Case Studies

Technology Transfer as a Strategy for Disaster Risk Reduction Among the Coastal Cities of Asia-Pacific: The Case of Jakarta

Farhan Latif, University of Waterloo, *Farhan.latif@uwaterloo.ca*

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Abstract

Technology-driven solutions that could identify and address the interrelated complexities of climate change and disasters provide coastal cities with an opportunity to achieve and safeguard sustainable development. However, depending on the technology cooperation approach between the technology haves and not haves, the growing use of global technologies for local disaster risk reduction (DRR) could exacerbate or reduce multifaceted socio-economic disparities. This paper examines Jakarta's technology-driven disaster risk reduction efforts to underscore the need to distinguish between technology transfer and technology-driven development through global assistance. Avoiding potential mismatch between the necessary actions to improve local disaster resilience and the ambitious technology-driven development projects in Jakarta requires effectively interlinking the concepts of DRR and technological possibilities.

Keywords: Technology Transfer; e-resilience; Climate Change; Jakarta Floods; ICT and Disaster Risk Reduction

Introduction

Natural and anthropogenic hazards and disasters significantly influence the development trajectory of all communities worldwide, and several of the coastal cities of Asia-Pacific are at the forefront of this destructive influence. Through collaborative efforts at the global and local levels, the interconnected nature of this influence of hazards on local development is becoming more apparent. In this new era of development, demand is growing for multidisciplinary inquiry, evidence-based policies, and localized technology solutions that could identify and address the complex and interrelated problems of climate change, disasters, and sustainable development (ODI and CDKN 2014).

The vastly different levels of disaster-related vulnerabilities between the economically prosperous and the economically developing communities reflect that inequalities of access to technology, knowledge banks, human and financial resources, and varying levels of institutional strength exist. These inequalities have created a dire need for increased focus on collaboration at the local, regional, and international levels to achieve mutual growth at the global level. Hence, the 17th Sustainable Development Goal (SDG) focuses on addressing the issue of access to technology and knowledge by facilitating technology transfer, information exchange, finance, and investment through partnerships.

This paper builds on the argument that increasing disaster resilience among disaster-prone coastal cities is an ongoing process significantly influenced by the associated approaches towards knowledge building and knowledge sharing. Therefore, technology collaboration, technology transfer, and mutually beneficial partnerships are essential for embedding effective disaster risk reduction strategies into local development planning (Gurstein, 2003). UNIDO (2004) defines technology transfer as a mechanism by which a particular entity shares (partially or wholly) its collected knowledge to another entity – primarily to allow the receiving entity to benefit from that knowledge. To further elaborate on the significance of technology transfer for DRR, this paper discusses the discourse of Jakarta's ongoing technology-driven efforts towards disaster risk reduction and elaborates on the associated socio-ecological, economic, and technical challenges. This paper uses argumentative research methodology using Jakarta as a case study. The research in this paper utilizes academic and grey literature sources, including published journal articles, United Nations reports, working papers, government and corporate webpages, and conference papers.

Jakarta, Climate Change, and Hazards

Greater susceptibility to disasters and the lengthy history of DRR efforts make Jakarta an excellent example of how and why disaster risk reduction must be incorporated into development planning to make the local development efforts more sustainable. Postcolonial Jakarta is one of the largest cities in Asia and the Pacific region, the center for urban development in Indonesia. Jakarta annually witnesses several hydro-meteorological hazards, many of which are strongly connected with the changing climate (BNPB, 2016). Rapid urbanization, local geography, unsustainable development trajectory, slow local growth of technical capacity, and global climate change is making Jakarta increasingly vulnerable to hydro-meteorological disasters. The vulnerability to these natural hazards is further exacerbated due to socio-economic risks such as poverty and marginalization.

Based on the national disaster risk assessments, the Government of Indonesia has listed twelve critical hazards in the country, many of which are strongly connected with the changing climate. Several of these hazards are evident in the city of Jakarta, including floods (coastal, riverine, and urban), land subsidence, landslide, extreme tidal wave and abrasion, extreme weather, drought, forest, and land fire, technological failure (threshold, technical limitations, the adaptive capacity of existing technological solution and infrastructure), biophysical hazard, and social conflicts (BNPB, 2016).

Jakarta's main hazard is severe floods and land subsidence, increasing at an alarming rate. Jakarta is a delta of 13 rivers discharging to the Jakarta Bay (Permanasari, 2019). Jakarta has long been suffering from both riverine and sea floods. To make the situation worse, Jakarta is sinking between 0.5 cm to 15 cm per year and may reach 17 cm per year in particular city areas (BNPB, 2016). Several studies suggest that this land subsidence is exacerbated primarily due to the massive extraction of groundwater and the increasing weight of the city due to the rapid construction in the past two decades (Sedlar, 2016). However, approximately 40 % of the

northern part of Jakarta is already below sea level. As a result, during the rainy season, Jakarta becomes a melting pot for seawater and riverine floods (Garschagen, 2018).

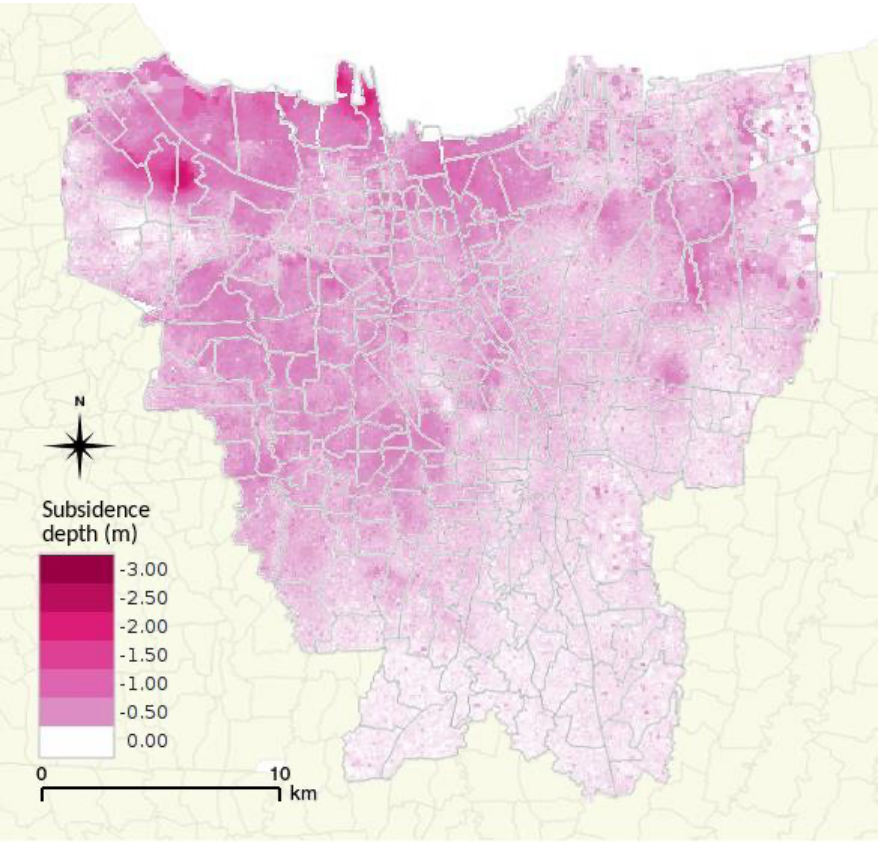

Figure 1: Spatial distribution of projected total land subsidence. (Budiyono, 2016)

The floods, both from upstream (seawater) and downstream (rivers) combined with inadequate infrastructure, have often paralyzed the city. The flood itself often takes casualties. Also, there will be no electricity for days during the floods - roads will be blocked, and the economy will be disrupted for days (Permanasari, 2019). Apart from these floods, Jakarta also faces massive population growth yet lacks supporting infrastructure. It is a megacity without the proper backbone of roads, public transport, and adequate city planning (Padawangi and Douglass, 2015).

Climate Change is exacerbating these hazards in Jakarta in various ways. Rising sea levels and increased rainfall due to unpredictable monsoon seasons increase the severity of floods. Changing global weather patterns are impacting the availability of resources, including the food supply chain of the megacity, freshwater availably, and local fisheries. Decreased rainfall in the greater Jakarta region during the dry season is resulting in droughts. For example, increased frequency and severity of El Niño events leading to hazards such as El Niño related drought (Garschagen et al., 2018). These climate-related hazards, combined with the socio-economic challenges, are resulting in increased food and water prices, worsening sanitation, health

(prevalence of respiratory and waterborne diseases) and nutrition challenges, loss of livelihoods, reduced incomes, increased poverty, and complex inwards and outwards flow of migration.

Disaster Risk Reduction, Colonial Past, and Technology Transfer

Jakarta's past interventions and hydraulic mission to control its rivers reflect that despite the recent surge in flood risk due to climate change, Jakarta's quest for flood risk reduction through technology and engineering solutions is not new. A principal example of technology transfer for flood management is the Dutch interventions in Jakarta during the colonial era. During the Dutch colonial rule, sophisticated flood protection measures were introduced in Jakarta (Garschagen et al., 2018). In the early 1600s, the Dutch started implementing a structured canal system in the city. Moreover, a major canal, the 'Western Canal,' was put into service in 1725 to divert some of the River Ciliwung's discharge around the city (Rahmayati and Himmayani, 2017). Integrating these measures into an overarching and comprehensive plan for the entire city of Jakarta, the van-Breens-Plan was subsequently issued in 1917, designed in collaboration with Dutch waterworks engineers, in response to a devastating flood event.

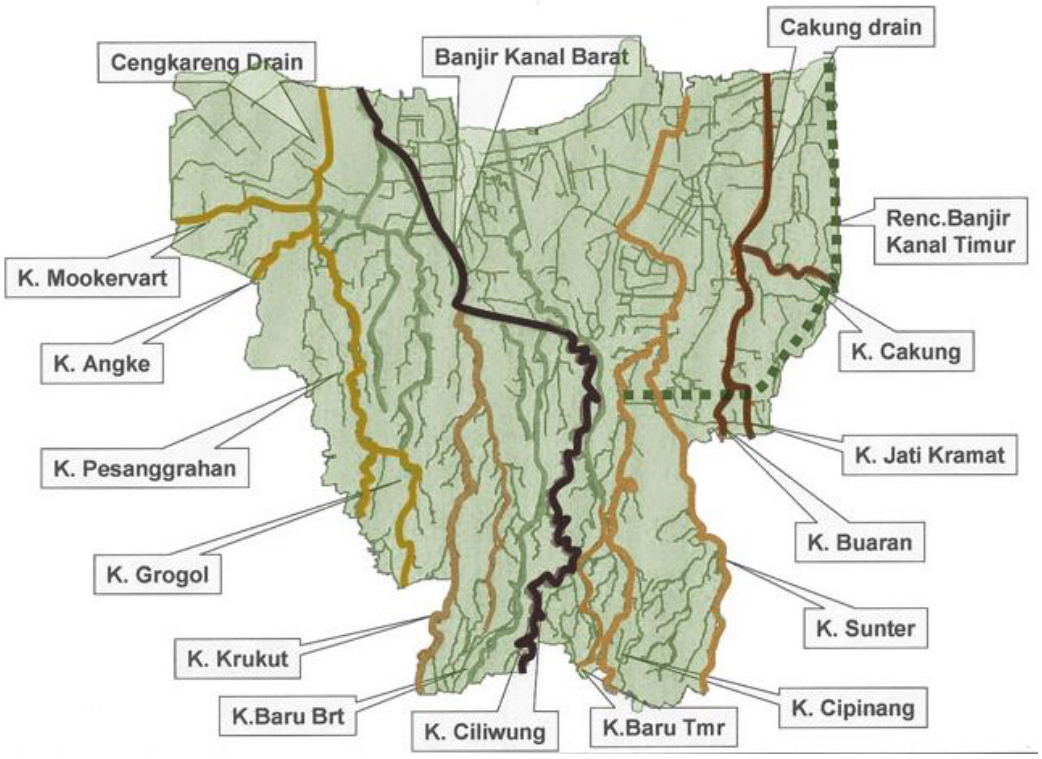

Figure 2: The Map of Jakarta's Key Flood Canals: Source Budiyono (2016)

This plan comprised significant structural measures, including additional diversion canals in the city's west and east sections - primarily to protect the new European settlements (Dewi and Van Ast, 2016). The plan's strong focus on engineering and technical assistance from the

Netherland provided the primary paradigm for other programs to follow. Many of which showed paved the path for long-term reliance on Indonesia's technical and non-technical collaboration with the international community, especially the Netherlands.

Over the years, sedimentation and solid waste accumulation have significantly reduced the water carrying and retention capacities of Jakarta's existing flood management infrastructure (Rahmayati and Himmayani, 2017). Moreover, between the 1920s and 1990s, no significant improvements were made to Jakarta's flood management system (ODI and CDKN 2014), reflecting the underlying deficiencies of this technical cooperation process.

While the technical assistance certainly improved Jakarta's immediate capacity to manage floods to some extent, the degree of Jakarta's prolonged reliance on the Dutch technical support reflects the fundamental deficit of this process. I reason that the Dutch floods risk reduction strategy, due to its linear approach towards floods management, neglected to focus on localization of technical knowledge through 'technology transfer,' which could have essentially made the city more resilient against potential future hazards through well-equipped local institutions and effective local capacity development processes.

These institutional capacity gaps are revealed by the prolonged disconnect between the administration's understanding of local flooding and the reality of floods in Jakarta. As Sedlar (2016) argues, the lack of innovation capacity among the local flood management institutions continues to result in flood management strategies that use a probabilistic-based approach towards flood management in Jakarta that only accounts for 'traditional flooding' that happens along topographical lines; however, Jakarta's flood history reflects that flooding in Jakarta seldom follows topographical lines.

The example of Jakarta's past flood management indicates that there is a need for the kind of technical cooperation between technology haves and have nots that not only results in the development of physical infrastructure for DRR but also results in local skills development, institutional empowerment, training, technology, and knowledge transfer, and sustainable financial support to the locally-led processes to achieve sustainable disaster risk reduction. Using the technologies and knowledge banks from the Netherlands, this technical assistance process for floods management remained focused on using a model-building approach (using Dutch experiences) towards capacity building and disaster risk reduction strategies in Jakarta (Dewi and Van Ast, 2016) without strengthening the local capacity development mechanisms needed to carry out further related improvements in the future.

Jakarta, Global DRR agendas, and Technology Transfer.

Many of the fundamental mechanisms that have led to Jakarta's improved technical and institutional capacity towards DRR planning and implementation align with two global frameworks that aim to reduce disaster risks, i.e., Hyogo Framework for Action (2005-2015) and Sendai Framework for Disaster Risk Reduction (2015-2030).

The Hyogo Framework for Action was the global blueprint for disaster risk reduction efforts between 2005 and 2015. One of the Hyogo Framework for Action objectives was developing and strengthening institutions, mechanisms, and legal frameworks for disaster risk reduction with decentralized responsibilities and capacities at the city level. About this framework, in 2010, Indonesia adopted a new legal framework with components that paved the path for the establishment of local disaster management agencies at the provincial and city levels, including Jakarta's Local Disaster Management Agency (BPBD).

Since its inception in 2013, this agency has been responsible for Jakarta's disaster management activities at the local level; however, the crucial goal to achieve decentralized responsibilities and capacities at the city level remains a challenge as Indonesia's National Disaster Management Agency (BNPB) still directly manages many of the local disaster risk reduction projects including the Jakarta Coastal Defense Strategy (Permanasari, 2019).

In 2015, 187 member states signed the Sendai Framework for Disaster Risk Reduction 2015–2030 to safeguard the SGD's (2015-2030) progress. This global agreement replaced the Hyogo Framework for Action 2005–2015. Under the Sendai Framework, countries and organizations have identified a range of science and technology-related needs. Across regions and development levels, countries seek to address the gaps they face in scientific capacities and information (Erian, 2018). Discussions on the sustainable development goals, climate change issues, and DRR agreements such as Sendai Framework have seen the global science community, governments, and international agencies call for a better mobilization of science and technology, through means including technology transfer, to support disaster risk reduction and efforts to improve local resilience.

Jakarta's recent technology-driven efforts towards DRR

Jakarta's river naturalization program that included restoration of Jakarta's floodways, canals, and water retention ponds was considered the most practical short-term step to help alleviate the impact of flooding in Jakarta (Garschagen et al., 2018). Emergency Dredging Initiative 2013-2015 (JEDI) and Jakarta Urban Flood Mitigation Project 2012-2019 (JUFMP) were introduced to restore the full capacity of flood canals. These two world Bank-funded projects achieved satisfactory results by dredging and rehabilitating selected key floodways, canals, retention basins, pump repairs, and retention ponds to improve flow capacity. Moreover, these two projects provided technical and financial assistance for technical capacity development within Jakarta's flood management institutions and agencies.

However, the focus remained on improving local capacity through top-down approaches, reflected in current institutional fragmentation, e.g., Jakarta Coastal Defense Strategy management by Indonesia's National Disaster Management Agency (BNPB) instead of Jakarta's Local Disaster Management Agency (BPBD). As Permansari (2019) highlighted, the Jakarta Coastal Defense Strategy project was overtaken by the national government.

National Capital Integrated Coastal Development (NCICD) Masterplan

The political resistance at the city level, financial uncertainties, and social justice issues associated with the NCICD project are excellent examples of why technology transfer, as a long-term strategy, is critical for embedding disaster risk reduction into local development plans. In pursuit of reducing the risk of coastal flooding and rising sea levels, the Jakarta Coastal Defense Strategy has been continuously revised and expanded, which led to the development of the National Capital Integrated Coastal Development (NCICD) Masterplan in 2014 (Permanasari, 2019). NCICD consists of several megaprojects that are supposed to utilize state-of-the-art construction and information technologies to overcome floods, rising sea levels, and coastal abrasion.

The plan aims to protect Jakarta against coastal flooding by constructing a seawall along the coast, a dam, and a new city district (commonly known as the Great Garuda) in the ocean. This new city district is expected to include 17 artificial islands in the bay of Jakarta. It is worth noting that Jakarta's current technological and institutional capacity does not allow the city to independently plan or implement this enormous project that carries significant uncertainties, technical complexities, and socio-economic challenges (Permanasari, 2019).

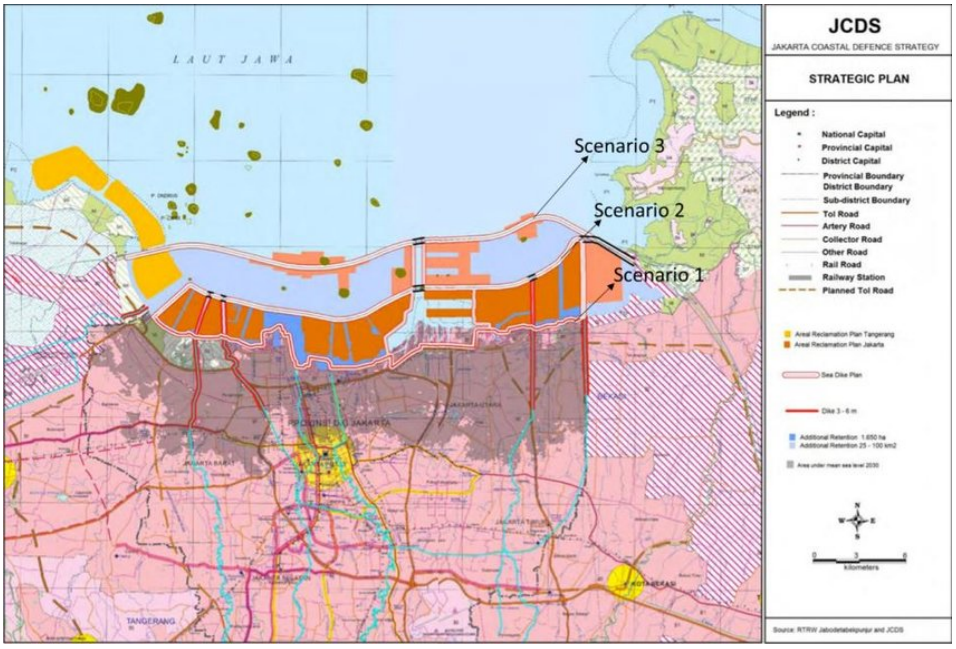

Figure 3: The NCICD's proposed master plan (Public Works, Jakarta Coastal Defense Strategy).

Due to a lack of agreement between Jakarta's local team of experts (urban designer, civil engineer, water management teams, and IT experts) and Jakarta's national government, the alternate plan development by the Dutch engineers was endorsed over the local consultants' plan (Permanasari, 2019). The Dutch plan was the winner of the smart cities prize at the world architecture festival in 2017, a prize that is awarded to projects that overcome key planning challenges of the future. However, as local critics of the Dutch plan call attention, the plan

proposed a new city that uses a grid system - predominantly similar European cities and nothing like the rest of Jakarta (Permanasari, 2019). These complexities, especially the postcolonial relationship between the colonized and the colonizer, raise a critical question of whether the method of technology cooperation that technology transfer is more important than the technology itself.

Participatory Information and Communication Technologies (ICTs) and Disaster Risk Reduction in Jakarta

As emphasized by the United Nations ESCAP (2019), the effective use of ICTs presents significant opportunities to reduce hazards and risks during all phases of disaster management by improving coping capabilities, providing inclusive disaster response, and improving preparedness mechanisms. This process of enhancing resilience through electronic information and communication tools is often described as 'e-resilience.' Several case studies in the United Nations E-Governance Survey 2018 Report demonstrate the significance of incorporating emerging digital technology, such as space applications, social media, geographic information systems, remote sensing, artificial intelligence, and several other geospatial information systems to achieve improved e-resilience.

Although the digital divide challenges exist, the extent of these opportunities for Jakarta is massive due to Jakarta's younger median-age population and higher familiarity with digital technologies, e.g., Jakarta is the most active city on Twitter in the world (Sedlar, 2016). Jakarta's complex demography, susceptibility to disasters, and megacity size reflect the critical need for incorporating e-resilience into governance and DRR efforts. This incorporation is essential to warrant undisrupted services and information to all communities of Jakarta before, during, and after any disaster.

By forming productive partnerships with technology haves, various institutes of Jakarta are increasing disaster risk reduction efforts through digital technologies and improvised digital connectivity. This increased emphasis on digital technologies is expected to offer enhanced levels of data availability for DRR planning, insights into the disaster trends, and improve disaster preparedness and coping capabilities to deal with future disasters. The discourse of some related hazards management, early warning interventions, and the role of technology transfer through partnerships is elaborated in the upcoming sub-sections. Preference is given to projects and interventions that focus on participatory processes and potentially improve institutional and social capacity through technology transfer.

PetaBencana Indonesia Emergency Response Platform

This emergency response platform was primarily designed in partnership with the Massachusetts Institute of Technology (MIT) to deal with the potential flooding hazard in Jakarta during the rainy season. To provide citizens of Jakarta with an interactive online platform to access and provide

information on the situation of floods, Jakarta's local Disaster Management agency, in partnership with MIT, launched this open-source platform in 2017. Through this platform, residents can access the website PetaBencana.id to obtain up-to-date information on flooding in various parts of Greater Jakarta. The platform offers users the opportunity to share real-time reports on the flood situation and flood maps using social media. The flood maps use GIS tools to illustrate a more holistic flood situation by overlaying interactive information on the maps, such as the water level in the flood canals and flood reservoirs and the location of the nearest flood pumps.

The platform uses a distinctive participatory method to ensure that information is not merely theoretical and without any residents' input. In order to achieve this objective, this platform combines data from the hydraulic sensors with confirmed reports from the users of this platform at the street level. It reduces the dependency on costly data collection and data processing methods. With a conceptual approach that "people are the best sensors," this platform generates near-real-time and precise maps of floods for all citizens and workers, including first responders.

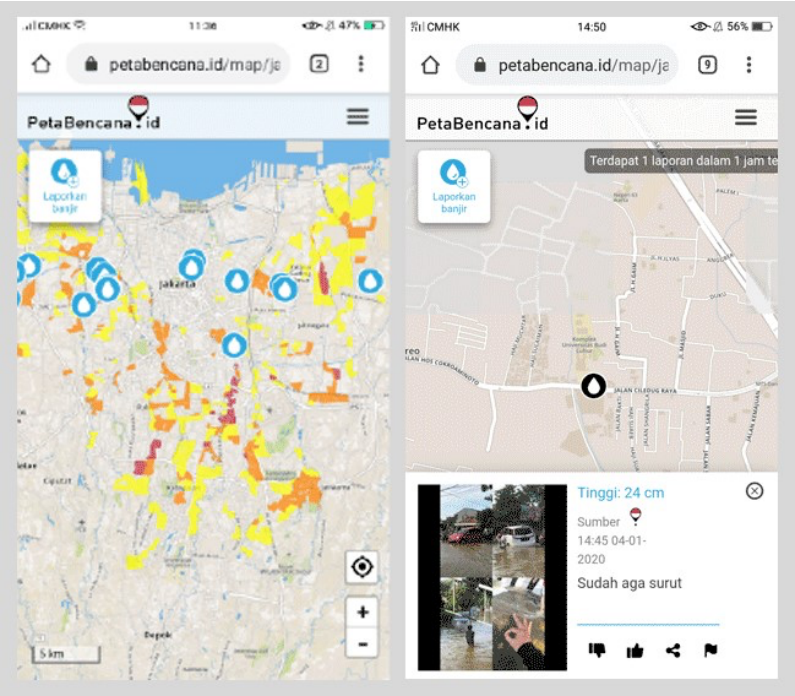

Figure 4: PetaBencana.id Platform Source: Petabencana, 2020

Utilization of Open-Sourced and Crowd-Sourced applications such as CogniCity (open-source software to visualize urban data) to build this emergency response platform not only reduces dependency on expensive, for-profit technologies but also encourages local scholars and professionals (programmers, developers, urban planners) to engage in the dialogue to improve

such Crowd-Source and Open-Source technologies further. PetaBencana Emergency Response Platform was designed and initiated by the Urban Risk Lab at MIT, which aims to increase the resilience of local communities through innovation and technology transfer (Urban Risk Lab, 2020). Various industry experts, research institutes, and development organizations support this platform to produce localized systems, prototypes, and technologies that aim to incorporate risk preparedness and disaster risk reduction into the design of cities and regions (UrbanRiskLab, 2020).

JakSAFE Flood Web Portal

Calculation of disaster damage and loss is a complex process. However, for understanding the magnitude of disaster damage and plan relief and rehabilitation activities, there is a need to collect and analyze exposure data, hazard information, and many other related variables. JakSAFE, a web-based application, is a system that was introduced in 2015 to collect information on flood damages and flood losses in Jakarta. This platform incorporates data from the local disaster risk reduction agency (BPBD), external reports, field observations of independent organizations, and social media to estimate flood damages and losses.

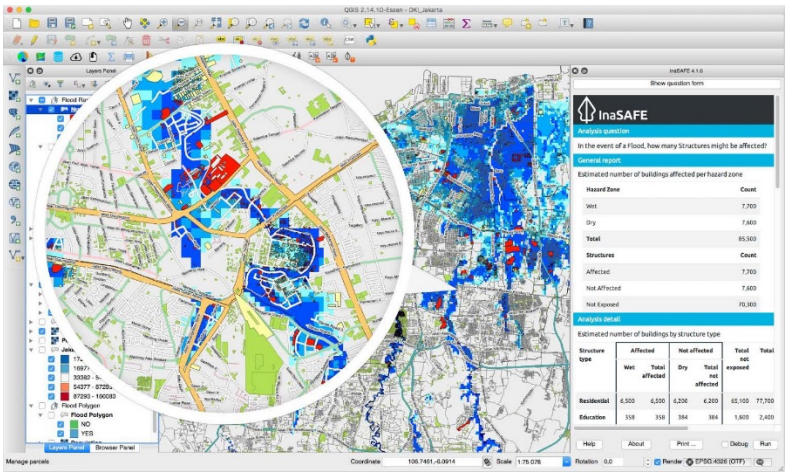

Figure 5: InaSAFE in QGIS: Source inasafe.org

Jakarta Smart City

How cities could combine smart initiatives to leverage existing and future technologies has a significant impact on hazard mitigation since timely collection, analysis, and communication of hazard-related information is necessary for effective hazard reduction. Smart city is an umbrella term used to define urban areas that use various types of electronic devices to collect data and then use that information to manage resources and services.

In 2015, Jakarta Smart City (JSC) introduced the Jakarta Flood Information Platform (JAFIP) - a participatory disaster information-sharing system that enables local users to share disaster information using a mobile app. Residents can use the app to send multimedia information and comments to the local authorities. Collected information is amalgamated with the data from the local disaster management agency. The application is integrated with Twitter feed, a widely-used social media in Jakarta, and the Jakarta Smart City system. The Jakarta Smart City system provides wide-ranging information to the general public in Jakarta about conditions in the city.

The usefulness of this platform reflects the significance of technology transfer and technology cooperation between technology haves and have nots to achieve improved social capital and e-resilience. Developed by Fujitsu, a Japanese multinational information technology equipment and services company funded by the Japan International Cooperation Agency (JICA), this application uses Japan's technical capacity, DRR experiences, and expertise. Japan is one of the most distance-prone countries in the Asia-Pacific region, with significant experience using social media for participatory disaster management.

The Jakarta Flood Information Platform (JAFIP) integrates with Disaster Information Management System (DIMS), another DRR platform developed in collaborating with BPBD Jakarta, Japan, and Fujitsu. Research suggests that in Japan, social media and similar disaster information megamenu applications (developed by Fujitsu) have been widely used as a detection and verification technique for collecting disaster information (JICA, 2015).

Opportunities and Policy Recommendations

This section highlights Jakarta's critical opportunities to improve its disaster management strategy through technology transfer to its institutions and citizens.

Improve Digital Connectivity Infrastructure

Regardless of the higher smartphone ownership and social media usage in Jakarta, access to affordable and reliable high-speed Internet remains a challenge for economically-marginalized groups of Jakarta that are also the most affected by disasters, e.g., coastal and riverine floods. As an overarching no-regret development policy, Jakarta should aim to increase the availability and affordability of broadband Internet for all people across the city, focusing on women and people with disabilities.

Improve Geographic Information Systems

There is a need for more significant support for development planning, hazards monitoring, and timely data availability for early warning technologies. Improvement in datasets such as increasing the resolution and scope of remote sensing technologies and improved access to updated and on-demand satellite imagery is essential to improve DRR capacity. Improved

collaboration with the ICT and Disaster Risk Reduction Division of UNESCAP can help Jakarta access some of the affordable commercial and non-commercial space technologies through partnerships (ESCAP, 2017).

Prioritize gaps in delivery and application of existing research for disaster risk reduction

As Erian (2018) elaborated, a critical gap exists where there is often a lack of awareness of existing scientific research among policy and decision-makers - partially due to the limited consultancy mechanisms within critical institutions and a lack of open access to academic scientific research. Jakarta's local disaster risk reduction agency should aim to form regional working groups to address the gaps they face in information, technological, and current scientific research capacities.

Improve DRR capacity through technical capacity development mechanisms

Jakarta can take several approaches to improve its evidence-based decision-making and policy development capacity. These approaches could include increased collaboration with local, regional, and international higher-education institutes to reshape the discourse of technical education programs within Greater Jakarta and fill the existing knowledge gaps by training the new generation of well-informed DRR managers and DRR researchers.

Regional Technical Collaboration and Partnerships

Regional and international DRR frameworks, including HFA and SFDRR, have produced a range of new and established partnerships and collaboration platforms for coastal cities. These platforms can generate and share DRR knowledge among entities of different sizes and missions, including policymakers, non-profits, the private sector, and civil society. For disaster-prone cities, it is essential that these lines of communication are improved and that improved collaboration between cities is achieved. A key opportunity for Jakarta is to actively collaborate with the other cities of Asia-Pacific using the Asia-Pacific Gateway for Disaster Risk Management and Development platform. Developed by the United Nations UNESCAP and Asian Disaster Preparedness Center, this interactive web platform offers a variety of tools and products that could enable various institutes of the city to mainstream disaster risk reduction ideologies, notions, and practices into their local development processes (UN ESCAP, 2020).

Conclusions

Despite the noteworthy progress towards disaster risk reduction in Jakarta, challenges remain. Climate change, rapid urban growth, socio-economic inequalities, and the profit-oriented nature of technological advancement (techno-capitalism) continue to challenge the effectiveness and

long-term sustainability of Jakarta's DRR efforts. Increasing disaster resilience among the coastal communities of Asia-Pacific, such as Jakarta, requires pooling technical expertise together and promoting technical and institutional alliances between the coastal cities of the Asia-Pacific region and at the global level. However, there is a need for a clearer understanding of both DRR needs and technological possibilities in Jakarta to ensure that the administration's focus on technology-driven intervention results in mutual growth for all population groups instead of exacerbating existing inequalities. Many low-income coastal communities and slums are increasingly cleared as a part of local DRR strategy while making space for many luxury residential and shopping complexes in the same area (Garschagen et al., 2018).

These social justice challenges raise the question of whether there is a disparity between the societal DRR expectations and the technological possibilities in Jakarta. In order to avoid the mismatch between technology-driven projects (e.g., building multiple artificial islands with high-end properties as a coastal defense strategy) and DRR efforts to safeguard existing coastal communities, the concepts of DRR necessities and technological possibilities should be effectively linked in Jakarta and similar coastal cities.

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