the environment at the aggregated regional level. Growing affluence was the most important driver over the whole study period, while increasing materials intensity was responsible for twice the increase in extractive pressure as population growth over the most recent decade. This indicates that any efforts to stabilize extractive pressures will need to address both affluence and materials intensity, and that stabilizing population, while helpful, will not grant much reprieve from growing environmental pressures.

3 Material use patterns and material efficiency in the Asia-Pacific region

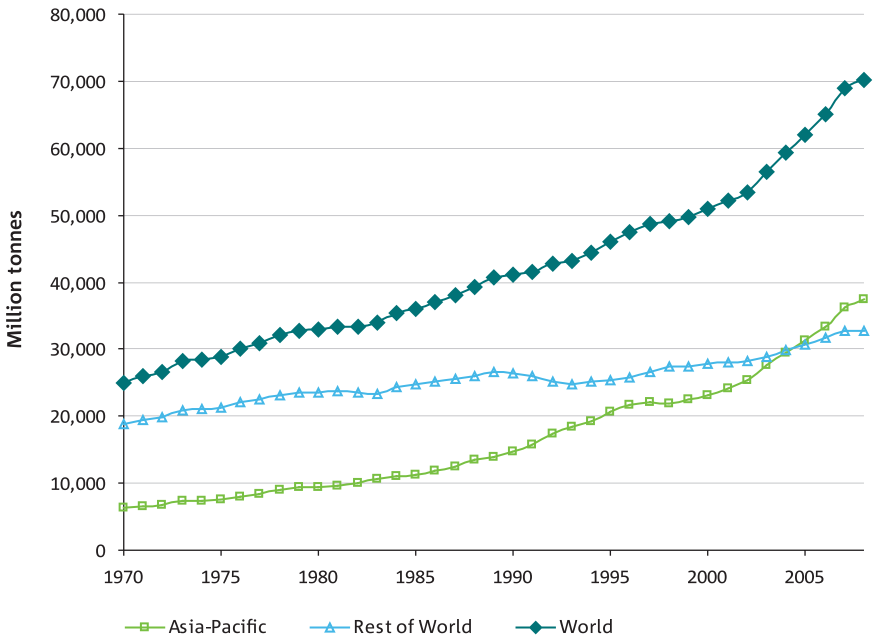


Figure 1 **Domestic Materials Consumption for the Asia-Pacific region, Rest of the World, and World, for the years 1970–2008**

Figure 1 shows domestic materials consumption (DMC) for the Asia-Pacific region increasing from 6.2 billion tonnes to 37.5 billion tonnes between 1970 and 2008, a compounding annual growth rate of 4.8%. Total DMC for the Asia-Pacific region surpassed that of the rest of the world (ROW) in 2005, having started out from a base of only one third of ROW materials consumption in 1970[1]. Because of the Asia-Pacific region's growing dominance in total world resources demand the demand curve for the World as a whole has come to increasingly reflect that for the region.

While rapid growth in the Asia-Pacific of around 4.2% during the decade 1970–1980 only lifted World growth above ROW growth by 0.5 percentage points (ROW = 2.3%, World = 2.8%), growth of 5.6 % in the Asia Pacific from 1998–2008 raised World growth by 1.8 percentage points above the ROW rate (ROW = 1.8, World = 3.6%). Over the initial year of the GFC, in 2008, almost all the World's continued growth in DMC could be attributed to the Asia-Pacific region, as DMC growth for the ROW was essentially static.

1 For this report, the ROW and world figures are calculated by summing MFA accounts for all individual countries in the appropriate grouping, all of which have been calculated using the exact same methodology and coefficients as for the Asia-Pacific. This constitutes a significant departure from the REEO (UNEP 2011), in which the ROW account was done by subtracting our Asia-Pacific estimates from a World total which had been calculated by Krausmann et al. (2008). The current method ensures improved consistency.

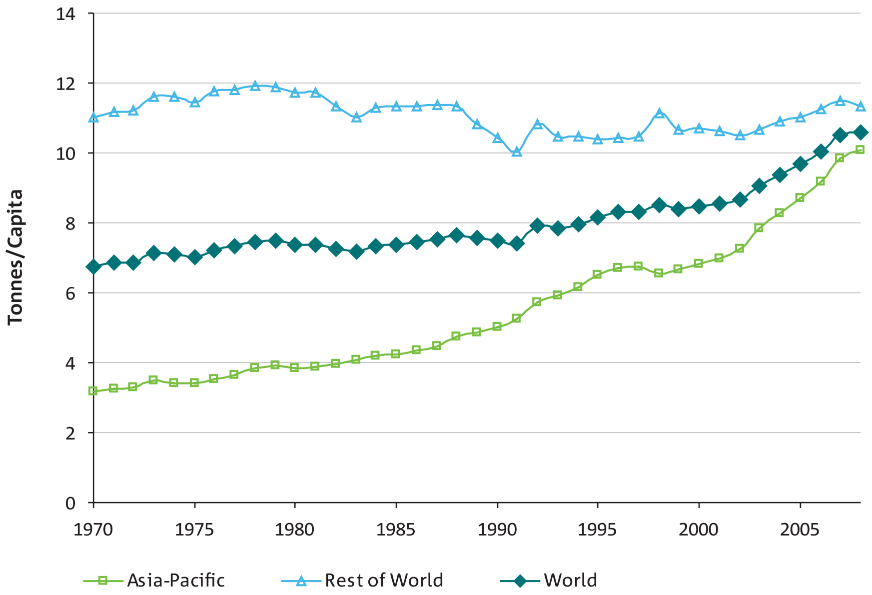


Figure 2 **Domestic materials consumption per capita for the Asia-Pacific region, Rest of the World, and World, for the years 1970–2008**

Figure 2 shows a convergence of per capita DMC between the Asia-Pacific and the rest of the World. While per capita DMC for ROW remained almost static over the entire period 1970–2008[2], it increased by a compounding rate of 3.1% p.a. in the Asia-Pacific, accelerating to nearly 4.4% for the final decade of that period.

At the outset of the GFC, per capita DMC declined slightly in the ROW, but continued to grow in the Asia-Pacific, albeit at a reduced rate. Taking into account the effect the GFC had on World growth, and the fact that this only caused a modest slowing in the rate of per capita DMC growth in the region, two points raised in UNEP (2011) are reinforced: there is little evidence for a tendency towards dematerialization of growth in the Asia-Pacific region, and the underlying rate at which per capita DMC is growing may in fact be continuing to accelerate. Confirmation of this later point will require a longer time series extending across the period from 2008 onwards, however it appears possible from the trends revealed in Figure 2 that a crossover point, where the Asia-Pacific's per capita DMC exceeds that of ROW, may already have been reached sometime after 2008.

2 The trajectories shown in Figure 2 vary considerably from those shown in the REEO (UNEP 2011), especially for the ROW. This is largely a result of the majority of the USSR's successor states being attributed to the Asia-Pacific region in the REEO (UNEP 2011) whereas for this report only the Central Asian republics are counted as part of the Asia-Pacific post dissolution, with most successor states including the Russian Federation remaining in ROW.

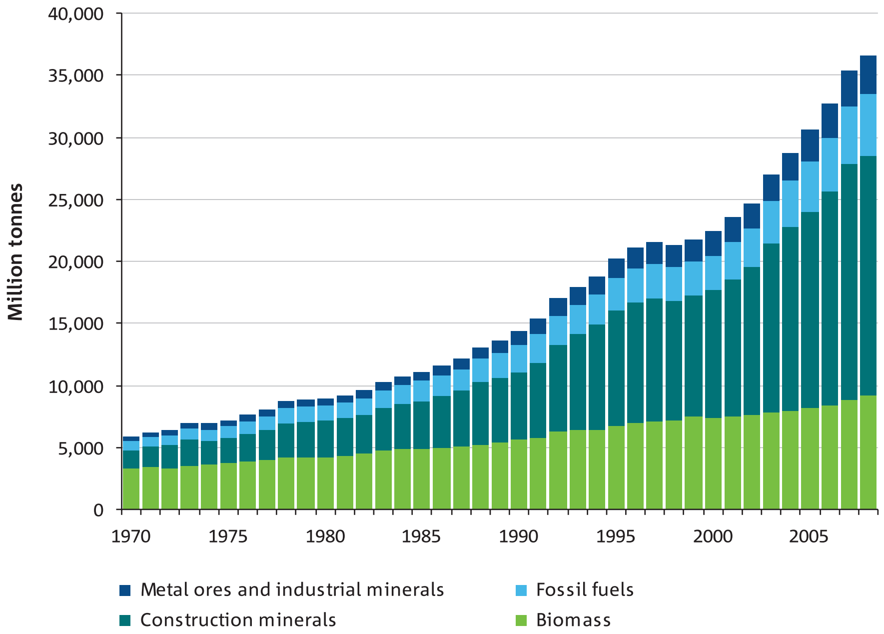
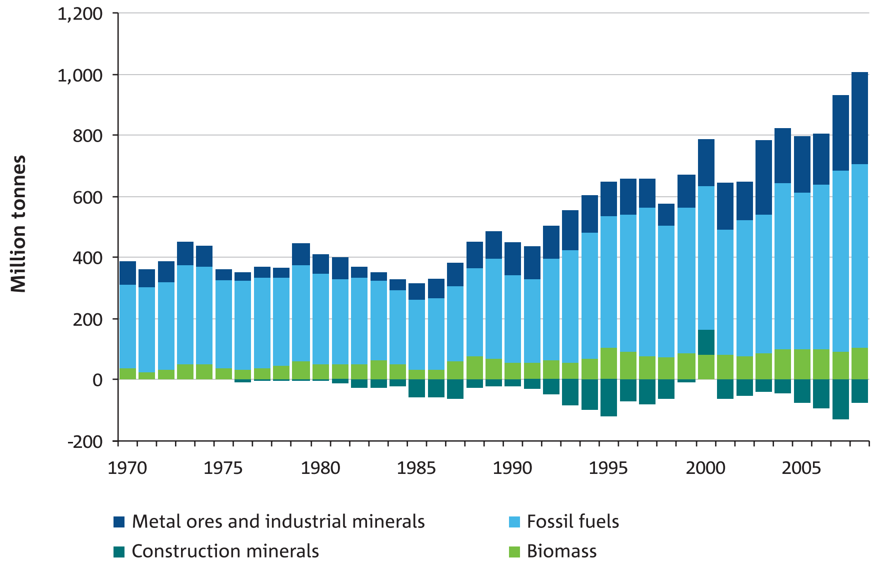


Figure 3 **Domestic Extraction in the Asia-Pacific region by major category of material for the years 1970–2008**

Figure 3 shows how domestic extraction (DE) of four major categories of primary materials has changed over time in the Asia-Pacific region. Extraction of all categories increased strongly over the period 1970–2008, with extraction of biomass compounding at 2.7% p.a., fossil fuels 5.1% p.a., metal ores and industrial minerals 6.1% p.a., and construction minerals by 7.1% p.a.

The different rates of growth of different categories of materials led to a major shift in the material basis of societies within the region. In the 1970s the region's most populous countries were still largely biomass based agrarian societies, reflected in the fact that biomass accounted for 57% of the region's DE. By 2008, biomass accounted for only 25% of DE, while construction minerals had grown to account for 53%, up from 25% in 1970. Share growth in metal ores and fossil fuels over the period was relatively modest, from 5% to 8% and from 13% to 14% respectively. These relative changes reflect the fact that the region's most populous countries are transitioning to industrialized societies which rely on non-renewable mineral sources of energy and materials, rather than the biomass dependence typical of agrarian societies (Krausmann et al. 2008, Schandl et al. 2009). These relative changes in shares translated to massive total increases: construction minerals consumption increased 12-fold, metal ores and industrial minerals consumption 8-fold, fossil fuels 6-fold, and biomass almost doubled.

Even after such increases in DE shown in Figure 3, the region's demand for primary materials is such that net imports of all materials except construction minerals have also grown, as shown in Figure 4. The magnitude of Physical Trade Balances (PTBs) in each category are generally small compared to DE, however the increase in metal ores and industrial minerals in particular is important, due to the highly concentrated nature of internationally traded products in this category compared to those domestically extracted, with one traded tonne of copper concentrate, for example, often embodying one hundred tonnes or more of primary ore (UNEP 2011). As a result, the actual economic impact of a tonne of net imports in this category is correspondingly greater than a tonne of domestic extraction, and does not reflect well the extractive demand placed on the environment at the point of origin. Traded biomass is subject to similar but less powerful concentration effects, fossil fuels far less so, and construction minerals least of all (Schandl and West 2012).



Source: CSIRO

Figure 4 **Physical Trade Balance for the Asia-Pacific region by major category of material for the years 1970–2008**

An important observation in relation to the physical trade balance shown in Figure 4 is that net imports of fossil fuels were only around 12% of DE in 2008. At a finer level of disaggregation of fossil fuels into separate categories for coal, natural gas, and petroleum, net imports of petroleum in 2008 were much higher, at 140% of DE. This is significant in that petroleum is relatively hard to cost effectively substitute for in some important applications, e.g. transport fuels (Hall and Klitgaard 2012), and because it is likely to be fossil fuels which (in their conventional form via well extraction) reach barriers to increased production first (IEA 2011). On the other hand, it is interesting that the region has actually decreased its relative dependence on imported petroleum since 1970, when net imports were equivalent to over 200% of DE. This relative decrease in dependency on net imports to the region also holds for fossil fuels overall, with net imports of fossil fuels in 1970 being equivalent to 36% of DE.

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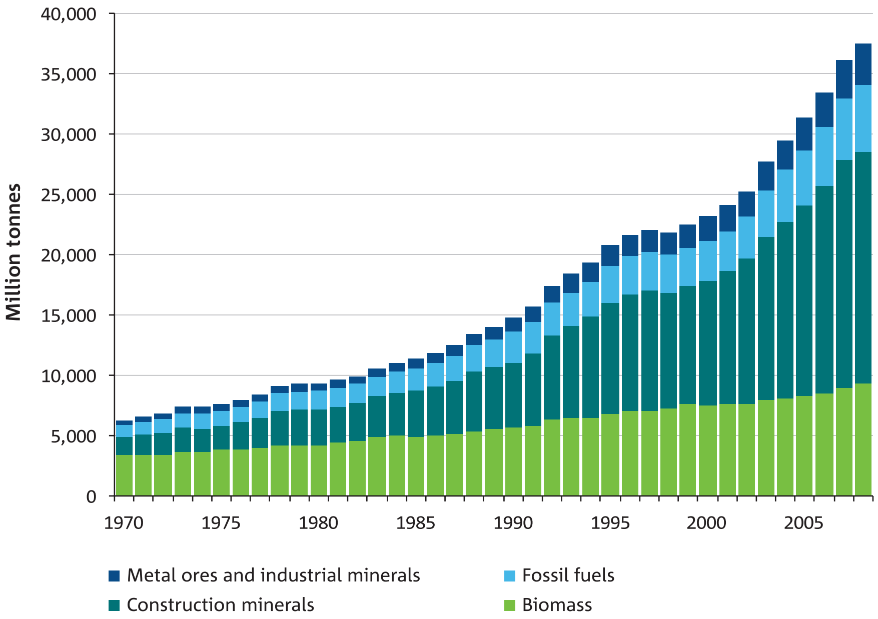

Source: CSIRO

Figure 5 **Domestic material consumption in the Asia-Pacific region by major category of material for the years 1970–2008**

Figure 5 shows DMC disaggregated by the four material categories. As DMC is calculated from the sum of DE and PTB, and PTB for this the Asia-Pacific region is small compared to DE, this figure closely resembles Figure 3, although the effects of trade concentration in some categories just discussed will tend to underplay the effective difference between the two measures. This effect will generally be less pronounced at the regional aggregate level than for individual countries. This is because much of the DE which is then traded in concentrated form actually occurs within the same region, and so shows up in the DMC account for the region as a whole.

Figure 6 presents side by side snapshots of the material bases for the region's economies for 1970 and 2008, to show the degree to which the transition from biomass based to mineral based societies has taken place. Note that DMC is the measure used here, accounting for the slight change in percentages for each material category from the discussion of Figure 3, which was based on DE.

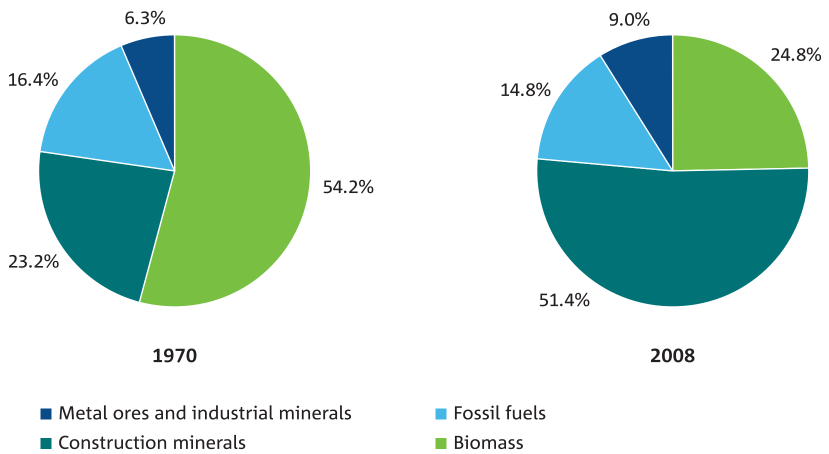

Figure 6 **Change in relative shares of domestic material consumption in the Asia-Pacific region by major materials categories for the years 1970 and 2008**

Table 1 provides detail on the changes in relative shares of 11 different categories of materials at five points in time from 1970 to 2008, while Table 2 provides changes in total tonnages, and shows the very large underlying growth in materials consumption which has taken place in almost all categories over the period 1970 to 2008, a perspective which may be lost if the reader looks only at the much more modest share changes.

In Table 1 it is apparent that the largest relative decrease was in the use of wood, which decreased from 11% of total DMC in 1970, to 2% in 2008. Looking at the same category in Table 2, despite such a large relative decrease in wood's share (over 80%), the total tonnage of wood used still grew slightly. In the case of grazed biomass, which showed the smallest relative decrease of all the biomass sub-categories, its decline from 8% to 6% of total DMC still equated to a fourfold expansion in total tonnage terms. This indicates that the trend within the region towards diets higher in animal products continued. The relatively low conversion efficiencies from raw primary production potential to dietary calories that characterize most animal production systems, and negative implications this has for both food security and greenhouse gas emissions, were briefly outlined in the previous report (UNEP 2011).

With regard to fossil fuels, the relative decline in the share of petroleum in the energy mix continues. Table 1 shows that coal constituted the same share of total DMC in 2008 as it had in 1970. More significantly, its share in fossil fuels in 2008 had actually rebounded past its previous peak, reversing a steady decline from 1985 through to the year 2000 (this latter can be determined from the detailed time series data online, where coal constituted 69% of the region's of fossil fuels in 1985 on a raw tonnage basis, 60% in 2000, and 70% in 2008). Natural gas had the highest relative increase of all materials categories over the full 1970–2008 period, but from Table 1 it is apparent that the very rapid relative growth that natural gas achieved was off a very low base, and that its share appears to have remained static from around 1990 onward. The updated data indicates that the Asia-Pacific region is reverting towards a higher greenhouse gas emitting fuel mix, a trend that was not so clear in the previous report (UNEP 2011). This is occurring despite the rapid increase in total tonnage terms of natural gas.

Table 1 **Changes of share of total domestic materials consumption in the Asia-Pacific region, for eleven material sub-categories, over the period 1970–2008**

	1970	1980	1990	2000	2008
Biomass (Mt)	54%	45%	38%	32%	25%
Primary crops	19%	16%	14%	12%	10%
Crop residues	17%	14%	12%	10%	8%
Grazed biomass	8%	7%	7%	7%	6%
Wood	11%	8%	5%	3%	2%
Fossil fuels (Mt)	16%	16%	17%	14%	15%
Coal	10%	10%	11%	8%	10%
Petroleum products	6%	6%	5%	4%	3%
Natural gas	0.2%	0.5%	1.1%	1.1%	1.1%
Metals and industrial minerals (Mt)	6%	7%	8%	9%	9%
Iron ores, concentrates, iron and steel	3%	3%	3%	3%	4%
Non-ferrous metal ores, concentrates, metals	2%	3%	4%	6%	4%
Industrial minerals	0.8%	1.0%	0.8%	0.6%	0.4%
Construction minerals	23%	32%	36%	44%	51%

The shares of both ferrous and non-ferrous metals increased strongly between 1970–2008, although the very rapid share growth for non-ferrous metals through to 2000 reversed over the final decade, even as total tonnages still increased by 15% over that 8 year period[3]. Industrial minerals' share decreased quite strongly from 1970–2008, while growth in total tonnage terms was almost as slow as for biomass, with DMC tripling.

Very rapid rates of growth of construction minerals DMC continued across the full 1970–2008 period, both in share terms, and in total tonnage terms. This growth accelerated in the final decade even though starting from a very high base. Stark variations exist between countries in the region on this measure, with some economies such as Thailand and the Republic of Korea appearing quite sensitive to events such as the Asian financial crisis of 1997 and the GFC in 2008, with strong contractions in DMC of construction minerals evident in their individual country analyses (see section 4). Others such as China and Viet Nam show little response. This is also visible in Figure 8, as is the degree to which China's consumption of primary resources has come to dominate regional aggregates, while the dominant role of construction minerals in China's account becomes clear in Figure 10. In combination, this indicates that the relative robustness of the region's growth into the beginning of the GFC largely reflects a continued very large scale build up of major infrastructure in China.

Table 2 Total changes in domestic materials consumption in the Asia-Pacific region, disaggregated by eleven material categories, over the period 1970–2008

	1970	1990	2008	RATIO 2008:1970
Biomass (Mt)	3,387	5,696	9,303	2.7
Primary crops	1,184	2,111	3,648	3.1
Crop residues	1,036	1,849	2,869	2.8
Grazed biomass	499	989	2,061	4.1
Wood	667	747	724	1.1
Fossil fuels (Mt)	1,002	2,550	5,533	5.5
Coal	644	1,677	3,879	6.0
Petroleum products	349	708	1,230	3.5
Natural gas	10	165	424	44.0
Metals and industrial minerals (Mt)	393	1,196	3,363	8.6
Iron ores, concentrates, iron and steel	192	445	1,648	8.6
Non-ferrous metal ores, concentrates, metals	149	639	1,566	10.5
Industrial minerals	51	112	149	2.9
Construction minerals	1,449	5,372	19,260	13.3
Total	**6,230**	**14,813**	**37,458**	**6.0**

3 The detailed time series data in the online database shows that non-ferrous metals is the only category for which an actual decline in total tonnage terms occurred between 2007 and 2008, perhaps indicating a higher sensitivity to adverse economic conditions for this category. Other materials just showed reduced growth rates.

The deteriorating trend in materials efficiency (MI) for the Asia-Pacific region identified in the previous report (UNEP 2011), has continued unabated (Figure 7). The driver behind this deterioration is the continued increase in relative share of GDP earned in the lower efficiency/higher MI economies of the region, compared to the low MI economies. Between 2005 and 2008, China's share of the regional economy grew from 19% to 23%, while Japan's further decreased from 50% to 46%. This dynamic is sufficiently strong that it continues to outweigh the improvements in material intensity being made within the individual constituent economies, e.g. over the same period China's MI decreased from 9.4 kg per US$ in 2005 to 8.7 kg per US$ in 2008, while Japan's decreased from 0.29 kg per US$ to 0.26 kg per US$.

The continuation of this deterioration of MI at the regional level is cause for concern. MI needs to decline at a rate roughly comparable to the rate of increase in GDP just to stabilize extractive pressures on the environment. In the current situation, where MI is actually increasing, extractive pressures on the environment will increase even more rapidly than the region's rapid rate of growth.

The trend in MI for the ROW also continues to be consistent with that derived in the previous report (UNEP 2011), with a sustained period of considerable improvement from 1970 becoming much weaker from 2000, at which point the improvement in MI for the ROW is no longer strong enough to keep world aggregate MI declining in the face of the continued increases in the Asia-Pacific. From 2000 on, the average dollar of GDP earned at the global scale placed a higher extractive burden on the environment. This again reinforces the lack of any evidence for an environmental Kuznets' curve (EKC) manifesting itself with regard to materials use, at the global scale.

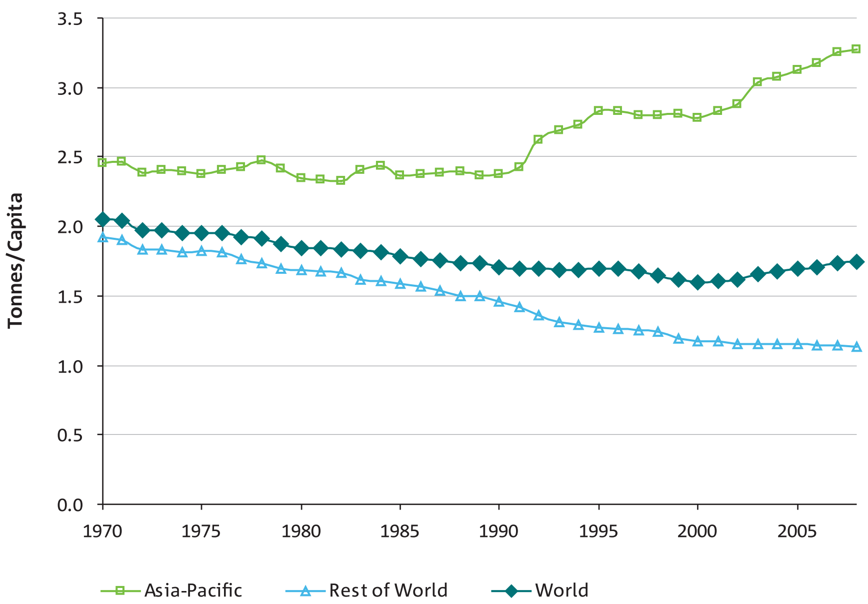

Figure 7 Material intensity (MI = DMC/GDP) for the Asia-Pacific region, Rest of the World, and World, for the years 1970–2008

4 Material use patterns and material efficiency for selected countries

In this section, material use patterns and material efficiency are reviewed for the ten countries having the highest total DMC in the Asia-Pacific region. These ten countries cover three of the six country classifications set out by Krausmann et al. (2008), and used as guidance to a country's socio-metabolic profile. The represented classifications include: high population industrialized countries (HDI), Low population density countries of the New World (LDI-NW) and high population density developing countries (HDD). The other three categories, low population density industrialized countries of the Old World (LDI-OW), low population density developing countries of the Old World (LDD-OW) and low population density developing countries of the New World (LDD-NW) are not covered here as their resource usage, in total terms, is not significant in the Asia-Pacific context.

Figure 8 indicates that by 2008, material flows in the Asia-Pacific region were heavily dominated by two HDD countries, with China accounting for over 60% of the regional total DMC, and India contributing over 14%, while no other individual economy accounted for more than 4% of the total. This was not the case in earlier decades, with Japan accounting for over 20% in the early 1970s, and Australia, the Republic of Korea and Indonesia all accounting for greater than 4% at different times. While the relative share of the seven HDD countries in the group (China, India, Indonesia, Pakistan, Viet Nam, Thailand, and Malaysia) grew from 61% of regional total DMC in 1970 to 85% by 2008, this growth is more than accounted for by the growth in China's individual share. From respective shares of 27.8% and 21.4% for China and India respectively in 1970, China's share has grown steadily while India's has contracted. Of the other HDDs, only Malaysia and Viet Nam's relative shares grew over the period.

Table 3 **Country classification system of Krausmann et al. (2008)**

	INDUSTRIALIZATION	
	INDUSTRIALIZED COUNTRIES	**DEVELOPING COUNTRIES**
High pop. Density	High-density industrial (HDI) *Japan, Republic of Korea*	High-density developing (HDD) *China, India, Indonesia, Pakistan, Viet Nam, Thailand, Malaysia*
Low pop. Density		
New World	Low-density industrial – New World (LDI-NW) *Australia*	Low-density developing – New World (LDD-NW)
Old World	Low-density industrial – Old World (LDI-OW)	Low-density developing – Old World (LDD-OW)

Note: Industrialized countries include OECD countries and transition markets; developing countries include developing and least developed countries based on the classification of UNSD (2006). Countries with a population density above 50 persons per km² are considered high-density.

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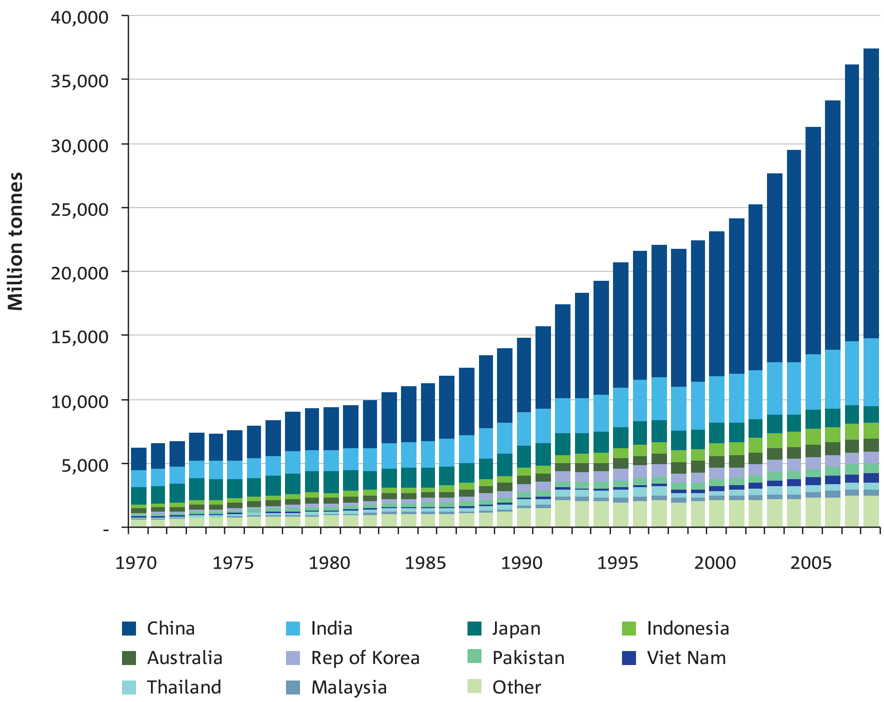

Figure 8 **Domestic Material Consumption of the ten highest consumers of materials in the Asia-Pacific region in 2008, for the period 1970–2008**

4.1 Australia

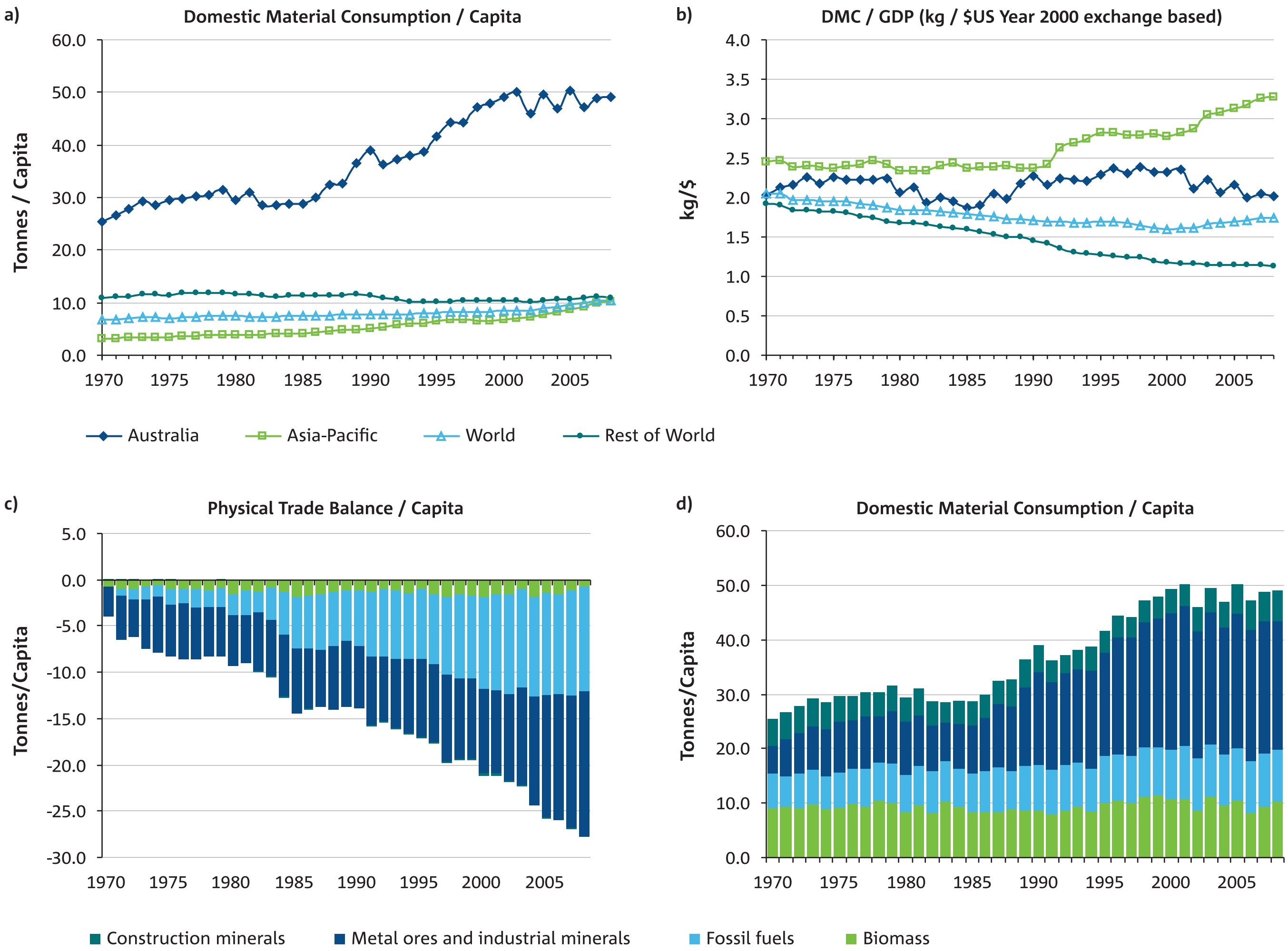

Figure 9 **Summary analysis of material flows and materials intensity indicators for Australia**

According to our country typology, Australia is an LDI-NW country. This class of country is characterized by large natural resource endowments per capita, and low population densities. From Figure 9 it is apparent that the stabilization of DMC per capita evident in the previous report (UNEP 2011) continued up until 2008, while a rapid expansion in PTB per capita continued (Figure 9(c)). This emphasizes the degree to which growth in DE per capita in Australia has been driven by exports of fossil fuels and metal ores, with Australia serving increasingly as an energy and materials supplier to the industrial transformation taking place elsewhere in the Asia-Pacific. DMC per capita is a factor of five higher than regional and world averages, much of which is accounted for by metal ores and industrial minerals, which frequently undergo initial processing stages in Australia prior to export in highly concentrated forms (Schandl and West 2012). Australia's trend in MI continued to be roughly static, with no sustained improvement for nearly four decades.

While the national MI trend is better than the average for the region, it needs to be remembered that the poor aggregated regional performance is a result of the changing shares of individual countries of regional GDP. On an individual country basis, Australia's result is poor, although this is perhaps an unavoidable outcome of being primarily an exporter of raw materials, especially when those exports are largely composed of metal ores and subject to high concentration factors in their exported form.

4.2 China

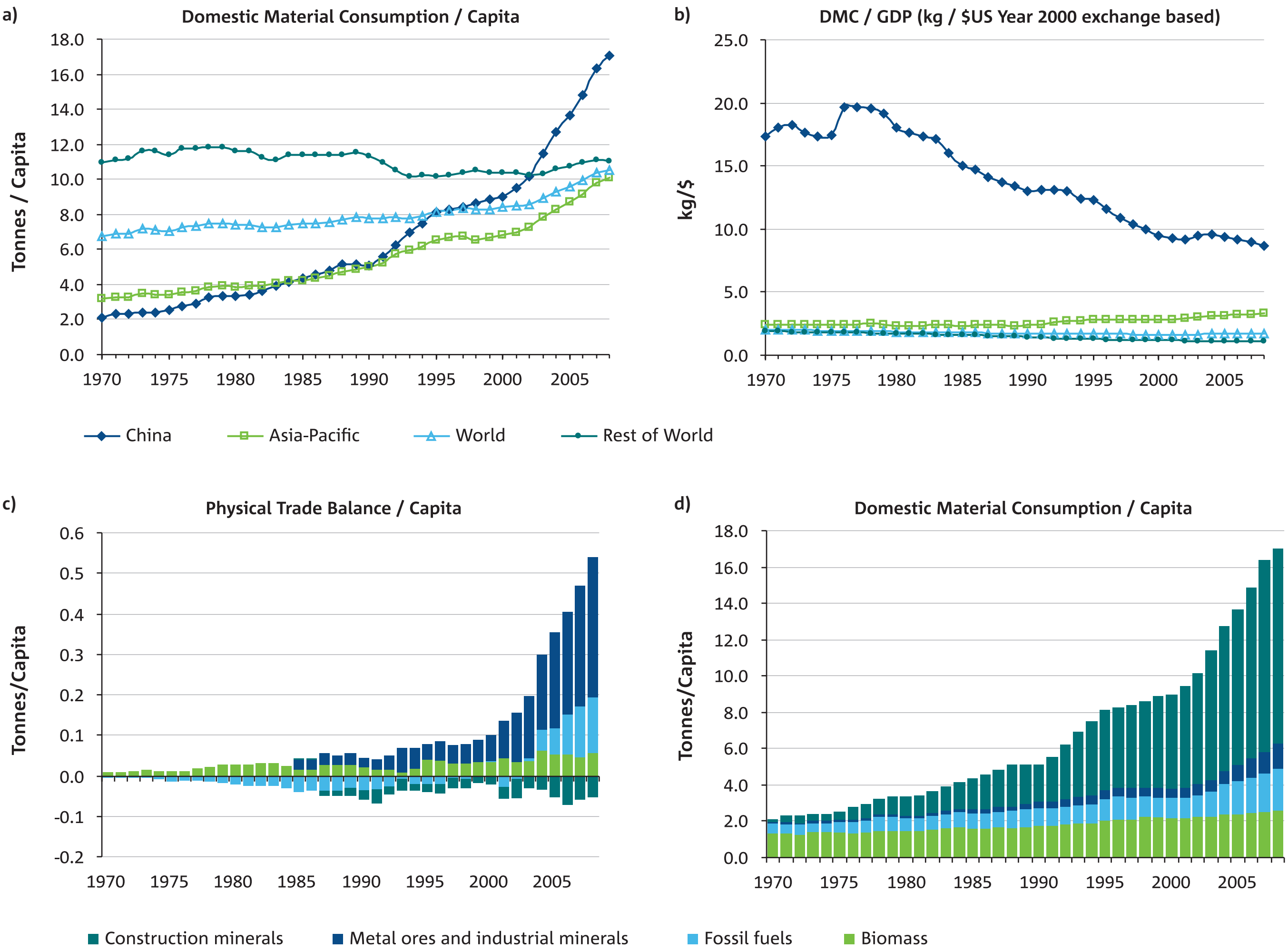

Figure 10 **Summary analysis of material flows and materials intensity indicators for China**

China is an HDD country with a long history of intensive agriculture leading to the current high population densities. It is apparent from Figure 10 that the extremely rapid growth in DMC per capita noted in the previous report (UNEP 2011) continued up to the onset of the GFC, and furthermore that the transition away from a biomass based to a minerals based society appears to have accelerated (Figure 10(d)). China first exceeded the world average DMC per capita in 1995, and by 2008 was consuming materials at a per capita rate over 160% of the world average. Accelerated growth in material use is continuing with DMC per capita increasing by 25% between 2005 and 2008. The latest data on PTB per capita emphasizes the rapidly increasing reliance of China on imports to meet its requirements for metals and fossil fuels. Net imports of metal ores and industrial minerals, which accounted for less than 10% of DMC in 1998, were equal to nearly 25% of DMC in 2008, and would contribute a much higher effective share of actual metal used if the concentration effects of traded commodities were taken into account. The ratio of imported fossil fuels to total DMC remains low, at around 6% in raw tonnage terms, however in the 11 category data disaggregation (online database), the apparent near self sufficiency of China in fossil fuels overall does not hold for petroleum, with imports contributing around 49% of total supply in 2008, up from 42% in 2005 and from being a net exporter in 1992.

While the strong trend towards decreasing MI from the mid 1970s to the year 2000 has not returned, modest improvements have formed a new trend since 2004, more than compensating for a period of increasing MI from 2002–2004. The rate of improvement in MI has not come close to offsetting the effect of growing GDP on resource demands, as is made evident from the rapid escalation in DMC discussed above. Also, as noted in association with table 2 above, even as China's individual MI improved, its rapidly growing share of the regional economy comes at the expense of low MI producers like Japan, and has thus driven regional MI higher.

4.3 India

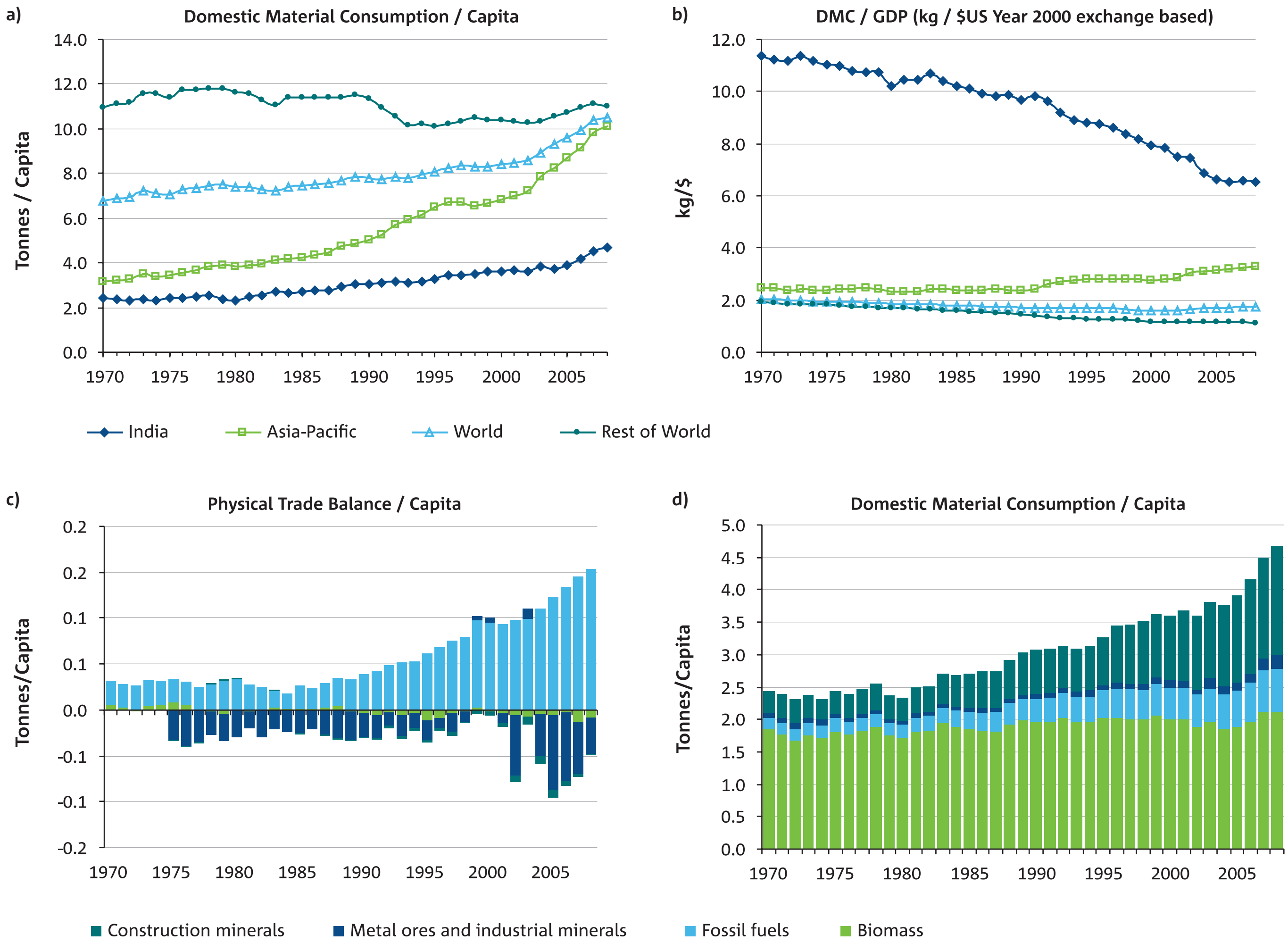

Figure 11 **Summary analysis of material flows and materials intensity indicators for India**

India is the second population giant in the region, and another HDD country. Unlike China, Figure 11 shows that DMC per capita in 2008 remained low, less than half of either World or Asia-Pacific averages, and roughly equal to the level reached by China in 1987. Significantly, the relatively subdued growth trend for DMC per capita displayed up until 2005 moved to a markedly faster rate from 2005 to 2008, with any visible impact from the onset of the GFC limited to a slight moderation of the new, higher growth regime from 2007–2008. Growth in DMC per capita over the full period 1970–2008 is almost entirely accounted for by growth in construction minerals and fossil fuels, with per capita consumption of biomass remaining roughly static since 1990. Consumption of metal ores and industrial minerals remained at very low levels (about 0.2 tonnes per capita), but from 1998 to 2008, it grew at a compounding annual rate of 8.6% p.a., compared to only 2.8% p.a. from 1970 to 2008. This is consistent with India entering a rapid acceleration phase of its transition to an industrialized economy. India has required steadily increasing net imports of fossil fuels per capita since the mid 1980s, both in total fossil fuel PTB per capita, and as a share of fossil fuel DMC. Between 1985 and 2008, net imports of fossil fuels grew from 9% of fossil fuel DMC, to 23%.

A long term decline (improvement) in MI evident in the Indian economy from 1970 appears to have stopped abruptly around 2004–2005, with static MI since that time. This is an important development, and not anticipated in the previous report (UNEP 2011). If this trend continues, any continued gains in economic growth will henceforth translate roughly into proportional increases in extractive pressures on the environment.

4.4 Indonesia

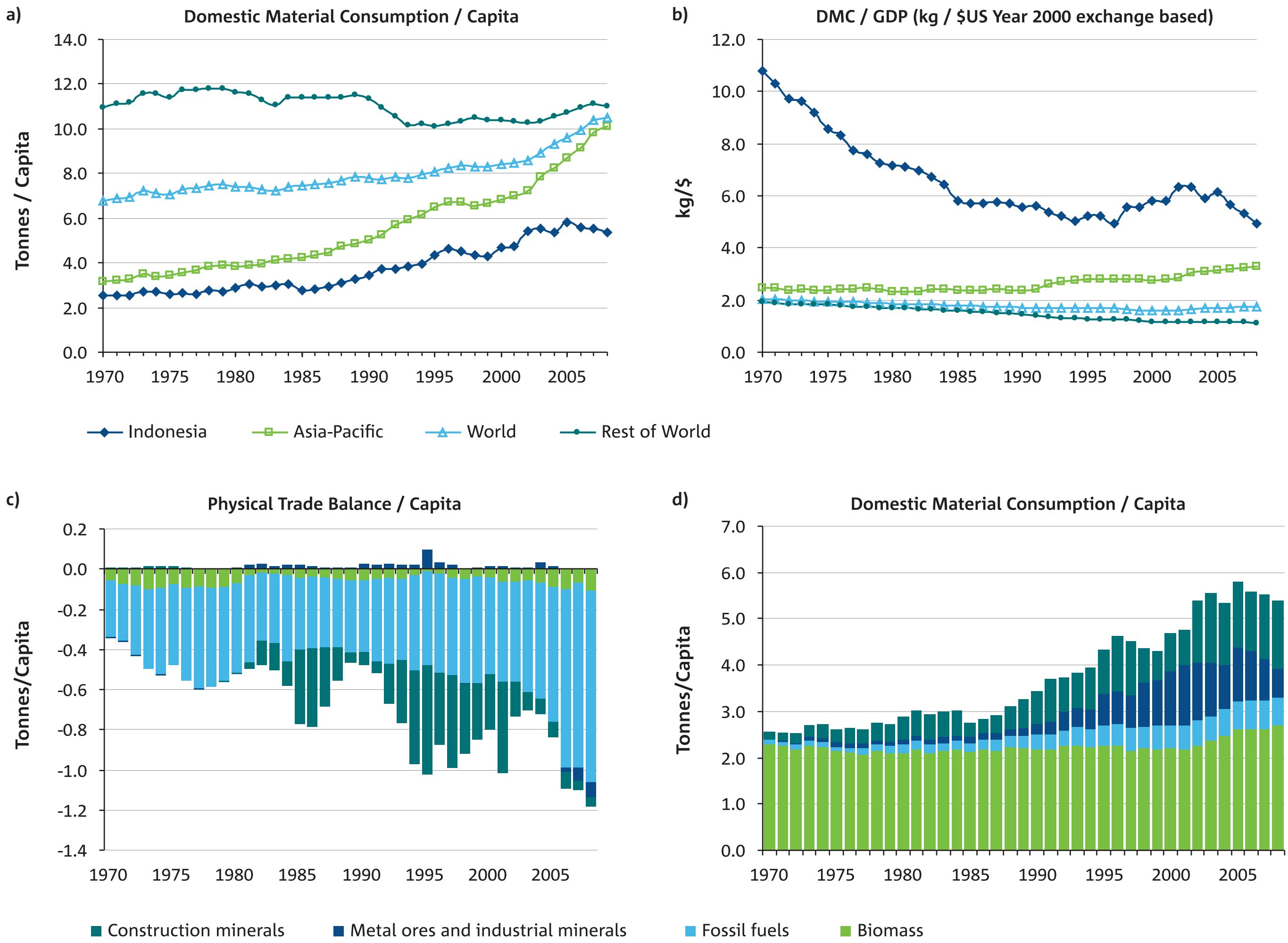

Figure 12 **Summary analysis of material flows and materials intensity indicators for Indonesia**

Indonesia is an HDD country, with DMC per capita in 1970 at a low base of around 2.5 tonnes per capita and remaining relatively low in 2008, at 5.4 tonnes per capita, a little more than half the World and regional per capita levels (figure 12(a)). Some fifteen years of very low growth from 1970 gave way to a period of rapid growth from 1985 to 1996, which saw DMC per capita increasing at a compound rate of 4.8% p.a. A period of contraction preceded and continued over the period of the Asian Financial Crisis (AFC), followed by a rebound, then a further, recent period of contraction. Growth in DMC per capita since 1996 has averaged 1.3% p.a. The four category breakdown of DMC per capita in Figure 12(d) shows that the relative volatility in Indonesia's DMC per capita is mainly due to fluctuations in the construction minerals and metal ores and industrial minerals categories. Indonesia shows a strong shift away from biomass and towards minerals/ fossil fuels over the period 1970 to 2008, but is a relatively unusual case in demonstrating a reversal of this trend in recent years. The degree of fluctuation seen in metal ores may be in large part an effect of the large proportion that the production from one single mine (Grasberg) contributes to the Indonesian total, and the fluctuations of production of different commodities (copper, gold and silver) from that mine. Indonesia's importance as a net supplier of fossil fuels to other countries continues to grow rapidly in gross terms; however it remains a net importer of petroleum (see online database).

MI improved very rapidly in Indonesia from 1970 to 1985, then entered a period of fluctuation, with only modest improvement overall from 1985 to 2008. Improvements since 2005 merely compensated for a deterioration from the late 1990s. A partial explanation for the latter may be the rapid increase in the share of relatively low value coal compared to high value petroleum in DE over that period, and Indonesia's transition to being a net importer of petroleum.

4.5 Japan

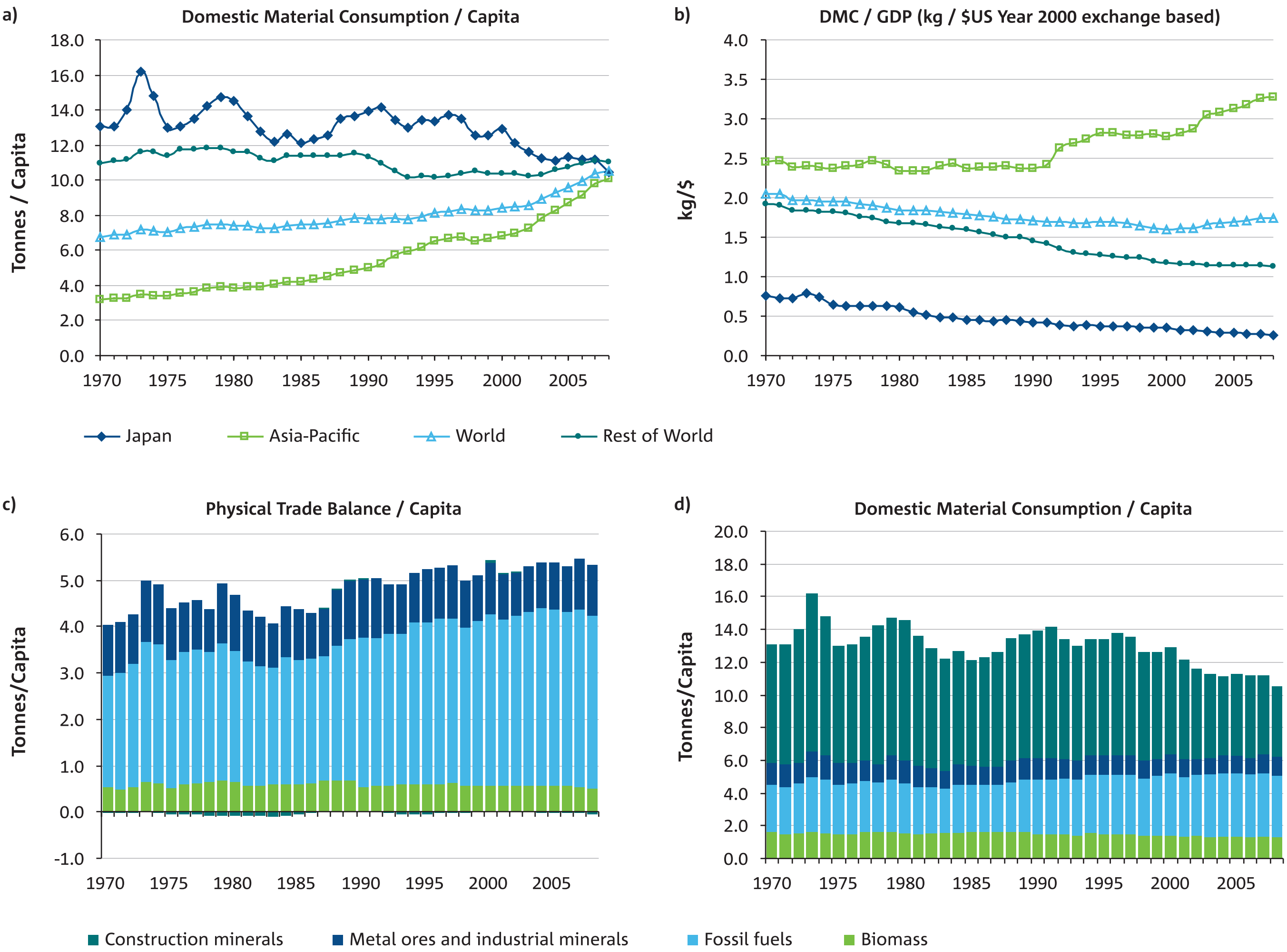

Figure 13 **Summary analysis of material flows and materials intensity indicators for Japan**

Japan is an HDI country. The overall picture in Figure 13 is that of a country which had essentially completed the agrarian to industrial transition at the beginning of the 1970s, and has entered a relatively stable state as a mature industrialized economy based on manufacturing and services. Japan's DMC per capita decreased slowly over the period 1970 to 2008, at a time when the corresponding values for the region, and the World overall, were increasing strongly. As a result, it has gone from consuming around twice the World average and four times the regional average, to being roughly average in both contexts. The main factor contributing to Japan's reduction in DMC has been an ongoing decline in consumption of construction minerals, while consumption of metal ores and biomass has also declined slightly, and fossil fuel consumption has increased. The PTB panel shows that Japan is dependent on imports for virtually all of its metal ores and fossil fuels, and for a significant proportion of its biomass DMC.

Japan's MI has decreased by an average of 2.7% p.a. compounding since 1970. Remarkably, this rate of improvement has actually accelerated, with MI decreasing at 3.7% p.a. from 2005 to 2008. These ongoing improvements mean that Japan is now over 12 times more efficient at generating GDP per unit DMC than the regional average, and 6.7 times more efficient than the ROW average. The extent to which this is a result of ongoing Japanese policy initiatives to decrease waste and raise efficiency, rather than an outcome of progressively off-shoring the most material and energy intensive stages of production processes, remains an open question.

4.6 Malaysia

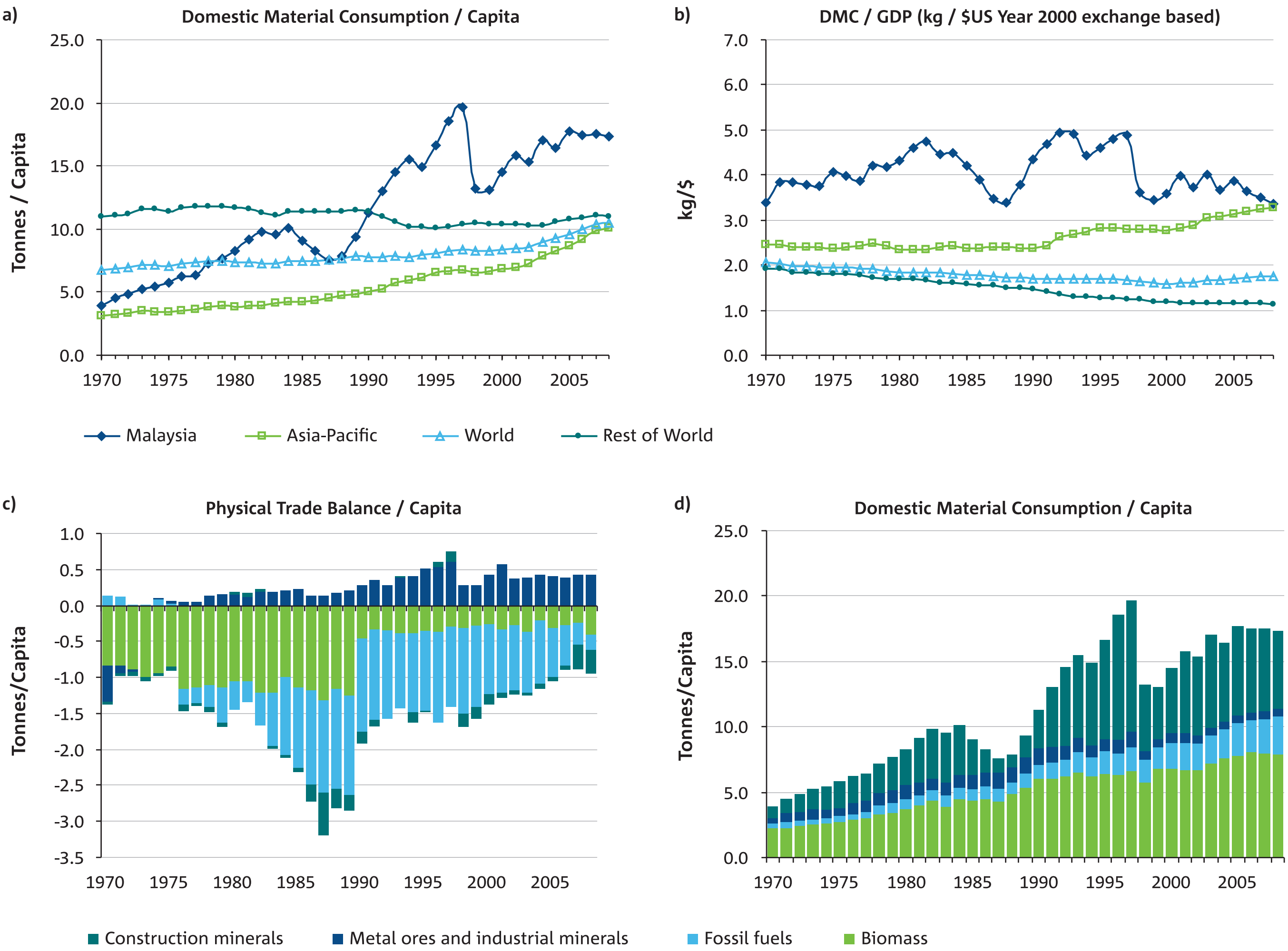

Figure 14 **Summary analysis of material flows and materials intensity indicators for Malaysia**

Malaysia is an HDD country, although at the lower end of population densities and higher range of per capita GDP for this classification. DMC per capita increased by 4% p.a. compounding from 1970 to 2008, although Malaysia has displayed notable volatility on this measure. In the four category breakdown of DMC in Figure 14(d), it becomes clear that most of this volatility is due to major variations in construction minerals. Malaysia is also one of the group of Asia-Pacific countries which show a very clear signature from the AFC of 1997 in their material flows record (Thailand and the Republic of Korea are two other examples). The record of PTB per capita shows Malaysia becoming rapidly less significant as a supplier of primary products to other countries. The decline in net exports of fossil fuels since the mid 1980s does not reflect reduced DE, but rather a combination of growing population and major increases in domestic consumption of fossil fuels. The major step decrease in PTB of biomass between 1989 and 1990 is attributable to a major decrease in net wood exports (see online database) from that year. An interesting feature of the four category breakout of DMC per capita is that while this measure has increased quite rapidly, the overall share of biomass compared to construction minerals was roughly the same in 1975 as 2008, with biomass a multiple of 1.39 times construction minerals in 1975, compared to 1.32 in 2008, having previously reached a low of under 0.66 in 1997.

Malaysia's MI remained largely static from 1970 to 2008, although it varied considerably during that period. While its MI has improved relative to the regional average, this is still a relatively poor individual performance for the same reason outlined for Australia, i.e. the poor aggregated regional performance being a result of the changing shares of individual countries of regional GDP.

4.7 Pakistan

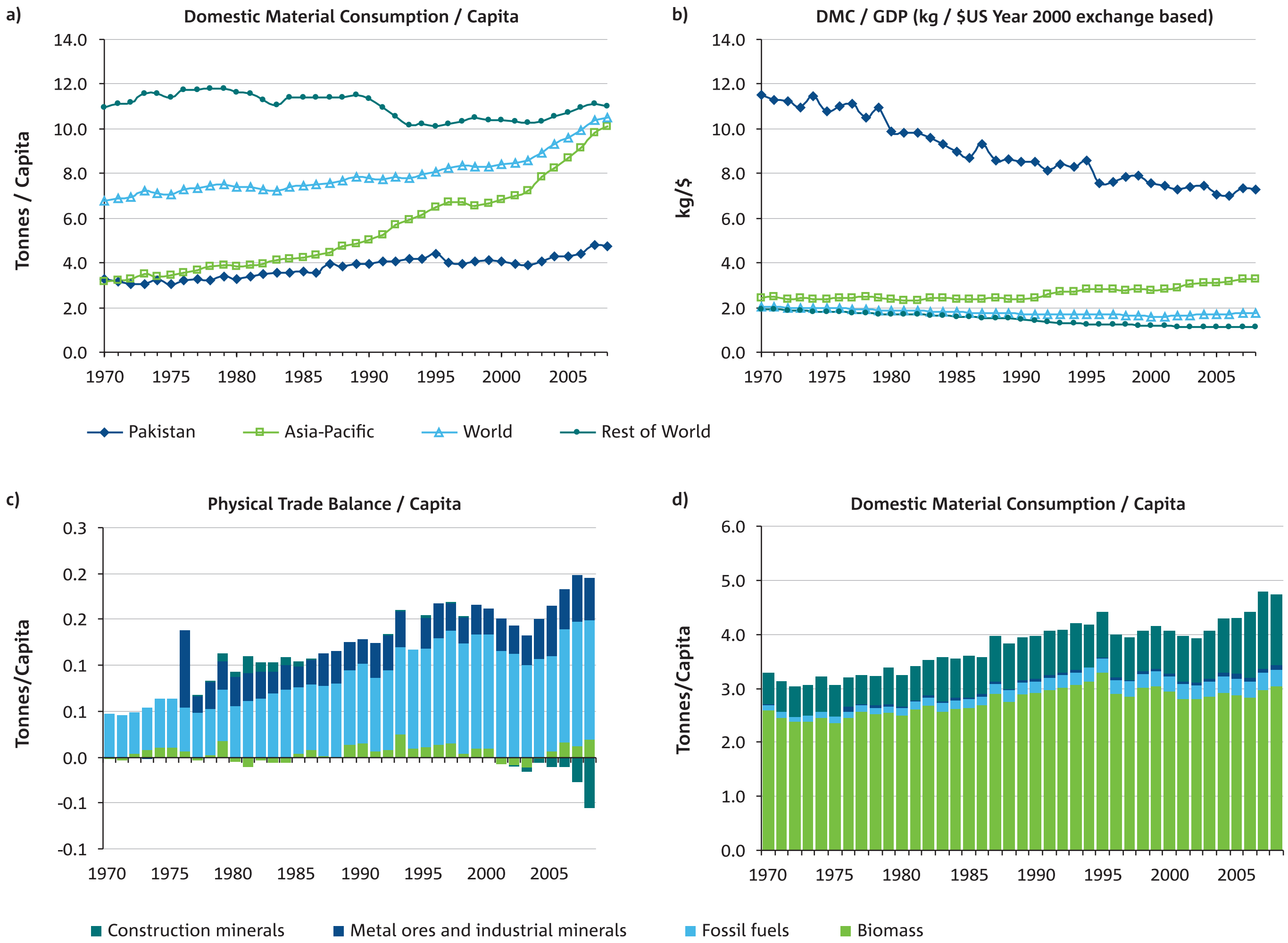

Figure 15 **Summary analysis of material flows and materials intensity indicators for Pakistan**

Pakistan is an HDD country. Figure 15 shows relatively subdued growth in DMC per capita, the lowest of the seven HDD countries examined in closer detail, with a compounding rate of just under 1% p.a. between 1970 and 2008. This low rate of growth on a per capita basis did not translate to a low total increase in DMC however, due to the county's rapid population growth. Total DMC grew at 3.7% p.a. Pakistan retains the highest dependency on biomass of the ten countries examined here, however the transition from a biomass based to a minerals based economy is proceeding to some extent, with the share of biomass decreasing from 79% of DMC in 1970 to 64% in 2008. The slow rate at which construction minerals DMC per capita has grown contrasts with the other HDD countries examined, and suggests a much lower emphasis on investment in major infrastructure. Similarly, the very low DMC for metal ores indicates only very limited and slow industrialization. Pakistan is reliant on increasing imports of fossil fuels for over 40% of its fossil energy DMC, however the ratio of PTB and DMC was roughly the same in 1970, 1990, and 2008, indicating that Pakistan has managed to increase its extraction of fossil fuels roughly in proportion to total demand, avoiding a deterioration in its level of self sufficiency in this category.

Pakistan's MI decreased steadily from 1970 to 1996 at a rate of 1.6% p.a. compounding, then remained almost static through to 2008, at roughly twice the regional and four times the World average MI for that year.

4.8 Republic of Korea

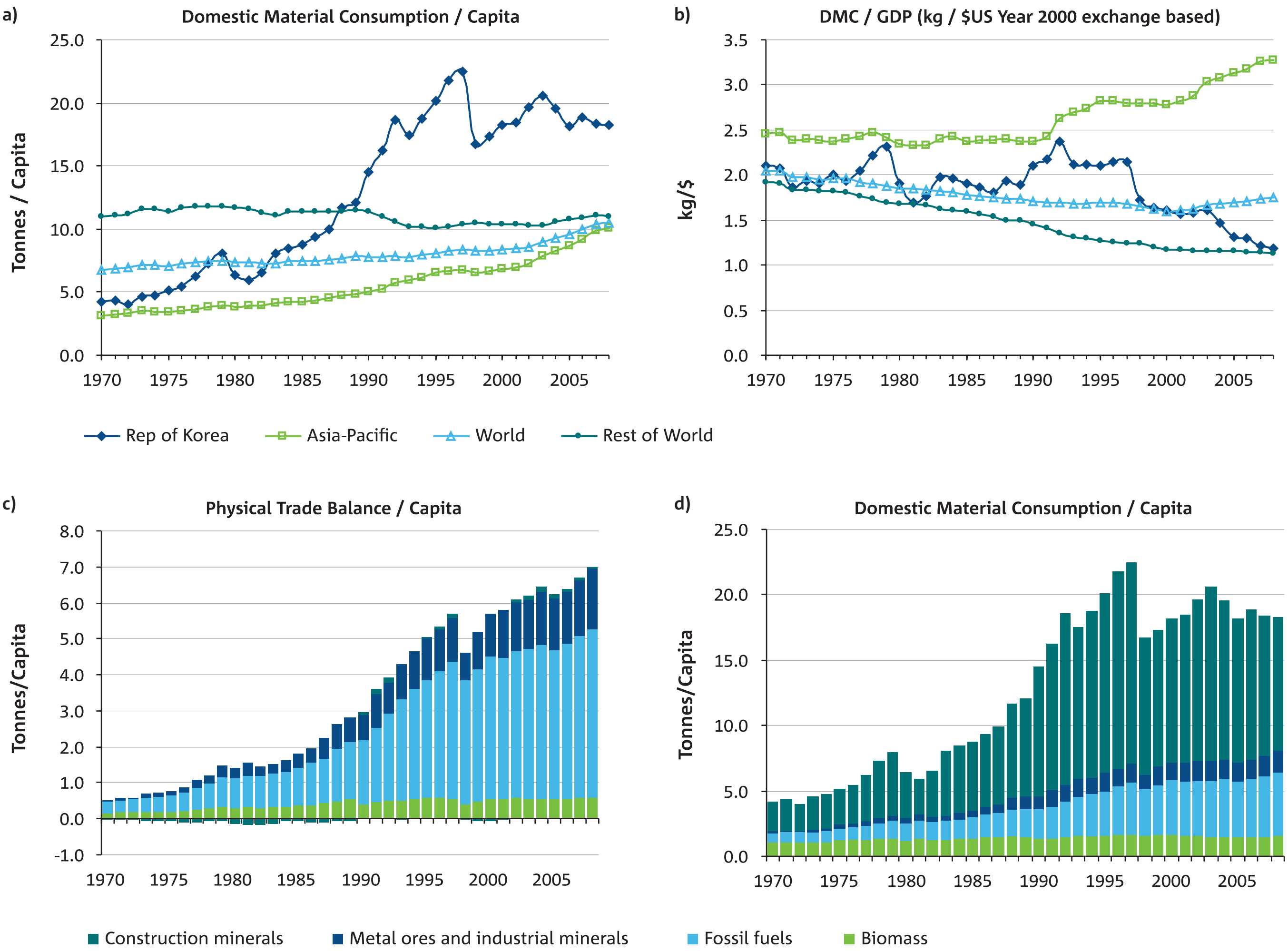

Figure 16 **Summary analysis of material flows and materials intensity indicators for the Republic of Korea**

The Republic of Korea is an HDI country, i.e. in the same category as Japan, however in contrast to Japan it is apparent from Figure 16 that its materials usage profile changed radically over the period 1970 to 2008, with DMC per capita growing by 4.0% p.a. compounding. The largest growth in total volume terms was in construction minerals, while in percentage terms metal ores grew fastest at 6.7% p.a. High and increasing net imports of fossil fuels are the most salient feature of the PTB. Relative dependence on imports increased greatly between 1970 and 2008. While net imports accounted for less than 28% of metal ores and around 45% of fossil fuels in 1970, by 2008 the shares were 98% and 97% respectively. The Republic of Korea in 1970 had a relatively low DMC per capita of around 4 tonnes, however its material flows already had a markedly different structure to other countries at such a low level of DMC, with biomass accounting for less than 26%, and fossil fuels already at 17%. This suggests that the transition to a minerals based society began well before 1970 but perhaps in an environment of general resource scarcity, where total DMC flows were unusually low. If this is the case, it has not translated into ongoing frugality, as the country now has DMC per capita approaching double regional and World averages.

The Republic of Korea's initial MI is also anomalously low for a nation beginning from such a low DMC base. Another unusual feature is that MI, while volatile, remained roughly static until the AFC in 1997, then improved rapidly over the following decade, decreasing at an average rate of 5.3% p.a. compounding, with around half of this improvement coming in a sustained trend rather than confined to the period immediately following the AFC.

4.9 Thailand

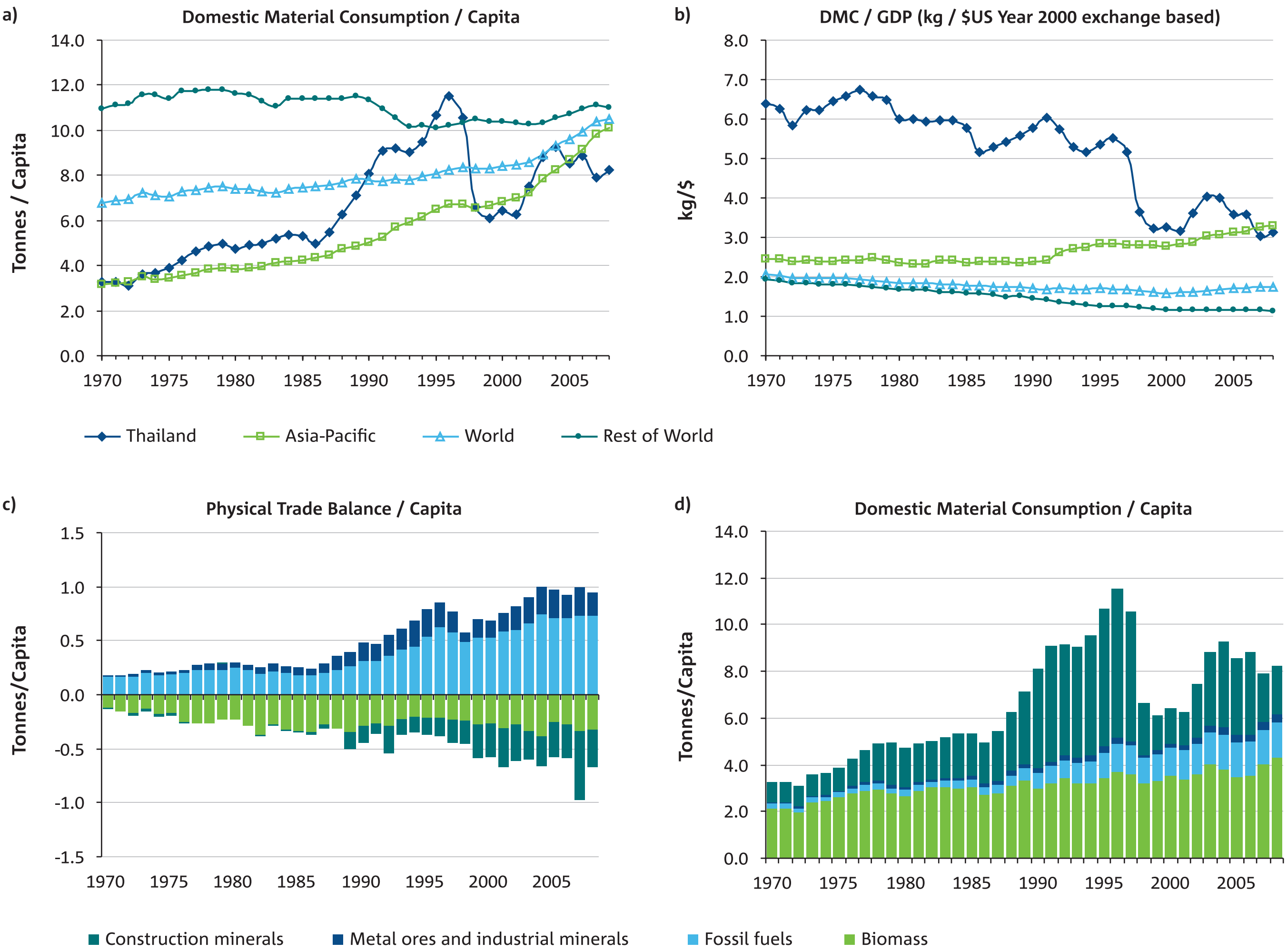

Figure 17 **Summary analysis of material flows and materials intensity indicators for Thailand**

Thailand is an HDD country.
Its aggregate DMC per capita began the period equal to the regional average and finished well below average, following a highly volatile trajectory. This volatility can be largely attributed to a rapid increase in consumption of construction minerals in the decade preceding the AFC, when Thailand's DMC per capita rose to 11.5 tonnes in 1996 (173% of the regional average), before falling to 6.1 tonnes in 1999. This general profile is also seen in the material flows of Malaysia and the Republic of Korea, although neither of those two countries suffered as large a shock to their construction sector. Thailand started the study period as a net exporter of biomass, and this remained a constant feature of its PTB. Since the late 1980s, construction minerals have become a second net export. DMC and PTB of fossil fuels grew strongly, however the relative importance of imports decreased, with 53% of fossil fuels sourced from domestic extraction in 2008, compared to only 8% in 1970. Thailand's near total dependency on imports for petroleum in 1970 has steadily decreased since, so that by 2008 it produced petroleum equivalent to nearly 40% of DMC. The changing structure of Thailand's material flows reflects an ongoing transition from agrarian to industrialized economy, although total minerals share actually peaked prior to the AFC as a result of the extraordinary increase in construction activity.

Thailand's MI decreased gradually between 1970 and 1996, at which point it fell precipitately following the AFC. The pattern from the AFC to 2008 is most similar to that of Malaysia, with a one off, step improvement followed by a static (average) trend. This is different to the ongoing decreases in MI seen for the Republic of Korea.

4.10 Viet Nam

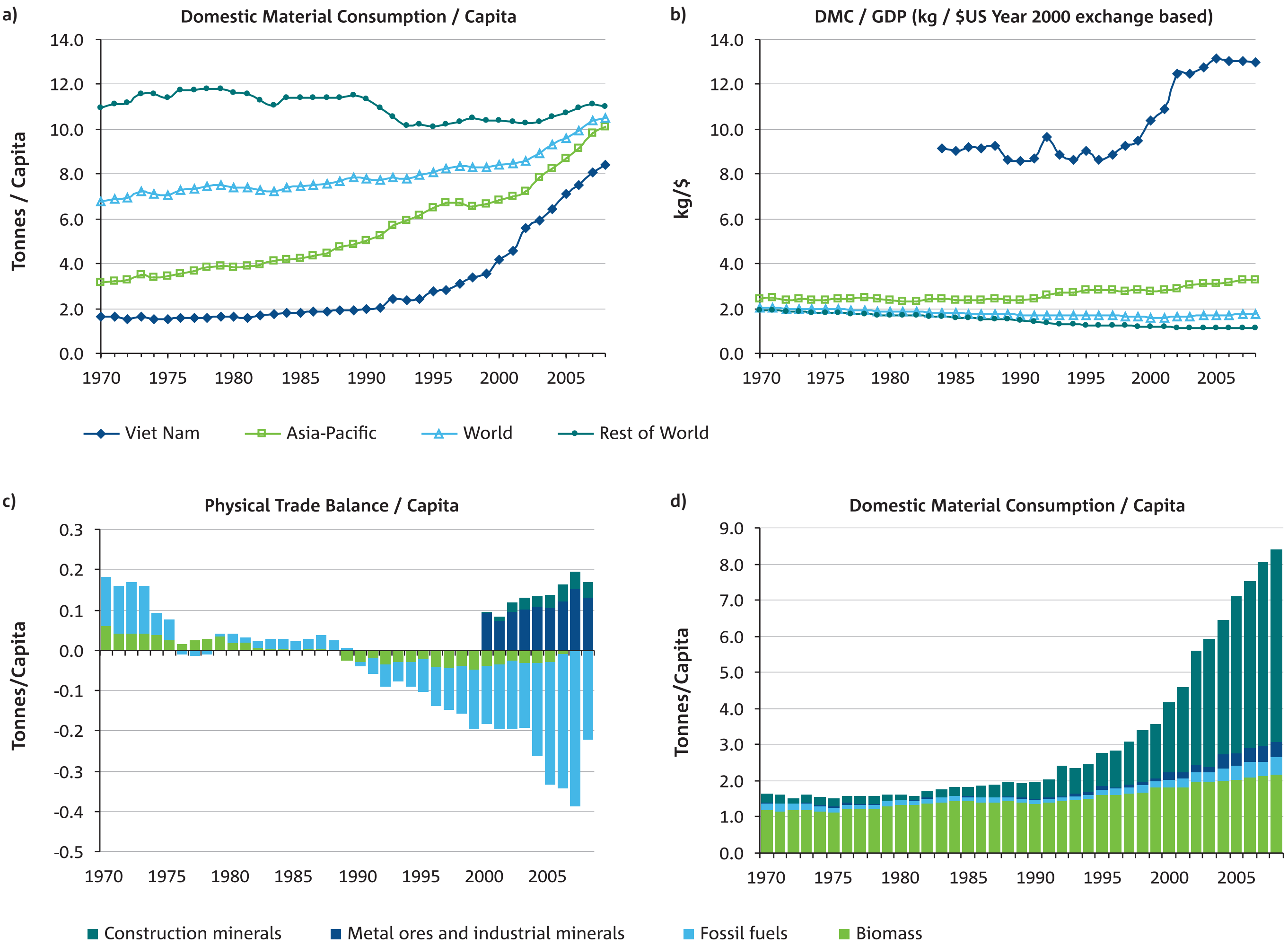

Figure 18 **Summary analysis of material flows and materials intensity indicators for Viet Nam**

Viet Nam is an HDD country, and begins from the lowest DMC per capita base of any of the ten countries studied. In Figure 18 little growth is apparent on this measure until the early 1990s, at which point it entered a period of very rapid growth. From 1970 to 1990, DMC per capita grew at under 0.9% p.a., while from 1990 to 2008 the rate was over 8.4%p.a. compounding, raising Viet Nam to around 80% of World average levels by 2008. The change in structure of Viet Nam's material flows between 1990 and 2008 is the most profound and rapid of any of the countries studied, with biomass decreasing from a 70% to 26% in just two decades. While the share of fossil fuels increased only marginally, from 5.3% to 5.8%, given the rapid rate of total growth in DMC, this corresponded to a sixfold increase in total volume. Both metal ores and construction minerals experienced rapid growth in share, which translated to increases in total volumes of over 31 times and 14 times respectively. A feature which is notable by its absence is any clear impact of the AFC. In this regard it resembles China more than the other South East Asian nations. The PTB panel shows that Viet Nam has gone from being a net importer of fossil fuels to a net exporter. Reference to the online 11 category database shows that while Viet Nam was a net exporter of coal for the whole 1970 to 2008 period it also became a net exporter of petroleum from 1991, and remained so until the end of the period. The reduced net exports of fossil fuels in 2008 come in part from reduced DE of both petroleum and coal, but the largest contributing factor was rapidly increasing domestic demand. This suggests that Viet Nam may revert to being a net importer of fossil fuels in the near future.

MI for the period available starts high and remains static until the mid 1990s then increases even further, to be the worst of the ten countries studied. At nearly 13 kg/$US in 2008, it is four times the regional and over seven times the World average. It is important to note however that this increase in MI was largely driven by a massive increase in construction minerals, and this would be consistent with major investment made in infrastructure, which typically delivers major improvements in MI in the future as it enhances societies' capacity to add value to their material inputs. However, this trend may not materialize where a country focuses on developing a large, export-oriented natural resources sector.

5 Drivers of material use patterns and material efficiency

A detailed discussion on the origins, rationale, and methodology of the IPAT identity and the way it has been applied is contained in the original report of resource efficiency for the region (UNEP 2011). It is applied again here in the same manner, with I = DMC, P = Population, A = GDP/capita, and T = MI. The time period covered has been extended here to almost four decades, and all values have been recalculated using the new, smaller set of countries with improved data quality. Importantly, the regional totals here also correct a misrepresentation in the earlier report[4]. The effect of this correction is that the already relatively small impact of improvements in $MI_{(T)}$ on reducing environmental impacts noted in the previous report (UNEP 2011) has decreased further, so that over most time periods T has actually exacerbated $DMC_{(I)}$ at the regional level, even though for most time periods a majority of individual countries have shown often quite strong improvements in $MI_{(T)}$. This is another manifestation of how the increasing share of regional GDP earned in lower efficiency/higher $MI_{(T)}$ countries within the region is outweighing the effect of improvements in $MI_{(T)}$ at the individual country level.

In Table 4, which covers 1970 to 1980, five out of the ten major countries covered show a decrease (i.e. improvement) in $MI_{(T)}$. The region as a whole also showed a modest decrease, the only period this happened. This modest decrease in $MI_{(T)}$ was far outweighed by increases in P and A, so that $DMC_{(I)}$ increased by around 50% over the period, with increasing A accounting for the largest portion of this increase. Very rapid rates of increase in A are notable for China and most countries in Southeast Asia, while population growth is most rapid in Pakistan. For three countries (Australia, India, and Pakistan) growth in P is the most important driver. The combination of rapidly increasing P, A, and $MI_{(T)}$ in Malaysia over this period gave it by far the highest increase of $DMC_{(I)}$ over the

Table 4 **Major drivers of the change in domestic material consumption for the 10 largest consumer nations in Asia-Pacific region over the period 1970–1980**

							SHARE CONTRIBUTION USING LOG TRANSFORMS		
	Δ $DMC_{(I)}$	Δ $DMC_{(I)}$ (tonnes)	$\Delta I_C/\Delta I$ [5]	ΔP	ΔA	Δ $MI_{(T)}$	P	A	$MI_{(T)}$
Australia	36%	115,672,573	1.00	17%	15%	1%	52%	44%	4%
China	91%	1,573,721,266	1.00	20%	53%	4%	28%	65%	6%
India	21%	279,412,702	1.00	26%	8%	-10%	119%	38%	-58%
Indonesia	41%	123,242,498	1.00	25%	70%	-34%	65%	153%	-119%
Japan	25%	336,685,032	1.00	12%	38%	-19%	51%	146%	-97%
Malaysia	170%	71,916,624	1.00	27%	68%	27%	24%	52%	24%
Pakistan	35%	70,537,351	1.00	37%	16%	-14%	102%	48%	-50%
Rep of Korea	82%	109,502,772	1.00	19%	69%	-10%	30%	87%	-17%
Thailand	83%	101,958,817	1.00	27%	53%	-6%	40%	70%	-10%
Viet Nam	24%	16,631,029	NA	26%	NA	NA	108%	NA	NA
Asia-Pacific	50%	3,114,312,314	1.00	23%	28%	-4%	50%	60%	-11%
World	32%	7,919,652,804	0.99	21%	21%	-10%	68%	70%	-38%

4 In addition using a larger set of countries for regional totals than the current report, the UNEP 2011 report's regional T value was calculated including the whole former USSR over early periods, and removing most of the USSR post dissolution (only Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan were retained). This gave an artificially high rate of apparent improvement in T for the Asia-Pacific region as a whole. This did not affect any individual country or sub-regional values.

5 Each of the values I, P, A, & T in the tables are determined independently. I for a region will include all DMC data available for each year / country data point in that region, however A & T will only include data for each year / country data point where both GDP and population, or DMC and GDP, are simultaneously available. This means that while I = PAT will hold strictly for individual countries, it will often not hold for multiple country regions, as regional values for I, P, A, and T can all come from slightly different subsets of country / year data points. The ΔIc/ΔI column here shows the ratio between the change in Ic (DMC) which would be calculated from P, A, and T, and that which has been directly compiled from base data. The extent to which this ratio differs from 1 indicates how strong this effect is for the period.

period. The lack of full data for Viet Nam over this period only allows us to deduce that its increased environmental impact over the period was slightly less than expected, ceteris paribus, from population increase alone, implying that either $MI_{(T)}$, A, or both decreased. None of the ten countries examined managed to reduce $DMC_{(I)}$, despite some strong individual decreases in T.

From 1980 to 1990, in Table 5 it is apparent that $DMC_{(I)}$ increased by 58%, with each of the three factors P, A, and $MI_{(T)}$ contributing to growth, and A becoming increasingly important relative to P. The Republic of Korea and Thailand show the greatest increase in $DMC_{(I)}$. In both cases, reference to the log transformed attribution in Table 3 indicates than over three quarters of this increase is attributable to increasing A. In Thailand's case this large growth in environmental impact came despite a modest decrease in $MI_{(T)}$. For Viet Nam it can be inferred from the (log) attribution of 53% to P, that A and $MI_{(T)}$ acting together accounted for nearly half of its 48.5% growth in $DMC_{(I)}$, but cannot attribute components separately to A and $MI_{(T)}$. Japan alone comes close to stabilizing its environmental impact, with growth in $DMC_{(I)}$ of only 1.5%, in large part due to a very large decrease in $MI_{(T)}$ of 31%.

It is for the period 1990 to 2000 that the importance of the changing shares of GDP earned in higher $MI_{(T)}$ countries becomes apparent. In Table 6 it is shown that despite quite strong decreases in individual $MI_{(T)}$ for seven of the top ten consumers, including all of the largest (China, Japan, India), $MI_{(T)}$ at the regional level became more important than P and comparable to A as a driver of $DMC_{(I)}$. Furthermore, even though this period takes in the AFC, and two of the top ten countries actually showed decreased $DMC_{(I)}$ (Thailand and Japan), growth in $DMC_{(I)}$ at the regional level continued unabated. Of the set of ten countries, only in Pakistan does growth in P remain the main driver of $DMC_{(I)}$. Viet Nam has the largest proportional increase in $DMC_{(I)}$, although it is coming off a very low base so total tonnages involved are relatively low. China posts the second highest growth rate for $DMC_{(I)}$, and having consistently posted growth of over 75% in the preceding periods, accounts for nearly two thirds of the regional increase in total tonnage terms.

Table 5 **Major drivers of the change in domestic material consumption for the 10 largest consumer nations in Asia-Pacific region over the period 1980–1990**

							SHARE CONTRIBUTION USING LOG TRANSFORMS		
	Δ $DMC_{(I)}$	Δ $DMC_{(I)}$ (TONNES)	ΔIC/ΔI	ΔP	ΔA	Δ $MI_{(T)}$	P	A	$MI_{(T)}$
Australia	53%	231,649,478	1.00	16%	20%	10%	35%	43%	22%
China	76%	2,498,626,023	1.00	16%	110%	-28%	26%	132%	-58%
India	62%	1,002,589,306	1.00	24%	38%	-5%	44%	67%	-11%
Indonesia	44%	185,646,879	1.00	21%	53%	-22%	52%	117%	-69%
Japan	2%	26,168,113	1.00	6%	39%	-31%	368%	2158%	-2425%
Malaysia	80%	91,419,428	1.00	32%	36%	1%	47%	52%	1%
Pakistan	59%	159,279,725	1.00	31%	41%	-13%	57%	74%	-31%
Rep of Korea	156%	380,312,800	1.00	12%	106%	11%	12%	77%	11%
Thailand	105%	234,949,075	1.00	20%	78%	-4%	25%	80%	-5%
Viet Nam	49%	42,167,419	NA	23%	NA	NA	53%	NA	NA
Asia-Pacific	58%	5,445,357,573	1.02	22%	31%	1%	41%	56%	3%
World	26%	8,544,041,368	0.99	19%	14%	-8%	76%	60%	-36%

Table 6 **Major drivers of the change in domestic material consumption for the 10 largest consumer nations in Asia-Pacific region over the period 1990–2000**

							SHARE CONTRIBUTION USING LOG TRANSFORMS		
	Δ $DMC_{(I)}$	Δ $DMC_{(I)}$ (TONNES)	ΔIC/ΔI	ΔP	ΔA	Δ $MI_{(T)}$	P	A	$MI_{(T)}$
Australia	41%	273,651,072	1.00	12%	23%	2%	33%	60%	6%
China	95%	5,512,745,379	1.00	11%	142%	-28%	16%	133%	-49%
India	41%	1,058,240,926	1.00	20%	42%	-18%	53%	104%	-57%
Indonesia	58%	353,991,470	1.00	16%	31%	5%	32%	58%	10%
Japan[6]	-5%	-79,850,356	1.00	3%	10%	-16%	-56%	-208%	364%
Malaysia	65%	132,830,655	1.00	29%	55%	-17%	50%	87%	-38%
Pakistan	31%	131,726,019	1.00	28%	15%	-11%	92%	53%	-45%
Rep of Korea	38%	234,802,804	1.00	10%	64%	-24%	29%	155%	-84%
Thailand	-13%	-59,166,277	1.00	10%	41%	-44%	-69%	-248%	417%
Viet Nam	151%	194,589,167	1.00	17%	77%	21%	17%	62%	20%
Asia-Pacific	57%	8,397,112,868	1.02	15%	18%	17%	31%	35%	34%
World	24%	9,797,934,834	1.00	15%	15%	-6%	66%	64%	-31%

Table 7 **Major drivers of the change in domestic material consumption for the 10 largest consumer nations in Asia-Pacific region over the period 2000–2008**

							SHARE CONTRIBUTION USING LOG TRANSFORMS		
	Δ $DMC_{(I)}$	Δ $DMC_{(I)}$ (TONNES)	ΔIC/ΔI	ΔP	ΔA	Δ $MI_{(T)}$	P	A	$MI_{(T)}$
Australia	12%	111,605,434	1.00	12%	15%	-13%	100%	125%	-125%
China	100%	11,266,439,041	1.00	5%	107%	-8%	7%	105%	-12%
India	45%	1,661,279,229	1.00	12%	58%	-18%	31%	123%	-54%
Indonesia	27%	263,621,025	1.00	11%	35%	-15%	42%	125%	-67%
Japan	-19%	-305,388,905	1.00	1%	10%	-26%	-3%	-46%	149%
Malaysia	39%	130,317,695	1.00	16%	28%	-7%	46%	75%	-21%
Pakistan	40%	225,847,341	1.00	20%	21%	-4%	55%	57%	-12%
Rep of Korea	4%	30,815,730	1.00	3%	36%	-26%	95%	877%	-872%
Thailand	39%	154,276,791	1.00	8%	34%	-4%	24%	89%	-13%
Viet Nam	124%	401,363,732	1.00	11%	61%	25%	13%	59%	28%
Asia-Pacific	61%	14,248,243,163	1.00	9%	26%	18%	18%	48%	34%
World	37%	19,074,496,272	1.00	10%	14%	10%	30%	42%	28%

In Table 7 it shows that for the latest period, $MI_{(T)}$ is making twice the regional contribution to $DMC_{(I)}$ of P, and over two thirds that of A. That this occurred despite moderate to strong decreases in $MI_{(T)}$ for nine out of ten individual countries helps underline the magnitude of the improvements in that would be $MI_{(T)}$ necessary to offset the changing distribution of production among countries. Regional $DMC_{(I)}$ grows faster than in any preceding period. In no country was P the main driver of $DMC_{(I)}$. China continued the rapid growth in $DMC_{(I)}$ which has characterized it for nearly four decades, and accounted for nearly 80% of the regional increase in $DMC_{(I)}$. In each period China's growing $DMC_{(I)}$ has been overwhelmingly driven by increasing A, with $MI_{(T)}$ acting to moderate growth in three of the four periods. Viet Nam continued to have the fastest relative growth in $DMC_{(I)}$, and continued to show a rapid increase in $MI_{(T)}$. This latter is interesting in constituting an unusually sustained and strong period of 'over-coupling', where economic growth is lower than growth in DMC.

6 In tables 6 and 7, some countries show a decrease in ΔI, indicated by –ve sign. For these cases, it should be remembered when reading the contributions of each component that the meaning of each number will be reversed from the usual, e.g. for Japan in Table 6, the -208% for A means that A still acted to increase I, while the 364% for T means that T again acted to reduce I.

5.1 Conclusions regarding IPAT analysis

In tracing the changing importance of P, A, and $MI_{(T)}$ over the four periods outlined above, several key points emerge. Firstly, population growth is now by far the least important driver of growing extractive pressures on the environment, so any efforts to stabilize $DMC_{(I)}$ will need to concentrate on either A or $MI_{(T)}$ as well. Secondly, growing affluence has been the most important driver in every period studied. While it may theoretically be possible to alleviate poverty without increasing GDP per capita in some wealthy countries, major countries in the region have such low GDP that even a perfectly even distribution of aggregate wealth would just leave everyone poor. Trying to reduce environmental impacts by reducing A would thus conflict directly with the region's most important political imperative, raising material living standards, and as such would be both undesirable and politically impossible. Finally, while there have been significant and ongoing improvements in $MI_{(T)}$ by a majority of individual countries, including those most important for material flows, the redistribution of industry away from countries with low $MI_{(T)}$ values to those with high $MI_{(T)}$ has led to aggregate regional $MI_{(T)}$ increasing rapidly over time. This ongoing deterioration in the role of $MI_{(T)}$, from moderating extractive pressures to exacerbating them, is particularly worrying as $MI_{(T)}$ is the 'lever' most often looked to as a politically viable path to secure sustainable development. This indicates that much stronger policies aimed at securing reductions in MI at a much greater and more consistent rate across whole the region would be required if we wish to reduce environmental impacts primarily via the technological/structural modernization route.

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This report is intended to supplement the original Resource Efficiency: Economics and Outlook for Asia and the Pacific report (UNEP 2011). The content is based on an updated material flows database which presents data up to 2008, and the onset of the Global Financial Crisis (GFC). The scope of this report is considerably narrower than the original report, focussing on deepening quantitative analyses specifically relating to primary material flows in the ten greatest resource consuming countries in Asia and the Pacific, and the trajectories of related resource efficiency indicators.

FOR MORE INFORMATION, CONTACT:

United Nations Environment Programme
Regional Office for Asia and the Pacific
U.N. Building 2 floor, Rajdamnern Nok Avenue
Bangkok 10200, Thailand
Tel: +662-288-2617/1133, Fax: + 662-280-3829
E-mail: uneproap@un.org
URL: www.unep.org/roap

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www.unep.org

United Nations Environment Programme
P.O. Box 30552 Nairobi, 00100 Kenya
Tel: (254 20) 7621234
Fax: (254 20) 7623927
E-mail: uneppub@unep.org
web: www.unep.org

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