International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Evaluation of Semi-Permanent Canal Partition Design with Overflow in Aceh Province

Poppy Wiharja[1], Riza Murti Subekti[2], Eka Jatnika Arifin[3]

[1,2]Environmental Impact Controller, Ministry of Environment and Forestry
[3]Environmental Educator, Ministry of Environment and Forestry

ABSTRACT

Canal blocking is a form of rewetting infrastructure that functions to improve water management in secondary or tertiary channels in damaged peatlands. In 2022, the Ministry of Environment and Forestry has built 17 canal blocking units spread across 3 districts, namely Aceh Jaya district, West Aceh district and Nagan Raya district. The canal block that was built was a simple or semi-permanent canal block construction made of wood. Canal blocking must be monitored and maintained every year. This research aims to evaluate the condition, function and impact of discussion through the construction of canal blocking. This research method is quantitative and qualitative in nature to analyze and evaluate: (1) the quality of the structure and (2) the function or performance of the canal block and (3) the wetting impact of the construction of the canal block. The condition of the 17 canal blocking units that have been built are still in good condition or slightly damaged taking into account the structural quality and function or performance of the canal blocking. The condition of the canal blocking is around 85-92% or has a damage percentage of around 5-10% for each canal blocking unit. The recommendations given are preventative maintenance including maintenance of the canal cerucuk and bulkhead boards, addition of mineral soil on both sides of the wings and maintenance of runoff. The wetting impact area obtained from calculations is around 5-10 hectares for each canal block that is built.

Keyword: Evaluation, Canal Blocking, Peatland

INTRODUCTION

Peatland is a type of marginal land found in wetlands, originating from the accumulation of organic material in the form of decayed plant remains that have undergone an imperfect decomposition process over thousands of years. Indonesia ranks fourth in the world for having the most extensive peatlands. According to the Agricultural Research and Development Agency (2014), the area of peatlands in Indonesia is approximately 149,300 km² and 270,000 km². The Ministry of Environment and Forestry (2017) reported that the Peatland Ecosystem Area in Indonesia covers 24.67 million hectares, spread across Sumatra (9.6 million hectares), Kalimantan (8.4 million hectares), Sulawesi (63.2 thousand hectares), and Papua (6.59 million hectares). The reduction in productive land in Indonesia has led to the increasingly intensive use of peatlands as agricultural land. According to Yugo Utomo et al. (2017), the damaged Peatland Ecosystem in Indonesia covers an area of 23.95 million hectares. Based on this statement, the condition of the Peatland Ecosystem has mostly been damaged, characterized by artificial drainage, exposure of pyrite and/or quartz sediments beneath the peat layer, reduced land cover, and lowered groundwater levels in peatlands (KLHK, 2016).

The annual accumulation of damage to the Peatland Ecosystem results in the shrinking of peat volume due to uncontrolled drainage networks, increasing water flow rates (over-drainage), and reducing water retention capacity in the peat ecosystem. Another impact of the declining peat water level is land subsidence due to oxidation, consolidation, and peat compaction (Hooijer, 2012). Since the forest and land fires in 2015, efforts to restore the Peatland Ecosystem have included rewetting the peatland drainage system. Canal blocking is a peatland rewetting technique that can be applied to raise the groundwater level (Dohong et al., 2017).

In 2022, the Ministry of Environment and Forestry constructed canal blocks to restore the hydrological functions of the peatland ecosystem in Aceh Province. A total of 17 canal blocks have been built across three districts: Aceh Jaya (6 units), West Aceh (5 units), and Nagan Raya (6 units). The canal blocks were constructed on community-owned peatland areas to retain and store water as long as possible within the Peat Hydrological Unit (KHG). The canal blocks have water level control devices, such as spillways (Dohong et al., 2017).

The constructed canal blocks are simple structures made of wooden materials. The Ministry of Environment and Forestry (2020) states that semi-permanent canal blocks made of wood with simple construction can last for 3 to 5 years post-construction. Monitoring and evaluation of the constructed canal blocks must be conducted regularly. Therefore, evaluating the condition, function, and impact of the rewetting through canal block construction is necessary to assess the success of restoring the hydrological functions of the Peatland Ecosystem in Aceh Province.

According to Cronbach and Stufflebeam (1982), program evaluation aims to provide information to decision-makers, emphasizing that evaluators provide information. Evaluation models have the same intent and purpose: collecting data or information related to the evaluated object. According to Alkin (1969), evaluation is a process of making decisions, selecting appropriate information, collecting and analyzing information, and reporting data summaries useful for decision-makers in choosing alternatives. He proposed five types of evaluation: (1) System assessment, (2) Planning, (3) Implementation, (4) Improvement, and (5) Summative evaluation.

This research aims to evaluate and monitor the quality and performance of the canal block construction of 17 units, including six units in Batee Roo Village, Aceh Jaya District; five units in Leuhan and Peunia Villages,West Aceh District; and six units in Padang Panyang and Kuala Baro Villages, Nagan Raya District. This is an essential part of canal block maintenance. This activity aims to quickly and accurately assess the condition of the canal blocks concerning their quality, functionality, and any changes. Observing the quality and performance of the canal blocks aims to evaluate (1) the structural quality and (2) the function or performance of the canal blocks. This activity involves visual assessment and direct field measurements through rapid surveys.

METHODOLOGY

The research location is in Aceh Province, covering three districts: Aceh Jaya, West Aceh, and Nagan Raya. The details of the locations are as follows: Aceh Jaya District with six units in Batee Roo Village, West Aceh District with five units in Leuhan and Peunia Villages, and Nagan Raya District with six units in Padang Panyang and Kuala Baro Villages. Figure 1 shows the distribution of canal block construction points.

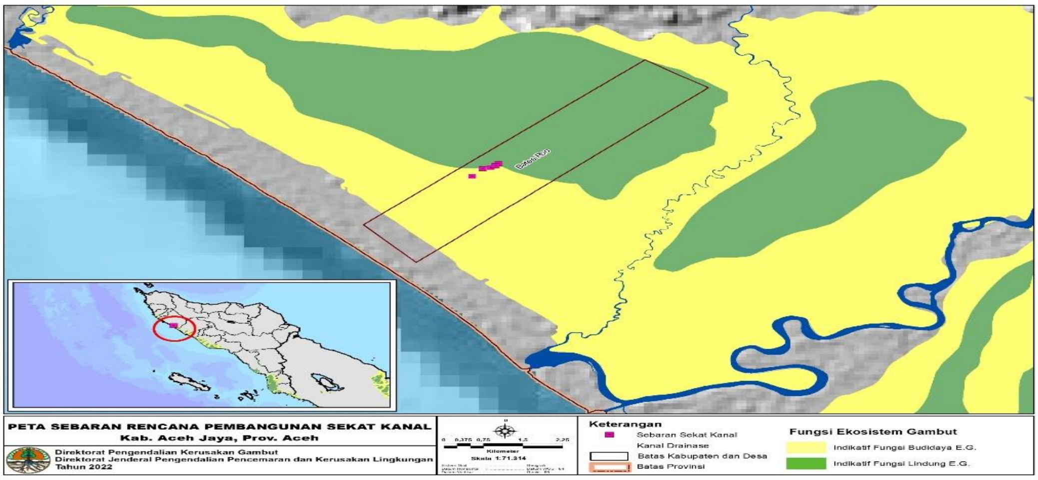


Figure 1a. Location of canal block construction in Aceh Jaya District (KLHK, 2022)

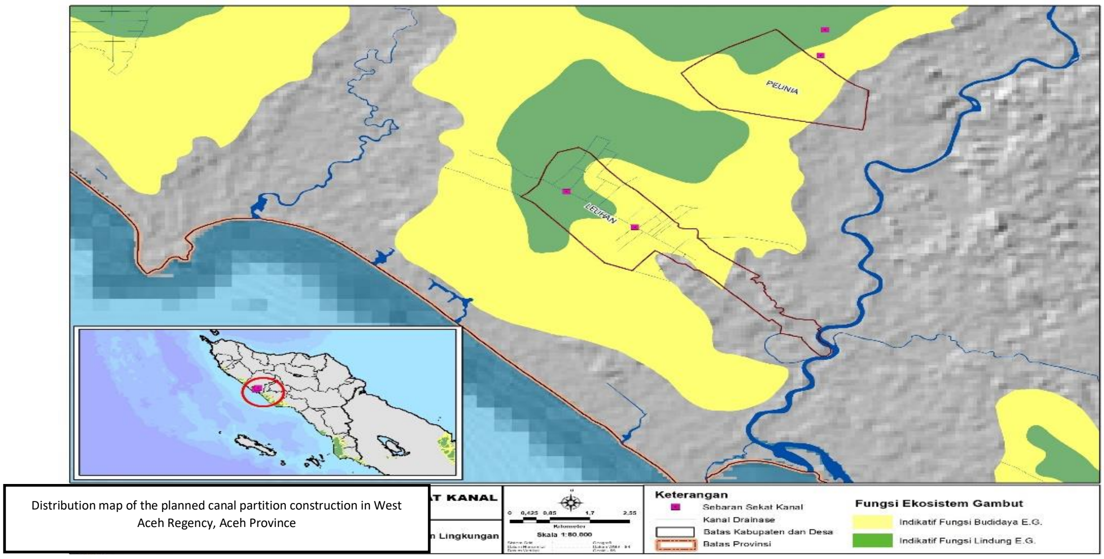


Figure 1b. Location of canal block construction in West Aceh District (KLHK, 2022)

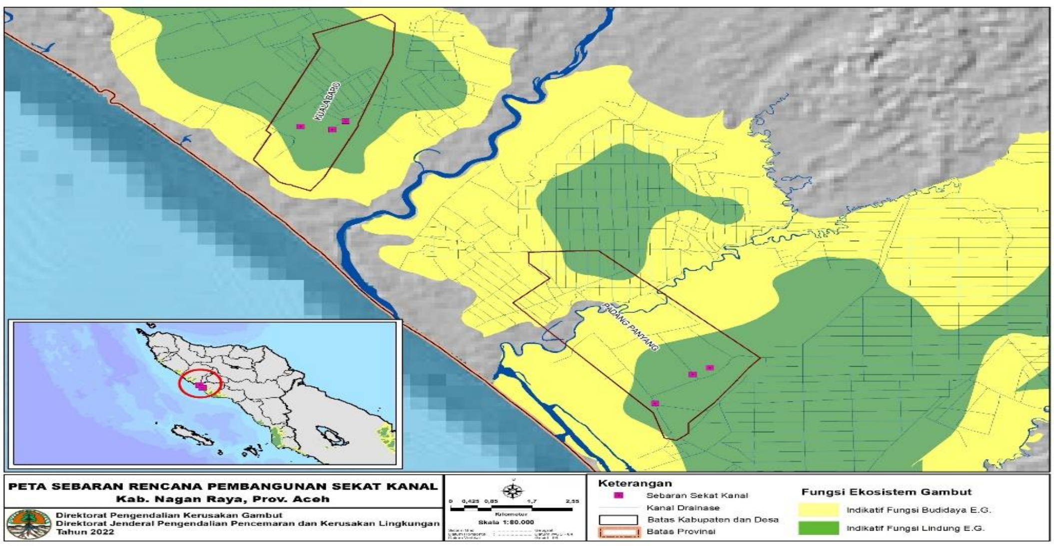


Figure 1c. Location of canal block construction in Nagan Raya District (KLHK, 2022)

This research employs both quantitative and qualitative methods to analyze and evaluate: (1) the structural quality, (2) the function or performance of the canal blocks, and (3) the impact of rewetting from the canal block construction. The activities are conducted through visual assessment and direct field measurements using rapid surveys. The data collection methods in this activity include:

First, the observers visit the predetermined canal blocks using GPS and maps, ensuring that the coordinates of the canal blocks match those specified.

Second, observations and measurements of the quality and performance of the canal blocks are carried out visually and through detailed inspections of the damaged parts of the canal blocks. For the damaged canal blocks, an assessment is conducted on the quality and performance parameters.

Third, the observers document the condition and performance of the canal blocks with photographs taken from various angles and distances. It is recommended to use reference objects, such as measuring tapes or GPS, to estimate the size of the photographed objects.

The data collected include two main components: (1) the quality of the canal blocks and (2) the functionality and damage of the canal blocks. The data and parameters related to the quality of the canal blocks consist of:

a. Structural Strength, including parameters:

- Deformation of the building structure
- Height reduction

b. Construction Stability, including parameters:

- Stability of the canal block components

c. Material Quality, including parameters:

- Condition of the primary material of the canal blocks
- Condition of the supporting materials of the canal blocks
- Condition of the protective vegetation

d. Hydraulic Conditions, including parameters:

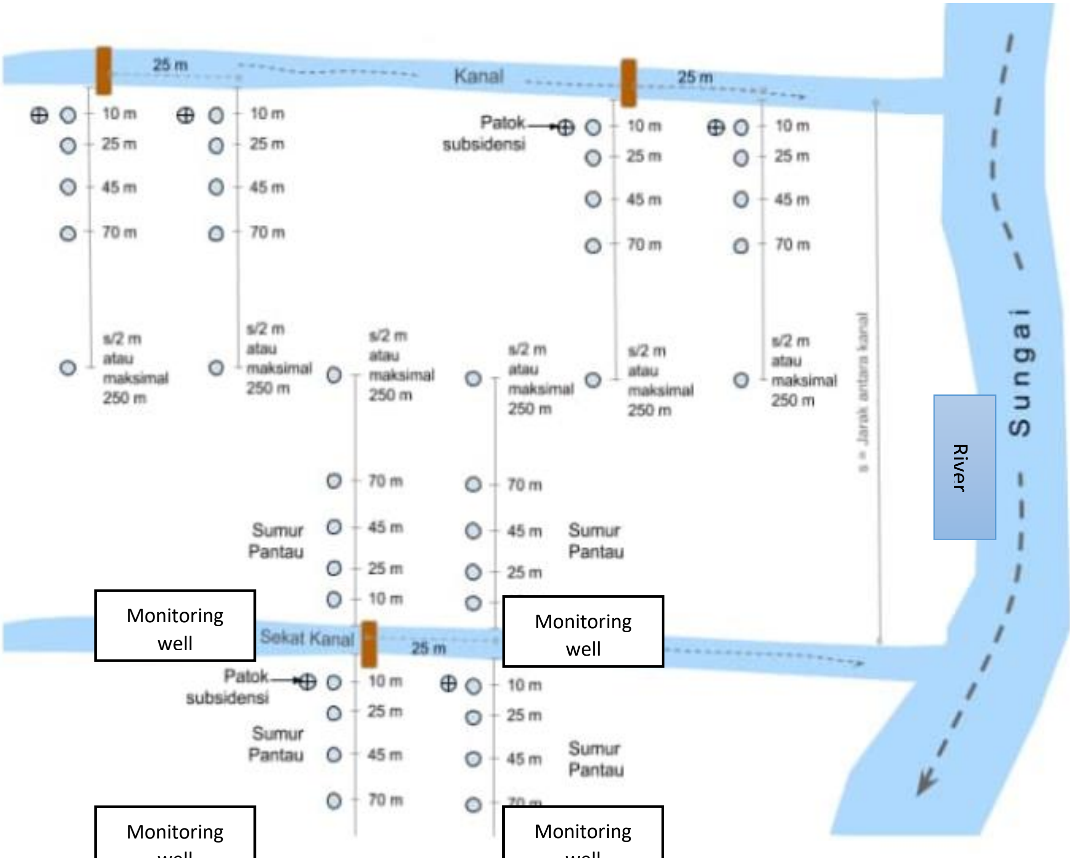
- Local scouring
- Erosion or slope failures around the canal blocks
- Dropping

The data and parameters related to the functionality of the canal blocks consist of primary and optional parameters. The primary parameters include:

1. The presence of a water level difference upstream and downstream of the canal block;
2. The surrounding peatland is not burned;
3. The surrounding peatland is wet, or the water level at the canal block is 0.4m;
4. There is no excessive drying during the dry season.

Source: Operational and Maintenance Guidelines for Canal Blocks for Peatland Ecosystem Restoration, Directorate of Peatland Ecosystem Damage Control, 2020 (page 103).

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com



...r 2. Ilustrasi dampak ... lahan gambut

Procedures to determine the area affected by peatland rewetting due to canal block construction involve measuring the Total Moisture Available for Transpiration (TMAT) along two observation lines. The first line involves measuring the TMAT at points to the left and right of the canal block. The second line involves measuring the TMAT at points 25 meters downstream from the first observation line on both sides of the canal. The observation points are stopped or continued until no more water is found in the TMAT measurements. The analysis of the observation points data on the impact of rewetting from the canal block construction is provided below.

L = ½ x d1 x d2

Where:

- **L** = Area of saturation (square meters, m^2)
- **d2** = Horizontal diagonal (meters, m), measured as the distance between the canal barrier or canal and the observation point where water is still present (meters, m)
- **d1** = Vertical diagonal (meters, m), calculated using the approximation: 2.5 x d2

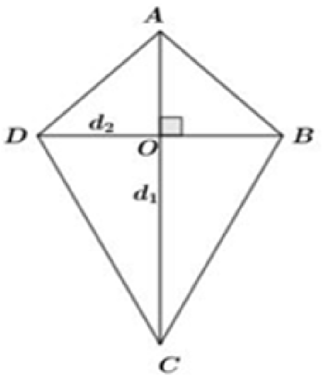


Image Explanation:

- **O** = Position of the canal barrier
- **A** - **C** = Direction of water flow from A to C
- **O** - **D** = Path of the observation point on the left side of the canal barrier
- **O** - **B** = Path of the observation point on the right side of the canal barrier

Based on the analysis of this data and information, recommendations for canal block maintenance are made. The types of canal block maintenance can be categorized as follows:
a) Preventive Maintenance Preventive maintenance aims to preserve the optimal function and performance of the canal blocks. This maintenance is conducted on canal blocks that are still in good condition or have minor damage (<40%).
b) Corrective Maintenance Corrective maintenance aims to correct and improve the inefficiencies in the function and performance of the canal blocks. This maintenance is conducted on canal blocks with moderate structural damage (40-60%).
c) Rehabilitative Maintenance Rehabilitative maintenance aims to repair and reconstruct the canal blocks. This maintenance is conducted to repair severely damaged canal blocks (>60%) or those that have been destroyed.

RESULTS AND DISCUSSION

Canal blocking is a rewetting infrastructure designed to maintain groundwater levels in peatlands, thereby preventing fires and improving water management (Gough et al., 2016). Blocking canals in secondary or tertiary channels helps retain water drainage from forests and peatlands, maintains the water holding capacity in peat forests, and raises the water table, thus rewetting the surrounding peatlands. Wet peatland conditions facilitate the rehabilitation of peatlands by planting species adapted to the unique peatland ecosystem (Noor and J., 2007). Ideally, canal blocks should be built permanently to expedite the peat swamp restoration process. However, the canals in the area are already used by the community for navigation, making permanent canal blocking currently impractical (Center for Socio-Economic and Environmental Research and Development, 2013).

In 2022, the Ministry of Environment and Forestry constructed canal blocks to restore the hydrological functions of the peatland ecosystem in Aceh Province. A total of 17 canal blocks were built across three districts: Aceh Jaya,West Aceh, and Nagan Raya. The construction of the canal blocks was carried out on community-owned peatland areas to retain and store water as long as possible within the Peat Hydrological Unit (KHG). The canal blocks were equipped with water level control devices such as spillways. Figure 3 illustrates the three-dimensional design of the canal blocks constructed in Aceh Province.
Figure 3. Three-dimensional design of canal blocks in Aceh Province (KLHK, 2022)
Based on interviews conducted during this research, it was found that the construction of canal blocks considered the results of the Survey Investigation Design (SID) of Aceh Province in 2022, followed the Community Work Plan (RKM) in the community independence program, analyzed the potential for forest and land fires in the work area, and assessed the extent of degraded/damaged peatland. Table 1 provides a detailed distribution of the canal blocks constructed in Aceh Province.

Table 1. Detailed Distribution of Canal Block Construction in Aceh Province

No.	Partition Code	Coordinates		Province	District	Village
		X	Y			
1	Partition 1	96.230139	4.093694	Aceh	Nagan Raya	Kuala Baro
2	Partition 2	96.236000	4.092778	Aceh	Nagan Raya	Kuala Baro
3	Partition 3	96.238306	4.095028	Aceh	Nagan Raya	Kuala Baro
4	Partition 4	96.304083	4.023667	Aceh	Nagan Raya	Padang Panyang
5	Partition 5	96.307028	4.025361	Aceh	Nagan Raya	Padang Panyang
6	Partition 6	96.296778	4.015389	Aceh	Nagan Raya	Padang Panyang
7	Partition 7	96.106833	4.215139	Aceh	West Aceh	Leuhan
8	Partition 8	96.104528	4.216444	Aceh	West Aceh	Leuhan
9	Partition 9	96.153278	4.250139	Aceh	West Aceh	Peunia
10	Partition 10	96.153333	4.250056	Aceh	West Aceh	Peunia
11	Partition 11	96.153194	4.252528	Aceh	West Aceh	Peunia
12	Partition 12	95.789528	4.497361	Aceh	Aceh Jaya	Batee Roo
13	Partition 13	95.791444	4.499556	Aceh	Aceh Jaya	Batee Roo
14	Partition 14	95.792694	4.499833	Aceh	Aceh Jaya	Batee Roo
15	Partition 15	95.793583	4.500472	Aceh	Aceh Jaya	Batee Roo
16	Partition 16	95.793417	4.500444	Aceh	Aceh Jaya	Batee Roo
17	Partition 17	95.793917	4.501000	Aceh	Aceh Jaya	Batee Roo

The primary concept for selecting the location of rewetting infrastructure on peatlands is to maximize water retention in the soil by minimizing water drainage rates through canal blocking and maximizing water absorption/storage in the soil. The planning concept for water zoning and canal blocking placement is crucial in rewetting infrastructure planning. The concept of "trapping" water per zone—placing canal blocks on multiple canals within the same zone is more effective than placing canal blocks on the same canal across different water zones. The principles for determining the location of rewetting infrastructure development include:

a) On canals that cut across contours. b) Canal blocking intervals based on elevation differences. c) Prioritized at higher elevation points to achieve broader downstream storage impacts. d) Prioritized in wider water zones for more extensive rewetting impacts. e) Prioritized in areas with deeper peat for greater storage impact.

The series of field data collection activities includes:

1. **Observation of Canal Block Conditions:**
   - Understanding the location of the canal block construction and the condition of the canal block post-construction.
2. **Observation of Canal Block Functionality:**
   - For canal blocks predicted to be still functional, measurements are taken for structural strength, construction stability, material condition, hydraulic condition, and canal block functionality.

1. Canal Block Conditions

Based on visual observations and interviews with local community members or village officials, the canal blocks constructed in Aceh Jaya, West Aceh, and Nagan Raya districts in Aceh Province are still in good condition and functioning. Figures 4a, 4b, and 4c show the observed conditions of canal blocks in the three districts where canal blocks have been constructed.

Figure 4a: Condition of canal blocks in Aceh Jaya district

Figure 4b: Condition of canal blocks in West Aceh district

Figure 4c: Condition of canal blocks in Nagan Raya district

Based on field data collection, the constructed canal blocks are still in a slightly damaged condition. The construction utilized high-quality materials in terms of strength and followed appropriate canal block construction methods. However, there were issues such as subsidence of the canal block's wing sections and non-functional water flow during dry channel conditions. This is primarily due to the use of peat soil to fill the canal blocks and errors in the location placement of the canal blocks. Canal block construction should follow the Director General of PPKL Regulation Number: 11 of 2020 regarding the Guidelines for Rewetting Infrastructure Development. The placement of canal blocks is highly accurate, based on the results of the SID planning study conducted by the Directorate of Peatland Ecosystem Damage Control - Ditjen PPKL in that year.

Good planning in construction results in strong and functional structures. In new areas, planning studies involve initial survey and design activities to assess the general physical, socio-economic, and biological conditions of the area and determine the most suitable parts for the intended construction. The purpose of the planning study is to identify the needs for upgrading and improving existing infrastructure. The outcome of the study will be in the form of a master plan and recommendations for detailed design studies (KLHK, 2020). The determination of canal block construction in an area must be well-considered, including Survey (Measurement/Survey), Investigation, Design (Technical Planning), Construction, and Operation.

2. Functionality of Canal Blocks

This data collection encompasses two main components: (1) the quality of the canal blocks and (2) the functionality of the canal blocks. Below are the results of the functionality measurements of canal blocks constructed in Aceh Province in 2022.

a) Aceh Jaya District

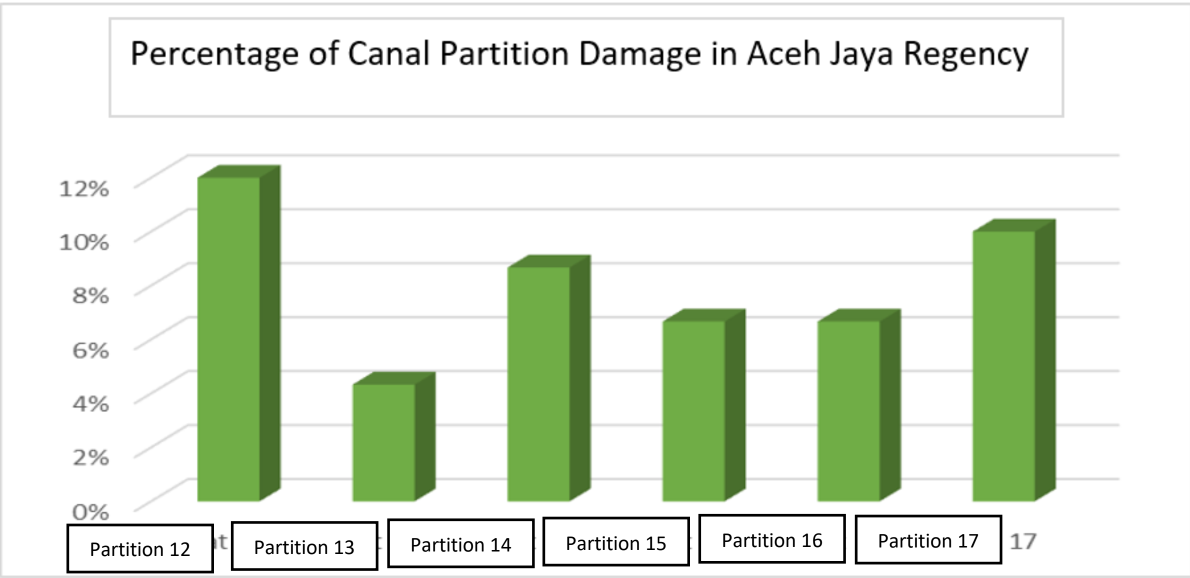
Each canal block underwent observation and data collection covering the quality and performance of the canal blocks. The quality of the canal blocks includes four aspects: (1) construction strength, (2) construction stability, (3) material quality, and (4) hydraulic condition. Table 2 shows the functionality measurements of six canal blocks constructed in Aceh Jaya District.

Table 2. Functionality Measurement Results of Canal Blocks in Aceh Jaya District

Partition Code	coordinator		Regency	Village	Year	structural strength of weight (15%)	Structural weight stability 15%	Hydraulic weight conditions 15%	Material weight conditions (15%)	Weighted canal partition function	Weighted scoring (%)	Category	Percentage of canal condition	Percentage of canal partition
	X	Y												
12	95.789.528	4.497.361	Aceh Jaya	Batee Rhoo	2022	0.39	0.45	0.35	0.45	1.00	2.64	good	88.00%	12.00%
13	95.791.444	4.499.556	Aceh Jaya	Batee Rhoo	2022	0.42	0.46	0.45	0.46	1.10	2.87	good	95.67%	4.33%
14	95.792.694	4.499.833	Aceh Jaya	Batee Rhoo	2022	0.39	0.47	0.35	0.47	1.10	2.74	good	91.33%	8.67%
15	95.793.583	4.500.472	Aceh Jaya	Batee Rhoo	2022	0.45	0.48	0.35	0.48	1.10	2.80	good	93.33%	6.67%
16	95.793.417	4.500.444	Aceh Jaya	Batee Rhoo	2022	0.45	0.49	0.35	0.49	1.10	2.80	good	93.33%	6.67%
17	95.793.917	4.501.000	Aceh Jaya	Batee Rhoo	2022	0.45	0.50	0.35	0.50	1.00	2.70	good	90.00%	10.00%

Based on Table 2, the canal blocks are in good condition regarding structure, construction stability, hydraulic condition, material quality, and functionality (no leakage). Graph 1 illustrates the percentage of canal block damage in Aceh Jaya District.

Graph 1. Percentage of Canal Block Damage in Aceh Jaya District



Graph 1 indicates that the highest damage was found in block 12 (12%), while the least damage was in block 16 (6.67%). The data analysis and visual observation show that the canal blocks in Aceh Jaya District are in excellent condition and functioning well.

b) West Aceh District

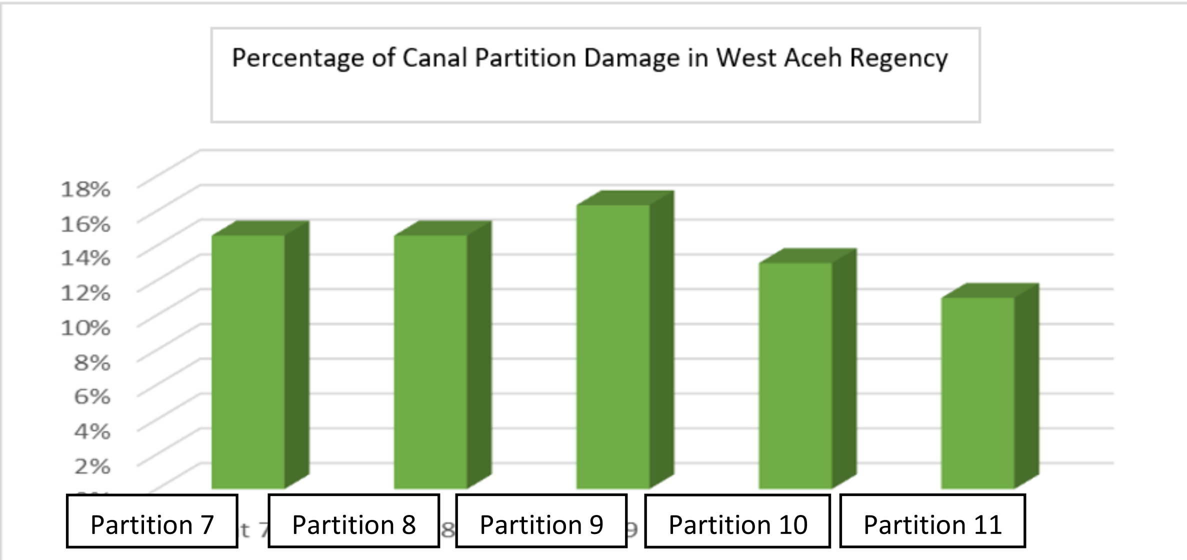
Each canal block underwent observation and data collection covering the quality and performance of the canal blocks. The quality of the canal blocks includes four aspects: (1) construction strength, (2) construction stability, (3) material quality, and (4) hydraulic condition. Table 3 shows the functionality measurements of five canal blocks constructed in West Aceh District.

Table 3. Functionality Measurement Results of Canal Blocks in West Aceh District

No	Partition code	Coordinate		Regency	Village	Year	Structural strength factor (15% weight)	Construction stability factor	Hydraulic condition factor	Material condition factor (weight)	Canal partition functionality	Scoring weight (%)	Category	Percentage of canal partition condition	Percentage of canal partition damage
		x	y												
1	Partition 7	96.106.833	4.215.139	West Aceh	Ieuhan	2022	0.45	0.45	0.45	0.41	0.8	2.56	Good	85.42%	14.58%
2	Partition 8	96.104.528	4.216.444	West Aceh	Ieuhan	2022	0.45	0.45	0.35	0.41	0.9	2.56	Good	85.42%	14.58%
3	Partition 9	96.153.278	4.250.139	West Aceh	Ieuhan	2022	0.36	0.45	0.25	0.45	1.00	2.51	Good	83.67%	16.33%
4	Partition 10	96.153.333	4.250.056	West Aceh	Ieuhan	2022	0.36	0.45	0.45	0.45	0.90	2.61	Good	87.00%	13.00%
5	Partition 11	96.153.194	4.252.528	West Aceh	Ieuhan	2022	0.42	0.45	0.35	0.45	1.00	2.67	Good	89.00%	11.00%

Based on Table 3, the canal blocks are in good condition regarding structure, construction stability, hydraulic condition, material quality, and functionality (no leakage). Graph 2 illustrates the percentage of canal block damage in West Aceh District.

Graph 2. Percentage of Canal Block Damage in West Aceh District



Graph 2 indicates that the highest damage was found in block 9 (16.33%), while the least damage was in block 11 (11%). The damage in block 9 was due to subsidence, measured by the height difference between the top of the canal block and the ground surface using a leveling method. Additionally, the canal block damage was caused by the material decaying due to frequent flooding.

c) Nagan Raya District

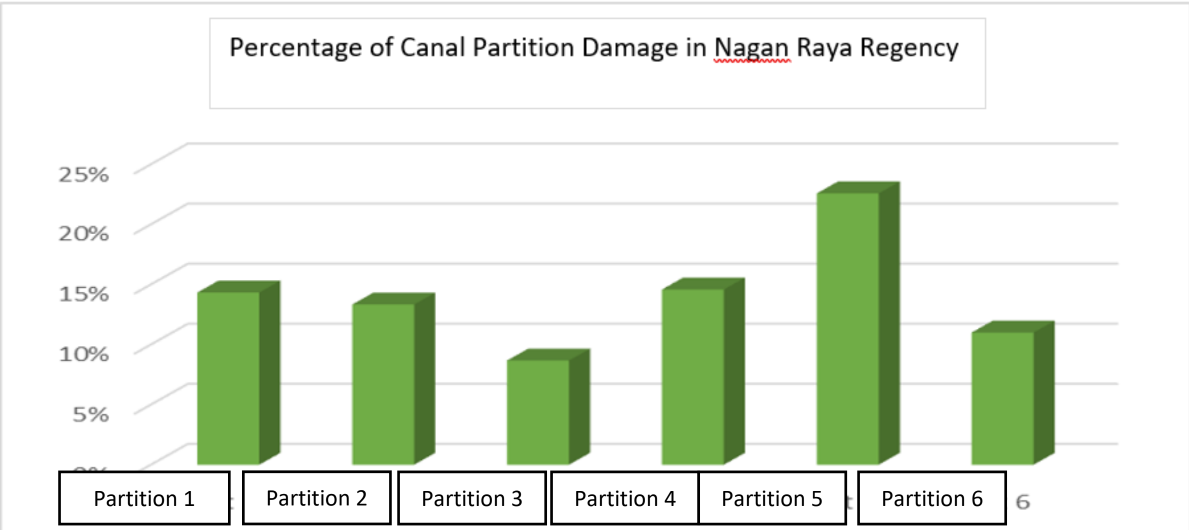
Each canal block underwent observation and data collection covering the quality and performance of the canal blocks. The quality of the canal blocks includes four aspects: (1) construction strength, (2) construction stability, (3) material quality, and (4) hydraulic condition. Table 4 shows the functionality measurements of six canal blocks constructed in Nagan Raya District.

Table 4. Functionality Measurement Results of Canal Blocks in Nagan Raya District

Partition code	Coordinates		Regency	Village	Year	Structural strength weight (15%)	Construction stability weight (15%)	Hydraulic condition weight (15%)	Material condition weight (15%)	Canal partition functionality weight (40%)	Scoring of canal partition quality	Category	Percentage of canal partition condition	Percentage of canal partition damage
	x	y												
Partition 1	96.230.139	4.093.649	Nagan Raya	Kuala Baro	2022	0.42	0.30	0.40	0.45	1.00	2.57	good	85.67%	14.33%
Partition 2	96.236.000	4.092.778	Nagan Raya	Kuala Baro	2022	0.45	0.35	0.45	0.45	0.90	2.60	good	85.67%	13.33%
Partition 3	96.238.306	4.095.028	Nagan Raya	Kuala Baro	2022	0.39	0.45	0.45	0.45	1.00	2.74	good	91.33%	8.67%
Partition 4	96.304.083	4.023.677	Nagan Raya	Padang panyang	2022	0.45	0.30	0.41	0.41	1.10	2.56	good	85.42%	14.59%
Partition 5	96.307.028	4.025.361	Nagan Raya	Padang panyang	2022	0.36	0.25	0.41	0.41	1.00	2.32	good	77.42%	22.58%
Partition 6	96.296.778	4.015.387	Nagan Raya	Padang panyang	2022	0.42	0.35	0.45	0.45	1.00	2.67	good	89.00%	11.00%

Based on Table 4, the canal blocks are in good condition regarding structure and functionality (no leakage). However, the stability and hydraulic conditions of some canal blocks have significantly deteriorated. This issue arose because some canal blocks could not withstand the water flow, necessitating additional canal blocks to manage the water flow, ensuring it aligns with the contour. Graph 3 illustrates the percentage of canal block damage in Nagan Raya District.

Graph 3. Percentage of Canal Block Damage in Nagan Raya District



Graph 3 indicates that the highest damage was found in block 5 (22.58%), while the least damage was in block 3 (8.67%). The damage in the canal blocks was due to the stability of the construction and hydraulic conditions. Therefore, additional canal blocks are needed for block 5. The observed hydraulic conditions in Nagan Raya included local scouring and high dropping.

The analysis and evaluation of the condition and function of canal block construction in Aceh Province in 2022 indicate that most canal blocks are still in slightly damaged condition. According to interviews with local community leaders and sources, the constructed canal blocks are expected to last 3-4 years due to the accurate location placement and high-quality materials. Moreover, good planning studies are crucial for the sustainability of canal block use in the field. Planning studies should cover technical, ecological, social, and cultural aspects of the local community.

The recommendations based on the evaluation of the condition and functionality of the 17 canal blocks include preventive maintenance such as repairing the stakes and boards of the canal blocks, adding mineral soil on both sides of the wings, and maintaining the spillways. Table 5 shows the maintenance recommendations for canal blocks based on the evaluation results in Aceh Province.

Table 5. Maintenance Recommendations for Canal Blocks

Partition Code	Coordinates (X)	Coordinates (Y)	Regency	Village	Year	Canal Partition Condition Percentage	Canal Partition Damage Percentage	Maintenance Recommendation
Partition 1	96.230.139	4.093.694	Nagan Raya	Kuala Baro	2022	85.67%	14.33%	Preventive
Partition 2	96.236.000	4.092.778	Nagan Raya	Kuala Baro	2022	86.67%	13.33%	Preventive
Partition 3	96.238.306	4.095.028	Nagan Raya	Kuala Baro	2022	91.33%	8.67%	Preventive
Partition 4	96.304.083	4.023.667	Nagan Raya	Padang Panyang	2022	85.42%	14.58%	Preventive
Partition 5	96.307.028	4.025.361	Nagan Raya	Padang Panyang	2022	77.42%	22.58%	Preventive
Partition 6	96.296.778	4.015.389	Nagan Raya	Padang Panyang	2022	89.00%	11.00%	Preventive
Partition 7	96.106.833	4.215.139	West Aceh	Leuhan	2022	85.42%	14.58%	Preventive
Partition 8	96.104.528	4.216.444	West Aceh	Leuhan	2022	85.42%	14.58%	Preventive
Partition 9	96.153.278	4.250.917	West Aceh	Peunia	2022	83.67%	16.33%	Preventive
Partition 10	96.153.333	4.250.056	West Aceh	Peunia	2022	87.00%	13.00%	Preventive
Partition 11	96.153.194	4.252.528	West Aceh	Peunia	2022	89.00%	11.00%	Preventive
Partition 12	95.789.528	4.497.361	Aceh Jaya	Batee Rhoo	2022	88.00%	12.00%	Preventive

Partition 13	95.791.444	4.499.556	Aceh Jaya	Batee Rhoo	2022	95.67 %	4.33%	Preventive
Partition 14	95.792.694	4.499.333	Aceh Jaya	Batee Rhoo	2022	91.33 %	8.67%	Preventive
Partition 15	95.793.583	4.500.472	Aceh Jaya	Batee Rhoo	2022	93.33 %	6.67%	Preventive
Partition 16	95.793.417	4.500.444	Aceh Jaya	Batee Rhoo	2022	93.33 %	6.67%	Preventive
Partition 17	95.793.917	4.501.000	Aceh Jaya	Batee Rhoo	2022	90.00 %	10.00%	Preventive

According to the Ministry of Environment and Forestry (2020), preventive maintenance aims to preserve the optimal function and performance of canal blocks to match the planned service level. The general criteria for preventive maintenance include:

- Applied to canal blocks that are still in good condition or have minor damage (<40%).
- Scheduled and conducted alongside operational inspections.
- Consists of simple maintenance and repair tasks that do not require detailed design calculations (as-built drawings).
- Not intended to enhance the canal block's functionality.
-

3. Impact of Canal Block Wetting

Observations and data collection on the impact of canal block construction were conducted in six villages: Kuala Baro and Padang Panyang in Nagan Raya District; Peunia and Leuhan in Aceh Barat District; and Batee Roo in Aceh Jaya District. Table 6 presents the results of the wetting impact calculations in three districts of Aceh Province.

Table 6. Wetting Impact Calculation Results of Canal Block Construction in Aceh Province

Location		Calculation of Submerged Area (Hectares)
Nagan Raya Regency, Aceh Province		
1.	Padang Panyang Village	18,15
2.	Kuala Baro Village	13,70
Aceh Barat Regency, Aceh Province		
1.	Leuhan Village	12,10
2.	Peunia Village	10,60
Aceh Jaya Regency, Aceh Province		
1.	Batee Roo Village	26,71
Total Wetting		**81,27**

Based on observations and measurements, the wetting impact area ranged from 5-10 hectares for each canal block constructed in Aceh Province due to the following factors:

1. The physical condition of the canal blocks remained in good shape with a minimum condition percentage of 85%.

2. The peat depth varied from 50-400 cm, with water flow patterns influenced by other canal flows and long-term peatland management, affecting the rate of peatland subsidence.
3. The cultural practices of peatland management differed from common practices.
4. Some canal blocks did not exhibit a difference in water level between upstream and downstream areas.
5. The groundwater level measurement techniques were not precise, as they waited for water stability before measurement.

Post-construction observations indicated that the canal blocks significantly raised the water level in the channels compared to the levels before their construction. This was followed by an increase in the groundwater level in the peatlands. Daryono's (2009) research stated that canal blocking could impede water flow in drainage channels, resulting in the re-wetting of the surrounding peatland areas. Research by Khotimah G H, et al. (2020) mentioned that canal block construction positively impacts maintaining groundwater levels and keeping peatlands consistently wet or moist up to 201 meters perpendicular to the canal.

CONCLUSION

Based on the evaluation results of the condition, function, and wetting impact through canal block construction for the restoration of the Peatland Ecosystem, the following conclusions have been drawn as inputs for the development of policies on peatland ecosystem restoration through canal block construction:

1. Integrated planning studies (SID) for canal block construction are crucial, considering that the use of canal water flows involves multiple stakeholders in the local villages. The use of appropriate materials and methods can result in more effective canal blocks.
2. The condition of the 17 canal blocks constructed remains good or only slightly damaged, considering the quality of the structure and the function or performance of the canal blocks.
3. The condition of the canal blocks in the three districts of Aceh Province showed that, on average, the canal blocks built over more than two years are approximately 85-92% intact, with damage percentages around 5-10% per canal block.
4. Recommendations from the evaluation of the condition and function of the 17 canal blocks include preventive maintenance, such as the upkeep of the piling and canal block boards, the addition of mineral soil on both wings, and runoff management.
5. The calculated wetting impact area ranges from 5-10 hectares per canal block. The use of kite formula calculations is still inaccurate for determining the wetting impact area of peatlands that have undergone canal block construction interventions in Aceh Province. This is due to the highly dynamic development of land management in each region, necessitating the adaptation of methods and techniques for calculating the wetting impact area in each region.

REFERENCE

1. Couwenberg, J., Thiele, A., Tanneberger, F., Augustin, J., Bärisch, S., Dubovik, D., ... & Joosten, H. (2010). Greenhouse gas emissions from managed peat soils: Is the IPCC reporting guidance realistic? Mires and Peat, 8, 1-10.
2. Dommain, R., Couwenberg, J., Glaser, P. H., Joosten, H., Suryadiputra, I. N. N., & Harris, N. (2011). Hydrological changes and their impact on carbon release in peatlands. International Journal of Environmental Science, 2(2).

3. Erviani, N. K., & Mirmanto, E. (2015). Kajian ekosistem gambut tropika: Kasus di Kalimantan dan Sumatera. Jurnal Ilmu Lingkungan, 13(1), 1-12.
4. Evers, S., Yule, C. M., Padfield, R., O'Reilly, P., & Varkkey, H. (2017). Effects of canal blocking on hydrology and water quality in peatlands. Journal of Hydrology, 548, 141-149.
5. Hobbs, R. J., & Harris, J. A. (2001). Restoration ecology: Repairing the Earth's ecosystems in the new millennium. Restoration Ecology, 9(2), 239-246.
6. Hooijer, A., Page, S., Jauhiainen, J., Lee, W. A., Lu, X. X., Idris, A., & Anshari, G. (2010). Current and future CO2 emissions from drained peatlands in Southeast Asia. Biogeosciences, 7, 1505-1514.
7. Joosten, H. (2009). The global peatland CO2 picture: Peatland status and drainage related emissions in all countries of the world. Wetlands International.
8. Kurnianto, S., Warren, M., Talbot, J., Kauffman, J. B., Murdiyarso, D., & Frolking, S. (2015). Strategies for sustainable peatland hydrology management in Southeast Asia. Wetlands Ecology and Management, 23, 291-305.
9. Miettinen, J., Shi, C., & Liew, S. C. (2012). Impact of peatland drainage and restoration on biodiversity and climate change. Global Change Biology, 18(9), 2457-2471.
10. Page, S. E., Rieley, J. O., & Banks, C. J. (2011). The impact of peatland drainage and fires on peatland carbon dynamics in Indonesia. Global Change Biology, 17(11), 798-810.
11. Ritzema, H. (2007). The role of drainage in the wise use of tropical peatlands. In Proceedings of the International Symposium on Tropical Peatland, Jakarta.
12. Roulet, N. T. (2010). Peatlands, carbon storage, greenhouse gases, and the Kyoto Protocol: Prospects and significance for Canada. Wetlands, 30(1), 1-9.
13. Silvius, M., Joosten, H., & Spiertz, H. (2008). Peatland degradation fuels climate change: An unwelcome contribution to the global greenhouse. Wetlands Ecology and Management, 16, 359-372.
14. Swails, E., Evans, K., Sunderland, T., & Giam, X. (2019). Community participation in peatland restoration: Insights from Indonesia. Society & Natural Resources, 32(8), 853-871.
15. Wahyunto, & Suryadiputra, I. N. N. (2008). Peta sebaran lahan gambut Indonesia. Bogor: Wetlands International Indonesia Programme and Wildlife Habitat Canada.
16. Wahyunto, Ritung, S., & Subagjo, H. (2013). Penelitian kawasan gambut tropika Indonesia. Jurnal Ekologi Tropika, 17(3).
17. Wosten, J. H. M., Clymo, R. S., & Page, S. E. (2008). Interacting effects of drainage, restoration, and climate change on peatland hydrology. Journal of Hydrology, 350(1-2), 1-12.
18. Xu, J., Morris, P. J., Liu, J., & Holden, J. (2018). Distribusi dan konservasi lahan gambut di Indonesia. Nature Communications, 9, 542.