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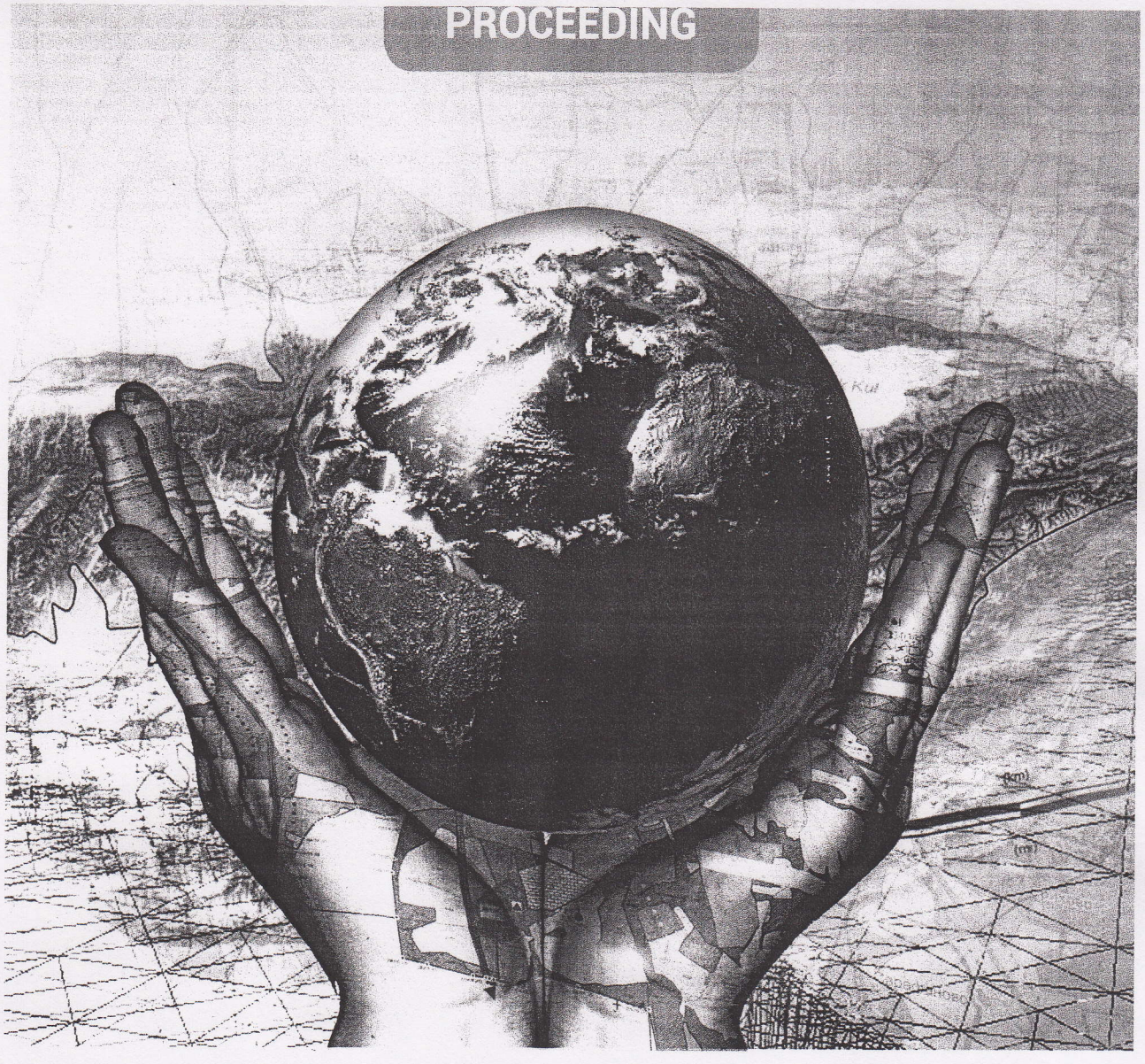
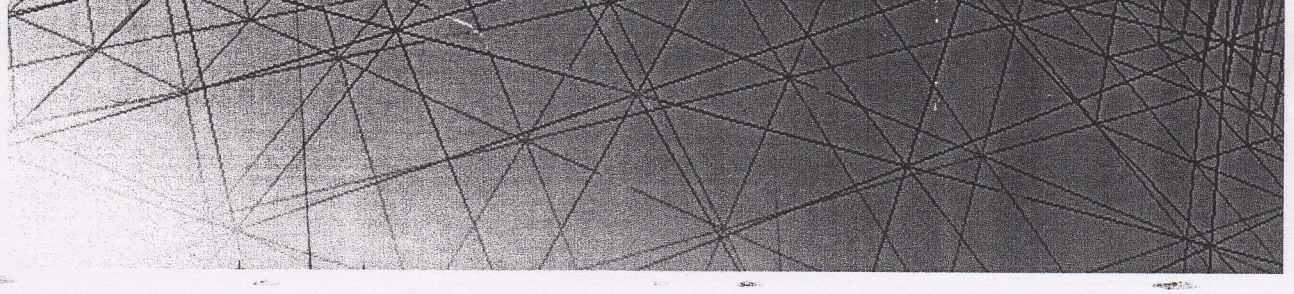


Geospatial and Human-Dimensions on Natural Resource Management



Settlement Landscape Planning for Earthquake Mitigation at Sub District of Pengalengan, Regency of Bandung*

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ABSTRACT

As one of the big archipelago which lies on the ring of fire zone and continental faults, earthquake often occur and cause fatal damage in Indonesia, include the earthquake occur in southern of West Java at September 2, 2009 with magnitude 7,3 RS. Following those infrastructure damage caused by earthquake happened in all village of Pangalengan Sub District, a predetermine effort for earthquake mitigation should be developed. The objective of research is to prevent or reduce damage caused by earthquake by arranging settlement landscape planning base on earthquake mitigation at Sub district of Pangalengan, Regency of Bandung.

The research using modified METLAND (the Metropolitan Landscape Planning Model Study) approach. This approach attempts to deal with preservation, protection, and development type of land use recommendation, respectively. Sequence of those three-phase process used to generate the following categories: (1) critical natural resources to preserve soil, surface and underground water, (2) hazard zones to protect earthquake hazard region from development or used to be limited, and (3) development for all areas to found suitable for development.

The result of study found that Pengalengan region predominantly characterized by suitable area for development. Those most safe area to built settlement and infrastructure identified as A's typology area (Ministerial Decree of Public Works No. 21/PRT/2007). This typology is useful to develop landscape planning for settlement area. The landscape planning, consist of spatial arrangements of settlement and infrastructure, evacuation and circulation, and green open space.

Keywords: settlement, earthquake mitigation, METLAND, critical natural resources, hazard zone, development suitability, landscape planning

Introduction

As one of the big archipelago which lies on the ring of fire zone and continental faults, earthquake often occurred and caused fatal damage in Indonesia. The big earthquake with magnitude 7,3 RS occurred in southern of West Java at September 2, 2009. The wave spread along to most part of West Java from Tasikmalaya to Jakarta.

One of area hit by the earthquake is Pangalengan. Loss of human life, and damage of buildings, homes, infrastructure caused by earthquake happened in all villages within of Sub District Pangalengan. Those human deaths, loss of properties and damage to structures following the earthquake disaster, caused by lag consideration to disaster prevention factor into spatial planning. Spatial development on landscape hazard, such as geologic fault, is subject that development to the hazard it self.

Following those damage, a predetermine effort for earthquake mitigation should be developed through spatial planning framework. The spatial planning, such as landscape planning, that considers natural hazards threatening a certain area as well as the vulnerability of this area should be developed.

Objective of study

The objective of study is to prevent or reduce damage caused by earthquake by arranging settlement landscape planning base on earthquake mitigation at Sub District of Pangalengan, Regency of Bandung, West Java.

Method

Study Site

The study site was located in Sub District of Pengalengan, Regency of Bandung, West Java. The site is laid on 107° 30' 00" East Longitude- 107° 38' 00" East Longitude and 07° 07' 00" South Latitude- 07° 18' 00" South Latitude (Figure 1). It was conducted from June 2010 up to January 2011.

Data and Analysis

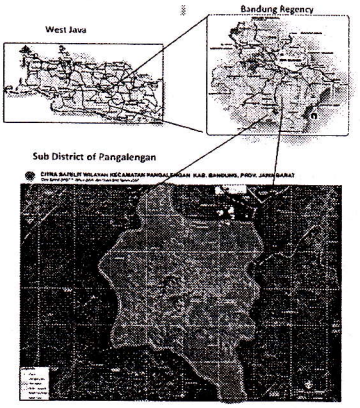

Figure 1. Study site in Sub District of Pengalengan, Regency of Bandung, West Java

The study consist of four stages, i.e. (1) Preliminaries study, (2) Field survey, (3) Analysis, and (4) Planning development. Preliminary studies were conducted by collecting, compiling spatial and attribute data, and preparing thematic maps. Field survey was conducted for verification, field checking and collecting field data.

Analysis was conducted base on METLAND (Metropolitan Landscape Planning Model) through the following procedure to generate three categories: (a) Identification of critical natural resources to preserve soil, surface and underground water, (b) Identification of hazard zones to protect earthquake hazard region from development or used to be limited, and (c) Identification development for all areas to found suitable for development (Fabos and Caswell, 1976)

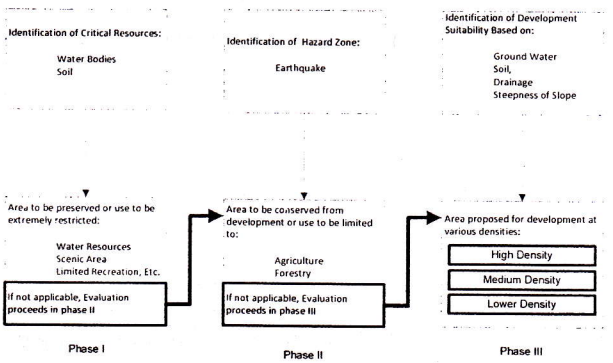

Figure 2. Framework of landscape analysis for preservation, conservation and development of site (after Fabos and Caswell, 1976)

The sequence of landscape analysis have designated the area should be preserved, conserved and suitable to development, respectively (Figure 2). Identification of critical resources designated the area to be preserved or use to be extremely restricted (Phase I). It is deal with two type of resources, i.e. water resources and soil. Both critical resources were analyzed base on formal criteria for determine of protective area (West Java Province

Regulation No. 2 Year of 2006 concerning Management of Protective Area), and in addition the criteria for assessing ground water quality (Fabos and Caswell, 1976) was aslo applied for water resources.

The hazard zone (Phase II) refer to earthquake vurnerability base on Guideline of Spatial Planning for Mountain Eruption Vulnerability Area, and Earthquake Vulnerability Area (Ministerial Decree of Public Works No. 21/PRT/2007). The earthquake vurnerability deal with two variables, i.e. geological information and stability assessment.

The geological information consist of four factors, i.e. physical rock properties, slope, earthquake intensity, and structural geology (existing fault). Those geological factors were composed to procedure earthquake vurnerability maps base on capability value and weigthed mentioned on the guideline. Capability values refer to the stabilize capability of geological factors to the earthquake. The weighted value refer to the level of importance of geological factor to determine hazard zone.

The stabilities assessment dealt with determine the level of area stability to earthquake hazard. Combination between capabilities value and weighted for each geological factor determines the score of such factor. Base on cumulative score for all those four geological factors determine the level of stability. Level of stabilities of the area to earthquake can be classified into 6 (six) typology of land capabilities rating, i.e. A, B, C, D, E, and F as mentioned in the guideline. Those typologies of land capabilities rating reflect the Earthquake Vurnerability.

The area classified as A's typology was suitable to development (Phase III). The remain area designated as hazard zone. Planning development was dealt with the area designated as suitable area for settlement (the A's typology). The landscape plan organized spatial arrangement for settlement, public facilities (such as school, health, sport), infrastructure, evacuation zone, circulation, and green open space.

Result And Discussion

Identification of Critical Resource for Protection

Identification of critical resource for protection refer to water and soil protection. Sub District of Pangalengan is located in up stream of CiTarum river basin. There are some water resouces, such as lake, water spring and wetland area. Since Pengalengan predominantly laid on recharging area, protection of those water resources is needed. As critical

resources, those surface and sub surface water can be preserved through designated protection area base on criteria mentioned in Local Goverment Regulation No. 2 Year of 2006 and ground water quality assessment technique (Fabos and Caswell, 1976) (Figure 3). Those protective area should be prevented from any development and agriculture activities which are potentially decreased the quality of water. There are soil resources of Pengalengan area that identified as critical resource in term of land vurnerable to landslide and considering as protected area (Figure 4).

By overlaying both critical resources, water (Figure 3) and soil (Figure 4), will be considered as critical resources to be preserved or use to be extremely restricted (Figure 5). Figure 5 shows the area should be prevented to any physical development.

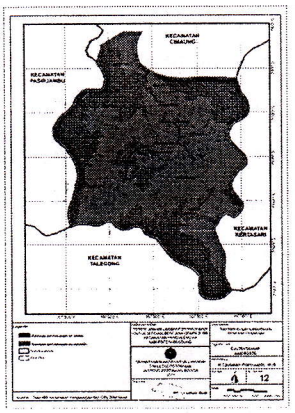

Figure 3. Map of Protected Water Resources

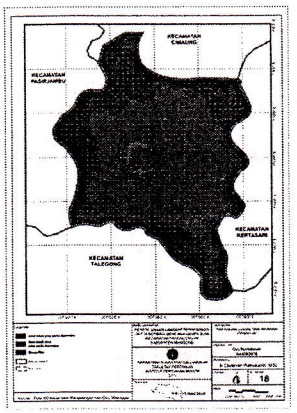

Figure 4. Map of Protected Soil Resources

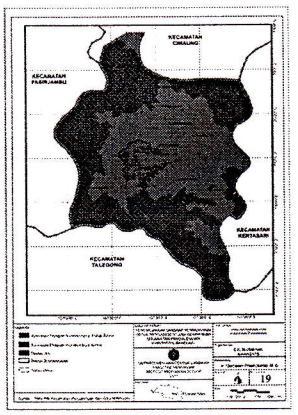

Figure 5. Map of Critical Resources to be Preserved

Identification of Hazard Zone

Refer to the geological information and stability assessment, there are 3 (three) hazard zones found in Sub District Pengalengan i.e. Typology A, B, and C (Figure 6). Area designated as Typology A located at a distance from fault line. When earthquake with high intensity occurred, geological characteristics factors (such as consolidated and strength rock properties) will reduce the level of damage. While on typology B, high intensity of earthquake will increased level of vulnerability as result of collective effect of geological factors. The typology C have, at least, two dominant factors to the effect increasing vulnerability level, i.e. high earthquake intensity and the weak rock properties or combine both the weak of rock properties and close to active fault line.

Identification of Land Suitable for Development

By considering the guideline (Ministerial Decree of Public Works No. 21/PRT/2007), those three hazard zones exist in study area have different typology of Land Capability Rating. The area classifed as Typology A is the most lagest area in Sub District Pengalengan. It is cover about 24.018,72 ha (88%) of total area. Refer to the guideline, the typology A is suitable to development. It is recommeded that the area can be developed as settlement, public facilities (such as bussiness area and office area), tourism area, production forest, community forest, agriculture area (such as paddy field, annual and perennial crop, animal, fishery) and mining area as well. By considering to the area which is classified as Typology A to be the most safety area within the earthquake vulnerability area, the other typology (B and C) will be considered as u*nsafety* area (Figure 7).

Identification of land suitable for development also consider topographical factor. Considering slope classification (Noor, 206) designated land suitability to any development use. By ***overlaying*** a set of ***map, i.e.*** Map of Critical Resources to be Preserved (Figure 5), Map of Savety Area to Earthquake (Figure 7), and Slope Class Map, the Land suitable for development can be designated as shown in Figure 8.

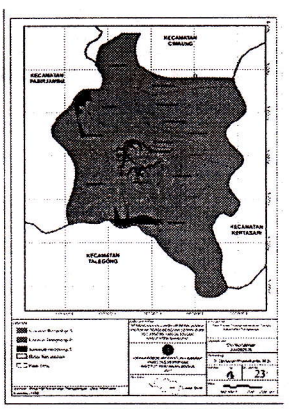

Figure 6. Map of Earthquake Vurnerability Area (Typology of Land Capability Rating)

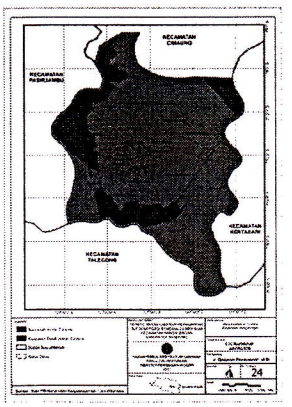

Figure 7. Map of Savety Area to Earthquake

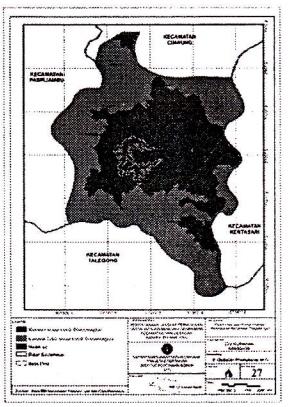

Figure 8. Map of Suitable Area to Development

Landscape Planning for Settlement

Development of landscape planning for Settlement considered the area suitable to development (Figure 8). Existing land use before earthquake (at September 2, 2009) almost coincide with the area designated as suitable land to development (Figure 8). Those

area cover 5 (five) village, i.e. Desa Pangalengan, Desa Margamukti, Desa Sukamanah, Desa Margamekar, dan Desa Margamulya, which serious damage when earthquake occurred. The landscape planning for settlement focused on those five villages (Figure 9).

Planning Concept

Development of Mitigation concept base on regulation of zoning as mentioned in guideline. There are three main land utilization type have proposed, i.e. cultivated area, built up area, and conservation area. Land utilization for cultivated focused on agriculture, estate crops, and forestry. The buitd up area utilized to structure and infrastructure for settlement development. Conservation area utilized as buffer of water resources. Figure 10 shows the Back Plan of those land utilization types.

Evacuation concept has developed on open spaces within settlement areas. Base on location and capacity, there are three type evacuation zone, i.e. macro, meso and micro.

Circulation concept has developed base on ensuring it's easily to escape in an earthquake disaster *through accessible circulation system. T*he *road network system* for an *evacuation* area proposed *should be simple, broad, not confuse, and prevent disorientation.*

Hierarchically, there are three type of access road, i.e. community road, local road, and collector road (Figure 11).

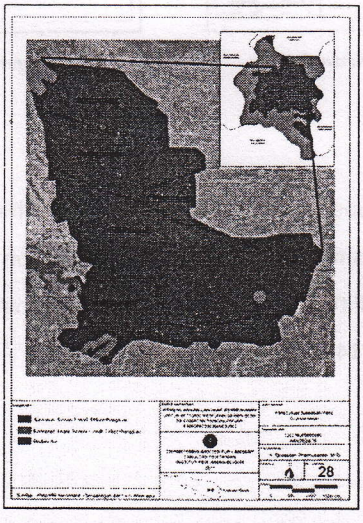

Figure 9. Landscape Planning Area focused on five Villages

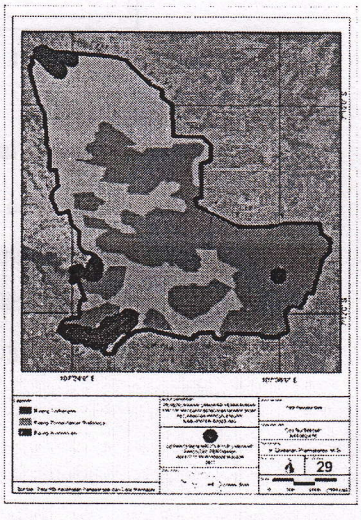

Figure 10. Block Plan of Land Utilization Types

The greenery concept has proposed to prevent or reduce damage caused by earthquake and to support in disaster relief as well. There are 4 (four) vegetation functions have proposed (Figure 12), i.e. (a) cultivated crop (such taro, yam, potatoes, cassava, sweet potatoes etc) as source of food during disaster relief, (b) conservation plant to protect the water catchment area and vulnerable land to mass movement, (c) border plant to navigate the refugee through the circulation network, (d) shading plant to ***protect*** the refugee ***from*** exposure to sun and climate amelioration.

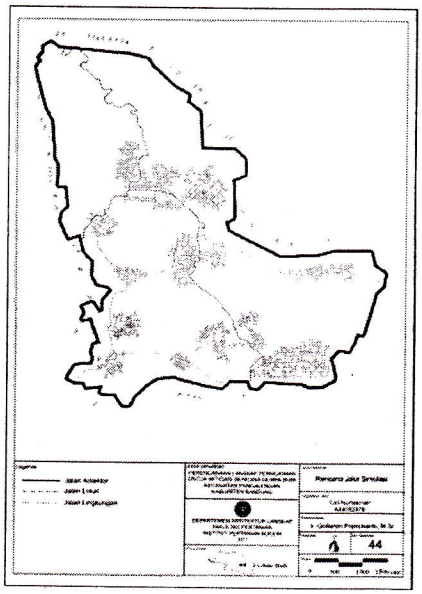

Figure 11. Circulation Network Plan

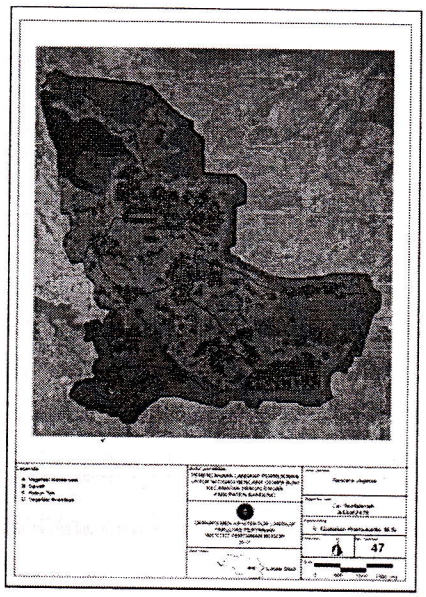

Figure 12. Greenery Plan

Landscape Planning

Landscape plan has developed to prevent earthquake within settlement area consist of spatial arrangement of housing, evacuation zones, circulation network base on evacuation area, other facilities and utilities, such as school, hospital, market, police office, and green open space (Figure 13 and 14).

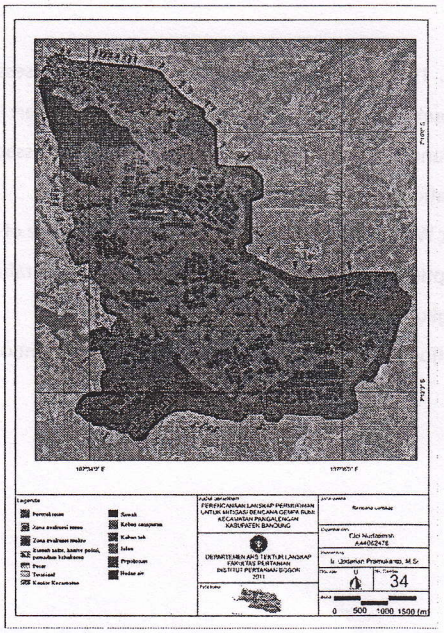

Figure 13. Landscape Plan for Settlement

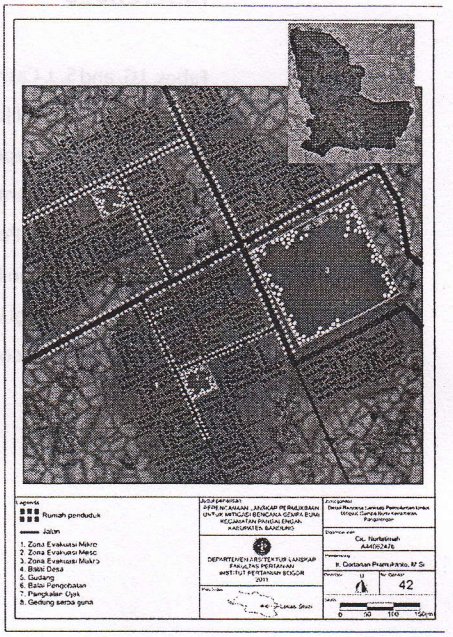

Figure 14. Detail Landscape Plan (Part)

Conclusions

The sequence of landscape analysis through METLAND (Metropolitan Landscape Planning Model) procedure has identified and designated the area should be preserved, the area to be conserved from development (hazard zone) and suitable to development, respectively. Refer to the land suitable to development can be proposed landscape planning for settlement base on preventing or reducing damage caused by earthquake at Sub District of Pangalengan, Regency of Bandung, West Java.

Settlement landscape plan focused on 5 (five) villages, which suffered serious damage when earthquake occurred at September 2, 2009. The landscape plan proposed spatial arrangement of housing, evacuation zones, circulation network base on evacuation area, and other facilities and utilities such as school, hospital, market, police office, and green open space.

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