



# Public Health, Climate Change, and Technology: Innovating Toward a Healthier Asia

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## EXECUTIVE SUMMARY

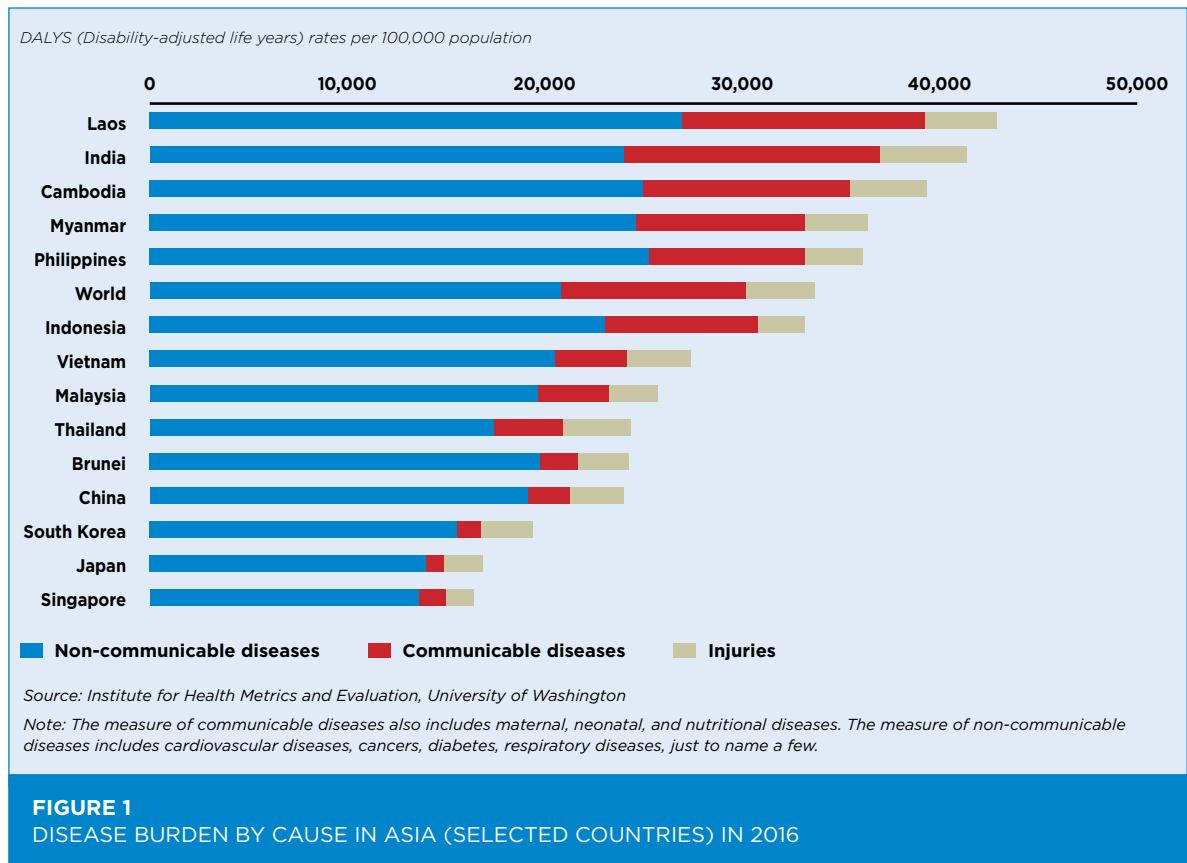
Public health and climate change are both great challenges for Asia. Together they create a nexus of concern that could become the next big crisis for the region. While rapid economic development has pulled hundreds of millions out of poverty and people's health and lives are much improved, Asia is dealing with an emerging set of health problems that are worsened by the effects of climate change.

Extreme weather events and warming temperatures accelerate disease spread. Developing economies, in ASEAN and India, which already suffer from communicable or infectious diseases as well as diseases related to poor sanitation and hygiene, are particularly affected. Increased industrial activity causing air pollution and haze leading to non-communicable respiratory and cardiovascular diseases affect countries that have experienced rapid industrialization, notably China. President Xi Jinping has put health at the center of policy-making, tying it to the country's future economic prosperity. Climate change destroys habitats of animal species and at the same time urbanization means humans are encroaching upon animal habitats, heightening pandemic risks related to animal-human cross-contamination. Moreover, densely packed populations in cities accelerate disease spread. Primary healthcare systems, already weak in many Asian countries, will come under increasing strain.

Public health should be a priority consideration for government and business alike. The actions of governments in the region are important, to set the regulatory tone. But the private sector is the nimblest actor in terms of implementation and often has resources that governments don't, especially in poorer countries. In particular, technological innovation has the potential, if properly harnessed, to help Asia make dramatic leaps in addressing health challenges. This briefing reviews case examples of businesses that have taken action to improve public health, through investing in scientific research on vector-borne diseases and technologies such as artificial intelligence and blockchain, making philanthropic efforts to fight disease spread and climate change, and moving to lower-carbon energy sources. These efforts to tackle the dual challenge of public health and climate change help businesses earn a social license to operate and boost the bottom line by ensuring that countries have healthy workers and consumers to sustain growth.

## DISEASES OF CONCERN

Diseases lead to death and also the loss of productive life. A commonly used measure of disease burden is the number of disability-adjusted life years (DALYs) lost per 100,000 individuals per year. Many developing Asian countries, notably in Southeast and South Asia, have disease burdens well above the global average. For example, Laos, India, Cambodia, and Myanmar have a mean DALY loss of around 40,000, which means that the equivalent of 40,000 years of healthy life were lost on average for every 100,000 people in the four countries per year due to disease, well above the global average of 34,000 years (see Figure 1). One DALY equals one lost year of healthy life.<sup>1</sup>



The overall disease burden in Asia is concentrated in developing economies, where communicable and infectious diseases including vector-borne, water-borne, and air-borne diseases are contributing a much larger relative share of DALYs. For developing countries, malaria and dengue fever, both transmitted by mosquitoes, are especially prevalent. Malaria is a life-threatening disease transmitted by infected female *Anopheles* mosquitoes that are hosts to the malaria parasite. Throughout Asia, malaria is a threat to about 1.6 billion people, including in India and parts of Southeast Asia.<sup>2</sup> Worldwide, there were 219 million cases of malaria in 2017, and 435,000 deaths.<sup>3</sup>

Dengue fever, which is transmitted by the bite of an infected female *Aedes aegypti* mosquito, is one of the World Health Organization (WHO)'s *Top Ten Threats to Global Health* in 2019. Dengue is a major public health concern throughout tropical and sub-tropical regions. It occurs mostly in urban and semi-urban areas, and is the most rapidly spreading mosquito-borne viral disease, with a 30-fold increase in global incidence over the past 50 years. As of 2018, about 390 million cases are reported each year, of which 96 million manifest with any severity of disease.<sup>4</sup> This results in about 25,000 deaths, annually, worldwide.<sup>5</sup> Currently, close to 75% of the global population exposed to dengue are in the Asia-Pacific region.<sup>6</sup> Though not usually fatal, dengue kills about 20% of those who develop dengue hemorrhagic fever, a more extreme form of the disease, if left untreated.<sup>7</sup> In 2014, southern China ex-

perienced its worst dengue outbreak in decades; Guangdong province reported more than 40,000 cases in just two months.<sup>8</sup>

Cholera is a water-borne, acute diarrheal disease that can kill from dehydration within hours if left untreated. Most cases can be cured if patients can rehydrate with oral rehydration salts. At present, South and Southeast Asia have the largest populations at risk.<sup>9</sup> Infants and older people are most vulnerable. In 2017, 1.2 million cases of cholera resulted in over 5,000 deaths worldwide.<sup>10</sup>

Tuberculosis (TB) is an air-borne bacterial infection that affects the lungs and is easily transmitted between people. It is one of the top 10 causes of death worldwide. In 2017, 10 million TB cases were reported, and 1.6 million died from the disease (including 0.3 million people with HIV). Counter to the declining worldwide incidence of TB, it is on the rise in the Southeast Asia and Western Pacific regions, where 62% of the new cases were reported. India, China, Indonesia, the Philippines, and Bangladesh were among the eight countries that accounted for nearly two-thirds of new TB cases in 2017.<sup>11</sup> TB is treatable, but the treatment regime is an onerous six-month course of four antimicrobial drugs. People often stop prematurely or don't follow it rigorously. This and low-quality drugs, as well as prescribing TB drugs for other conditions, has led multi-drug resistant forms of tuberculosis (MDR-TB) to develop. MDR-TB is a major public health concern.<sup>12</sup> Myanmar is one of the 30 highest TB and MDR-TB-burden countries in the world. TB is the leading cause of death in the country among adults (15-49 years old), comprising 9% of all deaths.<sup>13</sup>

Other air-borne diseases, including various forms of influenza, continue to spread in different parts of Asia, with Southeast Asia suffering the world's highest flu mortality risk after Sub-Saharan Africa and the Eastern Mediterranean. Up to 650,000 deaths each year are associated with respiratory diseases from seasonal influenza.<sup>14</sup>

Non-communicable diseases are also prevalent across Asia, and not just confined to developing countries (see Figure 2). Respiratory and cardiovascular diseases, from the combined effects of household air pollution and ambient air pollution, are two of the leading causes of death in South and Southeast Asia including India. In China, respiratory disease is the third-leading killer behind cardiovascular disease and cancer.<sup>15</sup> The health risks from ambient air pollution come from inhaling fine particulate matter (PM10 and PM2.5) from pollutants like sulfur dioxide, nitrogen oxide, and black carbon, generated from power plants, cars, and factories. PM2.5 particles pose the greatest risks to human health. When inhaled, they can enter the bloodstream and attack the heart, lungs, and brain.<sup>16</sup>

	Communicable Diseases	Non-Communicable Diseases
<b>Climate change-related</b>	<ul style="list-style-type: none"> <li>■ Vector-borne diseases: malaria, dengue, Zika, yellow fever, tick-borne encephalitis</li> <li>■ Water-borne diseases: cholera, typhoid, cryptosporidiosis</li> <li>■ Air-borne infections: tuberculosis, influenza</li> </ul>	<ul style="list-style-type: none"> <li>■ Respiratory diseases: severe allergies, asthma, chronic obstructive pulmonary disease, pneumonia, lung cancer</li> <li>■ Cardiovascular diseases: heart attack, stroke</li> <li>■ Heat-related illness: heat stroke, erythromelalgia</li> </ul>
<b>Not climate change-related</b>	<ul style="list-style-type: none"> <li>■ HIV/AIDS</li> <li>■ Measles</li> <li>■ Hepatitis B</li> </ul>	<ul style="list-style-type: none"> <li>■ Diabetes</li> <li>■ Alzheimer's disease</li> <li>■ Cataract</li> </ul>

**FIGURE 2**  
MAJOR DISEASES IN ASIA

Heat-related mortality is on a clear upward trajectory. An Asian Development Bank (ADB) study focused on Indonesia, the Philippines, Thailand, and Vietnam, predicts that by the end of the century, deaths due to cardiovascular and respiratory diseases that are exacerbated by heat stress will rise by 10% and 25% respectively.<sup>17</sup>

## **ASIA'S VULNERABILITY TO PUBLIC HEALTH AND CLIMATE CHANGE CHALLENGES**

Asia is the continent most affected by climate change and air pollution, which are at the top of the WHO's *Ten Threats to Global Health* in 2019.<sup>18</sup> Climate change will act as a threat multiplier for public health, according to the Intergovernmental Panel on Climate Change (IPCC), which found that higher temperatures will worsen the impact of air pollution and vector-borne diseases.<sup>19</sup> The ADB calculates that, if unmitigated, climate change will cause economic growth to slow and ultimately turn negative by 2100 in South Asia and the ASEAN countries.<sup>20</sup> Diseases in Asia are exacerbated by climate change in a multitude of ways, notably extreme weather events and warming temperatures. Climate change also multiplies the negative effects of industrialization-induced air pollution and haze; and urbanization—accompanied by increased trade and travel—worsens the potential spread of pandemics and increases the risk of animal-human cross-contamination. Weak public health infrastructure in many countries means healthcare systems are ill-prepared to tackle these diseases and slow down their harmful effects.

### **EXTREME WEATHER EVENTS AND WARMING TEMPERATURES**

Climate change is linked to more intense and frequent natural disasters and extreme weather patterns, both of which worsen disease spread. The relationship between climate change and increased disease vectors is clear. According to the IPCC, warmer, wetter weather is expanding the geographic range of the mosquitos that spread malaria and dengue fever. Increased temperature leads to faster incubation periods for disease parasites inside mosquitoes that spread malaria, leading to higher infection rates in humans.<sup>21</sup> The World Bank estimates that a temperature rise of two to three degrees Celsius, as seems almost certain, will increase the number of people at risk of malaria by 5% globally, or 150 million people.<sup>22</sup> In much of South Asia and Southeast Asia, 2015 marked a sharp increase in dengue cases. This was linked to the El Niño phenomenon of 2015/16, which brought warm weather.<sup>23</sup>

Floods and storm surges bring suffering and disease in their wake. Millions of people living in informal settlements in Asia's coastal cities are at risk from storm surge and its aftermath. In 2010, cases of infectious diseases spiked, with more than 115,000 acute diarrheal cases reported, especially among children, in the month following severe floods in Pakistan.<sup>24</sup> In 2017, Bangladesh suffered an outbreak of water-borne and other diseases after it experienced its worst flooding in a decade. Some 13,000 people suffered from diarrhea and respiratory infections.<sup>25</sup>

Drought can lead to water shortages and reduced agricultural productivity. By 2040, Southeast Asia, even under a scenario that models the minimum of two degrees of warming that is likely to occur, is likely to experience a one-third decline in per capita crop yield, according to the IPCC. A shortage of clean water increases the chances that people will drink dirty water and raises the risk of water-borne diseases such as cholera. Mental health is another issue. Studies show a positive correlation between hot years and suicides, in Australia and India.<sup>26</sup>

Due to building density and lack of air circulation, urban areas experience twice as many hot days as rural areas. By the end of the 21st century, the ADB predicts this number could be 10 times higher.<sup>27</sup> For example, in May 2015 in India, more than 2,300 people died of heatstroke and dehydration during the worst heat wave in a decade, with five consecutive days of 43 degrees Celsius in New Delhi and temperatures as high as 48 degrees Celsius in other cities. Power outages deprived people of desperately needed air conditioning. Deaths indirectly caused by the heat (especially among the elderly, related to

cardiovascular and respiratory disorders) may occur with a lag, thus the overall death toll may be even higher.<sup>28</sup> The IPCC finds megacities likely to become heat-stressed, even under a very benign warming scenario. Assuming no adaptation through land use, zoning, and building codes, with less than two degrees Celsius of warming, Karachi and Kolkata could regularly experience conditions equivalent to the deadly 2015 heatwaves on an annual basis. The IPCC also cites China's mega-cities as being at risk.<sup>29</sup> Even relatively wealthy Hong Kong could feel the heat, with experts at a Global Heat Health Information Network conference in December 2018 declaring the heat issue a "silent emergency" and noting higher hospitalizations and mortality associated with hot days.<sup>30</sup>

## AIR POLLUTION

Urbanizing Asian economies are increasingly becoming victims of their own success. The percentage of the population living in cities in Asia tripled, from 18% to 54%, between 1950 and 2018.<sup>31</sup> As hotspots of economic activity, cities emit waste in the form of particulate matter, PM10 and PM2.5, thrown off as exhaust from cars, and as waste from power plants and factories.<sup>32</sup> Tedros Adhanom Ghebreyesus, the head of the WHO, has called pollution "the new tobacco," since it is responsible for one-quarter to one-third of deaths from heart attack, stroke, lung cancer, and chronic respiratory disease.<sup>33</sup> Although smoking is the number one risk factor for cardiovascular and respiratory disease, people who want to live healthy lives cannot give up pollution as easily as they can choose to stop smoking.

Asia faces a double burden from air pollution's ill effects. According to the WHO, 5 million of the world's 8 million premature deaths from household (indoor) and ambient (outdoor) air pollution occur in Asia, annually.<sup>34</sup> These two killers strike South and Southeast Asia disproportionately. India has one of the world's highest levels of air pollution.<sup>35</sup>

Household air pollution, especially in developing parts of Asia, is a serious problem that is often neglected relative to outdoor air pollution. Asia's share of household air pollution deaths is 71% of the world's total.<sup>36</sup> They mainly result from burning kerosene and solid fuels such as wood or dung in stoves, open fires, and lamps. In China, air pollution, though a policy priority, is far from under control, and causes 1.6 million premature deaths a year.<sup>37</sup> Cooking and heating with coal and solid fuels is responsible for one-third of China's total PM2.5 emissions and more than half of China's total black carbon emissions.<sup>38</sup> A University of Chicago study showed that air pollution caused by coal-fired heating cut the average lifespan in northern China by nearly three years, compared with that of the south. Women and young children are the most affected.<sup>39</sup> Rachel Kyte, Chief Executive Officer of the U.N. Secretary-General Sustainable Energy for All, emphasized the importance of dealing with this oft-neglected problem, "I do think the female face on the problem has suppressed its significance. Now that we know that 4 million people die every year from indoor [household] air pollution, globally, and we know that cooking that meal is imperiling a child's health, not only in terms of pulmonary disease, but their ability to learn, and their ability to then be productive in society going forward, this has to rise up the political priority list."<sup>40</sup>

## URBAN PANDEMIC RISK

Climate change accelerates the migration and dislocation of both humans and animals, exacerbating disease formation and spread. Climate change destroys natural habitats of animals, and at the same time, rapid urbanization means humans are encroaching upon animal habitats.<sup>41</sup> This mixing of animals and humans creates the risk of zoonotic diseases (meaning microbes, such as viruses, bacteria, and parasites, originating in animals that spread to humans). In developing Asia, especially ASEAN and parts of India and China, cities are particularly vulnerable because of dense populations coupled with inadequate sanitation and hygiene.

WHO scientists in March 2018 warned about Disease X, their name for an as-yet-unknown disease, possibly zoonotic in nature, which could become the next pandemic.<sup>42</sup> Asia is seen as a hotspot where

Disease X may emerge, as it is a region with rapid urbanization and dense, confined living conditions, and frequent human travel and livestock trade. The WHO sees Southeast Asia as vulnerable to the emergence of pandemic microbial threats, including antimicrobial-resistant bacteria, viruses, and parasites due to inadequate water, sanitation, and hygiene in cities, the proximity of animal, agricultural sectors, and human activity, further made riskier by sub-optimal antibiotic regulation and stewardship.<sup>43</sup>

In 2002, Severe Acute Respiratory Syndrome (SARS) emerged in Southern China. This previously unknown virus originated in bats, and passed to civet cats, then to humans.<sup>44</sup> Spreading through the air or through contact with infected droplets, SARS infected upwards of 8,000 people, killing nearly 800. It could well be regarded as the Disease X of the aughts. Bad as it was, scientists fear that something worse is on the way.

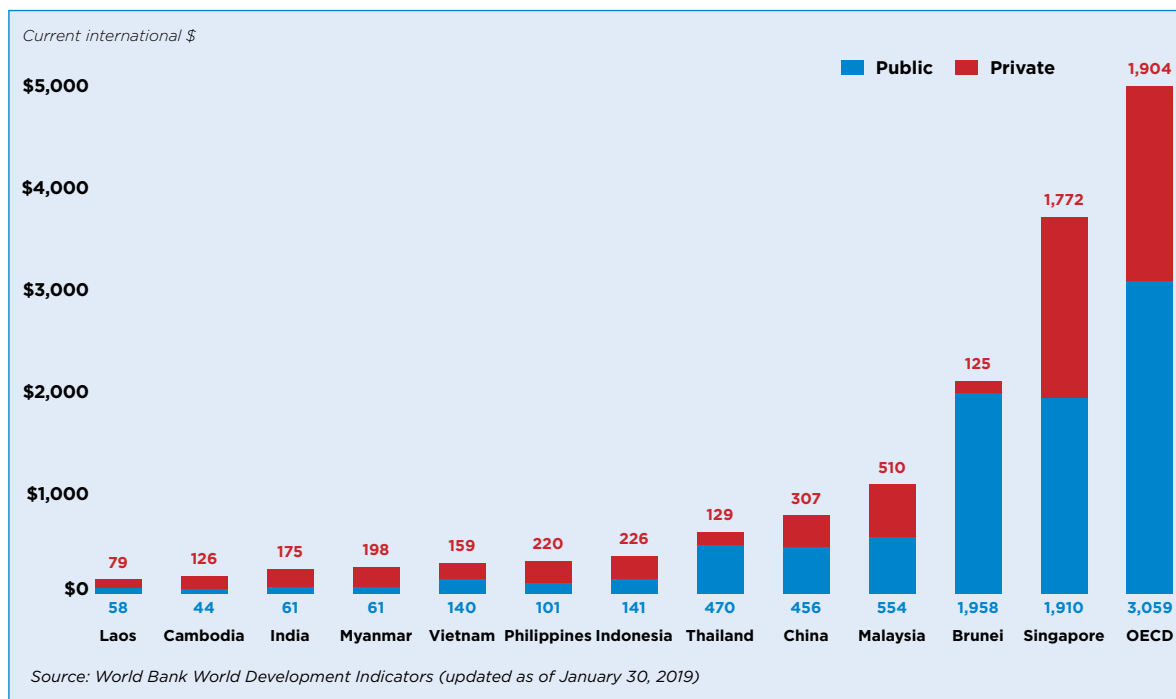
Influenza outbreaks in Asia have also become more frequent and intense. While influenza viruses typically survive for longer periods of time and produce outbreaks in colder temperatures, a number of research studies have found that certain influenza strains can survive in warmer temperatures, leading to longer flu seasons.<sup>45</sup> Scientists at Harvard University and Columbia University suggest that La Niña conditions (warm currents moving northward) may alter migratory patterns of birds and contribute to the jumbling and creation of novel pandemic strains that eventually infect humans.<sup>46</sup> In Hong Kong, in 1997, and Vietnam, in 2004, the H5N1 strain of avian influenza crossed the species barrier, making the jump from birds in rural small farms and wet markets to humans. Though only a few humans were infected, the mortality rate was extremely high. Fortunately, the H5N1 virus does not spread easily and sustainably between humans.<sup>47</sup> The fear is, if an influenza similar to it were to do so, it would have potentially devastating consequences. H5N6 has replaced H5N1 as the dominant avian influenza strain in southern China, especially among ducks. Sporadic human cases have been reported, according to the WHO.<sup>48</sup> It has resulted in at least 16 deaths in China.<sup>49</sup> While the current round of African swine fever that started in China and spread to Southeast Asia is not able to infect humans, past varieties of swine flu have done so. In 2015, the H1N1 swine flu killed roughly 2,500 people in India. It passed to the general population from pig farmers and veterinarians who were infected by sick hogs.<sup>50</sup>

## **WEAK HEALTH INFRASTRUCTURE**

Disease outbreaks and other health challenges aggravated by climate issues put an increasing strain on Asia's weak public health systems. Poverty and pockets of low government spending on public health infrastructure compound the problem. Asian economies spend substantially less on healthcare than the more-developed Organization for Economic Co-operation and Development (OECD) economies (see Figure 3). Less developed economies in the region are under-equipped and battling a shortage of medical personnel as well as hospital beds. Myanmar is one of 57 countries classified as having a critical shortage in its health workforce, with fewer than 1.5 doctors, nurses, and midwives per 1,000 people. The figure is below the 2.3 global benchmark level considered necessary for "adequate" coverage of essential health services.<sup>51</sup>

Importantly, the concept of healthcare infrastructure should be broadened to include efficient dispersal of accurate information and supplies. Past episodes like the mishandling of the outbreak of swine flu (H1N1) in India in 2015 and the suppression of accurate information on the SARS outbreak in mainland China in 2003 are instances of suppression of information, which led to a decline in public trust. In the case of India, the Ministry of Health put out a press release in which it claimed to have enough Oseltamivir (Tamiflu) for the outbreak. But widespread problems occurred in the distribution of the drug, including instances of hoarding, over-charging, and shortages in private pharmacies.<sup>52</sup> The government also officially denied that the flu virus had mutated, even after evidence proved the contrary. During the SARS outbreak, the Chinese government initially covered up and downplayed the seriousness of the epidemic, allowing it to spread further. Hong Kong's economy shut down during the





**FIGURE 3**  
HEALTH SPENDING PER CAPITA AT PURCHASING POWER PARITY IN ASIA (SELECTED ECONOMIES) IN 2015

SARS outbreak. The global economic cost of SARS was estimated at \$54 billion, a number that could have been far smaller had the existence of SARS been disclosed earlier by the mainland government.<sup>53</sup>

An ongoing series of scandals has shaken public trust in China's mandatory government vaccination program, further reflecting weaknesses in the healthcare system. In January 2019, expired polio vaccines were administered to more than 100 children aged three months to four years old, as part of China's compulsory immunization program, in Jiangsu Province.<sup>54</sup> In 2018, Changchun Changsheng Biotechnology Company, one of China's largest vaccine makers, received the highest fine ever imposed for a vaccine scandal in China for falsifying documentation to cover up the sale of substandard vaccines for rabies, diphtheria, tetanus, and whooping cough. These vaccines were administered to hundreds of thousands of children.<sup>55</sup> Forty-eight officials of various levels were punished in connection with this scandal.<sup>56</sup> In the Philippines, health authorities said child vaccination rates against illnesses such as measles fell by nearly a quarter following a vaccine scandal involving the Dengvaxia dengue vaccine from Sanofi, which led to deaths in children in late 2017.<sup>57</sup> The vaccine is only effective in patients who have previously been infected with dengue, and is only approved by the WHO for use in that patient population. Sanofi later said it regretted having bypassed the U.S. Food and Drug Administration and E.U.'s European Medicines Agency's rigorous approval processes. It did so to speed Dengvaxia to market. These incidents around Asia underscore the need for good governance and transparency in public health systems.

## PRIVATE SECTOR STRATEGIES TO ADDRESS THE NEXUS OF PUBLIC HEALTH AND CLIMATE CHANGE CHALLENGES

Both at a company level and at a social level, the private sector benefits from a healthy public. Better health is a good thing in itself; it also means more productive working populations to drive poverty reduction, income growth, and consumption. Longer-term benefits include improved learning at school and better financial sustainability of healthcare systems. This section presents some private-sector initiatives to tackle the nexus of public health and climate change challenges.



## INVESTING IN TECHNOLOGICAL INNOVATION

Technological innovation can be harnessed to tackle health challenges in Asia. Examples run the gamut from fighting and eradicating disease, to better predicting and tracking climate-related disasters and disease outbreaks, to increasing the efficiency of and access to healthcare systems, and to ensuring the safety of drugs and vaccines. Technological breakthroughs require large and patient investments in research and development, but hold out the promise of helping large numbers of people who are affected by climate-related diseases. Two very different initiatives, both using bacteria injected into mosquitoes to eradicate disease, by Tahija Foundation and Verily, are prime examples of how technological innovation holds promise in counteracting the spread of disease vectors by climate change.

Tahija Foundation in Indonesia has joined the global fight against dengue. Since 2011, the Foundation has invested over 95.4 billion rupiah (\$7.8 million) to fund groundbreaking research on injecting *Wolbachia* bacteria into *Aedes aegypti* mosquitoes, which are carriers of dengue, Zika, and chikungunya.<sup>58</sup> Harmless to humans, *Wolbachia*, a natural disease-blocking bacteria, is found in many insect species like flies and bees and some types of mosquitoes, but not usually in *Aedes aegypti* mosquitoes; the absence of the bacteria makes this mosquito species a major disease-transmitter.

As a local partner of the World Mosquito Program, which operates in 12 countries including Vietnam and India, the Foundation has worked with scientists to release lab-bred mosquitoes into parts of Yogyakarta, on Indonesia's dengue-prone Java island.<sup>59</sup> This new method does not eliminate mosquitoes or involve genetic modification. Over time, *Wolbachia*-infected mosquitoes breed with mosquitoes in the wild, resulting in offspring that carry the disease-blocking bacteria. This method is also considered more sustainable, as common ways of fighting dengue such as using insecticides are temporary, and vaccination campaigns face a unique set of challenges ranging from efficacy to availability to cost, for developing countries. While the Yogyakarta project has yet to be completed, a similar trial in Australia showed that dengue outbreaks were reduced from 54 locally acquired cases to just four cases within 44 months.<sup>60</sup> The Foundation is looking to expand the project to other cities in Indonesia. The research team ultimately hopes to use *Wolbachia* on a large scale at a cost of under \$1 a person and, in the long term, use it against malaria.<sup>61</sup>

Verily, a life sciences research company under Google's parent Alphabet, is also using *Wolbachia* to reduce the number of mosquitoes that spread disease, with added high-tech flourishes. In a partnership with *Project Wolbachia* led by Singapore's National Environment Agency, Verily is using new technologies that combine sensors and computer vision AI technology to quickly isolate male mosquitoes, which do not feed on human blood, and release them into specific sites in Singapore so they can mate with female mosquitoes in the wild. *Wolbachia* is present in the males but not in females, and this mismatch prevents the resultant eggs from hatching, in turn reducing the population of disease-carrying mosquitoes. Verily claims its AI-powered mosquito sex-sorter is much faster and more accurate than a human researcher using a funnel-type device to separate larger female mosquitoes from male ones.<sup>62</sup> Verily has developed an automated cart used to release the *Wolbachia*-injected males, which is capable of navigating narrow corridors in Singapore's densely-populated residential blocks.

AI is also at the forefront of disease-trend forecasting. In Penang, Malaysia, a U.S. company called AIME, an acronym that stands for "artificial intelligence for medical epidemiology," uses AI to predict dengue outbreaks up to three months in advance. Using machine learning, or algorithms that iteratively identify patterns in data and learn from them, the AI analyzes parameters including wind speed, roof architecture, and population density, to predict the location and timing of the next outbreak.<sup>64</sup> Armed with this knowledge, the government then sprays the area to eradicate mosquitoes, and takes other preventive measures. Penang's then Chief Minister, now the country's finance minister, Lim Guan Eng commended this surveillance system, which has since been nicknamed CAT (Crush *Aedes* Totally).<sup>65</sup>

Another example is AI that is used to pinpoint areas at high risk for dengue outbreaks in metro Manila, based on weather and land use patterns.<sup>66</sup> Kozo Watanabe, who heads up the Molecular Ecology and Health Laboratory at Japan's Ehime University, has developed a new type of AI mapping to help prevent dengue outbreaks. He and a team of collaborators from the University of Tokyo, De La Salle University in the Philippines, and Padjadjaran University in Indonesia, used machine learning to estimate the number of dengue cases per 1,000 people at locations throughout the city. This was done by taking into account the types of land use (such as high-density residential), and variables related to flooding. The researchers hope to give officials evidence-based grounds for health and environmental policy-making, such as improvement of urban drainage systems or dam construction, in order to reduce mosquito breeding grounds.

New AI systems can also be used to better predict climate disasters by scouring data from past tropical cyclones, floods, and heatwaves to detect patterns and offer real-time analytics for rescuers and decision-makers to improve emergency response. India suffers terribly from flooding, and one-fifth of the global flood-related fatalities each year occur in India.<sup>67</sup> The country's Central Water Commission has recently tapped Google's AI to generate inundation maps using data of rainfall records and terrain in Patna, in the northeastern Indian state of Bihar, where residents are now able to receive location-targeted, actionable flood warnings alerts up to three days before anticipated floods.<sup>68</sup>

AI also holds tremendous promise for transforming the provision of healthcare services in a way that circumvents weak primary health infrastructure. The ubiquitous use of smartphones, combined with growing investments in electronic medical records (EMRs) and cloud computing, provides nearly endless opportunity for AI applications to improve public health outcomes in Asia. This type of technology has grown rapidly in China's still relatively untapped healthcare market, where 43% of the population still lives in rural areas with weak healthcare infrastructure, and where access to quality healthcare for city-dwellers can be out of budget for many families.

Alibaba Cloud's ET Medical Brain is tapping into this market, aiming to make healthcare more affordable and available. The large volume of data generated by strong mobile phone penetration and developments in cloud computing are coinciding with growing investments in digitizing health information, as well as mobile health applications. ET Medical Brain uses AI to provide diagnoses through patients' mobile phones. Its cloud-based clinical diagnosis function can perform remote TB screening and evaluation, in areas where there is a shortage of medical staff. The system allows healthcare organizations as well as patients to access medical history and diagnosis quickly and easily.

Rival online healthcare solutions are emerging. Valued at \$5.5 billion in mid-2018, Tencent-backed WeDoctor has teamed up with insurance provider AIA (also a minority investor) and infrastructure and services group NWS Holdings Ltd., a listed subsidiary of New World Development in Hong Kong. It boasts a platform of over 2,700 hospitals, 220,000 doctors, 15,000 pharmacies and 27 million monthly active users.<sup>69</sup> WeDoctor's healthcare, cloud, insurance, and pharmaceuticals platform is not alone in tapping into this growth market.

Another contender, Ping An Good Doctor, spun off from Ping An Insurance, reports having almost 50 million monthly active users and a medical network covering 3,100 hospitals and 10,000 pharmacies.<sup>70</sup> The Hong Kong-listed company is teaming up with partners like Grab, the Singapore-based ride-hailing and food delivery platform operating in Southeast Asia. Good Doctor wants to expand its range to serve Southeast Asia's population of about 660 million including 200 million mobile users. It will focus on medical tourism centers like Bangkok, which have built a reputation for quality medical care at a reasonable price. Good Doctor is also extending its offline presence, rolling out self-service clinics—each about the size of a phone booth—in companies and pharmacies. So far, they are in eight provinces and cities, including a Volkswagen plant in Shanghai.<sup>71</sup> From inside the booth, a patient consults an AI doctor and shares his or her medical history. The AI doctor provides a preliminary diagnosis, before a

human doctor joins in, virtually, to ensure accuracy. Good Doctor clinics can so far provide consultation advice for 2,000 common diseases and prescribe over 100 commonly-used drugs.<sup>72</sup>

On a more cautionary note, medical and health apps have been subjected to extensive critiques over patient data privacy, presenting future challenges for countries to balance technology-enabled health-care provision and privacy rights.

In less-developed countries in Asia, fewer technology-driven solutions have emerged, and they tend to focus on basic healthcare challenges. Koe Koe Tech, a healthcare technology company, has built a mobile app that offers new maternal and child health solutions to Myanmar, a country suffering from high child and infant mortality rates and relatively low government spending on public health.<sup>73</sup> Pre-loaded on inexpensive (\$20 to \$30) phones, the company's maymay app sends users, usually pregnant mothers, daily health messages timed to coincide with their stage of pregnancy, and into the first three years of their baby's life.<sup>74</sup> It also allows women to order high quality, low cost products and access medical advice. Maymay was developed in partnership with Population Services International (PSI), a non-profit organization based in Washington, D.C., which focuses on reproductive health and trains a network of doctors throughout the country.<sup>75</sup> As of June 2018, the app had a user base of 30,000, and was adding users at a rate of 1,000 per day.<sup>76</sup>

The use of blockchain technology can be especially helpful in societies where public trust in health-care systems remains low, like China. Blockchain's indelible ledger, which logs all transactions, cannot be tampered with, and can be used to track products related to human health. Tencent Research Institute put out a paper in 2017 advocating use of a blockchain-based system for tracking vaccines, arguing blockchain would enable an open, transparent, and traceable vaccine surveillance system that would prevent tampering.<sup>77</sup>

In response to several high-profile incidents, Alibaba and separately Baidu and Sogou have developed online vaccine check tools that allow users to check expiration dates and cold chain integrity on vaccines.<sup>78</sup> Alibaba's AliHealth division runs a vaccine-tracking platform called 码上放心 (Mashang Fangxin), which had 95% of China's pharmaceutical manufacturers on it by July 2018.<sup>79</sup> Mashang Fangxin leverages cloud computing and big data tools to provide traceability and logistics tracking for vaccines as well as other products, including food and alcohol.<sup>80</sup>

Food safety is also an issue in China, where the memory of baby formula laced with melamine, which caused 300,000 children to fall ill and the deaths of six more than a decade ago, still lingers.<sup>81</sup> Private companies are using blockchain technology to improve safety in China's food value chain, improving farm to table traceability. In 2016 IBM, Walmart, and Tsinghua University demonstrated how to trace a shipment of pork through the supply chain in a pilot project using IBM's Linux Foundation blockchain-based Hyperledger technology. The project appeared prescient given a 2018/19 outbreak of swine fever. The pilot demonstrated increased speed and transparency relative to a manual process, requiring less than one minute to reveal a pork product's shipping status and origin of production, batch number, expiration date, and even the storage temperature.<sup>82</sup>

Singapore's government-owned technology development firm SGInnovate has invested in MediLOT Technologies, a blockchain and analytics start-up that is building a platform to facilitate clinical data exchange among hospitals.<sup>83</sup> Healthcare blockchains work by creating smart contracts that extract data from local storage systems, after obtaining patient permission to do so, and allow various healthcare providers to access them.<sup>84</sup> Blockchain provides a way to transfer health data, either out of a centralized file or into as many files as wished, without compromising data security, using Blockchain's indelible ledger. Blockchain transactions also allow patient data to be accessed from different electronic records systems with a high level of security.

## PHILANTHROPIC EFFORTS TO FIGHT DISEASE SPREAD AND CLIMATE CHANGE

Corporate philanthropy in Asia has extended well beyond just donating money to charities. Today, it includes everything from companies running innovative marketing campaigns to raise consumer awareness of climate-related infectious diseases to funding specific programs that tackle other public health challenges posed by climate change.

One example of private sector initiative in Asia is M2030. Launched by the Asia Pacific Leaders Malaria Alliance in April 2018, M2030 is a cause-based, consumer-marketing initiative supporting malaria elimination efforts in Asia Pacific.<sup>85</sup> It aligns with the United Nations Sustainable Development Goals of eradicating malaria by 2030. Myanmar businessman Serge Pun's Singapore-listed Yoma Strategic Holdings is a local partner of M2030 in Myanmar. His son Melvyn Pun, Chief Executive Officer of Yoma, is a private sector advocate for the initiative.<sup>86</sup> Funds raised by M2030 in Myanmar will be used to support malaria programs in the country. Yoma works in conjunction with the non-profit PSI, which supports the informal sector (for example, village heads and small pharmacies) to prevent and detect malaria. The company also uses the M2030 trademark in its products and services, and in return, uses its brands to raise consumer awareness of malaria. Myanmar has the highest incidence of malaria in the Greater Mekong Region, accounting for 75% of all cases.<sup>87</sup> Drug-resistant malaria has also been on the rise on the Thai-Myanmar border.<sup>88</sup> But overall, Myanmar is making progress towards its goal of malaria elimination by 2030 and has seen a 64% decline in malaria cases, from 200,000 in 2014 to a little over 85,000 in 2017.<sup>89</sup>

Beyond causing deaths and injuries, natural disasters continue to take a toll on local communities. Outbreaks of communicable diseases after cyclones and floods are common in developing Asia. Post-disaster epidemics are aggravated by contaminated food, lack of access to safe drinking water, as well as the collapse of health, sanitation, and communications infrastructure. Numerous disaster-relief efforts led by Asia businesses have contributed in part to reduce the risk of disease outbreaks in the region.

In April 2018, the Philippine Disaster Resilience Foundation (PDRF) launched the region's first private-sector-led Emergency Operations Center, a 24/7 operations hub for disaster training and monitoring of climate-related hazards to facilitate the coordination of relief efforts.<sup>90</sup> The PDRF is backed by prominent business leaders in the Philippines, including Jaime Augusto Zobel de Ayala, Erramon Aboitiz, and Federico Lopez. When super typhoon Mangkhut struck the northern Philippines in September 2018, the PDRF worked with companies to provide shelter, restore water and communications facilities that were essential for people's health and rescue operations. Ayala's malls were opened for affected residents. Smart Communications, through a partnership with the Vodafone Foundation, provided wireless broadband services and phone-charging stations to residents.<sup>91</sup>

Corporate efforts to build resiliency against health risks during disasters are also seen in other parts of Asia. When monsoon floods hit the east coast of Malaysia in December 2014, the government came under fire for being slow to provide relief to residents.<sup>92</sup> AirAsia Foundation, the philanthropic arm of AirAsia, complemented the government's relief efforts by providing flights for medical personnel and delivery of much needed food, water, and medical supplies to vulnerable populations.<sup>93</sup> The Foundation was a major donor to campaigns funding the purchase of new hospital beds and medical equipment in Malaysia's rural clinics, a move that helped restore the health system damaged by floods. Donation boxes made available on AirAsia flights also helped raise funds for relief works in wake of typhoon Haiyan in the Philippines in 2013 and cyclone Nargis in Myanmar in 2008.<sup>94</sup>

## MOVING TO LOWER-CARBON ENERGY SOURCES

More broadly, businesses can invest in tackling the nexus of health challenges and climate change by investing in broader and longer-term efforts to reduce the use of carbon-based energy sources, which lead to climate change.

On a local level, clean cooking technologies are essential in order to replace polluting fuels and stem household air pollution in Asia. Thus far, the private sector has shown little interest in developing clean cook stove offerings and mobilization efforts by governments have been inadequate to draw in the private sector.<sup>95</sup> However, the dialog is starting to change, with growing public awareness of the problem. In this case, where the introduction of clean cooking technology could solve a large respiratory health problem, governments could help jumpstart the market by providing incentives to the private sector. The roadblocks center on how to create markets for clean fuels, and business models that make clean cook stoves and fuel affordable and scalable in a way that is attractive to business and consumers.

Electricity generation needs to be progressively less carbon-intensive in order to minimize the effects of global warming. A decarbonized energy grid would lower greenhouse gas emissions and would drastically decrease respiratory ailments as well. For example, the prices for renewable energy sources such as solar and wind have been falling rapidly, and are on par with traditional energy in many parts of the world. The International Renewable Energy Agency (IRENA) estimates that by 2020, all mainstream renewable energy technologies will provide electricity at the lower end of the fossil-fuel cost range, with some solar PV and wind projects providing the lowest-cost electricity from any energy source.<sup>96</sup>

Several corporate leaders are beginning to implement changes to their portfolio of energy assets, either selling coal-fired assets outright, or pledging not to invest in coal. The Philippines, which is exposed to frequent and destructive typhoons, has seen first-hand the intensifying effects of climate change. Ayala Corp. in the Philippines has taken steps to climate-proof its businesses. AC Energy, a subsidiary of Ayala Corp., is moving to decarbonize its energy portfolio. It recently announced a deal in Vietnam to build out 80 megawatts of solar electricity generation capacity, in advance of Vietnam's June 2019 feed-in-tariff change. This is the latest in a string of deals for AC Energy, which is selling coal-fired assets to finance plans to develop 5 gigawatts of attributable capacity by 2025, half of which will come from renewable energy. First Philippine Holdings Corp. and its power generation subsidiaries First Gen Corp. and Energy Development Corp. are committed to lowering the carbon intensity of its electricity generation. The companies pledged in 2016 not to invest in coal-fired energy assets in favor of cleaner-burning gas-fired and geothermal assets.<sup>97</sup>

In the past, China was a strong voice on the issue of climate change, collaborating on the China-U.S. climate agreement that led to the Paris Climate Agreement in 2015, and dramatically expanding the use of renewable energy technologies in China. Its wind and solar industries are globally competitive. But the Belt and Road Initiative (BRI), its global infrastructure investment plan, belies these earlier statements through its carbon-heavy energy buildouts beyond China's borders. This has amounted to China exporting carbon-intensive energy generation while preaching decarbonization inside its walls. Going forward, the BRI has large-scale opportunities for decarbonization. Academic analysis has quantified the investment opportunity for China in renewable energy, specifically in the BRI countries, at \$1 trillion, based on a calculation of country-level commitments to the Paris Accord.<sup>98</sup> A 2018 study by the World Resources Institute, which analyzed China's BRI investments, found that most deals China financed in the energy sector were tied to carbon-intensive sectors and did not show a strong alignment with the low-carbon priorities included in the investee countries' Nationally Determined Contribution (NDC) pledges made at the Paris Accord.<sup>99</sup> This is short-sighted on China's part. The changing cost landscape, specifically the falling price of renewable energy, is making it more likely that coal-fired investments will be unprofitable. The debt for these stranded assets will weigh heavily on the public purse.

## CONCLUSION

In the coming decades, Asia will have to grapple with increasing costs and growth challenges from the nexus of public health and climate change. As Asia continues to develop, countries have to fight both diseases arising from poverty and those arising from development, both of which are exacerbated by



the effects of climate change. Natural disasters and warming temperatures worsening the spread of infectious diseases, indoor and outdoor air pollution leading to premature deaths, and the spread of zoonotic diseases in densely populated cities are urgent and severe challenges for Asia. This is especially the case for countries that suffer from weak healthcare systems. Strong and robust public health infrastructure will be required to enhance the lives and health of nations.

The multi-dimensional challenges of public health and climate change require integrated, system-wide solutions. They call for policies, investments, and actions by multiple actors, which will doubtless run up against entrenched interests resistant to change. But climate change is coming faster than previously expected, and the shortened planning horizon adds a level of urgency to the task. Strong governments are needed to plan and to set the regulatory tone. They can create incentives that can allow new markets to develop, for instance, by fostering investment in biomedical research, at the local, regional and national level. But governments, with some notable exceptions, have made slow progress, especially those in poorer Asian economies.

Businesses and civil society must play a role improving public health wherever possible. Opportunities abound. First movers in developing markets have a chance to create entire healthcare ecosystems. Humanitarian solutions as simple as clean cooking technology could save millions of lives. Through investing in new disease-fighting innovations, through committing to dedicated philanthropy, and more broadly, fixing the problem of climate change at its root by moving to lower-carbon energy sources, Asian businesses face great opportunities to do their part to ensure healthy workers and consumers. Focused efforts in one or more of these areas hold out the promise of stemming diseases' spread and even eradicating them, better diagnosing and treating patients, becoming more resilient to climate disasters, and reducing air pollution and climate change effects that are harmful to human health. To do otherwise would be short-sighted, given the threats to continued growth and progress posed by climate change. Within one or two generations, many of Asia's great strides, especially in developing Asia, could be erased. Ultimately, for businesses, these investments would pay off in the form of lowering the risks of investing and operating in developing Asian markets, and contributing to greater good for communities in which they operate.

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