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Policy perspectives towards a resource-efficient Asia-Pacific region

Matters pertaining to the Economic and Social Commission for Asia and the Pacific: policy perspectives on the environment and development in Asia and the Pacific

Sustainable management of natural resources in Asia and the Pacific: trends, challenges and opportunities in resource efficiency and policy perspectives

Note by the secretariat**

Summary

The present document includes an examination of how a focus on the sustainable management of natural resources and resource efficiency could present a strategic opportunity for countries in the Asia-Pacific region to realize high impact results in their efforts to achieve sustainable development.

Noting that the sustainable and efficient management of natural resources is a recurring and crucial aspect of the 2030 Agenda for Sustainable Development and other global agendas, the present document provides an updated review of trends, challenges and opportunities emerging from the use of natural resources in the region in recent years. The analytical work examines the relation among natural resource use (as captured by the concept of resource efficiency), well-being and other sustainable development aspects over the past decade and beyond. The findings are related to some of the drivers of resource productivity; and nine viable pathways to enable a transition towards resource efficiency at both macro and sectoral levels are identified. Delegates may wish to consider the progress made in the region and their aspirations for regional cooperation on the sustainable and efficient management of resources.

* E/ESCAP/MCED(7)/L.1.

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I. Sustainable management of the environment and natural resources in the context of the new development frameworks

1. In 2015 and 2016, countries agreed upon five major documents that provide concerted guidance for development in the years to come: the Sendai Framework for Disaster Risk Reduction 2015-2030, the Addis Ababa Action Agenda of the Third International Conference on Financing for Development, the 2030 Agenda for Sustainable Development, the Paris Agreement and the New Urban Agenda. In all of these documents the sustainable management of natural resources is emphasized and repositioned to be at the centre of social and economic development. In particular, the 2030 Agenda includes a declaration of determination to protect the planet from degradation, including through sustainable consumption and production and the sustainable management of its natural resources. All these international development frameworks include reaffirmations of the importance of the sustainable management of natural resources.

2. In the Sendai Framework priority areas, the need to strengthen the sustainable use and management of ecosystems and to implement integrated environmental and natural resource management approaches that incorporate disaster risk reduction are recognized. It also includes a call for the promotion of transboundary cooperation to enable policy and planning for the implementation of ecosystem-based approaches with regard to shared resources.

3. In the Addis Ababa Action Agenda, the need to protect ecosystems for the preservation of the planet and its natural resources, biodiversity and climate is emphasized. It contains a commitment to coherent policy, financing, trade and technology frameworks to protect, manage and restore ecosystems and to promote their sustainable use. It also contains a call for public and private investments in innovation and clean technologies, while noting that new technologies will not substitute for the necessary efforts to reduce waste or efficiently use natural resources. The fact that governments, businesses and households all need to change behaviours for resource efficiency, with a view to ensuring sustainable consumption and production patterns, is emphasized.

4. The Paris Agreement, while including an explicit call for developed and developing countries to conserve and enhance forests, sinks and other biological carbon reservoirs, also lists the sustainable management of natural resources as a way to build the resilience of socioeconomic and ecological systems. Also emphasized is the need to protect vulnerable ecosystems and to ensure food security, conservation and the sustainable management of forests in developing countries.

5. In the New Urban Agenda, the role of cities in leading the creation of more sustainable production and consumption patterns through resource-efficient infrastructure and ecosystems management is emphasized. The commitment to the sustainable use of resources and the protection of ecosystems reverberates throughout the vision of the New Urban Agenda, with special attention to environmentally sound management, recycling and the minimization of all waste, as well as systems that integrate urban and rural functions by leveraging proximity of resources, fostering equitable regional development across the urban-rural continuum.

6. In the 2030 Agenda, the fact that social and economic development depend on the sustainable management of the planet's natural resources is explicitly recognized. Calls for the prudent and efficient management of

natural resources and environmental capital are present throughout the 2030 Agenda; these will be instrumental in the achievement of the Sustainable Development Goals with their focus on conserving and responsibly using natural resources and providing opportunities to address the socioeconomic drivers of emissions and environmental degradation. A number of the Goals and their targets illustrate this:

- Goal 6 on water and sanitation and increasing efficiency in the use and management of water resources
- Goal 7 on affordable and clean energy, ensuring access to renewable energy, including advanced and cleaner fossil-fuel technology, and improving energy efficiency
- Goal 8 on decent work and economic growth, progressive improvement of resource efficiency in consumption and production and decoupling economic growth from environmental degradation
- Goal 9 on industry, innovation and infrastructure and making infrastructure and industries sustainable with increased resource-use efficiency
- Goal 11 on sustainable cities and communities, reducing the adverse environmental impact of cities, improving waste management and increasing the adoption and implementation of integrated policies and plans towards resource efficiency
- Goal 12 on responsible consumption and production and the sustainable management and efficient use of natural resources
- Goal 14 on life below water and Goal 15 on life on land, protecting marine and terrestrial resources, halting the loss of the environmental capital represented by biodiverse ecosystems and regulating their use in sustainable ways.

7. In addition, Goal 1 on ending poverty, Goal 2 on zero hunger and Goal 5 on gender equality are aimed at securing sustained and equal access for all to basic services and specifically mention land and natural resources; a healthy environment is considered a prerequisite for achieving the targets of Goals 1 and 3; education for sustainable lifestyles is a target of Goal 4 on quality education; and one of the aims of Goal 17 on partnerships is to strengthen the opportunity to develop, transfer and disseminate environmentally sound technologies as a means of implementation.

8. The overall framing of the global development agendas provides an opportunity for the Asia-Pacific region to centre the environment in national and regional sustainable development strategies, especially through the sustainable management of natural resources. The implementation of the Sustainable Development Goals can provide a critical opportunity to invest in processes and policies that could trigger a shift in productivity and resource use for a sustainable future. Recognizing that natural resources are intrinsically interlinked, as are the Sustainable Development Goals, and that pathways and policies designed to accomplish one Goal may either enhance or hinder progress towards others, regional actions will need to be concerted across the whole spectrum of the global agendas and involve different sectors.

II. Overview of the state of resource use in the Asia-Pacific region and trends and implications for sustainable development

9. Sustainable management of natural resources refers to a set of policies and practices that are employed to use natural resources in a way, and at a rate, that promotes the resilience of the ecosystems providing those resources and ensures that they are available in quantity and quality levels to cover the needs of future generations. The results are reflected in the health of ecosystems and the utilization rate of natural resources. Resource efficiency is one of the most important approaches to promote the sustainable management of natural resources and measure the results of related policies and practices. Resource efficiency is a macroeconomic concept referring to the ability to create more goods and services, more wealth and human well-being, with less input of natural resources and with lower emissions.

10. In the rapidly growing developing countries of Asia and the Pacific, resource use and emissions are increasing, thereby intensifying risks and vulnerabilities that are already leading to the depletion of ecosystems. Resource efficiency can contribute to the mitigation of these risks, including economic ones related to the volatility of resource prices or dependence on external resources, and social ones linked to competing demands for access to natural resource endowments. Resource efficiency can also constitute a way to reframe environmental challenges as opportunities for further technical progress, innovation and industrial competitiveness. Achievements in resource efficiency are fundamental to future economic prosperity and human well-being in Asia and the Pacific, and this is clearly reflected in the Sustainable Development Goals, as most of the targets related to the sustainable management of natural resources specifically focus on resource efficiency. Measuring resource efficiency requires data and information on natural resources use and on economic development.

11. There are different ways to measure natural resource use. Domestic material consumption and a material footprint are two commonly used measures. The domestic material consumption of an economy is its material usage mainly for production purposes. It captures the amount of materials extracted from nature, plus imports and minus exports. It comprises four main categories of materials, namely, biomass, fossil fuels, metal ores and non-metallic minerals.[1]

12. Countries can outsource material-intensive production to other countries to meet their consumption demands and record a low domestic material consumption. Therefore, to get a more complete picture of the total material resources that go into meeting a country's consumption demand, a material footprint measure is used to complement the domestic material consumption. The material footprint adds the material inputs that were required to produce imported goods, for example the by-products of imported televisions (such as scrap metals, by-products of metal production and scrap plastics), plus domestic extraction and subtracts the by-products of exports. The material footprint can be understood as the attribution of global material extraction used to meet the domestic final consumption demand of a country.

13. Resource efficiency is quantified as the difference of resource intensity over time. Resource intensity measures how much resource usage (measured in terms of domestic material consumption, material footprint, energy or water)

[1] See https://unstats.un.org/sdgs/files/metadata-compilation/Metadata-Goal-12.pdf.

is used per unit of gross domestic product (GDP). Therefore, if the resource intensity of an economy declines from one period to another, the economy is said to gain resource efficiency. This means that the economy is now able to produce the same unit of output (measured by GDP) with less use of material (measured by domestic material consumption or material footprint) or other resources (energy, water and land).

14. GDP[2] is a limited measure of development, and resource efficiency indicators based on GDP inherit those limitations. The Economic and Social Commission for Asia and the Pacific (ESCAP), in *State of the Environment in Asia and the Pacific 2005*, highlighted the need to measure broader eco-efficiency indicators that entail a more holistic view of the use of environmental resources, such as the rate of resource savings or benefit accumulation, and that are adjusted for the limitations of the natural resource endowment, such as the pressure on environmental absorptive capacity. However, lack of comparable cross-country data limits the usage of such indicators.

15. Another important measure of the results of resource efficiency policies and practices is decoupling. Decoupling or delinking resource use from economic growth signals increasing resource efficiency. A decoupling factor (see box 1) helps to quantify decoupling of resource use and GDP over specific time periods. Relative decoupling occurs between the specific period under consideration when the factor is between 0 and 1 (1 indicates maximum decoupling) and negative values of the factor indicate recoupling between resource use and economic activity.

16. The indicators of resource efficiency used in this analysis follow the 2030 Agenda indicator framework. Specifically, the indicators proposed as part of Goal 12, namely domestic material consumption per capita, material footprint per capita, domestic material consumption per GDP and material footprint per GDP are the key resource efficiency indicators used in the present document. In addition, considering the importance of energy as a resource, total primary energy supply per capita and total primary energy supply per GDP are also used as indicators in relevant sections. These indicators are part of the Goal 7 target of doubling the global rate of improvement in energy efficiency by 2030.

[2] All GDP values used in the document are measured in United States dollars at constant 2005 prices.

Box 1
Definitions: resource productivity, intensity and efficiency

Resource productivity (RP): Productivity is a term used in relation to the production of economic output (normally measured in monetary terms) by an input. Hence material and energy productivity are the economic output, Y, per unit of natural resource input, M (for example domestic material consumption, material footprint or energy). Therefore, material productivity in year i is RP(i) = Y(i)/M(i).

Resource intensity (RI): Resource intensity is the inverse of resource productivity; therefore, it measures how much material input (M(i)) has gone into per unit of economic output (Y(i)). Therefore, resource intensity in year i is RI(i) = M(i)/Y(i).

Resource efficiency (RE): In this analysis, resource efficiency improvements refer to a reduction in resource intensity of economic output (domestic material consumption per GDP, material footprint per GDP or total primary energy supply per GDP). Therefore, resource efficiency improvement over year i to year k is referred to as RI(i) > RI(k). This implies that each unit of economic output in year k contained less material input when compared to year i.

Decoupling factor: Decoupling factor to measure decoupling between period 0 and period t is defined as follows

$$\text{Decoupling Factor (period } 0-\text{t)} = 1 - \frac{\frac{resource\ use(t)}{resource\ use\ (0)}}{\frac{output\ (t)}{output\ (0)}}$$

Source: Adapted from United Nations Environment Programme, *Resource Efficiency: Potential and Economic Implications. A report of the International Resource Panel* (n.p., 2017) and Organization for Economic Cooperation and Development, "Indicators to measure decoupling of environmental pressure from economic growth", 2010. Available from http://www.oecd.org/environment/indicators-modelling-outlooks/1933638.pdf.

17. The following section uses a data set from 25 countries[3] in the Asia-Pacific region to trace trends in resource use and resource efficiency for the period 1990-2015. These are the only countries in the region for which comparable data on material resources is available for the full period. However, this group of countries constitutes 80 per cent of GDP of the Asia-Pacific region and 90 per cent of its population and is therefore representative of the region. The analysis starts with an overall measure of resource use and efficiency to give an overall picture of the trends in the region. It then shows the relationship of resource efficiency measures to human development indicators and selected Sustainable Development Goal targets on access to

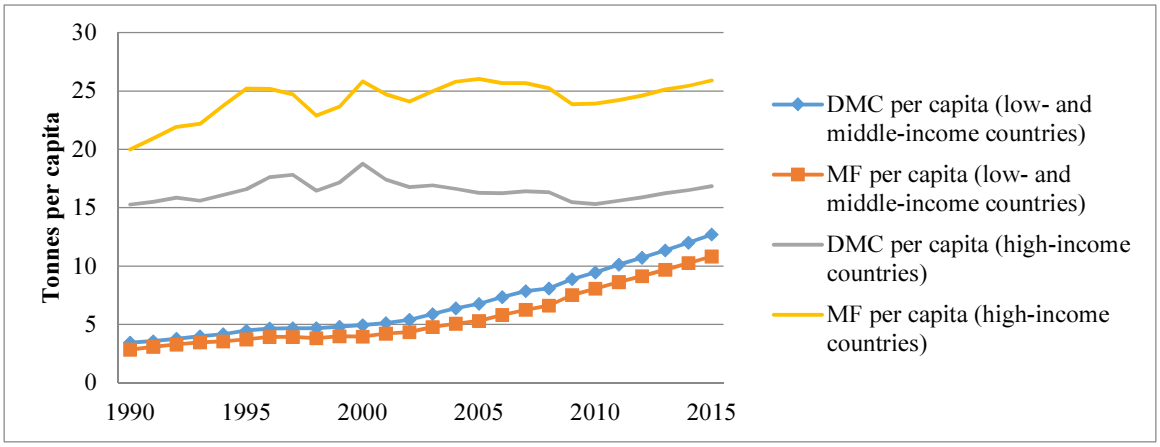
[3] Low and middle income countries: Afghanistan; Bangladesh; Bhutan; Cambodia; China; Fiji; India; Indonesia; Lao People's Democratic Republic; Malaysia; Maldives; Mongolia; Myanmar; Nepal; Pakistan; Papua New Guinea; Philippines; Sri Lanka; Thailand; and Viet Nam. High income countries: Australia; Japan; New Zealand; Republic of Korea; and Singapore.

water, energy, climate change and waste management.[4] This data analysis reveals important findings leading to some key policy pathways and options for regional cooperation to promote resource efficiency. By analysing these trends and providing evidence of linkages between resource efficiency and sustainable development, a case for focusing on resource efficiency approaches and policies can be built.

A. Overall trends in resource use and efficiency

18. From 1990 to 2015, most countries in the region recorded significant increases of resource use both in absolute and per capita terms. There is considerable difference in levels of resource usage between high-income countries and other countries in the region, but this gap is shrinking rapidly, especially in terms of domestic material consumption per capita. During this period, domestic material consumption per capita in the low- and middle-income countries increased 270 per cent, while that of high-income countries increased 10 per cent. Material footprint per capita saw an increase close to 280 per cent for low- and middle-income countries and 29 per cent for high-income countries (figure I).

Figure I
Trends in material use



Source: ESCAP calculations, using data from ESCAP Statistical database. Available from http://data.unescap.org/escap_stat/ (accessed 12 June 2017).

Abbreviations: DMC, domestic material consumption; MF, material footprint.

19. The emergence of China as the "world's factory" is reflected in its rising share of resource consumption. For example, China's share of the total domestic material consumption of the region increased from 38 per cent in 1990 to 67 per cent in 2015. The region accounted for approximately 60 per cent of global domestic material consumption and 55 per cent of global material footprint[5] but only 32 per cent of global GDP in 2015. These aggregate figures reveal that the region is highly resource inefficient compared to the rest of the world. However, this also presents the opportunity to make significant gains by improving resource efficiency.

[4] The correlations, unless otherwise stated, are based on panel data estimations for the full sample with appropriate country-specific fixed effects, with a minimum 90 per cent level of confidence.

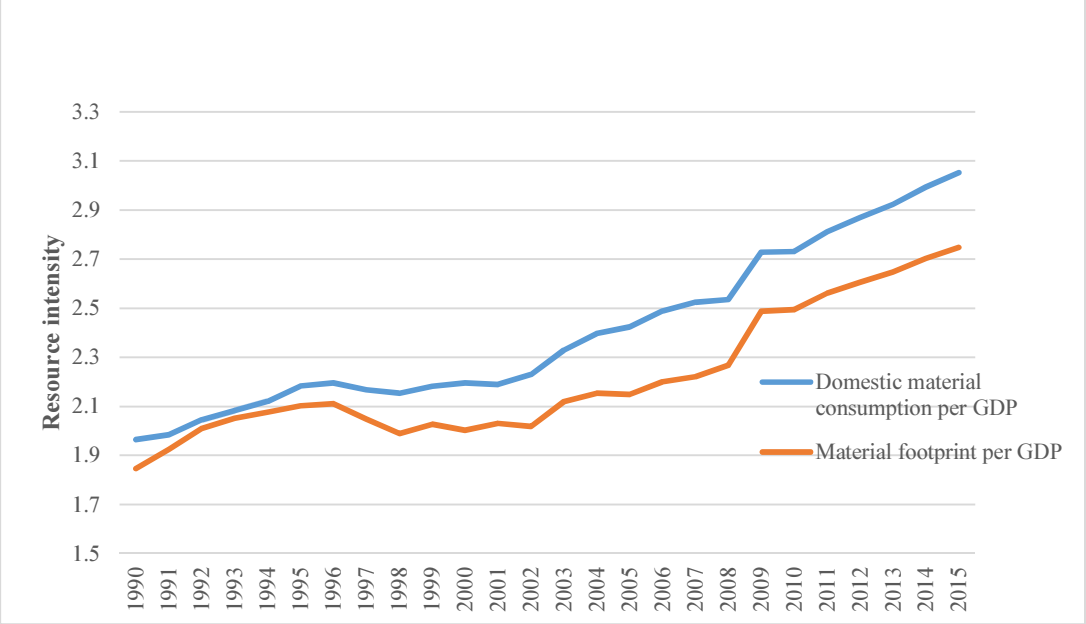
[5] This data is for 2010 due to limited availability of globally aggregated material footprint and domestic material consumption data.

20. The construction and manufacturing sectors contribute the most to the material footprint, followed by the services and agricultural sectors. The relatively high material footprint of the services sector implies that a transition to a services dominant economy will still generate a substantial material footprint. In terms of the actual constituents of the material footprint, minerals and biomass constituted the majority, followed by fossil fuels and metals.

1. Trends in resource efficiency

21. Figure II shows trends in resource intensity between 1990 and 2015. Though the region made some resource efficiency gains in that period (as shown by a reduction in resource intensity), those gains slowed in the early 2000s. In fact, resource efficiency has been declining in the region ever since. This can be attributed to the reduced share of economic activity in highly resource-efficient economies such as Japan. In fact, ESCAP and the Asian Development Bank (ADB) highlighted in *Green Growth, Resources and Resilience: Environmental Sustainability in Asia and the Pacific* that the rapid increase of material intensity of the Asia-Pacific region during 2000-2005 had resulted in a global increase of resource intensity. As shown in figure II, the rapid rise in resource intensity continued after 2005. In addition, when compared to 2005-2010 levels, there were further resource efficiency losses in the region during 2010-2015, with resource intensity increasing from a five-year average of 2.6 to 2.9 (in terms of domestic material consumption per GDP) and from 2.3 to 2.6 (in terms of material footprint per GDP). Also, the region is the most resource-inefficient geographic region in the world (measured in terms of material footprint per GDP).[6] These trends highlight the urgent need for policies to promote resource efficiency.

Figure II
Trends in resource intensity
(Kg per United States dollar)



Source: ESCAP Statistical database (see figure I).

Note: The aggregated value is weighted using GDP.

[6] Based on 2010 data as comparable data for the other regions are available.

22. However, resource efficiency gains in the energy sector in the region continue to accelerate. Energy intensity has been decreasing, with a steep decline from 222 kg of oil equivalent/$1,000 GDP in 1990 to 145 kg of oil equivalent/$1,000 GDP in 2014. Overall, energy intensity has declined in all productive sectors, with the residential sector a notable exception. Despite this progress in resource efficiency, the Asia-Pacific region has the highest energy intensity compared to other regions in the world.[7]

2. Decoupling resource use and economic growth

23. Between 1990 and 2015, there was very little evidence of any significant decoupling (a decoupling factor close to 0) for material use in terms of domestic material consumption and the material footprint, but decoupling was relatively stronger for energy. However, there seems to be an alarming general tapering away of decoupling and a shift to recoupling for the period 2010-2015. For example, in terms of domestic material use, 19 out of 25 countries in the sample showed signs of decoupling during 1990-1995; this number dropped to just 10 countries in 2010-2015. Also, in terms of overall material footprint, between 1995 and 2000, 21 countries showed decoupling trends, but between 2010 and 2015 only 10 countries seemed to be on the path of decoupling. These trends cause concern and need to be analysed in greater detail. However, in terms of energy consumption, the Asia-Pacific region has decoupled energy consumption from GDP growth.[7]

B. Links between resource efficiency and sustainable development

1. Resource efficiency and human development

24. Resource efficiency has broader implications for human development and sustainable development. Material use is required to create infrastructure and other input flows that are critical for sustaining healthy and high-quality livelihoods. The relationship between material use and human development has not been adequately studied,[8] and in particular the question of whether resources are being used in an equitable way to benefit people requires further investigation.[9] The association between resource efficiency in terms of material use and human development also remains underexplored. This section provides a preliminary exploration of these relationships.

25. In this section, the human development index is used as a measure of human development and an approximation of well-being. The human development index integrates three key aspects of human development, namely, life expectancy, education and per capita income. Figure III shows the relationship between material consumption per capita and the human development index. As expected, a higher material footprint per capita is required to achieve higher human development index levels. The figure also indicates diminishing returns to scale in terms of domestic material use and associated levels of the human development index. This implies that,

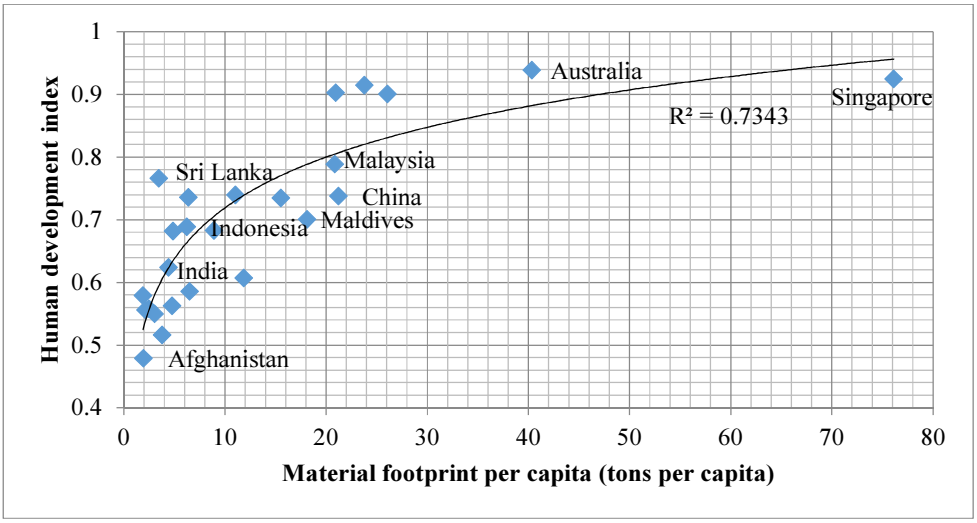
[7] Regional Cooperation for Sustainable Energy in Asia and the Pacific (United Nations publication, Sales No. E.17.II.F.10). Available from http://www.unescap.org/sites/default/files/publications/REGIONAL%20COOPERATION%20FOR%20SUSTAINABLE%20ENERGY%20IN%20ASIA%20AND%20THE%20PACIFIC.pdf.

[8] United Nations Environment Programme, *Global Material Flows and Resource Productivity Report* (Paris, 2016).

[9] ESCAP, ADB and United Nations Environment Programme, *Green Growth, Resources and Resilience: Environmental Sustainability in Asia and the Pacific* (ST/ESCAP/2600).

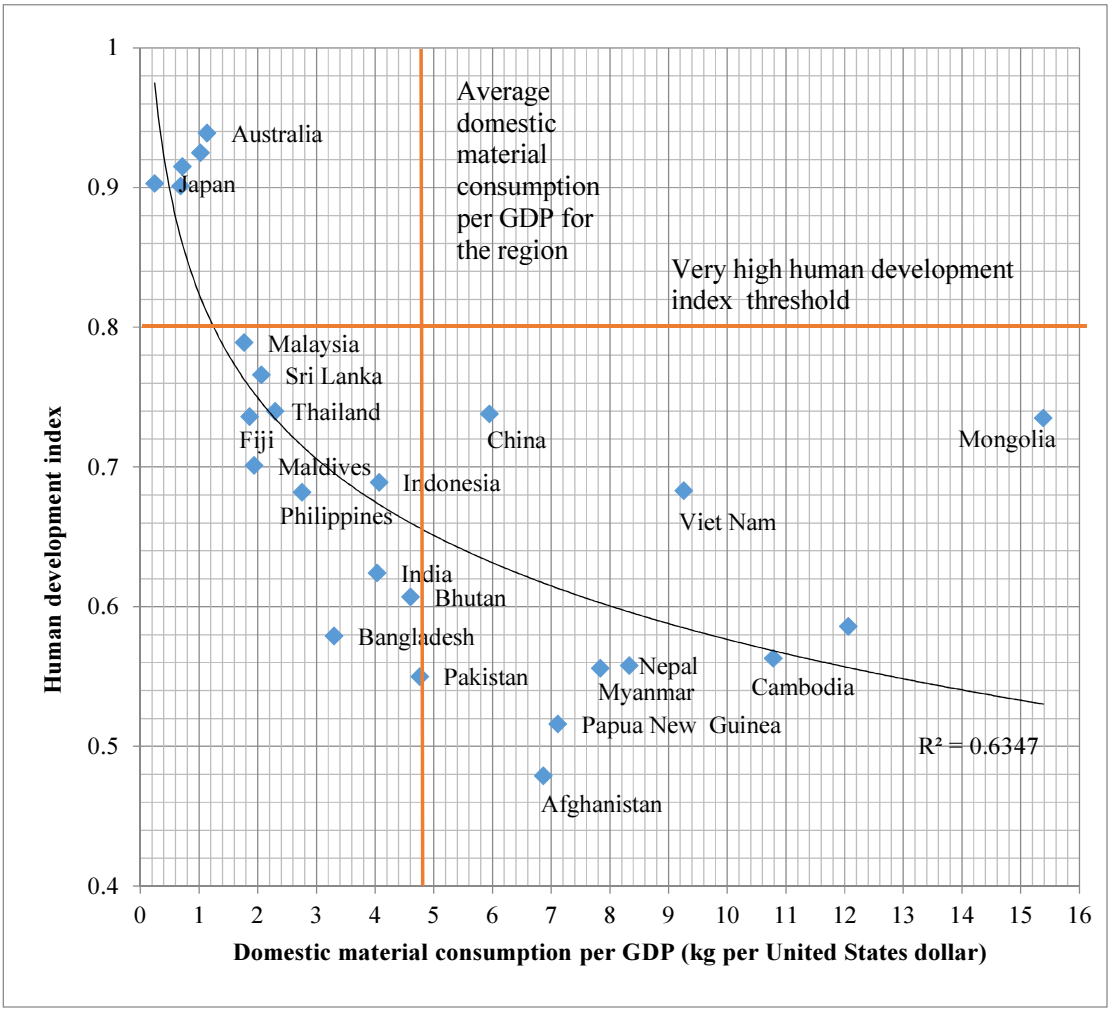
on average, as countries graduate to medium and high thresholds, even significant increases in material resources per capita contribute to only marginal improvements on the human development index.

Figure III
Human development index and material footprint per capita, 2015



Source: ESCAP Statistical database (see figure I).

Figure IV
Human development index and domestic material consumption per GDP, 2015



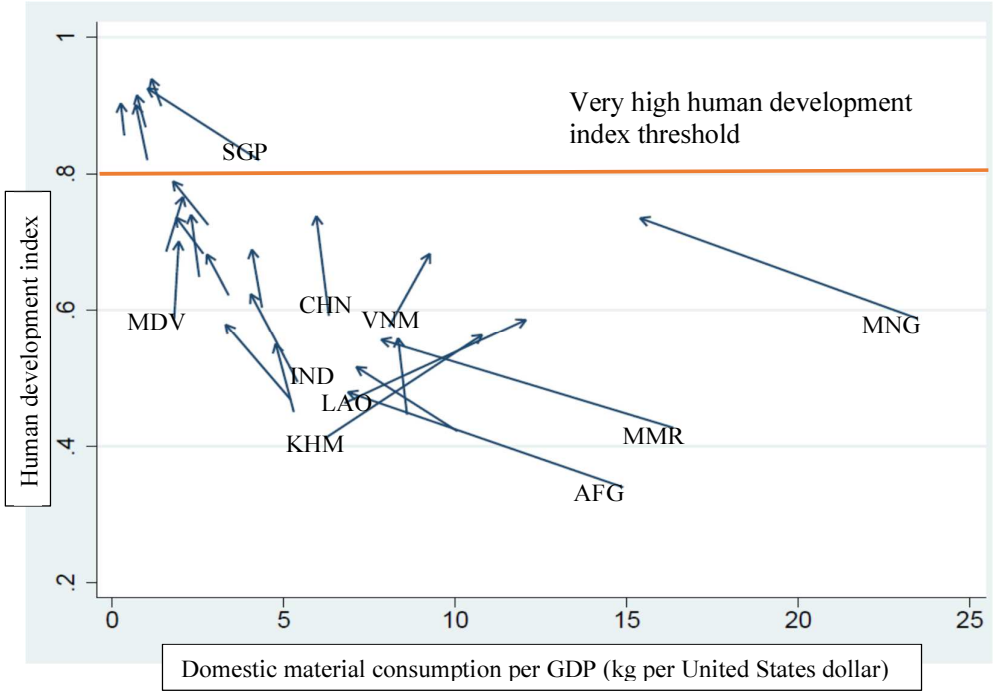
Source: ESCAP Statistical database (see figure I).

26. When analysing the linkages between resource efficiency and the human development index, some further interesting patterns emerge (figure IV). In general, only countries with very high resource efficiency also passed the very high human development index threshold (index value of 0.8). In the sample analysed, there is a very significant correlation between the human development index and resource efficiency for the period 1990-2015. Though it could be argued that this relationship is driven by the income component, which can jointly influence both resource efficiency and the human development index, the correlation remains significant despite explicitly controlling for income. Therefore, the relationship between resource efficiency and development indices such as the human development index needs to be studied further to explore the direction and mechanisms of causality.

27. Furthermore, some interesting patterns emerge while exploring the transition paths along both human development index and resource efficiency dimensions. Most countries that made improvements to their resource efficiency made simultaneous improvements in terms of the human development index, across all levels of the human development index. In figure V, these transitions are represented by a move towards the upper left quadrant. The majority of the transition paths of the sample countries was

towards this optimal direction in terms of improving both resource efficiency and the human development index, with some exceptions in countries such as Cambodia, Lao People's Democratic Republic and Viet Nam, which are notably three of the new emerging production hubs of Asia.[10] This raises the question of whether the manufacturing centres moving to these countries from more developed regions are more resource inefficient and carry higher environmental stress. Also, the fact that these countries made significant improvements in the human development index despite the loss in resource efficiency suggests the need to broaden the scope of development indices like the human development index to integrate the environmental dimension.[11]

Figure V
Transitions in the human development index and domestic material consumption per GDP, 2000 to 2015



Source: ESCAP Statistical database (see figure I).

Abbreviations: AFG, Afghanistan; CHN, China; IND, India; KHM, Cambodia; LAO, Lao People's Democratic Republic; MDV, Maldives; MMR, Myanmar; MNG, Mongolia; SGP, Singapore; VNM, Viet Nam.

2. Resource efficiency and selected Sustainable Development Goals

28. Resource efficiency also has implications for several Sustainable Development Goals that do not directly deal with sustainable consumption and production. The linkages to targets on education and health were already highlighted in the section on the human development index. Increased resource use per capita seems to be associated with higher achievements with regard to

[10] Karl Lester M. Yap, "Asia's smallest economies among its fastest growing", 13 January 2017. Available from https://www.bloomberg.com/news/articles/2017-01-12/asia-s-smallest-economies-are-among-its-fastest-growing.

[11] Norma Maccari, "Sustainable human development: human development index and the environment", *International Journal of Sustainable Human Development*, vol. 2, No. 1 (April 2014), pp. 29-34.

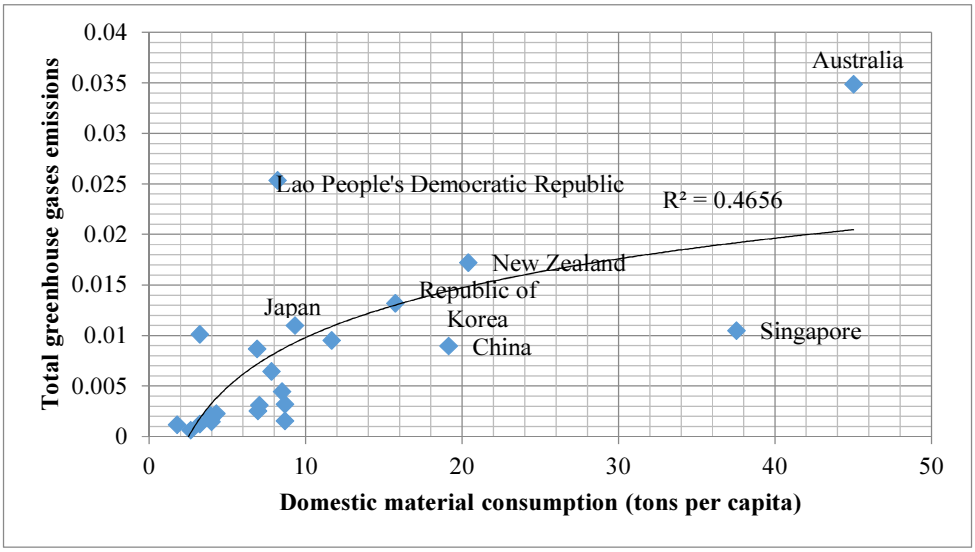
the targets on increased access to water, electricity and sanitation. However, this increase seems to have diminishing returns similar to the situation with the human development index. Further, a strong positive correlation between resource efficiency and access to water and sanitation (Goal 6) and electricity (Goal 7) can be seen in the region. This holds even after controlling for income, implying that the result is not driven by it. Therefore, improvements in resource efficiency could also pave the way for accelerated achievements for targets on water, sanitation and energy. However, the exact mechanism of potential impact of resource efficiency on these and other Sustainable Development Goal targets needs to be studied further.

29. Resource efficiency can also open new pathways to climate change mitigation and climate resilience.[12] Per capita usage of resources is highly correlated with total greenhouse gases emissions (figure VI). Hence, higher dependence on material use has strong repercussions in terms of the cost of climate change (represented by greenhouse gases emissions). While there is a positive and significant relationship between greenhouse gases per capita and resource efficiency in terms of materials, the magnitude of this relationship is weak. One per cent improvement in resource efficiency seems to be associated with only a 0.3 per cent decrease in greenhouse gases emissions per capita in the sample.[13] Therefore, resource efficiency improvements, though significant, would not be sufficient for the climate change mitigation ambitions of the Paris Agreement. In fact, some of the highest resource-efficient economies of the region still have very high per capita emissions. However, energy efficiency has been found to have a larger impact on emissions. The International Energy Agency has estimated that 40 per cent of the emissions savings needed to meet the targets of the Paris Agreement by 2050 could be generated by energy efficiency.[7] Therefore, strategies to improve resource efficiency would have to form part of a broader spectrum of climate change mitigation policies.

[12] United Nations Industrial Development Organization, “Resource Productivity for Climate Action”, 2010. Available from http://www.unido.org/fileadmin/user_media/Services/Environmental_Management/Cleaner_Production/Resource_productivity_Climate_Action.pdf.

[13] A panel data regression was conducted to estimate the model log (greenhouse gases per capita) = a (log (domestic material consumption per GDP)) + b(log(GDP)) + constant. The elasticity of the relationship between greenhouse gases per capita and resource efficiency (measured by b) is 0.3.

Figure VI
Greenhouse gases emissions and resource usage per capita, 2011



Source: ESCAP Statistical database (see figure I).

III. Drivers of resource efficiency and policy pathways to enable the transition to resource efficiency

30. The review in the previous section of resource efficiency trends in the region can be used to derive some important messages to inform recommendations on policy pathways to enable the transition towards the sustainable management of natural resources and improvements in resource efficiency. A key message is that the low levels of resource efficiency allow for a considerable scope for improvement and gains within the region. Given the high levels of the material footprints of developed countries of the region arising from their consumption patterns, resource efficiency improvements require joint efforts by both developed and developing countries.

31. Global studies have analysed the key determining factors of resource productivity (inverse of resource intensity), highlighting income, population density, technology, economic structure, energy structure and trade of raw materials. In this section, a cross-country multivariate regression for the period 1990-2015 is used to derive some of the macro level socioeconomic drivers of resource productivity.

Box 2
Analytical framework to find the determinants of resource productivity

A panel data fixed effects model was used to determine the statistical significance of some of the key socioeconomic factors[a] of the resource productivity of the sample for the period 1990-2015 (650 observations). This empirical model is derived from a study[b] which uses a simulation-based modelling approach to determine the key socioeconomic factors driving resource productivity at the global level. The factors identified through this approach are used in the estimation of the following empirical model:

$$Resource\ productivity_{it} = \alpha_0 GDP + \alpha_1 Share\ of\ manufacturing\ in\ GDP + \alpha_2 share\ of\ services\ in\ GDP + \alpha_3 share\ of\ renewable\ energy\ in\ total\ energy\ consumption + \alpha_4 share\ of\ mineral\ exports\ in\ total\ exports\ revenue + \alpha_5 share\ of\ agricultural\ raw\ materials\ and\ mineral\ in\ total\ imports + \alpha_6 population\ density + \varepsilon_{it}$$

[a] The World Bank, World Development Indicators database. Available from http://data.worldbank.org/data-catalog/world-development-indicators (accessed 12 June 2017).

[b] Yu Gan and others, "How to deal with resource productivity?", *Journal of Industrial Ecology*, vol. 17, No. 3 (3 January 2013).

32. Using the analytical framework presented in box 2 and building on the findings from the previous analyses in the present document, the following section includes a discussion of nine broad policy pathways that can be used to promote resource efficiency. These policy pathways are clustered at the macro and sectoral levels, suggesting the need for actions at all levels to drive resource efficiency. Concrete examples from the region (from both developed and developing countries) are given, suggesting that these policy pathways provide opportunities for sharing experiences and regional cooperation.

A. Macro level policy pathways

33. The transition to resource efficiency requires action starting at the very highest levels of policymaking. These macro level pathways will be fundamental in providing the required policy coherence and enabling frameworks in the transition to resource efficiency. They will be crucial in integrating the three dimensions of sustainable development.

1. Integrating resource efficiency targets within national development agendas

34. Integrating resource efficiency goals as an important guiding principle within national development frameworks is central to facilitating transformations towards more efficient use of resources. Several countries in the region have already taken steps in this direction. For example, the Government of China integrated specific targets on resource efficiency within its twelfth and thirteenth five-year plans.[14] The New South Wales government in Australia

[14] United Nations Environment Programme, *Capacity Building and Policy Needs Assessment for Sustainable Consumption and Production* (Bangkok, 2013). Available from www.switch-asia.eu/fileadmin/user_upload/RPSC/policy-assessment/Needs-Analysis-Final-report.pdf.

adopted a Government Resource Efficiency Policy that focuses on energy, water, clean air and waste management and is mandatory for general government sector agencies, while other entities are strongly encouraged to adopt the policy.[15] Establishing an appropriate institutional system to follow up and coordinate across ministries on these broad national resource efficiency targets is also important. The roles of the different ministries in facilitating the achievement of these targets need to be made clear and be identified at the outset to facilitate enhanced policy integration. By reviewing the progress in the attainment of these national-level targets, countries can measure the effectiveness of the existing policy mix in terms of promoting overall resource efficiency.

2. Establishing targeted legal and regulatory measures to enforce resource efficiency standards

35. In many cases it is important for governments to adopt legal and regulatory measures to achieve resource-use efficiency, especially by limiting inefficient usage of resources. There are several examples from the region of countries adopting this approach.[14] For example, Singapore has been a pioneer in setting and enforcing mandatory green building standards for resource efficiency in both new and existing, public and private buildings since 1979. The Philippines and Malaysia also have established resource efficiency standards for buildings.[16] Several countries have also imposed laws related to extended producer responsibility for certain products; these laws require producers to make provisions for the collection, reuse and recycling of products when they lose their consumer properties. For example, Japan instituted extended producer responsibility regulation on packaging materials in 1995.[17] Many developing countries in the region are introducing extended producer responsibility regulations in the electronic goods sector. In several cases countries in Asia and the Pacific have instituted national regulations on cleaner production to reduce industrial emissions and waste and to improve resource efficiency. The Government of China has instituted a national system of legislation, rules and regulations that led to the adoption of a compulsory national cleaner production audit system that has been in place for more than 10 years. The direct economic benefits from this system is estimated to be more than $3 billion annually.[18]

36. Green public procurement is another example of promoting resource efficiency via regulatory frameworks. The Government of Japan has a long-standing official policy to promote the procurement of eco-friendly goods and services by the state and other entities (Act on Promoting Green Procurement). The Government of India has recommended legislation to establish provisions

[15] New South Wales, Office of Environment and Heritage, "Government Resource Efficiency Policy (GREP)" (29 March 2017). Available from www.environment.nsw.gov.au/government/policy.htm.

[16] United Nations Development Programme, *Promoting Energy Efficiency in Buildings: Lessons Learned from International Experience* (New York, 2010). Available from www.thegef.org/sites/default/files/publications/EEBuilding_WEB_2.pdf.

[17] Hajime Yamakawa, "The EPR for packaging waste in Japan" in *Extended Producer Responsibility: Updated Guidance for Efficient Waste Management*, Organization for Economic Cooperation and Development, (Paris, 2016). Available from www.oecd-ilibrary.org/docserver/download/9716061ec018.pdf?expires=1499159024&id=id&accname=ocid195767&checksum=45B655C7AE463CE6BD533B19C7F8F15A.

[18] Duan Ning and others, "Analysis on Cleaner Production policy and its results in China", 2009. Available from www.advancesincleanerproduction.net/second/files/sessoes/4a/1/D.%20Ning%20-%20Relatorio%20-%204A-1.pdf.

and institutional arrangements to encourage the central Government to procure greener products and services. One important lesson from several regulatory attempts to improve resource efficiency is that they work best when they are accompanied by activities such as awareness-raising on the provisions in the law, wider information-sharing, and financial incentives to encourage enforcement in policy packages.[16]

3. Creating an overarching macroeconomic policy framework that promotes resource efficiency

37. An overarching macroeconomic policy framework that promotes resource efficiency is vital. Taxation policies, fiscal policies, including on government procurement, removal of subsidies and other measures that distort the price of natural resources, budgeting, investment policies and the social safety net are some of the key components of such a framework. Together, these macroeconomic policies define the incentive structure within an economy, which in turn determines the behaviour of both consumers and producers. It is important for these incentives to be aligned to promote the transition to resource efficiency.

38. Ten of the top twenty-five countries in the world that subsidize fossil fuel consumption belong to the region.[19] Fossil fuel subsidy reforms can enable huge resource efficiency gains. For example, the fossil fuel subsidy reform in the Islamic Republic of Iran, which involved a cut to fuel subsidies, a cash transfer program for households, and tax incentives for resource-efficient technologies, resulted in a 38 per cent reduction of gasoline and diesel consumption.[20] This underscores the need for simultaneous intervention through multiple policies. Taxing natural resource rents and providing simultaneous tax incentives to resource-efficient sectors could encourage a move to resource efficiency. However, it is important to mitigate the adverse welfare impact of any of these policies, especially on poor and vulnerable populations, through appropriate social safety net schemes (such as targeted cash transfers).

4. Promoting resource-efficiency-friendly financing frameworks

39. In the empirical model of determinants of resource productivity (see box 2), the income level (GDP per capita) of a country is positively and significantly related to resource productivity. What this result suggests is that strong financing mechanisms and financial resources underpin the transition to resource efficiency. Incremental costs in transferring to more efficient technologies or resource management tools often require upfront investments that may seem unattractive when weighed against business-as-usual approaches, especially as the use of traditional investment evaluation methods excludes environmental and social costs and benefits. Therefore, the availability of innovative financing mechanisms and integrated evaluation methods are important for upscaling and replicating resource-efficient practices. For example, the large-scale promotion of biogas plants in Viet Nam was made possible by harnessing global climate finance funds.[21] Another emerging source of finance is green bonds. The Governments of China, India and the Republic of Korea are leaders in the region in the use of green bonds to tackle sustainable development challenges and promote resource efficiency

[19] Asian Development Bank, *Fossil Fuel Subsidies in Asia: Trends, Impacts, and Reforms—Integrative Report* (Manila, 2016).

[20] ESCAP, "Environmental tax reform in Asia and the Pacific", April 2017. Available from www.unescap.org/sites/default/files/S2_Environmental-Tax-Reform.pdf.

[21] See www.snv.org/sector/energy/topic/biogas.

(especially in terms of energy usage).[22] Combining these finance mechanisms, de-risking, or providing guarantees with the help of public funds and grants can help to lower upfront investment costs and support the creation of a domestic market for sustainable solutions.

5. Re-evaluating trade portfolios and their implications for resource efficiency

40. The import and export portfolios of countries seem to have an impact on resource efficiency. For the sample of countries analysed (see box 2), a high dependence on ores export seems to be detrimental to resource productivity. This sends a clear message to economies with overdependence on primary exports to seek more productive use of minerals domestically. At the same time, dissimilar to global trends, where a heavier dependence on imported agricultural raw materials resulted in improved productivity, a heavier dependence on agricultural and other raw material imports (such as ores and metals) seems to negatively impact resource productivity in the countries of the Asia-Pacific region. This suggests that the region has not been converting its imported agricultural raw materials and other materials into value added products at the same level of resource productivity as other regions in the world. It also points to potential resource efficiency gains to be made in sectors that currently rely on imported primary raw materials for their production processes. Hence, countries need to re-evaluate their export and import portfolios and proactively seek opportunities to improve resource efficiency. Further, the analyses of the relationship between the human development index and resource efficiency trends in the region in the previous section reveal that some of the emerging production hubs in Asia managed to make gains in the human development index accompanied by a loss in resource efficiency. This raises the question of whether the manufacturing centres moving to these countries from more developed areas in the region are more resource inefficient and carry higher environmental stress. Therefore, countries need to evaluate the environmental implications of their location in global value chains and take adequate measures to address any elevations in environmental stress.

Sectoral policy pathways

41. Building on the strong foundations established by macro level policies, targeted sector-specific policy interventions are vital in enabling the achievement of resource efficiency. These sectoral policy pathways also promote participatory approaches to improving resource efficiency.

6. Mainstreaming resource efficiency targets within sectoral policies

42. Policies for the key sectors of the economy need to mainstream resource efficiency. For example, a sizeable proportion of the freshwater withdrawals in the region, approximately 70 per cent, is used for irrigated agriculture.[23] Hence, agricultural sector policies that explicitly promote more efficient use of water will have a substantial impact on the water-use efficiency in the region

[22] Asia Investor Group on Climate Change, "Investing for the climate in Asia", September 2016. Available from http://aigcc.net/wp-content/uploads/2015/12/AIGCC-final.pdf.

[23] Food and Agriculture Organization of the United Nations, "Successfully managing Asia's transitions to achieve food and nutrition security for all and build vibrant rural communities in a water-secure and prosperous Asia-Pacific Region: A white paper on water and food security in the Asia-Pacific" (Bangkok, 2015). Available from http://www.asia-water.org/images/Library/EFWSDoc/A%20White%20Paper%20on%20Water%20and%20Food%20Security%20in%20the%20Asia-Pacific.pdf.

as a whole. Incentivizing use of more resource-efficient agricultural practices and facilitating knowledge exchange[24] of best practices are examples of such policies. Manufacturing sector policies can be designed to mainstream resource efficiency. For example, the Government of India introduced a new certification scheme for manufacturing enterprises called "Zero Effect and Zero Defect". This scheme provides guidance to firms on how to reduce defects in production processes while ensuring minimum impact on the environment. Firms are assessed based on set criteria, which include sector-specific resource efficiency standards, and are given a performance rating.[25]

7. Leapfrogging to efficient technologies and improving innovation capacity

43. Technological advancement and improved innovation capacity are driving factors of resource efficiency. In the empirical model above (see box 2), a higher share of the manufacturing sector in the total economy seems to have a positive and significant impact on resource productivity. This increasing share of manufacturing represents a shift towards production structures that rely on advanced technologies as compared to an economy that is dominated by the agricultural sector. Adopting and leapfrogging to resource-efficient technologies would be a central component in the progress towards higher resource efficiency.

44. For the region, one important avenue of such technological leapfrogging is the transition to renewable energy sources. In the analytical framework in box 2, a transition to renewable energy sources is a significant determinant of improvements in resource productivity. The share of modern renewable energy sources is still relatively small in the region,[26] and this provides an important opportunity to use the transition to renewable energy as an impetus for resource efficiency. Many parts of Asia have already leapfrogged into more resource-efficient renewable energy technologies (especially solar-based).[27] At the same time, retrofitting (the addition of newer technology or features to older systems) resource-efficient technologies can be done in a whole array of activity domains, such as construction, building, transportation, manufacturing and utilities (such as water and energy). Even though resource-efficient technologies exist and are affordable, their widespread adoption might face several challenges, such as lack of awareness, technical know-how and functional markets as well as resistance to change. To overcome many of these challenges, public-private partnerships are crucial, for example because they could promote platforms to demonstrate and spread awareness of commercially viable resource-efficient technologies.

[24] Les Levidow and others, "Improving water-efficient irrigation: prospects and difficulties of innovative practices", *Agricultural Water Management*, vol. 146 (December 2014) pp. 84-94.

[25] See https://zed.org.in/brief-history.

[26] *Regional Cooperation for Sustainable Energy in Asia and the Pacific*, (United Nations publication, Sales No. E.17.II.F.10). Available from www.unescap.org/sites/default/files/publications/REGIONAL%20COOPERATION%20FOR%20SUSTAINABLE%20ENERGY%20IN%20ASIA%20AND%20THE%20PACIFIC.pdf.

[27] David Ferris, "Indian microgrids aim to bring millions out of darkness", 16 January 2014. Available from http://e360.yale.edu/features/indian_microgrids_aim_to_bring_millions_out_of_darkness.

45. Innovation is an essential means for decoupling resource consumption and growth.[28] In our sample, a higher investment in innovative capacity (measured in terms of research and development spending) is strongly correlated with resource efficiency improvements. Micro level success stories, such as the resource-efficient housing pilot project in the Philippines, reveal that many resource efficiency gains can be made when local governments and communities work together to develop locally relevant innovations.[29] More broadly, resource efficiency goals need to be a priority within national science, technology and innovation policies. Business model innovations can also contribute to resource efficiency. For example, new business models that promote sharing or leasing the same resource by several users can significantly reduce the consumption levels of resources.[30] With the right enabling policy frameworks, social innovation and social enterprises can also be channelled towards promoting resource efficiency.[31] Hence, a policy environment that enables a well-functioning innovative ecosystem would be central in promoting the resource efficiency goals of countries.

8. Prioritizing effective waste management

46. How countries manage generated waste is also an essential component of improving resource efficiency. In this regard, the 3Rs approach – reduce, reuse and recycle – and effectively managing the material cycle will help in decoupling resource consumption from economic growth. In fact, especially in low- and middle-income countries, the lack of effective waste management is also a missed opportunity. The resource-intensive lifestyle of the emerging middle class will further aggravate waste generation in these countries. Reducing the use of the resources involved in producing the same quantity of economic output, while reusing and recycling the same material resources to produce additional outputs, contributes to improved resource efficiency. Figure VII depicts waste management measured in terms of collection coverage of municipal solid waste and the resource efficiency of countries in the region. It shows that more resource-efficient countries in general are also better performers in terms of waste management. This alludes to the close relationship between resource efficiency and waste management and underlines the importance of giving adequate attention to waste management policies. There are several successful examples of national legislation to promote better waste management practices in the region. For instance, the Government of India enacted an e-waste law in 2016 that places responsibilities on both producers and consumers to better manage e-waste.[32]

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[28] Organization for Economic Cooperation and Development, "Policy guidance on resource efficiency", May 2016. Available from www.oecd.org/environment/waste/Resource-Efficiency-G7-2016-Policy-Highlights-web.pdf.

[29] See www.unescap.org/sites/default/files/Naga_Climate%20Change%20Resilient%20Pilot%20Housing%20in%20the%20Philippines%20For%20Half%20of%20the%20Market%20Price.pdf.

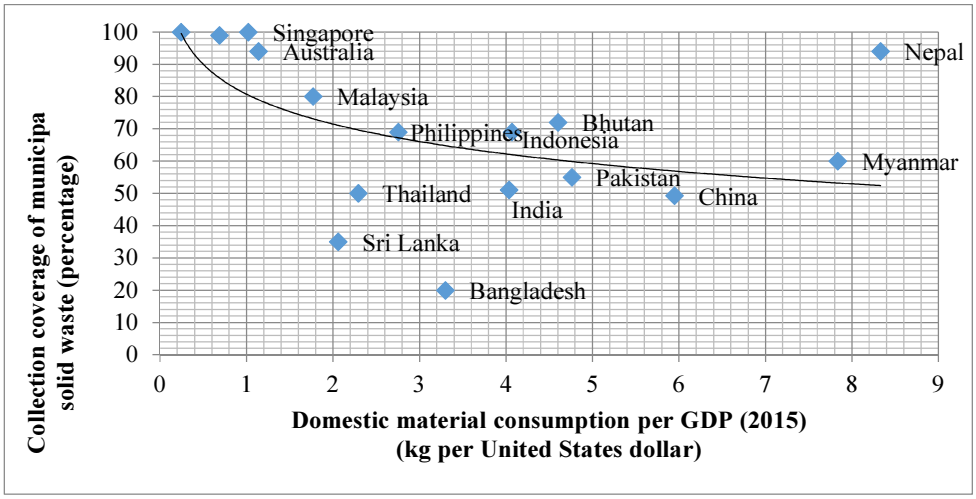
[30] European Commission, "European semester thematic fiche: resource efficiency", 26 November 2015. Available from http://ec.europa.eu/europe2020/pdf/themes/2015/resource_efficiency_20151126.pdf.

[31] For an example from Australia see www.sustainability.vic.gov.au/services-and-advice/funding/social-impact-investment-for-sustainability-program.

[32] SWITCH-Asia Mag, *Advancing the circular economy in Asia*, Winter 2016/17. Available from www.switch-asia.eu/fileadmin/user_upload/SCREEN_final_singlepages02.pdf.

Similarly, the Government of China enacted a circular economy law in 2008 to promote the 3Rs approach, grounded in practical changes to production and consumption processes through resource recovery.[33,32] On the other hand, it is also important to simultaneously promote decentralized and downstream approaches to waste management that rely on greater participation by consumers and waste handlers.

Figure VII
Waste management and resource efficiency



Source: ESCAP calculations, using data from Waste Atlas and ESCAP Statistical database. Available from www.atlas.d-waste.com/ and http://data.unescap.org/escap_stat/ (accessed 12 June 2017).

9. Generating better data and indicators on resource efficiency

47. It is important to closely monitor trends in resource usage and efficiency to analyse the impact of different policies on resource efficiency and to correct course when required. This is especially important since some measures to improve resource efficiency might have unintended rebound effects; for example, improvements in efficiency can lead in turn to increased use of resources. For instance, studies have shown that an increase in industrial energy efficiency of 5 per cent can result in a rebound effect of 36 per cent and 14 per cent of increased electricity usage in the short- and long-term respectively.[34] Hence, it is important for policies that promote resource efficiency to integrate measures to avoid such harmful rebound effects.[35] This further highlights the need to generate statistical frameworks to collect more granular (at the individual and micro level) data on resource usage and resource efficiency, as this would help to quantify and monitor the exact impact of policies on actual resource usage. Big data, satellite data and other

[33] ESCAP, *Low Carbon Green Growth Roadmap for Asia and the Pacific: Turning Resource Constraints and the Climate Crisis into Economic Growth Opportunities* (ST/ESCAP/2631). Available from www.unescap.org/sites/default/files/Full-report.pdf.

[34] Grant J Allan and others, "Modelling the economy-wide rebound effect", in *Energy Efficiency and Sustainable Consumption: The Rebound Effect*, Horace Herring and Steve Sorrell, eds. (Basingstoke/New York, Palgrave Macmillan, 2009).

[35] United Nations Environment Programme, *Resource Efficiency: Economics and Outlook for Asia and the Pacific*, (Bangkok, 2011).

innovative sources of data can also be harnessed to help to develop alternate indicators of resource efficiency.

IV. Conclusions and opportunities for regional cooperation

48. The region's rate of resource consumption coupled with current development patterns poses a serious risk of irreversible environmental damage, with social and economic consequences. This requires urgent action and the realization that sustainable development can only be achieved by rewiring societies and economies for principles that ensure quality of growth through the sustainable management and efficient use of resources.

49. As overall resource consumption continues to increase in the Asia-Pacific region, its pattern of resource use is less efficient, compared with the world average. This implies that improving resource efficiency and delinking economic growth from material resource use can provide significant gains. Resource efficiency gains are closely linked to the achievement of several Sustainable Development Goal targets, especially for the environment-related Goals, while the potential mechanisms of impact and interlinkages of resource efficiency on non-resource-related targets are still to be explored. As resource efficiency trends appear to be also closely linked to improvements in human development (measured by the human development index) in the countries of the region, resource efficiency measures can provide strategic opportunities for countries for the achievement of sustainable development. It needs to be highlighted that resource efficiency improvements in the Asia-Pacific region have occurred, through a number of macro and sectoral measures, both in industrialized and developing countries. What makes resource efficiency measures successful is the degree of their affordability and the benefits that they provide. Future efforts to achieve such objectives could focus on the nine broad policy pathways highlighted in the report and summarized below.

A. Macro level policy pathways

50. Macro level policy pathways will be fundamental in integrating the three dimensions of sustainable development, providing policy coherence and an enabling framework in the transition towards resource efficiency:

(a) **Integrating resource efficiency targets within national development agendas**. Integration and identification of the specific roles of different sectors in the achievement of these targets would help guide the transition to resource efficiency;

(b) **Establishing targeted legal and regulatory measures to enforce resource efficiency standards**. To be fully effective they need to be supplemented with complementary measures such as awareness-raising and financial incentives that can help boost resource efficiency and simultaneously generate economic benefits;

(c) **Creating an overarching macroeconomic policy framework that promotes resource efficiency**. Elements of this framework, such as taxation, subsidy and pricing policy reforms, investment policies and social safety nets, are important for creating an incentive structure to promote the transition to resource efficiency;

(d) **Promoting resource-efficiency-friendly financing frameworks**. An enabling financing framework that helps countries harness innovative sources of financing towards resource efficiency will be critical;

(e) **Re-evaluating trade portfolios and their implications for resource efficiency**. Countries need to re-evaluate their export and import

portfolios and their positions in global value chains based on the implications for resource efficiency. Accordingly, countries may wish to alter their production and consumption patterns to facilitate resource efficiency and to reduce the environmental stress of the growth trajectory.

B. Sectoral policy pathways

51. Building on the foundations laid by macro level policies, targeted sector-specific policy interventions are vital in enabling achievement of resource efficiency:

(a) **Mainstreaming resource efficiency targets within sectoral policies**. Key sectors (such as agriculture and manufacturing) need to mainstream resource efficiency targets within their sectoral policies;

(b) **Leapfrogging to efficient technologies and improving innovation capacity**. There are considerable opportunities in terms of leapfrogging into more efficient technologies and creating the capacity for innovation to promote resource efficiency;

(c) **Prioritizing effective waste management**. Instituting better waste management practices is a significant way to get more value out of existing resources, especially for countries with a growing middle-class population;

(d) **Generating better data and indicators on resource efficiency**. There is a need for generating better aggregated and disaggregated data and indicators on resource efficiency to track progress, to design more informed policies and to monitor the impact of existing policies to promote resource efficiency.

C. Opportunities for regional cooperation

52. The fact that resource use in developing countries of the region is driven by consumption demand from developed countries amplifies the case for regional cooperation between developed and developing countries to promote resource efficiency. The nine policy pathways discussed in the present document provide significant opportunities for regional cooperation. The diversity of the countries in the region, in terms of development, resource endowment, resource efficiency trends and vulnerability to environmental change, will affect how these policy pathways are approached by policymakers. Efforts on policy integration and rule of law will be crucial to harmonize environmental outcomes with economic growth and social inclusion. Given that several good examples in these policy pathways in the region already exist, regional coordination and cooperation would benefit from sharing and further dissemination of such practices.

53. Support from the United Nations system will be required for the implementation of regionally concerted actions for the sustainable management of natural capital. The 2017 regional road map for implementing the 2030 Agenda for Sustainable Development in Asia and the Pacific lists means of implementation for its priority thematic areas, including the management of natural resources. The regional road map provides a good framework for facilitating regional cooperation along the nine pathways to promote resource efficiency. These include regional cooperation opportunities in promoting policies and strategies with respect to resource efficiency and environmentally sound technologies; financing for development; sharing of experiences and cooperating on the management of natural resources, including oceans and seas, with a view to increasing food security and

conserving the environment; developing and sharing best practices; and opportunities to promote integrated policies based on systems approaches and methodologies, which could support the need for analytical studies to further assess the linkages between resource efficiency and the Sustainable Development Goals and their targets across different sectors, as well as the need to explore opportunities to integrate environmental dimensions into the human development index (or other indices). Studying cases of legal and regulatory environmental enforcement frameworks, as well as the impact of pricing of natural resources on reducing unsustainable environmental practices and dealing with waste and pollution, also provides good opportunities.

54. The policy pathway on re-evaluating trade portfolios implies that preferential trade agreements in the region should also factor in resource efficiency implications when trade agreements are negotiated. This signals a need for capacity development within governments, especially in terms of policy integration and multisectoral approaches. The policy pathway on technology and innovation calls for regional cooperation on transferring technologies and strengthening regional innovation systems that promote resource efficiency. The need to generate better data and statistics on resource efficiency will require that the statistical community of the region work together to develop standardized indicators that can be compared across countries.

55. ESCAP can play a key role in facilitating regional cooperation along macro and sectoral level policy pathways to promote resource efficiency through its analytical, normative and technical cooperation work. The Asia-Pacific Regional Coordination Mechanism, convened by ESCAP, through its Thematic Working Group on Resource-Efficient Growth, provides an opportunity to improve the capacity of governments and other stakeholders to use resource efficiency approaches and tools in the development, planning and implementation process, to ensure that economic growth is achieved alongside social protection and environmental conservation.