Case Study Report

Minimizing the Impacts of Indonesia New Capital City Development on Environmental Services and the Changing Climate

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Abstract

The massive development of new capital city (NCC) in East Kalimantan inevitably will create land use change from previously dominated by forest to urbanized area. As consequences, the built-up area development in a forest rich island therefore will bring disruption to the ecosystem, impacting on the services provided, and causing adverse impacts to human life. This paper assesses the potential impacts resulted by NCC development on environmental services (ESs) disruption. We limit our scope of study in three environmental services, namely: flood prevention, water provision, and fire prevention. Unavoidable impact of climate change on environment and human life will undoubtedly worsen the environmental services disruptions resulted from the city development. Using the spatial analysis on the wetland ecosystem, fire hot spot and peat land distribution, we identified the potential risk area. On the other hand, we also identified the high conservation value area within the planned NCC region and how significant the changing landscape impacts to the ecosystem services provision if the proportion of the built-up area of NCC take places. Based on those findings, the paper suggests the climate-sensitive design as the urban planning approach to minimize the impacts of built-up conversion. We expect that our paper will enrich the discussion on the urban-nature development and contribute to the planning discourse of NCC development.

Keywords

Ecosystem Services, New Capital City, Indonesia, Kalimantan

1. Background

Deterioration of Jakarta environmental quality, such as regular flood and poor air quality, has pushed Indonesia government to relocate new capital city (NCC) to North Penajam Paser and Kutai Kartanegara District in East Kalimantan Province. The NCC is designed to be able to support all the living of all inhabitants and social-economy activities taking place as the centre of Indonesia's government and administration. However, development of a new city in Kalimantan, known as a forest rich island (Harrison and Paoli, 2012), is going to be very challenging. The massive development of NCC in East Kalimantan inevitably will create land use change from previously dominated by forest to urbanized area. As consequences, the development of capital city in a forest rich island will bring disruption to the ecosystem, impacting on the services provided, and causing adverse impacts to human life. Studies have suggested that converting forest to non-forest increases risk in flooding (Bradshaw, Odhi and Peh, 2007) and drought (Bagley *et al.*, 2014). Deforestation, coupled with the escalating impact of climate change, have proven to amplitude the incidence of fire (Golding and Betts, 2008).

Despite the environmental concerns raised, NCC development continues. Unavoidable impact of climate change on environment and human life will undoubtedly worsen the environmental services (ESs) disruptions resulted from the city development. Unfortunately, despite a growing body of literature on capital city relocation, to the best of authors' knowledge, scholars largely neglect the impacts of new capital development on ESs and changing climate in designing new city.

This study conducts spatial analysis and propose recommendations of further actions to take to minimize adverse impact of the city development and the changing climate. Ultimately, the study result can contribute to early assessment on risks related to ESs provision and preliminary recommendations on climate change adaptation enabling the Indonesia government to better design the relocation plan.

2. Data and Analysis

2.1. Spatial data

We limited our scope within the area of NCC based on the official map issued by Ministry of Public Works and Public Housing (MoPWPH) of Republic of Indonesia. The NCC covers around 191,723 hectares area of Kutai Kertanegara District and Penajam Paser Utara District combined, in East Kalimantan Province. Potential disruption of ESs resulted from city development was assessed through High Conservation Value (HCV) approach, targeting three ESs based on biophysical condition of the area, namely water provision (HCV 1.3 and HCV 4.1), flood prevention (HCV 4.1), and fire prevention (HCV 4.3). We used data listed in table 1 to conduct spatial analysis to identify areas that contain HCV and the result is shown in Figure 1. Our assumption is based on if city development takes place in HCV area or impacts on HCV area degradation, ESs provision will be disrupted.

We target the three ESs because the current capital city of Jakarta has failed to maintain their provision leading to issues like flood, saltwater intrusion, and air pollution, which becomes the main reason of the relocation plan. HCV approach enables a thorough analysis at landscape level, where causality of land management is assessed beyond management unit, and integrates national and global concern over conservation importance (Common Guidance of HCV, 2013). We referred to (HCV Toolkit Indonesia, 2009) in identifying HCV area that fits to Indonesia local context. MoPWPH has released several maps of NCC development plan, which we compared with the analysis result presented in Figure 1.

Table 1. Spatial data used in HCV analysis

Spatial data	Year of data release	Source	Analysis	Environmental service (HCV)
NCC boundary	2019	MoPWPH	Scope of study	-
Infrastructure plan of NCC	2019	MoPWPH	Development plan and existing infrastructure	-
Area with flood risk	2019	MoPWPH	Flood-prone area	HVC 4.1
Forest estates	2019	Ministry of Environment and Forestry (MoEF)	Protected areas	HCV 1.3
Land cover map	2018	MoEF	Wetland ecosystems	HCV 4.1

Rivers	2016	Geospatial Information Agency (GIA)	Riverine zone	HCV 4.1
Swamp distribution	2016	GIA	Wetland ecosystem	HCV 4.1
Land system	1989	Regional Physical Planning Programme for Transmigration (RePPProT)	Wetland ecosystems	HCV 4.1
Peatland distribution	1992	Ministry of Agriculture	Peatland area	HCV 4.1
Fire hot spot (2001-2020)	2020	Global Forest Watch (https://www.globalforestwatch.org/)	Fire-prone area	HCV 4.3

2.2. Analysis of environmental services provision

The spatial analysis was done in ArcGIS 10.7.1, and the result is shown as a map (Figure 1). The green areas contain HCV 1.3, 4.1, and 4.3 combined, indicating areas important to maintain water provision, flood prevention, and fire prevention. The NCC contains HCV area of total 56,677 hectares, which equals to more than a quarter. Red zones indicate areas prone to fire generated from analysis of Global Forest Watch hot spot data collected for 20 years. Data of main infrastructures such as road, powerhouse, and power grid, are shown in the map to illustrate how close are these infrastructures to HCV or disaster-prone areas. The map shows that NCC also covers an existing residential area, indicated by road network in the west area, which is also identified to be flood-prone by MoPWPH. White zones represent area that does not contain HCV. City development taking place in white zones will not give direct impact to ESs provision but may still carry risk of disasters like flood and land/forest fire.

Figure 2 shows proportion of disaster-prone area and areas with HCV in the NCC. Distinction over wetland and non-wetland ecosystem of HCV area was done to emphasis vital roles of wetland ecosystem in supporting the continuation of ESs and preventing water-related disaster, which will be discussed later in this paper. If city development plan is underway in the whole NCC area, there will around 56,678 hectares HCV area impacted, 51% of which is wetland ecosystem playing vital role to store water and abate flood.

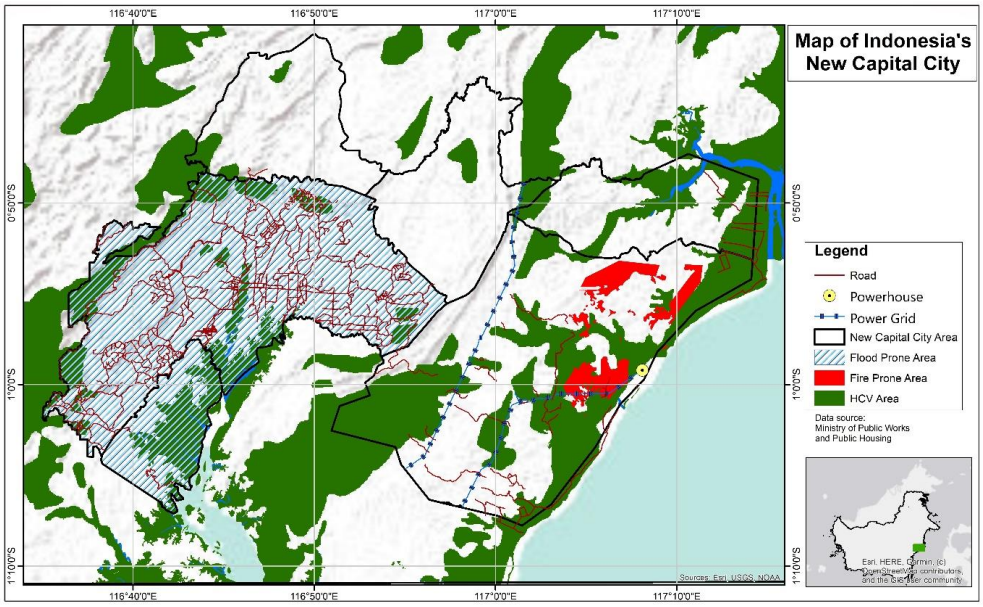

Figure 1. High Conservation Value analysis result emphasizing in three ESs (i.e. water provision, flood prevention, and fire prevention) in the New Capital City.

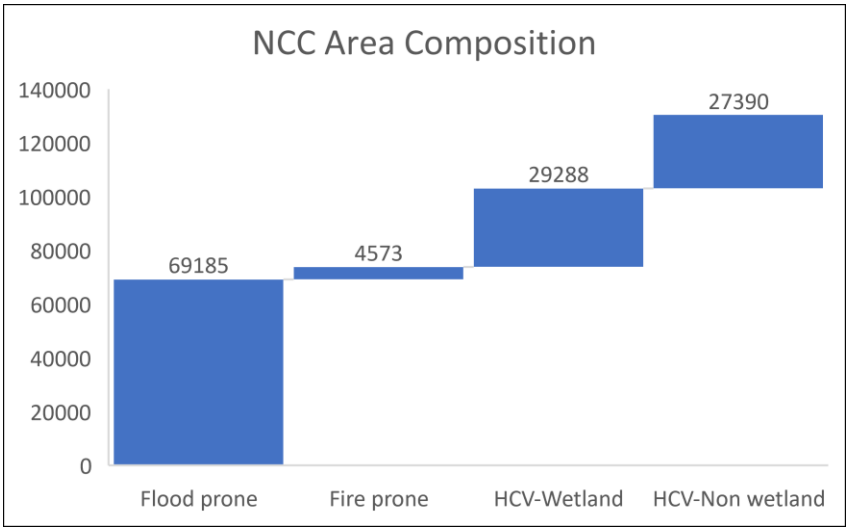

Figure 2. Area composition of the New Capital City (in hectares) consisting of disasters-prone area and area with HCV

3. Discussion

Water provision, flood prevention, and fire-free condition are among vital ESs to support urban life (Cohen, 2008; Barbedo *et al.*, 2014; Kandulu, Connor and MacDonald, 2014). As city development will take place and the impact of the changing climate is becoming more apparent, climate-related disasters (flood and fire) will become more frequent and disaster-prone areas are becoming more susceptible in the future (Anton and Lawrence, 2016; Arnell and Gosling, 2016; Schoennagel *et al.*, 2017). Uncontrolled development urban area will threaten sustainability of NCC because it does not only disrupt ESs provision, but it also worsens climate change impact. We propose two strategies in designing NCC to be more environmentally friendly and climate resilient. First, mitigation strategy aiming at conserving areas important to maintain ESs, and second, adaptation strategy emphasizing in supporting infrastructure development necessary to enhance city resilience to the changing climate.

3.1. Mitigation of flood, land and forest fire, and water scarcity (city planning)

Under mitigation strategy, priority should be given to conserve HCV areas, which amount to total area of 56,677 hectares (Figure 2). The HCV area shown in Figure 1 covers wetland and non-wetland ecosystems important to regulate water. Forest and wetlands help to prevent flood (Zedler and Kercher, 2005; Bradshaw, Odhi and Peh, 2007), minimize climate change impact (Horwitz and Finlayson, 2011), and act as barrier to fire spread (Thompson *et al.*, 2017). Mangrove avoids saltwater intrusion (Kaplan *et al.*, 2010), while inland wetlands like swamp and peatland play role in flood abatement by storing great amount of water (Zedler and Kercher, 2005). Riverine zone serves as water filtration essential for water purification and natural lake helps in run-off water collection. Riverine zone and inland wetland ecosystem's role in water storage will ensure water availability during dry season.

There are nearly 70,000 hectares area, which is also an existing residential area, categorized as flood-prone (Figure 2). Preserving the almost 30 thousand hectares of wetland ecosystems in NCC, as well as wetland ecosystems in nearby area, will help avoid severe flood in this existing flood-prone area and other area that can potentially become flood-prone due to city development. Just as important as wetland ecosystem for

flood abatement, non-wetland ecosystems with HCV also play vital roles in water purification and storage that ensure sustainable uncontaminated water source for city inhabitants.

3.2. Adaptation to flood, land and forest fire, and water scarcity (safeguard)

As the changing climate is more apparent in impacting on seasonal period (Still, Foster and Schneider, 1999), long period of dry season and wetter rainy season are expected. These conditions can increase urban susceptibility to disaster prone condition. Annual flood is one of the biggest issues of Jakarta that results in infrastructures damage and economic loss. Wildfire that hit California this year and Australia last year had burnt millions of forest and urban areas, causing biodiversity loss, respiratory issues, and devastated urban infrastructures. The two fire events have proven that climate change has exacerbated the risk and magnitude of fire incidences in recent years. Historical forest/land fire in Kalimantan is a challenge NCC should tackle to serve as centre of governmental activities and to avoid all the damages caused.

Adaptation strategy entails effort to make the city more adaptable to flood and fire disaster. City development in flood and fire prone areas (Figure 1) should orient in creating infrastructures that can minimize disaster impact. Instalment of green roof technology, creating more reservoirs, establishment of rain garden, and planting more trees are some ways to collect storm water (Ercolani *et al.*, 2018), which should be complemented by infrastructures that help reduce flood water amount, such as bioswales, permeable pavements, and decent urban drainage system (Berland *et al.*, 2017). Preserving wetland ecosystems in the surrounding flood prone areas will improve storm water management efforts owing to wetland's ability to store water.

As city development continues, the wildland-urban interface (WUI) – defined as the area where urban settlement and wildland plants converges – will inevitably grow. Where condition of fire to ignite is favourable, WUI will increase the risk of fire incidence as urban area expands (Thomas and Butry, 2014). This situation will get worse if housing development continues and put more risk in lives and infrastructure damage (Cohen, 2008; Radeloff *et al.*, 2018). Having known that fire habitually occurs in the area, housing and office buildings should not be built in or close to fire prone zone. Residential area density should also be maintained to the level where WUI does not induce fire activity (Spyratos, Bourgeron and Ghil, 2007). Safeguards to prevent fire from spreading should be in place in the surrounding area of fire prone, specifically, attention should be given to the areas where vital infrastructures, such as powerhouse and power grid, are located (Figure 1). Infrastructure to prevent fire from spreading (i.e. fire-barrier belt) should be established in the surrounding area. Conserving natural barriers, like wetland ecosystem (Kuhry, 1994; HCV Toolkit Indonesia, 2009), is strongly recommended to stop fire spread.

Mitigation and adaptation strategies are complementing to each other, the absence of one strategy will jeopardize the expected result of the other. Preserving important ecosystems is the first step to reduce the magnitude of flood and fire occurrence. Supporting infrastructure development and safeguard establishment to ease disaster impact is additional effort to supplement mitigation actions. The NCC should be designed to be able to adapt with the changing climatic condition, given the current condition of Kalimantan with historical fire events and flood prone area, as well as to ensure provision of ESs to support city life.

4. References

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