

Climate-related Health and Environmental Data in Selected Asian Countries

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ABSTRACT

Background. Climate change is a global phenomenon, although its effects vary across regions. In Southeast Asia, including Indonesia, Malaysia, the Philippines, Thailand, and Vietnam, rising temperatures have been documented. The Lancet Countdown on Health and Climate Change has identified key health and environmental indicators associated with climate change.

Objective. This study aimed to examine selected health and environmental factors related to climate change in the Philippines and selected Asian countries.

Methods. This descriptive study utilized secondary data from the Global Burden of Disease Study 2017 Health-related Sustainable Development Goals Indicators, 1990–2030. A database was constructed through the compilation of relevant indicators identified as health and environmental problems associated with climate change, based on the 2018 Lancet Countdown framework. Data were obtained for the following countries: the Philippines, Cambodia, Indonesia, Laos, Malaysia, Thailand, Japan, Singapore, China, Taiwan, and South Korea. Selected indicators included air pollution mortality, non-communicable disease mortality, neglected tropical diseases prevalence, disaster mortality, malaria mortality, household air pollution, ambient PM_{2.5} exposure, unimproved sanitation, and unsafe water.

Results. Trends in health and environmental indicators related to climate change were described across countries. In the Philippines, air pollution mortality peaked in 2012 at 110.54 deaths per 100,000 population, while neighboring countries demonstrated a generally declining trend. Air pollution mortality and household air pollution showed parallel increasing trends in the Philippines, unlike in other countries. Non-communicable disease mortality in the Philippines increased steadily from 425 per 100,000 population in 1990 to 543 in 2017. Indonesia showed a similar increasing trend from 464.7 in 2005 to 494 in 2017. The Philippines recorded the highest prevalence of neglected tropical diseases in Southeast Asia at 28%, with a peak of 70.33% in 2000. Laos had the highest prevalence of unimproved sanitation in 2017 at 62.919%.

Conclusion. This descriptive analysis identified key health and environmental factors associated with climate change in selected Asian countries using Global Burden of Disease data. Findings highlight persistent and emerging climate-related health challenges in the Philippines relative to neighboring countries.

Keywords: climate change, climate-related health factors, Asian countries



eISSN 2094-9278 (Online)
Published: September 30, 2026
<https://doi.org/10.47895/amp.v60i18.3979>
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INTRODUCTION

Climate change is occurring globally and is evidenced by increasingly unpredictable and extreme weather events.¹ At present, it is considered one of the most significant challenges confronting humanity. Its adverse impacts are already observable and are expected to intensify if greenhouse gas emissions are not substantially reduced. Recent scientific assessments confirm that warming of the climate system has been ongoing since the mid-20th century and is highly likely, at 95% probability, attributable to human activities such as fossil fuel combustion and land use changes.^{1,2} These processes contribute to radiative forcing, resulting in sustained increases in global temperature. The resulting environmental changes pose serious threats to ecosystems and human health.¹

Although climate change is a global phenomenon, its impacts vary by region. In Southeast Asia, including Indonesia, Malaysia, the Philippines, Thailand, and Vietnam, rising temperatures have been observed. Alterations in rainfall patterns, particularly those associated with monsoon variability, have also been documented. Analyses of extreme daily temperature and rainfall events across the Asia-Pacific region—including Australia, New Zealand, and parts of China and Japan—demonstrate spatial coherence in the increase of hot days, warm nights, and heat waves, along with a decrease in cold days and frost events.³ However, rainfall trends remain variable across the region.³

The Philippines is among the countries most affected by climate-related disasters.⁴ According to Germanwatch's Global Climate Risk Index, the Philippines ranked 11th overall in climate risk. Increased intensity of storms has contributed to flooding, extreme temperatures, and population displacement. The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAG-ASA) has documented an annual average of approximately 20 tropical cyclones entering the Philippine Area of Responsibility. A slight increase in cyclones with sustained winds exceeding 150 kph has also been observed. Between 1951 and 2000, statistically significant increases in hot days and decreases in cool nights were recorded.¹

Climate change poses a substantial threat to the attainment of the Sustainable Development Goals, particularly in low- and middle-income countries.⁵ It has far-reaching implications for individual and population health.⁶ The magnitude of health impacts depends on population sensitivity, exposure, and adaptive capacity to climate-related risks.¹ Climate change affects water resources, forestry, agriculture, coastal systems, and human health.^{1,7} Rising temperatures may facilitate the spread of water-borne and vector-borne diseases, increasing morbidity and mortality.⁵ Altered rainfall patterns and sea-level rise contribute to tropical cyclones and storm surges, threatening coastal communities. Agricultural disruption may reduce food production, increasing the risk of malnutrition.⁷ Livelihood loss may also result in population

displacement and urban crowding, potentially exacerbating air pollution and associated health problems.¹

The Philippines faces a “triple burden” of disease, characterized by the persistence of infectious diseases, the growing prevalence of non-communicable diseases, and the health consequences of injuries and natural disasters. Given these overlapping vulnerabilities, it is important to examine how climate change influences health outcomes in the country. This study compares the Philippines with selected neighboring countries in terms of climate-related health indicators and evaluates trends in mortality and environmental risk factors associated with climate change. The objective is to assess how the Philippines fares relative to other Asian countries in addressing climate change and health-related goals.

MATERIALS AND METHODS

A database was constructed through the compilation of secondary data from the Global Burden of Disease Study 2017 Health-related Sustainable Development Goals Indicators, 1990–2030.⁸ The GBD initiative generates a Health-related SDG Index score for each country using 41 individual indicators. These indicators are scaled from 0 to 100, representing the degree to which a country has achieved its target. The scaled values are derived from “unscaled” estimates such as deaths per 100,000 population, proportions, and case rates.⁸

Data were extracted for the following Asian countries: the Philippines, Cambodia, Indonesia, Laos, Malaysia, Thailand, Japan, Singapore, China, Taiwan, and South Korea. Selected indicators were included based on their relevance to health and environmental risks associated with climate change, as identified by the *Lancet Countdown on Health and Climate Change 2018*.⁹

The database covered selected years from 1990 to 2017, corresponding to the period with the most complete data across variables. Earlier years contained substantial missing data, while later years primarily consisted of projections. All information used in this study is publicly available and restricted to non-commercial use.

Data were analyzed using exploratory and descriptive trend analyses. Indicators were presented as time-series graphs to facilitate visual comparison across countries. The Philippines was highlighted to allow comparison with neighboring countries in relation to climate change-related health and environmental indicators.

RESULTS

The Philippines is widely recognized as one of the countries most vulnerable to climate change. As an archipelagic nation exposed to extreme weather events, it faces significant challenges related to limited adaptive capacity. Key economic sectors, particularly agriculture and mining, are highly climate-sensitive and have important environmental

implications. The anticipated impacts of climate change include effects on water resources, agriculture, coastal systems, and urban infrastructure, with corresponding consequences for human health such as increased vulnerability to infectious diseases, malnutrition, and climate-related injuries.⁷

Air pollution mortality in the Philippines increased from 89.57 in 1999 to a peak of 110.54 in 2012. In contrast, neighboring countries demonstrated a generally declining trend. For example, Laos recorded a decrease from 251.23 in 1990 to 105.8 in 2017 (Figure 1 and Appendix 1).

Household air pollution prevalence in the Philippines increased from 29.574% in 2000 to 32.236% in 2011, whereas South Korea, Singapore, and Japan reported near-zero prevalence by 2017 (Figure 2 and Appendix 2).

Disaster mortality showed notable spikes corresponding to major events. Indonesia experienced a substantial increase in 2004 due to the earthquake and Indian Ocean tsunami. The Philippines recorded its highest spike in 2013 during Typhoon Haiyan (Yolanda) (Figure 3 and Appendix 3).

Mean PM_{2.5} exposure is associated with increased mortality from respiratory infections, lung cancer, and cardiovascular disease.¹⁰ Indonesia recorded the highest levels, increasing from 81.29 in 1990 to 97.599 in 2011. China peaked in 2011 and subsequently declined. The Philippines remained largely within moderate exposure levels (Figure 4 and Appendix 4).

Non-communicable disease mortality in the Philippines increased from 425 in 1990 to 543 in 2017. Indonesia showed a similar upward trend from 464.7 in 2005 to 494 in 2017. (Figure 5 and Appendix 5).

The Philippines recorded the highest neglected tropical disease prevalence in Southeast Asia at 28%, with a peak of 70.333% in 2000.¹¹ (Figure 6 and Appendix 6).

Unimproved sanitation prevalence declined from 43.05% in 1990 to 11.81% in 2017 in the Philippines. Laos recorded the highest prevalence in 2017 at 62.919%. (Figure 7 and Appendix 7).

Unsafe water prevalence increased in the Philippines from 52.11% in 2004 to 54% in 2010 before declining to 49% in 2017. Diseases attributable to poor water, sanitation, and hygiene account for approximately 4.0% of global deaths and 5.7% of disability (Figure 8 and Appendix 8).¹²

DISCUSSION

Human activities, particularly fossil fuel combustion, contribute substantially to air pollution, which remains a major global public health concern. In many parts of Asia, air pollution levels remain dangerously high.¹³ Of the estimated 7 million premature deaths annually attributable to household and ambient air pollution, approximately 2.2 million occur in the Western Pacific Region.¹³ The World Health Organization (WHO) reports that nine out of ten people worldwide breathe air containing pollutant levels exceeding recommended limits.¹³ Polluted air penetrates

deeply into the respiratory and cardiovascular systems, contributing to significant morbidity and mortality. Nearly all pollution-related deaths occur in low- and middle-income countries, where household air pollution remains a leading cause of death.¹⁴

The present study demonstrates an overall declining trend in air pollution mortality across the Philippines and neighboring countries, reflecting a positive regional development. However, the Philippines experienced an increase in household air pollution prevalence between 2000 and 2011, suggesting persistent domestic exposure risks despite broader regional improvements.

Air pollution is categorized as ambient (outdoor) or household (indoor). Ambient pollution arises from inefficient energy use in households, industry, agriculture, transportation, and coal-fired power generation. Household air pollution results primarily from the incomplete combustion of solid fuels used for cooking and heating.¹⁴ The WHO estimates that household air pollution contributes to approximately 4.3 million deaths annually, representing 7.7% of global mortality, with the majority occurring in low- and middle-income countries.^{14,15} Many households in these settings rely on biomass and other solid fuels as primary domestic energy sources.¹⁵ Wong et al. reported that Asian urban populations may experience higher air pollution exposure than populations in Western industrialized nations due to greater time spent outdoors and less reliance on air-conditioned environments.¹⁶ The same study demonstrated significant associations between pollutant exposure and adverse health outcomes.¹⁶

The Philippines is classified as having moderately unsafe air quality based on WHO guidelines.¹⁷ National data indicate that leading causes of mortality attributable to air pollution include cardiovascular diseases, pneumonia, and chronic lower respiratory diseases, accounting for approximately 206,000 deaths in 2014.¹⁸ Major causes of morbidity include acute respiratory infections, bronchitis, acute lower respiratory tract infections, and pneumonia, with nearly 2.8 million cases reported in the same year.¹⁸ Household air pollution has similarly been associated with acute lower respiratory infections, chronic obstructive pulmonary disease (COPD), lung cancer, and other illnesses.¹⁵

Beyond health consequences, air pollution imposes significant economic burdens. In 2015, pollution-related diseases were estimated to cost the Philippines US\$1.0–1.3 billion in lost productivity, equivalent to 0.3–0.4% of the national gross domestic product.¹⁸ Total economic damages attributable to pollution-related diseases were estimated at US\$23 billion, or 6.5% of gross national income.¹⁸ Earlier estimates placed the cost of morbidity and mortality between US\$86 million and US\$435 million.¹⁹ These findings underscore the substantial economic and health burden of pollution.

Emerging evidence suggests interconnections between air pollution and climate-related processes such as sea-level rise. Vincent et al. estimated that controlling short-lived

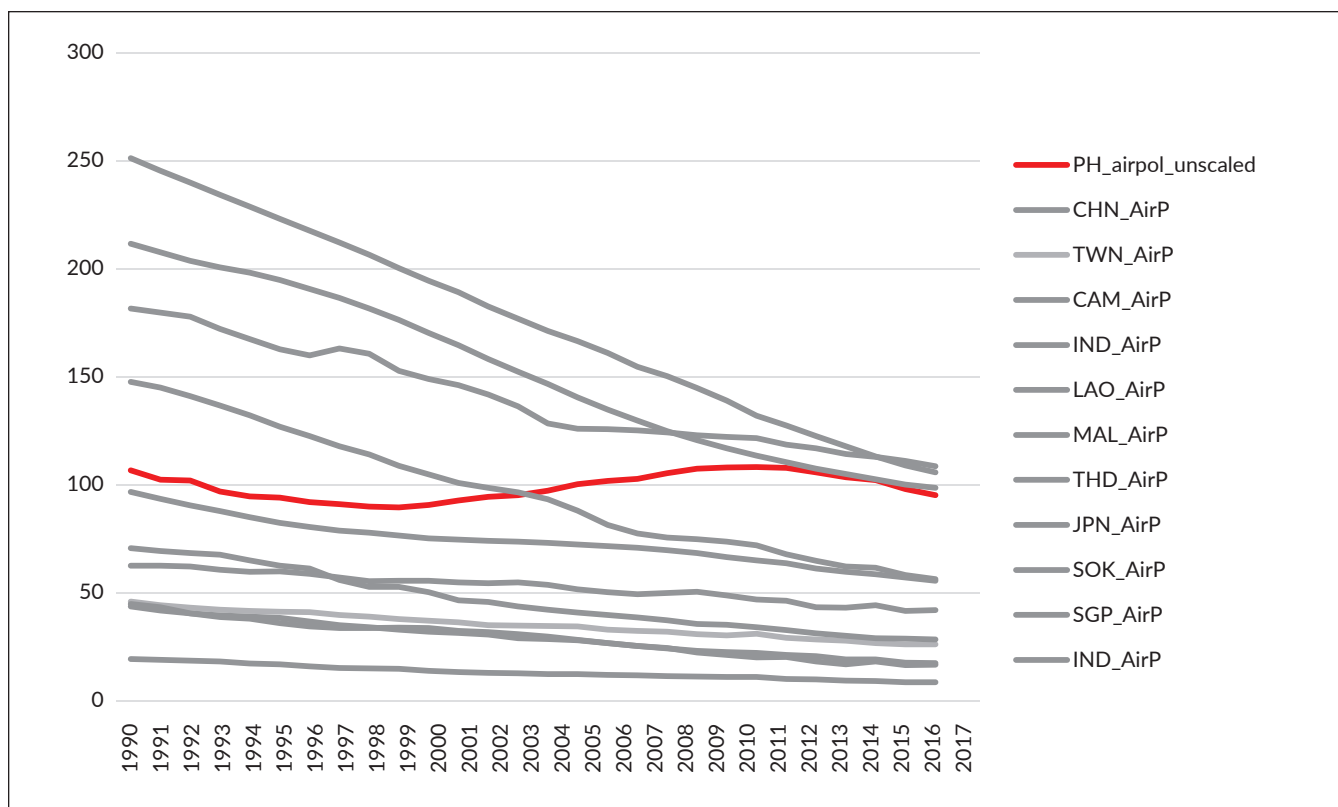


Figure 1. Comparison of air pollution mortality in the Philippines with neighboring countries.

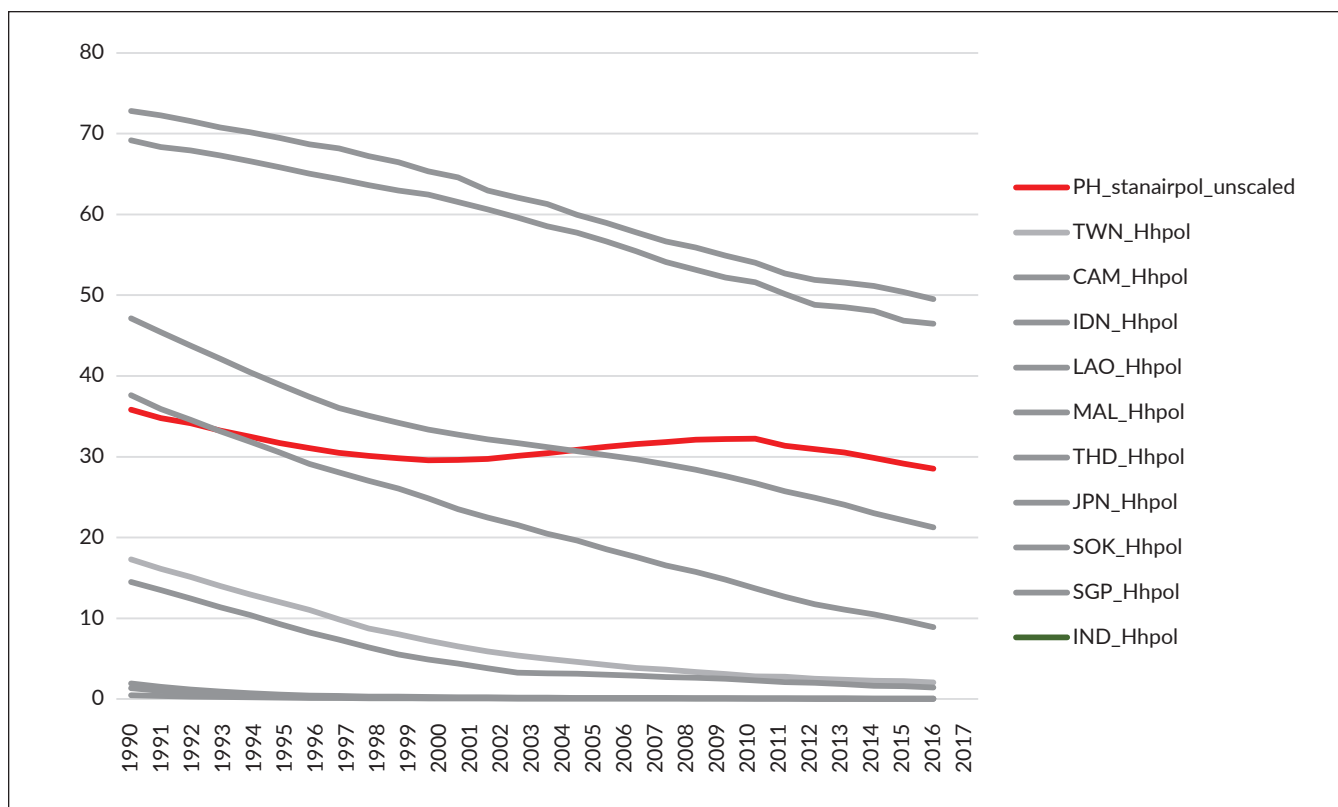


Figure 2. Comparison of the prevalence of household air pollution in the Philippines with neighboring countries.

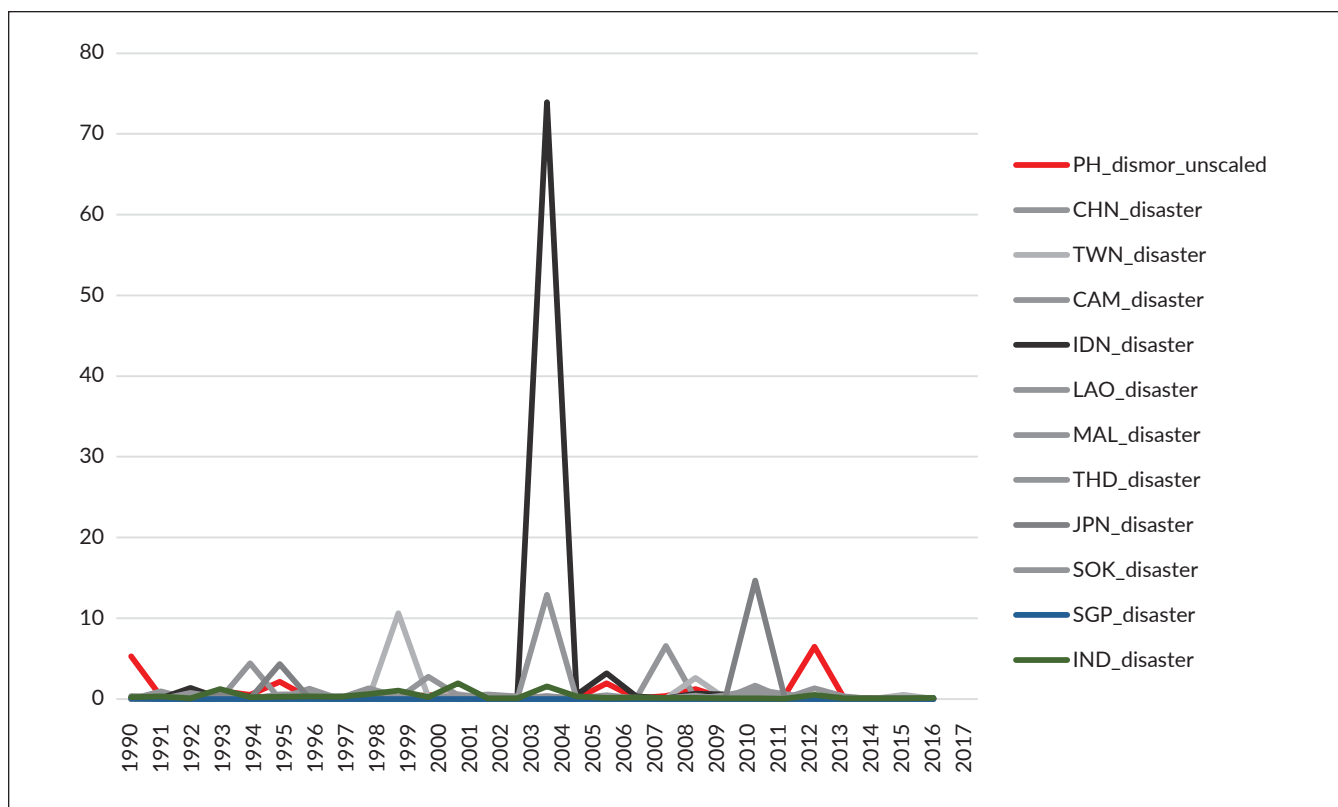


Figure 3. Comparison of disaster mortality in the Philippines with its Asian neighboring countries.

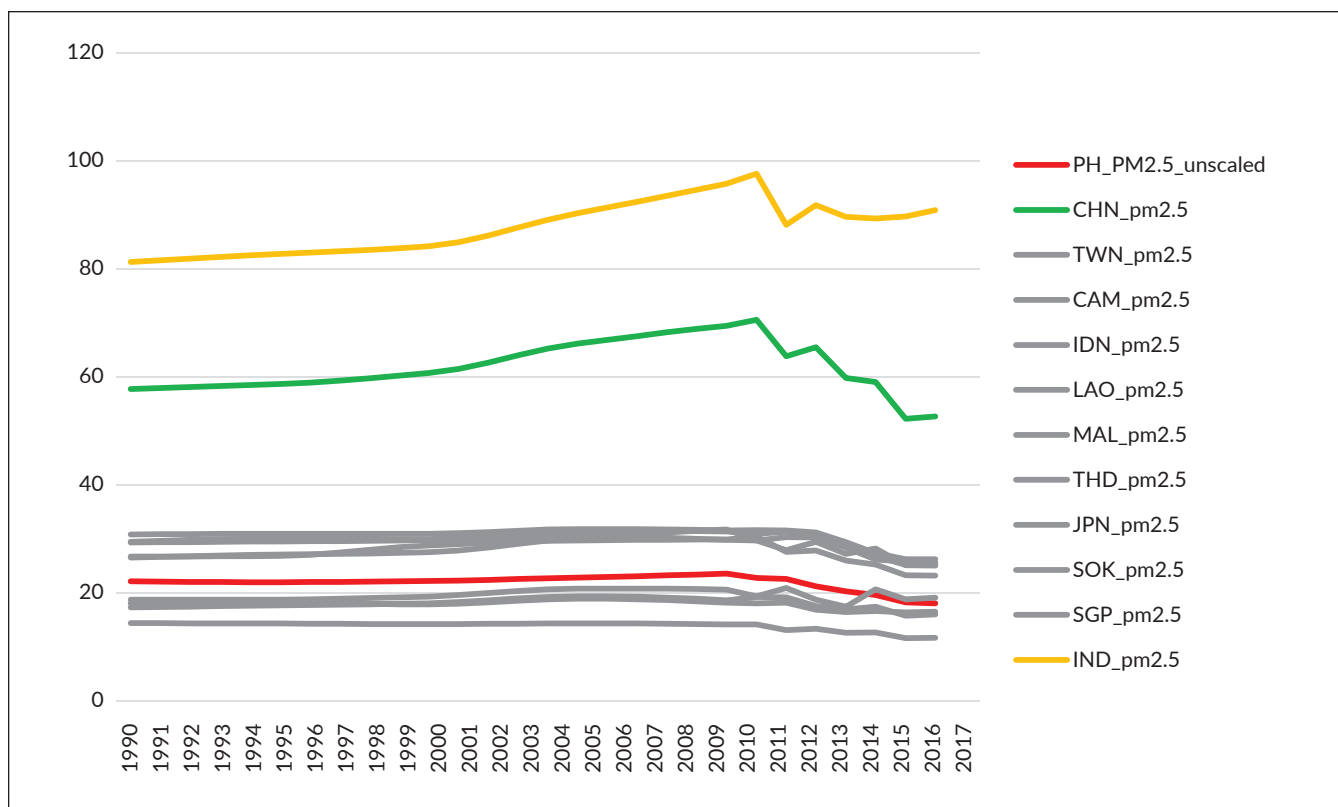


Figure 4. Comparison of Mean PM 2.5 levels in the Philippines with Asian neighboring countries.

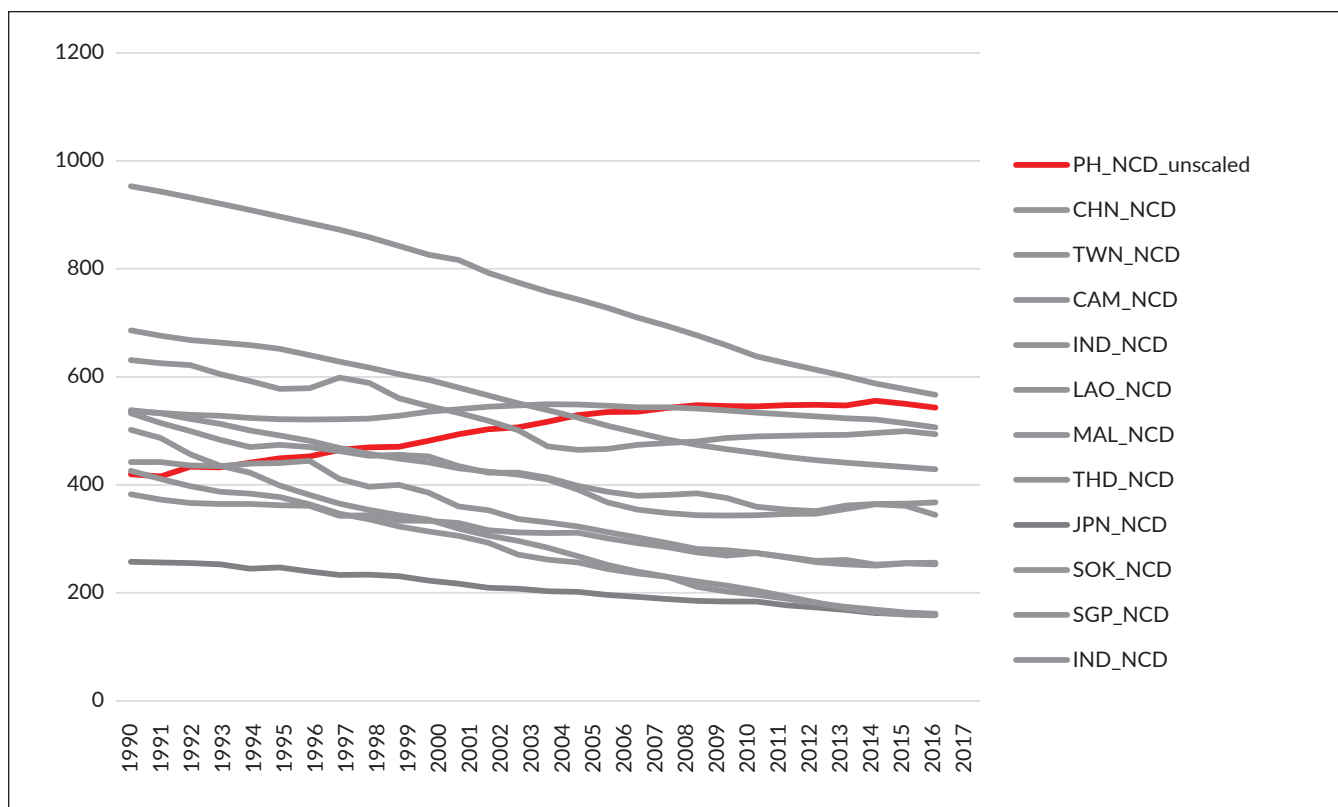


Figure 5. Comparison of mortality of non-communicable diseases (NCD) in the Philippines with Asian neighboring countries.

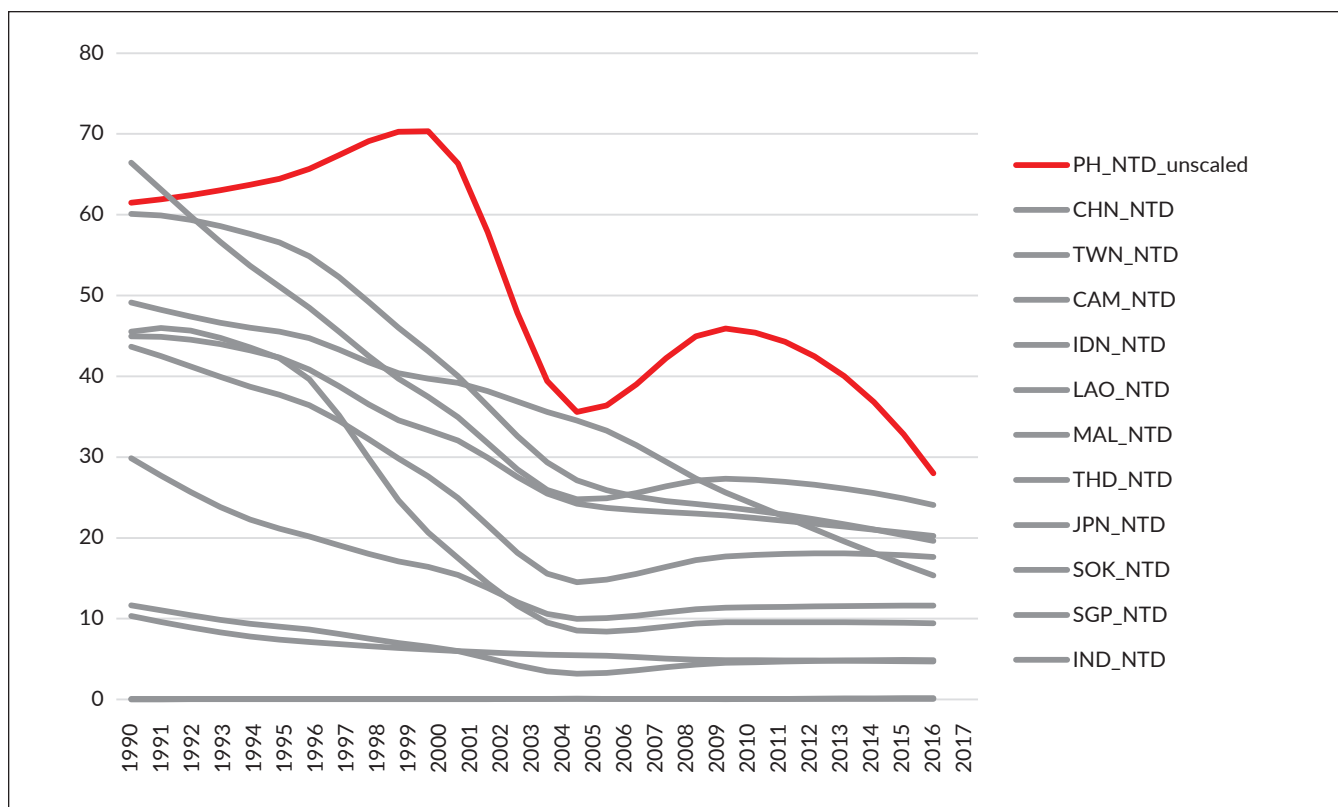


Figure 6. Comparison of the prevalence of neglected tropical diseases in the Philippines and neighboring countries.

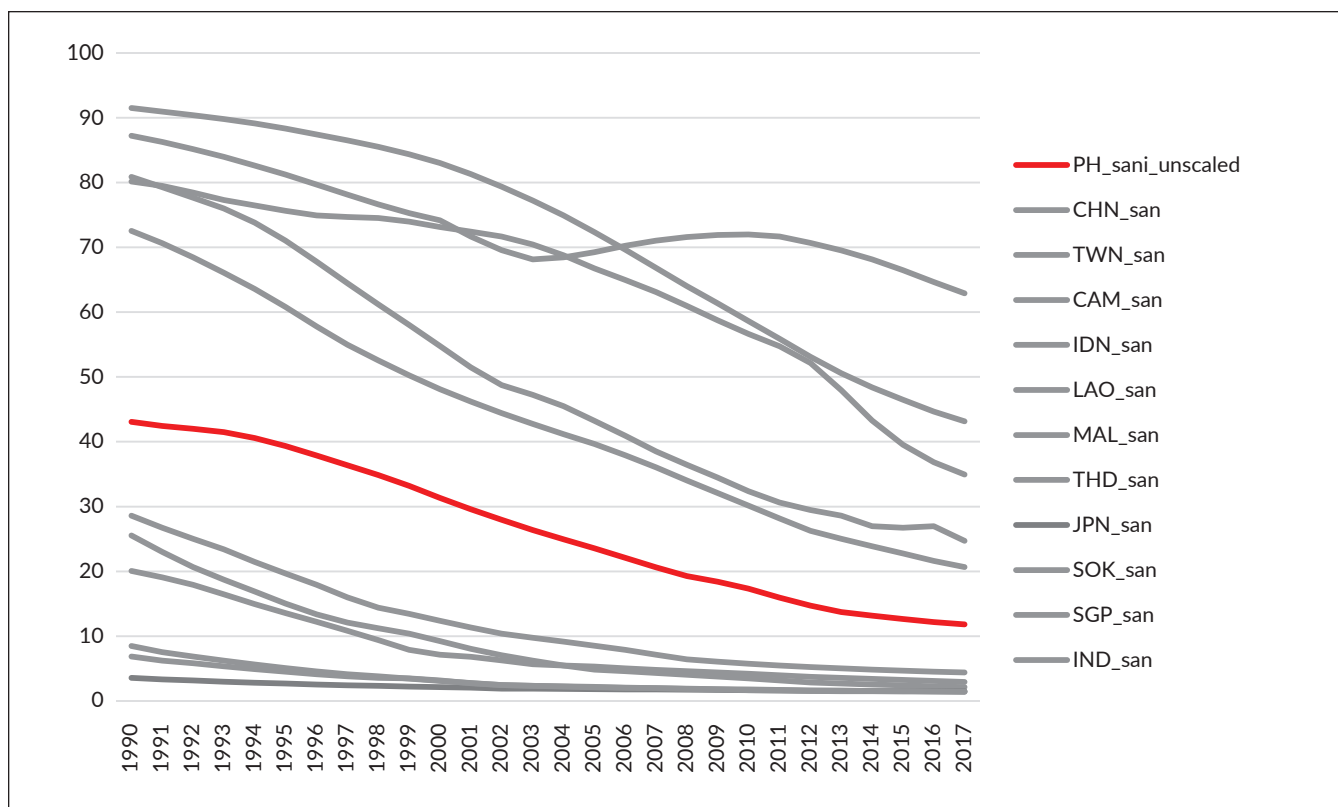


Figure 7. Unimproved sanitation prevalence in the Philippines and neighboring countries.

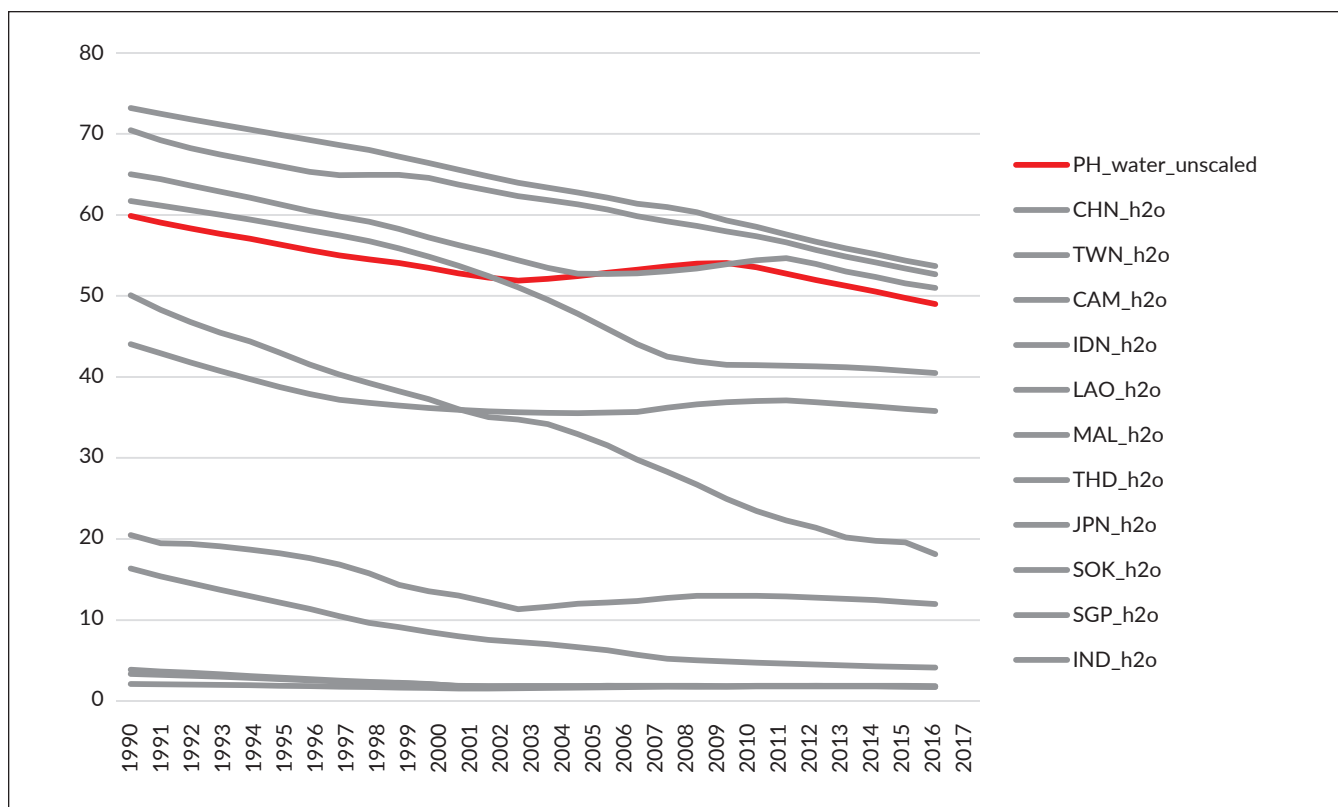


Figure 8. Unsafe water prevalence in the Philippines and neighboring countries.

climate pollutants, including black carbon, methane, hydrofluorocarbons, and tropospheric ozone, could reduce annual sea-level rise by up to 24% by 2100.^{20,21} These pollutants contribute significantly to the anthropogenic greenhouse effect.²¹ A growing body of evidence demonstrates direct and indirect health impacts of climate change, including associations between global warming, air pollution, and respiratory allergic diseases such as asthma and rhinitis.²² Poor air quality is also a major risk factor for child mortality. The UNICEF Child Mortality Report highlighted the association between air pollution exposure and increased mortality among children under one year of age.²³

Non-Communicable Diseases

Non-communicable diseases (NCDs) are the leading causes of mortality and morbidity in the ASEAN region. In the Philippines, NCDs accounted for approximately 70% of deaths and 64% of disabilities in 2016.²⁴ The present study confirms a steady increase in NCD mortality from 1990 to 2017. Indonesia demonstrates a similar upward trend, reflecting an ongoing epidemiological transition characterized by declining communicable diseases and rising NCD burden.^{25,26} Environmental alterations, technological changes, and lifestyle modifications contribute to this shift.²⁷

Globally, approximately 70% of deaths are attributable to NCDs, with 80% occurring in low- and middle-income countries.²⁸ Air pollution is recognized as the second leading risk factor for NCD mortality after tobacco use.²⁸ It accounts for 51% of COPD deaths and 21% of cardiovascular deaths worldwide.²⁹

Although data on direct climate change impacts on NCDs remain limited, emerging evidence indicates that climate-sensitive NCDs include respiratory diseases, type 2 diabetes, and cardiovascular conditions.³⁰⁻³³ Temperature variability, decreased rainfall, urban air pollution, and extreme weather events may exacerbate these conditions.³⁰⁻³³ Traffic-related air pollution has been correlated with increased cardiovascular morbidity and mortality.³⁰ Air pollutants impair oxygen exchange and contribute to vascular inflammation and atherosclerosis.³⁴ Longitudinal studies have demonstrated associations between PM_{2.5} exposure and increased carotid intima-media thickness, as well as elevated cardiovascular mortality among individuals living near major roads.^{34,35}

PM_{2.5}

Fine particulate matter (PM_{2.5}) is a critical air quality indicator due to its ability to penetrate deeply into the lungs and bloodstream, causing systemic inflammation and adverse cardiovascular and respiratory outcomes.³⁶ The Philippines falls within the “moderate” category based on Environmental Protection Agency standards, whereas Indonesia and China exhibit substantially higher levels. Rapid urbanization, industrialization, and economic expansion contribute to elevated PM_{2.5} levels in Indonesia.³⁷ In China, PM_{2.5} exposure has

been linked to significant proportions of stroke, acute lower respiratory infection, and ischemic heart disease mortality.³⁸ Studies have also demonstrated positive correlations between PM_{2.5} concentrations and lung cancer mortality.³⁹

Disaster Mortality

Disaster mortality trends show episodic spikes corresponding to major catastrophic events. The 2004 Indian Ocean earthquake and tsunami resulted in approximately 129,775 deaths and 38,786 missing persons in Indonesia. In the Philippines, the highest disaster mortality occurred in 2013 during Typhoon Haiyan, which caused widespread destruction in Leyte and Eastern Samar.⁴⁰ Disaster severity significantly disrupts health systems and increases the incidence of acute respiratory infections, injuries, hypertension, skin diseases, fever, and diarrheal diseases.⁴¹

Neglected Tropical Diseases

Neglected tropical diseases remain a major public health concern in the Western Pacific Region, affecting approximately 100 million individuals at risk of infection.^{42,43} In the Philippines, six NTDs are of primary public health importance: lymphatic filariasis, schistosomiasis, soil-transmitted helminthiasis, foodborne trematodiasis, rabies, and leprosy.⁴⁴ These conditions disproportionately affect impoverished communities and are strongly linked to inadequate water, sanitation, and hygiene infrastructure.⁴⁴

The present study demonstrates correlations between unimproved sanitation, unsafe water, and NTD prevalence. WASH interventions, combined with mass drug administration, are essential for sustainable control and elimination efforts.^{45,46} Climatic conditions influence parasite survival and transmission dynamics. Increased temperature and humidity facilitate the development and survival of soil-transmitted helminths.^{47,48} Despite progress, many provinces in the Philippines remain endemic for at least one NTD.⁴⁴

CONCLUSION

This descriptive analysis identified key health and environmental indicators scientifically linked to climate change across selected Asian countries using Global Burden of Disease data.

The findings demonstrate temporal trends in air pollution mortality, non-communicable disease mortality, neglected tropical disease prevalence, disaster mortality, malaria mortality, household air pollution, PM_{2.5} exposure, unimproved sanitation, and unsafe water. Statistical associations between environmental exposures and health outcomes highlight the multifaceted relationship between climate change and population health.

Although progress has been observed in several indicators, substantial gaps remain in achieving Sustainable Development Goals related to climate change and health. Strengthened multisectoral interventions addressing environ-

mental risk factors, health system resilience, and climate mitigation strategies are essential to reduce climate-related health burdens in the Philippines and across the region.

Statement of Authorship

The author certified fulfillment of ICMJE authorship criteria.

Author Disclosure

The author declared no conflicts of interest.

Funding Source

The study was funded by the University of the Philippines Resilience Institute.

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APPENDICES

Appendix 1. Air pollution mortality in the Philippines and neighboring countries from 1990 to 2017

	A	B	C	D	E	F	G	H	I	J	K	L
1990	106.745	147.621	46.054	211.67	96.764	251.23	62.694	70.796	19.431	44.893	43.706	181.574
1991	102.386	145.122	44.352	207.655	93.637	245.424	62.675	69.5	19.078	43.335	41.901	179.817
1992	101.95	141.165	43.125	203.756	90.511	239.898	62.164	68.416	18.723	40.479	40.579	177.809
1993	96.956	136.765	42.292	200.695	87.802	234.263	60.808	67.655	18.251	38.902	39.628	172.184
1994	94.598	132.261	41.741	198.226	84.972	228.74	59.746	65.046	17.385	38.169	39.08	167.537
1995	94.034	126.979	41.376	194.899	82.45	223.211	60.064	62.58	17.055	36.014	38.44	162.763
1996	92.082	122.604	41.151	190.639	80.46	217.682	58.886	61.266	15.994	34.433	36.817	160.045
1997	91.054	117.98	39.87	186.494	78.878	212.277	57.115	56.013	15.282	33.757	34.98	163.126
1998	89.947	114.037	39.088	181.641	77.883	206.579	55.448	52.838	15.074	33.727	34.12	160.771
1999	89.572	108.838	37.908	176.36	76.631	200.411	55.552	52.801	14.798	33.887	32.926	152.843
2000	90.638	104.88	37.058	170.404	75.328	194.435	55.603	50.387	13.925	33.687	31.996	148.96
2001	92.809	100.98	36.382	164.644	74.641	189.113	54.849	46.652	13.404	32.5	31.447	146.18
2002	94.41	98.642	35.162	158.354	74.198	182.525	54.488	45.742	12.95	31.824	30.703	141.915
2003	95.32	96.589	34.943	152.404	73.804	176.961	54.875	43.714	12.826	30.905	28.966	136.31
2004	97.387	93.272	34.74	146.808	73.25	171.221	53.708	42.312	12.522	29.744	28.721	128.442
2005	100.343	88.076	34.586	140.555	72.385	166.483	51.644	40.982	12.496	28.359	28.025	126.041
2006	101.812	81.524	33.022	134.935	71.755	161	50.323	39.764	12.087	26.813	26.701	125.739
2007	102.816	77.549	32.421	129.748	70.853	154.77	49.479	38.638	11.839	25.503	25.483	125.182
2008	105.368	75.711	32.076	124.787	69.808	150.347	50.024	37.406	11.581	24.24	24.516	124.381
2009	107.435	74.786	30.99	120.782	68.411	144.858	50.593	35.646	11.271	23.222	22.48	122.92
2010	108.147	73.788	30.35	116.993	66.631	138.987	48.914	35.204	11.117	22.626	21.374	122.172
2011	108.276	72.087	31.203	113.488	65.157	132.124	46.969	34.191	11.075	22.242	20.077	121.662
2012	107.844	67.883	29.223	110.539	63.729	127.486	46.385	32.833	10.203	21.268	20.335	118.644
2013	105.772	64.825	28.413	107.517	61.367	122.62	43.35	31.344	10.055	20.822	18.346	116.916
2014	103.569	62.327	27.842	105.138	59.713	117.941	43.254	30.243	9.387	19.311	16.988	114.35
2015	102.253	61.699	26.772	102.609	58.68	113.163	44.282	29.062	9.139	19.278	18.272	113.012
2016	98	58.336	26.207	100.191	57.074	109.084	41.606	28.803	8.585	17.796	16.676	111.15
2017	95.203	56.477	26.137	98.702	55.697	105.798	42.147	28.53	8.624	17.607	16.693	108.636

Legend: A: Philippines, B: China, C: Taiwan, D: Cambodia, E: Indonesia, F: Laos, G: Malaysia, H: Thailand, I: Japan, J: South Korea, K: Singapore, L: India

Appendix 2. Prevalence of household air pollution in the Philippines and neighboring countries from 1990 to 2017

	A	B	C	D	E	F	G	H	I	J	K	L
1990	35.832	43.107	17.277	72.826	47.145	69.182	14.494	37.622	0.465	1.37	1.925	52.682
1991	34.787	41.457	16.139	72.248	45.409	68.35	13.477	35.906	0.38	1.02	1.5	51.887
1992	34.175	40.066	15.126	71.548	43.736	67.914	12.47	34.561	0.309	0.761	1.184	50.839
1993	33.242	38.734	13.988	70.751	42.143	67.297	11.369	33.159	0.252	0.562	0.927	49.952
1994	32.478	37.428	12.966	70.174	40.447	66.579	10.402	31.879	0.204	0.407	0.712	49.015
1995	31.684	36.049	11.993	69.465	38.91	65.829	9.3	30.523	0.164	0.296	0.541	48.057
1996	31.08	34.519	11.026	68.657	37.401	65.036	8.257	29.114	0.146	0.236	0.446	46.914
1997	30.482	33.126	9.85	68.165	36.05	64.388	7.351	28.083	0.129	0.186	0.374	46.108
1998	30.112	31.86	8.742	67.225	35.064	63.642	6.394	27.02	0.114	0.149	0.314	45.37
1999	29.834	30.692	8.044	66.458	34.197	62.966	5.504	26.039	0.111	0.129	0.286	44.42
2000	29.574	29.546	7.247	65.338	33.38	62.45	4.892	24.841	0.107	0.114	0.265	43.287
2001	29.62	28.276	6.535	64.593	32.758	61.554	4.384	23.523	0.105	0.098	0.23	42.171
2002	29.75	27.147	5.881	62.959	32.137	60.611	3.792	22.482	0.101	0.087	0.209	41.127
2003	30.112	26.029	5.393	62.061	31.691	59.619	3.269	21.543	0.098	0.076	0.188	39.921
2004	30.462	24.827	5	61.275	31.184	58.517	3.2	20.47	0.095	0.069	0.171	38.783
2005	30.867	23.545	4.603	59.963	30.689	57.745	3.144	19.618	0.092	0.062	0.156	37.769
2006	31.256	22.136	4.216	58.943	30.202	56.666	3.004	18.567	0.089	0.056	0.145	36.642
2007	31.558	20.769	3.857	57.777	29.688	55.425	2.878	17.598	0.087	0.051	0.132	35.598
2008	31.805	19.497	3.665	56.654	29.065	54.123	2.744	16.561	0.084	0.046	0.121	34.445
2009	32.105	18.254	3.365	55.914	28.396	53.138	2.653	15.73	0.082	0.043	0.11	33.416
2010	32.176	17.014	3.097	54.907	27.595	52.173	2.52	14.782	0.079	0.04	0.103	32.433
2011	32.236	15.826	2.811	54.024	26.723	51.604	2.314	13.705	0.077	0.037	0.098	31.34
2012	31.343	15.519	2.767	52.697	25.726	50.124	2.112	12.659	0.077	0.036	0.088	31.22
2013	30.947	14.539	2.512	51.913	24.916	48.823	2.007	11.754	0.073	0.033	0.086	29.271
2014	30.532	13.996	2.39	51.573	24.047	48.495	1.851	11.086	0.072	0.032	0.084	27.602
2015	29.876	13.414	2.288	51.142	23.026	48.055	1.659	10.485	0.07	0.03	0.072	26.061
2016	29.157	13.405	2.229	50.396	22.123	46.859	1.594	9.732	0.069	0.029	0.07	24.908
2017	28.514	12.24	2.061	49.508	21.258	46.482	1.427	8.908	0.066	0.029	0.065	23.732

Legend: A: Philippines, B: China, C: Taiwan, D: Cambodia, E: Indonesia, F: Laos, G: Malaysia, H: Thailand, I: Japan, J: South Korea, K: Singapore, L: India

Appendix 3. Disaster mortality in the Philippines and neighboring countries from 1990 to 2017

	A	B	C	D	E	F	G	H	I	J	K	L
1990	5.258	0.111	0.049	0	0.124	0	0	0.086	0.116	0.348	0.031	0.238
1991	0.304	0.177	0.175	0.936	0.092	0	0	0.095	0.139	0.282	0	0.296
1992	0.117	0.119	0.053	0	1.373	0.731	0	0.01	0.031	0.011	0	0.1
1993	0.985	0.127	0.005	0	0.069	0.178	0.527	0.076	0.378	0.071	0	1.219
1994	0.529	0.249	0.142	4.433	0.309	0	0	0.187	0.017	0.062	0	0.234
1995	2.131	0.192	0.014	0	0.115	0.55	0.097	0.426	4.323	0.273	0	0.247
1996	0.114	0.426	0.324	0.5	0.145	0.619	1.267	0.164	0.053	0.133	0	0.291
1997	0.067	0.132	0.248	0.208	0.01	0	0.009	0.344	0.046	0.067	0	0.246
1998	0.203	0.351	0.091	0	0.018	0	0	0.002	0.07	1.312	0	0.582
1999	0.196	0.117	10.633	0.056	0.024	0	0.004	0.038	0.117	0.247	0	1.053
2000	0.457	0.037	0.171	2.747	0.218	0.281	0.071	0.173	0.034	0.143	0	0.213
2001	0.39	0.071	0.615	0.437	0.268	0	0.039	0.35	0.033	0.232	0	1.936
2002	0.094	0.108	0.053	0.223	0.113	0.036	0.086	0.297	0.021	0.533	0	0.081
2003	0.236	0.083	0.013	0	0.207	0	0.051	0.014	0.046	0.314	0	0.057
2004	0.262	0.059	0.202	0	73.913	0	0.384	12.879	0.169	0.103	0	1.566
2005	0.026	0.056	0.167	0.118	0.527	0	0.04	0.074	0.031	0.088	0	0.326
2006	1.927	0.071	0.048	0.036	3.17	0	0.062	0.466	0.066	0.198	0	0.118
2007	0.09	0.085	0.03	0.014	0.296	0	0.178	0.08	0.039	0.054	0	0.172
2008	0.348	6.567	0.074	0	0.056	0.097	0.026	0.058	0.041	0.043	0	0.143
2009	1.211	0.043	2.594	0.132	0.627	0.415	0.022	0.027	0.04	0.027	0	0.134
2010	0.043	0.518	0.06	0.055	0.536	0	0.014	0.438	0.028	0.045	0	0.079
2011	0.686	0.061	0.004	1.672	0.053	0.745	0.098	1.167	14.677	0.273	0	0.065
2012	0.457	0.061	0.081	0.093	0.037	0	0.021	0.597	0.067	0.048	0	0.026
2013	6.477	0.105	0.043	1.314	0.069	0.348	0.017	0.123	0.07	0.02	0	0.5
2014	0.065	0.116	0	0.291	0.097	0	0.064	0.047	0.201	0.101	0	0.065
2015	0.094	0.035	0.038	0	0.021	0	0.084	0.003	0.023	0.002	0	0.083
2016	0.085	0.07	0.522	0	0.075	0.073	0	0.045	0.063	0	0	0.059
2017	0.067	0.041	0.021	0	0.041	0	0.029	0.109	0.04	0	0	0.143

Legend: A: Philippines, B: China, C: Taiwan, D: Cambodia, E: Indonesia, F: Laos, G: Malaysia, H: Thailand, I: Japan, J: South Korea, K: Singapore, L: India

Appendix 4. Mean PM 2.5 levels in the Philippines and neighboring countries from 1990 to 2017

	A	B	C	D	E	F	G	H	I	J	K	L
1990	22.116	57.765	26.712	29.478	18.053	26.536	17.294	30.832	14.416	29.331	18.724	81.291
1991	22.06	57.917	26.715	29.655	18.104	26.674	17.376	30.866	14.393	29.372	18.714	81.609
1992	22.018	58.094	26.734	29.809	18.139	26.806	17.459	30.894	14.368	29.418	18.713	81.92
1993	21.989	58.283	26.765	29.933	18.159	26.925	17.54	30.917	14.345	29.461	18.72	82.221
1994	21.973	58.475	26.806	30.021	18.167	27.024	17.615	30.933	14.326	29.498	18.735	82.508
1995	21.97	58.66	26.855	30.067	18.165	27.095	17.683	30.94	14.313	29.521	18.755	82.771
1996	21.989	58.91	27.055	30.066	18.129	27.151	17.745	30.942	14.295	29.547	18.803	83.009
1997	22.033	59.275	27.471	30.035	18.053	27.215	17.81	30.944	14.267	29.594	18.894	83.244
1998	22.09	59.721	27.981	29.994	17.966	27.296	17.884	30.947	14.238	29.651	19.018	83.502
1999	22.151	60.21	28.464	29.966	17.898	27.403	17.971	30.952	14.216	29.711	19.165	83.802
2000	22.204	60.705	28.798	29.974	17.877	27.545	18.076	30.96	14.21	29.765	19.323	84.165
2001	22.284	61.48	29.025	30.14	17.996	27.863	18.285	31.054	14.226	29.864	19.579	84.902
2002	22.413	62.663	29.253	30.49	18.259	28.409	18.617	31.262	14.26	30.027	19.958	86.141
2003	22.564	64.005	29.459	30.9	18.569	29.059	18.975	31.508	14.299	30.205	20.356	87.63
2004	22.709	65.258	29.621	31.248	18.824	29.687	19.261	31.715	14.332	30.348	20.671	89.111
2005	22.819	66.175	29.716	31.409	18.927	30.17	19.378	31.807	14.349	30.407	20.801	90.326
2006	22.922	66.859	29.767	31.435	18.896	30.532	19.355	31.812	14.342	30.383	20.803	91.358
2007	23.062	67.561	29.813	31.451	18.81	30.875	19.277	31.801	14.316	30.312	20.794	92.444
2008	23.227	68.251	29.846	31.448	18.664	31.193	19.132	31.764	14.272	30.192	20.766	93.556
2009	23.407	68.9	29.863	31.416	18.452	31.481	18.909	31.69	14.214	30.022	20.708	94.668
2010	23.592	69.48	29.859	31.343	18.169	31.732	18.594	31.565	14.142	29.802	20.609	95.758
2011	22.755	70.542	30.457	30.92	18.05	29.67	19.203	31.61	14.141	29.681	19.349	97.599
2012	22.55	63.827	27.603	31.284	18.17	30.297	19.182	31.525	13.129	27.916	20.886	88.169
2013	21.216	65.515	27.819	30.337	16.879	30.259	17.554	31.175	13.363	29.462	18.707	91.805
2014	20.26	59.767	25.981	28.583	16.455	28.39	16.923	29.365	12.587	27.213	17.409	89.622
2015	19.582	59.063	25.252	26.769	16.64	26.139	17.441	27.345	12.687	28.214	20.663	89.303
2016	18.227	52.211	23.264	25.203	16.384	25.801	15.751	26.258	11.624	25.099	18.798	89.672
2017	18.07	52.665	23.192	25.614	16.503	25.11	16.036	26.257	11.705	25.039	19.078	90.873

Legend: A: Philippines, B: China, C: Taiwan, D: Cambodia, E: Indonesia, F: Laos, G: Malaysia, H: Thailand, I: Japan, J: South Korea, K: Singapore, L: India

Appendix 5. NCD Mortality in the Philippines and neighboring countries from 1990 to 2017

	A	B	C	D	E	F	G	H	I	J	K	L
1990	419.959	538.45	382.851	686.344	536.699	953.304	532.667	442.027	257.777	502.147	425.916	630.963
1991	415.435	532.675	372.923	676.292	533.076	943.524	514.947	442.356	256.287	487.106	411.17	625.045
1992	433.823	522.449	366.544	668.047	530.023	932.071	499.843	436.154	255.482	456.618	397.451	622.104
1993	432.547	512.799	364.667	663.786	527.76	920.92	483.56	434.9	252.725	435.23	387.183	605.103
1994	441.345	500.52	364.616	658.62	524.231	909.343	469.93	439.175	245.072	422.841	383.634	592.518
1995	449.295	491.34	362.59	652.037	521.827	896.881	474.355	440.471	246.948	398.989	377.292	577.91
1996	452.985	481.584	361.468	640.604	521.319	884.68	470.136	444.381	239.766	381.321	364.04	578.992
1997	464.905	468.202	342.725	628.486	521.463	872.665	462.693	410.787	233.241	365.329	347.03	598.753
1998	469.566	457.549	343.788	617.058	522.882	858.828	453.842	396.583	233.987	353.485	336.366	589.099
1999	470.734	448.494	334.072	605.25	527.807	842.675	455.617	400.059	231.215	344.148	323.047	560.446
2000	481.599	441.997	333.728	594.404	535.402	826.482	452.848	385.37	222.609	335.539	313.818	546.109
2001	494.128	430.706	329.266	579.868	539.974	816.395	434.765	360.043	216.919	318.791	305.749	533.382
2002	503.386	424.611	316.147	565.386	544.606	792.429	422.562	353.35	209.613	306.235	292.691	518.529
2003	506.754	419.217	311.944	551.026	547.413	774.798	422.64	337.006	207.69	296.171	270.695	501.353
2004	517.31	409.701	310.742	538.328	549.239	757.971	413.157	330.611	203.132	283.707	261.902	471.382
2005	529.268	391.312	311.252	524.468	548.766	743.405	398.416	322.839	202.161	267.792	256.482	464.702
2006	535.168	367.882	300.8	509.403	546.63	727.739	387.022	312.58	196.156	251.909	244.308	466.641
2007	535.801	354.469	292.296	496.727	543.532	709.666	379.558	302.458	192.662	239.474	236.214	473.915
2008	542.237	347.925	284.732	483.976	543.59	694.05	381.532	292.571	188.52	229.549	229.548	477.913
2009	547.611	343.913	274.735	474.231	541.62	677.114	384.18	281.346	185.366	221.135	211.293	480.374
2010	545.775	343.541	268.895	466.131	537.812	658.321	375.645	279.209	184.312	213.433	202.517	486.65
2011	545.246	343.863	274.055	458.967	533.726	638.015	359.435	273.589	183.77	204.126	196.794	489.958
2012	547.609	346.103	267.044	451.869	530.095	625.25	354.311	265.832	177.33	193.275	189.368	491.036
2013	548.288	346.884	259.581	445.613	526.723	613.185	351.152	256.747	173.19	182.034	180.912	492.017
2014	547.012	355.165	261.238	441.007	523.483	601.2	361.835	253.102	168.659	172.152	173.92	492.957
2015	556.107	364.103	252.282	437.139	520.859	587.775	364.543	250.679	162.511	164.554	168.841	496.279
2016	550.069	361.18	255.281	433.323	513.934	577.192	365.439	254.509	160.88	159.436	163.511	499.537
2017	543.085	344.428	255.576	429.01	506.745	566.743	367.36	252.818	160.581	158.361	161.577	494.029

Legend: A: Philippines, B: China, C: Taiwan, D: Cambodia, E: Indonesia, F: Laos, G: Malaysia, H: Thailand, I: Japan, J: South Korea, K: Singapore, L: India

Appendix 6. Neglected tropical diseases in the Philippines and neighboring countries from 1990 to 2017

	A	B	C	D	E	F	G	H	I	J	K	L
1990	61.49	29.861	11.66	60.121	66.456	44.943	45.542	43.655	0.063	10.33	0.023	49.139
1991	61.898	27.722	11.042	59.898	63.138	44.884	45.992	42.498	0.063	9.596	0.025	48.239
1992	62.419	25.674	10.42	59.365	59.823	44.551	45.66	41.221	0.063	8.909	0.027	47.394
1993	63.033	23.826	9.842	58.588	56.633	43.984	44.772	39.928	0.064	8.299	0.029	46.641
1994	63.718	22.283	9.358	57.63	53.688	43.22	43.557	38.722	0.064	7.794	0.03	46.012
1995	64.455	21.154	9.018	56.558	51.106	42.3	42.24	37.707	0.064	7.424	0.031	45.541
1996	65.657	20.177	8.654	54.873	48.483	40.847	39.658	36.417	0.064	7.135	0.032	44.722
1997	67.391	19.096	8.127	52.295	45.52	38.769	35.18	34.498	0.064	6.86	0.032	43.309
1998	69.112	18.029	7.536	49.216	42.502	36.52	29.835	32.214	0.065	6.605	0.032	41.723
1999	70.272	17.095	6.976	46.03	39.718	34.558	24.655	29.834	0.065	6.377	0.033	40.384
2000	70.327	16.413	6.545	43.127	37.459	33.337	20.668	27.623	0.065	6.182	0.034	39.711
2001	66.361	15.423	5.985	40.021	34.963	32.045	17.515	24.959	0.065	6.002	0.04	39.182
2002	57.855	13.805	5.132	36.326	31.738	29.934	14.381	21.551	0.065	5.825	0.055	38.16
2003	47.861	12.04	4.224	32.585	28.494	27.558	11.609	18.166	0.065	5.669	0.072	36.888
2004	39.428	10.605	3.496	29.344	25.937	25.475	9.542	15.572	0.065	5.552	0.086	35.602
2005	35.607	9.976	3.187	27.145	24.772	24.239	8.525	14.534	0.065	5.492	0.092	34.531
2006	36.403	10.067	3.299	25.908	24.902	23.735	8.393	14.827	0.065	5.41	0.088	33.278
2007	39.006	10.385	3.603	25.095	25.552	23.419	8.622	15.544	0.065	5.25	0.08	31.478
2008	42.243	10.796	3.986	24.569	26.393	23.209	9.022	16.433	0.065	5.067	0.07	29.412
2009	44.943	11.166	4.334	24.19	27.098	23.022	9.4	17.24	0.065	4.918	0.061	27.365
2010	45.932	11.359	4.535	23.819	27.336	22.776	9.565	17.714	0.065	4.857	0.058	25.625
2011	45.394	11.417	4.622	23.374	27.18	22.46	9.563	17.905	0.064	4.855	0.064	24.121
2012	44.263	11.474	4.702	22.869	26.927	22.124	9.565	18.031	0.064	4.848	0.08	22.599
2013	42.49	11.526	4.771	22.31	26.571	21.771	9.564	18.091	0.064	4.834	0.102	21.077
2014	40.025	11.571	4.827	21.701	26.111	21.404	9.555	18.082	0.064	4.813	0.124	19.574
2015	36.82	11.604	4.866	21.049	25.544	21.027	9.532	18.005	0.064	4.785	0.143	18.11
2016	32.826	11.621	4.885	20.357	24.866	20.644	9.49	17.858	0.064	4.748	0.155	16.702
2017	27.996	11.622	4.88	19.632	24.076	20.258	9.422	17.637	0.064	4.704	0.155	15.368

Legend: A: Philippines, B: China, C: Taiwan, D: Cambodia, E: Indonesia, F: Laos, G: Malaysia, H: Thailand, I: Japan, J: South Korea, K: Singapore, L: India

Appendix 7. Unimproved sanitation prevalence in the Philippines and neighboring countries from 1990 to 2017

	A	B	C	D	E	F	G	H	I	J	K	L
1990	43.053	80.875	28.585	91.497	72.557	87.215	20.059	25.55	3.548	8.485	6.854	80.156
1991	42.444	79.299	26.726	90.957	70.655	86.247	19.078	22.984	3.322	7.526	6.242	79.487
1992	41.984	77.668	25.037	90.379	68.453	85.169	17.911	20.668	3.151	6.848	5.827	78.437
1993	41.465	75.978	23.407	89.789	66.072	83.965	16.452	18.703	2.985	6.213	5.346	77.31
1994	40.565	73.823	21.456	89.11	63.586	82.626	14.929	16.873	2.828	5.625	4.907	76.47
1995	39.326	71.02	19.682	88.312	60.781	81.211	13.58	15.036	2.677	5.069	4.504	75.629
1996	37.87	67.772	17.919	87.432	57.768	79.69	12.202	13.364	2.547	4.57	4.123	74.922
1997	36.354	64.436	15.987	86.509	54.97	78.114	10.83	12.105	2.427	4.127	3.79	74.665
1998	34.847	61.197	14.381	85.525	52.56	76.638	9.406	11.227	2.323	3.79	3.571	74.53
1999	33.187	58.015	13.447	84.359	50.233	75.268	7.896	10.39	2.23	3.44	3.474	73.961
2000	31.332	54.771	12.389	83.02	48.119	74.152	7.135	9.254	2.144	3.094	3.17	73.138
2001	29.603	51.476	11.338	81.289	46.193	71.659	6.833	8.044	2.052	2.776	2.745	72.416
2002	27.965	48.749	10.402	79.357	44.429	69.569	6.249	7.057	1.918	2.462	2.443	71.663
2003	26.352	47.247	9.752	77.212	42.735	68.126	5.679	6.22	1.886	2.331	2.341	70.434
2004	24.933	45.49	9.172	74.909	41.155	68.451	5.472	5.467	1.846	2.215	2.253	68.765
2005	23.537	43.241	8.514	72.343	39.655	69.231	5.316	4.825	1.814	2.116	2.176	66.755
2006	22.099	40.946	7.907	69.645	37.908	70.226	5.026	4.599	1.78	2.019	2.068	64.976
2007	20.633	38.505	7.133	66.818	36.067	71.021	4.781	4.321	1.767	1.959	1.967	63.087
2008	19.258	36.447	6.431	64.015	34.024	71.594	4.61	4.027	1.742	1.896	1.859	60.941
2009	18.392	34.451	6.062	61.346	32.085	71.907	4.415	3.763	1.712	1.836	1.761	58.719
2010	17.341	32.36	5.739	58.613	30.145	71.976	4.188	3.473	1.675	1.767	1.678	56.627
2011	15.956	30.628	5.485	55.875	28.175	71.667	3.974	3.182	1.632	1.697	1.618	54.717
2012	14.715	29.446	5.244	53.122	26.234	70.663	3.742	2.865	1.574	1.616	1.539	52.159
2013	13.737	28.577	5.024	50.572	25.025	69.515	3.555	2.702	1.567	1.586	1.517	47.951
2014	13.149	26.948	4.826	48.394	23.875	68.119	3.402	2.542	1.56	1.56	1.504	43.253
2015	12.641	26.73	4.662	46.482	22.743	66.467	3.242	2.4	1.551	1.525	1.477	39.526
2016	12.165	26.978	4.521	44.638	21.631	64.636	3.073	2.261	1.538	1.483	1.446	36.86
2017	11.811	24.705	4.384	43.141	20.662	62.919	2.916	2.147	1.512	1.441	1.414	34.938

Legend: A: Philippines, B: China, C: Taiwan, D: Cambodia, E: Indonesia, F: Laos, G: Malaysia, H: Thailand, I: Japan, J: South Korea, K: Singapore, L: India

Appendix 8. Unsafe water prevalence in the Philippines and neighboring countries from 1990 to 2017

	A	B	C	D	E	F	G	H	I	J	K	L
1990	59.896	50.098	16.375	61.714	44.062	73.189	20.49	70.461	2.111	3.889	3.363	65.005
1991	59.058	48.298	15.392	61.145	42.908	72.479	19.479	69.238	2.072	3.66	3.231	64.421
1992	58.356	46.806	14.555	60.577	41.812	71.822	19.407	68.264	2.037	3.482	3.134	63.631
1993	57.683	45.48	13.738	60.041	40.733	71.165	19.102	67.455	1.992	3.292	2.99	62.873
1994	57.061	44.376	12.938	59.44	39.73	70.524	18.674	66.753	1.943	3.101	2.844	62.122
1995	56.352	42.982	12.179	58.793	38.761	69.887	18.223	66.014	1.889	2.908	2.699	61.303
1996	55.654	41.549	11.388	58.134	37.889	69.249	17.632	65.331	1.838	2.721	2.549	60.466
1997	55.02	40.314	10.47	57.475	37.194	68.622	16.868	64.924	1.78	2.536	2.404	59.809
1998	54.527	39.248	9.635	56.76	36.808	68.01	15.775	64.939	1.724	2.387	2.301	59.161
1999	54.058	38.247	9.106	55.859	36.454	67.196	14.331	64.938	1.668	2.225	2.25	58.252
2000	53.48	37.24	8.505	54.871	36.174	66.411	13.558	64.568	1.612	2.058	2.096	57.214
2001	52.79	36.023	8.004	53.718	35.955	65.588	13.019	63.752	1.533	1.876	1.859	56.269
2002	52.268	35.044	7.556	52.459	35.775	64.764	12.185	63.017	1.55	1.834	1.817	55.384
2003	51.89	34.755	7.274	51.071	35.645	63.967	11.335	62.33	1.59	1.838	1.833	54.419
2004	52.112	34.165	7.019	49.541	35.567	63.354	11.637	61.825	1.62	1.838	1.848	53.471
2005	52.47	32.941	6.636	47.814	35.54	62.761	12.014	61.324	1.651	1.839	1.861	52.756
2006	52.871	31.568	6.26	45.928	35.599	62.148	12.168	60.649	1.711	1.87	1.886	52.73
2007	53.223	29.786	5.702	44.034	35.672	61.396	12.352	59.854	1.745	1.875	1.863	52.803
2008	53.645	28.304	5.206	42.492	36.201	60.966	12.734	59.222	1.77	1.873	1.83	53.045
2009	54.006	26.724	5.041	41.909	36.609	60.312	12.999	58.644	1.787	1.866	1.798	53.405
2010	54.047	24.952	4.867	41.51	36.887	59.331	13.003	57.982	1.792	1.846	1.771	53.92
2011	53.546	23.463	4.74	41.459	37.043	58.518	12.975	57.361	1.833	1.866	1.796	54.403
2012	52.751	22.273	4.619	41.374	37.119	57.583	12.922	56.605	1.853	1.867	1.798	54.656
2013	51.976	21.395	4.498	41.32	36.892	56.683	12.749	55.695	1.872	1.864	1.804	53.945
2014	51.251	20.185	4.388	41.212	36.634	55.847	12.597	54.853	1.883	1.858	1.811	53.007
2015	50.551	19.775	4.3	41.027	36.366	55.154	12.464	54.135	1.882	1.834	1.794	52.333
2016	49.761	19.596	4.211	40.738	36.054	54.361	12.214	53.392	1.871	1.801	1.766	51.563
2017	49.009	18.122	4.124	40.489	35.778	53.683	11.964	52.695	1.848	1.767	1.739	51.004

Legend: A: Philippines, B: China, C: Taiwan, D: Cambodia, E: Indonesia, F: Laos, G: Malaysia, H: Thailand, I: Japan, J: South Korea, K: Singapore, L: India