A Study of the Watershed Management (Maintained and Restored) in Krueng Peusangan, Aceh Province, Indonesia

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Abstract

Natural resources such as forests, land and water are primary assets that should be maintained on the basis of the principle of sustainability and national benefits. Any development concerning natural resource management must be planned properly and directed in a watershed unit (DAS). Watersheds have different characteristics from one and another. It consists of size (area), elevation and slope (slope), aspect and orientation, the shape of the watershed and drainage network. Currently, stakeholders are not well handled by stakeholders, which is still technically (sectoral) and centralized. In line with the issue, it's important to study integrated watershed management to improve the community welfare in Aceh province, Indonesia. The purpose of this study is to identify the watershed management actions, including maintained and restored. This study is designed using cross-sectional data with a survey method which consists of four stages, i.e., preparation, preliminary survey, main survey, data analysis and result presentation. The data analysis carried out by utilizing the Classification of Watershed (e.g., criteria, sub-criteria and weighting). This study indicated that six sub-watersheds in the Krueng Peusangan must be restored, namely Krueng Celala, Krueng Meuh, Krueng Peusangan Hilir, Timang Gajah and With Balek due to watersheds are damaged, during drought and monsoon. In conclusion, this study has identified six sub-watersheds that needs to be restored across Krueng Peusangan, Aceh, Indonesia. Of these, some efforts must be made by the stakeholders, namely conserving soil on agricultural land, harvesting/ storing excess water during monsoon and utilizing it in drought. Also, promoting sustainable farming and stabilizing crop yields through improved agricultural systems management and improving ecological balance, including the relationship between upstream water management and downstream, water quality, land quality and capability and biodiversity.

Keywords

Natural Resource Management, Integrated Watershed Management (Maintained and Restored), Conservation Techniques, Watershed Classification.

1. Introduction

The utilization of natural resources of forests, land and water is one of the basic assets in national development that must be implemented based on sustainability and national benefits. Any development concerning natural resource management must be planned appropriately and directed in a watershed unit (DAS). Watersheds have different characteristics from one another (Heathcote, 2009). Watershed characteristics consist of size (area), elevation and slope (slope), aspect and orientation, the shape of the watershed and drainage network (Asdak, 2020). Currently, the handling of watershed problems is less and less well coordinated by all parties (Jessel, & Jacobs, 2005), where the handling of watersheds is still technically (sectoral) and centralized (centralized), while regionally the authority is under the Regional Government (PEMDA). Each agency projects and carries out programs/activities and develops its institutions. Given the strategic importance of a watershed in improving community welfare, it is necessary to carry out integrated watershed management. Watershed management must be carried out through planning, implementation, participation, community empowerment, funding, monitoring and evaluation (Johnson, Ravnborg, Westermann & Probst, 2002).

Judging from the criticality level of the land in the Krueng Peusangan watershed, the area of critical land is 81,258.55 hectares, a very critical area of 7,920.42 hectares, a slightly critical area of 84,222.01 hectares, critical potential of 69,119.58 hectares and a non-critical area of 7,216.40 hectares (Watershed and Protected Forest Management Center, 2020). From these data, it shows that the Krueng Peusangan watershed has been damaged, both physically, chemically and biologically, so that the land cannot function properly according to its designation as a production medium or as a water management medium. Seeing the current condition of damage to watersheds in Indonesia, watersheds must be maintained, and their carrying capacity must be restored. A watershed whose carrying capacity needs to be restored is a watershed with land conditions and water quantity, quality and continuity, socioeconomic, investment in water structures and spatial use in areas that are not functioning properly. In contrast, a watershed whose carrying capacity needs to be maintained still functioning properly. One of the watersheds in Indonesia, especially the watershed in Aceh that needs attention, is the Krueng Peusangan watershed.

1.1 Objectives

The purpose of this study is to identify the watershed management actions, including maintained and restored

2. Materials and Methods

This study was carried out in the Krueng Peusangan watershed, which crosses four districts: Aceh Tengah district, Bener Meriah district, North Aceh district, and Bireuen district. This research was started from July 2020 to December 2020. The tools used in this study consisted of ring samples, abney levels, GPS (Global Positioning System), ground drills, ring samples, stationery, a computer and ArcGIS software. 10.2 materials used in this study are the Krueng Peusangan watershed map, land use maps, topographical maps of land types, critical land maps (BPDASHL, 2020) and maps of protected areas and cultural areas (DLHK Aceh, 2020). While the data needed are rainfall data (BMKG Malikussaleh, 2020), Krueng Peusangan watershed discharge data (Aceh Irrigation Service, 2020), data on the number of poor people in the Krueng Peusangan watershed (BPS Aceh Tengah, BPS Bener Meriah and BPS Bireun, 2019). This study used a survey method consisting of 1) preparation stage, 2) preliminary survey, 3) primary survey and 4) data analysis and presentation of results. Analysis was carried out based on the Criteria for Determining the Watershed (Permenhut Number 60, 2014), determining the classification of the watershed on the basis of criteria, sub-criteria and weighting (Table 1).

Table 1. Criteria, Sub Criteria, and Weighting in Determining Watershed Classification.

No	Criteria / Sub Criteria	Weight
1	Land Condition	40
	A. Percentage of Critical Land	20
	B. Percentage of Vegetation Cover	10
	C. Erosion Index	10

2	Quality, Quantity and Water Continuity (Water System)	20
	A. Flow Regime Coefficient	5
	B. Annual Flow Coefficient	5
	C. Sediment Content	4
	D. Flood	2
	E. Water Use Index	4
3	Socioeconomic and Institutional	20
	A. Population Pressure on Land	10
	B. Level of Population Welfare	7
	C. Existence and Enforcement of Regulations	3
4	Water Investment	10
	A. Classification City	5
	B. Classification of Water Building Value	5
5	Spatial Use of Areas	10
	A. Protected Areas	5
	B. Cultivation Areas	5

Source: Minister of Forestry Regulation No. 60 of 2014

The criteria and sub-criteria (Table 1) above in its application require parameters that must be calculated. The results are classified into several classes. Each class is given a score that reflects the qualification of the indicators, from very low to low.

3. Results

On the basis of the results of classification processing in the Krueng Peusangan watershed, it appears that the Krueng Peusangan watershed is classified as Maintained and Restored. Based on the data obtained, the sub-watersheds that are included in the class classification to be maintained (score <100) are the Brawang Gajah Sub-watershed, Krueng Simpo Sub-watershed, Teupin Mane Sub-watershed, Ulee Glee Sub-watershed, With Brush Subwatershed and With Genengan Sub-watersheds. Meanwhile, the restored sub-watersheds (score> 100) are Krueng Celala sub-watershed, Krueng Meuh sub-watershed, Krueng Peusangan Hilir sub-watershed, Laut Tawar sub-watershed, Timang Gajah Sub-watershed and With Balek sub-watershed (Figure 1) handling is the problem faced in the upstream, middle and downstream parts, including the need for active participation in the upstream part to reduce sedimentation caused by upstream activities, and vice versa.
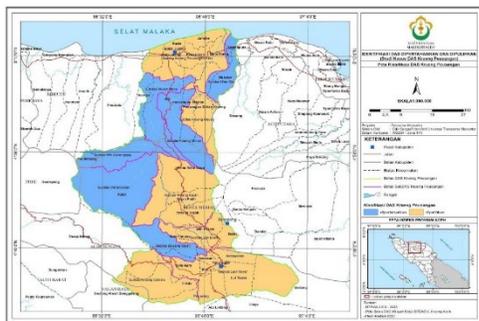

Figure 1. Peusangan Watershed

Another form of active participation is good coordination between sectors to manage the Krueng Peusangan watershed properly. Conservation techniques can be implemented on agricultural land include harvesting / storing excess water during the rainy season and utilizing it during the dry season, promoting sustainable farming and stabilizing crop yields through improved management of agricultural systems and ecological balance (relationship between upstream and downstream water systems, water quality, land quality and capability, and biodiversity).

4. Conclusion

In conclusion, the analysis of the Krueng Peusangan watershed classification shows that the Krueng Peusangan watershed is classified as Maintained and Restored. The sub-watersheds included in the class classification to be maintained (score value <100) are Brawang Gajah Sub-watershed, Krueng Simpo Sub-watershed, Teupin Mane Sub-watershed, Ulee Glee Sub-watershed, With Brush Subwatershed and With Genengan Sub-watersheds. While the sub-watersheds that were restored (score> 100) were the Krueng Celala sub-watershed, the Krueng Meuh sub-watershed, the Krueng Peusangan Hilir sub-watershed, the Tawar Laut sub-watershed, the Timang Gajah sub-watershed and the Wih Balek sub-watershed. Management efforts that must be carried out include: conserving soil on agricultural land, harvesting / storing excess water during the rainy season and utilizing it during the dry season, promoting sustainable farming and stabilizing crop yields through improved management of agricultural systems and improving ecological balance (relationship between upstream water management and downstream, water quality, land quality and capability, and biodiversity).

Acknowledgements

References

Asdak, C. 2020. Hydrology and Watershed Management. Yogyakarta. Gadjah Mada University Press.
Badan Pusat Statistik Aceh Tengah. 2019. Aceh Tengah dalam Angka, Takengon.
Badan Pusat Statistik Bener Meriah. 2019. Bener Meriah dalam Angka, Simpang Tiga Redelong.
Badan Pusat Statistik Bireun. 2019. Bireun dalam Angka, Bireun.
Department of Environment and Forestry. 2020. Database and Information. Aceh Province.
Dephut Departemen Kehutanan. 2014. Peraturan Pemerintah Nomor 61 Tahun 2014 tentang Monitoring dan Evaluasi Pengelolaan Daerah Aliran Sungai. Jakarta (ID): Dephut.
Heathcote, I. W. (2009). *Integrated watershed management: principles and practice*. John Wiley & Sons.
Jessel, B., & Jacobs, J. (2005). Land use scenario development and stakeholder involvement as tools for watershed management within the Havel River Basin. *Limnologica*, *35*(3), 220-233.
Johnson, N., Ravnborg, H. M., Westermann, O., & Probst, K. (2002). User participation in watershed management and research. *Water policy*, *3*(6), 507-520.
Krueng Aceh Watershed and Protected Forest Management Center. 2020. Database and Information. Aceh Province.
Meteorology, Climatology and Geophysics Agency. 2020. Database and Information. Aceh Utara
Ministry of Forestry. 2014. Government Regulation Number 61 of 2014 concerning Monitoring and Evaluation of Watershed Management. Jakarta (ID): Ministry of Forestry.

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