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***The Wuhan Coronavirus: Assessing the Outbreak, the Response, and
Regional Implications***

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Good afternoon, Chairman Bera, Ranking Member Yoho, and Members of the Committee. Thank you for giving me the chance to appear before you today to discuss the emergence and global spread of the 2019 novel coronavirus (2019 nCoV).

I am an Associate Professor in the Departments of Environmental Health and Engineering and Epidemiology at Johns Hopkins Bloomberg School of Public Health. I am also a Senior Scholar at the Johns Hopkins Center for Health Security. *The opinions expressed herein are my own and do not necessarily reflect the views of The Johns Hopkins University.* Our Center for Health Security's mission is to protect people's health from major epidemics and disasters and build resilience. We study the organizations, systems, and tools needed to prepare and respond. At the Center, I direct the Outbreak Observatory, which conducts operational research to improve outbreak response. My testimony is also influenced by my previous experiences as a public health practitioner. I have also served as a public health epidemiologist for New York City, where I conducted surveillance for infectious diseases.

My colleagues and I at the Johns Hopkins Center for Health Security have spent close to twenty years analyzing infectious disease outbreaks, including epidemics and pandemics, in attempt to better understand the resources, practices and policies that are need to prevent, mitigate and contain them. Like many others, we've been closely following novel coronavirus outbreak since it was first announced in China at the end of December. We've been trying to analyze and understand the risk the virus poses to the United States (US) and other countries around the world and to make recommendations to policy-makers, legislators and practitioners about what should be done to respond to this epidemic.

I have two caveats regarding my testimony today. First, I have not been involved in the on-the-ground public health response to 2019 nCoV. My knowledge and assessment of this epidemic comes from my analysis of publicly shared information and conversations I have had with

individuals and organizations that are closely involved in the response. Second, as you have likely heard, this is an evolving situation. Our knowledge of the virus is growing and changing as more data become available. What I offer you today is my best interpretation and judgment given the facts known at the time this testimony was prepared.

What Do We Know About 2019 nCoV?

The ongoing epidemic of 2019 nCoV was first recognized in the Wuhan city, Hubei Province, China. On December 31, 2019, health officials in Wuhan announced that they were investigating an outbreak of viral pneumonia involving 27 hospitalized cases in the city. Though the finding of viral pneumonia patients in any hospital during flu season is not by itself cause for alarm, health authorities were alerted to these cases by clinicians who noted the shared a common occupational exposure to the Huanan Seafood Wholesale Market. Wuhan health officials launched epidemiologic and environmental investigations. An official statement provided by the Wuhan Municipal Health Commission noted that all patients were treated in isolation and that there was no clear evidence of person-to-person transmission. Health officials closed the Huanan seafood market on January 1. One week later, health authorities in China announced that a novel coronavirus had been isolated from the viral pneumonia patients and the viral sequence was shared publicly.

Since the identification of 2019 nCoV as the likely cause of the viral pneumonia outbreak in Wuhan, we have learned several important things about the virus. First, the virus appears to be capable of sustained human-to-human transmission. Though it was initially thought that 2019 nCoV infection was limited to individuals with a history of exposure to the Huanan seafood market, cases have been found in individuals who reported never having visited markets in Wuhan. The appearance in other countries of multiple generations of 2019 nCoV cases who have not traveled to China provides additional evidence of sustained human to human transmission. This finding differentiates the virus from the Middle East Respiratory Syndrome coronavirus (MERS-CoV), for which only limited human-to-human transmission has been reported.

Second, though severe illness and deaths have been reported, virus appears to be capable of causing a spectrum of disease. The emergence 2019 nCoV was first recognized among patients who were hospitalized with viral pneumonia. Since then 2019 nCoV cases with milder disease presentations have since been reported. Hospitalized patients also have a varied clinical picture—ranging from relatively mild symptoms to critical illness.

There is evidence that the virus jumped from animals and may have caused human infections earlier than initially recognized. A study published in the *Lancet* has shown some evidence the initial outbreak of 2019 nCoV may have started at the beginning of December or earlier--weeks before the outbreak was first recognized. It is not known when the virus became adapted to humans and capable to being spread via person-to person transmission.

Since the first report of human 2019 nCoV cases, more than 17,000 cases and 300 deaths (as of February 3, 2020) have been recorded in 23 countries. China accounts for the vast majority of cases. Cases have spread well beyond Wuhan—every province in China has since reported cases. From public reports and limited scientific studies published to-date, it appears as though the

majority of reported deaths have occurred among elderly individuals and individuals with underlying medical conditions—patient groups known to be at risk for severe illness and death from other respiratory infections.

All deaths have occurred in China, with the exception of a death in the Philippines. The WHO has said that the deceased, who tested positive for nCoV, had also been infected with influenza and pneumococcus, a bacterium that causes pneumonia, bloodstream infections and meningitis. Outside of China, reported cases have so far been described as having mild disease presentations.

What is Unknown?

Size and scope of the epidemic

What is not yet known is the true size and geographic scope of this epidemic. Though countries are quickly ramping up surveillance for this virus, it is likely that many lack the capacity to actively search for cases. Even countries that have mobilized surveillance programs are likely missing cases. Surveillance in China seem to be heavily focused on cases that show up at hospitals or clinics. Though this makes sense given limited testing capabilities, what it means is that individuals who don't seek medical attention for their infections are likely not being captured by existing surveillance in China. Outside of China, countries have, for the most part, only been testing people who have travelled to Wuhan or, in some cases, broader China. Countries are not, as a matter of routine, looking for local cases that may result from infected individuals who entered the country before travel screening began.

Another complicating factor for surveillance is the occurrence of mild cases. Though there have been a concerning number of deaths and severe illnesses reported, the continued finding of mild cases raises the possibility that many more cases have occurred than have been detected. Mild cases are difficult to spot because their non-specific symptoms make them difficult to differentiate from other common respiratory illnesses. If individuals with mild symptoms don't seek medical attention, which is likely, and aren't tested, their infections will not be detected by most surveillance systems.

Hospitalization statistics are not reliable indicators of the burden of severe illness. China and other countries have been hospitalizing infected patients regardless of the severity of their symptoms. Infected patients are also remaining in hospitals until they are free of the virus, which may be well after patients' symptoms disappear.

Current US guidelines for testing for 2019 nCoV among individuals who are not contacts of confirmed cases are contingent on patients' symptoms and to travel to China. According to current guidelines from the US Centers for Disease Control and Prevention (CDC), individuals would likely not be tested for 2019 nCoV infection unless they are a symptomatic contact of a known case; traveled to Wuhan and experience fever and lower respiratory illness; or, traveled to broader China and are hospitalized for a lower respiratory infection. It is not clear whether and how these testing criteria will change now that all provinces in China and more than 20 countries are reporting cases.

Severity

We don't yet have a clear understanding regarding the severity of illnesses caused by 2019 nCoV. The reasons for the observed discrepancies in severe illness and deaths inside and outside of China is not yet known. Though a concerning number of severe and critically ill patients and deaths have been reported, the frequency with which infected people get critically ill and die is not yet understood. But the apparent discrepancy in between the severity of symptoms and number of deaths among cases in China versus other countries raises the possibility that outbreaks in other countries may be less severe and/or comparable to other respiratory viruses, such as influenza.

The way most countries are conducting surveillance for nCoV will not allow us to directly estimate the percentage of infected individuals that develops severe illness and die. A key reason is that we are likely missing many cases, and, in particular mild cases. An outbreak caused by a new pathogen, like 2019 nCoV, is often not recognized until an unusual cluster of severely ill patients turn up in hospitals or an increase in deaths is noted and people launch an investigation to figure out why. As we stand up surveillance for novel viruses, such as 2019 nCoV, and begin to look for cases more broadly, we may identify milder cases in individuals who either didn't seek medical attention or whose symptoms were misdiagnosed. We may be vastly underestimating the total number of infected individuals, which means it is not accurate to estimate severity from the total number of reported cases and deaths. Nonetheless, people have been attempting to determine the severity by doing crude estimates with the limited information available. These crude estimates show that the percentage of deaths among total reported cases may be falling, which, if true, would be consistent with what we've observed in previous emerging infectious disease outbreaks.

Asymptomatic spread

There have been a few case reports that have raised the possibility that individuals who experience no symptoms (asymptomatic) or have not yet developed symptoms (presymptomatic) may be capable of transmitting their infection to others. In addition, virus has been detected in patients after their symptoms went away, which raises the possibility of post-symptomatic spread. The extent to asymptomatic or presymptomatic cases are contributing to the larger epidemic is not known and the evidence supporting this is weak. If significant level of asymptomatic or presymptomatic transmission is occurring, this will make it harder to interrupt disease spread. However, the World Health Organization has said that asymptomatic patients are not likely to be the main driver of disease spread.

International Response

On January 30, the WHO declared the epidemic to be a Public Health Emergency of International Concern (PHEIC). This is the sixth time the WHO has designated an infectious disease event a PHEIC since the 2005 International Health Regulations (IHRs) gave the organization this power. This most recent declaration means that WHO is currently involved in

the response to three simultaneous PHEICs— 2019 nCoV, Ebola in the Democratic Republic of Congo, and international spread of poliovirus.

In announcing that the global spread of 2019 nCoV constituted a PHEIC, the WHO Director General Tedros Ghebreyesus made clear that countries should respond with “facts, not fear.” The WHO has said that it does not recommend that countries implement travel or trade restrictions to prevent the importation of the virus. WHO has cautioned that countries that do take these measures could accelerate the spread of the virus by hindering the ability of responders and supplies to travel to where they are needed and by diverting public health resources from local disease control efforts. Nonetheless, many countries are implementing measures that the WHO has specifically advised against. Many countries, including the United States, have announced suspension of travelers from China, and an intention to quarantine travelers returning from China for up to 14 days. The IHRs were created to define the maximum measures countries could take to prevent the importation of disease; countries that take measures that are above what the WHO recommends do so in contravention of the IHRs.

But despite these unfortunate developments, I see in countries’ initial response to this nCoV epidemic some important signs for optimism. First, I must commend the astute clinicians in Wuhan, China who first recognized this unusual event. Front-line clinicians are our first defense against infectious disease outbreaks. That they recognized that their patients shared an unusual commonality—a link to the seafood market—is possibly the only reason why this outbreak was detected when it was and not later. This points to the importance of having well-trained clinicians who can recognize and rapidly report unusual events.

Second, I am greatly encouraged by the speed with which health authorities are expanding laboratory testing for a never-before-detected virus. This includes China, which isolated, identified and published the sequence of the novel coronavirus quickly, enabling other countries to develop their own laboratory tests. This also includes other countries, who immediately began screening and testing symptomatic travelers from China for a completely new virus. It is important to point out this rapid surveillance work reflects advanced laboratory capabilities that require investment, training and sustainment.

In addition, epidemiological investigations conducted in and shared by other countries have improved our understanding of the virus and its transmission. Thailand identified a 2019 nCoV case in a traveler from Wuhan who reported not having exposure to the initially implicated seafood market. This epidemiological finding first raised the possibility of infection among those without a connection to the Huanan market. The first evidence that this virus was capable of human-to-human transmission was provided by health officials in Vietnam, who identified and investigated a 2019 nCoV case in a 27-year old man who had not visited China, but had been caring for his sick father who had recently travelled from Wuhan.

Each of the above examples illustrates why it is so essential that countries have the public health capacities to prevent, detect and respond to infectious disease emergencies. The sharing of detailed surveillance and case reports from Vietnam, Thailand, and other countries that are now reporting cases is indispensable for global efforts to control the spread of this disease. It is also how, in the face of scientific uncertainties about the virus, WHO makes a determination of the

global risk posed by the virus and how countries like the US gather the information they need to make decisions about how to protect their own citizens.

We should not take for granted the response successes that have occurred to date. The astute clinicians and the capacities to screen, diagnose and isolate patients with a novel virus and identify and monitor their contacts represent important global health security capacities—laboratory-based surveillance, trained epidemiologic workforce, infection prevention and control practices—that needed to be developed and maintained so that they could function in this epidemic. The speed with which countries have gathered and shared key epidemiological data has enabled others to better gauge risks posed by this virus and enhance response plans.

Comparing the 2019 nCoV epidemic to prior novel coronavirus outbreaks illustrates some of the progress that has been made in strengthening countries' global health security. In 2003, it took months before a novel coronavirus was identified as the cause of Severe Acute Respiratory Syndrome (SARS) as compared with weeks in the current epidemic. In 2015, the Republic of Korea experienced a large outbreak of Middle East Respiratory Syndrome coronavirus (MERS-CoV), in part due to delayed recognition and nosocomial spread of the virus. However, in 2019 Korea quickly detected and isolated an imported case with mild symptoms and became the third country outside of China to report cases. Korea and other countries that have experienced infectious disease challenges have done the hard work of improving their public health capacities deserve our recognition and gratitude.

The fact that countries are able to conduct surveillance for and epidemiological investigations of 2019 nCoV cases is the result of hard work and sustained investment, both by the countries themselves and by international donors. US technical and financial support has been critical to the development of surveillance systems and trained workforce in a number of countries now reporting 2019 nCoV cases. In the case of Thailand, US support spanned decades. Thailand now has a world class epidemiologic workforce and is a leader in global health security. In Vietnam, sustained US support and assistance have enabled the development an early warning surveillance system, which includes a network of emergency operations centers and enhancement of field epidemiology workforce training. These resources were used to support Vietnam's detection and response to Zika virus and are likely a supporting the country's on-going response to 2019 nCoV.

Worrisome Trends in Global Readiness for Epidemics and Pandemics

Much of the world is not fully prepared to respond to serious infectious disease epidemics or pandemics. Though there are positive examples of countries like Thailand and Vietnam rapidly responding to infectious disease threats, there are critical gaps in worldwide capacities that can inhibit the responses of many countries to this epidemic and others.

In October, my colleagues and I at the Johns Hopkins Center for Health Security and the Nuclear Threat Initiative, together with the research power of the Economist Intelligence Unit, released the Global Health Security Index (GHS Index), a first-ever assessment of 195 countries' global health security. The first GHS Index was the result of a sustained effort to define a framework to

comprehensively and reproducibly understand and compare global health security at the national level and to collect and measure the extent to which countries' show evidence of having the capacities and capabilities required to respond to an epidemic or pandemic. The GHS Index builds on peer evaluations conducted by the WHO but covers all UN members, including China, and is regularly repeatable to measure progress. What we found is that no country, including the US, is fully prepared for significant infectious disease outbreaks. There is even less evidence that countries have demonstrated the ability to exercise these capacities or use them in an actual emergency. How unprepared is the globe as a whole? Out of a possible score of 100 points, we found that the average GHS Index score across 195 countries was just 40.2. Even countries with more resources are not ready, as the majority of high- and middle-income countries do not score above 50. What these results tell us is that action is urgently needed to improve countries' readiness for high-consequence infectious disease outbreaks.

In declaring the 2019 nCoV epidemic a PHEIC, WHO Director General Tedros Ghebreyesus said that a key reason for the declaration was a concern about the weakness of health systems in much of the globe. I share his worries. Among each of the 6 categories measured in our GHS Index, countries' scores were lowest (the average score was 26.4 out of 100) in the category that examined the readiness of national health systems to treat the sick and protect health workers.

This finding tracks with observed challenges in recent epidemics, such as the on-going epidemic of Ebola in Democratic Republic of Congo (DRC), which represents one of the three on-going PHEICs to which the WHO is currently responding. Though DRC has prior experience and success in containing Ebola outbreaks, disease transmission occurring in unprepared health facilities has played an important role in exacerbating the spread of disease. Transmission in healthcare facilities also occurred during the 2003 SARS epidemic and during outbreaks of MERS in 2015.

What this tells us is that there may be critical gaps in hospitals and other health facilities that will likely be the on the front-lines of responding to the 2019 nCoV epidemic. Many countries—including well-resourced ones like the US, may experience difficulties in responding to a surge of patients infected with 2019 nCoV. If the virus produces more severe illnesses than have been seen outside of China to-date, then the challenges of safely treating these patients will be even greater. The recent report of a healthcare worker in France who became infected with nCoV is a concerning development that speaks to the challenges that even well-resourced countries are likely to face in responding to this disease.

My worries about these identified weaknesses in national capacities to respond to epidemics and pandemics is increased by the lack of resources allocated to address them. The GHS Index showed that only 5% of countries—fewer than 10 countries overall—scored above 66.7 out of 100 points for financing health security. Prioritizing health security, especially in the strengthening of foundational health systems, will be critical in helping to control this epidemic, but also in addressing future infectious disease emergencies.

Recommendations to Improve US Readiness for Continued Spread of 2019 nCoV

The ultimate trajectory of the 2019 nCoV epidemic is hard to predict with certainty, but there are increasing signs that it may not be possible to contain the disease. We must plan for the possibility that 2019 nCoV will result in a global pandemic. My recommended priority actions to improve preparedness for global spread of 2019 nCoV are divided between international engagement and domestic readiness.

International engagement recommendations:

1. Halt the current US policy of denying visas to travelers from China and quarantining Americans returning from China.
2. Engage in a productive, collaborative dialogue with China to in order to ensure continued access to data and critical medical supplies

Domestic response recommendations:

1. Ensure health departments have the resources they need to conduct surveillance to promote proven mitigation measures, such as case isolation outside a hospital to the extent possible.
2. Ensure hospitals and other health facilities have the resources needed to safely treat a surge of patients.
3. Facilitate the development of medical countermeasures, such as diagnostics, vaccines, therapeutics.

The current US policy to deny visas to travelers from China and to quarantine returning Americans is not the right approach to controlling the spread of 2019 nCoV and may make us less safe. These measures are unlikely to keep the virus out of our country. The virus is spreading too quickly and too quietly for us to possibly know where all cases are. We do not have a complete picture of where in the world the virus is spreading to be able to stop infected people from coming to the US. It is also possible that unrecognized infections are occurring in US. In the weeks before the US began to screen travelers and airlines began reducing flights, thousands of people traveled to the US from China each day. And just because we are only looking for cases among people with a connection to China doesn't mean that those are the only individuals who are infected. As global case counts continue to grow and as more and more countries report cases, it will raise the question as to whether we should continue to focus on travel to Wuhan or broader China as criteria for testing. It is unlikely that we would be able to maintain our current approach to quarantine returning Americans and screen travelers if we needed to include additional countries or regions of the world.

I am deeply concerned that these measures will make us less safe by diverting public health resources from higher priority disease mitigation approaches that I describe below. It is not yet clear which agencies will have the responsibility of caring for and monitoring returning travelers who have been placed into quarantine. It is possible that local health authorities would play a lead role, as they did in monitoring travelers returning from West Africa during the Ebola epidemic of 2014, which required considerable resources that had to be diverted from other

public health activities. Caring for and monitoring even small numbers of quarantined individuals would likely be a challenge for many health departments and would require a large investment of resources.

By singling out China for travel bans, we are, effectively penalizing it for openly reporting and sharing data about the epidemic. Our ability to respond to epidemics depends on having access to epidemiological information generated by other countries. Geographically-targeted measures may exacerbate the social and economic tolls of this epidemic and send a signal to countries that it may not be in their best interests to be forthcoming about disease outbreaks. This could diminish countries' willingness to be transparent about outbreaks and allow diseases to spread before outbreaks are uncovered, which would make everyone less safe. We should reward countries that report cases through offers of help and assistance.

It is in our best interest to maintain a productive and collaborative relationship with China and to help it better respond to the spread of 2019 nCoV disease. To appropriately gauge how the US should respond to this evolving health threat, it will be critical to continue to have access to data from China. Just prior to the US's announcement of travel bans, China indicated that it would allow US scientists in to participate in the epidemic response. This was an important development and may have led to an improved understanding of the current epidemic. But it is now questionable whether this offer is still viable, given the on-going travel restrictions.

It is essential that we maintain positive relationships with China to ensure the continued availability of essential goods. China is a major producer of the medical resources which the US will need to respond to this epidemic, such as surgical masks and other personal protective equipment. Our dependence on medical supplies from China is not just restricted to products needed for responding to this epidemic. For example, China is a major global producer of raw materials for commonly-used medicines, such as the blood thinner heparin. The US recently experienced shortages in its supplies of heparin, which is derived from pigs, due to China's efforts to cull pigs in order to control the spread of African Swine Fever. What this example should indicate to us that should help China respond to 2019 nCoV to ensure that the actions it takes do not interrupt the production and distribution of essential goods. There are already reports suggesting that China's massive efforts to restrict the movements of tens of millions of individuals may interrupt the production of goods. China needs our help and it is in our best interest to provide it.

We must now contemplate the possibility of pandemic spread of 2019 nCoV and must plan for how we will mitigate the impacts of the virus. In my view, it is highly likely that the United States will continue to see cases of 2019 nCoV, despite the recently implemented travel bans and quarantines. Though there are still important unknowns, this epidemic bears a number of similarities to the 2009 influenza A/H1N1 pandemic. It is essential that we plan for the possibility that the 2019 nCoV virus will follow a similar pattern to the 2009 pandemic. If the virus continues to circulate and cases keep climbing, the probability of community-wide transmission will increase. Responding to a novel virus for which no specific therapy or vaccine yet exists leaves only the possibility of mitigating the disease spread. What measures we take to find cases and mitigate disease spread will be determined by the observed severity and the availability of resources. If there continue to be concerns about the severity of the virus, our

priority should be to rapidly detect and isolate cases and identify and monitor their close contacts for signs of illness. Communities will likely consider other mitigation strategies, such as limiting public gatherings and closing schools, but the operational feasibility of these measures must be examined, and potential adverse consequences (e.g., reduced availability of healthcare personnel due to childcare obligations) should be considered. If the disease continues to demonstrate mild tendencies in cases outside of China, we may consider focusing efforts on protecting those most likely to become ill and preventing deaths.

We must ensure that responding agencies have the resources necessary to respond to 2019 nCoV cases across the country. Each of the above scenarios requires that health departments and hospitals have the resources they need to conduct surveillance to promote proven mitigation measures, such as case isolation. Unless patients require medical attention, they should be isolated outside of a hospital to reduce the possibility that they infect healthcare workers and other patients. Hospitals and other health facilities will need resources to safely treat a surge of patients.

If the number of 2019 nCoV cases in the US continues to grow, the US Congress will likely be called to appropriate emergency funds to enable states to respond to the virus. During the 2009 pandemic, the Ebola epidemic of 2014, and the response to the Zika pandemic, the US Congress approved emergency supplemental funding that went to support state and local response efforts. The current fiscal outlook in states is such that they will be unable to fully respond without additional federal funding. Federal agencies such as HHS and CDC, which have been responding to multiple on-going disease emergencies, such as Ebola in DRC, have already indicated that they may need additional emergency response funds to support the 2019 nCoV response.

Government leadership is needed to facilitate the development of medical countermeasures, including diagnostics. Though a number of efforts to develop a vaccine have been announced, it is likely that a usable vaccine will not be available for some time. Research is also being conducted to develop therapeutic medicines, which may help those with severe illness and prevent deaths. Enhanced diagnostic tools are essential to the use of both vaccine and therapeutics, yet comparatively less attention has been given to the need to accelerate the development of new diagnostic tools. CDC is currently conducting all of the testing for 2019 nCoV in the US, but has plans to roll out testing capabilities to state public health labs. This will be important to reduce current lag times in getting test results for persons under investigation for 2019 nCoV and to meet a likely increase in the demand for testing as case counts rise. However, there is also a need for diagnostics in clinical settings. If more patients seek care at healthcare facilities, there will be an increased need for diagnostic tools to help clinicians rule out infection with nCoV, make decisions about cohorting or isolating patients, and to determine course of therapy.

Conclusion

The points I have raised today hopefully paint a picture of an epidemic that is in many ways complex and evolving, but for which we are increasingly gaining clarity. International collaboration will be essential for continuing to monitor and learn about the virus and the

epidemic it is causing. Even amid uncertainty, we should root our response in evidence. Without evidence to guide our actions, we may inadvertently exacerbate the toll of this epidemic. In evaluating how we should respond to this public health emergency, we must consider not only whether the measures will work, but also whether the ends justify the means. While we want to do the utmost to protect health, we don't want to pursue measures that will extract a greater toll on societies and our economy than the virus would alone. We must continually assess whether our response strategies are matched to the level of threat that the virus poses and adapt our approach as new information becomes available. With evidence mounting of continued global spread despite aggressive actions being taken by countries, it is becoming clear that a change of course may be needed. Instead of trying to implement measures that likely will not work to prevent the virus from entering our country, we should focus on efforts that we know will help to lessen its impacts, such as ensuring that federal, state and local health agencies, and hospitals and health clinics have the resources they need to diagnose, isolate and safely treat cases, and to promote feasible approaches to community mitigation that are most likely to mitigate disease spread. For this we will need government leadership and additional investments.