Physical geography in planning an Indonesia’s new capital towards integrated tropical city

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Abstract. The purpose of this paper is to investigate all aspects of physical geography in planning the new capital in order to achieve an integrated tropical city. Many aspects are important in planning science because they are the basic aspects of implementing planning in an urban and regional, especially in planning a new capital as will be done by the Indonesian government, namely moving the capital from Jakarta to Kutai Kartanegara and Penajam Paser Utara. Many studies related to this have been carried out by academics, agencies or research groups, but lack of discussing the planning of the new capital in the viewpoint of physical geography in a systematic, comprehensive and complete manner, even though this study is needed so that the new capital can include all aspects of the planning needed. The research method uses study literature from various sources and spatial analysis with approaches to all aspects of physical geography. Investigations from the new capital found biodiversity and abundant natural resources in terms of physical geography. The conclusion obtained from the study is that the physical geographical aspects of the new capital have advantages and can be used as large capital in the future by incorporating the principles of smart, green and sustainability towards the integrated tropical city.

1. Introduction
Urban planning possesses three aspects namely physical, social and economic [1-3]. Social urban planning is a population planning in order to form a community with the aim of productivity improvement through economics of scale [4,5], labor specialization, and improvement of intellectual, culture, and recreational activity diversities in urban areas [6]. Urban economic planning is a planning to function residential area as producer of goods and services [7], so that it can support the lives of its inhabitants and the sustainability of the settlement itself [8] so that the city as an agglomeration of economic activity can contribute to a large gross domestic product for a country [9-11]. The physical city planning is a planning of land utilization, infrastructure and facilities availabilities, and relations between regions [12].

Urban planning through physical aspects can be explored using a physical geographical approach [13], which is one of the main branches of geography that studies the physical landscape of the natural phenomena that occur on the surface of the earth [14,15]. The scope of physical geography includes all-natural phenomena that occur in the atmosphere (air layer), hydrosphere (water layer), pedosphere
(soil layer), biosphere (life layer) and lithosphere (rock layer). Physical geography aspects consist of geology, geomorphology, pedology, meteorology, climatology, hydrology, oceanography, and biogeography.

Indonesian government has planned that the new capital will be located in the areas of Panajam Paser Utara and Kutai Kartanegara, East Borneo. Many studies of various scholars have been carried out by the government and by the private sector to help assess the region so that it is worthy of being the capital. This research is interested in investigating the location of the new capital from the perspective of physical geography as a basic aspect in determining the location of the capital city. Besides that, through physical geographic investigation, it is expected that the new capital will have minimum impact of natural disasters and will be able to utilize available natural resources.

The capital relocation planning through physical geography approach aims to produce Indonesian capital with a characteristic of integrated tropical city, a city that has a tropical climate that emphasizes physical geographical aspects, such as weather protection and urban forestry by increasing vegetation to reduce urban warming.

2. Research methodology
The type of this study is a spatial descriptive research based on literature review, which is supported by secondary data collection from various sources available. Data processing is categorized into eight indicators of physical geographic variables and then analyzed using spatial investigation methods, to produce conclusions that fulfill the concept of integrated tropical city in the new capital of Indonesia.

2.1. Conceptual framework
In this study, the physical geography variable includes eight indicators. The first is geology, which study rocks and the first aspect to be considered when preparing a regional spatial plan because the rock structure highly determines the construction of infrastructure on it. The second is geomorphology, which emphasizes land slope or topography and land suitability in urban planning.

![Conceptual framework](image)

**Figure 1.** Conceptual framework of study.

The third is biogeography that examines biodiversity based on time and space. The fourth is meteorology that involves atmospheric chemistry and physics, focusing on weather forecasts. The fifth
is climatology that conducts studies on averaged weather conditions over a certain period. The sixth is hydrology which studies water movement, distribution, and quality, as well as the hydrological cycle and water resources. The seventh is oceanography which learns about the ocean and all aspects included in it, including the coastal area. Meanwhile the eighth is biogeography which determines the pattern of organisms’ distribution in the region. The relationship of the overall indicators and research variables is illustrated in the following Figure 1.

2.2. Data collection
The data collected is related to eight indicators in the form of spatial and tabular data as secondary data. The data required is obtained from government or private institutions by collecting secondary data through literature study and data gathering from open source facilities. Spatial data used in this research is in the form of maps with a scale of 1: 50,000 dan 1:100,000, published within the last five years period (Table 1).

| Variable          | Indicators                  | Data                           | Sources                        |
|-------------------|------------------------------|--------------------------------|--------------------------------|
| Physical geography| Geology                      | Earth information              | Geological Agency              |
|                   | Geomorphology                | Landscape form                 | Geological Agency              |
|                   | Pedology                     | Peatland                       | Soil Research Institut         |
|                   | Meteorology                  | Air conditions                 | BMKG dan LAPAN                 |
|                   | Climatology                  | Wind and rain movements        | BMKG dan LAPAN                 |
|                   | Hydrology                    | The availability of fresh water| Ministry of Public Work        |
|                   | Oceanography                 | Coastal area                   | Ministry of Maritime Affairs    |
|                   | Biogeography                 | Living environment             | Ministry of Environment        |

2.3. Data analysis
The data is analyzed utilizing spatial investigation techniques which descriptively described by analyzing the relationship of indicators based on the results of previous data processing.

3. Results and discussions
East Borneo Province as a new location of Indonesia’s capital city has an area of 127,267.52 km². North Penajam Paser Regency is located between 00°48'29" - 01°36'37" South Latitude and 116°19'30" - 116°56'35" East Longitude as shown in the Figure 2.

![Figure 2. Area of study.](image-url)
3.1. Geology

The compositions of rocks in the new capital are generally very old ultramafic rock formations. The geological structure developed in this area is in the form of faults, lineaments, and folds, especially the ones in Samarinda anticlinorium. Tectonic activities that form the structural area, work at different times in each region. Panajam Paser Utara is a large hills area with a geological structure in the form of anticlinal and synclinal folds.

3.1.1. Geomorphology. The new capital has a bumpy topography from ramps to steep slopes with altitudes ranging from 0 to 1500 meters above sea level and slopes between 0 to 60%. Lowland areas are generally found in along rivers and plateaus such as found in the north western part. Mountainous areas have an average height of more than 1,000 meters above sea level with a slope of 300%. The topography of 43.35% of the land area is categorized as areas with slopes above 40%. As much as 43.22% of the area is located at an altitude of 100-1000 meters above sea level.

3.1.2. Pedology. The capital's land is dominated by peat, which is a source of water and carbon storage, and is able to prevent global warming. However, in the dry season, peat is vulnerable to burning if it is dry and the rainy season, vulnerable to flooding.

3.1.3. Meteorology. The weather in the new capital area ranges from 23-24 degrees Celsius which is categorized as area with a humid tropical, with rainfall level ranging from 1500-4500 mm per year. The average air temperatures is at 21°C at minimum and 34°C at maximum, with day and night temperature differences between 5° to 7°C. The weather is relatively hot because the area is located on the equator.

3.1.4. Climatology. The average day of rain in Penajam Paser Utara Regency is as much as 10 days per month with an average rainfall of 230 mm per month. However, rainfall level above 300 mm per month occurs between December and February. Rainfall of 100-300 mm per month generally occurs in March to June and in July to October. Climatic conditions in East Borneo Province show that the climate characteristics in Penajam Paser Utara region are categorized as a humid tropical climate region. The climate of the Kutai Kartanegara Regency is strongly influenced by the wet tropical climate, which is characterized by high rainfall with an even distribution throughout the year. That is why there is no clear change of seasons. Climate in Kutai Kartanegara Regency is also influenced by its geographical location, which is a humid tropical forest climate with an average temperature of 26°C, where the difference between the lowest temperature and the highest temperature reaches 5°-7°C. The amount of rainfall in this region ranges from 2,000-4,000 mm/year with an average rainfall of 130-150 days/year.

3.1.5. Hydrology. The new capital area is still covered by forests or water containment areas, so that water storage is relatively high with good quality. Hydrological conditions in North Penajam Paser Regency based on the existing conditions can serve the needs of irrigation for agriculture. In the North Penajam Paser Regency there are springs, weirs and natural dams spread throughout the regency, which possesses large potential to meet the needs of clean water for residents in North Penajam Paser Regency.

3.1.6. Oceanography. The new capital is located on the coast which is directly adjacent to the Makassar Strait. Significant wave height range waves in the high seas around East Kutai waters have a height ranging from 0.45 to 0.66 meters. The direction of the current generally moves in from north to south following the Makassar-Straits morphology pattern oriented North-south. The direction of the current varies greatly where in the west season the current moves from west to east (December) and turns from north to south (February).
3.1.7. **Biogeography.** The new capital has a lot of peat forest areas categorized as tropical forest biome, which is a biome that has the one of the highest diversity levels of plants and animals in the world and also this area is the ecosystem of oxygen-contributing for Indonesia and the world.

3.2. **Integrated Tropical City**

The planning of Indonesia’s new capital with a basic of integrated tropical city must be prepared as a comprehensive urban planning that covers various aspects or scopes to ensure optimum carrying and supporting capacities. The relocation of the capital must be supported by a careful planning because it will not only include building movement, but also people movement. The location of the new capital is one of the world's lungs that produce most of the world’s oxygen (O2) quantity. Because of that, an effort to preserve the environment that contains numerous flora and fauna that live and breed in it is highly required. Thus, the new capital city is expected to remain sustainable and be able to live side by side with humans.

The characteristic of integrated tropical city is the ability to control stable open green spaces, so that the green flora will be available in the new capital. With the city condition that has been accompanied by environmentally friendly technology, the life of flora and fauna in the new capital city will be better maintained. Besides that, non-polluting transportation is required to protect the earth in the future. Based on the above investigation, it is stated that the new capital has the minimum risk of disaster, either floods, earthquakes, tsunamis, forest fires, volcanoes and landslides. To achieve an integrated tropical city, efforts in the new capital need to be made including raising awareness of the negative effects caused by extreme climate. Adjust planning activities that are compatible with the nature of the climate to avoid losses, Conduct planning activities by applying technology to utilize climate resources.

4. **Conclusion**

This study recommends that the research area is suitable for new capitals towards sustainable cities in accordance with spatial planning by applying the concept of Integrated tropical city, namely the concept of sustainable and environmentally friendly city development, which is achieved with a balanced development strategy between economic growth, social life and environmental protection so that the realization of the new capital city planning can also produce a habitable place, not only for the current generation, but also the next generation.

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