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Economics & Climate Change – Asia

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Tackling the next crisis

Climate change in Asia

Rising sea levels are already inundating some of Asia's largest cities, while erratic weather patterns jeopardise food security

The region can no longer avoid addressing climate change without imperilling local populations and long-term growth

We take a first look at the economics of climate change in Asia, and assess implications for policymakers and investors

Onto the next one

The world has yet to emerge from the worst pandemic in recent memory, but it is time to shift attention to what will likely be the defining crisis of the century: climate change. It is, of course, nothing new. But for Asia, the economic and social impacts are already materializing: rising sea levels are inundating major cities while erratic weather jeopardizes food security. Fiscal and monetary policies will need to adjust. While it is easy to lay the blame on developed economies, Asia has contributed nearly all of global emissions growth since 1990, and the region's increasing reliance on coal is a pressing concern. Shifting energy demand patterns due to COVID-19 and more competitive renewable energy costs beg for a re-think of energy investment plans. Without urgent changes in Asia, we believe the world will not be able to effectively address climate change. We take a first look at Asia's climate challenges from an economics perspective.

Climate change is an urgent problem for Asia

- Studies suggest that of the 20 global cities most vulnerable to rising sea levels, 15 are in Asia: 5 in ASEAN, 5 in South Asia, 4 in mainland China, and 1 in Japan (see page 10).
- Climate change has resulted in increasing frequency and severity of extreme weather events: floods, typhoons, droughts, monsoons. This is jeopardizing long-run food security in India, China, and Southeast Asia, with implications for inflation and development.

Asia, however, is also a major contributor to climate change

- Since 1990, Asia has contributed 87% of the growth in total incremental greenhouse gas emissions, according to data sourced from *Our World in Data*. The region will continue to drive emissions due to relatively high economic growth and urbanization. Moreover, most countries in the region plan to meet burgeoning electricity needs with coal-fired power plants, which already account for c46% of global CO2 emissions (according to the IEA).
- While energy accounts for c75% of carbon dioxide emissions, in Southeast Asia, deforestation has historically been a key driver of regional emissions, especially in Indonesia. The problem has recently improved, but more work is needed.

The region has made commitments

- All economies have pledged some form of emissions reduction under the Paris Agreement, but not all are meeting their goals. Policymakers will need to rethink priorities, and investors should grasp the fact that based on the current trajectory, the region's policy actions will prevent the world from attaining the goals set forth in the Paris Agreement.

A summary of the major economic implications

It is impossible to accomplish development goals without accounting for climate change risks

Climate change actions need to be integrated with development goals across the region. Some of the region's economies hardest hit by climate change, such as India, Indonesia, and the Philippines continue to face an enormous challenge of reducing poverty, and improving access to healthcare, education, and safe food and drinking water. Ignoring the impact of human-induced climate change can only delay the achievement of these goals, which would be detrimental for reducing inequality and driving sustainable long-term growth.

Fiscal

The COVID-19 related hit to energy demand provides an impetus to reconsider significant investment in coal power plant

As we discuss on page 8, rising sea levels are already imperilling Asian cities, and annual GDP losses may range from 0.2-0.9% of GDP a year for China, India, and Indonesia (Schinko et al, 2020). The total cost to address the issue may be as much as 52% of 2050 GDP in the case of Vietnam, or 31% for India (Diaz, 2016). Moreover, studies indicate that fiscal tools such as price policies (i.e. carbon taxation) coupled with investment and public guarantees can be effective in fighting climate change. Even a modest carbon tax can allow for significant changes in electricity generation plans, resulting in a shift from coal-fired power towards increasingly cost-effective renewable energy generation, which in China and India now cost less than new coal-generated electricity. COVID-19 provides an impetus for policymakers to reconsider long-term energy plans.

Meanwhile, numerous economies such as India, Indonesia, Malaysia, and Vietnam will have to embark on fiscal reforms in order to lower public debt over time following the pandemic. One potential way to do this would be asset swaps, i.e. selling completed government owned assets such as roads and airports, and using the funds for building new assets. This is where climate change can be brought in. The new assets that authorities set to build should be consistent with its goals on mitigating and adapting to the risks of climate change.

Inflation and monetary policy

Policymakers will increasingly take into account climate change objectives

In this report, we will look closely at the impact of climate change on food security, which has clear implications for inflation-based monetary policy. We also believe there is a more direct role for climate change in monetary and macro-prudential policy formulation. **In India**, the RBI could include climate risks in stress tests and scenario analyses and extend central bank support to green finance initiatives. In **China**, the PBoC has gradually used monetary pools to incentivize green finance and incorporated green loans into its Macro-Prudential Assessment. **In Singapore**, the MAS has already started to stress test climate change-related risks, while in **Malaysia,** BNM is looking at the impact climate change will have on financial and real assets in the country, trying to ascertain the impact on the financial system.

Table 1: An overview of climate-change related indicators

	World	USA	EU	CH	IN	ID	MY	PH	SG	TH	VN	JN	KR
Share CO2 emissions (%)	100.0	14.8	9.4	27.5	7.3	1.7	0.7	0.4	0.1	0.8	0.6	3.2	1.8
Share of global GDP (%)	100.0	24.4	17.8	16.4	3.3	1.3	0.4	0.4	0.4	0.6	0.3	5.8	1.9
Share of global popul. (%)	100.0	4.3	5.8	18.2	17.8	3.5	0.4	1.4	0.1	0.9	1.3	1.6	0.7
GHG emissions per capita*	6.6	18.1	9.8	8.2	2.4	8.5	5.2	1.4	11.2	6.0	3.4	9.9	12.9
GDP per capita (USDth)	11	65	39	10	2	4	11	3	65	8	3	40	32
Emissions intensity of GDP**	0.4	0.3	0.2	0.6	0.4	0.5	0.3	0.2	0.1	0.3	0.3	0.3	0.4
Energy intensity level of primary energy***	5	5.1	4.4	6.1	4.2	3.5	4.2	3.1	3.1	5.1	5.6	3.7	6.4
Fossil-fuel based electricity (%)	65.2	67.1	41.5	73.0	81.9	89.3	90.0	74.6	96.9	91.5	63.3	80.3	67.7

Source: World Bank, Our World in Data, Global Carbon Tracker, IEA, HSBC. NB: *Tonnes of C02 equivalent emissions per capita,**CO2 emissions (kg per PPPUSD of GDP), ***MJ/PPPUSD of GDP)

This is a redacted version of the report published on 23-Sep-20. Please contact your HSBC representative or email *AskResearch@hsbc.com* for information.

Contents

An intro to climate change

- The world has collectively increased its GHG emissions every year, with a few blips for economic slowdowns
- COVID-19 may cause global emissions to fall around 4-7% in 2020e, but without a structural change, emissions will likely bounce back
- There is room for progress in Asia, especially on carbon pricing

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A short introduction to climate change

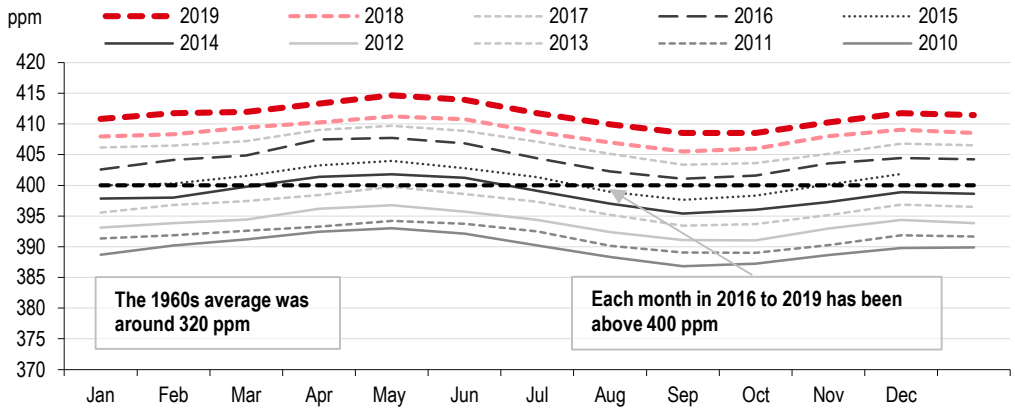
Climate change in short

Greenhouse gas (GHG) molecules trap heat because they absorb certain wavelengths of radiation (heat re-radiated from the Earth's surface) but then re-radiate this energy in all directions – in effect trapping some of that energy on Earth instead of allowing it to be re-radiated back into space. The Earth is only habitable because of our atmosphere and its ability to trap heat and so, essentially, GHGs are good in moderation. A change in the climate (average weather) occurs when the atmospheric concentrations of GHGs undergo a rapid increase (or decrease) in a (short) timeframe such that the Earth's systems cannot adapt. In a nutshell, this is climate change.

There are six main types of GHG: CO_2, CH_4, N_2O, SF_6, PFCs, HFCs.

GHG emissions: The problem is not specifically *emissions* of GHGs, but *concentrations* of GHGs in the atmosphere. The higher the atmospheric concentration of GHGs, the greater the ability to trap heat. Atmospheric concentrations increase not strictly because of emissions, but when these emissions reach and stay in the atmosphere because we did not capture them (to prevent them reaching the atmosphere), or because we destroyed the sinks that absorb them.

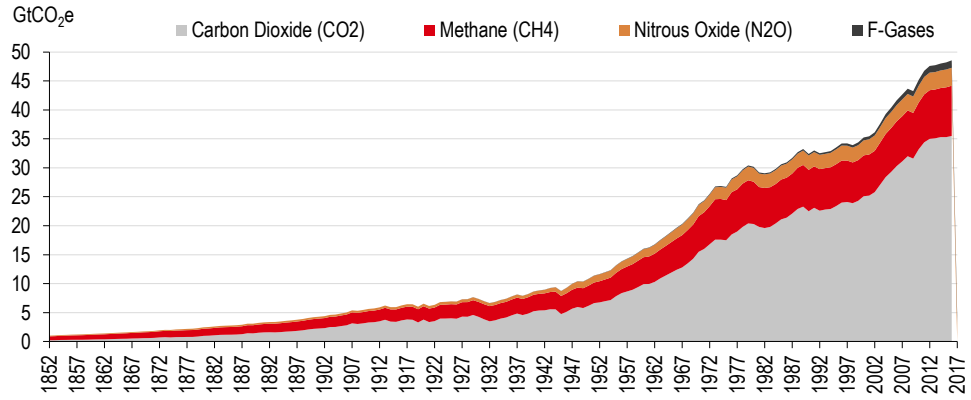
Chart 2: Atmospheric concentrations of carbon dioxide (CO_2) rise relentlessly



Source: Earth System Research Laboratory (NOAA).

Annual emissions: The world has collectively increased its GHG emissions every year, with a few blips for economic slowdowns. According to Le Quéré et al (May 2020), COVID-19 may cause global emissions to fall 4-7% in 2020; however, unless there is a structural change in the global economy, emissions will likely pick up again in the coming years.

Chart 3: Annual emissions chart by gases

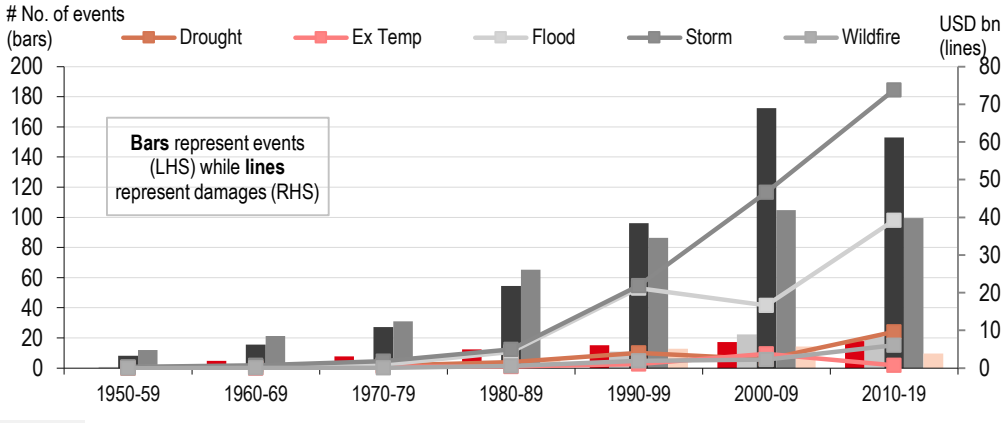


Source: PRIMAP

The consequences of climate change

The impacts of climate change are both physical and social in nature. The physical impacts are now so striking that they are almost a "new normal" with records broken in terms of heat waves, storms, floods, and wildfires almost every year. The social effects – how climate change hits livelihoods, vulnerable communities etc. is also becoming more prominent. The marches, strikes, and protests by the general population across many parts of the world have further highlighted the gulf between the urgency as shown by the science and the impacts, and the delayed action and indifference shown by some governments.

Chart 4: Extreme weather events are on the rise and causing more damage



Source:EMDAT

The Paris Agreement on Climate Change

In 2015, the world collectively adopted the Paris Agreement on Climate Change. The main aim is to keep the rise in global average temperatures to well-below 2°C above pre-industrial levels and preferably to 1.5°C in order to significantly reduce the risks and impacts of climate change.

As of 11 September 2020, 189 Parties, covering 96.1% of global GHG emissions had ratified the Agreement.

The UN's climate science body, the Intergovernmental Panel on Climate Change (IPCC) released a 'Special Report on Global Warming of 1.5 °C' in 2018. Its key finding was that the threshold of 1.5°C of warming will be reached by 2040 on current emissions levels unless global carbon dioxide (CO_2) emissions decline by 45% by 2030 and reach 'net zero' by 2050. There are many benefits to limiting warming to 1.5°C compared with 2°C including: 'avoided physical impacts' such as roughly 10cm more in sea level rises, significantly more ice-free Arctic summers and double the biodiversity loss, at 2°C. There are also social angles such as impacts on livelihoods, health and food security. The marginal abatement costs are 3-4x higher for 1.5°C vs 2°C.

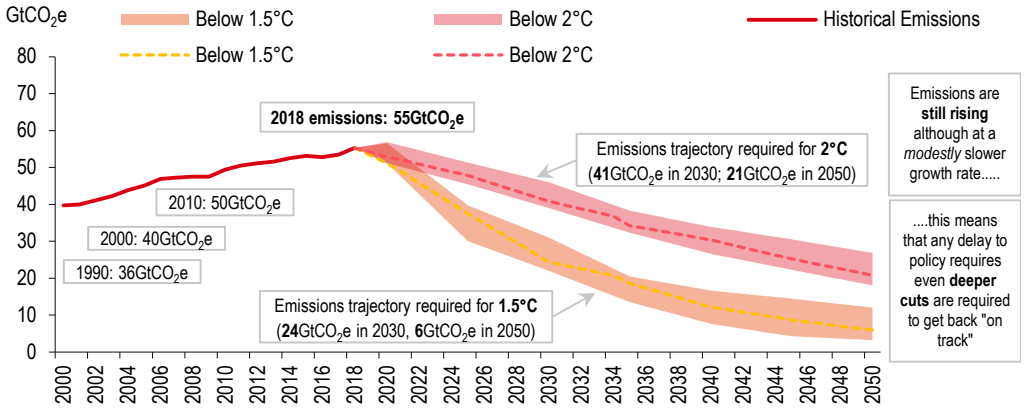
In 2019, the IPCC has also released a 'Special Report on Climate Change and Land' and 'The Ocean and Cryosphere in a Changing Climate'. The current series of special reports is part of the sixth assessment cycle (AR6) which will be published over 2021-22.

> **Limiting global warming to 1.5ºC would require rapid, far-reaching and unprecedented changes in all aspects of society.**
>
> **Intergovernmental Panel on Climate Change (IPCC)**

The urgency of decarbonisation

Essentially, the global economy must become less carbon-intensive (i.e. decarbonise). This transition to a lower carbon world should be economy-wide, affecting for example energy, industry, transportation, buildings and cities, and agriculture.

Chart 5: The global emissions trajectory must change significantly downwards



Source: Emission Gap report 2019

Pledging to reduce emissions

Some 186 Parties (to the UN's climate framework) have submitted a climate pledge – Nationally Determined Contributions' (NDCs) – covering emissions reductions as well as preparing for the impacts of climate change by building up resilience. These NDCs come in all shapes and sizes – some deal with mitigation, some adaptation, others both. They have different targets and timeframes. There is a push to standardise them through annual climate negotiations but this is difficult because of competing priorities, most especially amongst developed (known as Annex 1) and developing (known as Non-Annex 1) economies.

In June 2017, the US announced its intention to withdrawal from the Agreement; the formal exit will take place on 4 November 2020. We do not expect any other Parties to withdraw.

Whose responsibility is it to reduce emissions?

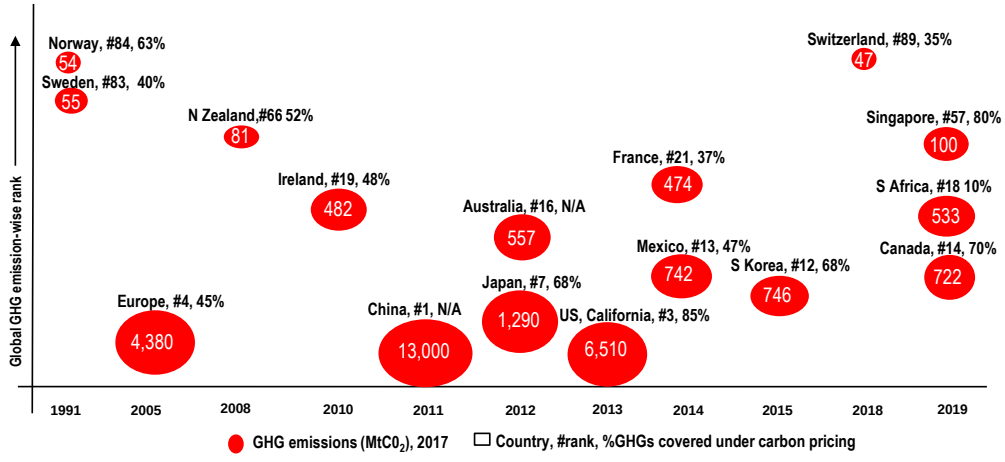
Climate pledges are "nationally determined" which means there is no "central body" which allocates the targets – Parties can choose whichever metric and ambition level depending on their economic circumstances. There has historically been some disagreement over the varying targets: which economies should do more or less, which have the finances, which need the finances, etc.

This debate stems from emissions responsibility: *current annual* emissions, *historical cumulative* emissions, or emissions *per capita*. We do not think there is a right or wrong answer here – there are many points to consider on all sides. We do believe, as the UNFCCC is working towards, that all economies should contribute to both reducing emissions and preparing for the consequences.

Putting a price on carbon emissions

Carbon pricing is a mechanism that tries to capture the external costs of GHG emissions such as healthcare, asset or crop damage; however, these external costs are not easy to quantify. Pricing comes in various forms, depending on market conditions, the developmental state of the economy, the climate commitments of the jurisdiction and the level of support from the businesses and public involved. There are many considerations that determine potential success such as the volume, form and source of emissions, the scope of coverage, price levels and what the revenues are used for.

Chart 6: Overview of key carbon pricing schemes by emitter



Source: PRIMAP, HSBC. Note: Y-axis denotes rank i.e. China is #1 emitter, Switzerland is #89

A number of governments around the world (national and sub-national) have tried to price emissions with varying success (Figure 6). In the ASEAN region, Singapore enacted a carbon tax which came into force in 2019, a mere two years after the first announcement during the budget of February 2017. It covers all facilities with GHG emissions of 25KtCO_2e or more and is designed to tackle emissions at source. The tax has been set at SGD5/tCO_2e (USD3.7) for the 2019-23 period and may increase to SGD10-15/tCO_2e (USD7.3-11) by 2030 after a review in 2023. The covered facilities together account for about 80% of the country's total GHG emissions. Revenues from the tax will be used to further reduce emissions.

In 2011, China approved pilot regions to trial carbon emissions trading. These were launched in 2013-14 to see what worked and did not work for Chinese businesses. A soft national emissions trading scheme was launched in December 2017 with participation from the power generation and heat sector. The pilot schemes are currently still in operation and the World Bank expects China to relaunch its National ETS in 2020.

That sinking feeling

- Rising sea levels are threatening metropolises such as Mumbai, Ho Chi Minh City, Shanghai, Bangkok, and Jakarta
- When exacerbated by groundwater depletion, some cities such as Jakarta are literally sinking, begging for urgent action
- Countries will have to make significant investments in mitigating infrastructure, and in some cases, shifting populations

Rising sea levels

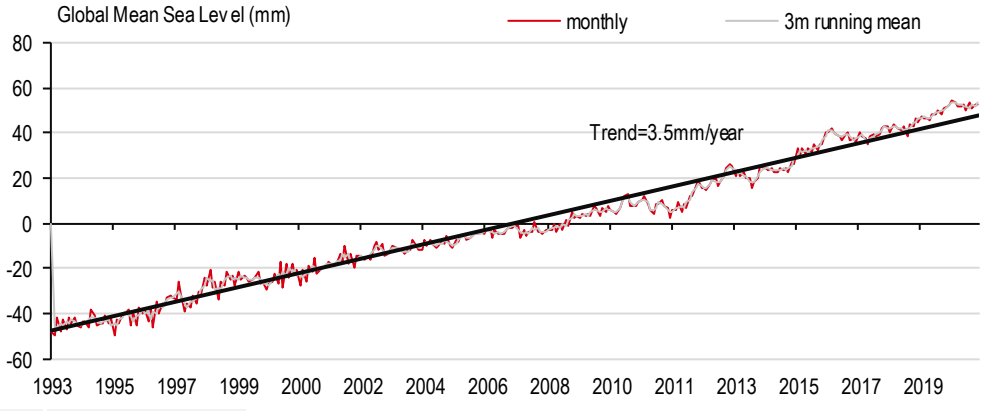
Rising sea levels is already happening, and it threatens the region's most important cities

One of the most tangible impacts of climate change has been rising sea levels. The causes are mainly two-fold: thermal expansions caused by the warming of the ocean (water expands as it warms) coupled with the increased melting of glaciers and ice sheets in the Arctic and Antarctica. The science shows that ice melting is the main cause of sea level rise and that its rate is accelerating (chart 7). Sea levels have risen about 2.6 inches between 1993 and 2014, and based on a "conservative estimate" in a recent NASA study, they may rise by 26 inches (65cm) by 2100. This poses immense risks to low-lying islands and coastal cities, with the risk exacerbated by an increased rate of devastating storms. To make matters worse, in many coastal locations, the pumping of ground water, upstream flood control, and other human-induced factors increase vulnerability.

The phenomenon disproportionately impacts Asia

Asia is on the front-lines. According to an initial OECD study on the topic, of the top 20 cities with the highest share of population exposed to sea-level-induced flooding by the 2070s, 15 are in Asia (see Table 10): 5 in ASEAN, 5 in Southeast Asia, 4 in mainland China, and 1 in Japan. As a rule of thumb, cities built on the river deltas or estuaries, typically soft marshy land already prone to flooding, are most at risk. Unfortunately, these are precisely the locations where Asia's largest and most economically, politically, and socially important metropolises are found. Take ASEAN

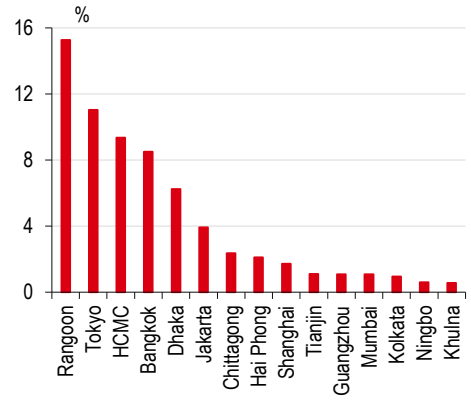
Chart 7: Rising sea levels is the most time-sensitive aspect of climate change



Source: CSIRO, ACE CRC, CRC Australia

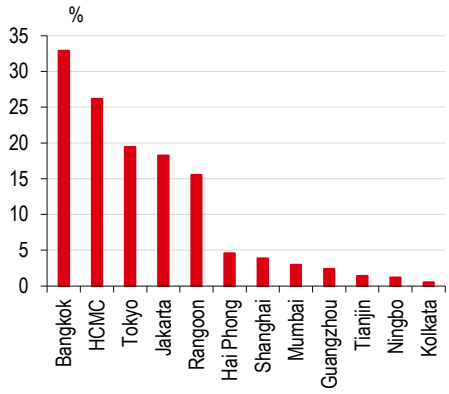
as an example: Ho Chi Minh City and Bangkok host approximately 9% of their respective national populations and contribute 26% and 33% to GDP, respectively. Both China and India's respective financial hubs, Shanghai and Mumbai, rank among the top-10 most impacted cities. Parts of Tokyo are also extremely vulnerable. Rising sea levels cannot be ignored.

Chart 8. Affected urban population as a % of national population in Asia, latest



Source: CEIC, OECD, World Bank, PopulationStat, Statistics of Tokyo, PwC, and various media reports

Chart 9. Affected urban contribution as a % of national GDP in Asia, latest



Source: CEIC, OECD, HSBC

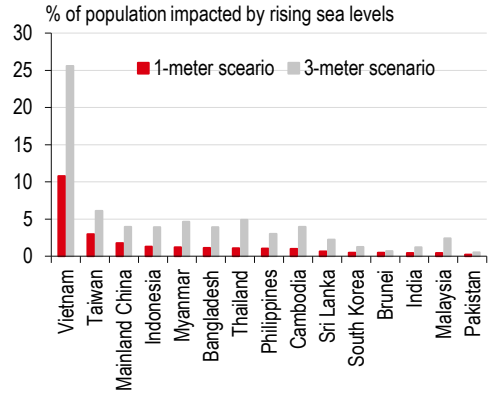
Another World Bank report yielded similarly alarming results when assessing the impact of rising sea level on developing countries depending on various scenarios ranging from 1 to 5 meter increases. On an aggregate level, the affected population in East Asia and Southeast Asia would rise from 2% (37 million) in the 1m scenario to almost 9% (162 million) in the 5m

Table 10: A ranking of the global cities most vulnerable to rising sea levels: It's an Asia story

Rank	Country	Urban	Future exposed population ('000)	% of population	% of GDP	City GDP ($bn, 2019)	Country GDP ($bn, 2019)
1	India	Kolkata	14,014	1.0	0.5	15	2,888
2	India	Mumbai	11,418	1.1	3.0	85	2,888
3	Bangladesh	Dhaka	11,135	6.3			312
4	Mainland China	Guangzhou	10,333	1.1	2.4	341	14,364
5	Vietnam	HCMC	9,216	9.4	26.2	68	260
6	Mainland China	Shanghai	5,451	1.7	3.8	551	14,364
7	Thailand	Bangkok	5,138	8.5	32.9	179	544
8	Myanmar	Rangoon	4,965	15.3	15.5	12	76
9	USA	Miami	4,795				
10	Vietnam	Hai Phong	4,711	2.1	4.6	12	260
11	Egypt	Alexandria	4,375				
12	Mainland China	Tianjin	3,790	1.1	1.4	204	14,364
13	Bangladesh	Khulna	3,641	0.6			312
14	Mainland China	Ningbo	3,305	0.6	1.2	173	14,364
15	Nigeria	Lagos	3,229				
16	Cote D'ivoire	Abidjan	3,110				
17	USA	New York - Newark	2,931				
18	Bangladesh	Chittagong	2,866	2.4			312
19	Japan	Tokyo	2,521	11.0	19.5	989	5,080
20	Indonesia	Jakarta	2,248	3.9	18.3	204	1,119

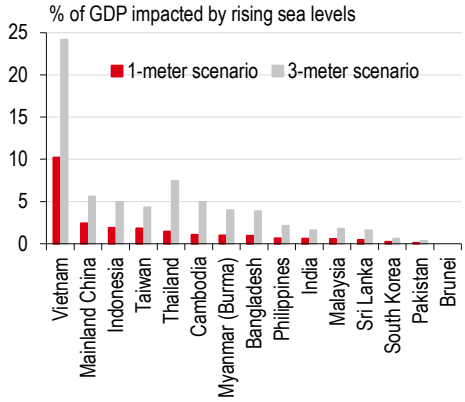
Source: CEIC, OECD, World Bank, PopulationStat, Statistics of Tokyo, PwC, and various media reports

Chart 11: Share of population impacted by rising sea levels



Source: World Bank, HSBC

Chart 12: Share of GDP impacted by rising sea levels



Source: World Bank, HSBC

scenario, with similar ratio of GDP impacted. The impact varies across countries, but based on metrics such as impacted area, population, GDP, and agriculture, Southeast Asia stands out – in particular Vietnam (charts 11 and 12).

Unfortunately, with the use of new elevation data, recent studies have shown that the impact is far greater than previously estimated. For example, a long-anticipated report prepared by the United Nations Intergovernmental Panel on Climate Change (IPCC) in 2019 suggests that coastlines are much more exposed to rising seas than previously anticipated. It argues that past scenarios, such as the OECD report cited above, underestimated land loss and population displacement by one-third (*Asia Times*, 8 January 2020)

New estimates from 2019 suggest rising sea levels will impact an even greater share of population

Meanwhile, Climate Central (2019) employed a new model called CoastalDEM in assessing global exposure to rising seas more accurately than the previous Shuttle Radar Topography Mission (SRTM) model, particularly in densely populated areas. It shows that around 300 million people globally are vulnerable to rising sea levels in 2050, much higher than a previous estimate of 79 million (Table 13). We show what this looks like on page 12. The risk is mostly concentrated in Asia, with the below six countries accounting for up to 80% of the exposed global population (table 13). In Vietnam, Indonesia and Thailand, rising water levels threaten a much larger population under the new model. In addition, the research also shows that land home to 200 million people could face permanent inundation by 2100.

Table 13: Top 6 countries of current population below the elevation of an average annual flooding in 2050

Country	SRTM (million)	CoastalDEM (million)
Mainland China	29	93
Bangladesh	5	42
India	5	36
Vietnam	9	31
Indonesia	5	23
Thailand	1	12
Global	**79**	**300**

Source: Climate Central, Oct 2019

In addition to frequent flooding, rising sea levels can also result in parts of cities literally sinking (Table 14). In fact, Jakarta is considered one of the fastest sinking cities in the world, due in large part to subsidence, or the extraction of ground water from aquifers. The city has “sunk” 4m in the past 30 years, with North Jakarta in particular sinking by 2.5m in the last decade

Table 14. Top 10 fastest sinking major cities

Country	City
Indonesia	Jakarta
Philippines	Manila
Vietnam	HCMC
USA	New Orleans
Thailand	Bangkok
Japan	Osaka
Bangladesh	Dhaka
Mainland China	Shanghai
Italy	Venice
Egypt	Alexandria

Source: John Englander and Bangkok Post

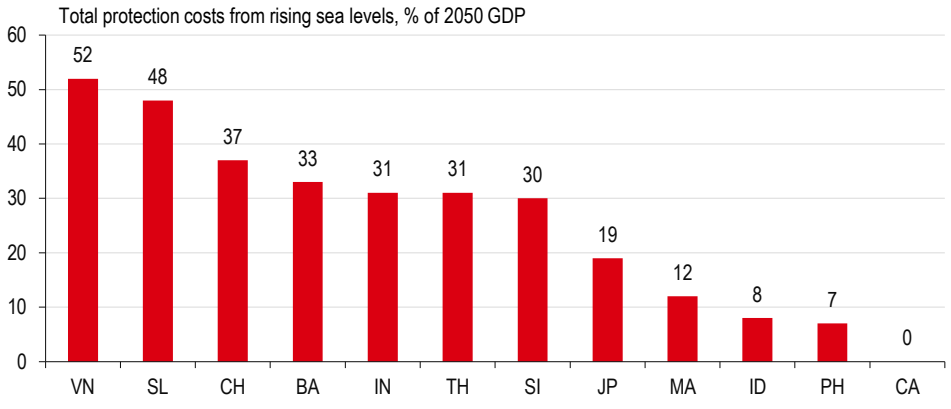
(*World Economic Forum*, 2018). The combination of subsidence and rising sea levels is forcing the government to take action. In fact, the Indonesian government announced a drastic plan of capital relocation, which is expected to take 10 years and cost USD33bn (*World Economic Forum*, 2019), shifting some population from Jakarta (mostly civil servants). Meanwhile, the Philippines is facing similar problems. Manila is sinking at an annual rate of 10cm, also driven by unchecked usage of water from groundwater sources (*Bangkok Post*, 2 September 2019).

In terms of impact on the broader economy, Vietnam is highly sensitive to rising sea levels (see charts 11 and 12). Around 40-45% of land in Ho Chi Minh City is less than 1m above sea level, and 154 out of the city's 322 communes and wards have history of frequent flooding (*McKinsey Global Institute*, April 2020). This has serious implications, given the significance of HCMC to Vietnam. Home to 9 million people, its contribution to Vietnam's GDP is as high as 26% of GDP in 2019. Fortunately, investments in mitigating infrastructure are already underway, but we believe further fiscal resources will be required, posing a challenge for the Vietnamese government given already-elevated levels of public debt.

Fully protecting against rising sea levels could cost up to 52% of 2050 GDP in the case of Vietnam

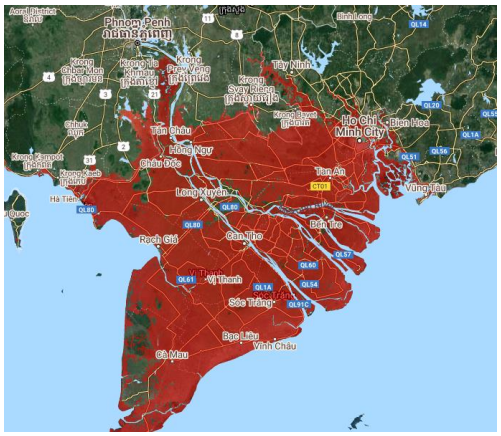
But how costly will it to be protect against rising sea levels? We look to research from the ADB (*Asuncion and Lee, Working paper 507, 2017).* By 2100, economic losses from rising sea levels may account for as much as 9.3% of global GDP. Hillen et al (2010) estimates that construction of dikes and sea walls tend to cost USD6.02 million per km of coastline per vertical meter of protection. Diaz (2016) then estimates that for Asian economies, a full protection strategy could cost up to 52% of 2050 GDP in the case of Vietnam (see chart 15 below).

Chart 15: Protecting against rising sea levels can be costly for some



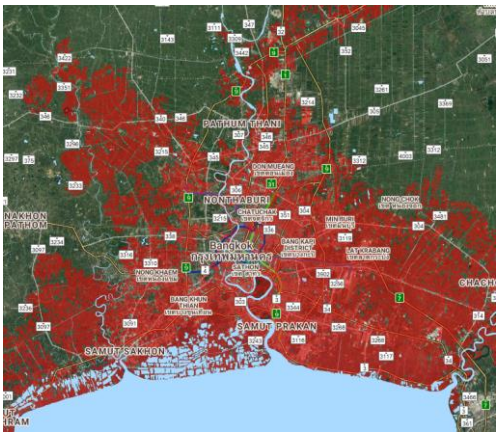
Source: Diaz, Delavane B. 2016. "*Estimating Global Damages from Sea Level Rise with the Coastal Impact and Adaptation Model*

16: Ho Chi Minh City: Land projected to be below tideline by 2050 under base case



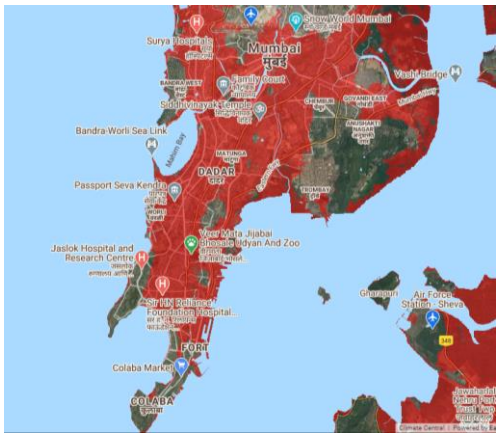
Source: Climate Central (coastal.climatecentral.org)

17: Bangkok: Land projected to be below tideline by 2050 under base case



Source: Climate Central (coastal.climatecentral.org)

18: Mumbai: Land projected to be below tideline by 2050 under base case

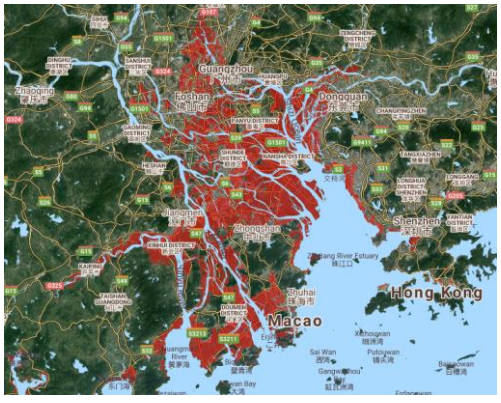


Source: Climate Central (coastal.climatecentral.org)

19: Manila: Land projected to be below tideline by 2050 under base case

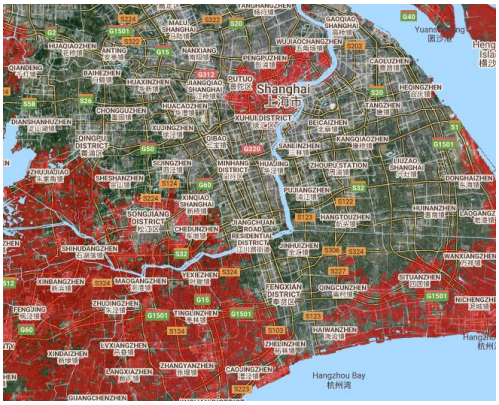
Source: Climate Central (coastal.climatecentral.org)

20: Pearl River Delta: Land projected to be below tideline by 2050 under base case



Source: Climate Central (coastal.climatecentral.org)

21: Shanghai: Land projected to be below tideline by 2050 under base case



Source: Climate Central (coastal.climatecentral.org)

Food security

- More extreme weather events such as typhoons, monsoons, droughts are jeopardizing food security in the region…
- …exacerbating already vulnerable food supply chains in countries such as India and the Philippines
- We take a closer look at climate change-induced food security implications for India, ASEAN, and China

A closer look at India, ASEAN, and China

Food Security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Climate change exacerbates the negative effects of land degradation and desertification (loss of fertile soil, increased soil erosion, and lack of organic material in the soil) through warming, precipitation and extreme weather events. This in turn affects food security (and nutrition) although the effects vary by region and locality.

Parts of Asia were already vulnerable from a food security perspective

In Asia, we look largely at the impact of an increasing rate of extreme weather events. Based on previous analysis, regional economies already rank quite poorly when it comes to climate change-induced vulnerability, which has implications for both regional and global food supply. In this section, we look closer at food security implications for India, China, and ASEAN. In India, we look predominantly at the impact of extreme temperatures, in ASEAN, we ascertain the impact of typhoons and droughts, and in China we look at increased flooding.

Table 22. Agricultural sector risk scores (lower score implies higher risk)

	Vulnerability score	Agricultural sector risk score	Agricultural sector risk rank
China	36.5	3	1
Indonesia	32.3	3.5	2
India	28.8	3.5	2
Malaysia	36.4	8.2	4
Vietnam	27.7	17.1	5
Thailand	35.5	24.4	6
Australia	51.7	36.2	7
Bangladesh	27.7	46	8
Philippines	24.8	54.8	9
Japan	34.3	64.6	10
Korea	41	360.8	11
Sri Lanka	20.5	437.8	12
New Zealand	48.9	1911.4	13
Singapore	53.1	n/a	n/a

Source: FAO, HSBC
Note: The agricultural score is a product of vulnerability score and global share of commodities. Vulnerability score is calculated by taking each country's exposure to climate change and their potential to respond to climate change.

India

The three pillars of food security – availability, accessibility and absorption – are closely linked to local and global environmental conditions. India's challenges are further exacerbated by the fact that it is forecasted be the most populous country in the world by 2027[1].

Availability: Impact on food production

Rising temperature and increased variability in rainfall impacts soil fertility and its moisture content. It also increases the incidence of locust and pest attacks. Various studies have tried to quantify the impact these changes on crop yields.

An IMF report has estimated a fall in crop yields by up to 25% by 2080 for developing countries[2]. Another study by the National Innovations on Climate Resilient Agriculture based on simulation models projects that rice yields in India may fall by 7% by 2050[3]. An RBI study focused on India estimates that one standard deviation increase in high temperature days pulls down crop yields by 12.6% and real wages by 9.8%[4]. Putting them together, these studies predict a fall in the yields of major crops by 7-25% over the next 30 to 50 years. Unless appropriate measures are implemented, India's food security will remain vulnerable to weather-induced disruption.

Furthermore, the impact of climate change is not limited to crop production. It can also be felt across animal husbandry and fisheries. Studies show that heat stress have a negative impact on fertility and reproductive behaviour of cows and buffaloes.

Likewise, changes in ocean temperature, currents, acidification, too, have an impact on fish production. A global FAO report projects a fall in maximum catch potential in the range of 2.8% to 12.1% in the world's exclusive economic zones by 2050 based on different greenhouse gas emission scenarios[5].

Accessibility: Impact on income and inflation

Climate change is likely to impact access to food, both directly and indirectly. India is home to 370 million poor people and they are likely to face a double whammy of rising food prices and falling farm incomes[6].

Calculating the income impact for farmers is a bit tricky due to opposite forces at play. On the one hand lower yields are likely to lower income. But on the other hand, lower supply tends to push prices higher. The economic survey of India finds that the loss in income due to lower yields tend to outweigh the gains from rising prices, resulting in lower farm income (see table 23).

Table 23: Impact of climate change on agriculture yields and farm revenue

	Agriculture yields		Farm revenue	
In percentage	Extreme temperature shock	Extreme rainfall shock	Extreme temperature shock	Extreme rainfall shock
Average Kharif	**4.0**	**12.8**	**4.3**	**13.7**
Irrigated	2.7	6.2	7.0	7.0
Unirrigated	7.0	14.7	5.1	14.3
Average Rabi	**4.7**	**6.7**	**4.1**	**5.5**
Irrigated	3.0	4.1	3.2	4.0
Unirrigated	7.6	8.6	5.9	6.6

Source: Economic Survey 2018, IMD, ICRISAT, HSBC

1 World Population Prospects report, United Nations, 2019
2 "Global Warming and Agriculture", William R. Cline, IMF quarterly magazine, March 2008
3 "Climate Change Poses Serious Threats to India's Food Security", Siraj Hussain, The Wire, September 2019
4 "Climate Change: Macroeconomic impact and policy options for mitigating risks", RBI bulletin, April 2020
5 "Impacts of climate change on fisheries and aquaculture", Food and Agriculture Organization of the United Nations, 2018
6 "Charting pathways out of multidimensional poverty: Achieving the SDGs", Global Multidimensional Poverty Index (MPI) by the United Nations Development Program (UNDP) Human Development Report, 2020

At a national level, rising temperatures and changing monsoon rainfall patterns could cost India 2.8% of GDP per capita by 2050[7].

The impact of climate change is not just a long-term phenomenon. An RBI study correlating food inflation with precipitation index (computed as rainfall deviation from long-run average) throws up evidence of significant short term impact as well. It finds a strong correlation (of 0.7 in a 12-month rolling coefficient analysis, starting January 2012) between changing precipitation trends and food inflation, particularly vegetable inflation. Furthermore, the impact of rainfall lingers for 5-6 months in case of both overall food inflation and vegetable inflation.

Utilization: Impact on nutrition and physical productivity

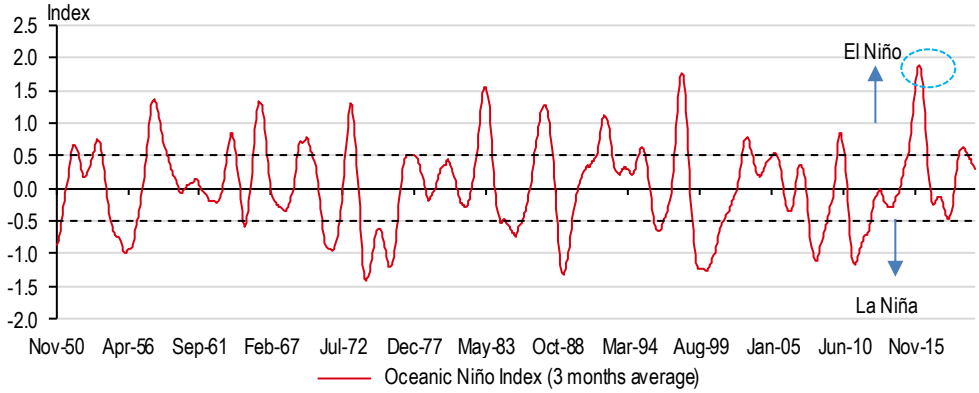
As per the 2019 Global Hunger Index, India ranked 102 out of 117 countries. There are 189 million undernourished people in India[8]. Overuse of fertilizer, land degradation and poor water quality impact both the quality and the quantity of food production. And poor and unsanitary living conditions, lack of healthcare and pollution tend to adversely impact the absorption of nutrients in the body. Challenges of climate change could only intensify these undernourishment troubles.

ASEAN

ASEAN nations continue to see bouts of food inflation, such as the Philippines in 2018 and Vietnam in 2019

Food security has been, and continues to be a paramount consideration for ASEAN policymakers. In 2008, the issue came to the limelight as regional prices of major cereals like rice, wheat, and maize rose by c40%. Such a bout of food inflation has acute implications for development and poverty reduction, given that it impacts the bottom 20% of the population the most. Looking back, a number of factors played a role in driving the food crisis: restrictive trade policies, higher oil prices, and greater demand for biofuel. Improvements have been made since, but as we saw in the Philippines inflation scare in 2018, the region still has food supply vulnerabilities. Climate change will increasingly make things worse.

24. Oceanic Niño Index shows increase in intensity of oscillation in oceanic temperature over time with the last El Nino being the most intense in 2015



Source: NOAA

For example, storms that strike Southeast Asia have been intensifying over the last four decades (*Scientific American*, September 2016). In fact, researchers found that typhoon intensity had increased basin-wide since the late 1970s and suggested that another 14 percent increase in intensity could be expected by the end of the century (Wei Mei and Shang-Ping Xie, 2016), as the ocean takes up the excess heat trapped by greenhouse gases. The researchers concluded that the proportion of storms that strike land as category 4 and 5 in the Western

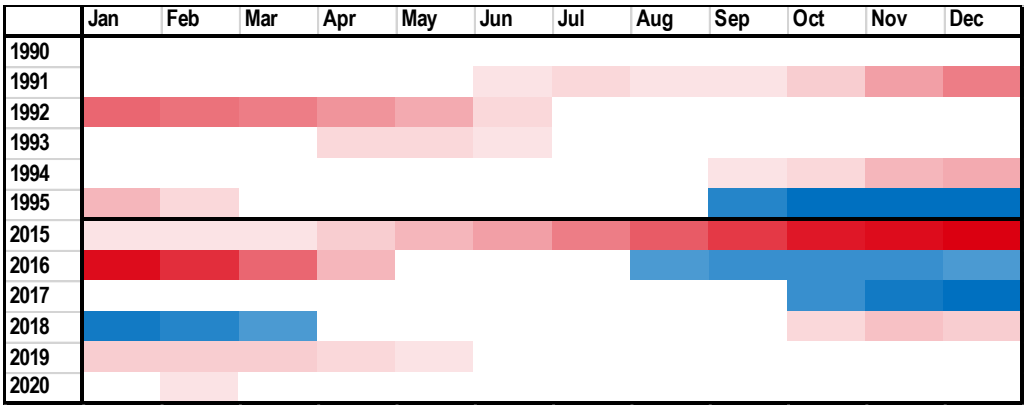
7 "South Asia's Hotspots: The Impact of Temperature and Precipitation Changes on Living Standards", World bank, 2018
8 "The State of Food Security and Nutrition in the World", World Food Programme, 2020

Pacific is rising because of warmer coastal waters. This suggests that typhoon-induced damage on agricultural production in places like the Philippines and Vietnam is set to increase.

New research suggests that climate change is increasing the intensity of El Niños, yielding more ferocious typhoons and droughts

One of the major climate distortions that the region faces typically comes from the El Niño or La Niña: phenomena that involve fluctuating ocean temperatures in the central and eastern Pacific. El Niño is characterized by unusually warm ocean temperatures Pacific, which can exacerbate extreme weather events. While the literature on the linkage between El Niño and climate change is somewhat inconclusive, new research finds that climate change is increasing the frequency of extreme El Niño events, leading to intensifying droughts, worsening floods, and shifting storm patterns.[9] In particular, El Niños are now forming closer to the Asian continent compared to before, increasing the risk of intense typhoons striking land. For example, before 1978, 12 of 14 El Niños forms east of the International Dateline, while since 1978, all 11 have formed in the central or western Pacific Ocean.

25. Both intensity and frequency of El Niño and La Niña conditions are rising



Source: NOAA, HSBC

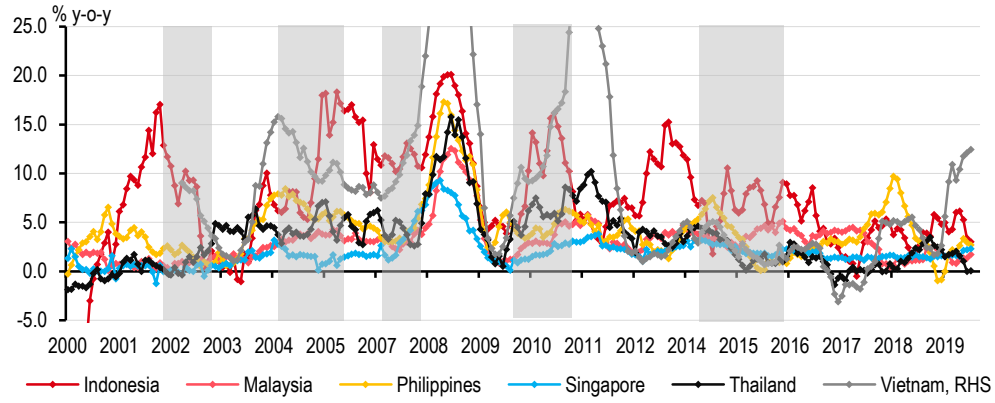
Chart 24 shows temperature fluctuations since the 1950s. A rise in the Oceanic Niño Index (ONI) beyond 0.5 results in El Niño conditions, while a drop below -0.5 results in La Niña conditions. Since the 1970s, the fluctuations increased in terms of both frequency and intensity, implying greater disruptions from both El Niño and La Niña. In Chart 25, we compare two periods – post 2015 and early 1990s. The later period (post 2015) shows much higher frequency of these incidents happening.

Implications for inflation and trade

Historically, El Niño conditions are accompanied by a spike in food prices in the ASEAN region, especially towards the end of the El Niño period due to shock in supply typically stemming from drought conditions. Chart 26 shows food inflation for ASEAN-6 and the grey shaded area highlights the El Niño periods. In particular, rice production tens to fall sharply during El Niño periods, and relatively restrictive trade policies across the region could exacerbate such spikes. A "super" El Niño can cause thousands of deaths from severe heat, flooding, and coastal storms. According to the UN, the 1997-1998 "super" El Niño caused USD96bn in damage[10].

9 Proceedings of the National Academy of Sciences, Historical change of El Nino properties sheds light on future changes of extreme El Nino, 28 June 2019
10 https://www.un.org/press/en/2000/20001027.unep76.doc.html

26. El Niño periods tend to have higher food prices



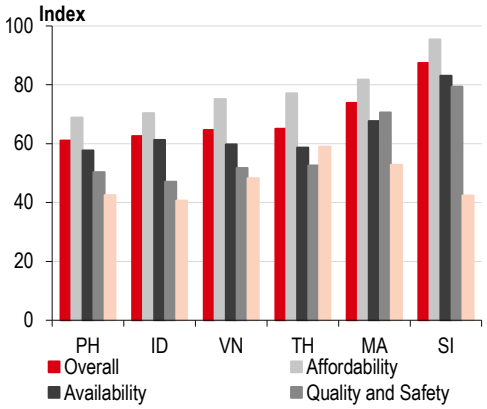
Source: CEIC, NOAA, HSBC

We find that in ASEAN, Philippines and Indonesia are most vulnerable, largely due to broader and pre-existing concerns about food security. The Global Food Security Index (GFSI) data by the *Economist Intelligence Unit* (Chart 27) allows us to frame the conversation. The index is based on three core issues namely affordability, availability and quality across a set of 113 countries in the world. Philippines is the worst performer among ASEAN-6 in this index due to lower affordability of essential food items and the impact on nutrition in the country. As a result, the country is unable to fulfil the dietary needs of people below the poverty line, leading to stunted development indicators. Most worryingly, however, is that much of the Philippines arable land is in the typical typhoon trajectory, and typhoons are expected to occur more frequently.

Active government policy is essential to combat food insecurity in the region. The Philippines seeks to end hunger and all forms of malnutrition by 2030. This is a commitment that the country made during its adoption of the global 2030 Sustainable Development Agenda, which involves attaining, where applicable, 17 sustainable development goals (SDG) and accompanying 169 targets during the United Nations General Assembly in September 2015.

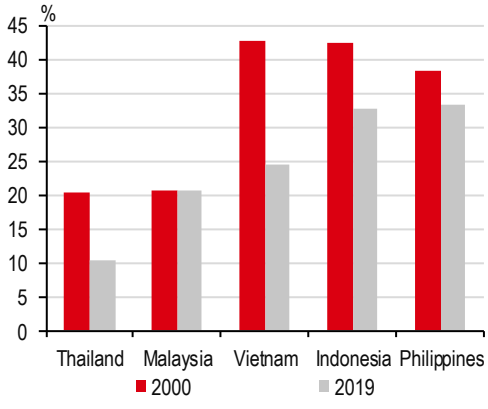
Increasing investments in rural infrastructure, agricultural research, technology development, and plant and livestock gene banks are crucial to enhance agricultural productivity. Moreover, preventing trade restrictions and distortions in regional agricultural markets are needed to ensure the proper functioning of food commodity markets and help limit extreme food price volatility. In the Philippines, the removal of quantitative import restrictions on rice, which exacerbated a rice

27: The Philippines and Indonesia have the lowest food security rankings…



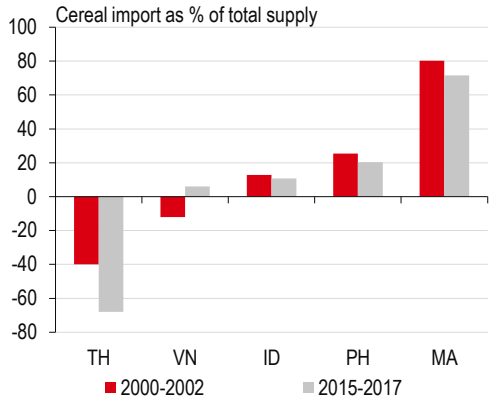
Source: EIU, HSBC

28: Which corresponds to lingering development issues, such as stunting



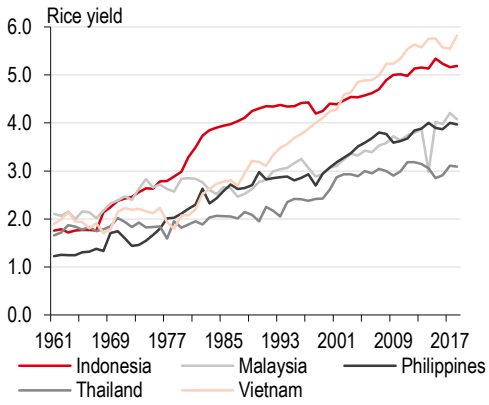
Source: IFPRI, HSBC

29: Most economies rely on imports for consumption of cereals



Source: FAO, HSBC

30: Governments have focused on increasing rice yields to improve resilience



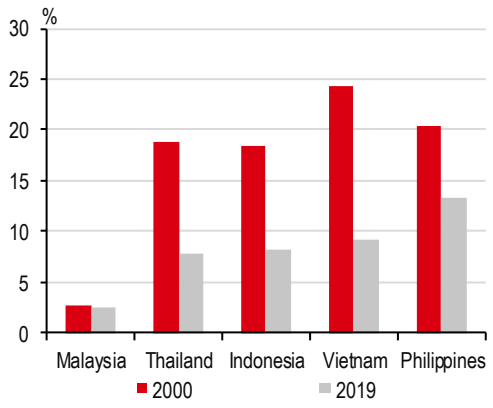
Source: FAO, HSBC

inflation shock in 2018, was a positive development. In Indonesia, food security has been one of President Jokowi's top priorities. For the last five years, the policy direction of the Food Security Agency in Indonesia has been focused on three main areas – food availability, food accessibility and food utilisation. The government has ensured ample availability of rice through increased imports, which has kept food prices in Indonesia relatively stable.

Across the region, there has been a strong focus on increasing rice yields to improve self-sufficiency, given that all countries except Thailand and Vietnam are reliant on imports (chart 29). To understand the problem of food security more thoroughly, we analysed rice production and consumption data, given that rice is the primary food staple in the region. Chart 30 shows rising rice yields in ASEAN.

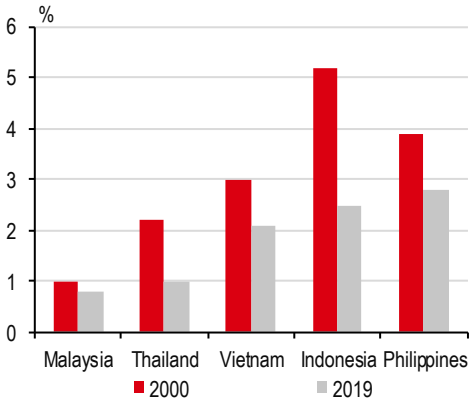
However, the high level of dependence on rice is a problem. Much of the population is replacing local, more nutritious cereal options (e.g. sorghum, corn, tubers, and root vegetables) with processed white rice in their diet, which contains less fibre and nutrients. This directly contributes to factors such as stunting, which directly impacts the health and productivity of the population, and it remains a serious challenge, especially in Indonesia and the Philippines (Charts 28, 31, 32). As such, there needs to be a focus on nutrition security, not just food security, when it comes to policy.

31. Proportion of undernourished people in the population has fallen



Source: IFPRI, HSBC

32. Mortality rate in children under five years is lowest in Malaysia and Thailand



Source: IFPRI, HSBC

China food security

Global warming limits China's food production potential

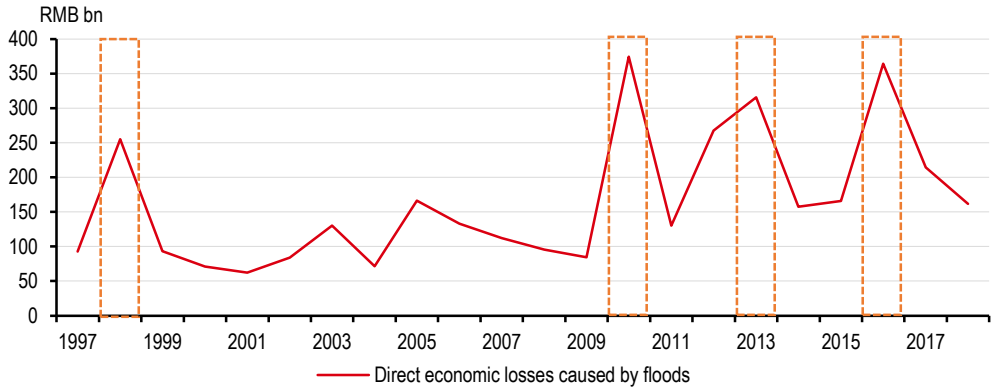
Studies have shown that for every 1°C increase in temperature, crop yield will decrease by 10%. Under high temperature conditions, the growth period of crops is shortened and the growth rate is reduced, which may offset the effect of extending the annual growth period. According to China Meteorological Administration, every time the temperature rises by 1°C, the growth period of rice in China will be shortened by an average of 7-8 days, and the growth period of winter wheat will be shortened by an average of 17 days.

As the growth period is shortened, the time for crops to accumulate dry matter through photosynthesis is reduced, and the quality will also decrease. On the premise that the current planting system, planting varieties and production levels remain unchanged, the production potential of China's farming industry may decrease by 5%-10% by 2030, with the output of irrigated and rain-fed spring wheat expected to decrease by 17.7% and 31.4%, respectively (China Meteorological Administration, 2009). From 2071 to 2100, China's winter wheat production potential will drop by 10%-30%, rice production potential will drop 10%-20%, and corn production potential will drop 5%-10%, according to the same source.

More frequent natural disasters raise concerns over impact on food supply and inflation

While China has barely gotten back on its feet from the COVID-19 crisis, heavy rainfalls and floods along the Yangtze River starting in May have made the path to recovery bumpier for the economy. In fact, if we look retrospectively at the history of natural disasters in China, it is quite obvious that catastrophic floods have become more frequent in China in the recent decade (based on the level of direct economic loss caused by floods every year, see Chart 33). Between 1997 and 2009, China only experienced one major flood in 1998. However, in the recent decade (2010-2020), major floods hit every three to four years, which is likely a result of the rising intensity and frequency of El Niño.

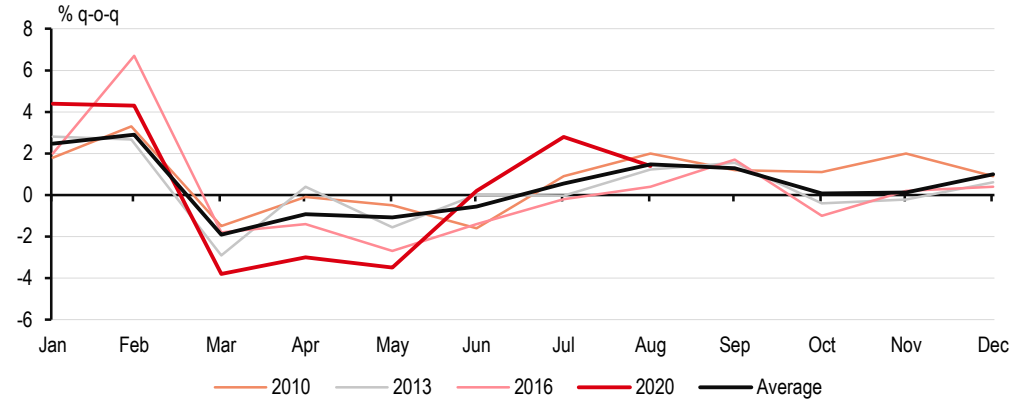
Chart 33: Catastrophic flooding has become more frequent in China in the recent decade



Source: China Floods and Droughts Communique (2018), HSBC

More catastrophic floods can impact China's economic growth in many ways, including destroying assets, affecting industrial production and reducing services demand. In addition, concerns have been rising over the potential impact of natural disasters on food supply and food inflation in China, particularly as food prices raised sharply on a sequential basis in the recent months due to supply disruptions. Looking retrospectively, we found that catastrophic floods can reduce vegetable supply and lift its prices most significantly, while the impact on meat and grain is relatively smaller. Therefore, it is indeed possible if major floods become increasingly frequent in the future, food inflation may see more volatility going forward.

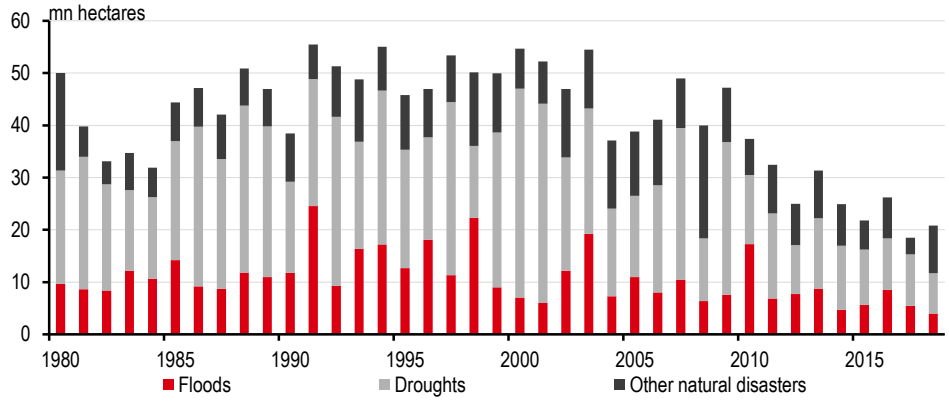
Chart 34: Flooding starting May has lifted q-o-q growth in food prices in China



Source: Wind, HSBC

That said, we believe China's better management of floods and other natural disasters has helped contain their overall adverse impact on agriculture in the recent years, and is likely to help mitigate the threats posed by natural disasters on food security in the future. As shown in Chart 35, the area of crops affected by natural disasters has shown a downward trend. While summer rainfall along the Yangtze River in 2016 was at a similar level as in 1998, the area of farms affected was much smaller than in 1998. Meanwhile, the construction of water conservancy projects is not only conducive to fighting floods, but has also helped mitigate the impact of droughts. In the past 20 years, the drought-affected area of crops has also drastically fallen.

Chart 35: Area for crops affected by natural disasters has been falling in the recent years



Source: Wind, HSBC

A (big) part of the problem

- Asia has accounted for a staggering 87% of global greenhouse gas (GHG) emissions growth since 1990
- Countries in the region have made commitments under the Paris Agreement, but the scope and progress of the pledges vary
- Curbing Asia's burgeoning coal consumption and reversing high rates of deforestation are key to realizing a "1.5°C" world

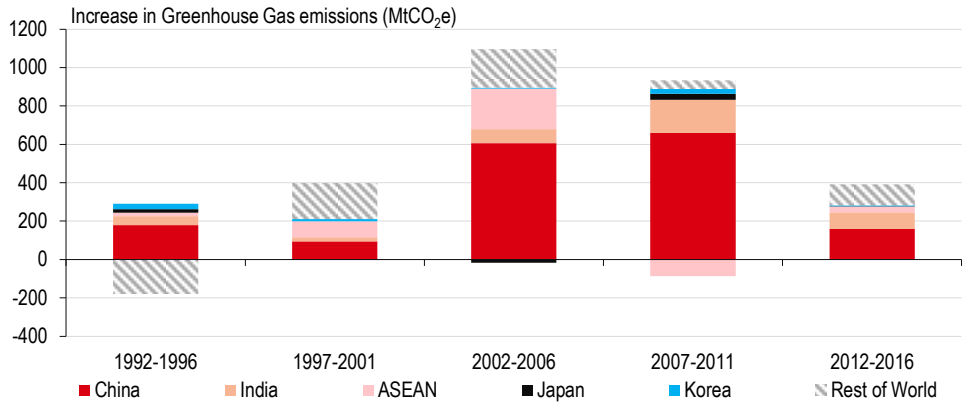
Looking within

Asia accounted for 87% of global greenhouse gas emission growth since 1990

Asia is not just on the receiving end of climate change: it has become an integral part of the problem. According to data from *Global Carbon Project*, the region accounted for 87% of global greenhouse gas (GHG) and 78% of CO_2 emissions growth since 1990. China alone has accounted for 60% of the increase in global GHG, with India and ASEAN filling in much of Asia's remaining contribution (chart 36). This leads us to a simple conclusion: stemming and ultimately reversing the explosive emissions growth from Asia is necessary if the world has any chance of addressing climate change.

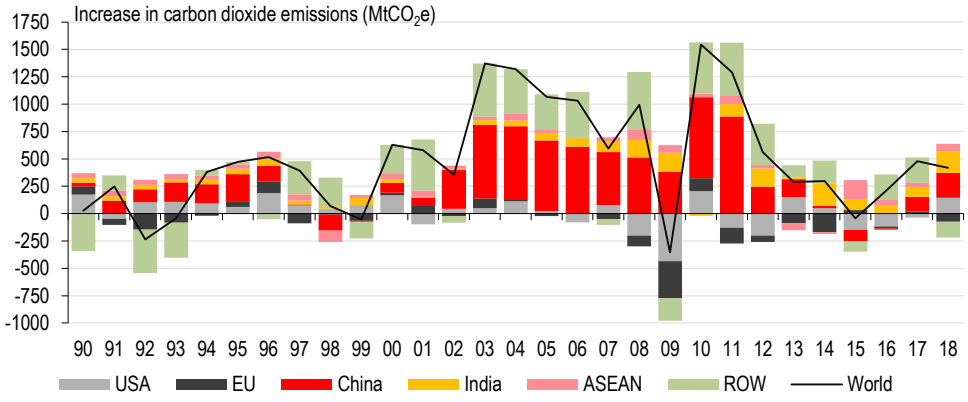
But it gets more complicated. While it is true that developed economies managed to reduce greenhouse gas emissions thanks to policy initiatives promoting greater energy efficiency, they also effectively shifted the most polluting industries, such as steel production and petrochemicals, to emerging markets, de-industrializing at home while enjoying cheaper imported products. Moreover, we acknowledge that high emissions growth in developing markets is unavoidable as economies urbanize and develop from a low base. But this does not mean that Asia should be absolved of responsibility: coal consumption continues to grow despite the availability of other low-cost options, especially in China, Indonesia, Vietnam, and India, and preventable deforestation was a major emissions contributor in Southeast Asia. While it is fortunate that all regional economies signed the Paris Agreement, pledging sizeable reduction in emissions through 2030, the scope and progress of the pledges are mixed.

Chart 36. Asia accounted for c90% of incremental greenhouse gas emissions since 1990



Source: World Bank, Our World in Data, Global Carbon Project, HSBC

Chart 37. Carbon dioxide emissions have once again started to rise, driven by China and India



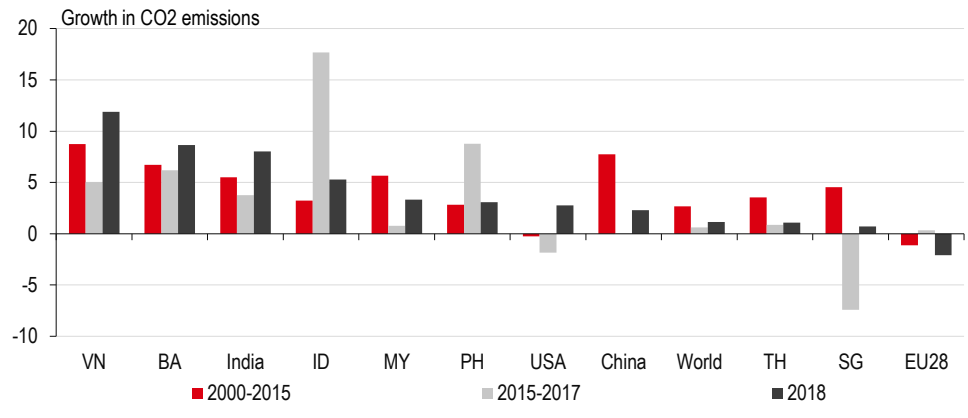
Source: World Bank, Our World in Data, Global Carbon Project, HSBC

While we tend to focus on overall greenhouse gases (GHG) in this report, in Chart 37, we look more closely at carbon dioxide, which accounts for 81% of GHG and for which we have more timely country and sector-level data. Chart 37 shows how mainland China drove a sharp increase in global emissions growth in the early 2000s, which coincided with an extended period of robust manufacturing and industrial growth after the country was admitted to the World Trade Organization. More recently, India's contribution has grown rapidly, overtaking China in multiple years since 2012. Meanwhile, in 2015, ASEAN accounted for the 95% of global CO_2 emissions due to forest fires.

The data show the stark reality how Asia is driving a renewed increase in global emissions since a trough in 2015. Failure to contain emissions means there is simply no way for the world to meet a 1.5°C Paris Agreement compatible goal (refer to page 6). In Chart 38, we show each country's growth in total CO_2 emissions since the turn of the century. While emission growth has broadly moderated since the signing of the Paris Agreement, key exceptions are unsurprisingly Asia's three fastest growing economies: Vietnam, Bangladesh, and India. This reflects the tight correlation between economic development and emissions growth. According to the Environmental Kuznets Curve, greenhouse gas emissions, or environmental degradation, tend to increase with per capita economic growth. As economies urbanize and develop, energy use rises. However, the EKC suggests that emissions per capita tend to subside at higher levels of per capita income.

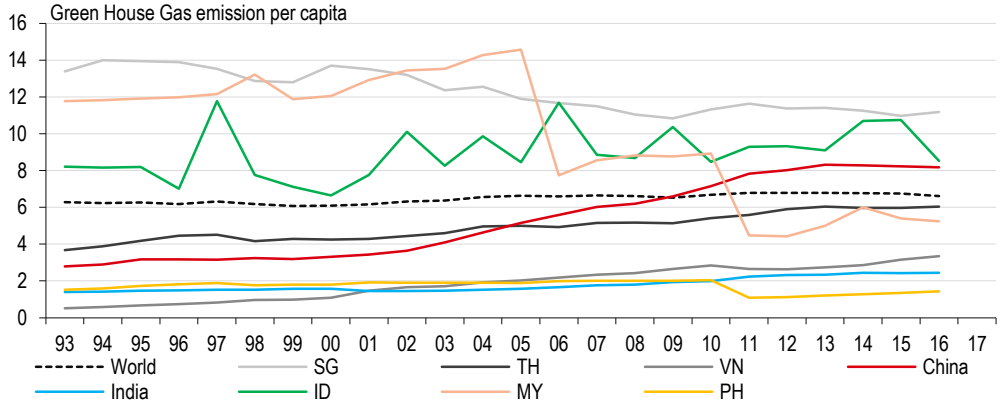
While some recent studies have cast doubt about the EKC (*World Development,* David Stern, The Rise and Fall of the Environmental Kuznets Curve, August 2004), we find that the data in Asia

Chart 38. Total emissions growth by country (add Korea, Japan)



Source: Our World in Data, Global Carbon Project, World Bank, HSBC

Chart 39. Greenhouse gas per capita: A mixed picture for Asia



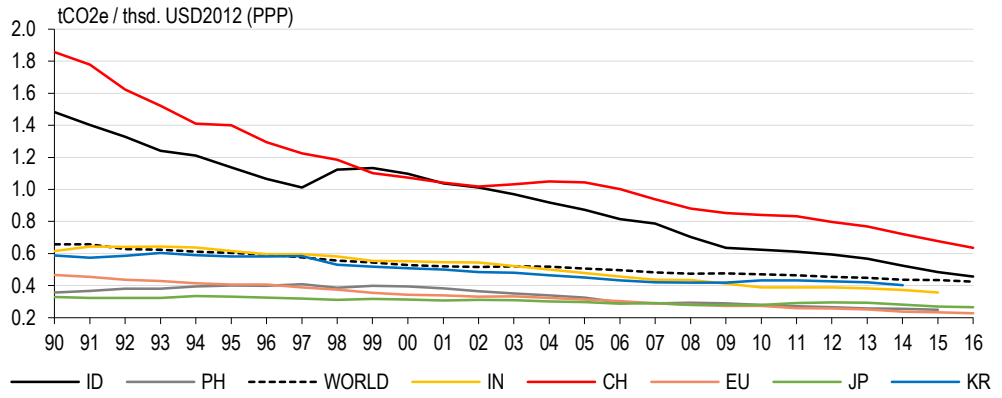
Source: Our World in Data, World Bank, Global Carbon Project, HSBC

broadly confirms the theory. More developed regional economies such as Japan, Korea, Singapore and Malaysia have seen (modest) declines in their per capita emissions as they reach higher levels of per capita income (Chart 39). But so have Indonesia and the Philippines. In the case of Indonesia, this boils down to recent efforts to contain deforestation, which resulted in Indonesia previously having one of the highest rates of per capita greenhouse gas emissions in Asia (more on this shortly). Simultaneously, both the Indonesian and Philippine economies have moderately de-industrialized, with manufacturing accounting for a smaller share of GDP.

Containing emissions per capita in developing economies is important…but significant financing aid from developed economies is necessary

As can be deduced from the previous charts showing emissions growth, China's per capita greenhouse gas emissions appear to have peaked around 2013-2014, while India's have also shown signs of stabilization, albeit at lower levels. Given high rates of population growth in South Asia and ASEAN, containing per capita emissions growth will be one of the most important factors determining whether the world will be able to meet the overarching Paris Agreement 2°C or even 1.5°C goals. But given ongoing development needs, significant assistance from advanced economies will likely be required. With stagnating Official Development Assistance (ODA) in recent years (*WEF*, 2019) and a shift in priorities amidst the COVID-19 pandemic, we worry that developing countries will not be able to make the incremental investments necessary that can significantly alter their emission growth trajectories.

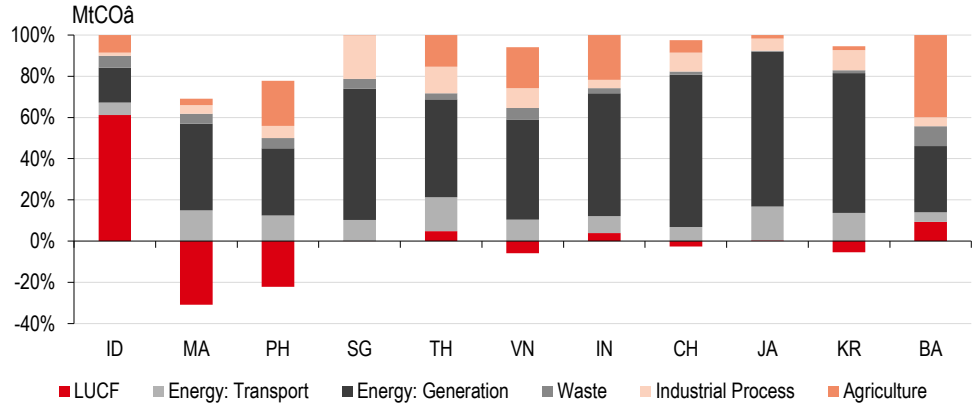
Chart 40: Emissions intensity of GDP growth: China and Indonesia have made progress



Source: World Bank, HSBC

The best way to contain per capita emissions is by reducing the emissions intensity of GDP growth. In theory, intensity should decline with economic development as economies become more services-oriented alongside technological improvements in energy production and a focus on less carbon-intensive energy sources. Energy generation accounts for 75% of global and regional emissions (Chart 41, Indonesia is a clear outlier due to significant emissions growth stemming from deforestation, which we discuss in detail on page 33). An improved energy mix can thus singlehandedly allow for emissions intensity to fall substantially – without necessarily impacting development goals thanks to lower renewable costs. Unfortunately, the share of coal in the primary energy mix is increasing in many Asian economies – singlehandedly Asia's largest sources of carbon emissions. We explore in depth in the next section.

Chart 41: Energy for electricity generation and transport account for 75% of emissions in Asia. The exception is Indonesia, where deforestation is the main driver of emissions



Source: ClimateWatchData

Paris Agreement

As discussed on page 5, all regional economies have signed onto and ratified the Paris Agreement, and submitted NDCs (Nationally Determined Contributions) to outline emissions reductions plans and related commitments. We summarize these in the table below. The scope and format of the pledges vary drastically. **ASEAN-6 economies** have made either absolute or emissions intensity reduction targets by 2030 compared to a "business as usual" scenario. These commitments range from 8% in Vietnam to 70% in the Philippines (note that the BAU scenario typically extrapolates the trend from 2005). ASEAN nations have made additional commitments that are conditional on international financing and technical support. These commitments are also aggregated into an ASEAN-specific NDC.

Meanwhile, India pledged to reduce *emissions intensity* between 30-35% by 2030, and achieve a target of 40% of electricity generation sourced from low-carbon sources (latest: 36%, including hydro). Meanwhile, China pledged to reduce emission intensity by 60-65% of 2005 levels and achieve "peak" carbon dioxide emissions by 2030, with "best efforts" to reach this earlier. An update is expected in the upcoming 14th Five-Year Plan. The country also hopes to source 20% of electricity from low-carbon sources by 2030. Japan and Korea have made simple emissions reductions targets by 2030.

How ambitious are these pledges? For an assessment of the pledges themselves, we turn to Climate Action Tracker, a portal that tracks and assesses the various Paris Agreement pledges for select countries. India and the Philippines stand out for having the most ambitious pledges in the region, which are consistent with a "2°C world", or a world in which temperatures remain within 2°C

Table 42: An overview of emission reduction pledges made under Paris Agreement

Emmission target reduction as compared to 2005 levels with time frame for implementation 2021-2030			
	Emission reduction target by 2030 (%) given BAU	Additional reduction (%) with int'l support	Additional commitments
Indonesia	29% reduction in total emissions	12	A 29% reduction in emissions by 2030, compared to business as usual. Indonesia says it will increase its reduction goal to 41% , conditional on "support from international cooperation". Includes a section on adaptation.
Malaysia	35% reduction in **emissions intensity**	10	Malaysia intends to reduce its greenhouse gas (GHG) emissions intensity of GDP by 45% by 2030 relative to the emissions intensity of GDP in 2005. This consist of 35% on an unconditional basis and a further 10% is condition upon receipt of climate finance, technology transfer and capacity building from developed countries.
Philippines	70% reduction in total emissions	-	A reduction in emissions of about 70% by 2030, relative to a business-as-usual scenario, on the condition of international support. Includes sections on adaptation and loss and damage.
Singapore	36% reduction in **emissions intensity**	-	A 36% reduction in emission intensity by 2030, compared to 2005 levels, with emissions peaking "around 2030". Singapore intends to achieve this without international market mechanisms, though will continue to study their potential. The INDC contains information on adaptation activities.
Thailand	20% reduction in total emissions	5	An unconditional 20% reduction in emissions by 2030, compared to business-as-usual levels. This could increase to 25% , conditional upon the provision of international support. Includes section on adaptation.
Vietnam	8% reduction in total emissions	17	An 8% reduction in emissions by 2030, compared to a business-as-usual scenario. This could be increased to 25% conditional upon international support. Also pledges to increase forest cover to 45% . Includes section on adaptation.
China	60-65% reduction in **emissions per unit of GDP**		China pledged to have a peak in carbon dioxide emissions by 2030, with "best efforts" to peak earlier. The country has pledged to source 20% of energy from low-carbon sources by 2030 and to cut emissions per unit of GDP by 60-65% of 2005 levels bye 2030.
India	30-35% reduction in **emissions intensity**		India pledged to reduce emissions intensity by 30-35% compared to 2005 levels, and will achieve 40% of electricity capacity from non-fossil fuel based resources by 2030. India will increase tree cover to create additional carbon sink of 2.5 to 3.0bn tonnes of CO2 equivalent by 2030.
Japan	26% reduction in total emissions (vis-à-vis 2013)		26% reduction in emissions by 2030 compared to 2013 levels
Korea	37% reduction in total emissions		37% reduction in total emissions compared to business as usual case. Plans to use carbon credits to achieve target.
Bangladesh	5% reduction in total emissions	15	5% reduction in greenhouse gas emissions by 2030 compared to business as usual, with an additional 15% reduction contingent on support.

Source: UN, Carbon Brief, HSBC

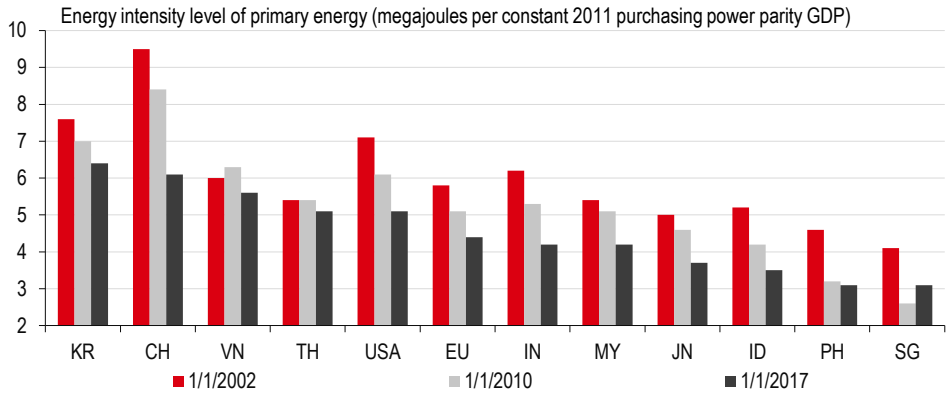
of pre-industrial levels. Asia's remaining pledges are ranked as either "highly" or "critically" insufficient, with only Vietnam in the latter category, the result of a modest 8% emissions reduction target by 2030. However, recent news suggest the country may significantly reduce coal-fired electricity plans, which would drastically shift its future emissions trajectory.

Table 43: Assessment of regional Paris Agreement pledges

	NDC pledge	Policy direction	Issue
China	Highly insufficient	Insufficient	
India	2°C compatible	On track	Coal
Indonesia	Highly insufficient	Insufficient	Coal
Philippines	2°C compatible	Insufficient	
Singapore	Highly insufficient		
Vietnam	Critically insufficient	Highly insufficient	Coal
Korea	Highly insufficient	Highly insufficient	
Japan	Highly insufficient		Coal

Source: Climate Action Tracker

Chart 44: Energy intensity of GDP growth



Source: UNdata, IEA

Energy: The elephant in the room

Energy production accounts for approximately three quarters of global greenhouse gas emissions both globally and within Asia. A particularly high reliance on coal for 61% of electricity generation in Asia (which may rise to 83% by 2030, according to the ADB) is the main contributor to the region's greenhouse gas emissions. Addressing emissions-heavy energy production is not only necessary for Asian economies to meet their specific Paris Agreement pledges, but is crucial if the world is to come even close to the goal of a "1.5°C" world.

Let's look at the basics. Energy-related emissions can be reduced through 3 main channels:

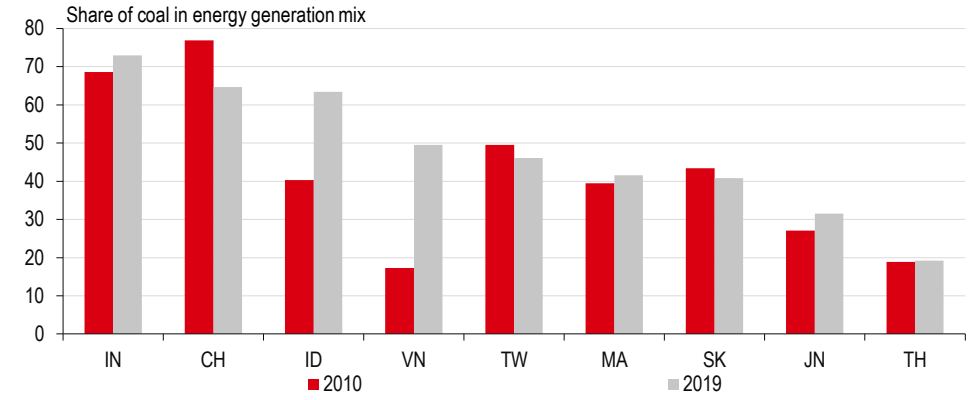
1) **Optimize**: Boost efficiency to reduce energy use
2) **Decarbonize**: Shift to zero-carbon technologies such as geothermal, solar, and hydropower to generate electricity
3) **Electrify**: Shift energy demand to electricity and away from fossil fuel combustion

We start by looking at energy intensity of GDP, which measures how much energy is used to produce one unit of economic output. The measure is imperfect: it does not adjust for standard of living (wealthier nations tend to generate and use more energy), the share of industry in GDP, or even the emissions intensity of energy production (coal vs. renewables). Still, it is a useful way to track changing energy usage trends. Korea, mainland China, Vietnam, and Thailand have the highest energy intensity (Chart 44). This is mostly attributable to their fairly high share of heavy industries: they are all massive steel, auto, or machinery producers.

In parts of Asia, a traditional impediment to improving energy efficiency has been excessively generous energy subsidies, especially for electricity and fuel consumption. On the consumer side, India, Indonesia, Malaysia, and Vietnam traditionally offered the largest subsidies, accounting for a sizeable share of total spending. On the industrial side, Chinese firms have historically received generous indirect energy subsidies, especially for industries deemed strategic. For example, according to *Harvard Business Review*, the government allocated USD15.7bn (0.45% of GDP) in electricity subsidies for the steel sector alone in 2007.

These subsidies have of course encouraged inefficient usage, and particularly in the case of India and Indonesia, contributed to increasing current account deficits. India has reformed and reduced many of its most inefficient subsidies since 2014, which corresponded to an improvement in its energy intensity, while China has also scaled back the amount of industrial

Chart 45: Coal has been increasing in the region's electricity generation mix



Source: BP, HSBV. CH=Mainland China

support while simultaneously providing generous renewable energy subsidies. In Indonesia, the record is mixed: initial reforms to remove generous direct government energy subsidies have since been diluted by indirect subsidies offered by SOEs.

De-carbonization

Before we look at the energy mix, a quick word an electrification. The only way to *eventually* achieve net zero carbon emissions from energy is by achieving full electrification in lieu of technologies that run on combustion (gasoline vehicles, natural gas heating and cooling, etc). Of course, as we will discuss briefly, much depends on *how* the electricity is generated (fossil fuels vs. renewables), but electrification is nonetheless the first step. Fortunately, most of Asia has achieved 100% electrification, although there is still progress to be made in Bangladesh, India, and the Philippines (85%, 95%, 95% electrification rate as of 2018, respectively). All three economies have released plans to achieve full electrification within the next few years. The next step is for all economies to promote policies to shift energy consumption towards electricity, such as a policy to encourage electric vehicle adoption. China, Japan, and Korea have all set relatively ambitious EV-related targets, while Indonesia is also moving to encourage an EV industry.

Coal: The elephant in the room

Asia increasingly runs on coal. Over the last decade, nearly every economy has increased the share of coal in the electricity generation mix (Chart 45), even in countries such as Malaysia where alternative sources (natural gas) are relatively cheap and plentiful. Currently, four economies derive more than half of their electricity needs from coal: India, China, Indonesia, and Vietnam (Chart 46). Even Japan has increased the share of electricity generated from coal, now accounting for roughly 30% of the total energy mix (Japan is the third largest consumer of coal in Asia). See charts 49-56. In aggregate, 62% of the region's electricity is generated from coal.

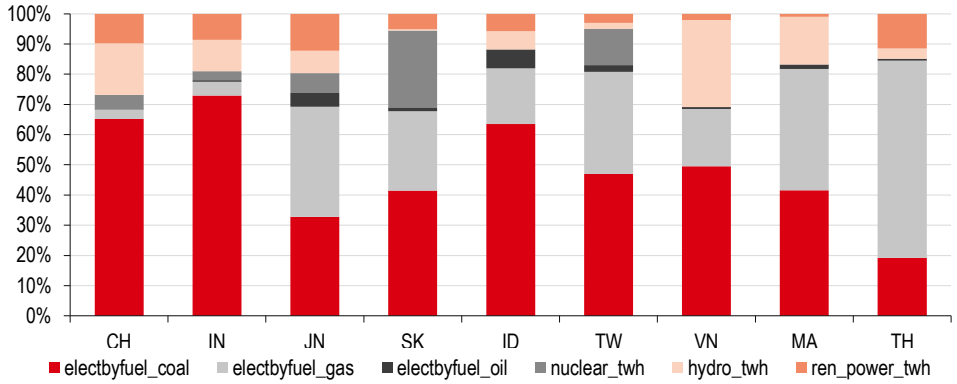
As we show in Chart 46, electricity generated from coal typically generates 40% more CO_2 than natural gas, which itself is carbon-heavy compared to low-carbon alternatives. Of course, some caveats are in order. There have been technological advancements that reduce the carbon emissions from coal-fired electricity plants, typically through a process called "carbon capture and storage [CCS]," which effectively captures CO_2 and transports it to a storage site (typically an underground geological formation) so it does not reach the atmosphere.

However, this technology is costly: employing CCS increases the cost of operating a new coal power plant by 50% and a pre-existing plant by 70%. Accordingly, it is virtually impossible to incentivize the broad-based usage of CCS technology in developing economies without an effective carbon pricing regime.[11] Unfortunately, the region is unlikely to cut its dependence on coal anytime soon based on the large pipeline of coal-fired energy plants under construction. 75% of incremental generating capacity in ASEAN will be coal-based.

Is there an alternative? While the cost of renewable electricity has fallen sharply – as we show briefly – coal consumption is nonetheless set to rise sharply in the region given its lower cost and stability from a grid perspective. This would severely frustrate Paris Agreement plans to limit rising temperatures to below 1.5°C. According to analysis by Carbon Brief, global coal-based emissions would need to fall by more than half in order for the world to keep warming "well below 2°C." This reflects the fact that coal emissions account for 46% of global CO_2 emissions, and Asia accounts for 72% of global coal-based electricity generation.

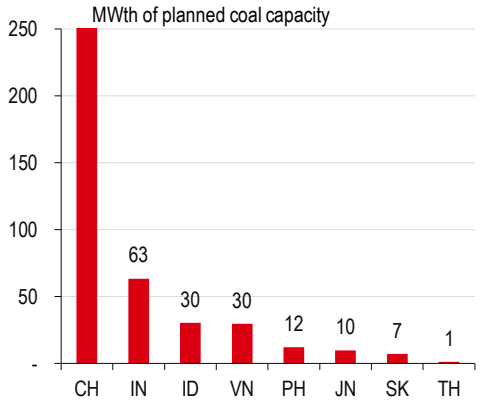
Accordingly, policymakers should rethink future electricity plans before it is too late. The sharp drop in energy demand stemming from the COVID-19 crisis provides policymakers with a perfect opportunity to re-assess coal power plants, and we see encouraging signals from India and Vietnam. We believe that even a moderate carbon pricing program across the region should help to facilitate a shift away from new coal plants, and this is an area where multilateral development banks should be able to provide additional financing assistance.

Chart 46. Electricity generation by source



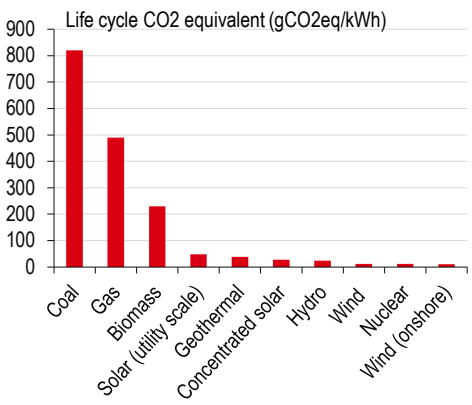
Source: BP, HSBC. CH=Mainland China.

Chart 47: China, India, Indonesia, and Vietnam plan significant increases in coal



Source: Carbon Tracker

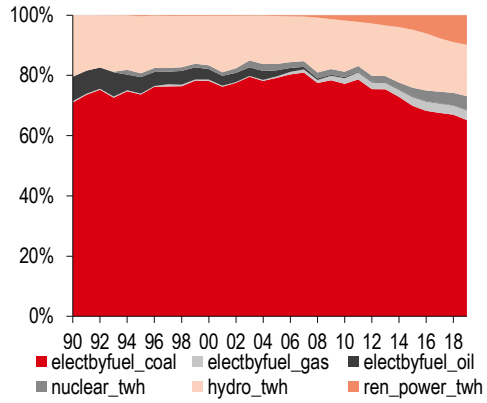
Chart 48: Coal generates far more GHG than other non-renewable sources



Source: UN, IPCC. We take median estimates for each energy source.

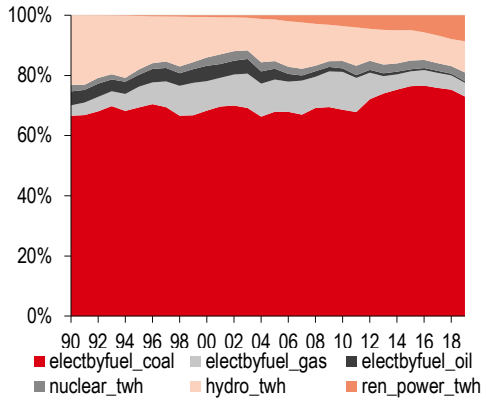
11 https://www.nbr.org/publication/learning-from-china-a-blueprint-for-the-future-of-coal-in-asia/

49: Electricity generation: Mainland China



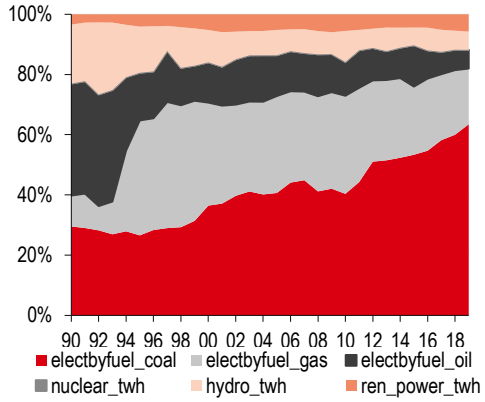
Source: BP

50: Electricity generation mix: India



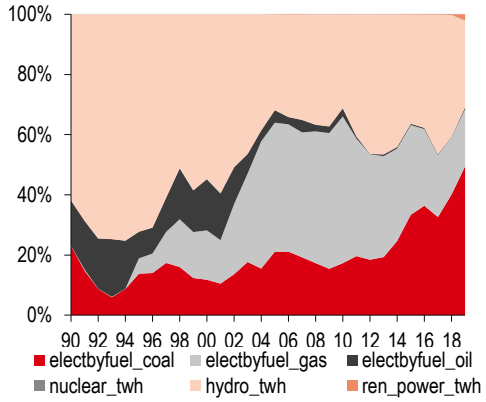
Source: BP

51: Electricity generation mix: Indonesia



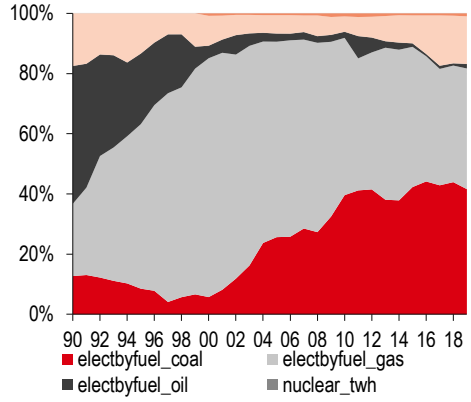
Source: BP

52: Electricity generation mix: Vietnam



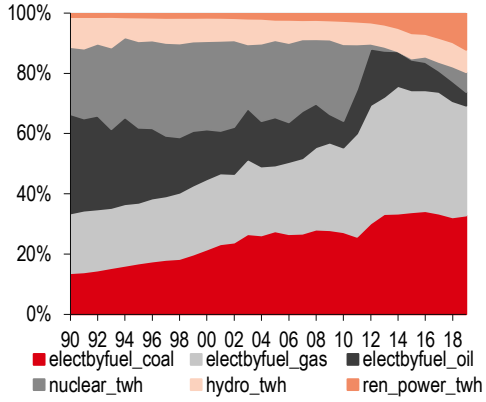
Source: BP

53. Electricity generation mix: Malaysia



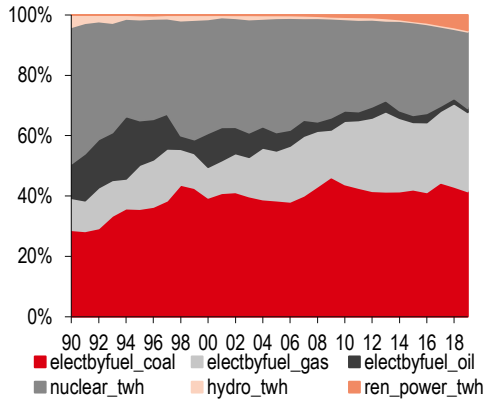
Source: BP

54. Electricity generation mix: Japan



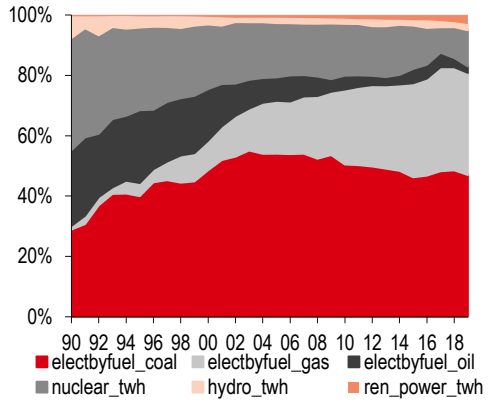
Source: BP

55. Electricity generation mix: Korea



Source: BP

56. Electricity generation mix: Taiwan



Source: BP

Scope for renewables adoption

The future is bright for renewables, and the economics are rapidly improving. For example, 56% of capacity additions for utility-scale renewable power across the world achieved lower electricity costs than the cheapest new coal plant, according to IRENA. Moreover, there would be an aggregate USD23bn of savings across the world if the costliest 500GW of existing coal were replaced by solar and wind. In short, technological advances have shifted the economics of renewable power globally, and given the collapse in energy demand amid the COVID-19 pandemic, policymakers across the region should re-assess energy development plans to increase the share of renewables.

In China and India, fixed axis solar generation is the cheapest source of new bulk electricity generation, according to data from Bloomberg NEF (not accounting for grid-specific factors such as storage capacity, which would increase the effective cost of solar power). With the right incentives, possibly including carbon pricing, there could be a quicker reduction of coal power plants. At the very least, thanks to lower global gas prices, there is scope to increase the usage of natural gas, which will have a lower levelized cost of electricity (LCOE) than coal in China within 10 years, according to BNEF.

Thanks to solar cost reductions, solar-based electricity now costs less than coal in India

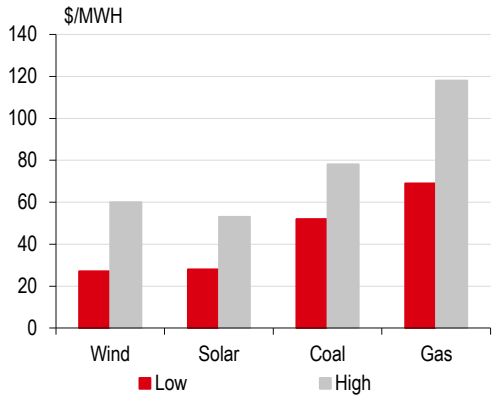
Broadly speaking, we are encouraged by developments in India. The cost of adding solar electricity stands at INR2.5 per unit generated, compared to INR4.5 for new coal capacity (this does not account for grid storage costs). Analysis by IEEFA found that renewables delivered more than two thirds of new generating capacity in the 2019-2020 fiscal year (*Climate Change N*ews, 7 May 2020). If additional policy support is provided, coal generation in India may peak in the coming 10 years. Still, there are significant plans for additional coal-fired power plants, and the government plans to open up 40 state coal pits, many of which sit under previously protected forest, for commercial mining in order to reduce the reliance on imported coal (*DW*, 25 August 2020). This runs the risk of accelerating deforestation, which would further contribute to India's emissions growth and may complicate the government's plans to increase forest cover.

In ASEAN, the economics for renewables appear less favourable compared to the rest of the region. Coal-generated electricity is the cheapest source of energy for many economies in the region, again according to BNEF estimates. This is particularly the case in Indonesia, which has the world's sixth largest coal reserves. According to the Institute for Essential Energy Services Reform (IESR) calculations, total cost range of coal-generated electricity is lower than renewable sources, especially solar and wind. In fact, according to NREL studies, the average cost of solar in Indonesia is among the highest among ASEAN member states (*Lee et al*, 2019).

However, for geothermal energy, the cost can be more comparable to coal thanks to the fact that Indonesia has the world's largest geothermal resources, although the high capex requirement is an offsetting factor. Note that our discussion of electricity costs is based on the "levelized cost of electricity," which represents the average revenue per unit of electricity generated required to recover the costs of building and operating a plant during the financial and cycle life. This measure is based on numerous assumptions and does not include grid-related factors, but the numbers nonetheless show that a country can significantly increase renewable-energy production at a competitive cost if the right incentives are provided.

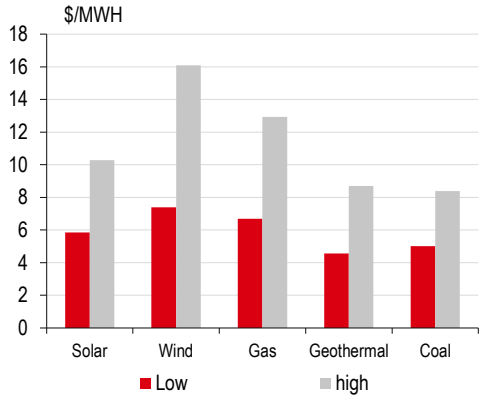
In Vietnam, the share of coal is set to increase by the sharpest pace in the region, with capacity expected to double in the coming decades (note that Vietnam has the region's least-ambitious Paris Agreement pledges). Fortunately, there have been some positive signals from the Vietnamese government. A government-linked research institute tasked with drawing up the country's next power sector roadmap, the Vietnam Energy Institute, suggested that the government could cancel seven planned coal projects, and postpone a further six (*Eco Business*, 28 July 2020). These 13 plants would have 17.1GW of capacity, not far from the country's current 18.9GW of installed capacity.

57. Levelized cost of electricity (LCOE) in India: Renewables cheaper than coal



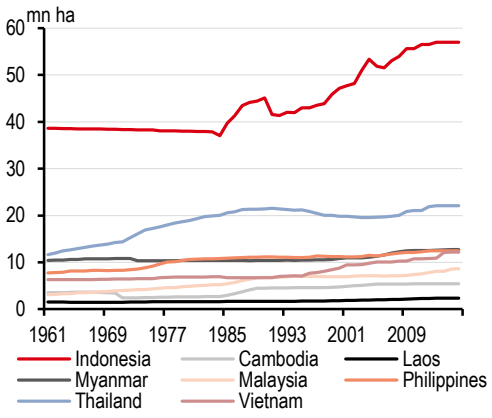
Source: Bloomberg NEF

58. Levelized cost of electricity (LCOE) in Indonesia: Coal is still competitive



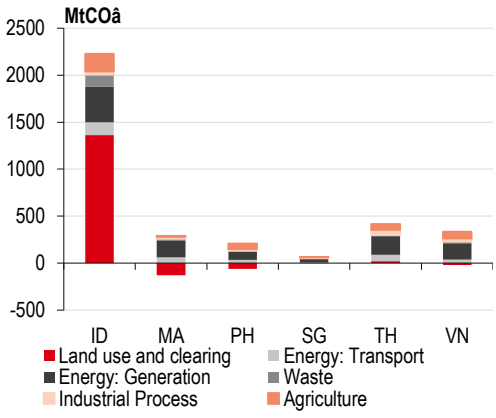
Source: IESR

59: Agricultural land use in Southeast Asia has increased over the decades



Source: World Bank, HSBC

60: Land clearing has driven most of Indonesia's emissions (2016 data)



Source: ClimateWatchData, HSBC

Deforestation in Southeast Asia

Earlier in the report, we noted that energy accounts for the majority of Asia's emissions. However, emissions from land clearing and agriculture came second, and in the case of ASEAN and Indonesia, deforestation alone has been a massive contributor to greenhouse gas emissions growth, not to mention the broader impact on biodiversity.

Southeast Asia is home to nearly 20% of the world's tropical forests. However, the region also ranks among the highest in terms of deforestation and severe biodiversity loss due to a variety climatic and human-related factors. According to estimates (*Brown*, 2013), Southeast Asia has the highest rate of deforestation of any major tropical region in the world, losing 1.2% of its forest annually, followed by Latin America (0.8%) and Africa (0.7%) (*Brookings; Brown*, V., 5 April, 2013). It is estimated that Southeast Asia has already lost more than 50% of its original forest cover, and it could lose around 75% of its original forests by 2100, in addition to 42% of its biodiversity, if deforestation is left unmitigated (*Sodhi, Koh, Brook, Ng*, 2004).

The increased usage of land for agriculture in Southeast Asia has been fuelled by accelerating urbanization since the 1960s, and increased international trade, particularly for highly demanded products such as palm oil. This has been especially true in Indonesia and Malaysia, which together account for around 84% of the global palm oil market. According to the UN, 55% to 59% of oil palm expansion in Malaysia, and at least 56% in Indonesia, occurred at the expense of primary forests. Between 1990 and 2005, 1 million hectares of forest were lost in Malaysia and between 1.7 and 3 million hectares of forest were lost in Indonesia due to oil palm expansion (*United Nations,* 2011). Compared to primary forests, palm plantations host fewer species of plants and animals, contributing to Southeast Asia's declining biodiversity.

According to studies, Indonesia has contributed most to the deforestation in Southeast Asia, followed by Malaysia, Vietnam, Cambodia, and Thailand (Victor, 2017). It is estimated that Southeast Asia lost about 80 million hectares of forest between 2005 and 2015, and Indonesia accounted for almost two-thirds of that loss, with a 62.0% share, while Malaysia came second with a 16.6% share (*Estoque, Ooba, Avitabile, et al.,* 23 April 2019).

Most alarmingly, deforestation-linked forest fires in Indonesia in 2015 produced GHG emissions higher than in the whole of the European Union (*Reuters*, 29 June 2016), and created a transboundary haze that led to health implications for the broader region. According to the World Bank, the estimated economic cost of the 2015 fires to Indonesia was around IDR221trn (USD16.1bn) or 1.9% of GDP (*World Bank*, February 2016). See chart 61. This is more than twice the reconstruction cost following the 2004 Aceh tsunami and is larger than the estimated value added from the country's entire 2014 palm oil production (USD12bn).

The World Bank analysis estimates the impacts of haze on agriculture, forestry, trade, tourism and transportation. The short-term effect of haze exposure on health and school closures were also included. However, the estimate does not capture the long-term impacts on health of sustained exposure to haze, nor the loss of all ecosystem services. Adding in regional and global costs, the actual figure will likely be much higher. For instance, Singapore's Ministry of Environment and Water Resources estimates that the haze in 2015 cost Singapore around 0.17% of its GDP.

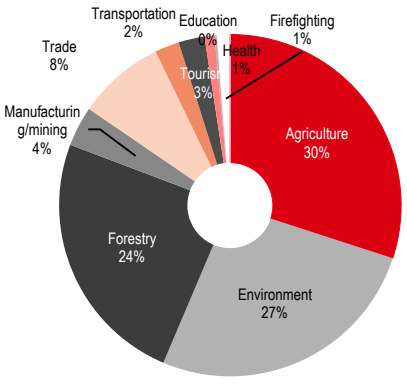
Addressing deforestation

The need to address deforestation has not been lost on ASEAN policymakers. All ASEAN countries have committed to the UN's Sustainable Development Goals (SDGs) as well as the Paris Agreement on Climate Change – both of which recognise the importance of forests in mitigating climate change. Most ASEAN countries are also REDD+ partners (Reducing Emissions from Deforestation and Forest Degradation), which is a program that compensates developing countries for their efforts in reducing deforestation.

Indonesia, under the Jokowi Administration, has been particularly active in combatting deforestation in recent years. In 2011, President Jokowi issued moratorium on new forest clearance for activities, such as palm plantations or logging. This moratorium has now been made permanent and covers around 66 million hectares (254,827 square miles) of primary forest and peatland. The administration has also pledged to cut emissions by 29-41% by 2030, compared to a "business as usual" scenario.

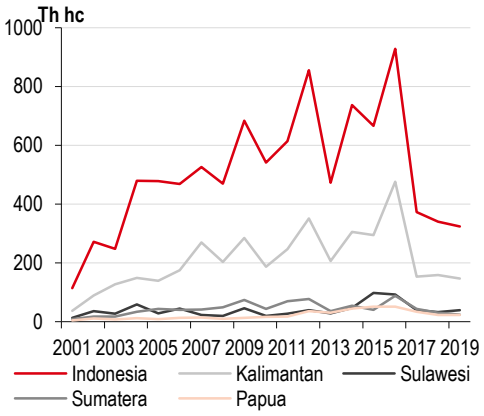
We find that Indonesia has actually made strong progress in reducing deforestation in recent years. According to the World Research Institution, the Jokowi administration's moratorium led to a 45% drop in deforestation inside the moratorium areas in 2018 compared to the average annual rate of loss in the 2002-16 period. The Indonesian government in 2018 also released data showing that the rate of forest loss has been declining from 2015 to 2018 (Chart 62). The data showed deforestation of 440,000 hectares in 2018, which was slightly lower than the 480,000 hectares in 2017 (*World Research Institution*, 24 July 2019). The government aims to limit annual deforestation to 325,000 hectares between 2020 and 2030.

61. Indonesia haze-related damage in 2015, by sector



Source: World Bank

62. Fortunately, the pace of deforestation has moderated sharply under President Jokowi



Source: Forest Watch

This is a redacted version of the report published on 23-Sep-20. Please contact your HSBC representative or email *AskResearch@hsbc.com* for information.

Disclosure appendix

Analyst Certification

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