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Re-design of Tegalega Park in Bandung for flood evacuation park

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Abstract. The Southern part of Bandung city Indonesia is often flooded in rainy season. The frequent flooding in this area is the main reason for Bandung municipality to initiate mitigation plan. The selected place for mitigation due to evacuation space provision was Tegalega Park. The mitigation plan was contained in Bandung City Planning 2011-2031. The Tegalega Park was considered as an evacuation park, which has been considered as one of several mitigation efforts in providing evacuation space. Evacuation park has functions as a city park on a typical day and a muster point in the event of a disaster. This study aims to design an evacuation park that meets both functions. Methods applied were spatial, descriptive and quantitative analysis. Spatial analysis was used to determine the appropriate area for the evacuation park (not located in flood prone area, far from hazardous area, and near with hospitals). Descriptive analysis was used to analyze social and cultural aspects and history of flood disaster in Bandung. Furthermore, quantitative analysis was used to calculate evacuation path distance (Mohammad Toha Street 6.35km and Cibaduyut Raya Street 6.74 km), optimum thermal temperature (without modification), and carrying capacity. The results of the analysis show that Tegalega Park can be used as evacuation site. The design of Tegalega Park took Bandung Lautan Api stilation as a design concept which were described in site plan and 3D perspective.

Keywords: Bandung City, Tegalega Park, design, flood, evacuation park

1. Introduction

West Java Province is a province in Indonesia where flood often occur during rainy season. Based on the West Java Province statistical data on 2002-2010, Bandung city is the most flood event occur with 108 incidents [1]. Meanwhile, the landform of Southern area of Bandung city is mostly concave landform where sensitive to flood disaster [2]. As a mitigation effort to flood disaster in South Bandung, the municipal government planned Tegalega Park as evacuation area for flood disaster [3], stated in the Bandung City Planning 2011-2031. The more in-depth research is needed to identify potential aspect of Tegalega Park as a flood disaster evacuation area. In addition, the design of Tegalega Park is need to be improved in order to integrate functions of Tegalega Park as a city park and an evacuation area. Evacuation park is a city park concept that has been widely developed in countries to deal with natural disasters. Japan is a country that already establish evacuation parks to face earthquake and tsunami.

The purpose of this research is identifying flood area in Southern part of Bandung city analyzing potential aspects of Tegalega Park as flood disaster Evacuation Park, and designing Tegalega Park as



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evacuation Park to face flood disaster. The benefits of this research are become input and consideration for Bandung City Government in developing Bandung Spatial Plan 2011-2031 in relation with mitigation and evacuation of disasters.

2. Methods

2.1. Study site

The research was conducted in Tegalega Park, Bandung city, Indonesia (Figure 1). the total area is 160.630m².

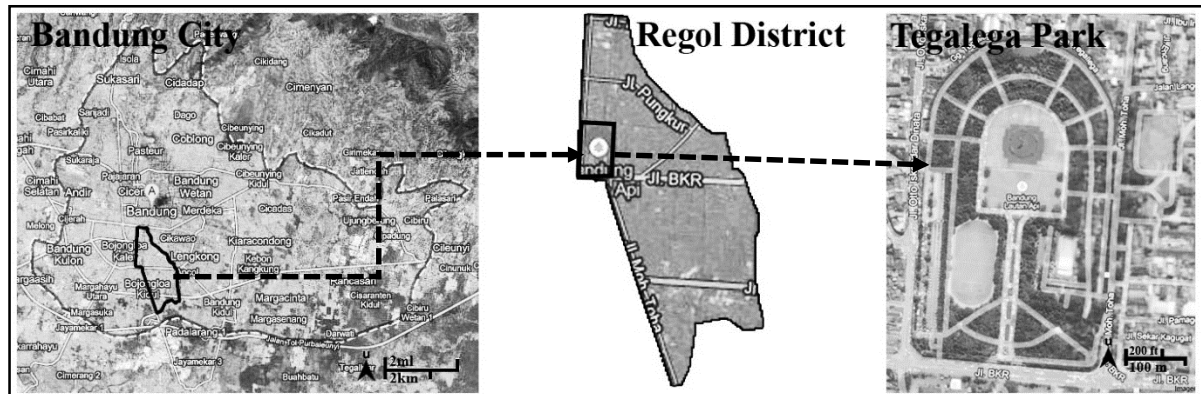


Figure 1. Orientation map of study area

2.2. Research methods

2.2.1. Spatial analysis.

The spatial analysis was implemented to determine suitability of Tegalega Park as an evacuation site. The physical and social aspects were analyzed to determine suitability (Tabel 1).

Tabel 1. Suitable Aspects for Evacuation Site

Aspects	Explanation	
	Suitable	Unsuitable
Flood zone [4][5]	Not located in flood prone area	In flood prone area
Evacuation route [5][6]	The distance of evacuation route is ≤ 8 km	The distance of evacuation route is > 8 km away
Safety location [4]	≥ 1.6 km from industrial area	< 1.6 km from industrial area
Health facilities [7]	≤ 8 km from hospital or clinic	> 8 km from hospital or clinic

2.2.2. Descriptive analysis.

The descriptive analysis was implemented to identify social and cultural aspects as well as history of flood disasters in Bandung. The social and cultural aspects consist of population who were potentially affected by flood, including their behavior and hopes as well as legal aspect.

2.2.3. Quantitative analysis.

The quantitative analysis was used to determine evacuation route, optimum thermal temperature and carrying capacity. Carrying capacity is an important aspect to be considered in identifying space and facilities should be available on the site. The carrying capacity (K) was calculated by dividing area (l) to needed standard (p). The formula was calculated as below [8]:

$$K = l / p$$

Evacuation route must be the shortest one. Therefore to determine which route that optimum for evacuation route, the maximum reachable distance of refugee to the evacuation site should be considered. The maximum distance (D_{max}) was measured by multiplying minimum warning time (T_{min}) to travel speed (a). This research assumed that evacuees travel without vehicle to get maximum time. The formula was calculated as follow:

$$D_{max} = a \times T_{min}$$

Evacuation space must have good quality of atmosphere and needs comfortable for evacuees. Optimum temperature was an indicator that affect human's comfort. The optimum temperature of evacuation space was calculated formulas follow [11]:

$$\text{Optimum Temperature} = 17.8 + (0.31 \times T_{a(out)})$$

where $T_{a(out)}$ is approximate temperature each month. The result of optimum temperature then will be subtracted by average temperature of Tegalega Park. If the deviation number is occur in 2.5°C or -2.5°C , then microclimate modification is needed. The microclimate modification can be done by using vegetation shade and a good ventilation of building.

3. Result

3.1. South Bandung

South Bandung was ranked as region with the highest flood disaster in West Java. The flood is not only caused by the overflow of Citarum River but also because of the concave landform of Southern part of Bandung city. There were three sub-districts in Southern part of Bandung city which were affected most by flood, include Baleendah, Dayeuhkolot, and Bojongsoang sub-districts.

Based on Citarum watershed study in 2011[12], 94% of Dayeuhkolot area were high risk to be flooded annually and also the most number of population. Based on recapitulation of flood events in 2013 until Maret 2014, Dayeuhkolot had 50-200cm water level of flood with 21,635 household suffered, and 884 households evacuated. It is possible to evacuate refugee from Dayeuhkolot sub-district to Tegalega Park because of closest distances than the other sub-district.

3.2. Tegalega Park

The flood analysis was done by overlaying flood threat of Citarum watershed map from National Board for Disaster Management of Indonesia (figure 2). Based on the spatial analysis, the Tegalega Park was not located in the flood prone area. Moreover, Tegalega Park was located far from industrial area that produce hazardous materials (figure 2). Furthermore, the park was also located close to hospitals; Immanuel Hospital within 1.25km far and Bhayangkara Sartika Asih Hospital within 2.37km (figure 2). Furthermore, the south side of Tegalega Park was bordered by BKR Street as evacuation route stated Bandung City Planning.

There are three main roads that can be used to evacuate from Dayeuhkolot to Tegalega Park, they are Mohammad Toha Street (6.35km length), Cibaduyut Raya Street (6.74km length), and Kopo-Soreang Street (9.28km length). Based on evacuation route calculation (the travel speed of evacuees is estimated at 4 km/h[9] and the minimum warning time for flood risk in Indonesia is approximately 1-2 hour [10]), the maximum distance for the evacuees to travel is 4-8km. Therefore the selected road as main evacuation route is Mohammad Toha Street and the best alternative of evacuation route is Cibaduyut Raya Street (figure 2).

Optimal temperature of Tegalega Park based on calculation was 25.1°C and the average of temperature in Tegalega Park was 23.5°C . The deviation of optimal temperature and average of temperature was 1.6°C . The result indicate that Tegalega Park does not need microclimate modification. Tegalega Park also has a good drainage system. The slope of Tegalega Park is approximately 0-15%, so the runoff possible to flow following the slope with direction to the south of Tegalega Park and ends at Ciateul River.

As a city park, Tegalega Park has many facilities and elements. The area of Bandung Lautan Api Monument, The Asia-Africa Conference Forest, and Tirta Lega Swimming Pool should be preserve but other areas can be planned for new function. Area of evacuation will be located close to road system and parking area. The area should be far from the preservation area to avoid vandalism.

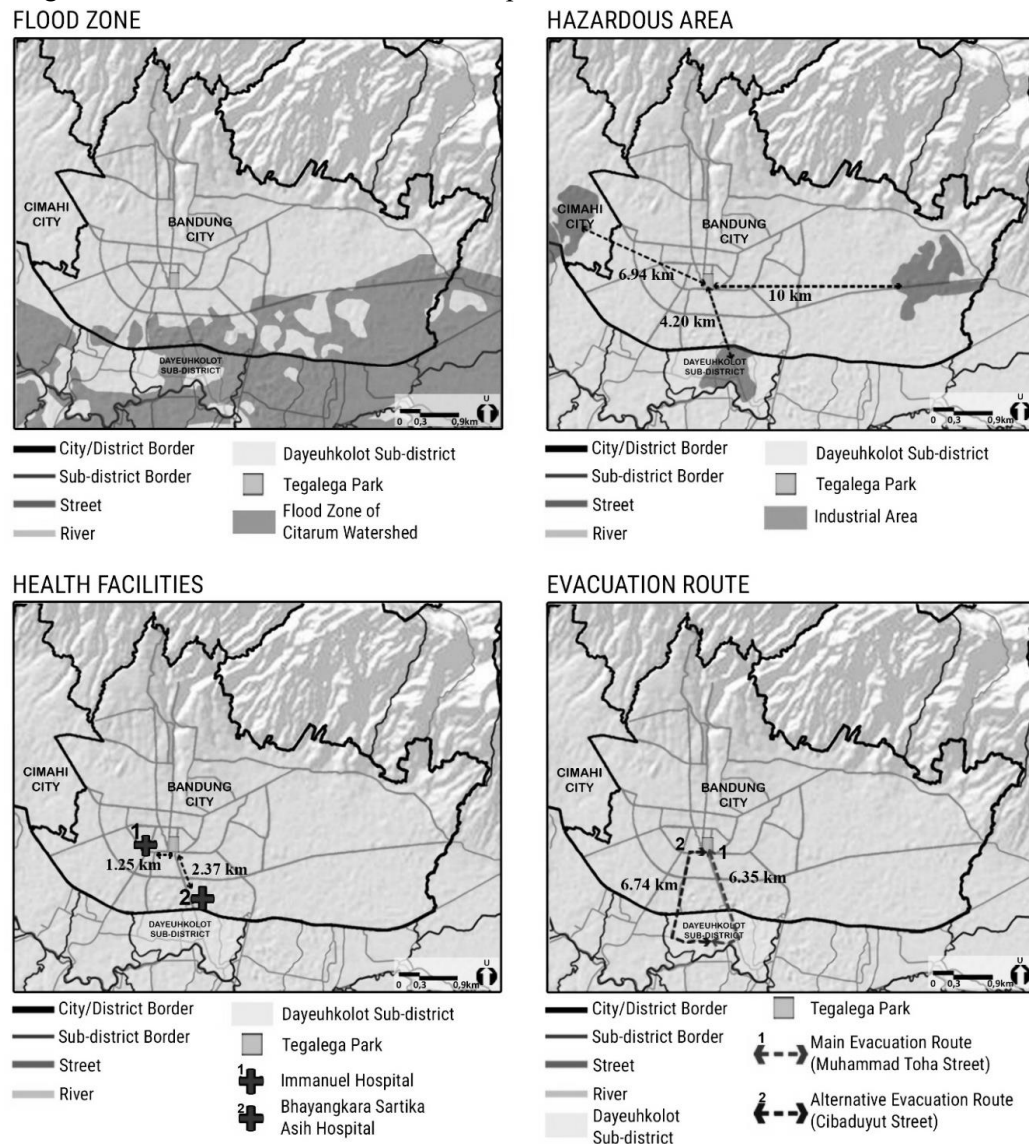


Figure 2. Spatial analysis of Flood Zone, Hazardous Area, Health Facilities, and Evacuation Route

3.3. Design of Evacuation Park

The re-design of Tegalega Park is expected to meet four values; resilient mitigation, historical, ecological, and social. As mentioned above, the Tegalega Park will be designed as an evacuation site during flood disaster according to Bandung City Planning 2011-2031. It aimed to help refugees in flooding period. The evacuation site will be considered as an evacuation park.

Tegalega Park has Bandung Lautan Api Monument. The monument has historical value that needs to be preserved. The monument was established to commemorate the struggle of the Indonesian

independence and patriotic values. Furthermore Tegalega Park had The Asia Africa Conference Forest as ecological value. That forest also needs to be preserved as public green open space for Bandung. On the other hand, Tegalega Park as a city park also has social functions such as recreational and sport activities.

3.3.1. Design Concept.

The design concept is taken from the shapes of Bandung Lautan Api Stilation. Bandung Lautan Api Stilation is triangular prism shaped the small monument, which spread over ten points in Bandung. Each stilation shows trace of Bandung Lautan Api event. Design concept diagrams are presented in figure 3.

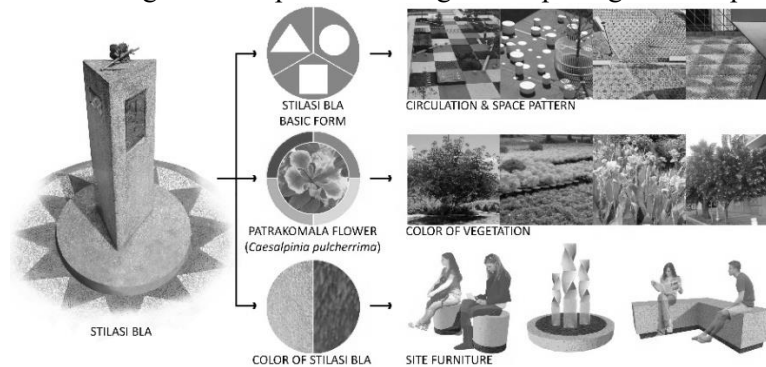


Figure 3.Diagram of Design Concept

3.3.2. Concept Development.

Concept development consists of spatial concept (figure 4), concept of circulation (figure 5), concept of vegetation, and concept of facilities and utilities.

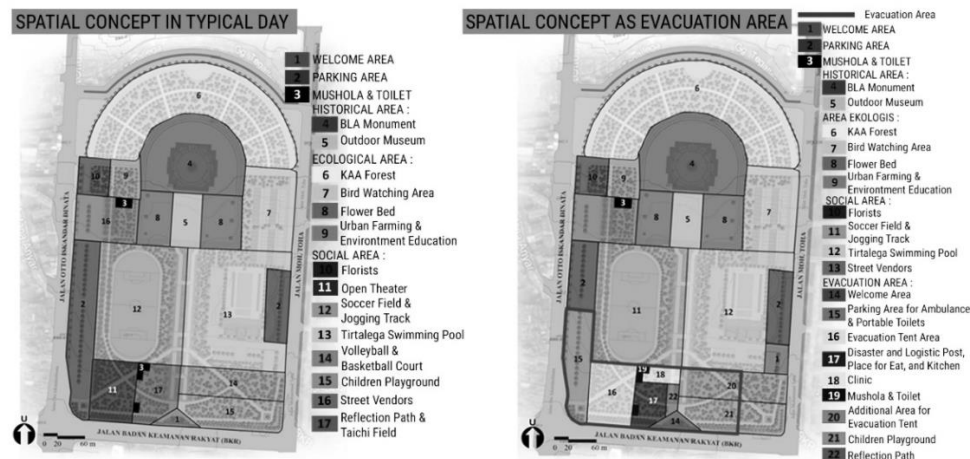


Figure 4. Spatial Concept of Tegalega Park

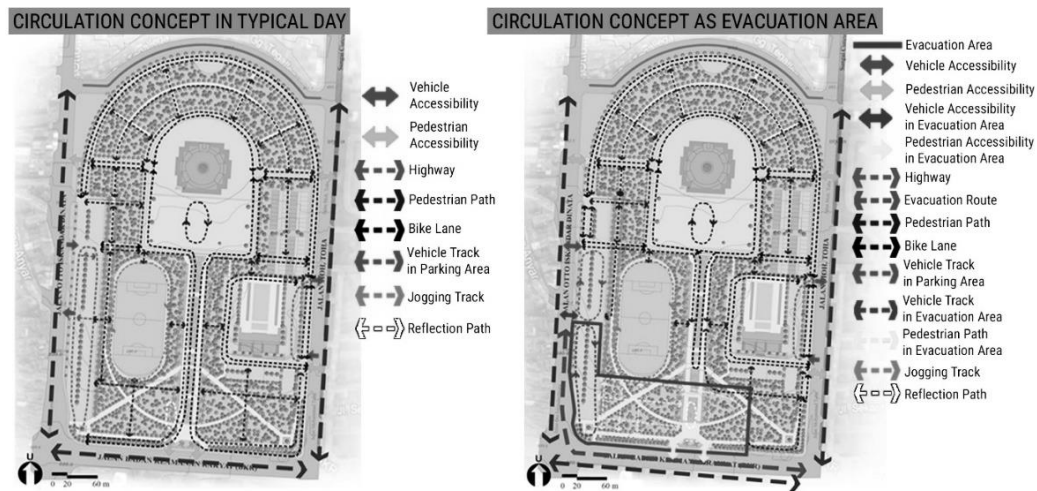


Figure 5. Concept of Circulation in Tegalega Park

3.3.3. Siteplan and Perspective.

The detail of siteplan and perspective will be focused in evacuation site. The evacuation site is also can be utilized as recreational area when eve rthe park is not used as evacuation area. The total area of evacuation site was 25,411.53m². The area was chosen as an evacuation site because it is more accessible and not in an area with historical value. There were some facilities will be provided in evacuation are, such as tent, disaster post, health center, public kitchen and dining area, children playground and reflection path, parking area, and generator house. The siteplan were presented in figure 6 (b) and figure 7.

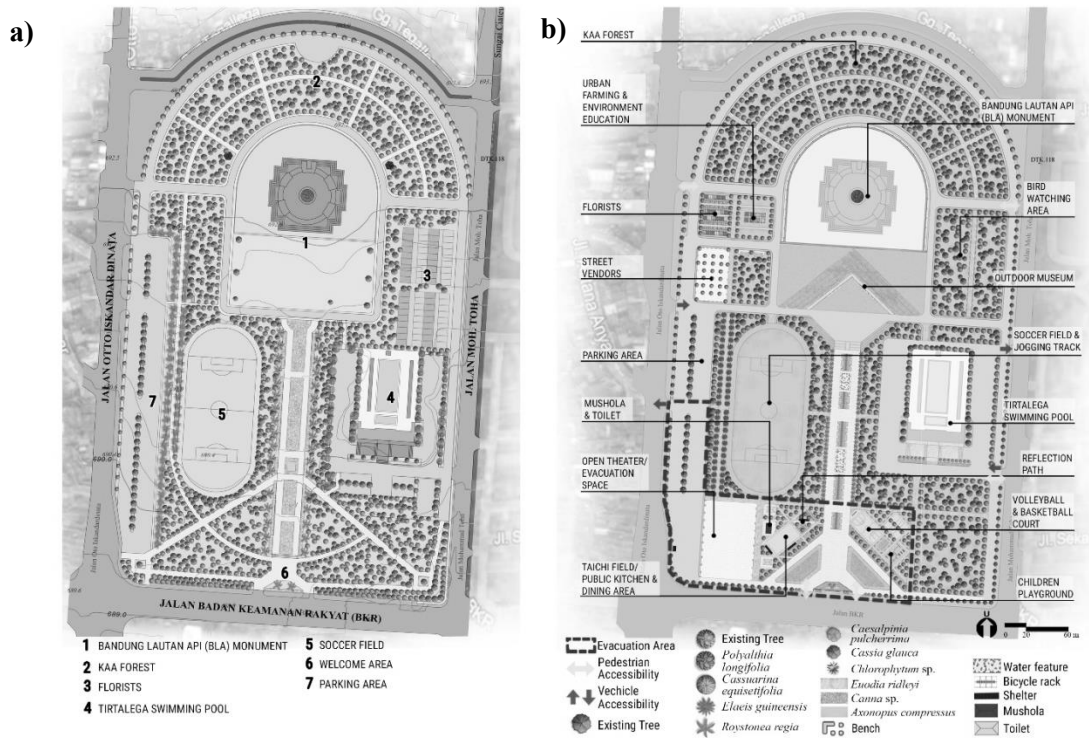


Figure 6. a) Basemap (before re-design); b) Siteplan of Tegalega Park

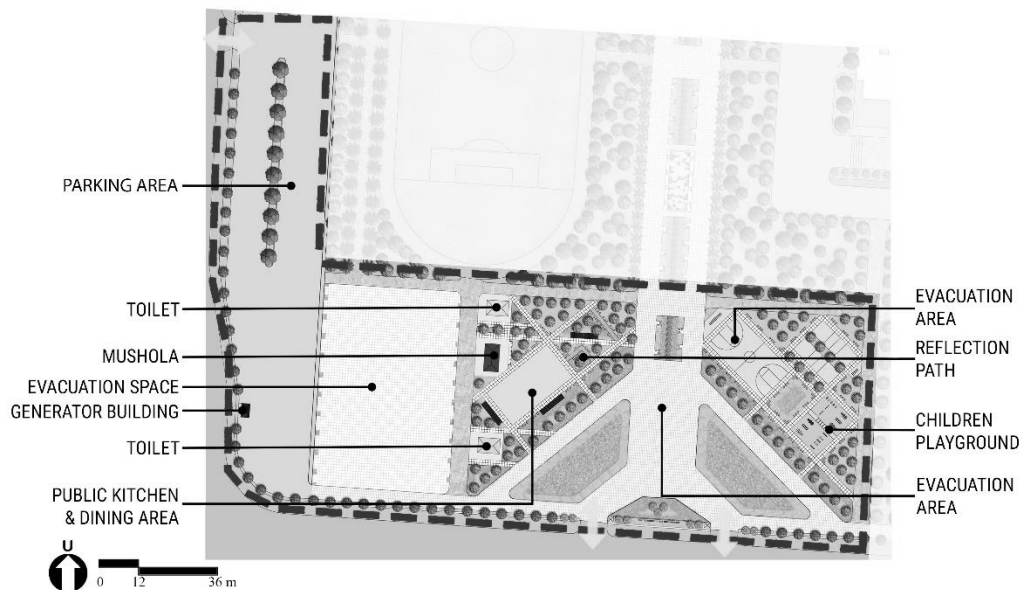


Figure 7. Siteplan of Evacuation Area

The open theater space will be functioned as tent area in flood period. Each tent's width is $5 \times 12 \text{ m}^2$ with capacity of 30 refugees. The area was also planned as disaster post and health center to accommodate the refugees. Velbed or folding bed is prepared in the health center for sick refugees. The area for evacuation tent use concrete pavement material with *Euodia ridleyi* as a border vegetation. This area has a total area of $3.415,58 \text{ m}^2$.

The evacuation area was also planned to accommodate utility area for public kitchen and dining area. This area will have a total area of 420 m^2 and used as a common field in a non-evacuation day. The base of each gazebo will be used as a logistic storehouse. Children playground and reflection path were planned as attractive recreational facilities for children and adults. Those facilities were provided for entertaining the refugees and eliminate post-disaster trauma experienced by refugees.

Mushola (praying room) and toilets were located beside the evacuation tent area. The Mushola was 55 m^2 and used by refugees for praying. There were two toilets provided for women and men, each consists of eight rooms. Based on UNHCR Emergency Standards and Indicators [13], one toilet is estimated to be used by 20 people in turn.

Parking area in evacuation site is used to park the ambulance, water wagon, and garbage container truck. This area is also used to put the portable toilets. There is emergency generator building near the parking area. This is used as additional electricity if is needed. The perspectives of every facilities are presented in figure 8.



Figure 8. Design Perspectives of the Evacuation Facilities

3.3.4. Carrying Capacity.

The carrying capacity calculation was used to estimate how much people or units can be accommodated in the evacuation area. The standard requirements of evacuation facilities refers to the standard preparation of mitigation space from Garden and Funeral Office of Jakarta [14] and United Nations High Commissioner of Refugees (UNHCR) [13] with modification. The result of carrying capacity calculation, facilities, and standard needed are presented in tabel 2.

Tabel 2. Carrying Capacity of each Facilities in Evacuation Area

No.	Facilities	Area(m ²)	Quantit y	Total Area (m ²)	Standard(m ² /person) / (m ² /unit)	Carrying Capacity
1	Evacuation Tent Area	3415.58	1	3415.58	84	40 tents
	Refugee Tent	60	38	2280	2	1140 persons
	Disaster Post	60	1	60	2	30 persons
	Health Center	60	1	60	2.5	24 persons
2	Basketball Court*	420	1	420	84	5 tents
	Refugee Tent*	60	5	300	2	150 persons
3	Front Plaza of Wellcome Area*	1008	1		84	12 tents
	Refugee Tent*	60	10	600	2	300 persons
	Disaster Post*	60	1	60	2	30 persons
	Health Center*	60	1	60	2.5	24 persons
4	Dining Area	420	1	420	1	336 persons
5	Public Kitchen	20	1	20	2	8 persons
6	Children Playground	248.1	1	248.1	10	24 persons
7	Reflection Path	20.25	1	20.25	10	2 persons
8	Mushola	55	1	55	1	55 persons
9	Toilet	44	2	88	4	16 toilets
10			1	5142.3		
	Parking Area	5142.34		4		
	Army Truck	25.5	10	255	25.5	10 units
	Ambulance	10	3	30	10	3 units
	Water Wagon	18	3	54	21	3 units
	Portable Toilet	4	15	60	4	15 units

*Additional spaces for evacuation tent in case the refugee increase

4. Conclusion

Tegalega Park is suitable area for evacuation because it is not located in flood prone zone, far from hazardous area, and near with hospitals. Evacuation route from Dayeuhkolot sub-district to Tegalega Park can be reached by Mohammad Toha Street as a main route with 6,35km distance and Cibaduyut Raya Street as an alternative route with 6,74km distance. Tegalega Park as evacuation area can accommodate 1.590 people of refugees.

The re-design of Tegalega Park was aimed to establish a city park which not only functions as recreational, historical education, and public green open space but also for resilient mitigation, that is evacuation space for flood disaster refugee. There were facilities designed to fulfill the functions of Tegalega Park as an evacuation site, such as evacuation tent area, disaster post, health center, public kitchen and dining area, children playground and reflection path, parking area, and generator house. Last but not least, the design concept of Tegalega Park is taken from shapes of Bandung Lautan Api Stilation which aims to strengthen historical value of Bandung Lautan Api history.

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