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An Analysis of the Relationship Between Access to At Least Basic WASH Services and the Economy in Southeast Asia and Its Role on the Achievement of the Sustainable Development Goals

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B.S. Public Health
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2016

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ABSTRACT

An Analysis of the Relationship Between Access to At Least Basic WASH Services and the Economy in Southeast Asia and Its Role on the Achievement of the Sustainable Development Goals
By Jacob Clemente

INTRODUCTION: The water, sanitation, and hygiene (WASH) sector remains a key focus of development. As a result of the 2030 Agenda for Sustainable Development, the sector has its own goal—Sustainable Development Goal (SDG) 6—that calls for access to at least basic drinking water and sanitation services for all populations. SDG 6, and the WASH sector, can play an important role in the achievement of the SDGs. This role can be emphasized by examining the relationship between WASH and the economy. To support this claim, this thesis proposes a cyclical framework that may depict this relationship.

METHODS: To conduct the analysis, an aggregated dataset was created with publicly-available datasets. At least basic water and sanitation coverage data from the WHO/UNICEF Joint Monitoring Programme informed the WASH services while values for annual growth rate of real GDP per capita and total official financial flows to water supply and sanitation SDG indicators from the UN Statistics Division served as the economic indicators. Data was from Indonesia, the Philippines, and Vietnam from 2000-2015.

RESULTS: Although there was growth in both access to at least basic drinking water and at least basic sanitation coverage, there was varied growth in the annual rate of GDP per capita and total financial flows to water supply and sanitation in all three countries. The relationships between the coverage of water services and the coverage of sanitation services were strong and significant for all three countries individually and in aggregate. There were similar relationships between WASH coverage and population. Lastly, the relationships between WASH coverage and the economic indicators varied in strength, direction, and significance.

DISCUSSION: There were no discernible patterns in the relationships between WASH coverage and economic indicators. Although there are some indications that there could be a relationship, the correlations were not consistently strong and significant across the three countries. The coverage for WASH services grew over the time period; however, the variability in the values for the economic indicators may be due to a plethora of inputs and outputs into the economy external to the WASH sector.

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INTRODUCTION

Since the year 2000, the United Nations (UN) has coordinated efforts to address disparities—from health to income to gender, and many more—on a global scale. World leaders signed onto an anti-poverty movement aimed at addressing all the dimensions that affect an individual's status. This declaration translated into the eight Millennium Development Goals (MDGs), which included topics such as the eradication of poverty and hunger to ensuring environmental sustainability. To track progress, baseline data was from 1990 and goals were to be met by 2015 for a time period of 25 years (UN, 2015a).

Although there were numerous positive outcomes by the end of the MDG era in 2015, including significant declines in extreme poverty and under-five mortality, the goals were not fully realized (UN, 2015a). In 2015, world leaders reconvened at the UN to discuss the current state of the goals and next steps. The meeting resulted in the declaration and signing of the 2030 Agenda for Sustainable Development. The 2030 Agenda builds upon the successes and shortcomings of the MDGs with an expanded vision of 17 goals with 169 targets, known as the Sustainable Development Goals (SDGs). With the overarching goal of eradicating all dimensions of poverty, the declaration calls for the sustainable development of economic, social, and environmental dimensions by 2030 (UN, 2015b).

Water supply and sanitation continue to be sectors where access has not been guaranteed for all populations across the globe. Although the water, sanitation, and hygiene (WASH) sector is active in development, the gaps in the coverage for water supply and sanitation continue to contribute to public health problems around the world, from an individual level to various levels of aggregation. As such, the WASH sector has been a focus for both the MDGs and the SDGs.

Goal 7 of the MDGs calls on the globe to ensure environmental sustainability, which includes Target 7.C, to halve the proportion of the population without sustainable access to safe drinking water and basic sanitation by 2015 (UN, n.d.-a). At the end of the time period, there was an increase of approximately 2.6 billion individuals using improved drinking water sources, with 1.9 billion people gaining access to piped drinking water. This translates to an increase of 15 percent from 1990 to 2015. In sanitation, about 2.1 billion people gained access to improved sanitation by the end of the time period—an increase of 14 percent of the global population. Although these numbers show that immense progress had been made, the world still missed the MDG target as the proportion of the population without access to basic sanitation failed to halve by the end of the time period (UN, 2015a).

Sustainable Development Goal 6

The UN General Assembly and the UN Human Rights Council recognized access to safe drinking water and sanitation as a human right (UN, 2010). In creating the SDGs, world leaders considered the progress and shortcomings from the MDG era as they built the aspirational goals for the SDGs. For the 2030 Agenda, the water and sanitation sector remains a key focus with Goal 6, which calls for the availability and sustainable management of water and sanitation for all (UN, 2015b). Target 6.1 calls for universal access to safe and affordable drinking water while Target 6.2 calls for universal access to adequate and equitable sanitation and hygiene (UN, 2018). These new targets are a departure from their MDG predecessor in a few ways, but most notably, there are now separate targets for water and sanitation in addition to language specifically targeting hygiene (UN, 2018). The targets specify the need for universal and equitable access, going beyond simply providing to also combatting inequalities. This added

dimension can be seen in the inclusion of language directly aimed at the needs of women, girls, and vulnerable populations. Additionally, the signatories of the 2030 Agenda qualify water as safe and affordable and sanitation as adequate, giving more direction to the quality of the services provided for people around the globe (WHO & UNICEF, 2017b).

As of 2015, 181 countries had achieved over 75% coverage of their populations for at least basic drinking water services. Additionally, 89% of the global population used at least basic drinking water services. Of those, 71%, or more than five billion people, used safely managed drinking water services (WHO & UNICEF, 2017b).

For at least basic sanitation services, 154 countries had achieved over 75% coverage of their populations by 2015. The proportion of the global population that used at least basic sanitation services is 68%. Only 39%, or almost three billion people, used safely managed sanitation services (WHO & UNICEF, 2017b).

There has been notable progress and growth in providing access to drinking water and sanitation services as evidenced by the growth in the proportions with access to at least basic services. But with SDG 6 set at providing universal coverage for water supply and sanitation, there is still much to be done to reach the targets.

Access to WASH Services, Economic Growth, and the SDGs

Due to the various inputs and outputs that can be associated with access to WASH services and the economy, independently and together, there is controversy about which aspect causes the other. There is an argument for access to WASH impacting the economy through its effects on the population by saving time and contributing to labor productivity. However, the

economy can also have effects on investments in infrastructure. A stable and growing economy can attract investments and governments can allocate funds for improving the WASH infrastructure. Several studies have noted the varying approaches to describing the relationship between water and sanitation services and economic growth. Sadoff et al. presented a stepwise structure while Sanctuary and Tropp presented their "virtuous cycle" that includes investment and growth (Sadoff et al., 2015; Sanctuary & Tropp, 2005). Overall, there seems to be a consensus that there is no defined linear causal relationship between access to WASH services and economic growth.

As a result, this thesis proposes *The Role of Water, Sanitation, and Hygiene (WASH) and the Economy on the Achievement of the Sustainable Development Goals (SDGs)* (Figure 1). By offering a cyclical framework, this thesis hopes to mitigate the concerns of which aspect came first—access, investments, or economic growth.

At the heart of the proposed framework is the achievement of the SDGs, which has brought the monitoring and investment in water, sanitation, and hygiene, to the forefront of development in a new way—by calling for universal access. Although the framework allows for entry through any of the outer dimensions, this thesis will begin with access to WASH services.

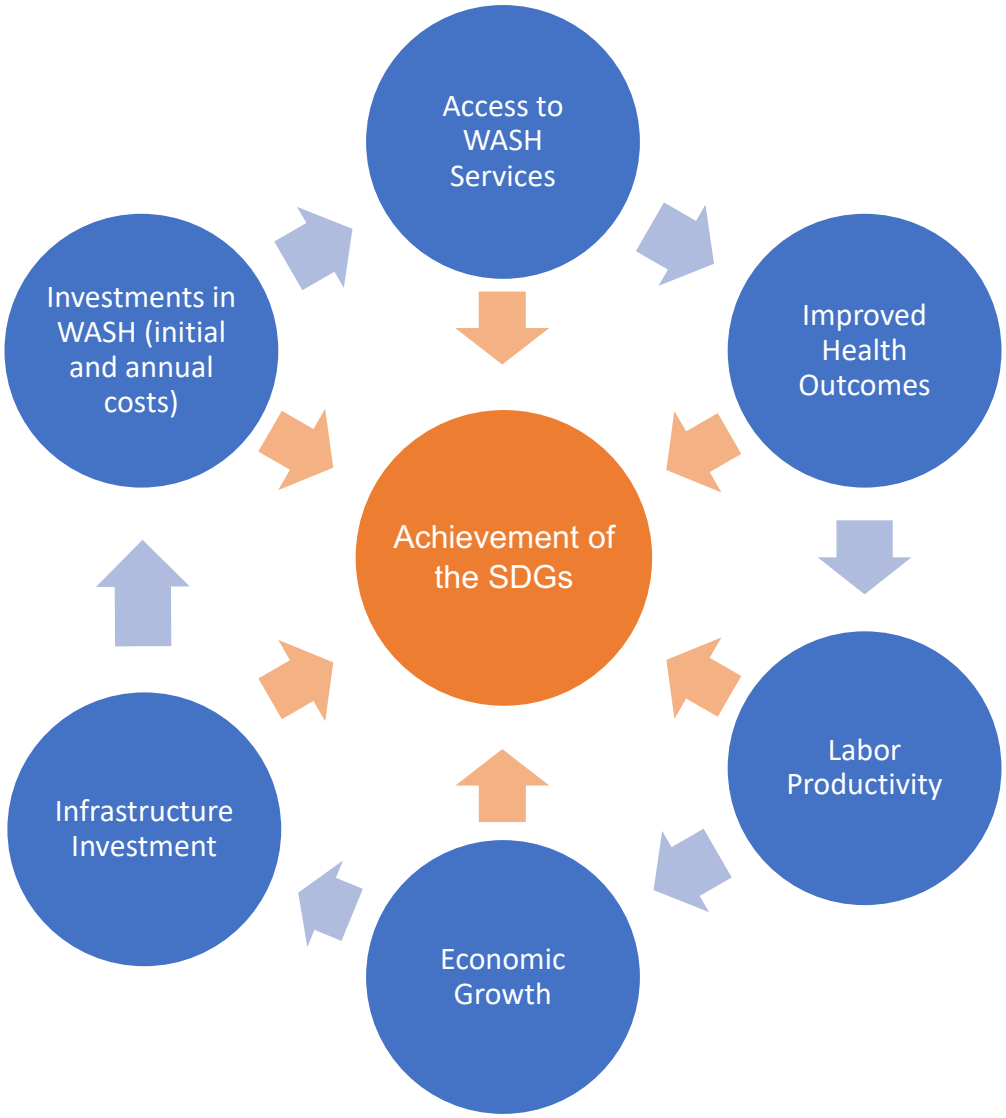

Figure 1. *The Role of Water, Sanitation, and Hygiene (WASH) and the Economy on the Achievement of the Sustainable Development Goals (SDGs): A Cyclical Framework*

Access to WASH services in this framework aims to mimic the requirements set forth by the 2030 Agenda. By increasing access to at least basic water and sanitation services for all people, there will be improved health outcomes ranging from decreased under-five mortality to decreased rates of diarrheal diseases. Improved health outcomes mean that individuals will spend less time ill or seeking care. This will then lead to increased labor productivity as individuals will

have more time to devote to their work. By increasing the amount of time spent at work and producing outputs, there will be an impact on the economic growth of a nation. Economic growth will stimulate investments in infrastructure. Of particular interest in this study is the investment in the infrastructure for water and sanitation services. Not only does the framework account for capital investments, or initial costs, it also specifies the effects on annual costs which include operation and maintenance (O&M) of the water and sanitation infrastructures. With capital and O&M investments, the sector can increase the access to WASH services for all people, which leads to the rest of the cycle.

The cyclical nature of the framework emphasizes the continual nature of the investments in WASH infrastructure and the need for attention to the sector as a whole. Additionally, by centering the framework around the achievement of the SDGs, it creates a platform for stakeholders to advocate for the achievement of the SDGs, with a focus on SDG 6, in the larger scheme of economic growth.

Study Purpose

Currently, there is a need to understand the importance of the role that access to at last basic water and sanitation services plays in the achievement of the SDGs external to the achievement of SDG 6 alone. The goal of this thesis is to determine if there is a relationship between coverage of WASH services and economic growth, which will provide support to the importance of the WASH? sector to the SDGs' overall goal of poverty eradication. In order to understand and address this need, the thesis has two aims. First, there will be an assessment of the effects of WASH on the economy through the study of the relationship between water and

sanitation access and GDP growth. Second, there will be an assessment of the effects of the economy on WASH through the study of the relationship between total financial flows to the WASH sector and access to WASH services. By describing this relationship, there could be an increased focus on the WASH sector and a greater push for the achievement of universal coverage of services as a means of achieving the other goals outlined in the 2030 Agenda.

LITERATURE REVIEW

Studies have shown that there is a relationship between access to WASH services, specifically water supply and sanitation, and the economy. WASH has known impacts on under-5 mortality and diarrheal diseases, amongst other health outcomes. But the sector also has effects on the national-level in terms of infrastructure development, economic growth, and combatting some inequalities (UN, n.d.-b). Although a direct causal relationship has not been validated, authors have argued for the importance of infrastructure investment, both generally and in water supply and sanitation. Notably, there have not been studies published on relationship between WASH, the economy, and the achievement of the SDGs; however, there are studies on the relationship of each of these two aspects and the achievement of the MDGs.

Infrastructure and the Economy

Generally, infrastructure availability had an influence on the development of regions and countries. According to Snieska and Simkunaite (2009), households used infrastructure services as a good that satisfies a need or want. The availability of such services influenced regional and country development; however, investments to capital infrastructure created inequalities between both regions and countries. Public infrastructure, according to the authors, was the foundation on which the economy is built (cite). The authors claimed that infrastructure has an indirect effect on the productivity of workers, i.e. infrastructure improves the productivity of workers, which affects economic growth. However the actual effect in the Baltic States was inconclusive as there was a lack of specific methodology to analyze the impact of infrastructure investments on both social and economic development (Snieska & Simkunaite, 2009).

Frone and Frone (2014) depicted the relationship between infrastructure and the economy through the lens of market supply and market demand. There were direct and indirect stimuli on market supply, with capital stock and modernization of infrastructure, respectively. Meanwhile, market demand dictated that infrastructure enabled people to access water and sanitation; services that are necessary and wanted. The authors also presented arguments for infrastructure's role in enhancing labor productivity, regional economic growth, and job creation in the short- and long-term (Frone & Frone, 2014).

One of the key points from Frone and Frone (2014) was the idea of reverse causality in the relationship between water supply and sanitation infrastructure and economic growth. In their examination of the effects of infrastructure to the economy, they created an equation that accounted for output per worker, productivity, time, and worker inputs (Frone & Frone, 2014). Although a positive correlation between infrastructure and output levels may appear, it fails to reflect actual productivity. The increase may just be caused by the increased demand (Canning & Bennathan, 2000). Output levels, which could be goods or services such as WASH access, may be affected by more than just infrastructure. Demand for these goods and services could affect the level of supply, not necessarily by the presence of the infrastructure that would enable production (Frone & Frone, 2014).

In addition, the relationship between economic growth and infrastructure may not have a one-way directionality; reverse causation may be present (Frone & Frone, 2014). This means that the size of GDP can affect investment in infrastructure or that investments can affect the size of GDP. There was no discussion of any positive or negative effects—no evidence on whether a large GDP can increase investments or if large investments can increase the size of GDP. The

reverse causation may have an effect on the equation that the authors generated, creating errors in the model (Frone & Frone, 2014).

Lastly, Frone & Frone (2014) presented one of the largest challenges in the analysis of these relationships: a definition of infrastructure (Frone & Frone, 2014). Without an accepted universal definition of infrastructure, it becomes difficult to determine the various components, both inputs and outputs, that can have an impact on infrastructure investment and growth (move your end sentence citation to here).

[this seems to be a different issue than basic infrastructure. Perhaps a new subtitle around water infrastructure?]

Meanwhile, Dadson et al. (2017) focused primarily on the idea of water scarcity and water-related risks as it relates to economic growth and production limits. Water scarcity, as defined by the authors, is the availability of an acceptable quality and quantity of water. The study aimed to create a conceptual model that accounted for the effects of the investments on water as an economic input and on losses due to water-related risks (Dadson et al., 2017).

Dadson et al. (2017) reasoned that investments in physical infrastructure for water resources management affect the economy by improving productivity and reducing the harmful effects caused by factors such as water-related diseases. Lastly, Figure 2 shows dynamic systems model, presented by the authors, that showed linkages between national wealth, productivity, and losses related to water (Dadson et al., 2017). The three pieces of the diagram are interconnected, with wealth having its own feedback loop. Notably, only expected loss has a terminus that does not connect to wealth or water-related assets.

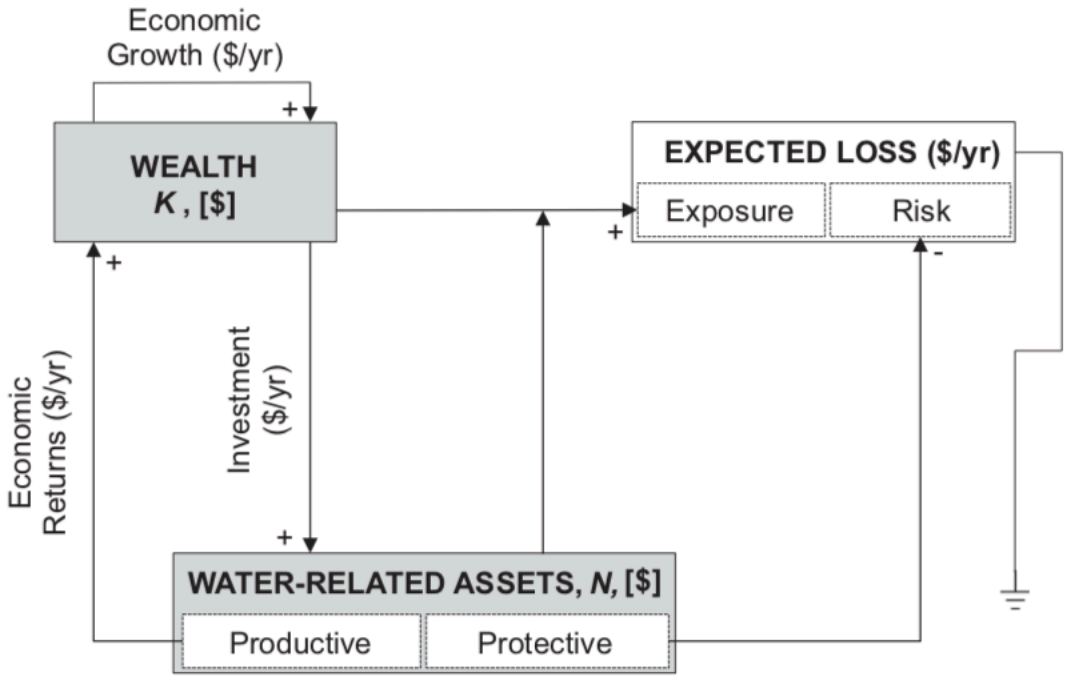

Figure 1. Schematic flow diagram depicting the relation between water, risk, and growth. Gray shaded boxes represent stores, arrows represent fluxes between stores with the direction of the relation between store size and flux indicated. The box labeled "Expected Loss" is not a store but is a diagnostic measure that is derived from the level of exposure (related to wealth) and risk (related to water-related assets). Exogenous risks (e.g., due to hydroclimatic variability) are assumed to be fixed and are not shown.

Figure 2. "Figure 1. Schematic flow diagram depicting the relationship between water, risk, and growth…" from *Water security, risk, and economic growth: Insights from a dynamical systems model* (Dadson et al., 2017)

WASH Access and the Economy

Other studies focused on the relationship between water, sanitation, and the economy. Sadoff et al. (2015) stated that total global economic losses of $260 billion annually had associations with inadequate water supply and sanitation. The analysis conducted for this study showed that economic losses are more pronounced in countries with certain characteristics, one

of which was low levels of access to safe water supply and sanitation (Figure 3) (Sadoff et al., 2015).

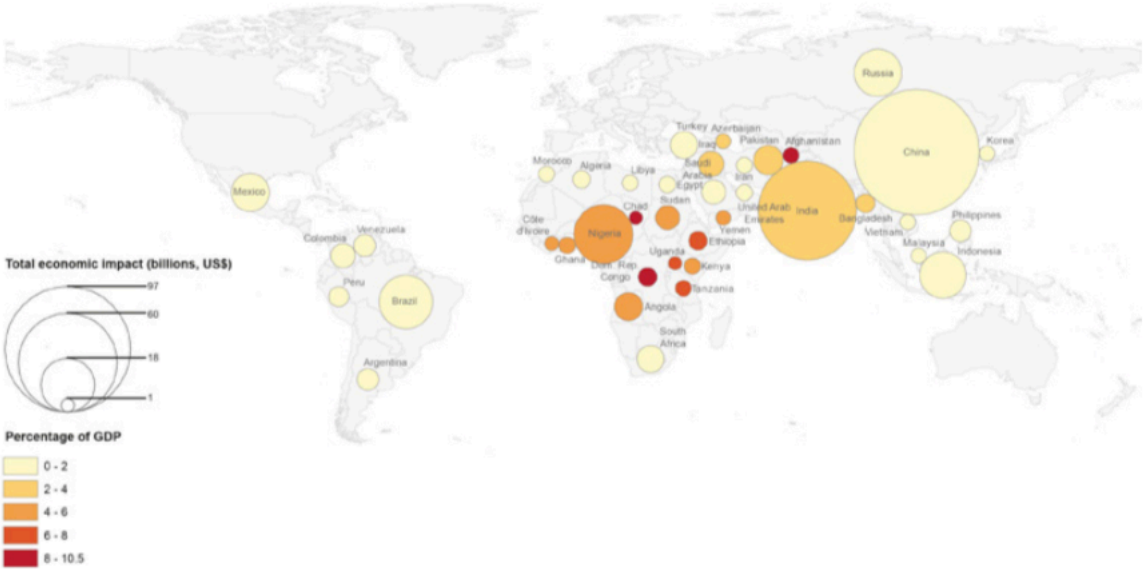

Figure 3. *Economic losses from inadequate water supply and sanitation from Securing Water, Sustaining Growth: Report of the GWP/OECD Task Force on Water Security and Sustainable Growth* (Sadoff et al., 2015)

In addition to well-documented improved health outcomes, Sadoff et al. (2015) include time saved and better quality of life—including the feeling of safety from not defecating in the open—as effects of improved and adequate water supply and sanitation (Sadoff et al., 2015).

Sadoff et al. (2015) also claimed that readily available water leads to enhanced economic opportunities. Conversely, unreliable or poor-quality water led to slower economic growth. Additionally, the authors presented a stepwise relationship: water-related investments can lead to better economic productivity growth, which in turn leads to more capital investments for water-related infrastructure. Although this relationship can be displayed as a strong positive

relationship, there is still no evidence, or even research, into the causal link. Further discussions have led to a larger conundrum of which came first, infrastructure investment or economic growth (Sadoff et al., 2015).

The Organisation for Economic Co-Operation and Development (OECD) released a report in 2011 that declared access to drinking water and sanitation has impacts on an individual greater than on an infrastructure level. The report stated that access to these services reduces health risks, saves time that can be allotted towards education, and increases productivity. OECD quantified the achievement MDG 7 as an annual benefit of USD 84 billion. On a broader scale, OECD called these services a key driver for economic growth, which included investments by firms. As with other studies, OECD also emphasized the reduction of diseases in relation to an increase to WASH services and the time saved by improved services (OECD, 2011).

In Sanctuary and Tropp (2005), the authors argued that improved water supply and sanitation, in addition to water resources management, has positive effects on economic growth and has a role in poverty eradication. The results of their study on the economic benefits of improved water services showed that poor countries with improved WASH access had an average annual GDP per capita growth of 3.7% while countries without improved WASH access only had an annual GDP per capita growth of 0.1% (Sanctuary & Tropp, 2005).

As a response to the argument for the high cost of investment in WASH, the authors found that improved water supply and sanitation had economic benefits that justified and overcame the costs. For every USD 1 invested, the economic benefits ranged from USD 3 to USD 34 in numerous sectors, including health. There were additional arguments for the contribution of WASH investments in increasing production and productivity in the economic sector; this has manifested in time saved during collection of water and access to sanitation and

amounts to USD 64 billion. Sanctuary and Tropp emphasize the essential and necessary nature of improved water services to economic development and growth, and suggests a "virtuous cycle" that improves lives of poor populations (Sanctuary & Tropp, 2005).

Sanctuary and Tropp (2005) strongly advocated for the need to invest in WASH services. They argued that public and private investments are necessary to improve water and sanitation services, which will have effects on better health outcomes, economic growth, and eradication of poverty. Economic benefits, they stated, will be both immediate and long-term, in the form of saved spending on health-related costs and time saved. The concept of time-saving was in both time saved collecting water or accessing safe sanitation and in time saved due to no illness. Another strong argument that the authors presented was that losses in productivity due to poor health and missed opportunities impede long-term growth. Sanctuary and Tropp framed all of their results in the context of achieving the MDGs (2005).

Evans (2005) shared in *Securing Sanitation: The Compelling Case to Address the Crisis* that the benefit of reaching the sanitation target of the MDGs would equate to 65 million USD annually. Like Sanctuary and Tropp presented, the benefits revolved around the time saved from finding a safe sanitation facility and time saved from better health outcomes. The author strongly argued for the centrality and importance of sanitation to the MDGs as a whole, listing the various dimensions that need to shift, including financing, institutional changes, and behavioral change. In order to achieve the target and stimulate economic growth, Evans outlined the need for action and information in determining both the definition of sanitation and which of its aspects must be prioritized (Evans, 2005). The WHO reinforced this argument by stating that adequate sanitation will have profound implications on health and poverty. Increasing access to sanitation can address barriers to a better life and fulfill a basic need (WHO, 2004).

Hutton and Haller (2004) aimed to estimate the costs and benefits of interventions to improve water and sanitation services. Shown sub-regionally and globally, there were decreases in the incidence of diarrheal disease in populations with interventions (Figure 4) (Hutton & Haller, 2004).

Table 12: Annual number of diarrhoeal cases avoided

WHO sub-region	Region/ Country	Pop. (m)	Cases of diarrhoea (million)	Number of cases avoided per year ('000s), by intervention				
				1	2	3	4	5
2	AFR-E	481	619	28'548	87'405	127'049	345'132	439'980
5	AMR-D	93	93	3'250	9'307	13'208	48'679	64'106
11	EUR-D	223	43	112	568	1'056	19'816	27'983
13	SEAR-D	1689	1491	26'895	146'829	272'361	807'596	1'043'922
15	WPR-B1	1488	1193	39'454	131'171	239'104	659'687	844'381
WORLD		7183	5388	154'854	545'950	903'004	2'860'951	3'717'971

Figure 4. A table of annual number of diarrheal cases avoided per region and by intervention from *Evaluation of the Costs and Benefits of Water and Sanitation Improvements at the Global Level* (Hutton & Haller, 2004)

The interventions noted in Figure 4 from Hutton and Haller (2004) were (I & II) achieving the MDG target for water and sanitation separately, (III) universal access to improved water and sanitation, (IV) universal access to improved water and sanitation with the addition of water disinfection at point of use, and (V) access to regulated piped water and a direct sewage connection. Costs included investment and annual costs. Benefits included time savings, labor productivity caused by less time in illness or visiting a healthcare provider, and decreased burden of health-associated costs. The authors argued for these general benefits that indirectly impact economic growth (Hutton & Haller, 2004).

A later study conducted by Hutton (2012) was a cost-benefit analysis of water and sanitation investments and gains in various indicators. The contribution of economic benefits to the total benefits in achieving the MDG targets for drinking water and sanitation were shown as stacked bar graphs for access times, mortality, productivity, and health care across the Southeast Asian region. For water, access time's benefit was 75% followed by health care (12%), productivity (8%), and mortality (5%). For sanitation, access time was also the greatest contributor at 85% followed by health care (7%), productivity (5%), and mortality (3%) (Hutton, 2012).

The value of total time contributed 10,300 million USD in terms of achieving universal water supply and sanitation in Southeast Asia. Meanwhile, the annual values of health care gains, mortality reductions, and health-related productivity amounted to over 2,000 million USD. The study emphasized that the Southeast Asian region was one where many countries were on track to meet both targets—drinking water and sanitation—for the MDGs (Hutton, 2012).

In a study conducted by Van Minh and Nguyen-Viet, the researchers found that the economic costs of poor sanitation and hygiene were greater than USD 9 billion annually in Cambodia, Indonesia, the Philippines, Vietnam, and Lao PDR (Van Minh & Nguyen-Viet, 2011).

The annual loss in Cambodia was USD 32 per capita and the total economic losses related to poor sanitation amounted to more than seven percent of the country's GDP in 2005. Indonesia's figures accounted for the majority of the losses for the countries identified at a total loss due to poor sanitation and hygiene amounting to over USD 6 billion. Health and water resources were the largest contributors to the losses, at annual figures of USD 3.3 billion and USD 1.5 billion, respectively. Meanwhile, in the Philippines, the amount lost due to poor

sanitation was almost USD 1.5 billion, with healthcare costs amounting to about USD 1 billion. In Vietnam, the economic losses were almost USD 800 million, with health and water resources accounting for almost 70% of the losses. Lastly, in Lao PDR, the losses were almost USD 200 million, with health accounting for 60% (Van Minh & Nguyen-Viet, 2011).

One of the main arguments presented in the study was the economic benefits associated with improved sanitation. These included direct benefits due to avoiding illnesses and the money saved from seeking care, indirect benefits from decreased work days lost to illness, and non-health benefits such as time saved. As in previously presented studies, time savings dominated the economic benefits from sanitation. The paper also emphasized the health benefits of improved sanitation in addition to its impacts on the environment, tourism, and other welfare concerns. There was a direct call towards the notion of the benefits outweighing the costs of investing in sanitation (Van Minh & Nguyen-Viet, 2011).

All the studies presented made key arguments for the importance of the relationship between water supply and sanitation infrastructure and services with economic growth. Time savings, in terms of collection and loss due to illness, were features in numerous studies. Savings from potential healthcare costs were also of note. Lastly, and perhaps most importantly for the argument of the investment in the achievement of the SDGs, several papers presented that the benefits caused by improved WASH services and access greatly outweighs the investments required.

METHODS

This study is a secondary analysis of publicly-available datasets from the World Health Organization (WHO)/United Nations Children's Fund (UNICEF) and the United Nations Statistics Division (UNSD) for the countries of Indonesia, the Philippines, and Vietnam.

Water and Sanitation Services Dataset - Joint Monitoring Programme for Water Supply, Sanitation, and Hygiene (JMP)

To monitor the progress being made towards the achievement of SDG 6.1 and 6.2, the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) collaborate on the Joint Monitoring Programme for Water Supply, Sanitation, and Hygiene (JMP). Since 1990, JMP has published reports on the progress made in the WASH sector using its vast database of information in households, schools, and healthcare facilities (WHO & UNICEF, 2017b). Moving into the SDG era from the MDG era, JMP had to adapt its methodology and definitions to properly report on the progress in its new context—including the updated service ladders that denote what level of drinking water, sanitation, and hygiene services a person is using. Population data and coverage for at least basic water and sanitation services are from the WHO/UNICEF JMP database (WHO & UNICEF, 2017a).

JMP builds its database by identifying national datasets, extracting data into tables, using the inputs to model country estimates, consulting with countries for review, and aggregating these estimates to create global and regional estimates. The JMP database is an aggregation of national census information, national surveys, and other sources. The 2017 update report

included more than 3,600 datasets, and more than 2,800 informed the estimates produced by JMP (WHO & UNICEF, 2018).

In addition to displaying data by year and geography, JMP disaggregates data into urban and rural as much as national datasets allow. For information presented in the 2017 update, 42 countries did not have disaggregated data available. Using the national datasets, JMP classifies services into improved and unimproved services for both water and sanitation. These classifications inform the production of estimates for the proportion of the population within a country with access to drinking water and sanitation services across the service ladders.

Drinking Water and Sanitation Indicators Selected for Secondary Analysis

SERVICE LEVEL	DEFINITION
SAFELY MANAGED	Drinking water from an improved water source that is located on premises, available when needed and free from faecal and priority chemical contamination
BASIC	Drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip, including queuing
LIMITED	Drinking water from an improved source for which collection time exceeds 30 minutes for a round trip, including queuing
UNIMPROVED	Drinking water from an unprotected dug well or unprotected spring
SURFACE WATER	Drinking water directly from a river, dam, lake, pond, stream, canal or irrigation canal

Note: Improved sources include: piped water, boreholes or tubewells, protected dug wells, protected springs, rainwater, and packaged or delivered water.

Table 1. JMP Ladder for drinking water services (WHO & UNICEF, 2017b)

For the SDGs, drinking water services has five service ladder classifications (Table 1): surface water, unimproved, limited, basic, and safely managed. The service ladder for drinking water stems from the classifications during the MDG era (WHO & UNICEF, 2018). Improved drinking water sources have the potential to safely provide water for consumption. For the SDG era, improved sources will be further classified into three groups—safely managed, basic, and limited—while there will be two groups of unimproved sources—unimproved and surface water (WHO & UNICEF, 2017b). Improved drinking water sources include piped water, protected dug wells or springs, and delivered water. At the top of the service ladder, safely managed drinking water sources are improved water sources that are accessible on premises, available when needed, and free from contamination. Basic drinking water service level are also improved water sources that do not meet all three criteria for safely managed. This service requires that collection time, roundtrip and including standing in line, do not take longer than 30 minutes. Limited drinking water services are also improved water sources, but unlike basic services, the total time spent traveling, collecting and standing in line is more than 30

minutes. Meanwhile, unimproved drinking water sources include unprotected dug wells or springs. At the bottom of the service ladder, surface water is drinking water sourced directly from lakes, rivers, dams, and the like (WHO & UNICEF, 2017b).

Like drinking water, the sanitation service ladder also has five classifications (Table 2): safely managed, basic, limited, unimproved and open defecation (OD). The split is also similar with drinking water in that there are two main groups, improved sanitation services—safely managed, basic, and limited—and unimproved sanitation services—unimproved and open defecation. Improved sanitation facilities hygienically separate excreta from human contact and include toilets connected to piped sewer systems, septic tanks, or pit latrines. To be considered a safely managed sanitation service, the improved facility must not be shared with other households and the excreta should be treated and disposed of in situ (on site); stored, emptied, transported, and treated off-site; or transported through a sewer system and treated off-site. Basic sanitation service does not include proper management of excreta and must not be shared with other households. On the other hand, limited sanitation services are the sharing of improved facilities between two or more households. Meanwhile, unimproved sanitation services include the use of pit latrines without a platform or slab. Lastly, at the bottom of the sanitation service

SERVICE LEVEL	DEFINITION
SAFELY MANAGED	Use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or transported and treated offsite
BASIC	Use of improved facilities that are not shared with other households
LIMITED	Use of improved facilities shared between two or more households
UNIMPROVED	Use of pit latrines without a slab or platform, hanging latrines or bucket latrines
OPEN DEFECATION	Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches or other open spaces, or with solid waste

Note: improved facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, composting toilets or pit latrines with slabs.

Table 2. JMP Ladder for sanitation services (WHO & UNICEF, 2017b)

ladder is OD, the disposal of excreta in open spaces, open bodies of water, or with solid waste. Monitoring OD is an important aspect of SDG 6 as it is specifically mentioned in Target 6.2 (WHO & UNICEF, 2017b).

Indicator	The proportion of the population that uses…
W_7	improved water sources not exceeding 30 minutes collection time (basic drinking water services)
W_{11}	safely managed drinking water services
S_8	improved sanitation facilities which are not shared (basic sanitation services)
S_{12}	safely managed sanitation services

Table 3. JMP indicators for drinking water and sanitation services (WHO & UNICEF, 2017b)

This thesis will focus on at least basic services, which equates to the proportion of populations accessing basic services and safely managed services for drinking water and sanitation. The JMP indicators for these service levels are shown in Table 3. For the focus countries in the study, there is no data available for safely managed services; as such, only the indicators for basic services (W_7 and S_8) were included.

WHO/UNICEF JMP Dataset Aggregation & Creation

To create its dataset, JMP aggregates the information from across the various sources collected directly from national authorities. Analysts classify the data according to category of improved or unimproved source and by service level. Survey conduction does not occur every year; JMP uses the data available and simple linear regressions to extrapolate estimates and generate annual data points. Figure 5 summarizes the processing of data, from sources to country files.

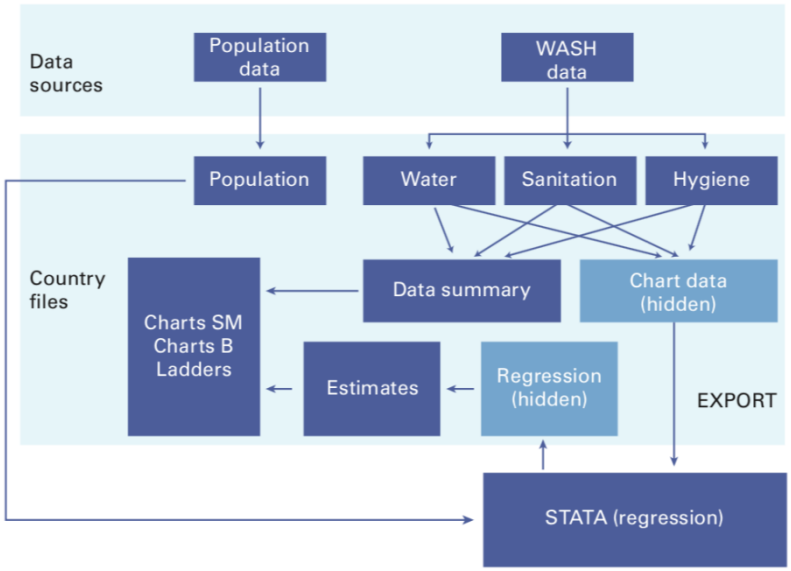

Figure 5. A diagram showing JMP's data processing of WASH services data from *JMP Methodology: 2017 Update & SDG Baselines* (WHO & UNICEF, 2018)

Economic Indicators Dataset – UN Statistics Division (UNSD)

Data for annual rate of real GDP per capita and total official financial flows for water and sanitation was from the UN Statistics Division. The data for these economic indicators were global monitoring data provided by international agencies. This data classification means that designated agencies produced data, based on country data, on a regular basis for the purpose of global monitoring (UNSD, 2019).

The dataset used for this study was a compilation of the values for population, at least basic water services coverage, at least basic sanitation services coverage, annual growth rate of

real GDP per capita, and total official financial flows for water supply and sanitation for the years 2000-2015.

For this thesis, economic indicators have been identified based on their use by the UN Statistics Division (UNSD) in the UN Global SDG Database for SDG Indicators. Compiled regularly, the database provides all goals, indicators, and corresponding databases that track the progress made towards each indicator. The initiative is in place for the UN Secretary General's use towards the annual report, "Progress towards the Sustainable Development Goals" (UNSD, 2019). For this study, two economic indicators will be presented: annual growth rate of real Gross Domestic Product (GDP) per capita and Total Official Financial Flows to Water Supply and Sanitation (Total ODA for Water Supply and Sanitation).

Annual Growth Rate of Real GDP Per Capita

Gross Domestic Product is a standard economic indicator that accounts for the gross value added by producers in the economy. Calculated annually, the value also includes product taxes but removes any subsidies not included with the value of the products. Additionally, GDP does not deduct for depreciation of assets or for degradation and depletion of natural resources. A weighted average, GDP per capita is the calculated Gross Domestic Product divided by the midyear population (World Bank, 2018).

SDG Target 8.1 calls for "[Sustaining] per capita economic growth in accordance with national circumstances and, in particular, at least 7 [percent] gross domestic product growth per annum in the least developed countries." Indicator 8.1.1 is the annual growth rate of GDP per capita (UNSD, 2019). The annual growth rate, shown in percentage, is based on local currency

(Ritchie, Roser, Mispy, & Ortiz-Ospina, 2018). The growth of GDP in a country signals economic growth due to production. In the framework proposed, the increased labor productivity that is downstream from providing access to WASH services could have an influence on the GDP growth in a country.

UNSD creates the dataset for annual growth rate with the use of annual GDP estimates collected through a national accounts questionnaire sent to countries. After internal validation, data conversion to US dollars occurs and then dividing by population to derive the per capita value. To calculate the values, UNSD uses the following equation: "[(G(t+1) – G(t))/G(t)] x 100, where G(t+1) is real GDP per capita in 2010 US dollars in year t+1 and G(t) is real GDP per capita in 2010 US dollars in year t" (UNSD, 2019).

Total Official Financial Flows to Water Supply and Sanitation

Total Official Financial Flows to Water Supply and Sanitation is the total official development assistance (ODA) received by countries specifically for water supply and sanitation. ODA is financial support from official agencies such as local and state governments that flows to countries and territories on the list of ODA recipients and to multilateral institutions. The support is in the form of grants and soft loans with the primary intention of promoting economic development and welfare (OECD, 2018).

SDG Target 6.a's call to action is "By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies." Indicator 6.a.1 is the amount of WASH-related ODA that is

part of a government's spending plan (UNSD, 2019). The value presented is the gross disbursement of ODA of each recipient country (Ritchie et al., 2018). The inflow of external funding, formally called ODA, for this indicator has an impact on the WASH sector in developing countries as it directly flows into the sector. This could have an effect on the provision of access to drinking water and sanitation services in a country. Additionally, economic growth could lead to increased assistance from other countries or agencies due to the stability that the GDP growth presents. Donors could perceive this stability as decreased risk for their investment.

To calculate the total official financial flows for the sector, UNSD used the water- and sanitation-related ODA from the UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water survey as a numerator. The denominator was the total water- and sanitation-related ODA disbursements gathered through OECD Creditor Reporting System.

The Case for Southeast Asia

This study aims to examine the association between the WASH sector and economic growth, with particular attention to the countries in Southeast Asia. The region accounts for about 9% of the total world population. In 2015, 11% of the population in the region had drinking water service levels below at least basic and 25% of the population in the region had sanitation service levels below at least basic (WHO & UNICEF, 2017a). Increasing investments in the WASH sector in anticipation of achieving SDG 6 would not only provide at least basic services to about one-tenth of the global population, it would also impact economic development

in that same population. Presenting a relationship between WASH service levels and economic development can impact the focus on the sector and the achievement of the SDGs.

Southeast Asia is a region that consists of 11 countries: Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, the Philippines, Singapore, Thailand, Timor-Leste, and Vietnam. The focus of this paper will be on the three countries with the largest populations in the region—Indonesia, the Philippines, and Vietnam (WHO & UNICEF, 2017a). These three countries, along with Malaysia and Thailand, are commonly known as the ASEAN-5, or the five fastest growing economies in the Association of Southeast Asian Nations (ASEAN). The ASEAN-5 is a grouping considered to be among the fastest growing economic regions but challenges to infrastructure has hindered its progress. With infrastructure as a vital input for the economy, its success and improvement can also improve income distribution. Although the ASEAN-5 has reduced poverty, Indonesia, the Philippines, and Vietnam have challenges with substantial portions of their populations still live below the poverty line (Seneviratne & Sun, 2013). In conjunction with each focus country's gap in achieving universal coverage for WASH, these economic considerations present an opportunity to explore the relationship between WASH services coverage and economic growth in the region.

Data Collection, Management, and Plan for Secondary Analysis

This researcher collected the data for the focus countries from the WHO/UNICEF JMP and UNSD datasets into Microsoft Excel 2016. Using this aggregated information, data visualizations were created using Microsoft Excel for population, services coverage, and

relationships between coverage and the economic indicators on a regional level showing all three focus countries. Individualized, per-country visualizations were also created for the relationships between coverage and the economic indicators. To determine descriptive statistics and correlation coefficients and their significance for the data, the study used SAS 9.4.

Ethical Considerations

As this paper is a secondary analysis of publicly-available data without the involvement of human subjects. Institutional Review Board approval was not required.

RESULTS

The analysis of the relationship between WASH and the economy will be presented first through the univariate data. Afterwards, results will be presented for Indonesia, the Philippines, and Vietnam individually. Lastly, regional patterns for the relationship between WASH and the economy will be shown.

Population

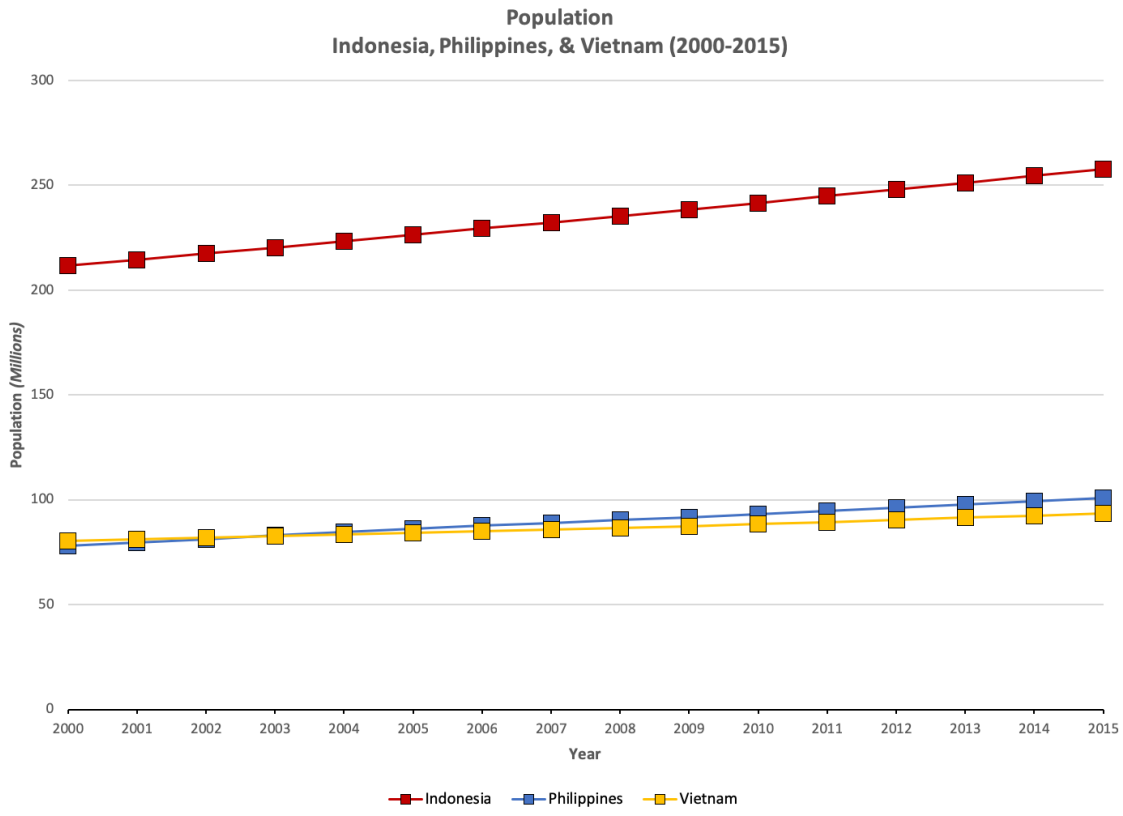

Figure 5. *Population of Indonesia, Philippines, and Vietnam (2000-2015)*

Figure 5 displays the population of the three focus countries. All three countries' populations increased over the time period. Indonesia has the highest population, ranging from about 211 million in 2000 to 257 million in 2015, double the population of either the Philippines or Vietnam throughout the given time period. The Philippines and Vietnam have similar population values throughout the time period, ranging from 80 million to 1000 million. In the year 2000, Vietnam had a larger population with 80 million compared to 78 million. However, within three years, the population of the Philippines outgrew that of Vietnam, a trend that continued until the end of the time period when the former had 100 million to the latter's 93 million.

WASH and the Economy

The tables and figures below contain information on the coverage of WASH services and the economic indicators in Indonesia (IND), the Philippines (PHL), and Vietnam (VNM).

	2000			*2015*		
Variable	**IDN**	**PHL**	**VNM**	**IDN**	**PHL**	**VNM**
At least basic water services coverage (%)	75	86	78	90	91	91
At least basic sanitation services coverage (%)	44	67	53	68	75	78

Table 4. *At Least Basic Water and Sanitation Services Coverage for Indonesia, Philippines, and Vietnam (2000 & 2015)*

Table 4 shows the data for services coverage and economic indicators for the years 2000 and 2015 in the three focus countries. The Philippines had the highest percentages of coverage of the total population with both at least basic water and sanitation services, at 86% and 67%, respectively, in 2000. The Philippines and Vietnam have similar at least basic water services coverage at 91% in 2015; an increase of five percentage points and 13 percentage points from 2000, respectively. Vietnam also has the highest at least basic sanitation services coverage at 78% in 2015, an increase of 25 percentage points from coverage in 2000.

	2000			*2015*		
Variable	**IDN**	**PHL**	**VNM**	**IDN**	**PHL**	**VNM**
Annual growth rate of real GDP per capita (%)	3.47	2.19	5.60	3.65	4.38	5.51
Total official financial flows (USD, Millions)	$ 82.65	$ 19.31	$ 216.04	$ 139.05	$ 66.00	$ 558.31

Table 5. *Annual Growth Rate of Real GDP Per Capita and Total Official Financial Flows to Water Supply and Sanitation for Indonesia, Philippines, and Vietnam (2000 & 2015)*

Meanwhile, Table 5 displays the data for the economic indicators at the beginning and at the end of the time period for the three focus countries. All three countries saw an increase in their total official flows from 2000 to 2015. GDP per capita also grew from 2000 to 2015 in Indonesia and the Philippines. Although Vietnam's GDP per capita growth rate decreased, it still had the highest economic indicators for both years. In 2000, Vietnam had an annual growth rate of real GDP per capita at 5.60% and 5.51% in 2015. The country's total official financial flows more than doubled from about USD 220 million in 2000 to almost USD 560 million in 2015.

Mean Values for WASH and the Economy in 2000 and 2015

Variable	***2000***	***2015***
At least basic water services coverage (%)	79.50	90.41
At least basic sanitation services coverage (%)	54.87	73.70
Annual growth rate of real GDP per capita (%)	3.75	4.51
Total official flows to water supply and sanitation (USD, Millions)	$ 106.00	$ 254.45

Table 6. *Mean Values for At Least Basic Water and Sanitation Services Coverage & Economic Indicators for Indonesia, Philippines, and Vietnam (2000 and 2015)*

Table 6 shows the mean values for at least basic water and sanitation services coverage and the two economic indicators—annual growth rate of real GDP per capita and total official financial flows to water supply and sanitation—across Indonesia, the Philippines, and Vietnam. The data shown are for the years 2000 and 2015, the start and end of the time period, respectively.

In 2000, the average value for at least basic water services coverage was 79.5% and by 2015, the average increased by almost 11 percentage points to 90.41%. The average value for at least basic sanitation services coverage in 2000 was 54.87% and it increased by more than 18 percentage points to 73.70% in 2015. The average annual growth rate of real GDP per capita across the three countries was 3.75% in 2000; the rate's average increased by 0.75 percentage points to 4.51% in 2015. On average, the total official flows to water supply and sanitation was $ 106,000,923 in 2010 and $ 254,452,5000 in 2015, more than doubling from the beginning of the time period.

At Least Basic Water Services Coverage

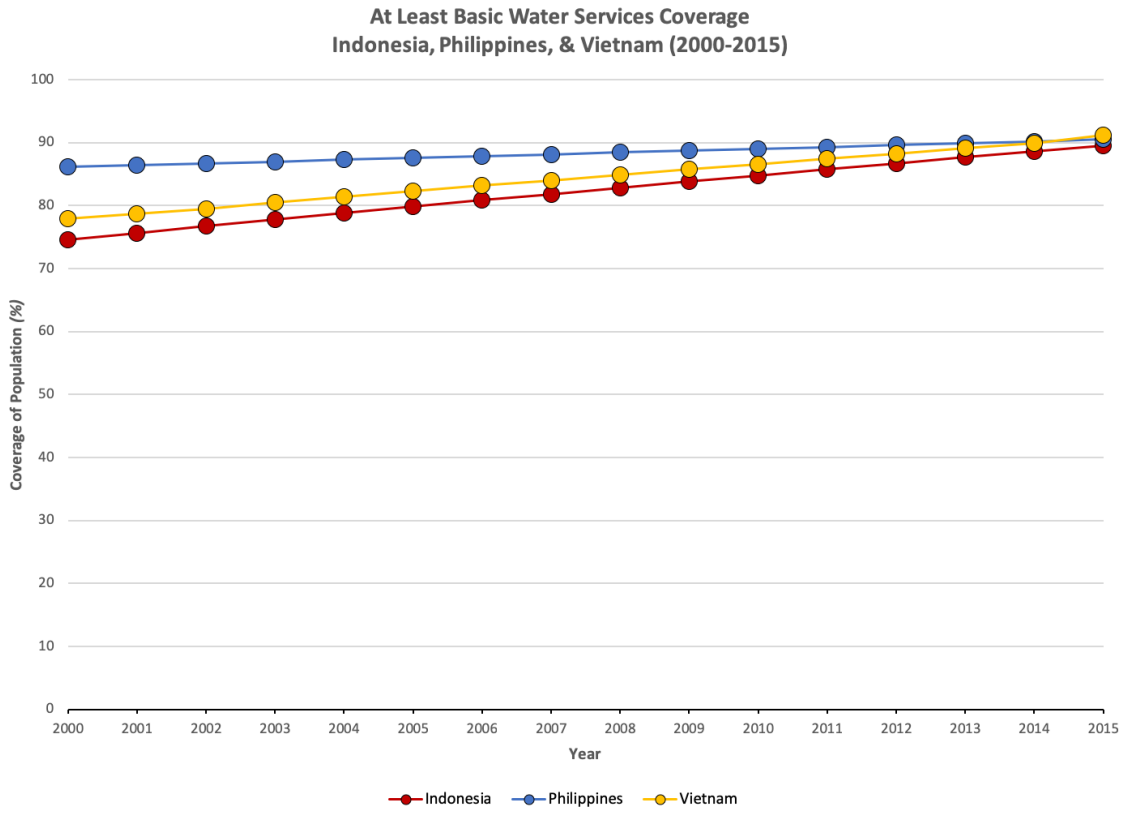

Figure 6. *At Least Basic Water Services Coverage in Southeast Asia (2000-2015)*

Meanwhile, Figure 6 is the coverage of at least basic water services in the three focus countries for the entire time period. All three countries have starting coverage values above 70% and they all have an upward trend as the time period continues. Indonesia and Vietnam have similar trajectories that appear to plateau or not grow as rapidly starting in 2012. The growth of coverage for at least basic water services in the Philippines appears to not grow at a similar rate to that of either Indonesia or Vietnam. It appears to have a fairly constant coverage throughout the time period with minimal growth, from 86% to 91% of the population. In comparison, the coverage for water grew from 75% to 90% in Indonesia and 78% to 91% in Vietnam. The three

countries have similar values at the end of the time period and have not reached universal coverage for at least basic water services.

At Least Basic Sanitation Services Coverage

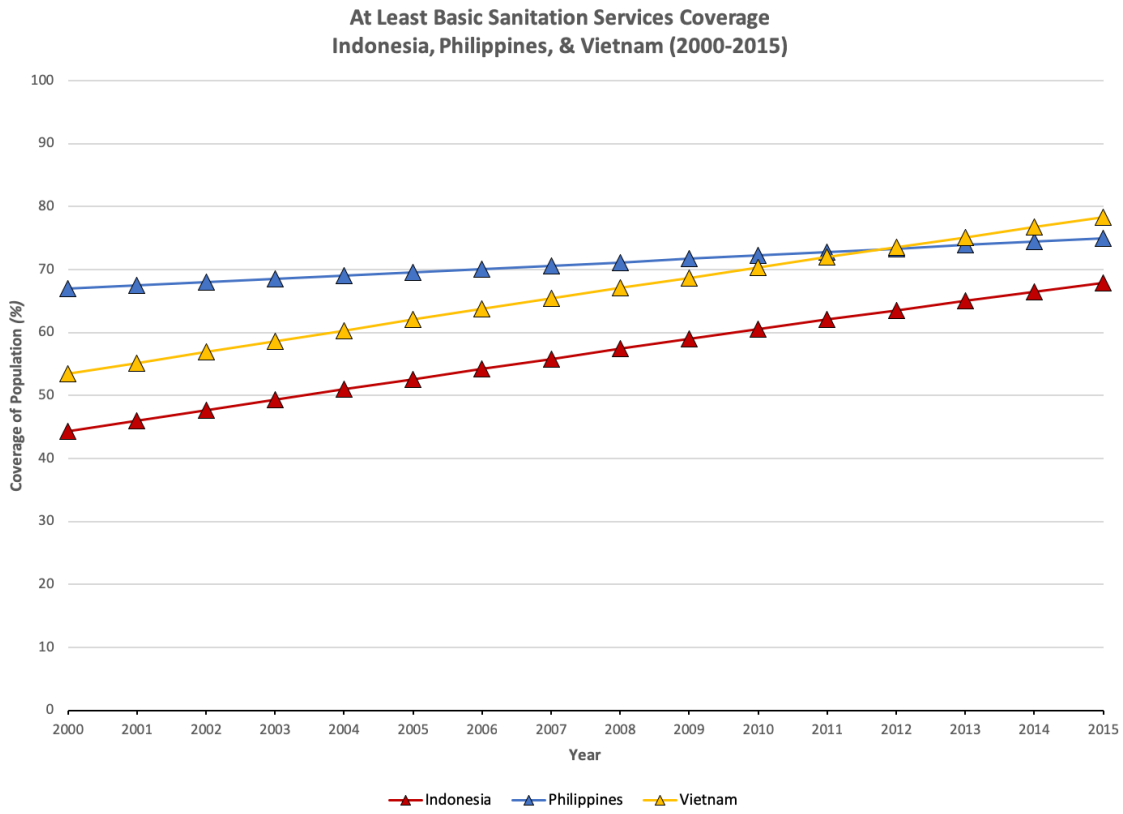

Figure 7. *At Least Basic Sanitation Services Coverage in Southeast Asia (2000-2015)*

The coverage for at least basic sanitation services also increased over the time period in all three focus countries. The growth of coverage looks fairly similar in Indonesia and Vietnam while the growth in the Philippines appears more constant. Additionally, the Philippines had the highest percentage of coverage for at least basic sanitation services in 2000, at 86%. Vietnam

overtook the Philippines starting in 2012 until the end of the time period with 91% of the population having access to at least basic sanitation services in 2015.

Relationship Between WASH and the Economy

The following analysis explores the relationship between access to at least basic water and sanitation services and the two economic indicators. The relationships will be presented individually for Indonesia, the Philippines, and Vietnam.

Indonesia

Figure 7 shows the relationship between at least basic water coverage and the two economic indicators while Figure 8 shows the relationship between at least basic sanitation services and the two economic indicators in Indonesia from 2000-2015. Overall, there is a gap in the coverage of at least basic services for water and sanitation. In 2000, 75% of the population in Indonesia had access to at least basic water services and this grew to 90% of the population by 2015. For sanitation, the numbers are considerably lower, with 44% of the population having access to at least basic sanitation services in 2000 and increases to 68% of the population in 2015. The 2015 value for sanitation services coverage is noticeably lower than the 2000 value for water services coverage.

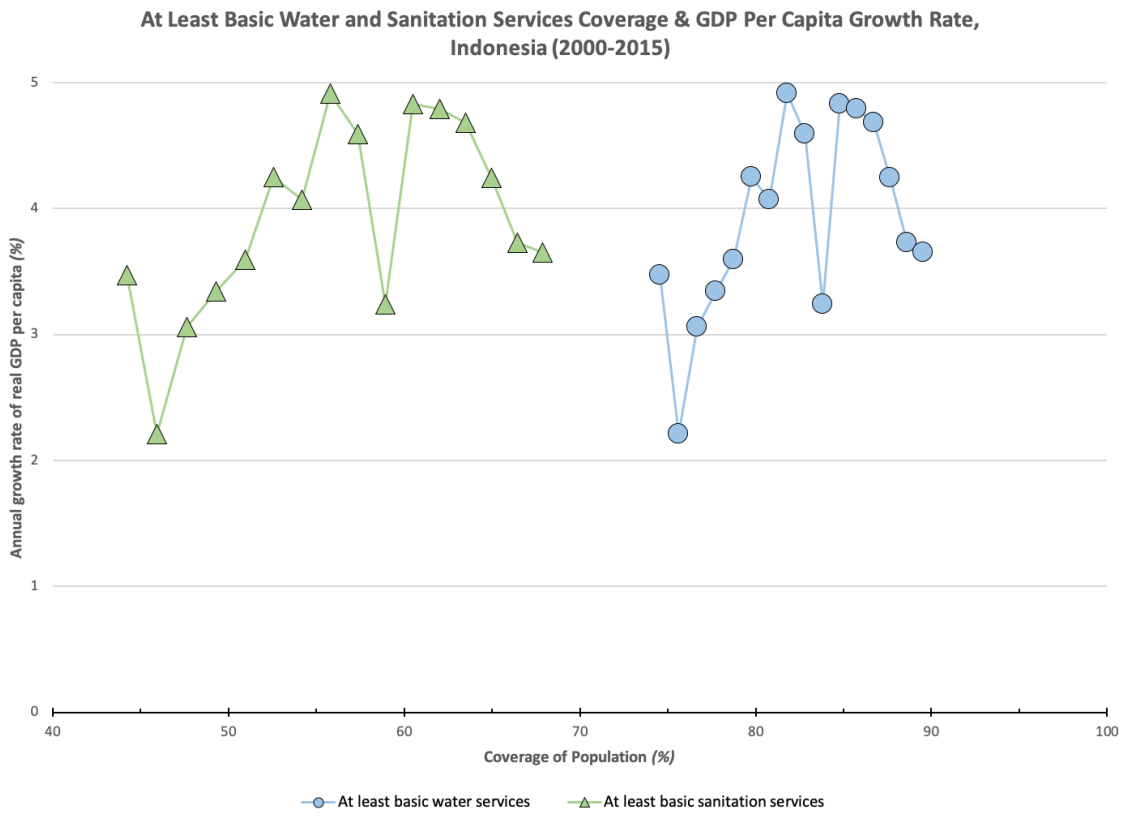

Figure 7. *At Least Basic Water and Sanitation Services Coverage & Annual Growth Rate of Real GDP Per Capita, Indonesia (2000-2015)*

For annual growth rate of real GDP per capita (Figure 7), Indonesia experienced a varied growth across the time period. In 2000, the growth rate was about 3.5% and decreased to 2.21% in the next year. The growth rate from 2001 was the lowest annual growth rate throughout the 16-year time period. The rate generally increased until 2007, where it had its largest value, at 4.91%. In 2008, there was a slight decrease in growth that then became a substantial decrease in 2009. The rate increased to a level similar to 2007 but has been in decline since and ended at 3.65% in 2015.

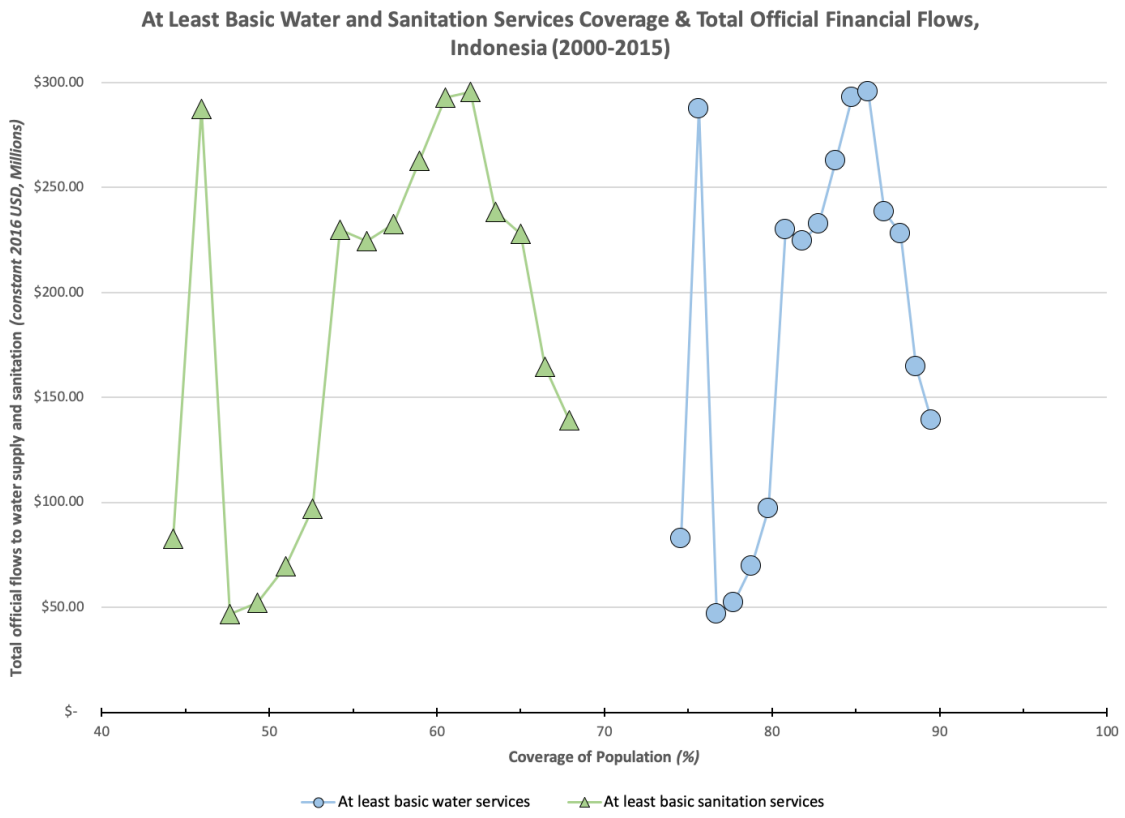

Figure 8. *At Least Basic Water and Sanitation Services Coverage & Total Official Financial Flows to Water Supply and Sanitation, Indonesia (2000-2015)*

The total official financial flows to water supply and sanitation (Figure 8) has a more varied trend. Indonesia had inflows of about USD 83 million in 2000. In the next year, there was a large increase of inflows to almost USD 300 million. In 2001, the total financial flow was the lowest across the time period at under USD 50 million. It generally increased from then and peaks in 2011 at over USD 295 million. Like the rate of GDP per capita, financial flows have been in decline since that peak and in 2015, the total was just under USD 140 million.

	Water	Sanitation
Water	1.0	
Sanitation	**0.99999 (<.0001)**	1.0
Population	**0.99929 (<0.0001)**	**0.99908 (<0.0001)**
Growth rate of GDP per capita	**0.52503 (0.0368)**	**0.5277 (0.0357)**
Total official flows	0.44114 (0.0872)	0.44275 (0.0859)

*All values in **bold** are significant ($p < 0.05$).*

Table 6. *Correlation Coefficients Between At Least Basic Water and Sanitation Service Levels & Economic Indicators in Indonesia*

As Table 6 indicates, there is a strong, positive, and significant correlations between coverage of water services and coverage of sanitation services (0.99999, $p<0.0001$). There are also strong, positive, and significant correlations between population and the coverage of water services (0.99929, $p<0.0001$) and the coverage of sanitation services (0.99908, $p<0.0001$). In addition, there are moderate, positive, and significant correlations between growth rate of GDP per capita and the coverage of water services (0.52503, $p = 0.0368$) and the coverage of sanitation services (0.5277, $p=0.0357$).

Philippines

Meanwhile, Figures 9 and 10 show the relationships between coverages of at least basic services and the two economic indicators for the Philippines. A distinct gap in the coverage of at least basic services for water and sanitation exists in the Philippines. In the Philippines, 86% of the population had access to at least basic water services; this percentage increased to 91% of the population by 2015. The numbers are lower for coverage of at least basic sanitation services at 67% in 2000. By 2015, this percentage had grown to 75%. Much like Indonesia, the 2015 value for sanitation services coverage is noticeably lower than the 2000 value for water services coverage.

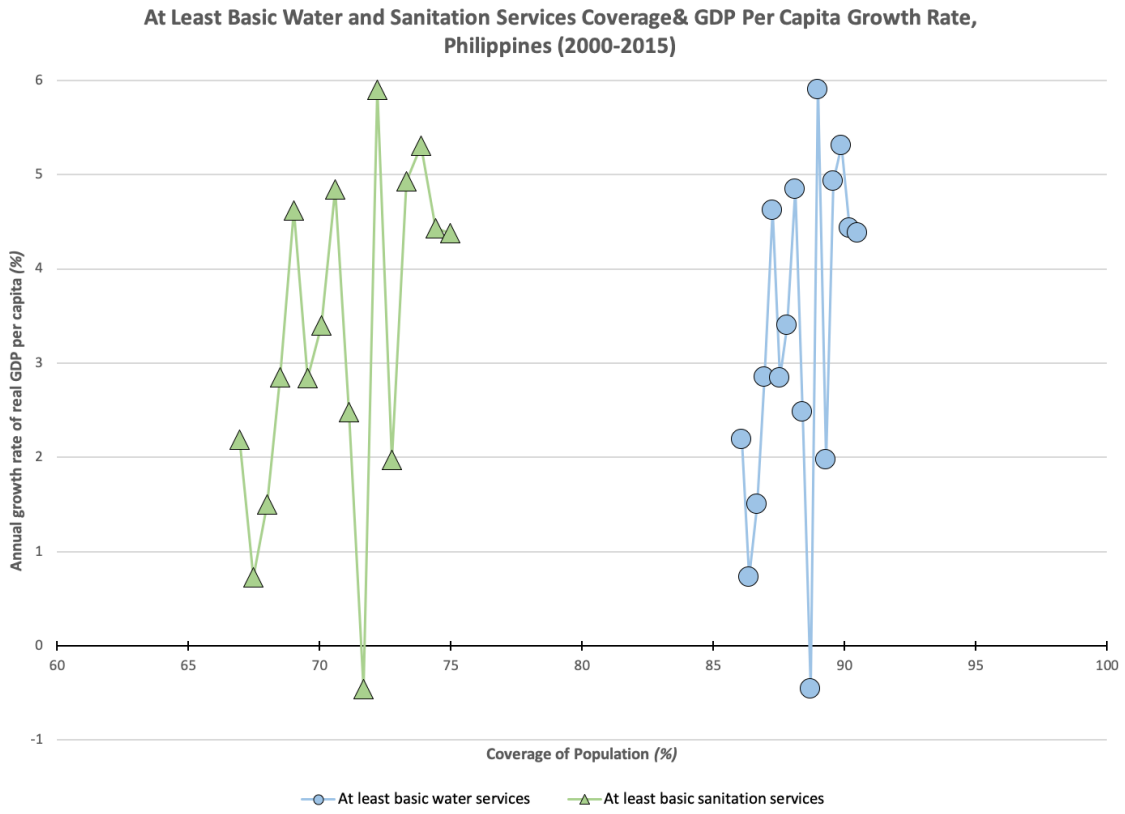

Figure 9. *At Least Basic Water and Sanitation Services Coverage & Annual Growth Rate of Real GDP Per Capita, Philippines (2000-2015)*

In the Philippines, the annual growth rate of real GDP per capita (Figure 9) experienced a varied growth across the 16-year time period. The values increased and decreased almost year-to-year. The growth rate for the time period began at 2.19% in 2000 and was 4.38% at the end of the time period in 2015. The highest growth rate was in 2013 at 5.31% while the lowest growth rate was in 2009 at -0.46%, which is the only negative growth rate in the entire dataset.

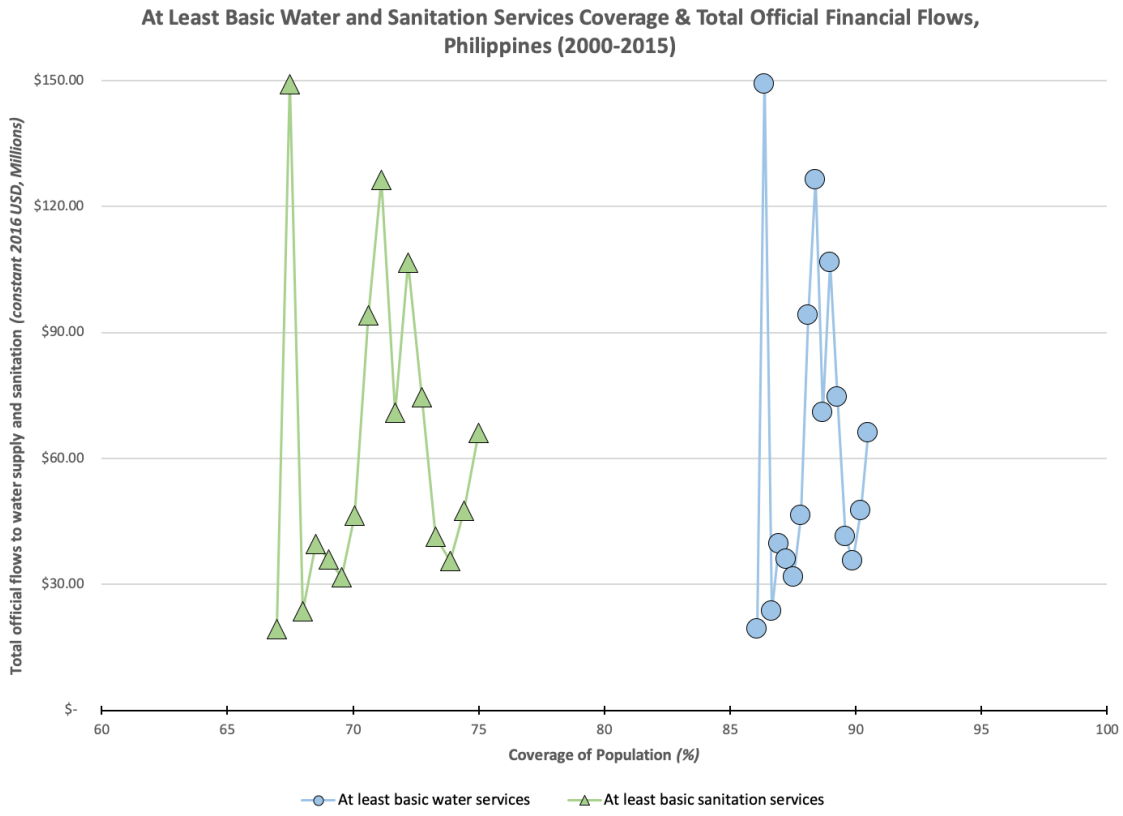

Figure 10. *At Least Basic Water and Sanitation Services Coverage & Total Official Financial Flows to Water Supply and Sanitation, Philippines (2000-2015)*

The total official financial flows to water supply and sanitation (Figure 10) also has a varied trend. In 2000, the Philippines had flows of around USD 19 million. There was a large increase in flows to the year 2001 where the Philippines saw almost USD 150 million for water

supply and sanitation; this was the highest amount of flows to the country. After a large decline of flows to around USD 24 million in 2002, the values generally increased until 2008. However, the values declined until 2013; thereafter, the official financial flows have been increasing and at the end of the time period, in 2015, the Philippines had total official financial flows of USD 66 million.

	Water	Sanitation
Water	1.0	
Sanitation	**0.99998 (<0.0001)**	1.0
Population	**0.99939 (<0.0001)**	**0.99917 (<0.0001)**
Growth rate of GDP per capita	0.48685 (0.0558)	0.48651 (0.0560)
Total official flows	0.04812 (0.8595)	0.04712 (0.8624)

*All values in **bold** are significant ($p < 0.05$).*

Table 7. *Correlation Coefficients Between At Least Basic Water and Sanitation Service Levels & Economic Indicators in the Philippines*

Table 7 shows that there are strong, positive, and significant correlations between coverage of water services and coverage of sanitation services (0.99998, $p < 0.0001$). In addition, there are also strong, positive, and significant correlations between population and at least basic water services coverage (0.99939, $p < 0.0001$) and at least basic sanitation services coverage (0.99917, $p < 0.0001$). The other correlations, between WASH services and the economic indicators, are not significant for the Philippines.

Vietnam

Lastly, Figures 11 and 12 depict the relationship between coverages of at least basic services and the two economic indicators in Vietnam. There is a gap in the coverage of at least basic services for water and sanitation in Vietnam. Access to at least basic water services for the total population was 78% in 2000. The coverage increased to 91% of the population by 2015. For at least basic sanitation services, 53% of the total population had coverage and this increased to 78% of the population by 2015. Although there is still an existing divide between water and sanitation coverage, it is notable that the 2015 coverage for sanitation equals the 2000 coverage for water services at 78%.

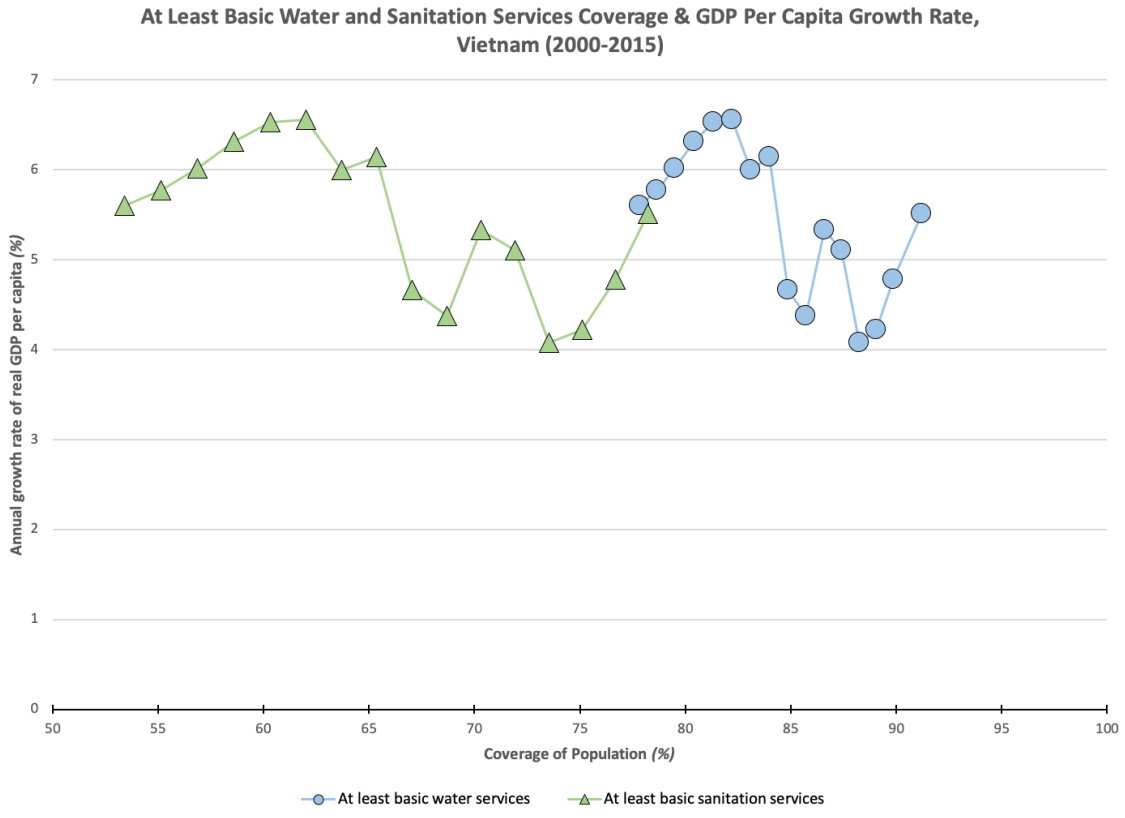

Figure 11. *At Least Basic Water and Sanitation Services Coverage & Annual Growth Rate of Real GDP Per Capita, Vietnam (2000-2015)*

The annual growth rate of real GDP per capita (Figure 11) is fairly constant, without much variation in its growth throughout the time period. In 2000, Vietnam had an annual growth rate of 5.6% and had its highest value in 2005 at 6.55%. There was a general decline until 2012 with an annual growth rate of 4.07%, the lowest value for Vietnam in the entire period. Since then, there has been an increase in growth rates and in 2015, the rate was 5.51%.

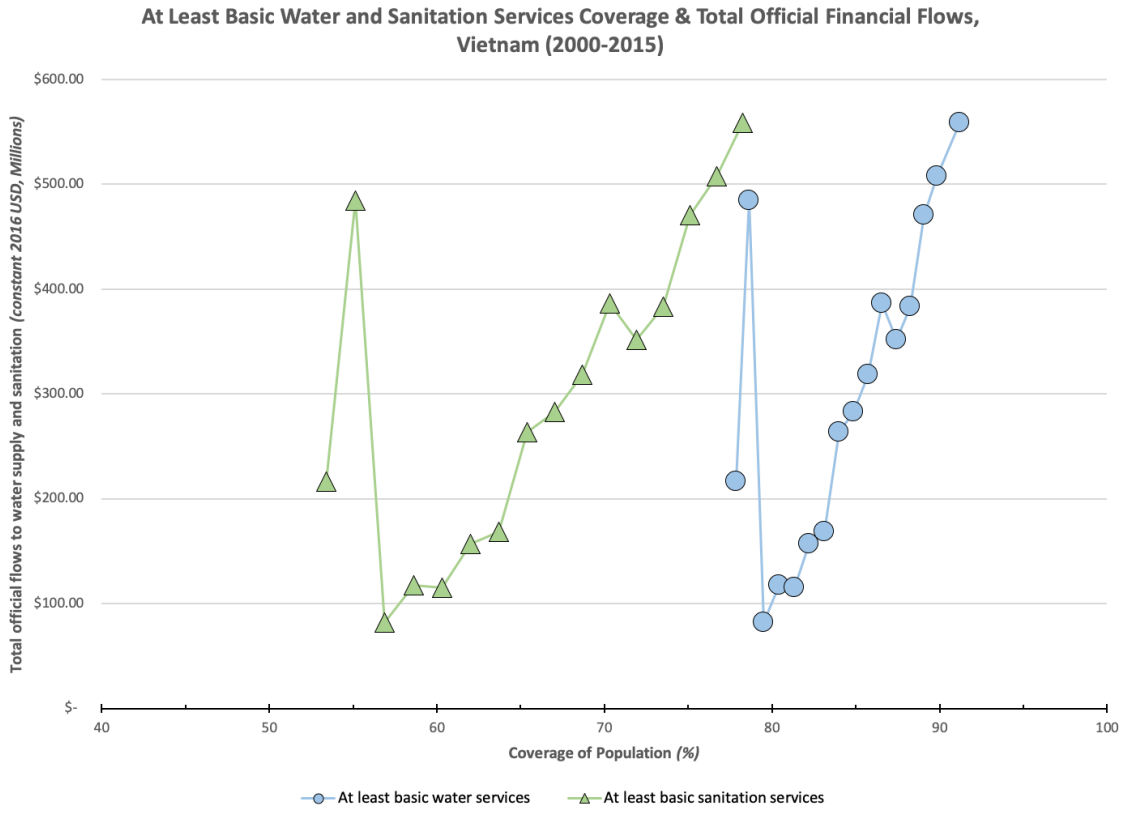

Figure 12. *At Least Basic Water and Sanitation Services Coverage & Total Official Financial Flows to Water Supply and Sanitation, Vietnam (2000-2015)*

The total official financial flows to water supply and sanitation in Vietnam (Figure 12) largely had an upward trend throughout the entire time period. In 2000, the total flows are about USD 216 million and increased to under USD 500 million in 2001. For 2002, the total flows

greatly decreased to around USD 81 million, the lowest value for the entire period. It had been generally increasing since then and the total flows peaked in 2015 at around USD 560 million.

	Water	Sanitation
Water	1.0	
Sanitation	**0.99959 (<0.0001)**	1.0
Population	**0.99757 (<0.0001)**	**0.99682 (<0.0001)**
Growth rate of GDP per capita	**-0.64526 (0.0069)**	**-0.65174 (0.0062)**
Total official flows	**0.70171 (0.0024)**	0.69569 (0.0028)

*All values in **bold** are significant ($p < 0.05$).*

Table 8. *Correlation Coefficients Between At Least Basic Water and Sanitation Service Levels & Economic Indicators in Vietnam*

As shown in Figure 8 for Vietnam, there are strong, positive, and significant correlations between coverage of water services and coverage of sanitation services (0.99959, p <0.0001). The relationships between population and coverage of water services (0.99757, p <0.0001) and coverage of sanitation services (0.99682, p <0.0001) are also strong, positive, and significant. There are moderate, negative, and significant correlations between growth rate of GDP per capita and coverage of water services (-0.64257, p=0.0069) and sanitation services (-0.65174, p=0.0062). Notably, there is a moderately strong and significant correlation between coverage of water services and total official flows (0.70171, p=0.0024) while there is not a significant correlation between sanitation coverage and flows (0.69569, p=0.0028).

Regional Trends of the Relationship Between WASH Services and the Economy

Figures 13-14 and Table 9 depict the relationship between the coverage of at least basic water and sanitation services and the two economic indicators from 2000-2015 on a larger level, as aggregates of the values for Indonesia, the Philippines, and Vietnam.

Relationship Between WASH and the Economy

Table 9 presents the correlation coefficients for the relationships between water and sanitation coverage, coverage and population, water coverage and the economic indicators, and sanitation coverage and the economic indicators for the region over the entire time period.

	Water	Sanitation
Water	1.0	
Sanitation	**0.9602 (<0.0001)**	1.0
Population	**-0.33112 (0.0215)**	**-0.56262 (<0.0001)**
Growth rate of GDP per capita	-0.11397 (0.4405)	-0.02415 (0.8706)
Total official flows	0.06896 (0.6414)	0.1319 (0.3715)

*All values in **bold** are significant ($p < 0.05$).*

Table 9. *Correlation Coefficients Between At Least Basic Water and Sanitation Service Levels & Economic Indicators for Indonesia, the Philippines, and Vietnam*

For the aggregation of the focus countries, there is a significant strong and positive correlation between at least basic water services coverage and at least basic sanitation services

coverage, with a value of 0.9602 and a p-value of less than 0.0001. There are also strong and negative correlations between at least basic water services coverage and population, with a value of -0.33112 ($p=0.0215$), and at least basic sanitation services coverage and population, with a value of -0.56262 ($p< 0.0001$). None of the other correlations are significant. The relationships between growth rate of real GDP per capita and access to water and sanitation services are weak and negative, at -0.11397 for water and -0.02415 for sanitation. The correlations are weak, but positive, for total official financial flows, at 0.06896 for water and 0.1319 for sanitation.

Annual Growth Rate of Real GDP Per Capita

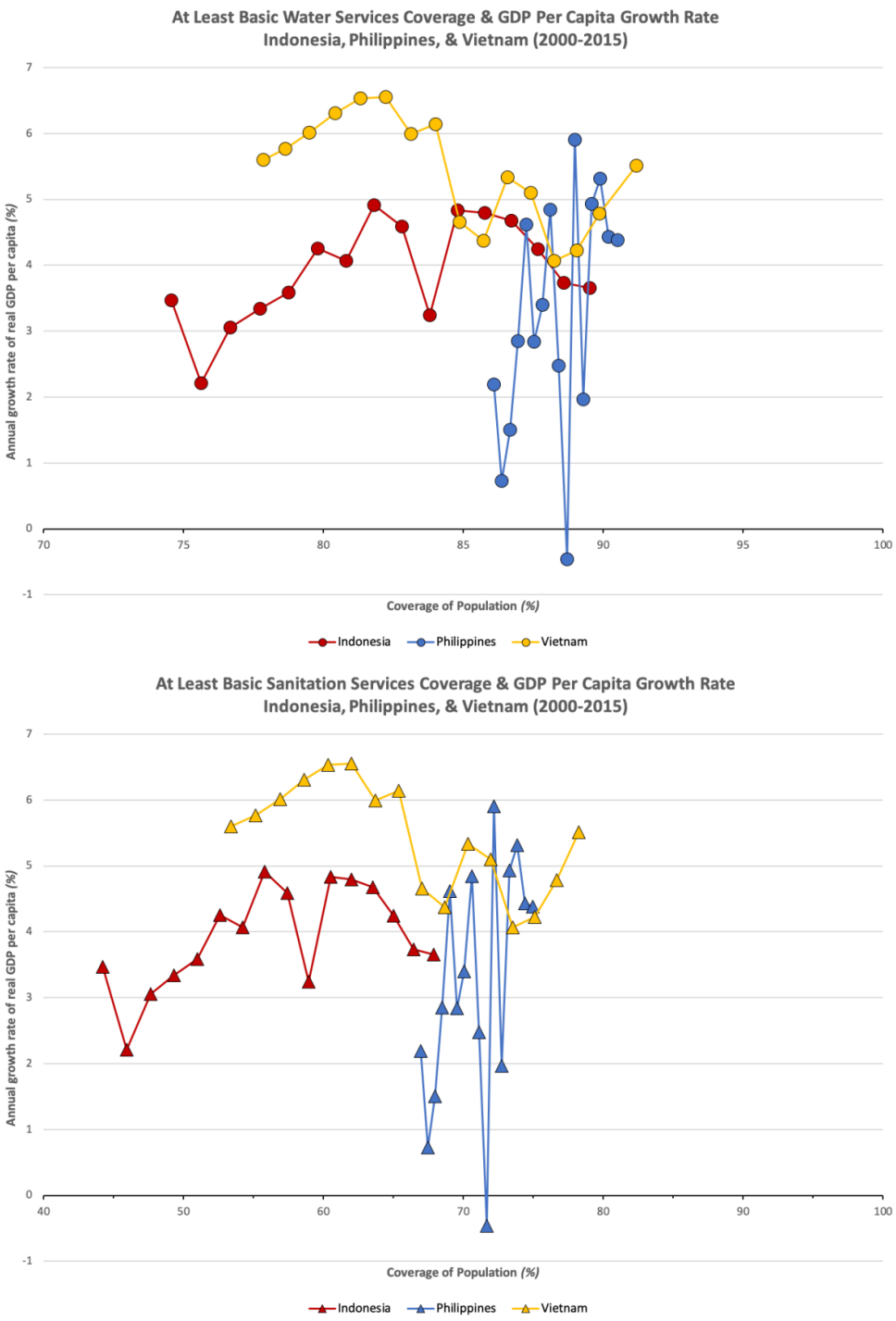

Figure 13. *At Least Basic Water and Sanitation Services & Annual Growth Rate of Real GDP Per Capita in Indonesia, Philippines, and Vietnam (2000-2015)*

The annual growth rate of real GDP per capita, shown in Figures 13, does not have a discernible trend. The growth rates for Indonesia and Vietnam in 2015 are similar to their values in 2000. For Indonesia, there is a more general upward trend after a decrease in the rate from 2000 to 2001. The country also has another decline in 2009. Vietnam, on the other hand, had a general increase from 2000-2005, and the rate decreased in 2006. The decrease continued until 2009, increased in 2010 but decreased again until 2012. From then, the growth rate has increased. The Philippines had up and down growth rates for GDP per capita throughout the entire time period but has an upward trend between 2000 and 2015. In 2009, the country experienced a negative annual growth rate, the only one to have a negative rate across the three countries. The correlation coefficients show that across the focus countries, there are weak and negative correlations between annual growth of GDP per capita and coverage for both at least basic services that are not significant.

Total Official Financial Flows to Water Supply and Sanitation

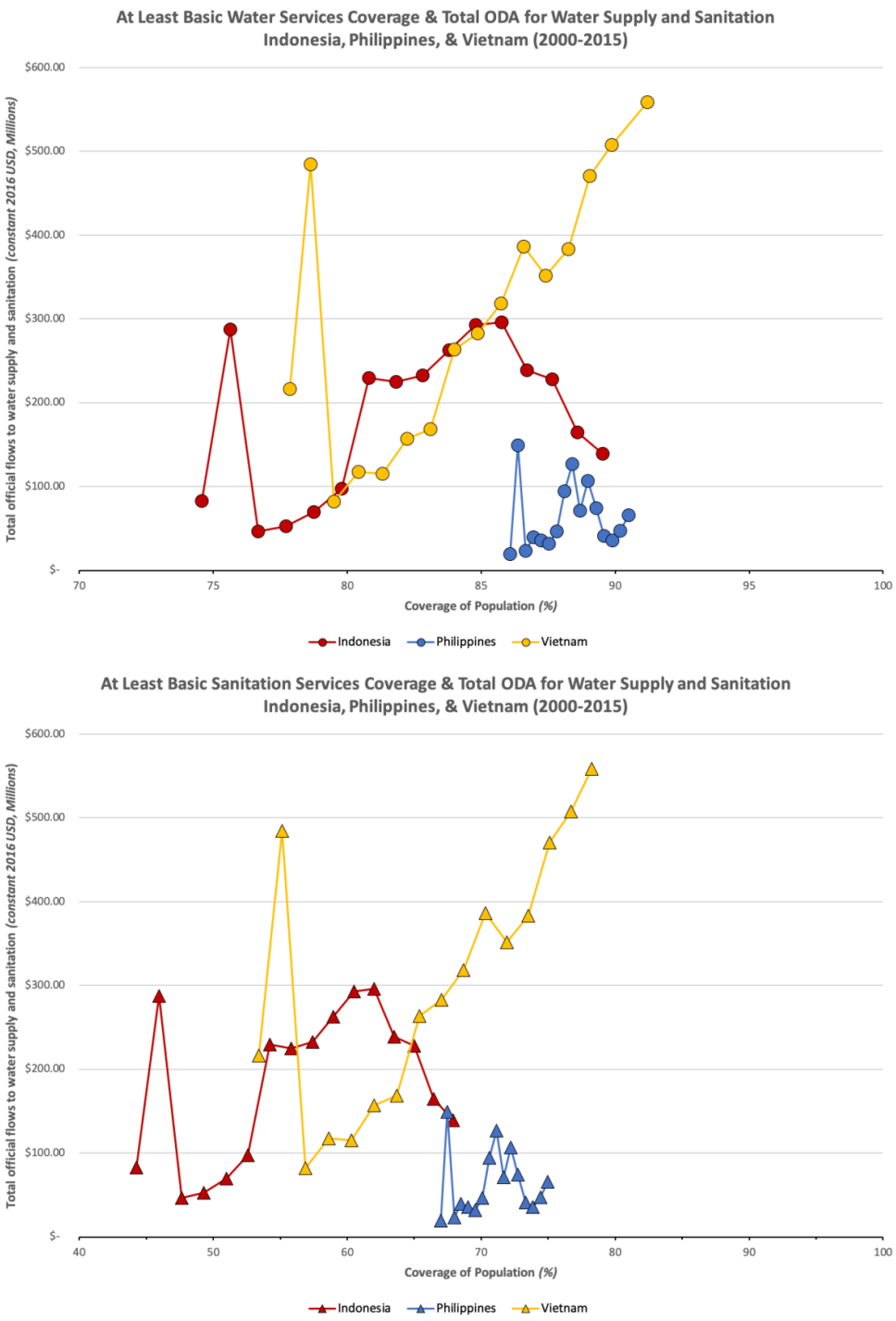

Figure 14. *At Least Basic Water and Sanitation Services & Annual Growth Rate of Real GDP Per Capita in Indonesia, Philippines, and Vietnam (2000-2015)*

Total official financial flows to water supply and sanitation, in Figure 6, shows a general upward trend across the focus countries in that the values in 2015 are higher than the values in 2000. Indonesia had a sizeable increase in flows in 2006 and has had decreasing flows since 2011. The Philippines has had varying levels of increases and decreases in flows throughout the time period. Vietnam has had fairly steady increases in total financial flows since the large decrease in 2002, with the exception of a slight decrease in 2011. The correlation coefficients between total official financial flows to water supply and sanitation and coverage for both at least basic services show that across the focus countries, there are weak and positive correlations that are not significant. All three countries experienced a large increase in financial flows in 2001 that were unmatched in any other year. The countries also had considerable decrease in flows the following year.

DISCUSSION

The results provide some evidence to the relationship between WASH and the economy in addition to a basis for the importance of the WASH sector and the achievement of SDG 6 to the achievement of all 17 SDGs as outlined in the 2030 Agenda.

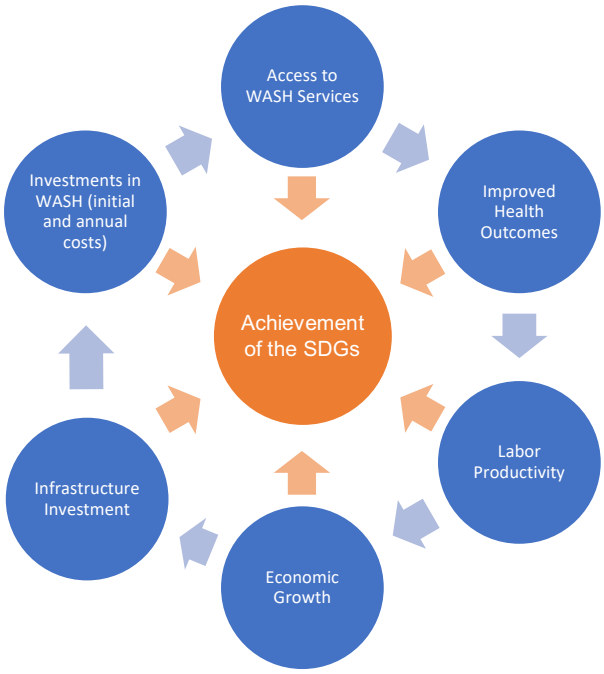

Figure 1. *The Role of Water, Sanitation, and Hygiene (WASH) and the Economy on the Achievement of the Sustainable Development Goals (SDGs): A Cyclical Framework*

On a macro scale, *The Role of Water, Sanitation, and Hygiene (WASH) and the Economy on the Achievement of the Sustainable Development Goals (SDGs)* (Figure 1) proposes a relationship between WASH access and the economy with intermediaries. Improvement in water, sanitation, and hygiene has well-documented positive effects on health outcomes, especially in relation to diarrheal diseases (OECD, 2011; Sadoff et al., 2015). Improved health outcomes can then lead to increased labor productivity due to time saved accessing water and sanitation services outside the household and avoiding illness due to improved quality of services (Evans, 2005; Sanctuary & Tropp, 2005). Labor productivity can then be seen as an input to the economy, affecting its growth in a country (Sanctuary & Tropp, 2005).

The investments in the sector generally increased for all three countries but as the flows were not linear in nature, there is not a direct relationship with the coverage of access to at least basic water and at least basic sanitation services.

Indonesia's coverage increased by 15% from 2000 to 2015 for at least basic water services and by 24% for at least basic sanitation services. Although Indonesia did experience high levels of investment throughout the time period, there does not seem to be a strong relationship, as evidenced by the correlation coefficients.

In the Philippines, the situation is fairly similar. The investments generally increase over time and there is a slight increase in coverage: an increase of 5% for at least basic water services and 8% for at least basic sanitation services. There is variety in the amount of investments and flows throughout the time period, but the overall relationship seems to be positive, albeit not significant.

Lastly, Vietnam's coverage for at least basic water services increased by 13% and for at least basic sanitation services increased by 25%. Vietnam's story is the most telling in that there is a fairly consistent upward trend in financial flows to the sector over the time period. The analysis resulted in a significant correlation between at least basic water services coverage and total financial flows for the sector. This suggests that in Vietnam, there is a relationship between flows and WASH coverage.

The findings reflect the complexity of the relationship between WASH and the economy. The uncertainty surrounding the relationships tested in the study may be due to the varying inputs and outputs for both WASH and the economy. The results, although inconclusive, are similar to current literature about the relationship between WASH and the economy. Without

standardized methods to understand the relationships more clearly, there is a failure to determine causality between WASH and the economy in either direction of the framework.

The proposed framework can be divided into two halves and the discussion will be presented accordingly. The relationship between at least basic water and sanitation services coverage and annual growth rate of real GDP per capita represents the flow of the relationship WASH services to the economy. Meanwhile, the relationship between coverage and the total official financial flows to water supply and sanitation represents the flow of the relationship from the economy to WASH services. Lastly, the discussion will explore the role that the WASH sector plays in the achievement of the SDGs.

Relationship of WASH Services to The Economy

The analyses showed a lack of an obvious relationship between access to basic water or sanitation services coverage and the growth rate of GDP. Although access to both at least basic water and at least basic sanitation services increased over time, the annual growth rate of GDP per capita did not show an obvious pattern over the same time period. The Philippines had a GDP per capita growth rate higher in 2015 compared to 2000 while Indonesia and Vietnam had relatively similar rates in 2015 compared to 2000. Indonesia and Vietnam had significant yet moderate, relationships between coverage of water and sanitation services and growth rate of GDP per capita.

Indonesia

Indonesia experienced a decline in GDP per capita rate growth in 2001. A period of generally positive growth of annual GDP per capita followed from 2001 to 2007, mimicking the global economy (Basri & Rahardja, 2010). In 2008 and until 2009, the GDP per capita rate growth declined (quite drastically in 2009) which may have been caused by the global financial crisis (Thee, 2012). The Indonesian economy recovered in 2010 with a fairly large increase in GDP per capita growth rate that may have been due to the economic resilience formed during the Asian financial crisis in the late 1990s (Thee, 2012). One year later, however, in 2011, a decrease in GDP growth rate began and continues until now. This decline may be attributable to the unstable labor situations in the country as workers have gone on strike to demonstrate their displeasure at rising costs of supplies and the economic inequality they are facing (Chatterjee & Rondonuwu, 2011).

Philippines

The Philippines had a varying growth rate throughout the entire period that may have been caused by the general instability experienced throughout the three presidencies within the time period. The corruption, political turnovers, and economic unrest may have contributed to the inconsistency of the economy (Batalla, 2016).

However, there is evidence that suggests the Philippine economy is one of the strongest in the region; possibly driven by the strong overseas remittances by Overseas Filipino Workers (Rappler.com, 2012). Like Indonesia, the Philippines suffered as a result of the global financial

crisis in 2008, which can be seen in the decline in the growth rate of GDP in 2008-2009 (Balisacan, Piza, Mapa, Santos, & Odra, 2010).

Vietnam

Much like the other two countries, Vietnam faced a decline in growth due to the global financial crisis in 2008 and 2009 (Fforde, 2016). Economic growth in the earlier half of the time period may be due to the increase in the service industry, as the workforce shifted away from the agricultural sector (Fforde, 2016).

The absence of strong and significant relationships between the growth of GDP per capita and access to WASH services in any of the focus countries fail to add to the current body of literature. Studies have alluded to the anecdotal presence of a relationship between WASH access and the economy in terms of the various intermediaries that have been previously discussed in this paper (Evans, 2005; OECD, 2011; Sadoff et al., 2015; Sanctuary & Tropp, 2005). A clear connection between WASH services and the economy cannot be proven through the analysis conducted.

Relationship of the Economy to WASH Services

Economic growth can signal stability in a country, which can encourage investments by external donors (Bengoa & Sanchez-Robles, 2003). The increase in investments, on WASH infrastructure in particular, can have an impact on the accessibility of WASH services for populations (UN Water, 2014).

The total official financial flows to water supply and sanitation had less variability. However, the results of this analysis showed that Vietnam had a clear upward trend of financial flows. Vietnam also showed a significant relationship between drinking water services coverage and total official financial flows with a p-value of 0.0024. These findings adds to perspectives within previous literature that ODA allocation in the WASH sector is not necessarily determined by need (Cha, Mankadi, Elhag, Lee, & Jin, 2017). This can be seen in the difference between Vietnam and the Philippines. In 2012, the coverage for at least basic sanitation in was higher at 74% to the Philippines' 73% yet the former received ODA nearly 10 times that of the latter.

Official Development Assistance

OECD provides a database of ODA investments that can be viewed by sector, recipient, donor, and year among other factors. Within this database, the major donors for specific years become apparent for each focus country. In Indonesia, there is a large increase in flows in the year 2006 that continues until 2011. These investments were primarily due to increases from the World Bank, Japan, and the Netherlands (OECD, 2019). Although more varied, the increase in investments during the time period of 2003-2010 in the Philippines was a result of the heavy investment by Australia (OECD, 2019). Lastly, in Vietnam, World Bank, Japan, and Australia accounted for the general upward trend in investments that began in 2002 (OECD, 2019). All three countries had a spike in financial flows in the year 2001 but it was difficult to ascertain donors and project allocations.

WASH and the Achievement of the SDGs

There is no clearly discernible relationship between coverage and the economic indicators across all three countries. The WASH sector is complex, with a variety of factors that affects it and outcomes that it affects. The economy is similar; there are a plethora of inputs and outputs into a country's economy that could affect it. However, the increase in the coverage of at least basic water and at least basic sanitation services throughout the time period in all three countries suggest that the achievement of SDG 6 is feasible for Indonesia, the Philippines, and Vietnam. In fact, the SDG-defined region of Eastern and South-eastern Asia is currently on track to achieve universal access by 2030, due in part to the rapid increase in the proportion of the population with at least basic drinking water services between 2000-2015 (WHO & UNICEF, 2017b). However, it is also one of four regions wherein estimates of safely managed drinking water services are currently unavailable due to insufficient data (WHO & UNICEF, 2017b). This means that the true gap of achieving SDG 6 is unknown.

Although the results of the analyses do not affirm the relationships between coverage and economic indicators, there are still indications of potential effects that WASH access can have on the economy and vice versa. The results can serve as an advocacy tool for the importance of the WASH sector to the economy which can contribute to the achievement of all 17 SDGs. If framed correctly, stakeholders from different sectors and levels will be able to understand the role that granting access to WASH services for all populations can have on the growth of an economy. The increased economic growth, along with access to at least basic WASH services, can then contribute to poverty eradication, which is the larger aim of achieving the SDGs.

CONCLUSION

By generating discussion that will support and advocate for the need for increased investments in the WASH sector in Southeast Asia, the report hopes to contribute to the goal of achieving SDG 6 and other SDGs by emphasizing the importance of WASH development to the economy. As is the case with the global burden of lack of universal access to WASH services, there is still work to be done in order to achieve the targets set in the 2030 Agenda.

LIMITATIONS & RECOMMENDATIONS

The paper, as presented, has several limitations. First, the use of secondary data restricts the ability to determine causality. The governing bodies of the datasets had their own set of assumptions and separate methodologies. For example, JMP has assumptions and linearly extrapolates its data for service levels, which could have had effects on the analyses conducted. UNSD had its own set of assumptions for its datasets for the SDG indicators.

Although the WASH sector has an extensive research arm, there seems to be a lack of literature and well-monitored data to inform research on its relationship with the economy. Describing the financial flows to water supply and sanitation did not have direct attribution for donors and projects that are easily accessible. With the growth rate of GDP per capita, there was no specificity as it relates to the WASH sector.

The study did not have clear indications of a strong and significant relationship between WASH coverage and economic indicators; however, there may be relationships affected by different inputs and outputs as presented in the proposed framework. Future directions could include determining causality between the different aspects of the framework, especially in the half that flows from WASH access to the economy due to its specific intermediaries.

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