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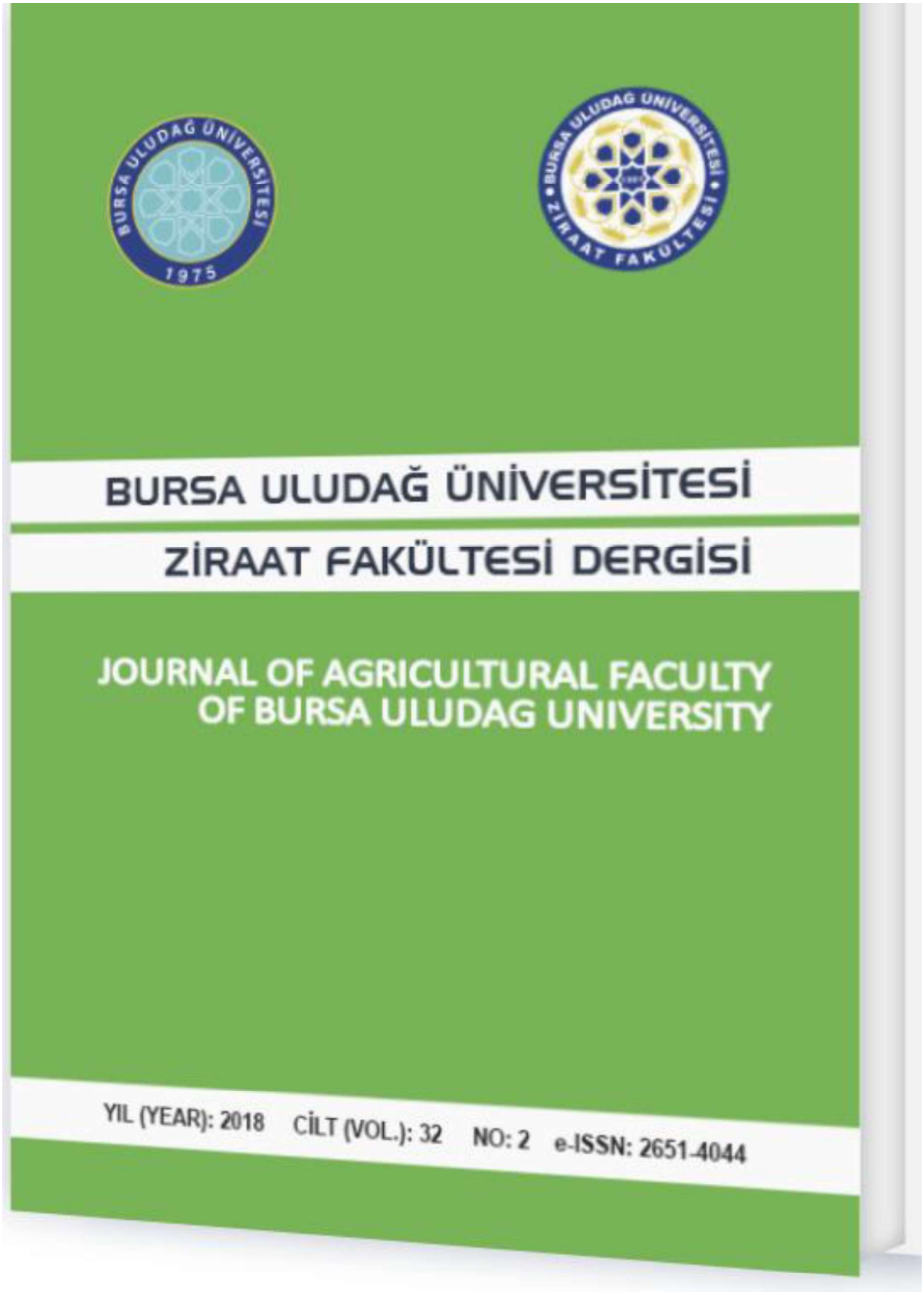
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Landscape Design at The Border of The Krueng Aceh River Based on Agrosilvopastura[A]

Rini FİTRİ[1], Achmad Yozar PERKASA[2*], Dahlan DAHLAN[3], Reza FAUZİ[1]

Abstract: The changes in land use along the Krueng Aceh riverbank area are widely used by the local community for livestock activities, monoculture farming and culinary stall business activities which have a major impact on the decline in the ecological quality of the area's environment and visual or aesthetic quality. This study aims to design a landscape design based on agrosilvopasture in the Krueng Aceh riverbank area. This study uses qualitative methods and landscape design of the Krung Aceh riverbank through the stages of inventory, analysis, synthesis, concept and design. The data used in this study are climatology, hydrology, vegetation and environmental data, all of which are collected from stations in the research area, namely the Krueng Aceh Watershed. The results of the study indicate that there are several things that can be recommended to be done, namely by improving the irrigation network so that efficiency can increase, implementing optimization of the irrigation water management system in the Krueng Aceh Watershed by considering the mainstay discharge and the current effective area, modifying the planting pattern in the Krueng Aceh Irrigation

[A] The study does not require approval from an ethics committee. The article has been prepared according to research and publication ethics.

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Area to accommodate the decreasing availability of irrigation water so that water utilization becomes more optimal. In addition, the space in the Krueng Aceh riverbank area has been designed by dividing it into two areas, namely the functional area and the space requirement area. The functional area is used for agrosilvopasture efforts, grass planting activities, and also forestry plantation efforts.

The space requirement area is divided into a built-up area, which is used to build a cattle pen, then the open space area is used for livestock grazing activities and also developed as a seasonal crop cultivation area.

Keywords: Agroforestry, agrosilvopastura, krueng aceh river, landscape.

Aceh'deki Krueng Nehri Sınırı Boyunca Tarımsal Silvopasture Bazlı Peyzaj Tasarımı

Öz: Krueng Aceh nehri kıyısı boyunca arazi kullanımındaki değişiklikler, yerel topluluk tarafından hayvancılık faaliyetleri, monokültür çiftçiliği ve mutfak tezgahı işletme faaliyetleri için yaygın olarak kullanılmaktadır ve bu durum bölgenin ekolojik kalitesinin ve görsel veya estetik kalitesinin azalması üzerinde büyük bir etkiye sahiptir. Bu araştırma, Krueng Aceh Nehri kıyısındaki alanda silvopasture temelli tarımsal peyzaj tasarımı tasarlamak amacıyla yürütülmüştür. Bu çalışma, envanter, analiz, sentez, kavram ve tasarım aşamaları aracılığıyla Krung Aceh nehri kıyısının nitel yöntemlerini ve peyzaj tasarımını kullanılmaktadır. Bu çalışmada kullanılan veriler, araştırma alanındaki istasyonlardan, yani Krueng Aceh Havzası'ndan toplanan klimatoloji, hidroloji, bitki örtüsü ve çevresel verilermektedir. Çalışmanın sonuçları, sulama şebekesinin iyileştirilerek verimliliğinin artırılması, Krueng Aceh Havzası'nda sulama suyu yönetim sisteminin ana debi ve mevcut etkili alan dikkate alınarak optimize edilmesi, Krueng Aceh Sulama Alanı'ndaki ekim deseninin sulama suyunun azalan mevcudiyetini karşılayacak şekilde değiştirilmesi ve böylece su kullanımının daha optimum hale getirilmesi gibi önerilebilecek birkaç şey olduğunu göstermektedir. Bunun dışında Krueng Aceh nehrinin kenarı boyunca fonksiyonel alan ve alan ihtiyaç alanı olmak üzere iki alana bölünerek tasarlanan bir alan bulunmaktadır. İşlevsel alan, tarımsal silvopasture çalışmaları, çim ekim faaliyetleri ve ayrıca ormancılık ekim çalışmaları için kullanılmaktadır. Alan ihtiyacına göre hayvancılık için kullanılan meskun alanlar, hayvan otlatma faaliyetleri için kullanılan açık alanlar ve mevsimlik mahsullerin yetiştirilmesi için ekim alanı olarak geliştirilen alanlar olarak ayrılmıştır.

Anahtar Kelimeler: Tarımsal ormancılık, agrosilvopastura, krueng aceh nehri, peyzaj.

Introduction

The condition of the landscape along the riverbank is an ecological area that is grown by many shade trees, shrubs and shrubs which have ecological, social and aesthetic functions. The definition of a river based on Government Regulation of the Republic of Indonesia Number 38 of 2011 Article 1 paragraph 1 is a natural or

artificial water channel or place in the form of a water drainage network and the water in it, starting from the upstream to the estuary, then bounded on the right and left by a border line. The river border has a function, namely as a buffer space between the river ecosystem and the land so that river functions and human activities will not be disturbed (Fitri et al., 2022). The Krueng Aceh River is a part of the river in the Sumatra I River Region Hall which flows through Aceh Besar District and Banda Aceh City, whose upper reaches are in the mountainous area of Seulawah and then ends towards the Malacca Strait.

The situation on the border of the Krueng Aceh river is currently widely used by the community for raising livestock, planting grass and also cultivating seasonal crops. In an effort to use land along the riverbanks for the cultivation of monoculture crops, they are very prone to erosion and can reduce land productivity. The transition of the function of the Krueng Aceh river bank is currently widely used by the community for various purposes and will have the potential to reduce the quality and function of the river border (Dahlan et al., 2021; Sari et al., 2014). River banks with open area conditions without vegetation cover from various kinds of flora can increase the occurrence of landslides. This condition is feared to increase river sedimentation in the estuary, thus triggering flooding (Wahyudien et al., 2018).

The existence of vegetation on the riverbank has an important role in efforts to protect well-functioning river flows and maintain water quality, retain soil particles and prevent erosion (Soewandita, 2017; Surni et al, 2015). The development and management of landscapes on the riverbanks must be able to improve and preserve the riverbanks. The landscape in the riparian area is prioritized must refer to the concept of sustainability, so that further development and management can be beneficial for improving river ecosystems, making the riparian area a center for environmental education, improving the quality of landscape services and having the potential to integrate local and environmental knowledge for synthesized into ecological landscape designs (Fitri et al., 2022; Gret-Regamey et al., 2016; Chen et al. 2016). The concept of a riverfront on the riverbank, settlements around it can have access to green open space and is part of the public space that is the right of all elements of society, a riverbank study is very important so that it can produce a guideline for design scenarios that are appropriate to local landscape conditions in the River (Vollmer et al., 2015). The landscape design on the Krueng Aceh riverbank is the effort to develop agrosilvopastura based on exploring the potential of local wisdom in supporting the improvement of the riverbank landscape to maintain the quality and function of the riverbank landscape. The aim of this research is to determine an agrosilvopastura design model that can improve the quality of the landscape on the Krueng Aceh riverbank.

Materials and Methods

Location and Time of Research

The research was conducted from August 2022 to May 2023, the research location was in the Krueng Aceh river riparian landscape in the downstream Aceh Province starting from Lambaro (Aceh Besar District) to Lamnyong (Banda Aceh City). The sub-districts that are passed by the Krueng Aceh River at the research location are

included in the Aceh Besar District area including Kuta Baro District, Ingin Jaya District, Krueng Barona Jaya, Darul Imarah District and Darussalam District while those included in the Banda Aceh City area are only Syiah Kuala sub-district (Figure 1 and 2).

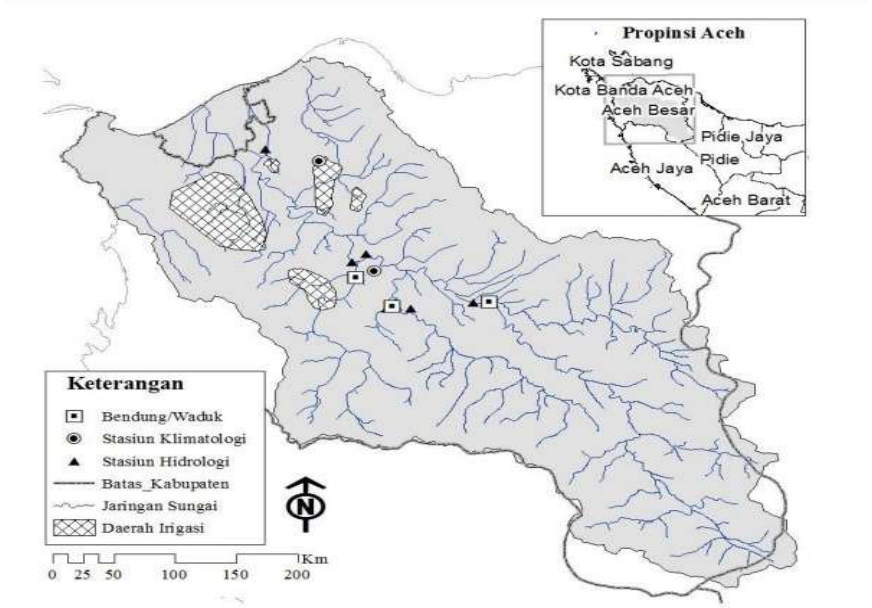

Figure 1: The flow of the Krueng Aceh river. Source: Ferijal et al., 2016.

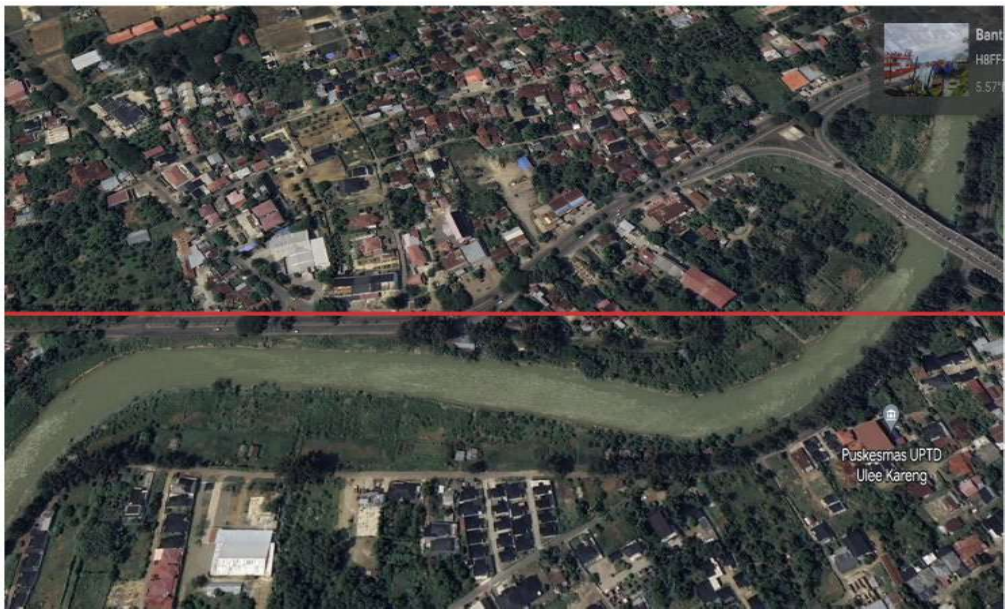

Figure 2: Research location. Source: Google earth, 2024.

Data Types and Sources

This study used various types of data such as spatial data and qualitative data. The data were obtained using field observation methods, literature studies and interviews. Spatial data is a map of the location of the Krueng Aceh River border obtained by using Google Earth by taking pictures of the research location directly. This map serves to further analyze land cover and explain the results spatially. The qualitative data is data on the edge type of the Krueng Aceh River riparian landscape and the agrosilvopastura model that can be used in the riparian landscape. Qualitative data is data on the banks of the Krueng Aceh River obtained by observing sample locations and interviewing local natives and then visualizing and explaining it descriptively.

Data analysis

Analysis of ecological, biological and physical conditions in the landscape along the Krueng Aceh riverbank in the first part of this research is to analyze the biological and physical conditions of the Krueng Aceh River border in Aceh Province. The biological and physical conditions observed included land cover, ecological values in the riparian landscape, vegetation characteristics on various types of river banks and the strength of the built river bank structures. Every ecological, biological and physical condition observed uses several different methods and approaches. The agrosilvopastura design analysis in this study was carried out on the banks of the Krueng Aceh River, especially those within the riverbank area. Studies in the analysis of agrosilvopastura designs use an integrated method approach between research and design, which is an adaptive design model with the output of making a design model (Milburn and Brown, 2003).

Results and discussion

Overview of the Krueng Aceh River Border

The agroforestry landscape design based on agrosilvopastura was carried out on the downstream side of the Krueng Aceh river from Lambaro to Lamnyong which is administratively located in Aceh Besar District and Banda Aceh City. The Krueng Aceh River is one of the rivers in Aceh Province, more precisely in the northern part of the island of Sumatra. The upstream area of the Krueng Aceh river is in Aceh Besar District which irrigates most of the Aceh Besar District and Banda Aceh City and ends towards the Malacca Strait. Spatially the map of the location of the agrosilvopastura landscape design is shown in Figure 1, with a total area of the border designed for agrosilvopastura ranging from (180 Ha).

Analysis and synthesis

Analysis and synthesis are steps for processing data resulting from observations and inventories at research locations to obtain information regarding potentials and constraints at research locations. The process of analysis and synthesis is carried out to obtain alternatives for solving problems and exploiting the potential in the riparian landscape as well as solutions for the constraints that exist in the research location as seen in Table 1.

Climate conditions in the Krueng Aceh watershed include class B rainfall type (wet) and the average annual rainfall in the Krueng Aceh watershed is 1225.9 mm. The highest rainfall in the Krueng Aceh watershed is 1,772 mm/year, while the lowest rainfall in the Krueng Aceh watershed is 1,207.4 mm/year. Climate change has occurred in the Krueng Aceh watershed, marked by an increase in rainfall and average air temperature. The increase in rainfall occurred in the Indrapuri area by 28.3 mm/year and in the Blang Bintang area by 65.8 mm/year. The increase in average air temperature occurred in the Indrapuri area by 0.0018°C/year and in the Blang Bintang area by 0.0301°C/year. This climate change has an impact on the decrease in the discharge of the Krueng Aceh river. The discharge of the Krueng Aceh river has the potential to be less than 18.77 m3/s. The mainstay discharge of the Krueng Aceh River fell by 23.5% in the April–December period (Yulia, 2025; Ferijal et al., 2016).

Table 1. Analysis for Potentials and Constraints; Potential Utilization and Problem Solving; and Alternative Solutions for Problem Solving

Landscape Elements	Data	Analysis		Synthesis	
		Potency	Constraint	Potential Utilization and Problem Solving	Alternative Actions
A. Biophysical Aspects					
Accessibility	The downstream area of Krueng Aceh in the riparian landscape from Lambaro, Aceh Besar District to Lamnyong, Banda Aceh City	Access is easy to reach	Small and narrow road	Created one line	Circulation arrangement
Topography and soil type	The topography is flat 2-8% located at an altitude of 0.40 to 1.00 m above sea level (asl) with soil type latosol	The flat topography makes it easy to arrange the hardscape	Poor/ not well organized drainage	Building paths Pedestrian with hardscape elements	Agrosilvopastura landscape arrangement
Climate	▪ Rainfall 1,269.3–1,993.9 mm per year. The number of rainy days ranges from 105 – 163 days per year, months with low rainfall from June – September and high rainy months from October – May. ▪ Humidity ▪ Temperature ▪ Wind Speed	The climate is good for agrosilvopastura		Can be used for agrosilvopastura landscape arrangement	Agrosilvopastura Landscape Arrangement

Vegetation	There have been various types of annual plants	There are annual plants, and grass	Vegetation is not well organized	The addition of vegetation related to the needs of agrosilvopastura landscapes	Vegetation arrangement must comply with agrosilvopastura landscape criteria
Hydrology	The river flow is hampered by garbage		River water quality not good	Installing a trash filter	Setting the border River as a catchment area
Land use	The rise of land conversion into buildings		Built-up land is larger than undeveloped land (green open space)	Protect the site by landscaped agrosilvopastura	Designing agrosilvopastura landscapes
Sedimentation	The river border is silting	The river is quite wide	High sedimentation	Routine sedimentation checks	River dredging to protect river banks and arrange them with agrosilvopastura landscapes
B. Non-physical aspects					
Local customs	Lack of knowledge about river bank preservation	The people live in peace	Building the cage at some point, worsens the visual quality	Set the riparian footprint to improve visual quality	Designing agrosilvopastura landscapes
Visitors and activity	Generally active adults	Activities carried out: agriculture, animal husbandry, and trading	Unorganized activity society	Provide water for local community activities	Provide facility

Source: Observation Results, 2023

Development Concept

The design concept developed for the agrosilvopastura landscape concept on the Krueng Aceh riverbank site was chosen based on the function and needs of each space. The concept of development on the banks of the river was designed based on the results of an analysis of the potential, constraints from physical and non-physical data in the research area (Fitri et al., 2021). Data obtained from observations on the Krueng Aceh riverbank were processed at the analysis and synthesis stage so that the agrosilvopastura-based agroforestry landscape is a development concept that is suitable for the Krueng Aceh riverbank footprint. The conservation space is arranged with vegetation to resist erosion, namely vetiver (*Chrysopogon zizanioides*) and elephant grass (*Pennisetum purpureum*). Space for conservation and utilization is arranged with seasonal plants, namely elephant grass (*Pennisetum purpureum*), papaya (*Carica papaya L*) banana (*Musa spp*). Utilization space is arranged with annual crops, ground cover vegetation and livestock namely coconut (*Cocos nucifera*), petai cina (*Leucaena leucocephala*), papaya (*Carica papaya L*) banana (*Musa spp*.), petai (*Parkia speciosa Hassk*), cattle and goat livestock.

Agrosilvopastura Landscape Design Model

The agrosilvopastura-based agroforestry landscape design on the Krueng Aceh riverbank for its arrangement follows a natural pattern. Existing vegetation is combined with alternative vegetation to support the agrosilvopastura landscape pattern on the Krueng Aceh riverbank. The combination of existing vegetation, selection of alternative vegetation and livestock for the agrosilvopastura landscape model defined on the site is shown in Table 2.

Table 2. Selection of Vegetation and Livestock Combinations in the Agrosilvopastura Landscape Model

Existing Vegetation	Planned zone	Vegetation Selection
Ground Cover Vegetation : Melala grass (*Brachiaria mutica*), Elephant Grass (*Pennisetum purpureum*)	Zone 1: the zone closest to the riverbank (conservation space)	Vetiver (*Chrysopogon zizanioides*), Elephant Grass (*Pennisetum purpureum*)
Annuals Plants: Banana (*Musa paradisiaca*), Elephant Grass (*Pennisetum purpureum*)	Zone 2: the middle part of the riparian area (conservation space and utilization space)	Elephant Grass (*Pennisetum purpureum*) Papaya (*Carica papaya L*) Banana (*Musa spp*.)
Annual Plants, Vegetation ground cover and Livestock: Coconut (*Cocos nucifera*), Chinese Petai/bean (*Leucaena leucocephala*), Elephant grass (*Pennisetum purpureum*), Banana (*Musa paradisiaca*) and Cattle	Zone 3: the zone closest to land use and settlements (utilization space)	Chinese petai/bean (*Leucaena leucocephala*), Petai/smelling green bean (*Parkia speciosa Hassk*) Papaya (*Carica papaya L*) Banana (*Musa spp*.) Cattle and Goat Livestock

Source: Observation and Analysis Results, 2023

Selection of suitable vegetation for agrosilvopastura in the Krueng Aceh river riparian landscape is determined according to the needs of each zone. The agrosilvopastura design in the Krueng Aceh riparian landscape is adapted to the agroforestry concept and the suitability of the designation in the Krueng Aceh riparian landscape as shown in the agrosilvopastura design in the riparian landscape in Figure 3, Figure 4 and Figure 5.

Figure 3. *The Landscape of the Krueng Aceh River*

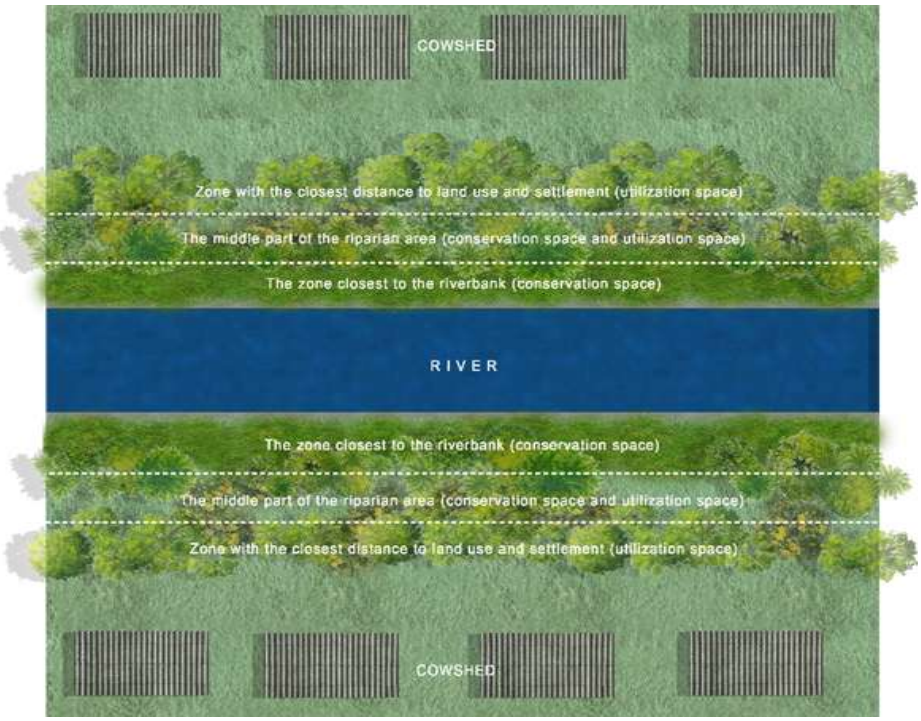

Figure 4. *Design Plan of the Krueng Aceh River Border landscape*

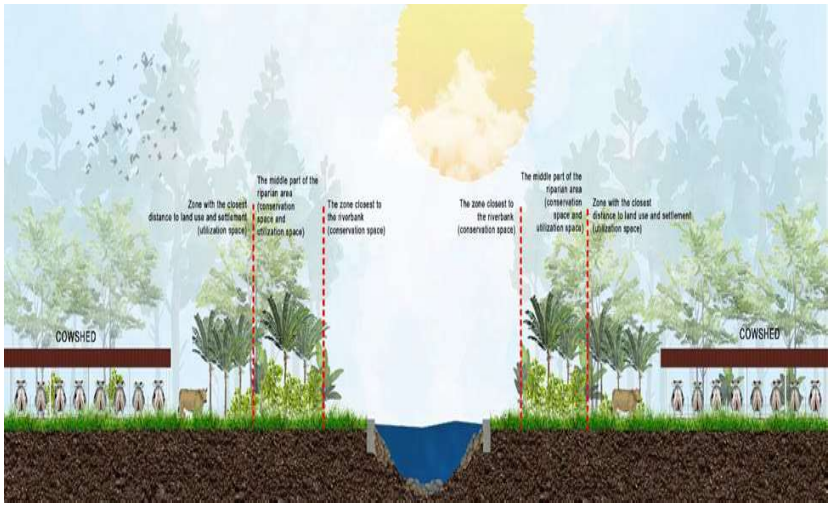

Figure 5. *View of the Agrosilvopastura Landscape Border Landscape of the Krueng Aceh River*

Conclusion

The agrosilvopastura design applied to the landscape on the Krueng Aceh riverbank is not only to preserve the function of the riverbank landscape from erosion, sedimentation and landslides, but can also increase the green open space area. There are several things that can be recommended to be done, namely by improving the

irrigation network so that efficiency can increase, implementing optimization of the irrigation water management system in the Krueng Aceh Watershed by considering the mainstay discharge and the current effective area, modifying the planting pattern in the Krueng Aceh Irrigation Area to accommodate the decreasing availability of irrigation water so that water utilization becomes more optimal. Agroforestry design based on the concept of landscape agrosilvopastura in the riparian area of course can maintain the riparian and can be sustainable.

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