

Sustainable Development in Indonesia: Holistic Assessments and Pathways

by

Aditya Yodha

B.Eng. Electrical and Electronic Engineering (2009)

Nanyang Technological University

Submitted to the System Design and Management Program
in Partial Fulfillment of the Requirements for the Degree of

Master of Science in Engineering and Management

at the

Massachusetts Institute of Technology

June 2018

© 2018 Aditya Yodha
All rights reserved

The author hereby grants to MIT permission to reproduce and to distribute publicly paper and electronic copies of this thesis document in whole or in part in any medium now known or hereafter created.

Signature of Author

Aditya Yodha
System Design and Management Program
May 22nd, 2018

Certified by

Nicholas A. Ashford, PhD., JD
Thesis Supervisor
Professor of Technology and Policy

Accepted by

Joan Rubin
Executive Director, System Design & Management Program

Sustainable Development in Indonesia: Holistic Assessments and Pathways

By

Aditya Yodha

Submitted to the System Design and Management Program
on May 22nd, 2018 in Partial Fulfillment of the
Requirements for the Degree of Master of Science in
Engineering and Management

ABSTRACT

This thesis assesses the status of sustainable development in Indonesia, identifies the systemic barriers, and offers holistic development pathways toward sustainability. The framework employed in this research looks at the interactions between the economy, employment, and environment while taking into account the forces of technology and globalization.

It concludes that the development in Indonesia is not yet on a sustainable path. The economy is performing well and unemployment is low, but inequality is very high, capacity to adapt is low, and the environment is quickly degrading. The major barrier towards sustainability are fundamentally politics: messy decentralization, pervasive corruption, and persistent elite capture. Other systemic barriers are the low level of education, fragmented innovation system, and low awareness of sustainability issues.

To make progress towards sustainability, the systemic barriers must be cleared. Local governments need to be made clean and competent; lifelong learning systems established; local innovations boosted; pollutions prevented at the source using technological or organizational innovations; and awareness of sustainability issues raised.

The findings in this thesis are summarized and mapped to the UN Sustainable Development Goals in the concluding chapter.

Thesis Supervisor: Nicholas A. Ashford
Title: Professor of Technology and Policy

*To Dhini,
for her selfless support.*

*To Arin, Anin, and Bagas,
for always making me smile.*

“Lestari alamku, lestari desaku.”

—Gombloh

Aditya Yodha was born and raised in Jakarta, Indonesia. He earned his B.Eng. in Electrical and Electronic Engineering from Nanyang Technological University in Singapore in 2009, after which he spent six years working at National Instruments before enrolling in System Design and Management program at Massachusetts Institute of Technology in 2016.

While writing this thesis, he was reminded of the above lyric from a classic Indonesian song written by Gombloh in 1982. It roughly translates to a wish that one’s nature and village will co-exist forever. It was in that spirit that this thesis on sustainability was written.

CONTENTS

1	Introduction	7
1.1	Background	7
1.2	Literature Review	7
1.3	Methodology.....	8
1.4	Structure	9
2	Holistic Assessments of Sustainable Development in Indonesia.....	10
2.1	Economy.....	10
2.1.1	Macroeconomic Stability	10
2.1.2	Economic Vulnerabilities.....	12
2.1.3	Section Summary	13
2.2	Employment.....	15
2.2.1	Employment Structure and Growth.....	15
2.2.2	Employment Issues	16
2.2.3	Section Summary	20
2.3	Environment.....	21
2.3.1	Emission gap	21
2.3.2	Renewable Energy Options.....	22
2.3.3	Environmental Issues	24
2.3.4	Section Summary	37
2.4	Discussion: The Big Picture and Interrelated Issues	38
3	Systemic Barriers and Pathways toward Sustainable Development	40
3.1	Barriers.....	40
3.1.1	Messy Decentralization.....	40
3.1.2	Persistent Corruption.....	42

3.1.3	Elite Capture.....	43
3.1.4	Fragmented Innovation System.....	43
3.1.5	Weak Performance of the Post-Secondary Education System.....	45
3.1.6	Lack of Awareness and Urgency.....	46
3.1.7	Section Summary.....	47
3.2	Pathways.....	48
3.2.1	Clean and Competent Local Government.....	48
3.2.2	Lifelong Learning Systems.....	49
3.2.3	Local Innovation.....	49
3.2.4	Pollution Prevention.....	50
3.2.5	Raising Awareness.....	52
3.2.6	Section Summary.....	52
4	Summary and Conclusions.....	53
5	References.....	57
6	Appendix.....	70
6.1	Strict Fiscal Rule.....	70
6.2	Regional Contribution to GDP.....	71
6.3	Tax Revenue.....	72
6.4	Gross Enrollment Ratio.....	72

1 INTRODUCTION

1.1 BACKGROUND

Indonesia is a fascinating country to study. It is the world's largest archipelago with 17,504 islands [1] and is considered as one of the regions with the highest biodiversity in the world [2]. This diversity extends to its 250 million inhabitants [3], which comprises of more than 300 ethnic groups [4] speaking 700 languages¹ [5]. About 87% of the population are Muslim, with the rest embracing Protestantism, Catholic, Hinduism, Buddhism, and indigenous faiths [4].

The nation is also a growing democracy ever since the major reform in 1998, which was triggered by the Asian financial crisis and widespread rioting that abruptly ended more than three decades of authoritarian rule under Soeharto [6]. Subsequently it faced economic stagnation and a period of political instability until the first direct presidential election in 2004. Since then, according to the World Bank [7], the economy has been steadily growing at around 5% per year and the poverty rate drastically declined from 24.4% of the population in 2004 to 6.8% in 2016. The GDP, at purchasing power parity, was the 8th largest in 2016. The World Bank now classifies Indonesia as a developing country with lower-middle-income status, similar to India [8]. Recent review on Indonesia by OECD [9] even suggested that health, education, and social outcomes in general have never been better, resulting in higher standards of living for more Indonesians.

Such remarkable progress should continue. The important question is to ask how sustainable the development is and, if not, what the pathways that lead to sustainability are. This thesis aims to shed light on both queries.

1.2 LITERATURE REVIEW

Prior published research assessing the sustainable development in Indonesia are few and far between. Probably the earliest work was in 1990 by the World Bank, who focused on sound management of forest, land, and water for economic growth [10]. Basiago followed it up five years later by suggesting that the best way to balance economic growth and environmental preservation in Indonesia is by employing the

¹ The ethnic and language diversity are not widely distributed. Most of these can be attributed to the tribes in the island of Papua and Borneo.

age-old indigenous regime for environmental management [11]. Afterwards, a vacuum: no research on the topic was published between 1995 and 2004, which is the reformation period marked with very high political uncertainty (see Background). Perhaps it reflects severe difficulty or irrelevance in conducting such research given the situation. In 2004, Alisjahbana and Yusuf [12] employed quantitative methods to measure sustainability based on capital: a sustainable economy should show non-declining stock of capital (both man-made and natural). They concluded that the Indonesian economy has not been on a sustainable path in the 20 years before. All of these early works focus on the interplay between economic development and environmental conservation, but not so much on the social aspects of sustainability.

Later publications filled this gap. Hsu and Perry [13] made a holistic qualitative assessment in 2014 and found a few major problems hindering sustainability efforts in Indonesia: forest degradation and fire; low coverage of social safety net; corruption; and lack of government revenue. Bakri [14] delved deeper to the regional level and suggested that current plans for regional development are not sustainable.

This thesis contributed to existing literature in two ways: (1) by looking into not just the three pillars of sustainability (economy, social, and environment) but also the forces affecting them, namely technology and globalization; and (2) by proposing solutions that co-optimize all of the said pillars, i.e. advancing all of them without compromising any one.

1.3 METHODOLOGY

The definition of sustainable development in this thesis follows the most frequently cited one from Brundtland Report [15]:

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

It is meaningful but very broad for analysis, so this thesis requires an analytical framework that captures the many dimensions of sustainability yet still be manageable. The framework used here is based on work by Ashford and Hall [16]. It looks at the interrelatedness between economy, employment², and the environment while taking into account the forces of technology and globalization. Thus, this thesis has

² Most work in the literature depicts the sustainability pillars to include social concerns (or equity) instead of employment. Ashford and Hall argue for employment because it is more directly related to the economic and environmental concerns. Besides, social concerns will likely be found anyway when looking at the economy and environment.

wide coverage and synthesizes existing research on each area in the framework. This is supplemented by a few interviews with high-level officials from the government of Indonesia³. The insights gained through the framework inform the solutions that co-optimize the three pillars of sustainability.

There are limitations with the chosen method. The framework — despite being broad — may not capture all sustainability issues in Indonesia because of time constraints, though hopefully the most pertinent ones are revealed. Similarly, the solutions provide guidelines and not detailed implementation plans. These are left for future research.

1.4 STRUCTURE

The thesis proceeds in Chapter 2 by assessing the current status of sustainable development in Indonesia through the lens of the framework⁴ (see Methodology). Chapter 3 discusses plans already in place toward sustainable development and ask whether these are enough. Chapter 4 identifies the implementation barriers derived from the insights in previous chapters. Chapter 5 offers solutions that addresses the barriers and issues found. Finally, Chapter 6 summarizes the results.

³ The author took advantage of coincidental visits by the officials to Harvard Kennedy School.

⁴ Technology and globalization do not get dedicated section in Chapter 2 because these are forces that are present in all three pillars, which are elevated as sections.

2 HOLISTIC ASSESSMENTS OF SUSTAINABLE DEVELOPMENT IN INDONESIA

The government of Indonesia has incorporated the UN Sustainable Development Goals (SDG) into its National Medium-Term Development Plan⁵ for 2015-2019 [17]. This commitment was reiterated by submitting Voluntary National Review on SDG progress in 2017 [18]. Thus, ideally, implementing the national plan means implementing the SDG.

This chapter assesses the status of sustainable development in Indonesia by looking at three pillars of sustainability: economy, employment, and environment. The interconnection between issues across the pillars is also explored. The SDG will be revisited in the last chapter, to summarize which goals this thesis has attempted to address.

2.1 ECONOMY

2.1.1 Macroeconomic Stability

Indonesia learned an important lesson from the Asian Financial Crisis in 1998: prudent macroeconomic policies. Nasution [19] chronicled the event and recorded that the economy was devastated: GDP shrank by -13.1%; inflation and interest rate rose to more than 60%; and Rupiah devalued from Rp2,300 per US Dollar to Rp10,261. The government sought help from IMF and entered its rescue program in 1997-2003. Release of the loans were tied to reform measures which includes, among others, strict fiscal rule to limit the government's budget deficit to at most 3% of annual GDP and low debt-to-GDP ratio of 60% maximum (see Appendix 6.1). Both are legally binding and still in place today [20], [21]. Many Indonesians felt that the initial prescriptions made matter worse and prolonged the recession — IMF later acknowledged this [22]. Resenting the intervention, Indonesian government accumulated large international reserves to better cope with future crises. These policies contributed to economic stability: during the Global Financial Crisis in 2009, the government was able to set up a fiscal stimulus [23] which may have helped the GDP to still grow at 4.65% that year, close to the running average of around 5% (in contrast, world GDP contracted by -1.7% [7]). Inflation is also under control at about 4% per year [24].

The financial system is resilient. Recently IMF and World Bank assessed the banking system and concluded that it is “broadly resilient to shocks even under the most adverse scenarios”, i.e. the systemic risk is low

⁵ The official title in Indonesian is Rencana Pembangunan Jangka Menengah Nasional (RPJMN).

[25]. The banks have more than enough capital relative to its risk and corporate vulnerabilities are in check. The government has also been strengthening financial oversight and crisis management capability through the launch of integrated regulator (OJK) and Financial System Crisis Prevention and Resolution law.

The stable economy allowed structural transformation to take place, as seen in below chart from World Bank [7]. The contribution of agriculture has been low even before the Asian Financial Crisis and it declined further afterwards, to around 13.5% of GDP in 2016. However, contrary to the experience of developed countries but as seen in other developing countries, services grew faster before the industry matured [26]. Services has been contributing to GDP more than the industry sector do since 2013. The impact of this change is further explored in section 2.2.1 and 2.4.

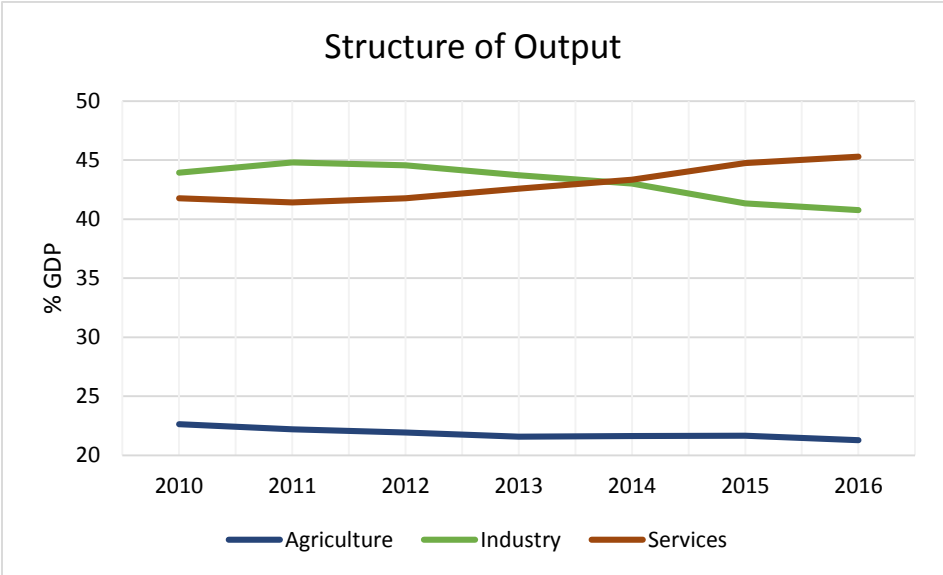


Figure 1: Structure of Output (source: World Bank [7])

Indonesia also aspires to be part of regional free-trade agreement to boost the economic growth further. It is part of the ASEAN Economic Community (AEC, for Southeast Asian countries) since 2015 but not much actual economic impact has been seen [27]. In addition, Indonesia actively participates in the ongoing negotiation for Regional Comprehensive Economic Partnership (RCEP, between ASEAN, Australia, China, India, Japan, South Korea and New Zealand) [28]. The government has recently said that Indonesia may join the revised Trans-Pacific Partnership (so called TPP11) in the future [29]. Peterson Institute simulated TPP and RCEP options to find the global income benefit [30]; they concluded that TPP11 plus Indonesia, Korea, Philippines, Taiwan, and Thailand (all of which declared interest) will generate much higher

economic gain than RCEP or TPP11. The other effects of this integration will be explored throughout the rest of this chapter.

2.1.2 Economic Vulnerabilities

Behind the steady economic performance lies a few vulnerabilities. The economy is too dependent on resource-extraction and are thus prone to global price fluctuations, as evident in the persistently slower growth after the end of the commodities super cycle in 2011 [9], though this seems to have turned around in 2017 [31]. The top commodities, amounting to 30% of all goods export in 2016, are palm oil (8.71%), coal (8.59%), gas (4.55%), crude oil (3.25%), rubber (2.27%), and copper (1.97%) [32].

The fruits of economic growth have not been equally distributed. Western islands, especially Java and Sumatera, are much more developed than eastern ones. Over 2010 to 2016, about 80% of the GDP was due to only two islands: Java and Sumatera [33] (see Appendix 6.2). Data on GDP per capita in 2016 shows that the economic benefits are concentrated in Java, Sumatera, and resource-rich regions such as North and East Kalimantan (palm oil, crude oil, coal) and Papua (gold, copper) [9].

Income inequality is rising. The official statistics from the government shows that the GINI coefficient has been increasing from 0.34 in 2002 up to 0.41 in 2014 then settling at around 0.39 in 2017 [34]. The same dataset also highlights persistent trend that urban inequality is higher than rural one by about 0.07.

However, the measurement may be inaccurate. Nugraha and Lewis [35] found that the official agency claimed to derive the GINI ratio from survey of household consumption per capita but never published the exact method. Thus they dig deeper to the underlying survey and measure inequality using both market income (wage, business, rent) and — crucially — non-market income (consumption of own production, income in kind). The latter category turns out to be important because many households still consume the goods they produced; in developed countries these are provided by the market. Using this new method, they found that GINI coefficient in 2008 was 0.21, a big drop from the official figure of 0.41.

Despite the apparent improvement, an alternative method to measure inequality provide startling contrast. Oxfam [36] measured inequality using wealth (not income) distribution from data compiled by Credit Suisse in 2016. The results: Indonesia has the sixth worst inequality of wealth in the world, where the wealthiest 1 percent of the population owned nearly half (49 percent) of total wealth. World Bank arrived at similar conclusion using the same dataset [37]. The common themes postulated as reasons behind the wealth inequality are: (1) unequal start in health and education; (2) political capture by the

economic elite; (3) unfair labor markets; and (4) unequal resilience to shocks such as natural disasters⁶. Both Oxfam and World Bank cited growing consensus in the literature that the extreme inequality in wealth harms economic growth at best and risks sociopolitical instability at worst. This is in line with the seminal work by Acemoglu and Robinson [38], who theorized and provided historical evidence that political and economic inclusivity are required for a nation to prosper. Clearly the inequality situation in Indonesia is not sustainable and politically stable in the long term. This systemic challenge in wealth inequality cannot be addressed by market forces alone — government must be empowered to act on it as a trustee of the people.

Sadly, the government of Indonesia lacks the financial resources: its tax revenue as a share of GDP is low (10.3% in 2016 and declining), even compared to its neighbors with similar development level [7] (see Appendix 6.3). One way to bypass this problem is through allowing a deeper budget deficit, but this is limited to 3% of GDP by law, which is very low compared to global standards. Thus the government is left with cutting spending, increasing tax revenue, or both. Spending cut is possible for inefficient programs but sometimes there is a real and urgent need, such as tackling the inequality identified above. Improving tax revenue is the long-term solution. Hamilton-Hart and Schulze analyzed the tax situation and concluded that the problem lies not with the income-tax system but tax policy and administration, which are notoriously weak and marred by corruption such that Indonesia collects less than half of its potential revenues, a situation that has not improved much in the past few years [39]. The tax amnesty program in 2016 seemed to have broaden the tax base and resulted in short-term windfall, but it is too early to assess the long-term impact. Finally, Hamilton-Hart and Schulze recommended the government to capture more revenue by increasing tax on harmful products such as tobacco and introducing fossil-fuel tax, which also helps with reducing pollution.

2.1.3 Section Summary

Indonesia has a strong macroeconomic stability and its financial system is resilient. This allows structural transformation from agriculture towards industry and services to take place. To further boost growth, the country participates in regional trade agreements with ASEAN and other countries in Asia-Pacific.

⁶ These reasons for wealth inequality are systemic and thus will be covered in more details throughout this thesis, especially in sections on Employment, Environment, and Barriers.

However, there are vulnerabilities. The economy is too dependent extraction of natural resources. The bounty from economic growth has been very unequally distributed across regions and income level. The tax revenue as a share of GDP is also very low compared to neighboring countries.

2.2 EMPLOYMENT

2.2.1 Employment Structure and Growth

Employment policies in Indonesia are implemented through a tripartite system: government (Kementrian Ketenagakerjaan), employers' association (Apindo), and three major trade unions (KSPSI, KSBSI, KSPI) [40]. It is interesting to note that each union does not seem to specialize; rather, every union represents employees from diverse occupations, industries, and regions which sometimes overlap with other unions.

The structural transformation of the economy (see section 2.1.1) is well reflected in the labor market as more workers are moving from rural to urban areas and from agriculture towards services, whereas employment in manufacturing is rather stagnant. The size of the urban population has been steadily increasing, from around 40% in 1998 to just above 54% in 2016 [7]. ILO made an estimate of the number of people employed by the sectors between 2006 to 2016 using national economic survey conducted by the government. The calculations showed that the only drop in employment was in agriculture, from 42% of total in 2006 to just 32% in 2016; while services grew from 19% to 24%; and manufacturing stayed at around 14% [41]. Other studies found similar result [42], [43]. Pandian argued that this decline in manufacturing share of employment does not negatively affect economic growth in developing countries (the opposite is true for developed countries) [44]. However, Rodrik argues that this hinders economic growth and may even trigger democratic failure (see section 2.4 for detailed discussion).

Indonesia is enjoying a demographic dividend, where the share of the working-age population (15 to 64) is larger than the non-working-age share of the population (14 and younger, and 65 and older), resulting in high economic potential [45]. The government estimates in the national development plan for 2015-2019 that this benefit will last until around 2030 [17], so the window of opportunity is only about decade. To take advantage of the potential, the government is implementing supporting policies in education improvement, health insurance coverage, and job creation [46]. The effectiveness of these policies will be explored in more details in the rest of this section.

Thanks to the rapidly growing economy, the labor market is able to absorb the demographic dividend so far. Unemployment has been on a strong downward trend, from about 11% in 2006 to 5.5% in 2017 according to official government data [47]. This translates to employment for about 120 million people, close to half of the population, in 2017 [48, p. 15]. Many observers credits this outcome to the rapidly expanding online platforms and the associated opportunities in e-commerce (e.g. Tokopedia, an online

platform for formal and informal SMEs), on-demand services, and transportation (e.g. Gojek, an online delivery and ride-sharing platform for motorcycle taxis) [41], [49].

Encouragingly, the employment growth accommodates more women to enter the work force across all age groups, averaging just above 6% increase between 2006 and 2016 — a rate much faster compared to their male counterparts [41]. This is still not enough to significantly improve the low number of women in the work force, which is still close to just 50% in 2017 [50]. Many women in the survey cited that they were fully committed to doing household activities [41].

Another promising development is on the declining number of youth not in employment, education, or training (NEET). Data collected by ILO shows that the proportion of idle youth has been steadily going down from 31.9% of all youth in 2005 to 21.5% in 2017 [50]. The current level is similar level to Philippines (22.2% in 2016) but much higher than Thailand (14.97%) and Malaysia (11.69%) [7]. A deeper analysis by Understanding Children’s Work (UCW⁷) found that the NEET status among youth in Indonesia is determined to an important extent by general labor market conditions rather than by youth-specific labor market barriers [51].

2.2.2 Employment Issues

The strong performance in job creation masks a few important issues that threaten its sustainability. This section looks at the issues through the lens of formal and informal sectors in the labor market.

The unionized workers in the formal sector claim that the employment situation is rather bleak. ITUC, an international body representing trade unions, in its Global Rights Index for 2017 judged that union rights in Indonesia are not guaranteed: specifically, the laws and regulations are in place but the enforcement is lacking [52]. It highlights the brewing tension between the government and the unions with regards to policies designed to be friendly to businesses and investors.

The most publicized bone of contention is the new regulation — PP no. 78/2015 [53] — which indexes minimum wage to inflation and GDP growth every year, whereas previously tripartite negotiation took place every year to set the minimum wage [54]. The equation to calculate the minimum wage is shown below.

⁷ An inter-agency research cooperation project formed by ILO, UNICEF, and World Bank. It focuses on combating child labor.

$$W_{t+1} = W_t(1 + i_t + G_t)$$

Where W_{t+1} is the new minimum wage; W_t , previous minimum wage; i_t , annual inflation rate; G_t , annual GDP growth.

The new rule also stipulates that every five years the indexed minimum wage will be compared against minimum standard of living determined by Ministry of Labor in consultation with National Wage Committee (Depenas). It provides predictability to the employer and accommodates welfare concerns of the workers, but unions strongly oppose the absence of the negotiation process and claim that this will lead to systematic decline in workers' livelihoods. Suhendra [55] tried to resolve the disagreement by applying the new formula to the data in year 2011-2015 and compared the actual minimum wage increase as a result of tripartite negotiation during the same period. He showed that there was little difference between the two, averaging to a gap of just about 0.8%. Yamada performed empirical analysis on the effect of minimum wage increase in 1990s in Indonesia and concluded that the it failed to improve living standards and inequality [56]. More recently in 2017, Dong and Manning [42] found that the new rule harmonizes wage increases across the country, whereas previously several areas with strong industrial clusters and unions have higher increases compared to other regions, contributing to regional wage disparity. According to ADB, a sustainable approach for the unions is to let minimum wage be a safety net instead of an instrument to enhance welfare and to strengthen alternative avenues for wage negotiation at the industry and enterprise level, which have been lacking [43]. Therefore, on balance, the outlook for unionized workers are not too worrying.

Looking more broadly at the dynamics between formal and informal sectors, in the last decade there has been steady movement by informal workers toward formal employment. The government defines informal workers to include own-account worker⁸, casual employees, unpaid/family worker, and employer assisted by temporary/unpaid worker [57]. The remaining categories are formal workers: employee and employers assisted by permanent/paid employees. Based on that definition and official data [48], about 57% of workers were in informal sector in 2017, down from close to 70% in 2005, though the current size of informal sector is still comparatively high. This can be seen in below chart.

⁸ ILO defines own-account workers as those who hold self-employment jobs and do not engage 'employees' on a continuous basis. Refer to ICSE-93 for more information.

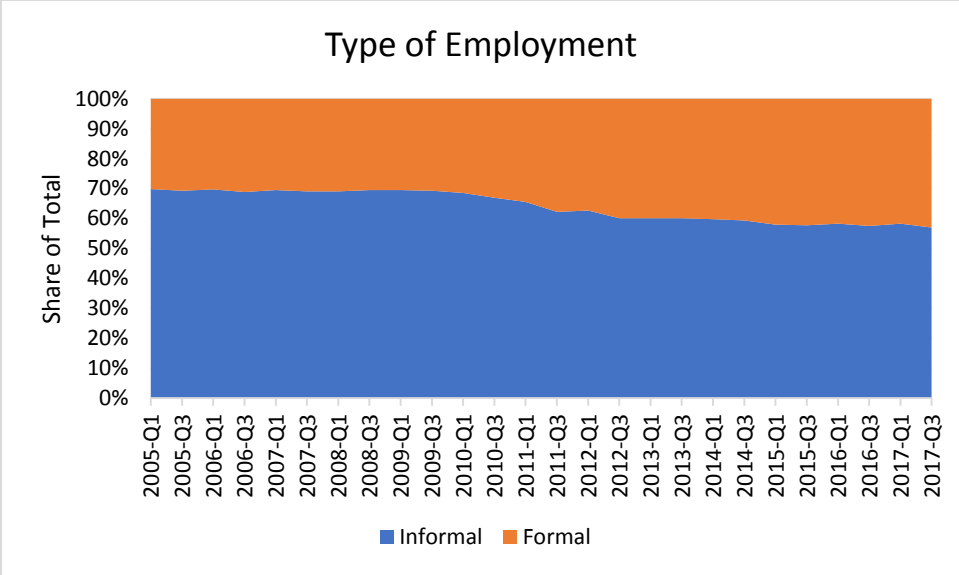


Figure 2: Share of Employment by Type (source: author’s calculation on data from Statistics Indonesia)

Informal firms in Indonesia pose problems for the government: Rothenberg et al found that these firms are less willing to pay taxes, have low productivity, and are difficult to track [58]. Other than simply growing the economy, the researchers’ suggestion is to entice formalization by improving and promoting the benefits, such as easier access to credit or skilled workers. On the other hand, Tambunan [59] found that the informal sector plays an important role during economic crisis: it absorbs laid-off workers from the formal sector, preventing mass unemployment. Throughout the crisis in 1998 (Asian financial crisis) and 2008-2009 (global economic crisis), total employment actually increased because of the movement towards the informal sector. Hence, the existence of the informal sector by itself may not be completely problematic.

Perhaps the bigger concern is the low coverage of health and employment insurance in the informal sector, jobs in which tend to be more vulnerable than formal ones. The government enacted policies in 2014 to unify and simplify the fragmented insurance system⁹, with a target of covering the whole population by end of 2019 for health insurance. Data on the progress for the informal sector is difficult to come by. Dartanto et al [60] had privy to an internal research by the national health-insurance agency (BPJS Kesehatan) in January 2016 which estimated that as few as 15.08 million households with employment in informal sector registered for the insurance. Comparing this number with the total number of households, at 65.5 million in 2015 from official statistics [61], the health insurance covers only about 23% of the

⁹ For example, there was a different health insurance provider for the poor, formal worker, military, and so on

informal workers. Dartanto et al conducted a survey to find the main barriers to adoption: poor availability of health services (hospitals, doctors) and lack of insurance literacy, but not the premium [60].

The national employment-insurance scheme for the informal sector tells similar story. The official agency (BPJS Ketenagakerjaan) recorded that 21.8% of the informal workers are covered in 2016, which is a big jump from just 0.4% in the year before¹⁰ but is still rather low [62]. This may indicate a welcome focus towards informal workers, narrowing the gap with the coverage of formal workers (28.9% in 2016). Nevertheless, the sustainability of the reformed insurance system is still in question: ILO assessed the financial sustainability of the system in 2015 and concluded that the contribution rate was enough only for the short-term, thus it should be gradually increased [63].

Finally, the most worrisome development in both formal and informal sectors are the workers not being sufficiently prepared to adapt to strong forces of technological change and globalization. Sale of industrial robots from overseas to Indonesia have been increasing [41] and the government is worried about its potential to replace labor [64]. ILO estimated in 2015 that about 56% of salaried jobs in Indonesia were at risk of being automated [65] and predicted that this would lead to polarized jobs as argued by Brynjolfsson and McAfee [66]: middle-skill jobs will diminish and the available jobs are either very high-skilled (the lucky few) or low-skilled (the worse off). There are empirical evidence that serious polarization is happening: Narjoko argued that companies are replacing workers with machines [67] while Jaumotte et al confirmed that this technological change is increasing inequality [68]. Globalization amplifies this problem because recent studies suggest that increases in foreign-owned firms and foreign direct investment increased demand for more skilled labor [69], [70].

The workforce is ill prepared to adapt to technological, globalization, and climate change because of the poor level of education in general. Official data recorded that close to 42% of the population have at most primary school education in 2017 [71]. ILO delved deeper into the underlying survey for 2016 and calculated that less than 10% has university degrees, 75% of which comes from urban areas [41]. Further analysis in the same study revealed that the number of jobs demanding higher education is growing while low-skill works are plenty and increasing, at 30% of total. The government plans to help the workers adapt by instituting a lot more vocational schools, but Dong et al argued that the plan will face difficulties because Indonesia does not have as strong tradition in vocational training as Germany does [42]. To make

¹⁰ There is no other data source to verify the drastic increase in coverage.

matters worse, corruption is deeply rooted in Indonesia (see section 3.1.2) and it has been found to moderate the benefits from investing in human capital [72].

2.2.3 Section Summary

Employment policies in Indonesia are implemented through a tripartite system. The structural transformation of the economy is also reflected in the labor market, where workers are moving from rural to urban areas and from agriculture to services, while employment in manufacturing is rather stagnant. The strong economic growth helps the labor market to absorb much of the demographic dividend the country is enjoying; this is expected to continue until 2030. Unemployment is low, more women are entering the workforce, and more youths are in employment or education.

Despite the strong performance, some important issues remain. The unions are very concerned with the new indexation of minimum wage to inflation and GDP growth, but many studies suggest that the impact of this indexation is not alarming. The informal sector has been in decline but it still represents the majority of employment. Workers in that sector are vulnerable but the national health and insurance system cover only a small portion of the workers. The major concern is the fact that 42% of workers have only primary education or less, so they are exposed to the full force of changes in technology, globalization, and climate change.

2.3 ENVIRONMENT

2.3.1 Emission gap

Indonesia is a party to the UNFCCC (the Paris Agreement on Climate Change) and has outlined its targets in emission reduction to mitigate climate change in its NDC (Nationally Determined Contribution), ratified and submitted in November 2016 [73]. The target is to reduce emission by 29% below BAU (business-as-usual) emissions of GHG (greenhouse gas), including LULUCF (land use, land-use change, and forestry), by 2030, plus a conditional target of up to 41% reductions below BAU with sufficient international support.

There are a few salient points in the NDC document. First, the BAU in 2030 roughly doubles the emission level in 2010. Second, LULUCF is the largest contributor to emission, at about 63% in 2010. This is mostly due to deforestation and forest fires, which are difficult to predict (more details in section 2.3.3.3). Third, the NDC cites the National Energy Policy (*Rencana Umum Energi Nasional*, or RUEN), which includes a roadmap towards increasing the share of renewables in primary energy mix. The most recent roadmap in 2017 shows ambitious target for renewables [74]: from 4.2% of total energy supply in 2014 to more than 23% by 2025, even as the demand keeps growing. However, in absolute value, energy capacity from fossil fuel is planned to keep increasing: from 51.4 GW in 2015 to 90.4 GW in 2025. This is because Indonesia still has abundance of coal and gas [75]. In other words, the government still allows increase in total emission (presumably to grow the industry and the economy) while reducing the emission from forest degradation.

Independent assessments of the NDC and current progress show mixed results. UNEP, in its Emissions Gap Report 2017 [76], says that there is not enough evidence to confidently say that Indonesia will meet its target. The report points out that new coal-powered plants are being built, locking long-term emissions. Excluding the unpredictable emissions from forest fires, CAT (Climate Action Tracker) recently concluded that Indonesia can meet its target if it realized a high increase in renewables [77]; PBL (Netherlands Environmental Assessment Agency) similarly says so with some additional measures [78]. Including LULUCF, WRI estimated that Indonesia can meet its target if they strengthen current policies, especially expanding the forest moratorium and increasing renewable energy [79].

Thus, overall, the emissions targets look feasible. The question is whether the government will realize its plan and what it needs to do to get there. The next section will look at the options for renewable energy,

whereas the issue of deforestation and forest fires will be included in the section thereafter on vulnerabilities and readiness.

2.3.2 Renewable Energy Options

Official estimates put the total renewable-energy potential at 443 GW, but only 1.9% of this is used, contributing to only about 4% in the energy mix in 2015 [74]. This thesis focuses on solar and geothermal potential, which represents 53% of the total and for which sufficient number of independent research about their sustainability has been published. The rest will be briefly addressed near the end of this section.

2.3.2.1 Solar Potential

For a country sitting on the equator, it is no surprise that Indonesia has huge potential for solar energy. But estimates vary widely, as shown in below table. Even with this uncertainty, the middle range of the feasible plan — 27 GW potential which translates to 37 TWh/year — still represents 26% of total electricity consumption in 2010 [80] and about 344 times the currently installed capacity (75 MW) [74].

Source	Total Potential (GW)	Viable Utilization (GW)
National Energy Plan [74]	208	6.5 (by 2025)
Veldhuis and Reinders [80]	1100	27.0
IRENA [81]	532	47.0 (by 2030)

Table 1 Potential for Solar Energy

The raw potential is not the only promising prospect. Solar PV can be installed off the grid for local communities at smaller scale, so this is a great fit for the remote areas and many of the 17,500 islands in Indonesia [82]. IRENA (International Renewable Energy Agency) predicted that close to 1.1 million households in remote areas can be electrified with solar PV [81].

Alas, many barriers prevent the deployment of solar PV. The most significant is the large subsidy for electricity which makes solar uncompetitive against coal and gas-powered plants, though the steady decline in PV system costs and the upcoming feed-in-tariff may overcome this issue [80]. Another hurdle is technical: according to an evaluation commissioned by World Bank [83], detailed and accurate solar-related data using ground measurement is lacking, so most studies use satellite data and model estimation. This uncertainty raises the risk and cost when planning for solar installation.

2.3.2.2 Geothermal Potential

Like solar PV, geothermal power is another renewable source for which Indonesia has huge untapped potential thanks to its location in the Pacific Ring of Fire¹¹. It is a relatively mature technology with clean credentials. Fan and Nam [84] argued that conventional geothermal plants emit 3-5% of CO₂ created by coal power plant producing equivalent amount of electricity. The latest version, called closed-loop binary plants, emit zero or near-zero emissions of sulfur dioxide, nitrous oxide, and carbon dioxide. Geothermal plants also require less land (0.4 m²/MWh) than other energy technologies, from three times less than wind power to nine times less than coal power, while using less than 5% of the water (38 L/MWh) of an equivalent coal power. Furthermore, many potential geothermal sites are located near population centers and also in eastern islands, where electrification rates are low and poverty rate highest.

The government estimated the total geothermal potential to be at 27 GW [74], but Fauzi corrected this figure to 24 GW after finding that some data are double counted [85]. Still, the revised potential is about 24% of the global total. Sadly the installed capacity in 2014 was just 1.4 GW, or 5.8% of its potential [86] because many projects have been delayed permits [87]. In contrast, neighboring Philippines has a bit more capacity (1.9 GW) but it generates 27% of its electricity needs in 2015 [88].

The underutilization is due to technical, financial, and political roadblocks. The technical problem is the lack of accurate, reliable, and widely available geological data (e.g. borehole heat flow and social or environmental impact) crucial for locating available resources, significantly reducing risk, and encouraging private investment [84]. A suitable solution for this is to use the New Zealand model: the government invest in the explorations and then charges private companies for the data [89].

The next barrier is the financial: high up-front cost and low ceiling tariff. The table below shows the rule of thumb for total investment and operating cost of geothermal compared to coal powered plants in Indonesia, according to Fan and Nam [83]. It can be seen that Geothermal plants have competitive operating cost against coal but the total investment required is typically higher. This capital cost can be significantly reduced if the government invests in the initial exploration to gather high quality data and reduce risk.

Power Plant Type	Total Investment (US\$ per MW)	Operating Cost (US¢/kWh)
Geothermal	8 million	8.5
Coal	2-3 million	4.2-19.3

¹¹ Pacific Ring of Fire is a major location of volcanic activity and earthquakes, located along the pacific coasts.

Table 2: Comparison of Total Investment and Operating Cost between Geothermal and Coal Powered Plants

Unfavorable politics is the last and probably most significant roadblock, according to Hasan [90]. The ceiling tariff — which is based on recent years' electricity price dominated by cheap coal-powered electricity — is too low for geothermal to be profitable in developed islands, though it is still attractive for eastern islands. The government has set up the Geothermal Fund Facility to encourage the initial exploration and reduce risk, but the disbursement has been slow. The decentralization of power since reformation in 1998 also poses difficulties because local officials lack technical and financial capacity to develop geothermal potential. This has been partially reversed recently in 2014 for geothermal investment but the results remain to be seen.

2.3.2.3 Other Renewables

The official estimate for hydrothermal capacity is large (75 GW) [74] but independent assessment shows that the economically-viable option to be around 10 GW [81]. There is a similar story for wind energy: the official potential of 60.6 GW is very much higher than the 2.7 GW feasible capacity calculated by researchers [91]. Bioenergy looks promising given that Indonesia can use the residue of many suitable crops and woods already produced, but there are serious concerns for its environmental sustainability because of historically lax enforcement of ecological conservation and land-clearing [92]. Finally, more research is needed to better predict the potential of ocean energy and how best to harness it [93].

2.3.3 Environmental Issues

2.3.3.1 Vulnerable and Not Ready for Climate Change

Various studies using different methods suggest that Indonesia is vulnerable to climate change and not ready to adapt to it. According to the Notre Dame Global Adaptation Initiative (ND-GAIN), this is so because of lower agricultural output, low technological capacity, low level of education, and pervasive corruption [94]. Frame et al [95] calculated a measure of how unfamiliar future climate will be based on projected change in surface air temperature; their data for Indonesia suggest that even in the lower range of best-case scenario (lowest 16% under RCP2.6¹²), most areas of Indonesia will still experience a climate that is unfamiliar: “an average year in the new climate [2070-2100] would have been expected once every 44 years under the old climate [1986-2005]”. The worst case (RCP8.5) is unimaginable: the new climate

¹² RCP stands for Representative Concentration Pathways. These are possible trajectories of greenhouse gases adopted by IPCC for a proxy of future climate based on radiative forcing values in W/m², e.g. RCP2.6 means +2.6 W/m² in year 2100 compared to pre-industrial level. Higher number indicates worse outcome.

happened only once every 741 years in the old one. In addition, Mora et al [96] calculated the timings of climate departure — the year in which annual air-temperature moves beyond variability seen in the last 150 years — to be as early as 2030 for Indonesia. Farmers in some parts of Indonesia are already feeling key farm dates moving into unfamiliar ranges [97]. Drought and floods, which are the most common disasters in Indonesia [98], will be even more frequent, exposing more people to poverty [99].

2.3.3.2 Climate Change Mitigation and Adaptation Effort

The government is taking steps to reduce the vulnerability and adapt to climate change. This is reflected in the increased budget for climate change mitigation and adaptation by 7% from 2016 to 2017, bringing the total to about US\$5.5 billion¹³ [100]. A review of climate change policies by IISD (International Institute for Sustainable Development) concluded that Indonesia is making positive progress by enacting adaptation policies, not just mitigation ones [101].

2.3.3.3 Deforestation and Forest Fire

Forest degradation is a major environmental problem in Indonesia. Land-use, which among others includes deforestation and burning biomass, is a large contributor to emission: 68% in 2014 [102]. The breakdown for land-use emission is shown in below chart from FAOSTAT (Figure 3): deforestation is about 68% of total in 2015; whereas forest fires vary wildly, from 0.42% to around 20% every year [103]. It is also evident that the emission from deforestation has been increasing since 2000.

¹³ The value in local currency is Rp77.6 trillion.

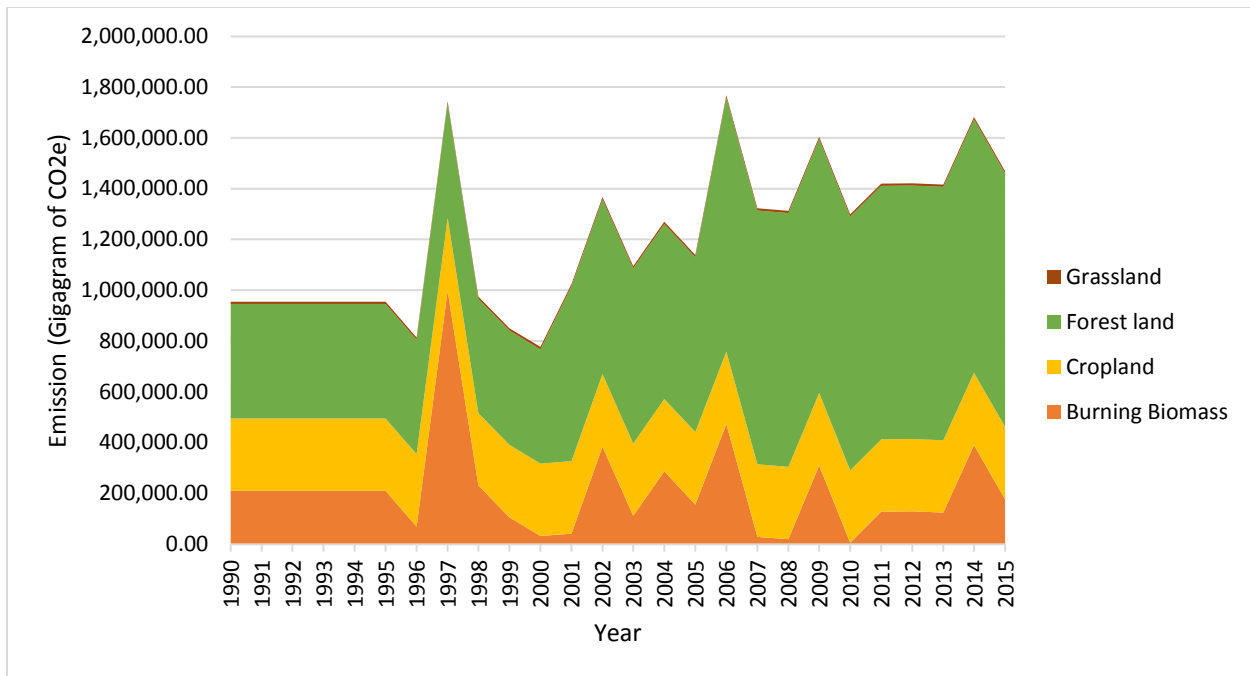
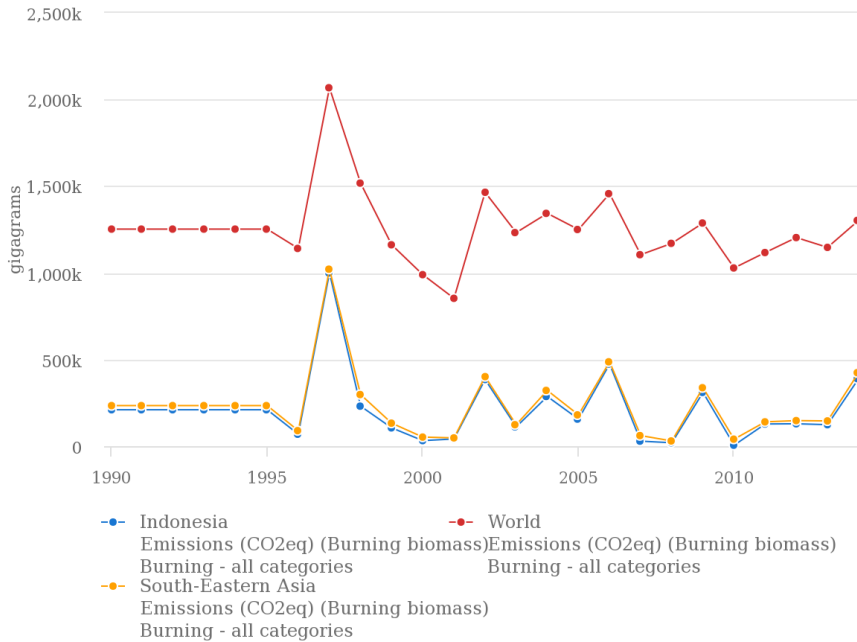


Figure 3: Land-Use Emission in Indonesia (source: FAOSTAT [103])

The fires are seasonal by nature due to the El Niño¹⁴ phenomenon but often made worse by land-clearing practices using fire, especially for agriculture on peatlands. A quantitative model of forest fires incidence by Fernades et al [105] predicts that Indonesia faces higher probability of forest fires by up to 40% even during non-drought years. In 2015, extended drought due to El Niño created the largest carbon emissions from forest fires since 1997; the emission rate per day in Indonesia was faster than the entire EU's [106]. Below chart from FAOSTAT [103] shows that forest fires in Indonesia are so large and recurring that the total for the world follows its shape.

¹⁴ According to NOAA [104], the term El Niño refers to the large-scale ocean-atmosphere climate interaction linked to a periodic warming in sea surface temperatures across the central and east-central Equatorial Pacific.



Source: FAOSTAT (Apr 28, 2018)

Figure 4: Emission due to Forest Fire in Indonesia compared to the Global one

The fires create severe air pollution which negatively affects health and productivity domestically and across national borders. Kim et al [107] found that the air pollution from the major forest fire in 1997 has lasting negative effects, which are especially problematic for the elderly. (Children seem to recover quite well from the early pollution shocks.) The researchers concluded that one standard deviation of air pollution in Indonesia raises the likelihood of bad health by about 3%. Furthermore, the same researchers also argued that the impact extended to labor productivity: their analysis implies that a one standard deviation increase in air pollution results in a decrease of 0.99 hour in labor supply, resulting in approximately US\$10 billion of lost productivity [108]. Sheldon and Sankaran extended this argument by analyzing the impact across borders in Singapore and Malaysia [109]: one standard deviation increase in the Indonesian fire radiative power increases air pollution in Singapore by 1.4 standard deviations and causes a 0.7 standard deviation increase in polyclinic attendance for acute upper respiratory tract infections and acute conjunctivitis.

Most policies to mitigate forest degradation have been ineffective so far. There is an agreement ratified by all Southeast Asian countries to reduce transboundary haze pollution (ASEAN Agreement on Transboundary Haze Pollution), but its mitigating impact remains to be seen [110]. Another major

initiative is REDD+¹⁵, through which Norway committed to offer monetary reward to tropical nations for keeping their forests, thereby reducing emissions from land-use change and carbon released from dead trees. It is faltering but Indonesia is not ready to give it up [111]. Of US\$1 billion offered, only US\$60 million has been used so far [112]. Laely suggested that the legal framework for preventing deforestation was inadequate due to weak or corrupt local government, sporadic effort (not integrated), and poor alignment between national and local governments [113]. Suwarno [114] created a model to simulate how communities and companies would react in response to the moratorium on forest use recently extended [115]; the results suggested that the moratorium as implemented would be ineffective because it did not include incentives for local communities to benefit from conserved forest. Wijaya et al confirmed this prediction with observations on the ground and argued that the local authorities do not follow the moratorium because of two reasons: (1) it is issued as Presidential Instruction without consequences to the perpetrators; and (2) the decentralized political system allowed sub-national government to issue conflicting policies [116]. This poor governance also prevented effective application of market-based forest-management practices such as FSC [117].

2.3.3.4 *Palm Oil*

The degradation of forest is in large part due to palm oil expansion, which is important for the economy: Indonesia is the top exporter of palm oil, capturing 49% of the global total [118]; domestically, palm oil represents 8.71% of total export by value in 2017 [32]. It contributed to the development of rural villages by providing good jobs and economic diversification away from subsistence agriculture [119], [120].

The palm oil industry is moving towards sustainability, but there are hurdles at local level. New plantations now expand to non-forest or degraded land, of which there are still plenty: 30.2 million hectares nationwide meet biophysical suitability for palm oil cultivation [121]. Large plantations introduced sustainability policies since 2000, three years after major forest fire event, and codified in RSPO (Roundtable on Sustainable Palm Oil). Small and medium-scale planters, however, do not follow these policies [120]. As such, the sustainability policies by the large companies do not align well with the government's (called ISPO), which tries to protect small and medium-scale planters [122]. There is ongoing effort to harmonize the two policies but the outcome is yet to be seen.

¹⁵ The full name of REDD+ is rather long: Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries

2.3.3.5 Food Security

Climate change threatens the food security in agriculture and fishery.

A major agricultural product for consumption is rice, the staple food in Indonesia. But there is too much dependence to it: the government (through BULOG¹⁶) buys rice at much higher price than the international standard and limits import of rice too [123], [124]. This discourages diversification towards more nutritious crops, which not only increases farmers' livelihood but also helps the agriculture sector become more resilient against climate change.

The fertilizers are heavily subsidized too: it costed about 50% of the Ministry of Agriculture's budget in 2016, but production barely rose [123], [125]. Worse, collusion among state-approved retailers led to the subsidized fertilizers being sold at 40% above state-set price, so only large plantations can afford it, not the small-scale farmers the policy aims to support [126]. Excessive use of fertilizers can also cause more eutrophication¹⁷, especially when precipitation is higher because of climate change [127]. It would be wiser to use the money for agricultural public goods such as R&D, extension services (i.e. training), irrigation, risk management, or even targeted cash transfers [128].

In addition, overuse of pesticide caused reappearance of resistant pest (rice brown planthopper). Thorburn has been closely following the pesticide use in Indonesia since 1970s (often by being present on the field) and reported that the new problem from resistant pest in 2015 approached the disastrous level seen in 1985-1986, which ironically also happened due to excessive use of pesticide to achieve the government's self-sufficiency goal in rice [129]. Back then the solution was to use Integrated Pest Management (Pengendalian Hama Terpadu), which minimizes pesticide use by controlling the ecosystem through natural means, such as introducing the pest's natural predator. This largely disappeared from the government's agenda after the reformation in 1998, triggering aggressive marketing campaign by pesticide companies. The resulting uncontrolled use of pesticide led to the recent disaster.

The bleak outlook in food security is made worse by climate change. Indonesia's rice production varies on average by 1.4 million tons for every 1°C change in August SSTAs (sea-surface temperature anomalies) [130]. A 30-day delay in the monsoon onset due to climate change causes rice production on Java and Bali to fall by 1.12 million tons on average for the January-April harvest season alone; it is not uncommon for

¹⁶ Badan Usaha Logistik (Bureau of Logistics)

¹⁷ It is an excessive enrichment of nutrient in a body of water due to fertilizer (among other chemicals) runoff from land. This harms ecosystem and water resources.

the government to import 10-20% of total world rice trade in particularly dry years [131]. Climate change increases incidence of floods and droughts, which in Indonesia on average causes 455 ha of damaged crops per event [132]. As a result, net revenue for farmers could decline by as much as 20% in year 2100 compared to 2014 [133].

In addition to reviewing the policies already identified above, policymakers have a few mitigation options to ensure security of agricultural products in the face of climate change. Naylor et al [131] suggested that the government can take advantage of the fact that Indonesia is exposed to predictable weather pattern (El Niño) that affects 60% of the inter-annual variation of rice yield. They also created a framework to integrate this sound science with policymaking. Förster et al [134] link the mitigation in agriculture to sea-level rise: the research shows a method which is useful in prioritizing areas/provinces most impacted by sea level rise in terms of its impact to agricultural output (of the five most important food in Indonesia).

The outlook for fishery is much brighter. In a public lecture at Harvard Kennedy School, the current Minister of Maritime Affairs and Fisheries, Susi Pudjiastuti [135], delivered some good news on the fishery sector that are consistent with FAO assessment [123]. Fish represents 54% of total animal protein intake by Indonesians, so it is an important food stock. But illegal, unreported, unregulated fishing in 2003-2013 caused close to 45% drop in the number of fish-catching businesses, majority of whom (68%) are small-scale fishermen. The ministry combated these illegal fishermen and subsequently the fish stock almost doubled from 6.52 Mton in 2011 to 12.54 Mton in 2017. The minister went even further to preserve the biodiversity in the ocean: water conservation area is now at 19.14 million Ha, a 16% increase from the area 2014.

The latest effort is to monitor vessels in Indonesian waters through collaboration with the Global Fishing Watch, which monitors ships using satellite and ship tracking data provided by the government [136], [137]. Going forward, the ministry is researching more policy options toward sustainable increase in fish biomass and catch [138].

2.3.3.6 *Sea-Level Rise*

With 17,500 islands, Indonesia is particularly vulnerable to any rise in sea level. According to the World Bank [98], sea-level rise threatens 42 million Indonesians who live less than 10 meters above sea level. Furthermore, a one-meter rise in sea level could inundate 405,000 hectares of land and reduce Indonesia's territory by flooding low-lying islands. Joseph et al [139] found that coastal communities adapt by

diversifying livelihood, e.g. from rice farming to prawn farming, fishing, or unskilled labor. Most of them did not get any formal training or financial help — instead they rely on friends or family in addition to learning the new trade by themselves.

Recognition of the risk is low and the mitigation effort has been limited. Spatial planning in northern coast of Java has not integrated mitigations of global sea level rise, hence it increases risk to disaster and economic cost [140] [141]. Jakarta (the capital) faces 33% chance that it will see inundation around 184.9-342.3 cm above mean sea level (MSL) between 2020-2040. In the worst case, at 3.57% probability, the height is 271.1-408.9 cm above MSL [142]. By the middle of this century extensive floods could potentially reach several kilometers inland in Jakarta; land subsidence from over-extraction of ground water is responsible for 88% of this increase [143]. The local government is erecting a giant sea-wall along the north coast of Jakarta [144], but current design will drastically intensify eutrophication effects from municipal waste water [145]. Still, this wall does not directly address the root cause of sinking land. Perhaps Jakarta can learn from Tokyo, which successfully stopped groundwater use in 1970s from a start in 1960s [144].

2.3.3.7 Urban Air Pollution

The discussion here focuses specifically on air pollution in urban areas, complementing the one from forest fires in section 2.3.3.3.

Haryanto [146] argued that the transportation sector contributes the most to air pollution in urban areas, at about 80%. The large number of vehicles together with lack of infrastructure in cities result in major traffic congestion that lead to high levels of air polluting substances, harming public health. About 50% of morbidity across Indonesia is due to air pollution. This fact is rather lost on the public: their willingness to pay for air pollution mitigation varies by city but all were very low, at around US\$1-3 per year [147], [148].

Both et al [149] conducted a real-time measurement of exposure to PM_{2.5}, ultrafine particles, and carbon monoxide (CO) for commuting workers, school children, and traffic police in Jakarta. The measurement covered 36 individuals for 93 days. The data showed that traffic-related pollutant exposures of Jakarta citizens are among the highest in the world. The on-road exposure was greater for commuters using private cars than the ones using public transport. This is because the private car commuters travel much longer distances even though the pollutant concentrations in the cars were lower.

According to Haryanto [146], some efforts had been conducted to combat the air pollution problems, but almost no significant results were found on the reduction of both the emission and health impacts. The proposed solution was for the government to support the diffusion and deployment of clean-energy technologies, such as the adoption of European emission standards (Euro 4 or Euro 6). Ambarwati et al [150] argued that integrated planning for urban structure and public transport could lead to drastic improvement. Simulation of such integrated planning in Surabaya suggests that the mode share of public transport could be increased from 6% to 70%, the commuting distance could be shortened by 53% and the emission load could be reduced by 90%. Given the existing urban structures in cities, such radical results might not be practical.

Clearly, urban air pollution is still a major issue for the government to tackle.

2.3.3.8 Water Pollution

Most published studies about water pollution in Indonesia are for very specific sites and type of pollutants at a given time, while comprehensive reports on the matter by international organizations [151] [152] are often based on aggregate figures from the government. This may reflect a lack of effort by the government to consistently and reliably collect accurate data on water pollution, which often requires costly and time-consuming on-site measurements instead of the more affordable remote-sensing or satellite-based inference available to check greenhouse gas emission. Hence the overall findings here are supplemented by a recent and widely publicized case on Citarum river, one of the world's most polluted river according to the World Bank [153].

Indonesia is rich in water resources. About 6% of the world's water is in the country and total water availability is estimated at 690 billion m³/year, whereas total demand is 175 billion m³/year [151]. However, the distribution of water resources is not even (83% of available surface water is in the large island of Papua, Kalimantan, and Sumatra) and seasonal variability creates water stress in the dry season [152], which will get worse with climate change. As such, the government is building 65 new reservoirs with a capacity of 8.2 billion m³ by 2019, thus raising water availability per capita from 49.2 m³ in 2014 to 76.4 m³ in 2019 [152]. Thus, water supply is not an issue.

The problem lies with the quality of the water. The rivers are polluted: from 2012 to 2016, the number of heavily polluted rivers stayed around 74% of the total [151]. An overview of 44 large rivers all over

Indonesia shows that only four of them meet the Class II Water Quality Criteria¹⁸ in Government Regulation 82/2001 [152]. Most of the 15 major lakes are in hypereutrophic category [152]. In urban areas, only 1% of the wastewater is safely collected and treated; not much better than in rural areas where the wastewater is neither collected nor treated [152].

This high level of water pollution happens even though integrated water resources management in Indonesia has a comprehensive legal and institutional framework [151] [152]. The regulations already cover basic principles; water-quality conservation and standards; water pollution; wastewater; stakeholder participation; and public-private partnerships. There was even a successful industrial policy called pollution control, evaluation, and rating (PROPER) back in 1995-1998 which was the first major initiative in the developing world that used information disclosure to reduce industrial pollution [154] [155], but current revival of the program falls short [156].

The following case study about severe pollution in Citarum river suggests that the laws are rendered ineffective because of a confluence of factors.

Citarum is one of the major rivers in Indonesia. It is located in West Java and stretches for 300 km. About 28 million people depend on the river's waters, which supply Jakarta, support 400,000 hectares of rice paddies, sustain fish farms, and fill reservoirs that generate about 2 GW of hydropower [157]. Since the 1970s hundreds of textile factories have set up in and around Majalaya, one of the tributaries to the river [158]. It was then that the residents started to notice the pollution in the river.

Decades of neglect led to Citarum now being one of the world's most polluted river [153]. About 1500 textile factories dump 280 ton of chemical waste into the river every day [156], [157]. According to tests conducted by Greenpeace at one of the factories [156], the wastewater flowing into the river had pH14 — the highest possible level of alkalinity, capable of burning human flesh. They also detected a variety of hazardous chemicals: nonylphenol, nonylphenol ethoxylates, tributyl phosphate and high levels of dissolved antimony. As a result, the residents around the river experience recurring skin irritation, chronic dermatitis, and respiratory problems [156]. One farmer's rice yield is now down by two-thirds in the rainy season [153]. The total cost of pollution is estimated to be at US\$831 million [157].

¹⁸ Class II Water is defined by the government as just below drinking-water quality. Specifically, Class II Water can be used for water recreation, infrastructure/means, freshwater fish farming, animal husbandry, water for irrigation, and/or other usage that requires similar water quality for such usage.

Many reasons are cited for this unfortunate outcome. The textile factories employ hundreds of thousands of local people and contribute local economic development, giving the factories significant political power [156]. It is open secret that environmental inspectors can be paid to ignore the pollution [156]. As a result, the factories are deemed compliant in the public record of industrial polluter. In addition, the inadequate waste management facilities prompted residents to dump their garbage into the river [156].

Prior programs to restore the river did not progress well. In 2009 the ADB lent the Indonesian government \$500m, to be released over a period of 15 years [157]. However, the bank had financed only \$41.9 million of that amount so far, which was spent mostly on developing an “integrated water resources management roadmap” [158]. The bank cited two difficulties stemming from the decentralized structure of the government: (1) in administering the money to the districts; (2) in mobilizing support from the local government.

The latest clean-up effort just got started in February 2018. This was triggered by international pressure due to a viral documentary of the river’s state filmed by a pair of French brothers [160]. The central government decided to take back the responsibility for the river away from the local government [153]. The President’s target is to make the water drinkable by 2025 [161]. This attracts business interests from China and Japan to clean the river [162]. The commitments and work on display so far are promising, but it is rather doubtful that the central government has enough resources to replicate such program for all major rivers. Perhaps a better alternative is to invest in inherently cleaner and safer technology for textile production (see section 3.2.4).

In summary, the reason for the grim outlook of water pollution in Indonesia can be traced to decentralization, corruption, elite capture, and lack of infrastructure for waste management.

Lastly, the existence of microplastics in the water system is a very recent issue that is worth highlighting here for further evaluation in the future. Microplastics has been found in coastal systems all across Indonesia: in Cilacap [159], Jakarta [160], and Makassar [161]. However, the science is just emerging on the impact of microplastics [162], so the government is conducting research to better understand this problem [163].

2.3.3.9 Waste Management

For three years before the Asian Financial Crisis in 1998, municipal solid waste (MSW) management in Indonesia was at a sound performance level [164]. Thanks to Adipura Award program, many cities were

motivated to improve their cleanliness and sanitation. Then the crisis struck and waste management vanished from the political agenda. Fast forward to 2015, the Environment and Forestry Ministry waste management director Sudirman said that there were so many problems with regard to waste management in Indonesia that he was mulling whether or not he should declare a state of emergency [165].

Based on the ministry's data for 2015, a typical Indonesian generates 0.7 kg/day of solid waste. Thus, the total population would generate around 175,000 ton/day of MSW, or a staggering 64 million ton per year [165], [166]. About 60-70% of this is organic waste [166]. Majority of the waste (69%) goes to landfill [165], but only 3% of the landfills are sanitary [167]. The rest of the landfills are categorized as open dumps (81%) or controlled landfills (16%) [167]. Hence, the majority of the landfills are hazardous to health and environment.

It is worth highlighting the transboundary nature of electronic waste (e-waste) in Indonesia [168]. Data on the total size is scarce, but the e-waste from cellphone alone is around 9500 ton per year and most of these are dumped in landfills. Recovery rate is very low (1%) because there is no regulation on e-waste, thus only a few manufacturers bother offering take-back option and most of the public are unaware of the option. More importantly, potential e-waste in the form of scrap materials or second-hand devices arrives at remote Indonesian islands from wealthier countries in Europe and North America. This occurs even though Indonesia ratified the Basel Convention in 2005, which prohibited import of hazardous waste. In total, around 40% of electronic devices sold in Indonesia are illegal imports. Interviews with users of such imports suggest that they are willing to return their obsolete devices if an incentive system is available.

Regulations on waste management already exist. For example, the concept of producer responsibility is incorporated in the law but its implementation faces challenges [169]. The situation for the principle of at-source separation is similar [170]. Indeed, the government has a poor track record of convincing the public to live by the 3R (reduce, reuse, recycle) concept in law No. 18 of 2008 [171].

Similar to the barriers identified in other sectors in this chapter, the misalignment between the central and local government plays a significant role. After decentralization effort post 1998, waste management became the responsibility of local government, who then altered the existing policies in significant ways [164]. Most local authorities prefer open dumping, the easiest method [166]. This creates a despondent

situation in the landfill site. The misalignment is caused by the fact that the central government was responsible for providing the capital investment for new landfills, while the landfill operational costs need to be covered by local governments [167].

Another significant barrier is the existence of illegal scavengers, who made their livelihood from looking for recyclable materials in the dump site and then sell them to recyclers [172]. Their household income was estimated to be approximately US\$216 per month, which was virtually equivalent to the minimum wage in Jakarta in 2013. Living conditions of scavengers at the site were horrible and their working conditions were dangerous. Despite these problems, they were attracted to the freedom of entering the informal recycling system. Closing off their access to the open dump sites will jeopardize their livelihood because most of them do not have other marketable skills.

To solve the waste management crisis, the government embarked on a development project with the World Bank in January 2018 [173]. Many researchers have proposed various potential solutions. One possible track is to use technology, such as converting the waste to energy by using the landfill gas, thereby reducing waste and emissions from power generation at the same time [171]. This method has the potential to be a net carbon sink in a cost-effective way, as one empirical study for Palembang (a major city in Sumatra) shows [174]. The same study estimated that the major urban centers in Indonesia can generate enough waste to provide just less than 80 MW of electricity through landfill gas. Hence, it offers environmental, social, and economic benefits.

Another path towards potential solution is to formalize the scavengers' recycling work and provide the institutional framework [175]. This provides them with secure jobs while incentivizing them to contribute to the waste management issue. The idea is based on successful practices in three sites throughout Indonesia [167], [176].

In a similar vein, involving citizens in the waste management effort may be fruitful. A great example of this idea is the Surabaya Green and Clean (SGC) initiative in Surabaya, the provincial capital of East Java [164]. It engages the citizens by providing them with the relevant environmental knowledge, appointing environmental champions in each district, and arranging competition between the communities to see who are the best in handling their waste. This resulted in increasing participation in waste segregation while also creating opportunities for income from the sale of valuable waste.

Overall, Indonesia is facing a crisis in waste management but there are positive signs of progress towards sustainable solutions.

2.3.4 Section Summary

Indonesia is a major emitter of greenhouse gas because of forest degradation and dependence on fossil fuel — especially coal — for energy. The emission targets committed to UNFCCC (the Paris Agreement on Climate Change) still allow for more emissions but lower than the business-as-usual scenario. The targets are feasible but the government must: (1) consistently enforce policies already in place to prevent forest degradation; and (2) invest in huge untapped potential for renewable energy, such as solar and geothermal power.

The country is vulnerable and not ready for climate change in many domains: forest conservation, food security, and sea-level rise. This is made worse by rising pollution in air, water, and land. The crisis in waste management further complicates the problem. The combination of these impacts will affect the poor first and may even trap them in poverty. Most of the current mitigation policies are found to be ineffective.

2.4 DISCUSSION: THE BIG PICTURE AND INTERRELATED ISSUES

This chapter concludes by taking a step back from the details discussed above and then looking at the big picture showing the interconnected issues across the pillars of sustainability.

Indonesia risks political instability because of the extreme inequality in wealth (section 2.1.2). Climate change worsens the problem by negatively and firstly affecting the poor households (section 2.3.3.1) working in informal sector, for which the national health and employment insurance system have not sufficiently covered (section 2.2.2). This leads to further inequality. Furthermore, Laurent argues that pollution does not only affect inequality — the reverse, inequality creating more pollution, is also a possibility [177]. For example: in Indonesia, inequality is closely related to elite capture and corruption, which has been found to impede environmental sustainability efforts across many sectors discussed in this chapter. It closes the vicious cycle between pollution and inequality that leads to increased political risk over time.

There is a chance that Indonesia will see a repeat of its recent history. The reformation in 1997-1998 (which created political and economic instability for more than 5 years after) had similar set of conditions prior to the Asian Financial Crisis: economic opportunities was concentrated around the president's cronies (section 3.1.3); social safety net barely existed; and El Niño was so severe that the extreme dryness impoverished many people. The difference is that the government now is much better prepared to handle an economic crisis (section 2.1.1) and political power is more distributed (section 3.1.1), but they are not so ready when looking at the likely impacts of changing climate (section 2.3.3.1).

Looking back at the current situation, Indonesia is undergoing what Rodrik called premature deindustrialization [178] [179]: “This means countries are running out of industrialization opportunities sooner and at much lower levels of income compared to the experience of early industrializers.” Rodrik provided evidence that labor-saving technologies and globalization in manufacturing are behind this phenomenon and it may hinder the growth of economy and trigger democratic failure. The assessments discussed in this thesis supports Rodrik’s argument. Start with the economic impact: manufacturing tends to show unconditional convergence and medium to long term productivity growth, but premature industrialization slows this process (section 2.1.1 and 2.2.1). One alternative source of economic growth is services, especially those sectors that are highly productive and tradeable, such as IT and finance. The problem: both are highly skill-intensive, leading to polarized jobs (see section 2.2.2) which cannot absorb labor that developing economies have in abundance. Comparatively, other services sectors are either

technologically static or non-tradeable¹⁹. The second impact is politics: manufacturing mobilizes a lot of people from various background, leading to unions (section 2.2.1) that gives non-elites the power to negotiate with the elites. This creates political institutions other than elections that aggregate the political wills of non-elites.

Overall, premature deindustrialization means that low-skilled workers, which developing countries like Indonesia have in abundance, move to low-skilled services in informal sectors, i.e. petty activities. This movement may explain the persistently large informal sector in Indonesia (see section 2.2.2). Thus the power of non-elites is very diffused and difficult to organize in a way that can pose serious threat to the elites. Again, this is applicable for Indonesia because elite capture is a major barrier toward sustainability (see section 3.1.3). In short, many of Rodrik's warnings about premature deindustrialization are found to happen in Indonesia.

Another interesting insight is that the government may have not looked far enough in the future when deciding to still invest in fossil-fuel plants to meet the growing energy demand (section 2.3.1). The decision fastens the global change in climate which will first be felt in tropical countries, thus negatively affecting many Indonesians first (section 2.3.3.1). In other words, by investing in fossil-fuel power, the government might have done a disservice to the citizens.

¹⁹ Non-tradeable means that the sector can be performed mostly by domestic players only.

3 SYSTEMIC BARRIERS AND PATHWAYS TOWARD SUSTAINABLE DEVELOPMENT

This chapter looks at the barriers that prevent sustainable development in Indonesia and then charts a few future pathways taking the barriers into account. The focus here is on a systemic view: the barriers are the common issues seen or inferred across sectors identified in the previous chapter; similarly, the pathways advance all three pillars of sustainability (economy, employment, environment). This reflects the transdisciplinary nature of sustainable development [16]. Barriers that are specific to a sector are discussed in chapter 2.

3.1 BARRIERS

3.1.1 Messy Decentralization

Decentralization is arguably the most fundamental and significant barrier towards sustainable development in Indonesia. To understand why, we first need to look at its history. Mietzner [180] recorded that during the 30-year reign of Soeharto prior to his downfall in 1998, the political structure in Indonesia was highly centralized around him and ran like a military. The political and economic institutions were extractive, doling out wealth from extracting natural resources to only the elites. Acemoglu and Robinson [38] argued that one reason civilizations in such situation eventually fell was because of power struggle at the top, which is what happened to Soeharto: he was already 76 years old in 1998 but had not created any succession planning when the Asian financial crisis hit at the same time as huge agricultural loss due to a particularly severe dry year. The reformers learned from this mistake and sought to radically distribute the political power from the center to the regions and districts. According to Holzhacker et al [181], the first phase of decentralization in 2000 was very problematic because a lot of power was dissolved, but accountability was not established. The second phase in 2004 fixed that structural change and it has stayed in place so far.

There are some good outcomes from the decentralization effort. It allowed Joko Widodo to be the first President of Indonesia not from military or an elite background: growing up in a poor family, he applied himself at school, graduated from university, ran a wooden furniture business, and was later elected as the mayor in Surakarta, where he enacted structural reforms. This earned him national recognition that propelled him to be the governor of the capital Jakarta and subsequently to the presidency [182]. It is a prime example of the far-reaching political impact from decentralization [183]. In addition, district

government's revenue and expenditure — especially on public works — increased after decentralization [184]. Budget transfers to the municipalities are relatively equitable and consistent with poverty situation at local level, thus decentralization continued the downward trend of the poverty rate [185].

However, there are many more problems. The sudden nature of the decentralization²⁰ provided sub-national governments with political power but not technical and institutional capacity [186]. In other words, they were not ready. Even recently in 2016, OECD found that the governance in some regions is still weak, and rent-seeking is rampant [9]. Pisani [187] and Rudy [188] observed that decentralization created local kings who implemented policies that are popular for their electorate but are detrimental to the nation as a whole, e.g. allowing deforestation to continue despite the moratorium by the central government. The sequence of events leading to this result is as follows: soon after the first wave of decentralization in 2000, local strongmen used their contacts in central government to get their own district, thus increasing the number of districts by 70%; the rivalries between the local kings across districts drove their election campaigns to be much more expensive such that it entrenched a culture of patronage, where the winners hand out benefits to their supporters.

This problem is fundamental because it is seen in many sectors: the slow progress towards meeting international treaties, such as UNFCCC [189], and even national plans (which incorporated Sustainable Development Goals) [14]; the uncontrolled forest fire and deforestation [190], in which increasing number of political jurisdictions are associated with increased deforestation [191]; the dearth of innovation in primary healthcare [192] and neonatal care [193]; the large regional disparity in educational attainment [194]; the persistent corruption in mining [195]; and so on. Even corruption changed in nature after decentralization. Before decentralization, corruption cases are grander but relatively fewer in number; afterwards, the cases are less notorious but many more local actors are involved, so decentralization alone did not prevent corruption as the reformers hoped for [196].

To recap, this is not to say that the decentralization process should be stopped. On the contrary, distributed political and economic power are the common theme among countries which managed to become developed, as argued by Acemoglu and Robinson [38]. The big question is how best to do so when even the honest local officials are so used to simply executing strict orders from the center. This is

²⁰ Often called the “big bang” decentralization in the literature.

reflected in the fact that now the decentralization structure is still evolving with laws being continuously revised [186].

3.1.2 Persistent Corruption

Corruption is another major barrier hindering efforts toward sustainability. It took root during the centralized governance in Soeharto era [197], [198]. Pisani [187] provided a concise description of how it unfolded: “Under [Soeharto], the Indonesian political system formed a single pyramid with a very wide base. He was careful to dole out monopolies and other benefits to people who would give something back: national stability in the case of the military and industrialization, investment, and jobs in the case of the conglomerates. It was not until his children grew up and became greedy that Suharto began to give away something for nothing; it was then that patronage in return for services turned into plain old graft. It was then, too, that Indonesians grew fed up with him, which led to his downfall.”

As discussed in the previous section, decentralization and corruption jeopardized sustainable development efforts in many sectors and geographies. This pervasive corruption also saps government of financial resources, which are already limited due to low tax revenue (see section 2.1.2). During a recent public lecture at Harvard Kennedy School, Susi Pudjiastuti, the current Minister of Maritime Affairs and Fisheries, shared that the ministry used to have “words with wings”: positive-sounding but vague words (such as empower, strengthen, and so on) that allow corrupt officials to unnecessarily add expenditures, thereby increasing the amount of money they can siphon off [135]. Her ban of these words forced the officials to exactly specify what the budget was for, ultimately saving 40% of the allocated budget (US\$700 million) for doing essentially the same projects.

Corruption exists not only in government but also in corporations because the standards and practices of corporate governance are much less demanding against corruption as compared to the ones in Malaysia and Thailand [199]. Situation at the remote areas is worse [200]: corruption there is more rampant and exposed cases are mostly due to rivalries between local elites. Furthermore, the exploding cost of campaigning drives candidates for public office into all sorts of illicit fundraising methods, which limit their policy space.

All of these result in persistently high perception of corruption. Indonesia’s score in Corruption Perception Index 2017 edition (37 out of 100) represents an increase by only 5 points since 2012 [201].

3.1.3 Elite Capture

Similar to corruption, elite capture in Indonesia is a legacy from the Soeharto era, when powerful politicians maintained their regime by carefully giving out economic benefits (such as generous contracts for extraction of natural resources) to first military officers and later selected civilians, mostly ethnic Chinese entrepreneurs [180]. The accumulated wealth allowed these individuals to buy more political influence, further capturing the economic bounty by rigging the economic policies to increase their profit. This formed a vicious cycle between the political and economic elites, raising inequality. Some of these politicians retained their position after reformation, causing elite capture to be more entrenched [202].

Today, elite capture is still present across sectors and regions of the country thanks to decentralization. Local elites took advantage of the poor majority's diverse preferences to push for their agenda in a unified front [203]. For example, decentralization allows local elites to capture more of the benefit from forest products, rising local inequality even though forest conservation improved [204]. It is also happening in illegal mining [75], palm oil [205], and deforestation [186]. The elites' vested interest in fossil fuels might have prevented exploration of Indonesia's huge potential for renewable energy.

There is some tentative effort to measure this effect for the whole economy. The Economist [206] constructed a crony-capitalism index based on billionaires' wealth data from Forbes and a rough qualitative estimate on whether the industry a billionaire work in is prone to cronyism. The result suggests that billionaires in Indonesia captured 3.8% of the GDP in 2016, a significant figure compared to other countries in the study. Oxfam [36] delved deeper into this research and found that about 84% of the billionaires' wealth comes from crony-prone industries such as agriculture and mining. Whatever the exact number, it is likely that elite capture slows the progress toward sustainable development in Indonesia given its pervasiveness and long history.

3.1.4 Fragmented Innovation System

There are many reasons why innovation is an important element of sustainable development [16]. Disruptive innovations can displace unsustainable technologies in which incumbents already invested. For Indonesia, this represents a possibility to bypass elite capture. One example is deploying an affordable and maintainable small-scale solar-power system [207] that can be distributed across villages and islands instead of investing in large and centralized fossil-fuel power plant. Strong innovation system allows government to be more stringent with environmental standards and put more emphasis on labor-enhancing (instead of labor-displacing) technologies [16]. Local and indigenous innovation may also

better understand what actually the people need by utilizing locally available resources and existing institutions [208]. Gojek is a good example: it is a local ride-sharing and packages delivery platform which utilizes motorcycle taxis, a unique profession in Southeast Asia.

However, many scholars find that the innovation system in Indonesia is weak and most of them cite many common causes [209]–[216]. First, government focus on innovation was very recent because the economy still depends on extraction of natural resources as reflected in its export. Data from UNESCO [217] shows that R&D spending was about \$2.1 billion (in PPP²¹) in 2013, which was only 0.08% of GDP and very low by global standards. The number of researchers was also very small, at just 59 researchers in a million population. As a result, the number of peer-reviewed publications in international journals — a measure of good research output — is still low. Furthermore, the structure of the innovation system is labyrinthine, highly fragmented, and not collaborative enough. This discourages private actors to engage with local innovators, preferring to use foreign technologies that are proven. It does not help that: (1) IP is not well protected; (2) skilled laborers are scarce; (3) local officials lack technical capacity; and (4) innovation intermediaries, such as industry associations which bridge public and private sector, are almost non-existent. Hence, dissemination of technology is slow: In 2010-2016, only 217 new technology products or services, 33% of the total, that were developed domestically by advanced R&D institutions have been applied or commercialized in Indonesia, mostly for the agricultural sector [211].

Even in the case of technology transfer from developed nations, the evidence offers mixed result. Indirect measurement by Jacob et al using quantitative analysis of import and labor productivity shows positive correlation [218], but a closer qualitative assessment by Wie revealed that FDI and technology transfer had not effectively translated to higher technological capacity of domestic players due to confusing policies and weak absorption [219].

The government is trying to address this deficiency. One of the most publicized effort is in creating physical infrastructure for nation-wide broadband access: Palapa Ring is a fiber-optic network spanning the whole country that is set to be completed in 2019 [220]. The hope is to reduce the regional disparity in access to the internet and information, thereby greasing the communication exchange across regions. Another initiative in this direction is the construction of science and technology parks where collaborative research

²¹ Purchasing Power Parity

takes place [221]. The government has also set up independent bodies to coordinate the national innovation system [209].

3.1.5 Weak Performance of the Post-Secondary Education System

High-performing innovation system requires well-educated population, especially at post-secondary level. Since the reformation in 1998, Indonesia has been investing heavily in education, at close to 20% of the national budget every year as mandated by the revised constitution [222]. As a result, the country has been making great progress in the enrollment and quality of primary and secondary education, though not yet so for tertiary level.

Based on gross enrollment ratio as compiled by UNESCO [217], Indonesia has been catching up and is now not too far behind its neighbors (except Singapore) at all levels of education (see Appendix 6.4). Similarly, PISA test²² for 15-year-old students in 2015 [223] revealed that Indonesia was the fifth-fastest improving education system across the 72 countries in the study. If this pace continues, Indonesia's children born today has a realistic chance of matching the performance of their peers in industrialized nations by 2030. There are also signs that Indonesian youths can keep up with technological change: about 75% of them actively uses the internet in 2016 [224]; and enrollment in ICT and engineering programs at vocational schools and universities are generally higher than the average in Southeast Asian countries [41].

However, the progress on post-secondary education is slow. UNESCO [217] recorded that the percentage of Indonesian population who have completed at least bachelor's or equivalent level in 2016 was only 8.4%, well below neighboring countries such as Philippines (16.9% in 2013) and Thailand (13.1% in 2013). The universities are also ranked well outside the top 200 globally by both Times Higher Education and QS in 2018 [225], [226]. Wie and Hill [227] in 2012 analyzed the tertiary education system in details and found several problems. First, significant disparities in the student body persist: only 15% of university students came from rural background and more than 70% were from the top 25% richest household. For the professors, salary structure in higher education is complex, leaves little room for serious academic research, and promotes too much based on seniority. As a result, most academics devote most of their time to non-campus work: 75% of professors' income comes from supplementary or non-core activities such as external research projects, consulting, and additional teaching (often in another institution). These

²² Programme for International Student Assessment (PISA) by OECD is an international test that measures 15-year-old school pupils' scholastic performance on mathematics, science, and reading.

distractions contribute to low alignment between educational outcomes at tertiary institutions and the expectations of the industry [228].

Beyond the university system, the government in 2015 embarked on a mission to improve coverage and quality of technical vocational education and training (TVET). This is important because most students in TVET come from the bottom 75% in household income [229], thus expanding the sector will improve education equity and provide skilled labor for the growing economy. One initiative is to build more community colleges (Akademi Komunitas, or AK) in which graduates of vocational secondary school (Sekolah Menengah Kejuruan, or SMK) can further their education instead of entering low-paying lower-skill jobs (mostly in the informal sector). The target is to have 500 community colleges by 2018 [230] and improve the rate of SMK graduates progressing to further education, which was just 15% in 2015 [229]. However, an assessment by OECD and ADB in 2015 [229] showed that there is a persistent gap between the skills taught in vocational schools and what the industry actually requires.

The same study also found a pressing issue: data on adult learning in Indonesia was severely lacking [229]. This may be because of organizational difficulty in gathering the data or the sector is virtually non-existent. In either case, the lack of focus there is a major challenge for sustainable development because about 42% of Indonesians aged 15-year-old and over have completed only primary education or less [71]. Thus, they are vulnerable to today's rapid technological change and competition from globalization. Instituting lifelong learning system ought to be part of the development plan for the education system.

3.1.6 Lack of Awareness and Urgency

Public awareness and political discourse about sustainable development is low. Despite many studies pointing that Indonesia is vulnerable and not ready for climate change (see section 2.3.3.1), public perception on the threat from climate change is increasing rather slowly, from 42% on 2015 to 56% in 2017 [231], [232]. It has also not gained traction in political debate: the media has not given the topic much coverage partly because of a lack of expertise on the subject [233]. Without public support, it is difficult to see the politicians pushing for policies to adapt to climate change. Better public awareness of sustainability may also reduce the demand for unsustainable products, forcing companies to adapt accordingly.

Increasing the awareness is made more difficult by the recent proliferation of organized false-news outlet. Saracen is one such group; they accepted payments to incite bitter religious and ethnic division before

and after the gubernatorial election for Jakarta in 2017 [234], [235]. Muslim Cyber Army is another network that is even more organized, systematic, and dangerous than Saracen [235]. Both groups exercise their influence through social media, for which there are 106 million active users in Indonesia (40% of the population) in 2017 [236]. This is a worrying trend because false news travel much faster than truth [237]. To counter the false news, major media organizations launched a website (cekfakta.com) dedicated to verify the veracity of news in social media [238].

3.1.7 Section Summary

For Indonesia, the major barriers toward sustainable development are political: sudden decentralization left local officials with little technical and institutional capability; corruption is pervasive and persistent, creating local kings in decentralized political structure; and the capture of political agenda by the economic elites spread from the center to the districts. The interactions between them amplify their collective impact that prevent sustainable development across many sectors. In addition, adapting for sustainability requires strong innovation and education system, but both systems are found to be lacking. This means the population is not ready to meet the change in climate, technology, and globalization. Finally, public awareness and political discourse of issues in sustainable development is low.

3.2 PATHWAYS

Many solutions for specific domains are in place but not effective, as already discussed in Chapter 2. This section instead looks at systemic pathways that co-optimize all three pillars of sustainable development, i.e. not sacrificing any one of the economy, environment, or employment sector. These pathways are not detailed and serve only as guidelines in which efforts should be focused.

3.2.1 Clean and Competent Local Government

Good governance at district level is a prerequisite for sustainable development in Indonesia. As discussed in preceding sections, any policies or initiatives by the central government are unlikely to be implemented well if the local officials are corrupt or lack the technical and institutional capacity.

Holzacker et al [181] argued that most governance failures due to decentralization in Indonesia require organizational solutions, both through formal hierarchy and informal networks, that are very specific “in the design of authority relations, the distribution of responsibilities, workflow interdependencies, the implementation of procedures for coordination, communication, monitoring, and control, and fostering climates of mutual trust.” Following the low-cost organizational pathways is a reasonable pattern found in many countries. Certainly, the first step is to freeze formation of new sub-national jurisdictions until comprehensive guidelines for its assessment is in place [239].

The paradox of decentralization is that it requires strong central leadership. Pisani [187] proposed that this can be achieved by setting clear investment priorities (or targeted fiscal transfer [239]), creating legal certainty of the decentralization structure, and giving the districts an incentive to cooperate. The districts’ performance should be randomly audited to expose corrupt politicians, thus increasing the non-electoral cost of corruption [240]. Of course, the central government must be clean too. So the existing Corruption Eradication Agency (KPK) — already one of the most respected and trusted government agency — should be strengthened [241].

At the same time, the technical and institutional capacity of the sub-national governments should be improved. Targeted training from the central government (or foreign donor) can help bridge the gap in technical capacity. Sutiyo and Maharjan [242] argued that decentralization can work well for the rural areas in Indonesia because these have strong social capital, good village officers, and functioning community leaders. The key is to institutionalize the participation of rural communities in their development, say by setting up confidential whistleblower system online through which the citizens can

voice their concerns. An appropriately designed community-driven development (in contrast to top-down approach) is not necessarily prone to capture by local elites [243]–[245].

To further reduce elite capture, the political financing system should limit donations from corporations to electoral candidates [36]. The government could also involve independent external agency to monitor implementation of policy at the district level; this has been found to reduce elite capture in the decentralization of forestry management [204].

3.2.2 Lifelong Learning Systems

As discussed in section 3.1.5, the pressing educational need in Indonesia is to train adults, especially the 42% of the population over 15 years old who have only primary school education or less. This is essential to help them adapt to changes in technology, climate, and competition. It also provides an opportunity to get higher-skilled jobs and thus improve their earning capacity. Given such chance, perhaps these workers — who are mostly in the informal sector — will be tempted to formalize their skills and enter the formal sector, where job vulnerability is lower and social safety net is more assured.

There are plenty of examples to learn from. The SkillsFuture program in Singapore is flexible and designed well but existing culture of pragmatism slows its adoption [246]. In Spain, adults who have completed formal e-learning activities experienced more stable employment even during economic crisis [247]. Formal and informal study circles in Sweden enhances the social capital of participants, counteracting social inequalities and encouraging lifelong learning [248]. It is also possible to reorient higher education institutions toward lifelong learning or to create lifelong learning institutes [249], [250]. In summary, these initiatives suggest that lifelong learning is quickly being recognized as an essential requirement for sustainable development [251].

3.2.3 Local Innovation

Indonesia has low innovation capability and this is detrimental to sustainable development there. The government is making tentative steps to fix it (see section 3.1.4), but more can be done.

According to Mazzucato [252], the state plays an important role in innovation by investing in high-risk and disruptive technologies which most private actors are unwilling or unable to undertake. Thus, the government of Indonesia should continue with the effort to coordinate the innovation system and establish national agencies that provide competitive research funding for targeted areas of innovation, similar to how DARPA and NSF in the United States operate. This program-based funding is more

competitive than the current method of funding research through R&D institutions [209]. At the same time, the salary structure at public universities should be redesigned to incentivize serious research so that there will be takers of the program-based funding. Such policies help in moving the country out of its dependence on extraction of natural resources and into design of complex products, which are much more likely to reduce inequality [253] and lead to more sustainable innovation-driven growth [16].

Another approach is to consider bottom-up, not just top-down, innovations. This may be more in line with the ongoing decentralization process (see section 3.2.1). The idea is to encourage communities to develop (or adopt) locally-appropriate technologies and maintain their use in the community, whereas the central government simply provide guidelines to evaluate what technologies are sustainable. This improves technological capacity at local level and provide good jobs while ensuring the technologies are inherently sustainable. There are a few studies on such technologies that are promising for Indonesia: micro solar-power system (as discussed in section 2.3.1) or micro hydropower for distributed energy system at community level [254]; small-scale cellular networks to provide communication in remote areas [255]; and sustainable peatland agriculture to improve food security and reduce greenhouse gas emission from deforestation [256].

Perhaps Indonesia can learn from its history: infrastructure built by the Dutch during their occupation of Indonesia had to be adapted to local context by actively involving local actors at district level. These technologies were so successful that the Dutch applied them at some places in developed countries, including the Netherlands [257].

3.2.4 Pollution Prevention

In the face of weak regulatory environment in Indonesia (section 3.1.1 to 3.1.3), technological-assistance solutions may offer a more effective pathway in preventing pollution compared to enforcing the existing laws or creating new ones [16]. This is because technology, if well designed, can bypass parts of the bureaucracy while delivering economic, employment, and environmental benefits — a win-win solution that will trigger the interest of all stakeholders. The technology can be developed by local innovators (section 3.2.3) or transferred from other countries.

One option is to invest in what UNEP (United Nations Environment Programme) calls resource-efficient and cleaner production (RECP): “The continuous application of an integrated environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment”

[258], [259]. Some countries/institutions call it eco-efficiency, waste minimization, pollution prevention, or green productivity. It is different to traditional pollution control (or end-of-pipe) technologies: whereas pollution control is an after-the-event, reactive approach; cleaner production anticipates and prevent pollution at the source. UNEP has been implementing this approach successfully in many countries.

One potential application of RECP approach in Indonesia is the conversion of waste into energy production (section 2.3.3.9). This is possible thanks to the high organic content of waste (60-70%) in Indonesia. Empirical studies in have shown that this technology can be a net carbon sink in cost-effective way in Indonesia [174], thus providing simultaneous benefits for the economy (cheap energy), cleaner environment, and better health. The application of RECP approach may also solve the severe pollution in Citarum river (section 2.3.3.8) by displacing the textile production technologies that discharge obnoxious amount of toxic waste into the river. The government's current plan of scrubbing the river is not sustainable if the textile factories still use the dirty production technologies. Similarly, the urban air pollution problem (section 2.3.3.7) can be mitigated by adopting greener transportation technologies, such as hybrid engine and public transportation.

Another approach to prevent pollution is to use process or organizational innovation. An example of this in Indonesia is the practice of integrated pest management that reduces the use of pesticides while still delivering similar yield (section 2.3.3.5). In a similar vein, formalizing waste scavengers and engaging the citizens (section 2.3.3.9) can reduce the waste management problem.

Lastly, the government may also consider putting a tax on pollution. This requires sound implementation of regulations, which is difficult to do in Indonesia (section 3.1.1 to 3.1.3), but it offers higher revenue for the government which can be split with the local governments as an incentive. Thus, a well-designed pollution tax can be a practical way to increase the low tax revenue (section 2.1.2). International studies on carbon tax (a type of pollution tax) have shown that it can be significantly effective in reducing emissions without damaging the economy or being regressive to the poor by recycling the windfall from carbon tax towards labor income or even direct payment to the poor [260]–[262]. A separate study just for Indonesia confirmed the general conclusion [263].

In summary, studies have suggested that the effective and sustainable pathways to prevent pollution in Indonesia are through technological innovation, process/organizational innovation, and pollution taxes. This serves as a guide, not a comprehensive list of solutions.

3.2.5 Raising Awareness

The government has already set up a central agency to promote the impacts of climate change [264], so that is a good start. Another way is for Indonesia to host a UN conference on climate change or, more broadly, sustainable development. This would be similar to UN Climate Change Conference held in Bali in 2007.

Hopefully, this thesis will also contribute to promoting sustainable development in Indonesia.

3.2.6 Section Summary

The first step toward sustainable development in Indonesia is to have good governance at sub-national level. Effective decentralization can be achieved through various ways but the common theme is strong leadership from the central government. Existing corruption eradication institutions should be strengthened and elite capture be minimized through regulations and independent monitoring.

Adapting well to threats from climate change, technology, and globalization requires well educated population and strong innovation system. The focus for education system should be on adults (especially the poor ones), who are most exposed to the threats. Instituting lifelong learning can solve this problem and Indonesia can learn from existing efforts in many countries. The innovation system should be focused on encouraging high-risk disruptive innovation for sustainability by involving local actors taking into account local context.

Pollution must be prevented or significantly reduced. Studies have suggested that the effective and sustainable pathways to prevent pollution in Indonesia are through technological innovation, process/organizational innovation, and pollution taxes.

Finally, this thesis hopes to contribute to public awareness of the urgent for sustainable development in Indonesia.

4 SUMMARY AND CONCLUSIONS

Below table shows a summary of the major findings in this thesis.

Pillars of Sustainable Development	Strengths	Vulnerabilities	Barriers	Pathways
Economy	Macroeconomic stability. Resilient financial system.	High dependency on extraction of natural resources. High regional disparity. Extreme inequality in wealth. Low tax revenue.	Messy decentralization. Persistent corruption. Elite capture. Fragmented innovation system. Weak post-secondary education. Lack of awareness and urgency on sustainability issues.	Clean and competent local government. Lifelong learning systems. Local innovation. Pollution prevention: cleaner production technology, organizational innovation, pollution taxes. Better awareness on sustainability issues.
Employment	Demographic dividend. Low unemployment. Rising number of women in workforce. Declining number of idle youth.	Low coverage of national health and employment insurance. Unprepared to adapt to changes in technology, climate, and globalization.		
Environment	Plentiful natural resources. Large untapped potential for renewable energy.	Growing greenhouse gas emission. One of the countries firstly and strongly impacted by climate change. Ongoing deforestation and forest fire. Rising sea level. Food insecurity, especially agriculture. Rising pollution in air, water, and land. Waste management crisis.		

Table 3: Summary of Thesis

Overall, Indonesia has a steadily growing economy coupled with resilient financial system that generates plenty of jobs. However, from the viewpoint of sustainable development, there are significant vulnerabilities: inequality is extremely high; considerable number of the population are not ready to adapt to changes in technology, globalization, and climate change because of their low level of education; the country is among the first that will feel a strong impact from climate change; and rising level of pollution in tandem with poor management of waste threaten the livelihood of the citizens, particularly the poor.

Some of the issues are interrelated. Climate change and pollution strongly and firstly affect the poor, further increasing inequality that risks political instability. The government's decision to continue investing in fossil-fuel energy is a disservice to the citizens because of the country's vulnerability to climate change. Lastly, premature deindustrialization causes low-skilled workers to move to petty activities in the services sector (mostly informal ones), rendering their political power diffuse and less likely to challenge political capture by the economic elites, which is a long-standing problem in Indonesia.

The systemic barriers towards sustainability are political in nature: misalignment between the central and local government; pervasive corruption; and persistent elite capture. In addition, the national innovation system is not performing well and so is the education system, thus hindering any adaptation needed to be sustainable. Lack of awareness on sustainability issues hinder the problems from entering political agenda.

There are several pathways to sustainably develop Indonesia. The local government must be made clean and competent, which can be achieved in many ways. A lifelong learning system should be instituted so that the population can keep their skills and knowledge current. In turn, this helps foster local innovation that has been shown to be an important driver for sustainable development. Pollution must be prevented or significantly reduced, and the best way to do so in a weak regulatory environment is through the use of technology assistance and technology transfer that addresses the source of the pollution.

To conclude, development in Indonesia is not yet on a sustainable path. The vulnerabilities are too many and the barriers will take years to overcome. All the more reason to urgently start going down the pathways toward sustainability proposed in this thesis.

At this point, it is useful to review what this thesis has covered in terms of the UN Sustainable Development Goals (SDG), which Indonesia has also incorporated in its medium-term national development plan (RPJMN 2015-2019). Below table shows which goals this thesis has covered, whether

it was covered directly (in a dedicated section) or indirectly (mentioned in non-dedicated sections), and in which sections it is addressed. The following graph visually highlight the SDG icon addressed in this thesis. The intent here is not to comprehensively review all targets within each goal against the progress Indonesia has made in sustainable development following the national development plan. That would be left for future research.

SDG No.	SDG Name	Addressed in This Thesis?	Thesis Section
1	No Poverty	Yes, indirectly	2.2.2; 2.3.3.1; 2.4
2	Zero Hunger	Yes, directly	2.3.3.5
3	Good Health and Well-Being	Yes, indirectly	2.2.2; 2.3.3.3; 2.3.3.7 to 2.3.3.9
4	Quality Education	Yes, directly	3.1.5; 3.2.2
5	Gender Equality	No	N/A
6	Clean Water and Sanitation	Yes, directly	2.3.3.8
7	Affordable and Clean Energy	Yes, directly	2.3.1 and 2.3.2
8	Decent Work and Economic Growth	Yes, directly	2.1; 2.2; 2.4
9	Industry, Innovation, and Infrastructure	Yes, directly	2.1.1; 2.2.1; 3.1.4; 3.2.3
10	Reduced Inequalities	Yes, indirectly	2.1.2; 2.4
11	Sustainable Cities and Communities	Yes, indirectly	2.3.3.6; 2.3.3.7; 2.3.3.9
12	Responsible Consumption and Production	Yes, indirectly	2.3.3.7 to 2.3.3.9; 3.1.4; 3.1.6; 3.2.3 to 3.2.5.
13	Climate Action	Yes, directly	2.3.1; 2.3.3.1 and 2.3.3.2
14	Life below Water	Yes, directly	2.3.3.5
15	Life on Land	Yes, directly	2.3.3.3 to 2.3.3.5
16	Peace, Justice, and Strong Institutions	Yes, directly	3.1.1 to 3.1.3; 3.2.1
17	Partnership for the Goals	Yes, indirectly	2.1.1; 3.2.3

Table 4: UN Sustainable Development Goals mapped to sections in this thesis. Goals that are addressed directly in dedicated sections are colored green; indirectly in non-dedicated sections, yellow; not addressed, red.



Figure 5: UN Sustainable Development Goals visually grouped according to whether the goals are addressed in this thesis. Goals that are addressed directly in dedicated sections are bordered green; indirectly in non-dedicated sections, yellow; not addressed, red.

Another useful avenue for future research on this topic is to design a detailed roadmap for the sustainability pathways by rigorously analyzing future scenarios, either through model-based simulation or qualitative framework.

5 REFERENCES

- [1] Statistics Indonesia, "Total Area and Number of Islands by Province, 2002-2016." [Online]. Available: <https://www.bps.go.id/statictable/2014/09/05/1366/luas-daerah-dan-jumlah-pulau-menurut-provinsi-2002-2016.html>. [Accessed: 16-Apr-2018].
- [2] R. A. Mittermeier, W. R. Turner, F. W. Larsen, T. M. Brooks, and C. Gascon, "Global Biodiversity Conservation: The Critical Role of Hotspots," in *Biodiversity Hotspots*, Springer, Berlin, Heidelberg, 2011, pp. 3–22.
- [3] Statistics Indonesia, "Population Projection by Province, 2010-2035." [Online]. Available: <https://www.bps.go.id/statictable/2014/02/18/1274/proyeksi-penduduk-menurut-provinsi-2010--2035.html>. [Accessed: 16-Apr-2018].
- [4] Statistics Indonesia, *Nationality, Ethnicity, Religion, and Daily Language of Indonesian Population 2010*, 2010th ed. Statistics Indonesia, 2012.
- [5] Ethnologue, "Indonesia," *Ethnologue*. [Online]. Available: <https://www.ethnologue.com/country/ID>. [Accessed: 16-Apr-2018].
- [6] H. A. Crouch, *Political Reform in Indonesia After Soeharto*. Institute of Southeast Asian Studies, 2010.
- [7] "World Development Indicators," World Bank.
- [8] World Bank, "World Bank Country and Lending Groups – World Bank Data Help Desk." [Online]. Available: <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>. [Accessed: 16-Apr-2018].
- [9] OECD, "Economic Survey of Indonesia 2016," OECD, Jakarta, Oct. 2016.
- [10] World Bank, *Indonesia : sustainable development of forests, land, and water*. Washington, D.C. : World Bank, 1990., 1990.
- [11] A. D. Basiago, "Sustainable development in Indonesia: a case study of an indigenous regime of environmental law and policy," *Int. J. Sustain. Dev. World Ecol.*, vol. 2, no. 3, pp. 199–211, 1995.
- [12] A. S. Alisjahbana and A. A. Yusuf, "Assessing Indonesia's Sustainable Development," *ASEAN Econ. Bull.*, vol. 21, no. 3, pp. 290–307, Dec. 2004.
- [13] S. Hsu and N. Perry, *Lessons in sustainable development from Malaysia and Indonesia*. New York : Palgrave Macmillan, 2014., 2014.
- [14] B. Bakri, "Assessment of regional sustainable development in Indonesia," *Int. J. Humanit. Soc. Sci.*, vol. 6, no. xi, pp. 191–200, 2016.
- [15] "Our Common Future," World Commission on Environment and Development (WCED), A/42/427, 1987.
- [16] N. A. Ashford and R. P. Hall, *Technology, globalization, and sustainable development : transforming the industrial state*. New Haven, Conn. ; London : Yale University Press, c2011., 2011.
- [17] "National Medium-Term Development Plan (RPJMN) 2015-2019." Ministry of National Development Planning of Indonesia (Bappenas), 2014.
- [18] UN, "Voluntary National Reviews Database," *Sustainable Development Knowledge Platform*, 2017. [Online]. Available: <https://sustainabledevelopment.un.org/vnrs/>. [Accessed: 15-May-2018].
- [19] A. Nasution, *Macroeconomic Policies in Indonesia: Indonesia Economy Since the Asian Financial Crisis of 1997*. Routledge, 2014.
- [20] "Indonesia proposes to raise 2017 budget deficit to close to legal..." *Reuters*, 06-Jul-2017.
- [21] M. Gorbiano, "Indonesia to keep debt-to-GDP ratio below 30%," *The Jakarta Post*, Jakarta, 05-Sep-2017.
- [22] W. Arnold, "Indonesia Ready to Free Itself of I.M.F.," *The New York Times*, 30-Jul-2003.

- [23] A. Doraisami, "Macro-Economic Policy Responses to Financial Crises in Malaysia, Indonesia and Thailand," *J. Contemp. Asia*, vol. 44, no. 4, pp. 581–598, Oct. 2014.
- [24] Bank Indonesia, "Inflation Target and Actual Inflation," *Bank Indonesia and Inflation*. .
- [25] IMF and World Bank, "Republic of Indonesia Financial Sector Assessment," World Bank, Jun. 2017.
- [26] T. Dartanto, *Two Decades of Structural Transformation and Dynamics of Income Equality in Indonesia*. Asian Development Bank, 2017.
- [27] "ASEAN Economic Community," *ASEAN*. [Online]. Available: <http://asean.org/asean-economic-community/>. [Accessed: 26-Apr-2018].
- [28] "Regional Comprehensive Economic Partnership Free Trade Agreement," *Asia Regional Integration Center*. [Online]. Available: <https://aric.adb.org/fta/regional-comprehensive-economic-partnership>. [Accessed: 26-Apr-2018].
- [29] D. Reid, "Indonesia is on path to joining the Trans-Pacific Partnership, finance minister says," 18-Apr-2018. [Online]. Available: <https://www.cnbc.com/2018/04/18/indonesia-is-on-path-to-joining-the-trans-pacific-partnership-finance-minister-says.html>. [Accessed: 26-Apr-2018].
- [30] P. A. Petri, M. Plummer, S. Urata, and F. Zhai, "Going It Alone in the Asia-Pacific: Regional Trade Agreements Without the United States," Peterson Institute for International Economics, 17–10, Oct. 2017.
- [31] World Bank, "Indonesia Economic Quarterly, March 2018 : Towards Inclusive Growth," World Bank, Mar. 2018.
- [32] Center for International Development at Harvard University, "What Did Indonesia Export between 1995 and 2016?," *Atlas of Economic Complexity*, 2016. [Online]. Available: <http://atlas.cid.harvard.edu/explore/stack/?country=103&partner=undefined&product=undefined&productClass=HS&startYear=undefined&target=Product&year=2016>. [Accessed: 19-Apr-2018].
- [33] Statistics Indonesia, "Distribution of GRDP to Total GRDP of 34 Provinces at Current Market Prices by Province, 2010-2016 (Percent)," *Statistics Indonesia*, 2016. [Online]. Available: <https://www.bps.go.id/dynamictable/2015/10/07/959/-seri-2010-distribusi-pdrb-terhadap-jumlah-pdrb-34-provinsi-atas-dasar-harga-berlaku-menurut-provinsi-2010-2016-persen-.html>. [Accessed: 19-Apr-2018].
- [34] Statistics Indonesia, "Gini Ratio Provinsi 2002-2017," *Statistics Indonesia*, 2017. [Online]. Available: <https://www.bps.go.id/linkTableDinamis/view/id/1116>. [Accessed: 19-Apr-2018].
- [35] K. Nugraha and P. Lewis, "Towards a better measure of income inequality in Indonesia," *Bull. Indones. Econ. Stud.*, vol. 49, no. 1, pp. 103–112, Apr. 2013.
- [36] L. Gibson, "Towards a more equal Indonesia: How the government can take action to close the gap between the richest and the rest," Oxfam International, Feb. 2017.
- [37] T. W. Bank, "Indonesia's rising divide," The World Bank, 106070, Mar. 2016.
- [38] D. Acemoglu and J. A. Robinson, *Why nations fail : the origins of power, prosperity and poverty*. New York : Crown Publishers, c2012., 2012.
- [39] N. Hamilton-Hart and G. G. Schulze, "Taxing Times in Indonesia: The Challenge of Restoring Competitiveness and the Search for Fiscal Space," *Bull. Indones. Econ. Stud.*, vol. 52, no. 3, pp. 265–295, Sep. 2016.
- [40] ILO, "Workers' and Employers' Organizations in Indonesia and Timor-Leste (ILO in Indonesia and Timor-Leste)," *International Labour Organization*. [Online]. Available: <http://www.ilo.org/jakarta/areasofwork/workers-and-employers-organizations/lang--en/index.htm>. [Accessed: 23-Apr-2018].
- [41] O. Parray and G. Yameogo, "Indonesia jobs outlook 2017: Harnessing technology for growth and job creation," ILO, Report, Dec. 2017.

- [42] S. X. Dong and C. Manning, "Labour-Market Developments at a Time of Heightened Uncertainty," *Bull. Indones. Econ. Stud.*, vol. 53, no. 1, pp. 1–25, Jan. 2017.
- [43] A. D. Bank, *Indonesia: Enhancing Productivity through Quality Jobs*. Asian Development Bank, 2018.
- [44] R. K. Pandian, "Does Manufacturing Matter for Economic Growth in the Era of Globalization?," *Soc. Forces*, vol. 95, no. 3, pp. 909–940, Mar. 2017.
- [45] UNFPA, "Demographic Dividend," 05-May-2016. [Online]. Available: <http://www.unfpa.org/demographic-dividend>. [Accessed: 23-Apr-2018].
- [46] A. Hayes and D. Setyonaluri, "UNFPA Indonesia | Taking Advantage of The Demographic Dividend in Indonesia: A Brief Introduction to Theory and Practice," UNFPA, Apr. 2015.
- [47] Statistics Indonesia, "Unemployment Rate (UR) by Province, 1986 - 2017," *Statistics Indonesia*, 2018. [Online]. Available: <https://www.bps.go.id/statictable/2014/09/15/981/tingkat-pengangguran-terbuka-tpt-menurut-provinsi-1986---2017.html>. [Accessed: 24-Apr-2018].
- [48] Statistics Indonesia, "Population 15 Years To Top Who Worked by Main Industry 1986-2017," 2018. [Online]. Available: <https://www.bps.go.id/statictable/2009/04/16/970/penduduk-15-tahun-ke-atas-yang-bekerja-menurut-lapangan-pekerjaan-utama-1986---2017.html>. [Accessed: 24-Apr-2018].
- [49] R. R. Mufti, "Government, marketplaces team up to encourage SMEs to go online," *The Jakarta Post*, Jakarta, 24-Apr-2018.
- [50] ILO, "ILOSTAT." [Online]. Available: <http://www.ilo.org/ilostat>. [Accessed: 24-Apr-2018].
- [51] I. Kovrova and S. Lyon, "NEET youth dynamics in Indonesia and Brazil: A cohort analysis," *Understanding Children's Work*, Rome, 2013.
- [52] ITUC, "Global Rights Index," ITUC, 2017.
- [53] Government of Indonesia, *Peraturan Pemerintah Nomor 78 Tahun 2015*. 2015.
- [54] The Jakarta Post, "New minimum wage formula comes into effect," *The Jakarta Post*, 27-Oct-2015. [Online]. Available: <http://www.thejakartapost.com/news/2015/10/27/new-minimum-wage-formula-comes-effect.html>. [Accessed: 25-Apr-2018].
- [55] Suhendra, "Yang Terlupakan dari Kenaikan UMP," *tirto.id*, 20-Oct-2016. [Online]. Available: <https://tirto.id/yang-terlupakan-dari-kenaikan-ump-bWkv>. [Accessed: 25-Apr-2018].
- [56] K. Yamada, "Tracing the impact of large minimum wage changes on household welfare in Indonesia," *Eur. Econ. Rev.*, vol. 87, pp. 287–303, Aug. 2016.
- [57] D. Glinmourinse, "BPS: Pekerja informal lebih banyak daripada formal," *SINDOnews.com*, 05-May-2014. [Online]. Available: <https://ekbis.sindonews.com/read/860487/34/bps-pekerja-informal-lebih-banyak-daripada-formal-1399279557>. [Accessed: 25-Apr-2018].
- [58] A. D. Rothenberg *et al.*, "Rethinking Indonesia's Informal Sector," *World Dev.*, vol. 80, pp. 96–113, Apr. 2016.
- [59] T. T. H. Tambunan, "The Importance of Informal Sector during an Economic Crisis: A Story from Indonesia," *J. Asian Dev. Stud.*, vol. 5, no. 2, pp. 62–79, Jun. 2016.
- [60] T. Dartanto, J. F. Rezki, W. Pramono, C. H. Siregar, Usman, and H. Bintara, "Participation of Informal Sector Workers in Indonesia's National Health Insurance System," *J. Southeast Asian Econ.*, vol. 33, no. 3, pp. 317–342, Dec. 2016.
- [61] Statistics Indonesia, "Number of Households by Province, 2000-2015," *Statistics Indonesia*, 2018. [Online]. Available: <https://www.bps.go.id/dynamictable/2015/09/07/851/banyaknya-rumah-tangga-menurut-provinsi-2000-2015.html>. [Accessed: 26-Apr-2018].
- [62] BPJS Ketenagakerjaan, "Laporan Tahunan 2016," BPJS Ketenagakerjaan, 2016.
- [63] *Actuarial study on the reform of the Indonesian BPJS Ketenagakerjaan: technical report*. ILO, 2017.
- [64] S. Tani, "Beware of robots, says Indonesian Vice President Kalla," *Nikkei Asian Review*, 06-Jun-2017. [Online]. Available: <https://asia.nikkei.com/Spotlight/The-Future-of-Asia-2017/Beware-of-robots-says-Indonesian-Vice-President-Kalla>. [Accessed: 26-Apr-2018].

- [65] L. V. C. Orozco, "ASEAN in transformation: How technology is changing jobs and enterprises -- Indonesia Country Brief | April 2017," ILO, Fact sheet, Apr. 2017.
- [66] E. Brynjolfsson and A. McAfee, *The second machine age : work, progress, and prosperity in a time of brilliant technologies*. New York : W. W. Norton & Company, [2014], 2014.
- [67] D. Narjoko and C. T. Putra, "Industrialization, globalization, and labor market regime in Indonesia," *J. Asia Pac. Econ.*, vol. 20, no. 1, pp. 57–76, Jan. 2015.
- [68] F. Jaumotte, S. Lall, and C. Papageorgiou, "Rising Income Inequality: Technology, or Trade and Financial Globalization?," *IMF Econ. Rev.*, vol. 61, no. 2, pp. 271–309, Jun. 2013.
- [69] J.-W. Lee and D. Wie, "Technological Change, Skill Demand, and Wage Inequality: Evidence from Indonesia," *World Dev.*, vol. 67, pp. 238–250, Mar. 2015.
- [70] H. Kasahara, Y. Liang, and J. Rodrigue, "Does importing intermediates increase the demand for skilled workers? Plant-level evidence from Indonesia," *J. Int. Econ.*, vol. 102, pp. 242–261, Sep. 2016.
- [71] Statistics Indonesia, "Education Indicator, 1994-2017," *Statistics Indonesia*, 2018. [Online]. Available: <https://www.bps.go.id/statictable/2010/03/19/1525/indikator-pendidikan--1994-2017.html>. [Accessed: 26-Apr-2018].
- [72] C. E. Bryant and R. G. Javalgi, "Global Economic Integration in Developing Countries: The Role of Corruption and Human Capital Investment," *J. Bus. Ethics*, vol. 136, no. 3, pp. 437–450, Jul. 2016.
- [73] Republic of Indonesia, "First Nationally Determined Contribution," Nov-2011. [Online]. Available: <http://www4.unfccc.int/ndcregistry/pages/Party.aspx?party=IDN>. [Accessed: 26-Apr-2018].
- [74] *Peraturan Presiden Republik Indonesia Nomor 22 Tahun 2017 tentang Rencana Umum Energi Nasional*. 2017.
- [75] R. Dutu, "Challenges and policies in Indonesia's energy sector," *Energy Policy*, vol. 98, pp. 513–519, Nov. 2016.
- [76] "The Emissions Gap Report 2017," UNEP, Nairobi, Kenya, Nov. 2017.
- [77] Climate Action Tracker, "Indonesia: Current Policy Projections," *Climate Action Tracker*, 30-Apr-2018. [Online]. Available: <http://climateactiontracker.org/countries/indonesia/current-policy-projections/>. [Accessed: 27-Apr-2018].
- [78] "Greenhouse Gas Mitigation Scenarios for Major Emitting Countries," NewClimate Institute, 2675, Nov. 2017.
- [79] A. Wijaya, H. Chrysolite, M. Ge, C. K. Wibowo, A. Pradana, and K. Austin, "How Can Indonesia Achieve Its Climate Change Mitigation Goal? An Analysis of Potential Emissions Reductions from Energy and Land-Use Policies," World Resources Institute, Oct. 2017.
- [80] A. J. Veldhuis and A. H. M. E. Reinders, "Reviewing the potential and cost-effectiveness of grid-connected solar PV in Indonesia on a provincial level," *Renew. Sustain. Energy Rev.*, vol. 27, pp. 315–324, Nov. 2013.
- [81] D. Gielen, D. Saygin, and J. Rigter, "Renewable Energy Prospects: Indonesia," International Renewable Energy Agency (IRENA), Abu Dhabi, Mar. 2017.
- [82] A. M. Fathoni, N. A. Utama, and M. A. Kristianto, "A Technical and Economic Potential of Solar Energy Application with Feed-in Tariff Policy in Indonesia," *Procedia Environ. Sci.*, vol. 20, pp. 89–96, Jan. 2014.
- [83] T. W. Bank, "Solar resource and photovoltaic potential of Indonesia," The World Bank, 115347, May 2017.
- [84] K. Fan and S. Nam, "Accelerating Geothermal Development in Indonesia: A Case Study in the Underutilization of Geothermal Energy," *Cons. J. Sustain. Dev.*, vol. Issue, no. 19, Feb. 2018.
- [85] A. Fauzi, "Geothermal resources and reserves in Indonesia: an updated revision," *Geotherm. Energy Sci.*, vol. 3, no. 1, pp. 1–6, Feb. 2015.
- [86] *Geothermal power: Technology brief*. Abu Dhabi: IRENA, 2017.

- [87] B. Matek, "2016 Annual US Global Geothermal Power Production," GEA, Mar. 2016.
- [88] R. Bertani, "Geothermal power generation in the world 2010–2014 update report," *Geothermics*, vol. 60, pp. 31–43, Mar. 2016.
- [89] A. D. Bank, *Unlocking Indonesia's Geothermal Potential*. Asian Development Bank, 2015.
- [90] M. Hasan and A. Wahjosudibjo, "An Update on Indonesia's Geothermal Activities," in *Forty-First Workshop on Geothermal Reservoir Engineering*, Stanford University, Stanford, California, US, 2016, vol. 39.
- [91] S. Martosaputro and N. Murti, "Blowing the Wind Energy in Indonesia," *Energy Procedia*, vol. 47, pp. 273–282, Jan. 2014.
- [92] I. Mukherjee and B. K. Sovacool, "Palm oil-based biofuels and sustainability in southeast Asia: A review of Indonesia, Malaysia, and Thailand," *Renew. Sustain. Energy Rev.*, vol. 37, pp. 1–12, Sep. 2014.
- [93] M. A. J. R. Quirapas, H. Lin, M. L. S. Abundo, S. Brahim, and D. Santos, "Ocean renewable energy in Southeast Asia: A review," *Renew. Sustain. Energy Rev.*, vol. 41, pp. 799–817, Jan. 2015.
- [94] "Notre Dame-Global Adaptation Index (ND-GAIN) Country Index," University of Notre Dame, 2016, 2016.
- [95] D. Frame, M. Joshi, E. Hawkins, L. J. Harrington, and M. de Roiste, "Population-based emergence of unfamiliar climates," *Nat. Clim. Change*, vol. 7, no. 6, pp. 407–411, Jun. 2017.
- [96] C. Mora *et al.*, "The projected timing of climate departure from recent variability," *Nature*, vol. 502, no. 7470, pp. 183–187, Oct. 2013.
- [97] W. Adiyoga, "Farmers perceptions on climate change in lowland and highland vegetable production centers of South Sulawesi, Indonesia," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 122, no. 1, p. 012001, 2018.
- [98] World Bank, "Climate Change Knowledge Portal 2.0," 2018. [Online]. Available: <http://sdwebx.worldbank.org/climateportal/index.cfm>. [Accessed: 01-May-2018].
- [99] T. Fujii, *Climate Change and Vulnerability to Poverty: An Empirical Investigation in Rural Indonesia*. Asian Development Bank, 2016.
- [100] antaranews.com, "Pemerintah naikan anggaran mitigasi-adaptasi perubahan iklim," *Antara News*, 06-Sep-2017. [Online]. Available: <https://www.antaranews.com/berita/650933/pemerintah-naikkan-anggaran-mitigasi-adaptasi-perubahan-iklim>. [Accessed: 27-Apr-2018].
- [101] P. Gass, H. Hove, and J.-E. Parry, "Review of Current and Planned Adaptation Action: East and Southeast Asia," International Institute for Sustainable Development, Nov. 2011.
- [102] "CAIT emissions data - Climate Watch," World Resources Institute, Washington, DC, 2017.
- [103] FAO, "FAOSTAT," 2018. [Online]. Available: <http://www.fao.org/faostat/en/>. [Accessed: 28-Apr-2018].
- [104] National Oceanic and Atmospheric Administration, "What are El Nino and La Nina?," *National Oceanic and Atmospheric Administration*. [Online]. Available: <https://oceanservice.noaa.gov/facts/ninonina.html>. [Accessed: 17-May-2018].
- [105] K. Fernandes, L. Verchot, W. Baethgen, V. Gutierrez-Velez, Miguel Pinedo-Vasquez, and C. Martius, "Heightened fire probability in Indonesia in non-drought conditions: the effect of increasing temperatures," *Environ. Res. Lett.*, vol. 12, no. 5, p. 054002, 2017.
- [106] V. Huijnen *et al.*, "Fire carbon emissions over maritime southeast Asia in 2015 largest since 1997," *Sci. Rep.*, vol. 6, p. 26886, May 2016.
- [107] Y. Kim, S. Knowles, J. Manley, and V. Radoias, "Long-run health consequences of air pollution: Evidence from Indonesia's forest fires of 1997," *Econ. Hum. Biol.*, vol. 26, pp. 186–198, Aug. 2017.
- [108] Y. Kim, J. Manley, and V. Radoias, "Medium- and long-term consequences of pollution on labor supply: evidence from Indonesia," *IZA J. Labor Econ.*, vol. 6, p. 5, Apr. 2017.

- [109] T. L. Sheldon and C. Sankaran, "The Impact of Indonesian Forest Fires on Singaporean Pollution and Health," *Am. Econ. Rev.*, vol. 107, no. 5, pp. 526–529, May 2017.
- [110] D. Heilmann, "After Indonesia's Ratification: The ASEAN Agreement on Transboundary Haze Pollution and Its Effectiveness As a Regional Environmental Governance Tool," *J. Curr. Southeast Asian Aff.*, vol. 34, no. 3, pp. 95–121, Dec. 2015.
- [111] N. Shahab, "Indonesia not ready to bury REDD+," *CIFOR Forests News*, 23-Oct-2017. [Online]. Available: <https://forestsnews.cifor.org/52186/indonesia-not-ready-to-bury-redd?fnl=en>. [Accessed: 10-Apr-2018].
- [112] "Norway admits that 'We haven't seen actual progress in reducing deforestation' in Indonesia," *REDD Monitor*, 03-Mar-2016. [Online]. Available: <http://www.redd-monitor.org/2016/03/03/norway-admits-that-we-havent-seen-actual-progress-in-reducing-deforestation-in-indonesia/>. [Accessed: 10-Apr-2018].
- [113] L. Nurhidayah, "Legislation, Regulations, and Policies in Indonesia Relevant to Addressing Land/Forest Fires and Transboundary Haze Pollution: A Critical Evaluation," *Asia Pac. J. Environ. Law*, vol. 16, pp. 215–240, 2013.
- [114] A. Suwarno, M. van Noordwijk, H.-P. Weikard, and D. Suyamto, "Indonesia's forest conversion moratorium assessed with an agent-based model of Land-Use Change and Ecosystem Services (LUCES)," *Mitig. Adapt. Strateg. Glob. Change*, vol. 23, no. 2, pp. 211–229, Feb. 2018.
- [115] "Indonesia president approves two-year extension of forest moratorium," *Reuters*, 24-May-2017.
- [116] A. Wijaya, R. Juliane, R. Firmansyah, and O. Payne, "6 Years After Moratorium, Satellite Data Shows Indonesia's Tropical Forests Remain Threatened," *World Resources Institute*, 24-May-2017. [Online]. Available: <http://www.wri.org/blog/2017/05/6-years-after-moratorium-satellite-data-shows-indonesia%E2%80%99s-tropical-forests-remain>. [Accessed: 01-May-2018].
- [117] Ruslandi, A. Klassen, C. Romero, and F. E. Putz, *Forest Stewardship Council certification of natural forest management in Indonesia: Required improvements, costs, incentives, and barriers*. 2014.
- [118] A. Simoes and C. Hidalgo, "The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development," presented at the Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence, 2011.
- [119] M. Gatto, M. Wollni, R. Asnawi, and M. Qaim, "Oil Palm Boom, Contract Farming, and Rural Economic Development: Village-Level Evidence from Indonesia," *World Dev.*, vol. 95, pp. 127–140, Jul. 2017.
- [120] R. Padfield *et al.*, "Landscapes in transition: an analysis of sustainable policy initiatives and emerging corporate commitments in the palm oil industry," *Landsc. Res.*, vol. 41, no. 7, pp. 744–756, Oct. 2016.
- [121] K. G. Austin, A. Mosnier, J. Pirker, I. McCallum, S. Fritz, and P. S. Kasibhatla, "Shifting patterns of oil palm driven deforestation in Indonesia and implications for zero-deforestation commitments," *Land Use Policy*, vol. 69, pp. 41–48, Dec. 2017.
- [122] R. Pirard, S. Gnych, P. Pacheco, and S. Lawry, "Zero-deforestation commitments in Indonesia: Governance challenges," *Cent. Int. For. Res.*, 2015.
- [123] FAO, *Country fact sheet on food and agriculture policy trends – Indonesia*. Rome: FAO, 2017.
- [124] S. Meylinah and C. Rittgers, "Indonesia Grain and Feed Update November 2017," USDA, Jakarta, ID1731, Nov. 2017.
- [125] C. G. Osorio, D. E. Abriningrum, E. B. Armas, and M. Firdaus, "Who is benefiting from fertilizer subsidies in Indonesia?," The World Bank, WPS5758, Aug. 2011.
- [126] "Subsidy sham: Fertilizers reach Indonesia plantations, not small farmers," *Reuters*, 15-Feb-2016.
- [127] E. Sinha, A. M. Michalak, and V. Balaji, "Eutrophication will increase during the 21st century as a result of precipitation changes," *Science*, vol. 357, no. 6349, pp. 405–408, Jul. 2017.
- [128] "Indonesia - Agriculture public expenditure review 2010," The World Bank, 69346, Sep. 2011.

- [129] C. Thorburn, "The Rise and Demise of Integrated Pest Management in Rice in Indonesia," *Insects*, vol. 6, no. 2, pp. 381–408, Apr. 2015.
- [130] R. Naylor, W. Falcon, N. Wada, and D. Rochberg, "Using El Niño–Southern Oscillation Climate Data to Improve Food Policy Planning in Indonesia," *Bull. Indones. Econ. Stud.*, vol. 38, no. 1, pp. 75–91, Apr. 2002.
- [131] R. L. Naylor and M. D. Mastrandrea, "Coping with Climate Risks in Indonesian Rice Agriculture: A Policy Perspective," in *Uncertainty and Environmental Decision Making*, Springer, Boston, MA, 2009, pp. 127–153.
- [132] J. A. Lassa, A. Y.-H. Lai, and T. Goh, "Climate extremes: an observation and projection of its impacts on food production in ASEAN," *Nat. Hazards*, vol. 84, no. 1, pp. 19–33, Nov. 2016.
- [133] B. O. Abidoye, P. Kurukulasuriya, B. Reed, and R. Mendelsohn, "Structural ricardian analysis of south-east asian agriculture," *Clim. Change Econ.*, vol. 08, no. 03, p. 1740005, Aug. 2017.
- [134] H. Förster *et al.*, "Sea-level rise in Indonesia: on adaptation priorities in the agricultural sector," *Reg. Environ. Change*, vol. 11, no. 4, pp. 893–904, Dec. 2011.
- [135] S. Pudjiastuti, "Challenges in Public Policy: Lessons Learned from Indonesia's Fishery Sector," presented at the Public Lecture with Susi Pudjiastuti: Indonesia Minister of Maritime Affairs and Fisheries, Harvard Kennedy School, 12-Mar-2018.
- [136] J. Armstrong, "Indonesia's Fishing Vessel Tracking Data Now Available to the Public – SkyTruth." .
- [137] "NOAA to partner with Global Fishing Watch, help catch Indonesia's 'dark fleet,'" *Undercurrent News*, 16-Jan-2018.
- [138] U. Muawanah *et al.*, "Review of national laws and regulation in Indonesia in relation to an ecosystem approach to fisheries management," *Mar. Policy*, vol. 91, pp. 150–160, May 2018.
- [139] V. Joseph, A. Thornton, S. Pearson, and D. Paull, "Occupational transitions in three coastal villages in Central Java, Indonesia, in the context of sea level rise: a case study," *Nat. Hazards*, vol. 69, no. 1, pp. 675–694, Oct. 2013.
- [140] D. S. A. Suroso and T. Firman, "The role of spatial planning in reducing exposure towards impacts of global sea level rise case study: Northern coast of Java, Indonesia," *Ocean Coast. Manag.*, vol. 153, pp. 84–97, Mar. 2018.
- [141] I. Buchori *et al.*, "A predictive model to assess spatial planning in addressing hydro-meteorological hazards: A case study of Semarang City, Indonesia," *Int. J. Disaster Risk Reduct.*, vol. 27, pp. 415–426, Mar. 2018.
- [142] H. Latief, M. R. Putri, F. Hanifah, I. N. Afifah, M. Fadli, and D. O. Ismoyo, "Coastal Hazard Assessment in Northern part of Jakarta," *Procedia Eng.*, vol. 212, pp. 1279–1286, Jan. 2018.
- [143] H. Takagi, M. Esteban, T. Mikami, and D. Fujii, "Projection of coastal floods in 2050 Jakarta," *Urban Clim.*, vol. 17, pp. 135–145, Sep. 2016.
- [144] "In flood-prone Jakarta, will 'Giant Sea Wall' plan sink or swim?," *Reuters*, 14-Sep-2017.
- [145] S. A. van der Wulp, L. Dsikowitzky, K. J. Hesse, and J. Schwarzbauer, "Master Plan Jakarta, Indonesia: The Giant Seawall and the need for structural treatment of municipal waste water," *Mar. Pollut. Bull.*, vol. 110, no. 2, pp. 686–693, Sep. 2016.
- [146] B. Haryanto, "Climate Change and Urban Air Pollution Health Impacts in Indonesia," in *Climate Change and Air Pollution*, Springer, Cham, 2018, pp. 215–239.
- [147] S. R. Pratiwi, "Green Line Strategy in Mitigating Climate Change: Case Study in Tarakan City, North Kalimantan," *Procedia - Soc. Behav. Sci.*, vol. 227, pp. 430–434, Jul. 2016.
- [148] E. Gravitanian and R. E. W. Kristanti, "Adaptation Strategy on Urban Air Quality, Case Study: Semarang Urban Area, Indonesia," *Adv. Econ. Bus.*, vol. 3, no. 2, pp. 57–61, Feb. 2015.

- [149] A. F. Both, D. Westerdahl, S. Fruin, B. Haryanto, and J. D. Marshall, "Exposure to carbon monoxide, fine particle mass, and ultrafine particle number in Jakarta, Indonesia: Effect of commute mode," *Sci. Total Environ.*, vol. 443, pp. 965–972, Jan. 2013.
- [150] L. Ambarwati, R. Verhaeghe, B. van Arem, and A. J. Pel, "The influence of integrated space–transport development strategies on air pollution in urban areas," *Transp. Res. Part Transp. Environ.*, vol. 44, pp. 134–146, May 2016.
- [151] Ministry of the Environment, Japan, "WEPA Outlook on Water Environmental Management in Asia 2018," Water Environmental Partnership in Asia (WEPA), Mar. 2018.
- [152] ADB, *Indonesia Country Water Assessment*. Asian Development Bank, 2016.
- [153] The Straits Times, "Indonesia scrubbing the 'world's dirtiest river,'" *The Straits Times*, 02-Mar-2018. [Online]. Available: <https://www.straitstimes.com/asia/se-asia/indonesia-scrubbing-the-worlds-dirtiest-river>. [Accessed: 19-May-2018].
- [154] J. H. García, T. Sterner, and S. Afsah, "Public disclosure of industrial pollution: the PROPER approach for Indonesia?," *Environ. Dev. Econ.*, vol. 12, no. 6, pp. 739–756, Dec. 2007.
- [155] J. H. García, S. Afsah, and T. Sterner, "Which Firms are More Sensitive to Public Disclosure Schemes for Pollution Control? Evidence from Indonesia's PROPER Program," *Environ. Resour. Econ.*, vol. 42, no. 2, pp. 151–168, Feb. 2009.
- [156] J. Hewson, "Pollution flows freely in Indonesia's rivers," *Al Jazeera*, 21-Nov-2013.
- [157] "Indonesia aims to banish toxic waste from lifeline river," *Reuters*, 02-Mar-2018.
- [158] "Indonesia president says toxic river should be clean enough to...," *Reuters*, 23-Feb-2018.
- [159] A. D. Syakti *et al.*, "Beach macro-litter monitoring and floating microplastic in a coastal area of Indonesia," *Mar. Pollut. Bull.*, vol. 122, no. 1, pp. 217–225, Sep. 2017.
- [160] A. A. Manalu, S. Hariyadi, and Y. Wardiatno, "Microplastics abundance in coastal sediments of Jakarta Bay, Indonesia," *Aquac. Aquar. Conserv. Legis. - Int. J. Bioflux Soc. AACL Bioflux*, vol. 10, no. 5, pp. 1164–1173, Oct. 2017.
- [161] C. M. Rochman *et al.*, "Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption," *Sci. Rep.*, vol. 5, p. 14340, Sep. 2015.
- [162] G. Readfearn, "WHO launches health review after microplastics found in 90% of bottled water," *The Guardian*, 15-Mar-2018.
- [163] T. J. Post, "Ministry to follow up study on microplastics in drinking water," *The Jakarta Post*, 17-Mar-2018. [Online]. Available: <http://www.thejakartapost.com/news/2018/03/17/ministry-to-follow-up-study-on-microplastics-in-drinking-water.html>. [Accessed: 27-Apr-2018].
- [164] E. Damanhuri, W. Handoko, and T. Padmi, "Municipal Solid Waste Management in Indonesia," in *Municipal Solid Waste Management in Asia and the Pacific Islands*, Springer, Singapore, 2014, pp. 139–155.
- [165] H. N. Jong, "Indonesia in state of waste emergency," *The Jakarta Post*, 09-Oct-2015.
- [166] H. Sudiby, Y. S. Pradana, A. Budiman, and W. Budhijanto, "Municipal Solid Waste Management in Indonesia - A Study about Selection of Proper Solid Waste Reduction Method in D.I. Yogyakarta Province," *Energy Procedia*, vol. 143, pp. 494–499, Dec. 2017.
- [167] E. Munawar, Y. Yunardi, J. Lederer, and J. Fellner, "The development of landfill operation and management in Indonesia," *J. Mater. Cycles Waste Manag.*, vol. 20, no. 2, pp. 1128–1142, Apr. 2018.
- [168] M. Panambunan-Ferse and A. Breiter, "Assessing the side-effects of ICT development: E-waste production and management: A case study about cell phone end-of-life in Manado, Indonesia," *Technol. Soc.*, vol. 35, no. 3, pp. 223–231, Aug. 2013.
- [169] A. P. N. Sulami, T. Murayama, and S. Nishikizawa, "Current Issues and Situation of Producer Responsibility in Waste Management in Indonesia," *Environ. Nat. Resour. J.*, vol. 16, no. 1, pp. 70–81, 2018.

- [170] A. Aprilia, T. Tezuka, and G. Spaargaren, "Inorganic and Hazardous Solid Waste Management: Current Status and Challenges for Indonesia," *Procedia Environ. Sci.*, vol. 17, pp. 640–647, Jan. 2013.
- [171] B. M. Mecca, "Is Waste-to-Energy technology a permanent solution to Indonesia's garbage problem...," *The Jakarta Post*, 01-Feb-2017.
- [172] S. Sasaki, T. Araki, A. H. Tambunan, and H. Prasadja, "Household income, living and working conditions of dumpsite waste pickers in Bantar Gebang: Toward integrated waste management in Indonesia," *Resour. Conserv. Recycl.*, vol. 89, pp. 11–21, Aug. 2014.
- [173] World Bank, "Indonesia - Improvement of Solid Waste Management to Support Regional and Metropolitan Cities Project," World Bank, SFG3783, Jan. 2018.
- [174] E. Papargyropoulou, S. Colenbrander, A. H. Sudmant, A. Gouldson, and L. C. Tin, "The economic case for low carbon waste management in rapidly growing cities in the developing world: The case of Palembang, Indonesia," *J. Environ. Manage.*, vol. 163, pp. 11–19, Nov. 2015.
- [175] S. Aparcana, "Approaches to formalization of the informal waste sector into municipal solid waste management systems in low- and middle-income countries: Review of barriers and success factors," *Waste Manag.*, vol. 61, pp. 593–607, Mar. 2017.
- [176] B. Schippers and A. Pratiwi, "Unravelling of Waste in a Touristic Area of Pangandaran from Neglecting Towards Embracing Informal Waste Management Practices, West Java, Indonesia," *J. Hum.*, vol. 29, no. 2, pp. 191–197, Jun. 2017.
- [177] E. Laurent, "Inequality as pollution, pollution as inequality : The social-ecological nexus," Sciences Po, info:hdl:2441/f6h8764enu2lskk9p4a36i6c0, 2014.
- [178] D. Rodrik, "Premature Deindustrialization," National Bureau of Economic Research, Working Paper 20935, Feb. 2015.
- [179] D. Rodrik, "Is Liberal Democracy Feasible in Developing Countries?," *Stud. Comp. Int. Dev.*, vol. 51, no. 1, pp. 50–59, Mar. 2016.
- [180] M. Mietzner, "Authoritarian elections, state capacity, and performance legitimacy: Phases of regime consolidation and decline in Suharto's Indonesia," *Int. Polit. Sci. Rev.*, vol. 39, no. 1, pp. 83–96, Jan. 2018.
- [181] R. L. Holzacker, R. Wittek, and J. Woltjer, "Decentralization and Governance for Sustainable Society in Indonesia," in *Decentralization and Governance in Indonesia*, Springer, Cham, 2016, pp. 3–29.
- [182] Encyclopædia Britannica, "Joko Widodo," *Britannica Academic*, 01-Feb-2018. [Online]. Available: <https://academic.eb.com/levels/collegiate/article/Joko-Widodo/611174>. [Accessed: 07-May-2018].
- [183] H. Hill and Y. Vidyattama, "Regional Development Dynamics in Indonesia Before and After the 'Big Bang' Decentralization," *Singap. Econ. Rev.*, vol. 61, no. 2, p. 1, Jun. 2016.
- [184] E. N. Skoufias Ambar Dasgupta, Basab Kaiser, Kai, *Electoral accountability, fiscal decentralization and service delivery in Indonesia*. The World Bank, 2011.
- [185] T. Sudhipongpracha, "Do the poor count in fiscal decentralization policy? A comparative analysis of the general grant allocation systems in Indonesia and Thailand," *J. Asian Public Policy*, vol. 10, no. 3, pp. 231–248, Nov. 2017.
- [186] M. M. Wihardja, "Indonesia's democracy and decentralization in the post-1997 era," in *Macroeconomic policies in Indonesia: Indonesia economy since the Asian financial crisis of 1997*, A. Nasution, Ed. New York: Routledge, 2015, pp. 280–298.
- [187] E. Pisani, "Indonesia in Pieces: The Downside of Decentralization," *Foreign Aff.*, vol. 93, no. 4, pp. 142–152, 2014.
- [188] Rudy, Y. Hasyimzum, Heryandi, and S. Khoiriah, "18 Years of Decentralization Experiment in Indonesia: Institutional and Democratic Evaluation," *J. Polit. Law*, vol. 10, pp. 132–139, 2017.
- [189] M. Salahuddin, "Challenges for the UNFCCC in Indonesia's Decentralisation," *Indones. Law Rev.*, vol. 4, pp. 1–31, 2014.

- [190] S. A. Edwards and F. Heiduk, "Hazy Days: Forest Fires and the Politics of Environmental Security in Indonesia," *J. Curr. Southeast Asian Aff.*, vol. 34, no. 3, pp. 65–94, Dec. 2015.
- [191] R. Burgess, M. Hansen, B. A. Olken, P. Potapov, and S. Sieber, "The Political Economy of Deforestation in the Tropics," National Bureau of Economic Research, Working Paper 17417, Sep. 2011.
- [192] S. Miharti, R. L. Holzacker, and R. Wittek, "Decentralization and Primary Health Care Innovations in Indonesia," in *Decentralization and Governance in Indonesia*, Springer, Cham, 2016, pp. 53–78.
- [193] A. Hodge, S. Firth, E. Jimenez-Soto, and L. Trisnantoro, "Linkages between Decentralisation and Inequalities in Neonatal Health: Evidence from Indonesia," *J. Dev. Stud.*, vol. 51, no. 12, pp. 1634–1652, Dec. 2015.
- [194] T. Muttaqin, M. van Duijn, L. Heyse, and R. Wittek, "The Impact of Decentralization on Educational Attainment in Indonesia," in *Decentralization and Governance in Indonesia*, Springer, Cham, 2016, pp. 79–103.
- [195] J. Hamidi, "Management of Mining in Indonesia: Decentralization and Corruption Eradication," *J. Law Policy Glob.*, vol. 44, pp. 80–101, 2015.
- [196] M. S. Silitonga, G. Anthonio, L. Heyse, and R. Wittek, "Institutional Change and Corruption of Public Leaders: A Social Capital Perspective on Indonesia," in *Decentralization and Governance in Indonesia*, Springer, Cham, 2016, pp. 233–258.
- [197] Gellert Paul K., "Extractive Regimes: Toward a Better Understanding of Indonesian Development," *Rural Sociol.*, vol. 75, no. 1, pp. 28–57, Jan. 2010.
- [198] Sutiyo and K. L. Maharjan, "Historical Background of Decentralization in Indonesia," in *Decentralization and Rural Development in Indonesia*, Springer, Singapore, 2017, pp. 1–11.
- [199] N. Wijayati, N. Hermes, and R. Holzacker, "Corporate Governance and Corruption: A Comparative Study of Southeast Asia," in *Decentralization and Governance in Indonesia*, Springer, Cham, 2016, pp. 259–292.
- [200] D. Tomsa, "Local Politics and Corruption in Indonesia's Outer Islands," *Bijdr. Tot Taal- Land- En Volkenkd. J. Humanit. Soc. Sci. Southeast Asia*, vol. 171, no. 2–3, pp. 196–219, Jan. 2015.
- [201] Transparency International, "Corruption Perception Index 2017," Transparency International, 2017.
- [202] M. Martinez-Bravo, P. Mukherjee, and A. Stegmann, "The Non-Democratic Roots of Elite Capture: Evidence From Soeharto Mayors in Indonesia," *Econometrica*, vol. 85, no. 6, pp. 1991–2010, Nov. 2017.
- [203] O. Bandiera and G. Levy, "Diversity and the power of the elites in democratic societies: Evidence from Indonesia," *J. Public Econ.*, vol. 95, no. 11–12, pp. 1322–1330, Dec. 2011.
- [204] L. Persha and K. Andersson, "Elite capture risk and mitigation in decentralized forest governance regimes," *Glob. Environ. Change*, vol. 24, pp. 265–276, Jan. 2014.
- [205] P. Pacheco, S. Gnych, A. Dermawan, H. Komarudin, and B. Okarda, "The palm oil global value chain: Implications for economic growth and social and environmental sustainability," *Cent. Int. For. Res.*, 2017.
- [206] "The party winds down," *The Economist*, 07-May-2016.
- [207] D. L. Chandler, "Bringing microgrids to rural villages," *MIT News*, 01-Jun-2015. [Online]. Available: <http://news.mit.edu/2015/microgrids-rural-villages-india-0601>. [Accessed: 08-May-2018].
- [208] Y. Suseno, "Disruptive innovation and the creation of social capital in Indonesia's urban communities," *Asia Pac. Bus. Rev.*, vol. 24, no. 2, pp. 174–195, Mar. 2018.
- [209] OECD, "Indonesia: innovation profile," pp. 153–180, Apr. 2013.
- [210] B. Lakitan, "Connecting all the dots: Identifying the 'actor level' challenges in establishing effective innovation system in Indonesia," *Technol. Soc.*, vol. 35, no. 1, pp. 41–54, Feb. 2013.

- [211] Mulyanto, "Performance of Indonesian R&D institutions: Influence of type of institutions and their funding source on R&D productivity," *Technol. Soc.*, vol. 38, pp. 148–160, Aug. 2014.
- [212] B. Lakitan, D. Hidayat, and S. Herlinda, "Scientific productivity and the collaboration intensity of Indonesian universities and public R&D institutions: Are there dependencies on collaborative R&D with foreign institutions?," *Technol. Soc.*, vol. 34, no. 3, pp. 227–238, Aug. 2012.
- [213] OECD, "National Intellectual Property Systems, Innovation and Economic Development," Jan. 2014.
- [214] E. Mahendra, U. Zuhdi, and R. Mulyanto, "Determinants of Firm Innovation in Indonesia: The Role of Institutions and Access to Finance," *Econ. Finance Indones.*, vol. 61, no. 3, pp. 149–179, Dec. 2015.
- [215] A. Watkins, T. Papaioannou, J. Mugwagwa, and D. Kale, "National innovation systems and the intermediary role of industry associations in building institutional capacities for innovation in developing countries: A critical review of the literature," *Res. Policy*, vol. 44, no. 8, pp. 1407–1418, Oct. 2015.
- [216] G. Schulze and U. Schulze, "Innovation in manufacturing and service sector: Determinants and challenges," in *The Indonesian Economy: Trade and Industrial Policies*, 1st ed., L. Y. Ing, G. H. Hanson, and S. M. Indrawati, Eds. London: Routledge, 2017, p. 30.
- [217] UNESCO Institute for Statistics, "UIS.Stat," UNESCO Institute for Statistics, 2018.
- [218] Jacob Jojo and Szirmai Adam, "International Knowledge Spillovers to Developing Countries: The Case of Indonesia," *Rev. Dev. Econ.*, vol. 11, no. 3, pp. 550–565, Jan. 2007.
- [219] T. K. Wie, "The Major Channels of International Technology Transfer to Indonesia: An Assessment," *J. Asia Pac. Econ.*, vol. 10, no. 2, pp. 214–236, Jan. 2005.
- [220] Indonesia Investments, "Internet Infrastructure Indonesia: What About Progress on the Palapa Ring?," *Indonesia Investments*, 16-Apr-2018. [Online]. Available: <https://www.indonesia-investments.com/id/news/todays-headlines/internet-infrastructure-indonesia-what-about-progress-on-the-palapa-ring/item8737>. [Accessed: 06-May-2018].
- [221] Z. S. Kusharsanto and L. Pradita, "The Important Role of Science and Technology Park towards Indonesia as a Highly Competitive and Innovative Nation," *Procedia - Soc. Behav. Sci.*, vol. 227, pp. 545–552, Jul. 2016.
- [222] Y. H. Widiartanto, "Menkeu: Anggaran Pendidikan Indonesia-Vietnam Sama, Kualitas Beda," *KOMPAS.com*, 22-Nov-2017. [Online]. Available: <https://ekonomi.kompas.com/read/2017/11/22/142001726/menkeu-anggaran-pendidikan-indonesia-vietnam-sama-kualitas-beda>. [Accessed: 08-May-2018].
- [223] OECD, "PISA Country Note: Indonesia," OECD, 2015.
- [224] Kominfo, "Laporan Tahunan 2016," Kementerian Komunikasi dan Informatika Republik Indonesia, 2016.
- [225] Times Higher Education, "Times Higher Education: World University Rankings," Times Higher Education, 2018.
- [226] QS, "QS World University Ranking 2018," QS, 2018.
- [227] H. Hill and T. K. Wie, "Indonesian universities in transition: catching up and opening up," *Bull. Indones. Econ. Stud.*, vol. 48, no. 2, pp. 229–251, Aug. 2012.
- [228] B. Y. Moeliodihardjo, B. W. Soemardi, S. S. Brodjonegoro, and S. Hatakenaka, "University, Industry, and Government Partnership: Its Present and Future Challenges in Indonesia," *Procedia - Soc. Behav. Sci.*, vol. 52, pp. 307–316, Jan. 2012.
- [229] OECD and ADB, "Education in Indonesia: Rising to the Challenge," Mar. 2015.
- [230] N. Clark, "Education in Indonesia," *World Educ. News Rev.*, pp. 1–15, Apr. 2014.
- [231] J. Carle, "Climate Change Seen as Top Global Threat," *Pew Research Center's Global Attitudes Project*, 14-Jul-2015. .

- [232] J. Poushter and D. Manevich, "Globally, People Point to ISIS and Climate Change as Leading Security Threats," *Pew Research Center's Global Attitudes Project*, 01-Aug-2017. .
- [233] Herminindah Wahyuni, "Mainstreaming climate change issues: Challenges for journalism education in Indonesia," *Pac. Journal. Rev.*, vol. 23, no. 1, pp. 80–95, Jul. 2017.
- [234] "Indonesia court sentences administrator of 'fake news factory' Saracen to jail," *The Straits Times*, 12-Jan-2018.
- [235] Fadiyah, "SETARA: The Family MCA More Threatening than Saracen," *Tempo*, 02-Mar-2018.
- [236] S. Kemp, "Digital in Southeast Asia in 2017," *We Are Social*, 16-Feb-2017. [Online]. Available: <https://wearesocial.com/special-reports/digital-southeast-asia-2017>. [Accessed: 10-May-2018].
- [237] S. Vosoughi, D. Roy, and S. Aral, "The spread of true and false news online," *Science*, vol. 359, no. 6380, pp. 1146–1151, Mar. 2018.
- [238] T. Siddiq, "Online Media Collaboration Launches Cekfakta.com to Fight Hoax," *Tempo.co*, 06-May-2018. [Online]. Available: <http://en.tempo.co/read/news/2018/05/06/055918197/Online-Media-Collaboration-Launches-Cekfaktacom-to-Fight-Hoax>. [Accessed: 10-May-2018].
- [239] P. Vujanovic, "Decentralisation to promote Regional Development in Indonesia," Apr. 2017.
- [240] E. Avis, C. Ferraz, and F. Finan, "Do Government Audits Reduce Corruption? Estimating the Impacts of Exposing Corrupt Politicians," National Bureau of Economic Research, Working Paper 22443, Jul. 2016.
- [241] S. Isra, Yuliandri, F. Amsari, and H. Tegnan, "Obstruction of justice in the effort to eradicate corruption in Indonesia," *Int. J. Law Crime Justice*, vol. 51, pp. 72–83, Dec. 2017.
- [242] Sutiyo and K. L. Maharjan, "Policy Options for Decentralization and Rural Development in Indonesia," in *Decentralization and Rural Development in Indonesia*, Springer, Singapore, 2017, pp. 151–157.
- [243] S. A. Fritzen, "Can the Design of Community-Driven Development Reduce the Risk of Elite Capture? Evidence from Indonesia," *World Dev.*, vol. 35, no. 8, pp. 1359–1375, Aug. 2007.
- [244] V. Alatas, A. Banerjee, R. Hanna, B. A. Olken, R. Purnamasari, and M. Wai-Poi, "Does Elite Capture Matter? Local Elites and Targeted Welfare Programs in Indonesia," National Bureau of Economic Research, Working Paper 18798, Feb. 2013.
- [245] A. Dasgupta and V. A. Beard, "Community Driven Development, Collective Action and Elite Capture in Indonesia," *Dev. Change*, vol. 38, no. 2, pp. 229–249, Mar. 2007.
- [246] C. Tan, "Lifelong learning through the SkillsFuture movement in Singapore: challenges and prospects," *Int. J. Lifelong Educ.*, vol. 36, no. 3, pp. 278–291, May 2017.
- [247] J.-F. Martínez-Cerdá and J. Torrent-Sellens, "Formal Lifelong E-Learning for Employability and Job Stability during Turbulent Times in Spain," *Int. Rev. Res. Open Distrib. Learn.*, vol. 18, no. 6, pp. 261–287, Sep. 2017.
- [248] A.-K. Boström, "Lifelong Learning in Policy and Practice: The Case of Sweden," *Aust. J. Adult Learn.*, vol. 57, no. 3, pp. 334–350, Nov. 2017.
- [249] J. Yang, C. Schneller, and S. Roche, *The Role of Higher Education in Promoting Lifelong Learning. UIL Publication Series on Lifelong Learning Policies and Strategies: No. 3*. UNESCO Institute for Lifelong Learning, 2015.
- [250] J. A. Henschke, "An International Perspective on Reorienting Traditional Higher Education Institutions toward Lifelong Learning," *Procedia - Soc. Behav. Sci.*, vol. 142, pp. 36–46, Aug. 2014.
- [251] UNESCO, "Education for People and Planet: Creating Sustainable Futures for All," UNESCO, Paris, 2016.
- [252] M. Mazzucato, *The Entrepreneurial State: Debunking Public Vs. Private Sector Myths*. Anthem Press, 2015.
- [253] D. Hartmann, M. R. Guevara, C. Jara-Figueroa, M. Aristarán, and C. A. Hidalgo, "Linking Economic Complexity, Institutions, and Income Inequality," *World Dev.*, vol. 93, pp. 75–93, May 2017.

- [254] Erinofiardi *et al.*, "A Review on Micro Hydropower in Indonesia," *Energy Procedia*, vol. 110, pp. 316–321, Mar. 2017.
- [255] K. Heimerl, S. Hasan, K. Ali, T. Parikh, and E. Brewer, "A Longitudinal Study of Local, Sustainable, Small-Scale Cellular Networks," *Inf. Technol. Int. Dev.*, vol. 11, no. 1, pp. 1–19, Mar. 2015.
- [256] A. Surahman, G. Shivakoti, and P. Soni, "Chapter 15 - Prospect of Sustainable Peatland Agriculture for Supporting Food Security and Mitigating Green House Gas Emission in Central Kalimantan, Indonesia," in *Redefining Diversity & Dynamics of Natural Resources Management in Asia, Volume 1*, Elsevier, 2017, pp. 291–303.
- [257] W. Ravesteijn, "Between Globalization and Localization: The Case of Dutch Civil Engineering in Indonesia, 1800-1950," *Comp. Technol. Transf. Soc.*, vol. 5, no. 1, pp. 32–64, Apr. 2007.
- [258] N. A. Ashford, *Government Strategies and Policies for Cleaner Production*. UNEP, 1994.
- [259] UNEP, "UNEP DTIE SCP Branch: Resource Efficient and Cleaner Production," *United Nations Environment Programme Division of Technology, Industry, and Economics Sustainable Consumption & Production Branch*. [Online]. Available: <http://www.unep.fr/scp/cp/>. [Accessed: 14-May-2018].
- [260] A. R. Barron, A. A. Fawcett, M. a. C. Hafstead, J. R. Mcfarland, and A. C. Morris, "Policy insights from the emf 32 study on u.s. carbon tax scenarios," *Clim. Change Econ.*, vol. 09, no. 01, p. 1840003, Feb. 2018.
- [261] J. Caron, S. M. Cohen, M. Brown, and J. M. Reilly, "Exploring the impacts of a national u.s. co2 tax and revenue recycling options with a coupled electricity-economy model," *Clim. Change Econ.*, vol. 09, no. 01, p. 1840015, Feb. 2018.
- [262] D. L. Chandler, "Carbon taxes could make significant dent in climate change, study finds," *MIT News*, 06-Apr-2018. [Online]. Available: <http://news.mit.edu/2018/carbon-taxes-could-make-significant-dent-climate-change-0406>. [Accessed: 13-Apr-2018].
- [263] A. Yusuf and B. Resosudarmo, "On the distributional impact of a carbon tax in developing countries: the case of Indonesia," *Environ. Econ. Policy Stud.*, vol. 17, no. 1, pp. 131–156, Jan. 2015.
- [264] Kementerian Lingkungan Hidup dan Kehutanan, "Knowledge Centre Perubahan Iklim." [Online]. Available: <http://ditjenppi.menlhk.go.id/kcpi/index.php>. [Accessed: 11-May-2018].

6 APPENDIX

6.1 STRICT FISCAL RULE



Figure 6: General government deficit (source: OECD)

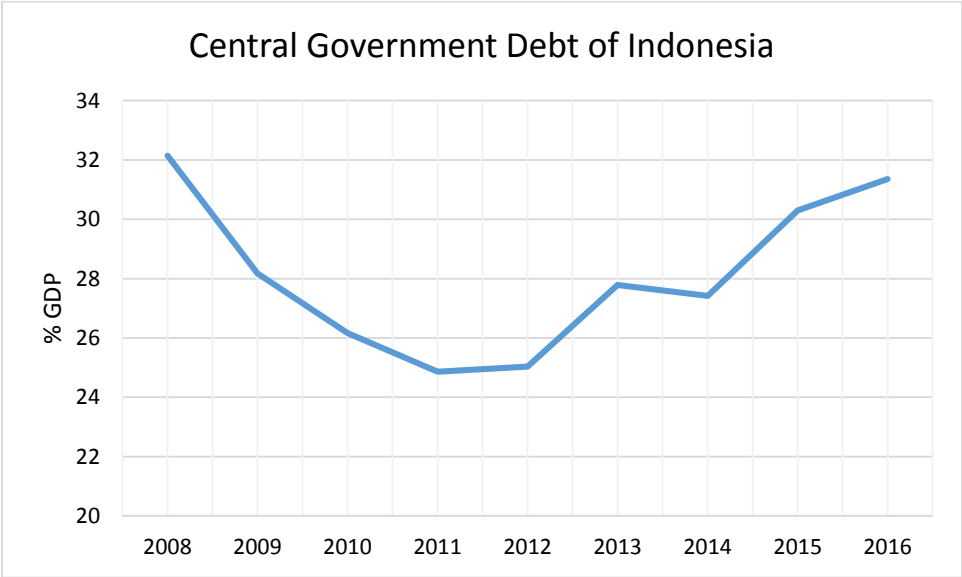


Figure 7: Central Government Debt of Indonesia (source: World Bank, World Development Indicators)

6.2 REGIONAL CONTRIBUTION TO GDP

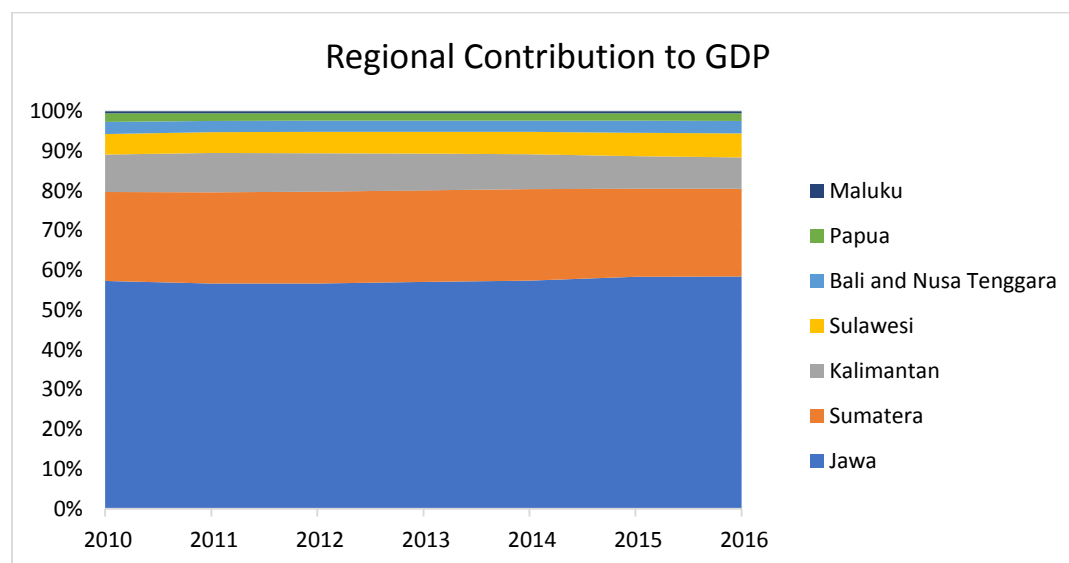


Figure 8: Regional Contribution to GDP (source: author's calculation on data from Statistics Indonesia)

Source: The author aggregated the original data for each province (Statistics Indonesia: Distribution of GRDP to Total GRDP of 34 Provinces at Current Market Prices by Province, 2010-2016) into major regions as shown in below table.

Province	Region
ACEH	Sumatera
BALI	Bali and Nusa Tenggara
BANTEN	Jawa
BENGKULU	Sumatera
DI YOGYAKARTA	Jawa
DKI JAKARTA	Jawa
GORONTALO	Sulawesi
JAMBI	Sumatera
JAWA BARAT	Jawa
JAWA TENGAH	Jawa
JAWA TIMUR	Jawa
KALIMANTAN BARAT	Kalimantan
KALIMANTAN SELATAN	Kalimantan
KALIMANTAN TENGAH	Kalimantan
KALIMANTAN TIMUR	Kalimantan
KALIMANTAN UTARA	Kalimantan
KEP. BANGKA BELITUNG	Sumatera

Province	Region
KEP. RIAU	Sumatera
LAMPUNG	Sumatera
MALUKU	Maluku
MALUKU UTARA	Maluku
NUSA TENGGARA BARAT	Bali and Nusa Tenggara
NUSA TENGGARA TIMUR	Bali and Nusa Tenggara
PAPUA	Papua
PAPUA BARAT	Papua
RIAU	Sumatera
SULAWESI BARAT	Sulawesi
SULAWESI SELATAN	Sulawesi
SULAWESI TENGAH	Sulawesi
SULAWESI TENGGARA	Sulawesi
SULAWESI UTARA	Sulawesi
SUMATERA BARAT	Sumatera
SUMATERA SELATAN	Sumatera
SUMATERA UTARA	Sumatera

6.3 TAX REVENUE

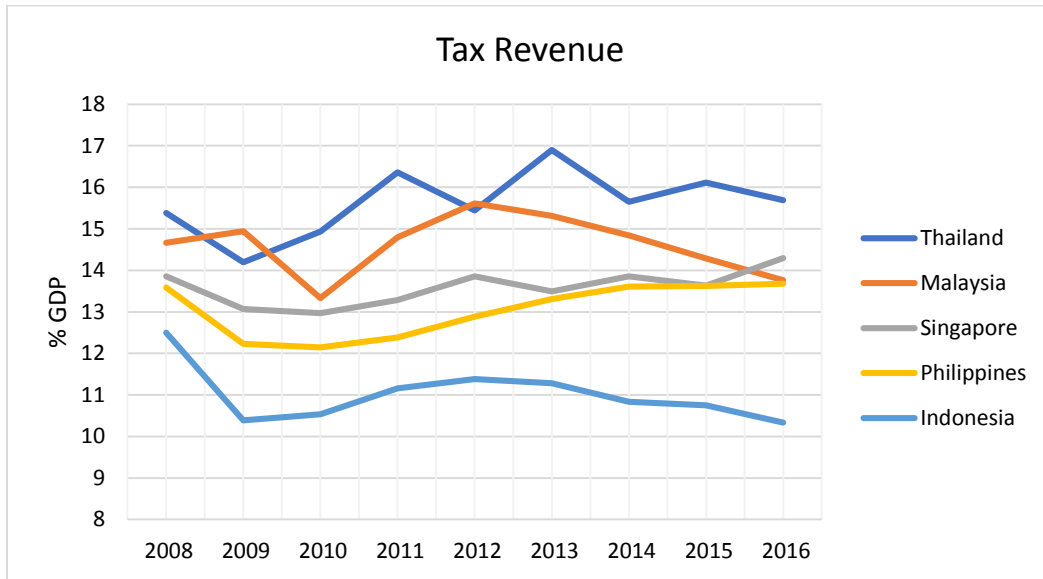


Figure 9: Tax Revenue (source: World Bank, World Development Indicator)

6.4 GROSS ENROLLMENT RATIO

All charts here are from UNESCO Institute for Statistics (2018), UIS.Stat.

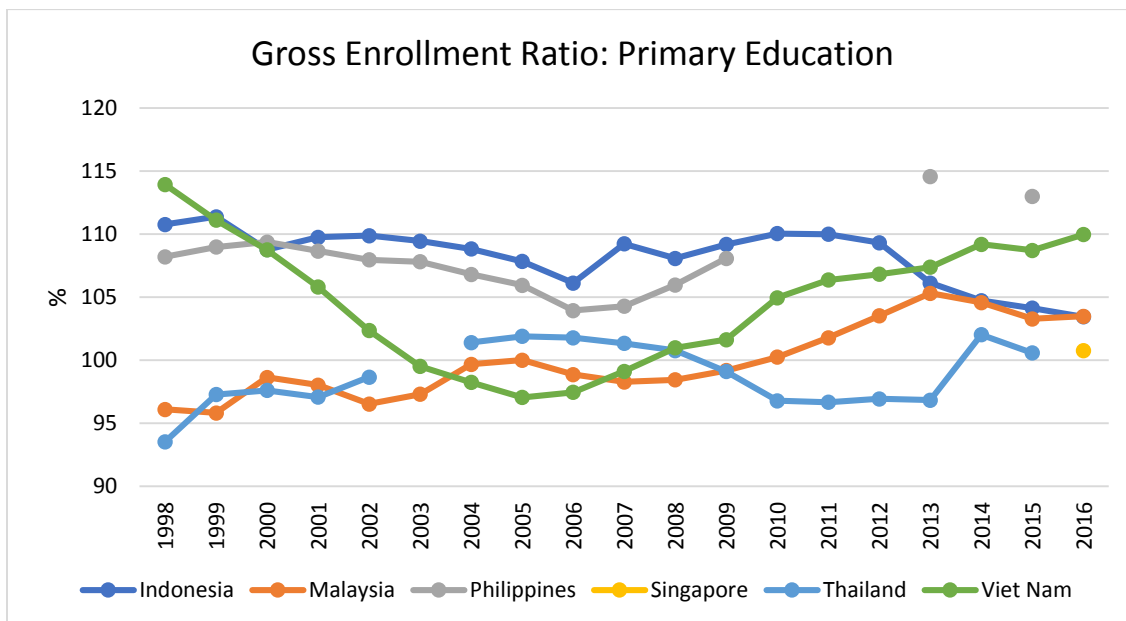


Figure 10: Gross Enrollment Ratio for Primary Education

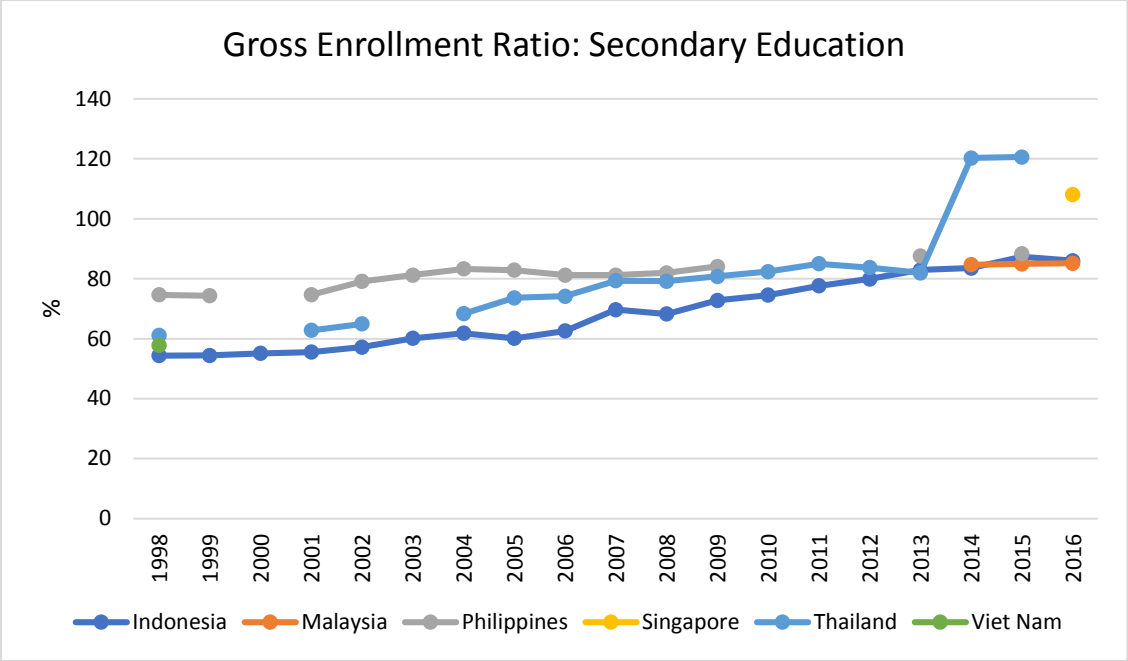


Figure 11: Gross Enrollment Ratio for Secondary Education

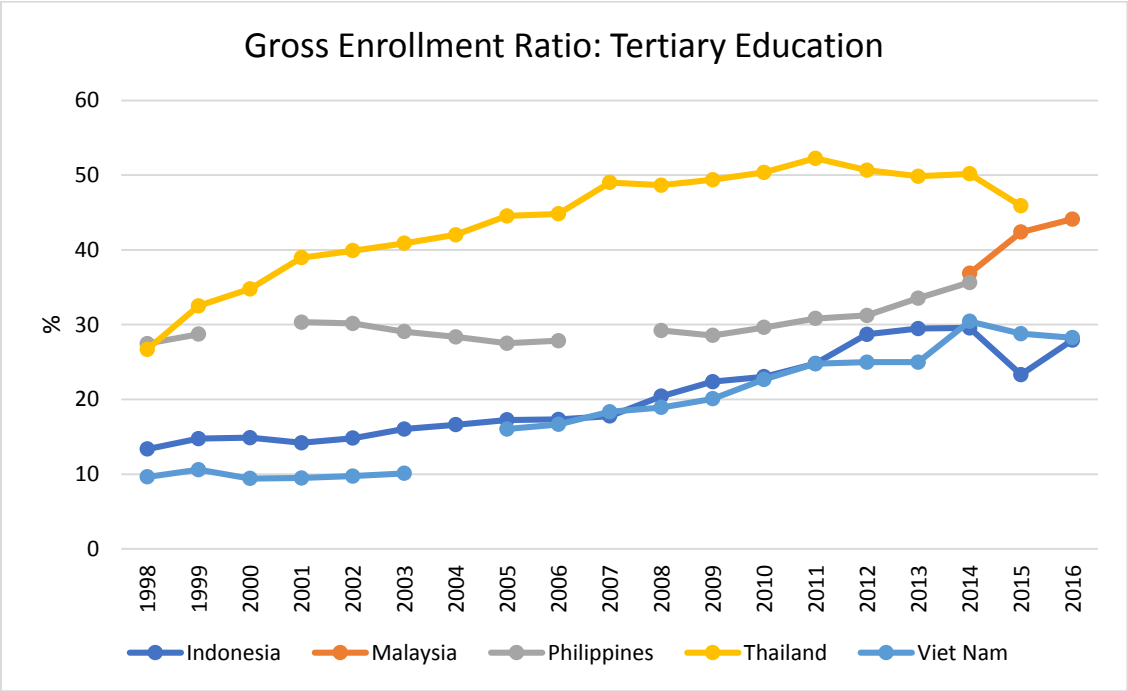


Figure 12: Gross Enrollment Ratio for Tertiary Education