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Evaluation of land use to critican Batang Kuranji watershed in Padang City

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Abstract. This study aims to 1). find out the land use index 2). analyze the suitability of land use based on land capability, 3). How is the spread and extent of critical watersheds 4). calculate the level of erosion hazard in the Padang City Kuranji Watershed. This research uses quantitative descriptive method. Quantitative analysis is done by classifying, scoring, and weighting with existing scales and criteria. Samples are taken based on land units obtained from overlapping maps of landform units, slopes, land use, land and geology. The results showed 1). there are three classes of land use index, namely good class 11,375 km² (97.23%), medium class 37.50 km² (43.91%) and bad class 214.22km² (16.71%). 2). suitability of land use consists of two classes, namely: Appropriate class 19,099 km² (85.97%) and class not appropriate 3.13 km² (14.3%). 3) there are three classes to watershed criterion namely uncritical class (70.94%), critical potential class (24.54%) and critical class (4.53). 4). erosion danger level there are five classes: Very light (68.64%), Lightweight class (9.75%), Moderate class (14.68%), Weight class (4.79%) and Very Heavy class (2, 14%).

1. Introduction

Land criticality has occurred in many regions, this is one of the consequences of population growth that requires land for their livelihood, both for settlements as well as for business. The lands that were formerly used as buffer or conservation land, are now replaced by built land, as a result this change often brings problems for the many communities around them, namely the occurrence of groundwater and river droughts, floods and landslides. Likewise with increasing the air temperature in a watershed

The watershed management program (DAS) in Indonesia has been started since Pelita I of the new order period of the 70s which was implemented in the form of reforestation and reforestation projects. The first activity began in 1973 in the form of the Upper Watershed Management and Upland Development Project in the Bengawan Solo Watershed with the assistance of FAO / UNDP. Whereas lately a watershed management project carried out by the government under the Ministry of Forestry is the National Movement for Forest and Land Rehabilitation (GNRHL / GERHAN) since 2003. The watershed management activities have sought to maintain and improve the quality of watersheds in



Indonesia so they can be used sustainably. But the reality on the ground shows that watershed conditions in Indonesia are getting worse and the problems are increasingly complex ^[1].

Watershed problems in Indonesia often do not guide the direction of land area functions which eventually cause various natural disasters. The description of the condition of the watershed in Indonesia which is increasingly damaged can be observed based on the number of priority watersheds that are increasing from year to year. In 1984 of the 458 watersheds in Indonesia there were 20 super priority watersheds (Priority I) and 37 in 1992. In 1999, the number of priority I watersheds increased to 60 watersheds. 2006 increased to 108. [1]

In the city of Padang there are 4 watersheds that often bring various disasters to the community, namely, Air Dingin Watershed, Kuranji watershed and Arau watershed and Kalumpang watershed. According to PP No. 17 of 1980, the area of Padang City was 694.96 Km² The effective area including the river was 205,007 km², while the area of the hilly area including the river was 486,209 km². Padang City consists of 11 Districts and 103 Villages with the widest sub-district is Koto Tengah which reaches 232.25 Km². Of the total area of Padang City, most or 52.52% is in the form of forests protected by the government, in the form of buildings and yards covering 9.01% or 62.63 km², while those used for paddy fields cover 7.52% or 52.25 km² [2].

Land use in Padang City can be grouped into 3 categories, namely forest land, rice fields and non-rice fields. More than 51% of Padang City's land is in the form of forests, but there are some places in urban areas that are not properly used by the community, so often causing landslides, especially in the Kuranji watershed such as land clearing, agricultural activities, development of residential areas, trade or services. which is not in accordance with environmental concepts. Efforts to utilize protected areas into cultivated areas are increasing. In addition, there is still a tendency for people to use shifting cultivation systems as well as land clearing for agricultural purposes and built-up areas [3], which has the potential for floods and landslides as had happened several years earlier.

In the use of space for various activities in the city of Padang, there are various problems such as the conversion of forest land into residential land and gardens, development that violates established boundaries and development that is not in accordance with land use, land use in the area along the watershed can interfere with the ecological function of the watershed so that the impact on residential areas downstream. Batang Kuranji watershed has an area of 22,544 ha [4]. Throughout 2008-2009, showed runoff coefficient value (c) and the River Regime Coefficient (KRS) was high, so that it could be said that the watershed conditions were bad. Therefore the watershed includes the Super Priority Watershed. The last Banjir Bandang on July 24, 2012, caused high runoff, large erosion and sedimentation. Based on these problems, it is necessary to do research with the title "Evaluation of Land Use Against the Criticality of Batang Kuranji Das in Padang City"

2. Research Methods

2.1. The materials used in this study are as follows:

Basic map for research: Padang Sheet Topographic Map (0715-32) Scale 1: 50,000 in 1984, Solok Sheet Topography Map (0815-11) Scale 1: 50,000 in 1984, Map of the Land Type of Padang City Scale 1: 100,000 in 2008, Padang City Land Use Map Scale 1: 100,000 in 2013, Geological Map of Padang City Scale 1: 100,000 in 2008, 2012 Padang Quickbird Image g) DEM (Digital Elevation Model)

2.2. Research Sample

Samples were taken based on the land unit map found in the Padang City Kuranji Watershed. Maps of watershed land units are obtained from overlapping maps of landform units, slopes, land use, types of soil and geology. Determination of samples drawn by purposive sampling is withdrawal based on calculations, namely samples taken as much as one sample per unit of land. The land unit sample in the study area was 26 land units. The type of data needed is; Slope, soil texture, effective depth of soil, drainage, crop management taken from the everlay map and primary data in the field.

To determine watershed criticality, Landsat TM +8 satellite imagery, thematic maps and topographic maps were corrected and analyzed, both visually and digitally for the Kuranji sub-watershed. After identifying the location of the observation from the field data taken then do a scoring for each parameter. After that, do the overlay process of the maps with the Geographic Information System so that the critical watershed level can be obtained in the Kuranji watershed division.

Critical watershed analysis all these parameters are scored. The critical level of watershed in terms of land use is based on the total score of the parameters used with the following formula or model:

$$\Sigma = \text{IPL} + \text{KPL} + \text{TBE} + \text{PL} \quad (1)$$

Where:

IPL : Index of Land Closure by Vegetation
 KPL : Suitability of Land Use
 TBE : Danger Level of Erosion
 PL : Land Management

To determine the critical level of watershed in the Kuranji watershed, the scoring and weighting method is used where the score of each critical land parameter is multiplied by the weight of each critical land parameter.

Table 1. Total Score on watershed criticality level

No	watershed criticality	Score
1	Critical	4 - 9,3
2	Critical Potential	>9,3 - 14,7
3	Not Critical	>14,7 - 20

3. Research Results and Discussion

3.1. Land Use Index in the Kuranji Watershed of Padang City

Land use in the Kuranji watershed is mostly used for forests by 59.87% and only 7.78% is used for settlements, for details, see table 2.

Table 2. Use of watersheds. Kuranji

Land Use	Area (km ²)	%
Forest	133,63	59,87
Settlement	17,36	7,78
Garden	19,98	8,95
Rice Fields	52,24	23,40
Quantities	223,22	100

Permanently restricted watershed area is obtained from the land use map of 1: 150,000 scale in 2013. The permanent vegetation referred to is annual crops and forests that function as protection or conservation. The land use index is obtained from a permanent vegetation map with a watershed map. The next stage is to calculate the area of permanent vegetation and sub-watersheds divided by the area of the sub-watershed. The classification of land use index in the Kuranji watershed can be seen in the sub-watershed table 3.

Table 3. Land Use Index (IPL) of the Kuranji Sub-watershed

No	Sub Watershed	LVP (Ha)	Area Sub Watershed (Ha)	Percentage (%)	IPL
1	Watershed Kuranji	2250,58	5501,11	40,91	Medium
2	Sub Watershed Belimbing	524,15	892,73	58,71	Medium
3	Sub Watershed Limau Manis	3040,9	3129,33	97,45	Good
4	Sub Watershed Lubuk Gajah	976,00	3039,63	32,11	Medium
5	Sub Watershed Padang Janiah	2120,07	2126,07	99,72	Good
6	Sub Watershed Padang Karuah	4733,00	4738,93	99,88	Good
7	Sub Watershed Sapih	214,22	1282,21	16,71	Bad
8	Sikabu Gadang	1481,36	1612,82	91,86	Good
	Jumlah	15340,28	22322,83	68,72	Medium

LVP: Permanent Vegetation Areas

Land use in the Kuranji watershed can be divided into 3 classes of indices, namely: "Good" index class where permanent vegetation in a large watershed of 75% is spread in the Padang Karuah Sub-watershed, Sikabu Gadang Watershed (91.86%) Sub Lake Limau Manis watershed (97%) and Padang Janiah sub-watershed, with an average index class of 97.23% and all land area of 11.375 km².

"Medium" Index where permanent vegetation in the watershed 30% -75% is spread in the Belimbing Sub-watershed, Lubuk Gajah Sub-watershed, and Kuranji watershed with an average index class of 43.91% covering 3.750 km², while index-class land use "Ugly" scattered in the Sapih Sub-watershed with index class 16.71%, the number of permanent vegetation is less than 30%, the dominant land use in this area is settlements and rice fields. Overall class of overall land use index of watershed. Bt. Kuranji is "Medium".

3.2. Land Use Suitability (KPL)

The suitability of land use in the Kuranji watershed consists of 2 classes, namely: "Appropriate" class (85.97%) which is scattered in frictional shoals, alluvial and volcanic plains, where this area is dominated by forest land cover, rice fields and plantations. Class "not suitable" (14.03%) spread in alluvial plains and alluvial fans with residential land use, plantations and rice fields with large erosion. The suitability of land use in the Kuranji watershed can be seen in the table 4.

Table 4. Suitability Level of Use of Kuranji Watershed

No	Suitability Level of Use	Area Amount	Amount (km ²)	%
1	accordingly appropriate	191,99		85,97
2	not appropriate	31,32		14,03
	Amount	223,31		100

Source: Primary Data Processing 2018

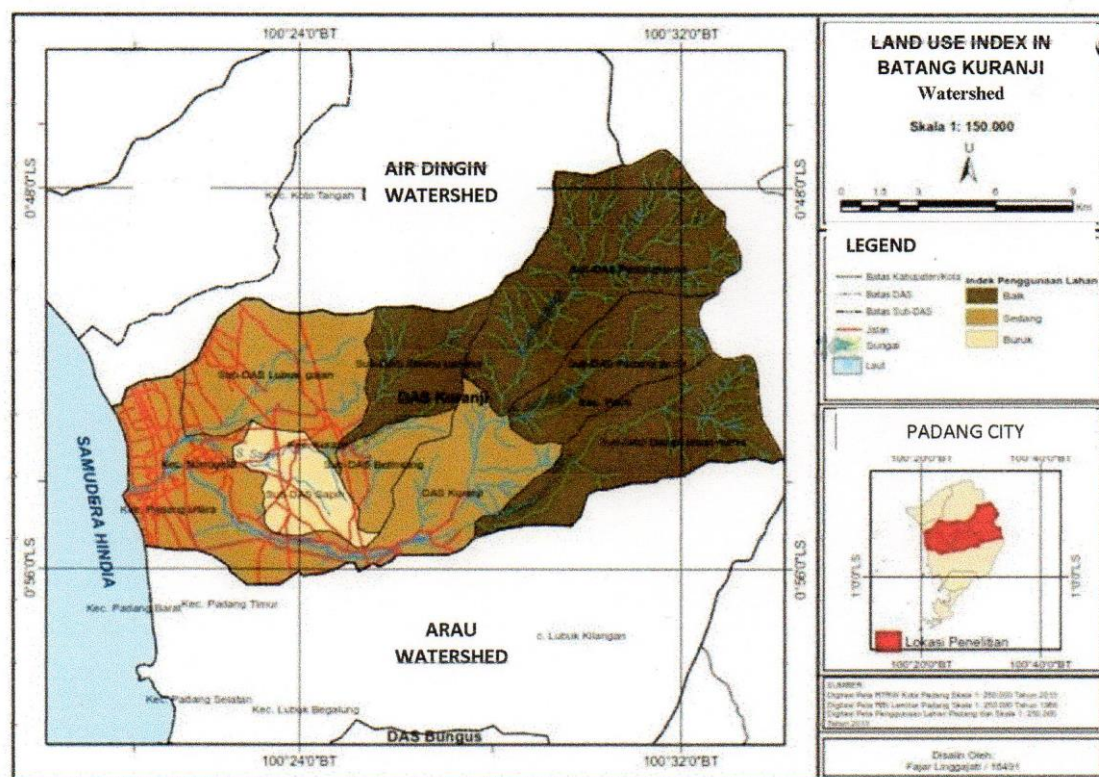
3.3. Distribution and Extent of Critical Watersheds

The criticality level of the Kuranji watershed consists of 3 classes: "uncritical" class (70.94%) spread in the form of volcanic land, critical potential class (24.54%) spread in the central part of the Kuranji watershed with the use of rice fields and plantations, and Critical class (4.53%) is spread in alluvial fan land area with residential land use, plantations and rice fields. For more details, see Table 5 and map critical watershed levels.

Table 5. Watershed criticality level

No	Watershed criticality level	Area (ha)	%
1	Critical	1011,06	4,53
2	Critical Potensial	5478,78	24,54
3	No Critical	15840,00	70,94
	Amount	22329,84	100

Land at a critical level is generally characterized by turbid river flow caused by the amount of sedimentation due to lack of permanent vegetation and the amount of erosion in the area around the river, also due to inappropriate land use, both based on the damage and geology.

**Figure 1. Map of Land Use Index in Batang Kuranji Watershed, Padang City**

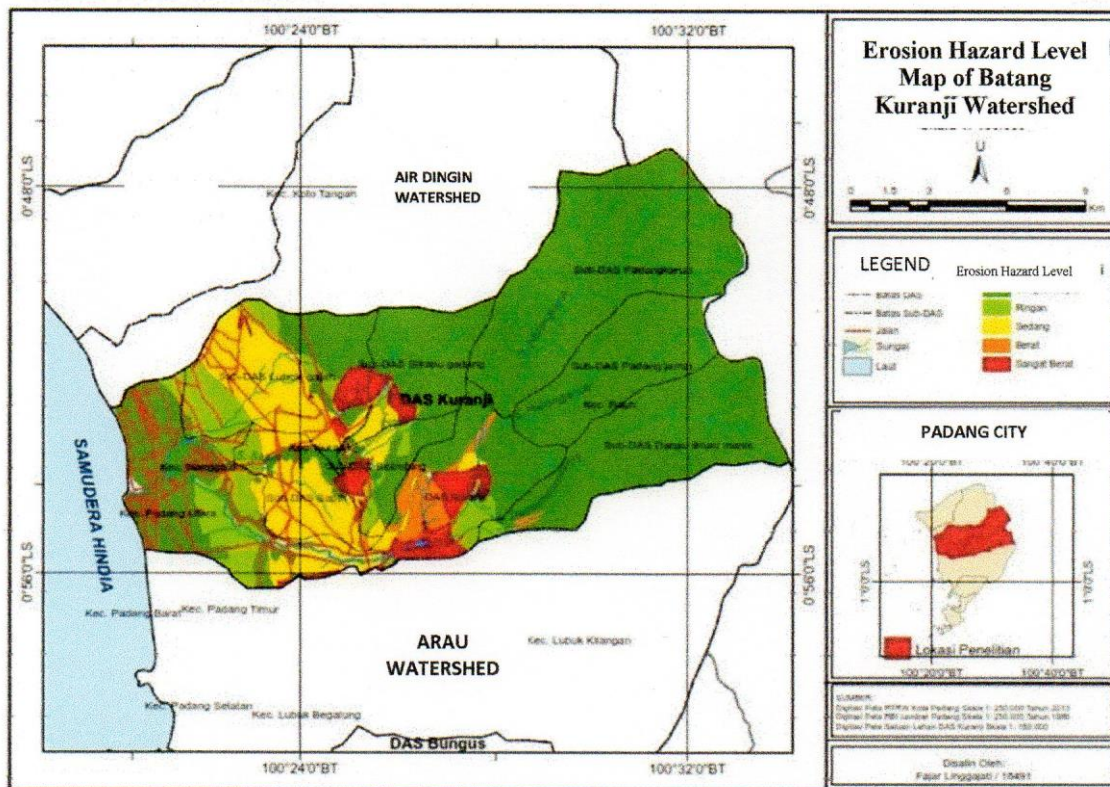
3.4. Danger Levels of Erosion

There are 5 classes of erosion hazard in the Kuranji watershed: Very light (68.64%) spread in the middle part of the watershed with the use of plantation land and rice fields with flat slope, Lightweight (9.75%) scattered in the alluvial fan area with use of plantation land and rice fields, Medium class (14.68%) spread in the middle area of watershed and volcanic central slope with forest land use, Weight class (4.79%) spread in alluvial fan areas with forest land use and very steep slope, Very Heavy class (2.14%) spread in alluvial fan areas with residential land use, plantations and rice fields. More details can be seen in table 6 and the map on the next page.

Table 6. Danger Level of Erosion

No	Danger Level of Erosion	Area(ha)	%
1	Very Mild	15328,24	68,64
2	Mild	2178,21	9,75
3	moderate	3179,37	14,68
4	Heavy	1068,95	4,79
5	Very Heavy	477,36	2,14
	Amount	22332,13	100

The high erosion in the study area was caused by the shallow soil solubility in the upper part of the Kuranji watershed and the degree of slope. To reduce erosion, the forest in this area must be maintained and the community is prohibited from clearing land for other purposes. Erosion hazard land distribution can be seen in figure 2.

**Figure 2.** Erosion Hazard Level Map of Batang Kuranji Watershed in Padang City

4. Conclusion

From the results of research that has been obtained in the Padang City Kuranji Watershed, conclusions can be drawn as follows:

- There are 3 classes of land cover index in the Kuranji watershed namely good class 11,375 km² or 97,23%, medium class 3750,73 km² or 43,91% and bad class (214,22 km²) or 16,71%
- The suitability of land use in the Kuranji watershed in many downstream areas that do not match what, residential land use, rice fields and plantations are found in the land suitability

class of class V-VIII. There are 3132.41 ha or 14.3%. land that is not suitable for the Kuranji watershed.

- c. There are three classes of watershed criticality in the Kuranji watershed namely 70.94% non-critical class, 24.54% critical potential class and 4.53% critical class.
- d. The erosion hazard level of the Kuranji watershed is classified as 4.79% by weight and very heavy by 2.14%. The greater erosion that occurs in an area will result in the loss of topsoil, covered soil pores, high run-off and the amount of sedimentation that adversely affects the watershed.

5. Suggestions

- a. At the location of the high watershed critical level it is recommended to make green open spaces and plant trees in the home garden.
- b. Land use by the community is as good as being able to guide land use maps to reduce the risk of landslides, drought and damage to soil structure.
- c. At the upstream part of the river, it should be carried out roboisasi and still be conserved in order to reduce damage to the watershed.
- d. In high erosion class locations, land clearing and existing protective vegetation should not be damaged and the community is prohibited from settling there for the safety of the risk of lonsor disaster.

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