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ENVIRONMENTAL RISK ANALYSIS IN MAGROVE AND CRAB CONSERVATION AREAS IN PAMUSIAN VILLAGE DUE TO LAND USE CHANGE IN TARAKAN CITY

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ABSTRACT

Mangroves are one of the largest coastal ecosystems in Indonesia that provide ecosystem functions and services for terrestrial biota, sea, seagrass ecosystems - coral reefs, and surrounding areas. Indonesia has the largest mangrove area in the world with an area of 22.6%, so that Indonesian mangroves contribute significantly to the absorption of carbon dioxide (CO2), one of the greenhouse gases. So that Indonesia's mangroves play an important role in regulating global climate change. The area of mangrove forests in Indonesia has declined sharply over the past two decades. The main drivers of mangrove degradation are use for settlement and cultivation. Currently, sustainable management is needed to maintain and improve the area and quality of mangroves. Mangrove forests are very important ecosystems for the conservation of fish resources. Mangroves are the habitat of fish, shrimp, crabs, and others. The ecological or biological function of mangrove ecosystems includes spawning grounds, foraging and breeding grounds for animals, especially fish, crabs and shrimp which are excellent commodities that benefit fishermen. Physically, mangrove forests prevent coastal abrasion, resist seawater intrusion and windbreaks, and reduce greenhouse gas emissions such as CO, CO2, SOx and NOx in the air and pollutants in coastal waters (Noor et al., 2006). The main factors of mangrove destruction are (1) pollution, (2) conversion of mangrove forests without considering environmental factors, and (3) excessive deforestation.

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INTRODUCTION

Mangroves are one of the largest coastal ecosystems in Indonesia that provide ecosystem functions and services for terrestrial biota, sea, seagrass ecosystems - coral reefs, and surrounding areas. Indonesia has the largest mangrove area in the world with an area of 22.6%, so that Indonesian mangroves contribute significantly to the absorption of carbon dioxide (CO2), one of the greenhouse gases. So that Indonesia's mangroves play an important role in regulating global climate change. The area of mangrove forests in Indonesia has declined sharply over the past two decades. The main drivers of mangrove degradation are use for settlement and cultivation. Currently, sustainable management is needed to maintain and improve the area and quality of mangroves.

Mangrove ecosystems have ecological, physical, and socio-economic functions that are important to be developed, especially in coastal areas. According to Pramudji (Kordi, 2001), mangroves are transitional ecosystems between land and sea and are strongly influenced by waves, coastal topography, tides and especially salinity. In addition, the decomposition process that occurs in mangrove litter can support the life of creatures in it.

Mangrove forests are very important ecosystems for the conservation of fish resources. Mangroves are the habitat of fish, shrimp, crabs, and others. The ecological or biological function of mangrove ecosystems includes spawning grounds, foraging and breeding grounds for animals, especially fish, crabs and shrimp which are excellent commodities that benefit fishermen. Physically, mangrove forests prevent coastal abrasion, resist seawater intrusion and windbreaks, and reduce greenhouse gas emissions such as CO, CO2, SOx and NOx in the air and pollutants in coastal waters (Noor et al., 2006). The main factors of mangrove destruction are (1) pollution, (2) conversion of mangrove forests without considering environmental factors, and (3) excessive deforestation.

The mangrove area in Tarakan City which is part of the city's RTH is divided into two areas, namely: 1. Mangrove and Proboscis Conservation Area in Karang Rejo Village 2. Mangrove Forest Area of AL Port Mamburungan. The plan to develop mangrove areas as RTH includes: 1. Crab Mangrove Conservation Area in Pamusian Village 2. Mangrove area in West Tarakan District, 3. Mangrove area in Central Tarakan District, 4. Mangrove area in East Tarakan, and 5. Mangrove area in North Tarakan District. Over time, there was encroachment by the community, precisely in the magrove forest area in Pamusian village. This has happened since early 2021 when there were some indigenous groups, who recognized that the land belonged to them. The Tarakan City Government did not remain silent through the village piohak, Satpol PP and the Environmental Office conducted field data collection and it was produced that there were several people who had occupied and cut down mangrove trees, which were planned to be used as residential areas.

METHOD

The data used in this study is the administrative map of Pamuisan Village, Central Tarakan District, taken from the RTRW document. Implementation of Data Collection Research Data collection is divided into two types of data, namely in the form of primary data and secondary data. Primary data is obtained from direct checks in the field. Secondary data are obtained from relevant agencies or supporting literature.

In general, there are three important information to perform HEA calculations, namely:

1. Information related to the subject to be counted, namely ecosystems or natural resources that have been damaged.
2. Initial damage
3. Possible exosystem recovery rate

These three pieces of information form an integral part of the HEA calculation and will determine the final result, namely the scale of restoration needed to compensate for the damage to the ecosystem that occurs. Therefore, like the percentage of maintenance relative to the baseline (% hectare or % ton), a single matrix makes it easy to calculate the damage and recovery required. Dunford et al (2004) state that when using matrices, attention should be paid to:

1. Relationship with resource wealth or important natural resource functions in habitat
2. Relationships between degraded habitats and more general habitats such as forests, wetlands, and sediments
3. Can be measured or estimated relative to the baseline
4. Comparable (measured) with metrics for restored habitat

In terms of scaling, the concept essentially seeks the modulus of the number of units that must be recovered to ensure that the discounted present value of the recovery gain is equal to or equal to the discounted present value of the intermediate damage. There are two types of scale approaches in the field of environmental damage assessment: the assessment approach and the service-to-service approach. HEA uses both. This is because the resulting scaling factor represents a service that can be recovered to compensate for lost services.

Mathematically it can be interpreted with a simple equation, namely:

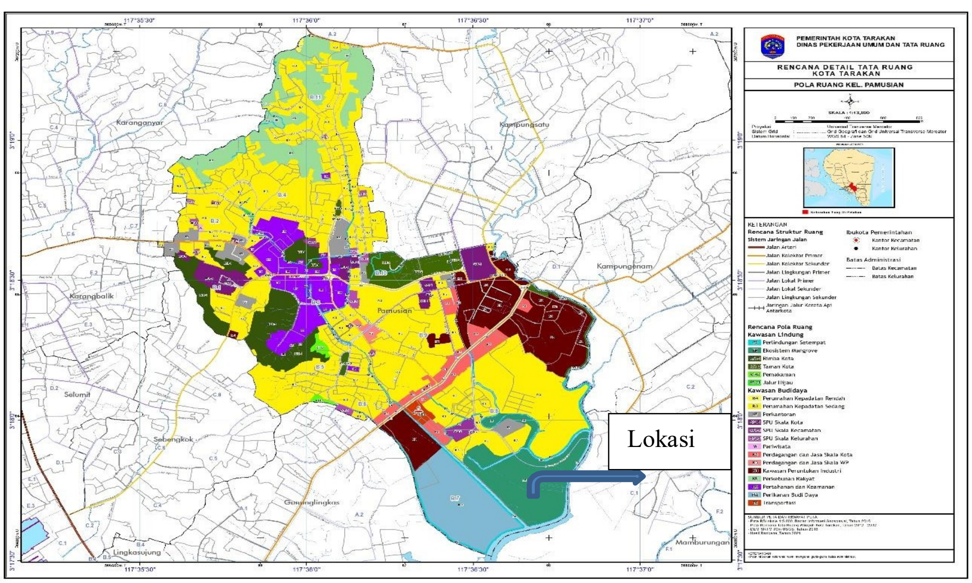
$$\sum_{t=t0}^{t1} Lt\,(1+r)^{(p-t)} = \sum_{s=s0}^{s1} Rs\,(1+r)^{(p-s)}$$

Information:
Lt = major damage
Rt = major repair
r = *discount rate*
t = time
P = first year started
t1 = end of breakdown
s1 = end of repair bats

RESULTS AND ANAYSIS

a. **Conditions of the practice area**

Map of spatial pattern of Pamusian Village as shown below:



Based on data in Regional Regulation No. 3 of 2021 concerning the RTRW of Tarakan City for 2021-2041, that Pamuisan Village has a mangrove and crab conservation area covering an area of approximately 25 hectares. After juxtaposing the 2014 image map with the 2022 image map, which can be seen in the following image:

2014 imagery map

image 2021 image

After looking at the 2021 aerial imagery map, there was encroachment of the area, namely: There is logging and illegal dwellings at the location after an inventory and measurement of approximately 5 hectares of land that has been taken and used by the community which can be seen in the photo documentation below:

b. Data analysis with HEA Calculation for environmental sustainability

Based on the results of field reviews and interviews with crab hunters, the following results were obtained:

1. There was damage to the mangrove area with a damaged area of 5 hectares. Calculation of losses (discharge) for the initial year of the 2021 baseline and the final year of losses in 2052 assuming natural restoration of mangrove forests for 30 years. The base year of the *discount factor* is 2023 assumed to be 1, the degree of loss is 20% of the total area area, and the decline of this service until 2023 and until no more losses are assumed in 2052. Discount rates are assumed to be 3%, 5% and 7% per annum.
2. According to crab seekers by ngambo / install crab traps in 1 week 3 pairs of bubu approximately 50 pieces, with catches of 3 to 5 Kg. So that in one week approximately 12 kilograms.

1. Analysis of the calculation of the area of damage to magrove

Based on the data obtained and carried out the calculation of HEA below:

Table 9.1 Calculation of HEA Discharge Affected area

Year	Area Affected (Ha)	Percent of Services Lost(%)	Discount rate 3%		Discount rate 5%		Discount rate 7%	
			Discount Factor	**Debit (DSHaYS)**	**Discount Factor**	**Debit (DSHaYS)**	**Discount Factor**	**Debit (DSHaYS)**
2021	5	0.200	1.06	1.06	1.10	1.10	1.14	1.14
2022	5	0.200	1.03	1.03	1.05	1.05	1.07	1.07
2023	5	0.200	1.00	1.00	1.00	1.00	1.00	1.00
2024	5	0.195	0.97	0.95	0.95	0.93	0.93	0.91
2025	5	0.190	0.94	0.90	0.91	0.86	0.87	0.83
2026	5	0.185	0.92	0.85	0.86	0.80	0.82	0.76
2027	5	0.180	0.89	0.80	0.82	0.74	0.76	0.69
2028	5	0.175	0.86	0.75	0.78	0.69	0.71	0.62
2029	5	0.170	0.84	0.71	0.75	0.63	0.67	0.57
2030	5	0.165	0.81	0.67	0.71	0.59	0.62	0.51
2031	5	0.160	0.79	0.63	0.68	0.54	0.58	0.47
2032	5	0.155	0.77	0.59	0.64	0.50	0.54	0.42
2033	5	0.150	0.74	0.56	0.61	0.46	0.51	0.38
2034	5	0.145	0.72	0.52	0.58	0.42	0.48	0.34
2035	5	0.140	0.70	0.49	0.56	0.39	0.44	0.31
2036	5	0.135	0.68	0.46	0.53	0.36	0.41	0.28
2037	5	0.130	0.66	0.43	0.51	0.33	0.39	0.25
2038	5	0.125	0.64	0.40	0.48	0.30	0.36	0.23
2039	5	0.120	0.62	0.37	0.46	0.27	0.34	0.20
2040	5	0.115	0.61	0.35	0.44	0.25	0.32	0.18
2041	5	0.110	0.59	0.32	0.42	0.23	0.30	0.16
2042	5	0.105	0.57	0.30	0.40	0.21	0.28	0.15
2043	5	0.100	0.55	0.28	0.38	0.19	0.26	0.13
2044	5	0.095	0.54	0.26	0.36	0.17	0.24	0.11
2045	5	0.090	0.52	0.23	0.34	0.15	0.23	0.10
2046	5	0.085	0.51	0.22	0.33	0.14	0.21	0.09
2047	5	0.080	0.49	0.20	0.31	0.12	0.20	0.08
2048	5	0.075	0.48	0.18	0.30	0.11	0.18	0.07
2049	5	0.070	0.46	0.16	0.28	0.10	0.17	0.06
2050	5	0.065	0.45	0.15	0.27	0.09	0.16	0.05
2051	5	0.060	0.44	0.13	0.26	0.08	0.15	0.05
2052	5	0.000	0.42	0.00	0.24	0.00	0.14	0.00
		Total Discounted servicehectar-year lost (DSHaYS)		**15.95**		**13.80**		**12.22**

Table 9.2 Debit loos dengan Discount rate 3%, 5% dan 7%

Year	3%	5%	7%
2021	1.06	1.10	1.14
2022	1.03	1.05	1.07
2023	1.00	1.00	1.00
2024	0.95	0.93	0.91
2025	0.90	0.86	0.83
2026	0.85	0.80	0.76
2027	0.80	0.74	0.69
2028	0.75	0.69	0.62
2029	0.71	0.63	0.57
2030	0.67	0.59	0.51
2031	0.63	0.54	0.47
2032	0.59	0.50	0.42
2033	0.56	0.46	0.38
2034	0.52	0.42	0.34
2035	0.49	0.39	0.31
2036	0.46	0.36	0.28
2037	0.43	0.33	0.25
2038	0.40	0.30	0.23
2039	0.37	0.27	0.20
2040	0.35	0.25	0.18
2041	0.32	0.23	0.16
2042	0.30	0.21	0.15
2043	0.28	0.19	0.13
2044	0.26	0.17	0.11
2045	0.23	0.15	0.10
2046	0.22	0.14	0.09
2047	0.20	0.12	0.08
2048	0.18	0.11	0.07
2049	0.16	0.10	0.06
2050	0.15	0.09	0.05
2051	0.13	0.08	0.05
2052	0.00	0.00	0.00

Graph 9.1 Debit loos dengan Discount rate 3%, 5% dan 7%

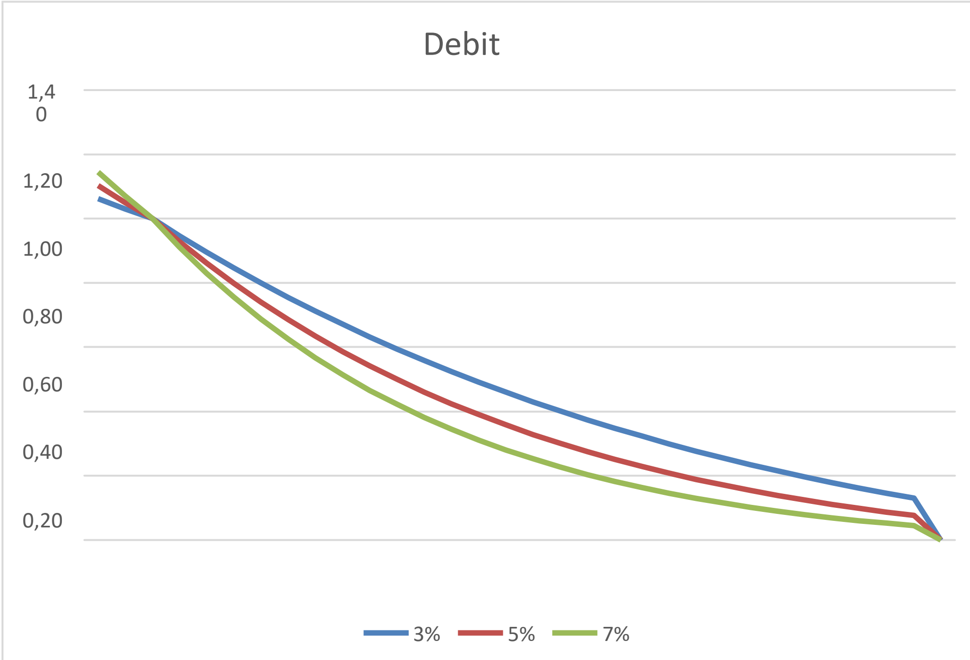


Table 9.3 HEA Credit Calculation Utilization area

Year	Unit (Ha)	Degree of Benefit (% Increase)	Discount rate 3%		Discount rate 5%		Discount rate 7%	
			Discount Factor	**Debit (DSHaYS)**	**Discount Factor**	**Debit (DSHaYS)**	**Discount Factor**	**Debit (DSHaYS)**
2021	1	0%	1,06	0,00	1,10	0,00	1,14	0,00
2022	1	10%	1,03	0,10	1,05	0,11	1,07	0,11
2023	1	20%	1,00	0,20	1,00	0,2	1,00	0,2
2024	1	25%	0,97	0,24	0,95	0,24	0,93	0,23
2025	1	30%	0,94	0,28	0,91	0,27	0,87	0,26
2026	1	35%	0,92	0,32	0,86	0,30	0,82	0,29
2027	1	40%	0,89	0,36	0,82	0,33	0,76	0,31
2028	1	45%	0,86	0,39	0,78	0,35	0,71	0,32
2029	1	50%	0,84	0,42	0,75	0,37	0,67	0,33
2030	1	55%	0,81	0,45	0,71	0,39	0,62	0,34
2031	1	60%	0,79	0,47	0,68	0,41	0,58	0,35
2032	1	65%	0,77	0,50	0,64	0,42	0,54	0,35
2033	1	70%	0,74	0,52	0,61	0,43	0,51	0,36
2034	1	75%	0,72	0,54	0,58	0,44	0,48	0,36
2035	1	80%	0,70	0,56	0,56	0,45	0,44	0,36
2036	1	85%	0,68	0,58	0,53	0,45	0,41	0,35
2037	1	90%	0,66	0,60	0,51	0,45	0,39	0,35
2038	1	95%	0,64	0,61	0,48	0,46	0,36	0,34

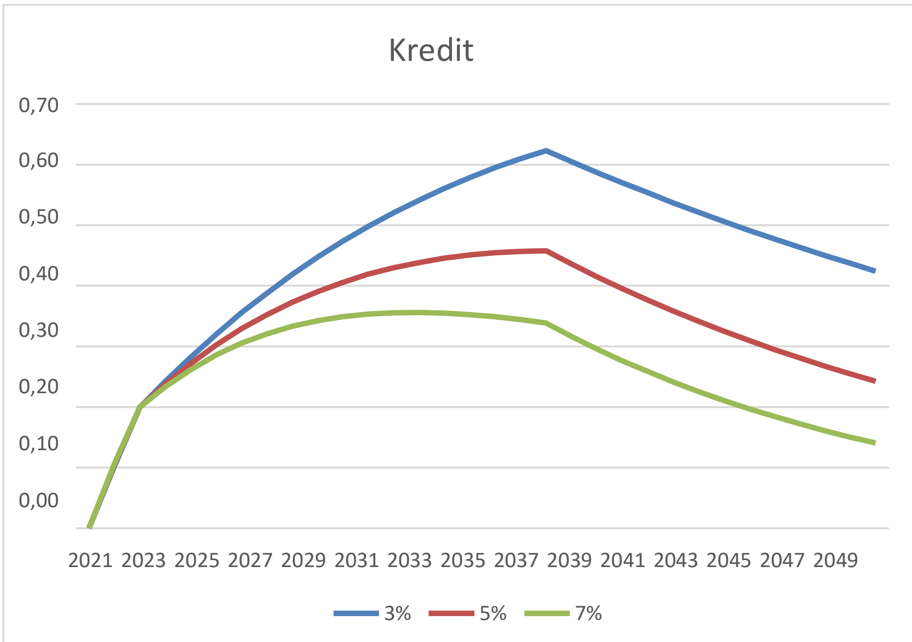
2039	1	100%	0,62	0,62	0,46	0,46	0,34	0,34
2040	1	100%	0,61	0,61	0,44	0,44	0,32	0,32
2041	1	100%	0,59	0,59	0,42	0,42	0,30	0,30
2042	1	100%	0,57	0,57	0,40	0,40	0,28	0,28
2043	1	100%	0,55	0,55	0,38	0,38	0,26	0,26
2044	1	100%	0,54	0,54	0,36	0,36	0,24	0,24
2045	1	100%	0,52	0,52	0,34	0,34	0,23	0,23
2046	1	100%	0,51	0,51	0,33	0,33	0,21	0,21
2047	1	100%	0,49	0,49	0,31	0,31	0,20	0,20
2048	1	100%	0,48	0,48	0,30	0,30	0,18	0,18
2049	1	100%	0,46	0,46	0,28	0,28	0,17	0,17
2050	1	100%	0,45	0,45	0,27	0,27	0,16	0,16
2051	1	100%	0,44	0,44	0,26	0,26	0,15	0,15
2052	1	100%	0,42	0,42	0,24	0,24	0,14	0,14
	Total Discounted service hectar-year lost (DSHaYS)			**14,39**		**10,83**		**8,38**

Table 9.4 Utilization credit with Discount rate of 3%, 5% and 7%

Tahun	**3%**	**5%**	**7%**
2021	0,00	0,00	0,00
2022	0,10	0,11	0,11
2023	0,20	0,20	0,20
2024	0,24	0,24	0,23
2025	0,28	0,27	0,26
2026	0,32	0,30	0,29
2027	0,36	0,33	0,31
2028	0,39	0,35	0,32
2029	0,42	0,37	0,33
2030	0,45	0,39	0,34
2031	0,47	0,41	0,35
2032	0,50	0,42	0,35
2033	0,52	0,43	0,36
2034	0,54	0,44	0,36
2035	0,56	0,45	0,36
2036	0,58	0,45	0,35
2037	0,60	0,45	0,35
2038	0,61	0,46	0,34
2039	0,62	0,46	0,34
2040	0,61	0,44	0,32
2041	0,59	0,42	0,30
2042	0,57	0,40	0,28
2043	0,55	0,38	0,26
2044	0,54	0,36	0,24
2045	0,52	0,34	0,23

2046	0,51	0,33	0,21
2047	0,49	0,31	0,20
2048	0,48	0,30	0,18
2049	0,46	0,28	0,17
2050	0,45	0,27	0,16
2051	0,44	0,26	0,15
2052	0,424	0,243	0,141

Graph 9.2 Utilization credit with Discount rate of 3%, 5% and 7%



The next step in calculating the restoration scale is as follows:
The result of the discharge analysis is 3% = 15.95 DSHaYs
Credit analysis result 3% = 14.39 DSHaYs
3% restoration scale = $\frac{15,95}{14,39}$
= 1.11 hectares

Restoration Scale	3%	5%	7%
	1.11	1.27	1.46

2. Analysis of crab production calculations

The calculation of HEA on the impact of crab production with the results of interview data with crab hunters is:

Table 9.5 Calculation of Production Crab HEA Discharge

Year	Crab Production (Kg)	Percent of Services Lost	Discount rate 3%		Discount rate 5%		Discount rate 7%	
			Discount Factor	Debit (DSHaYS)	Discount Factor	Debit (DSHaYS)	Discount Factor	Debit (DSHaYS)
2021	576	0.200	1.06	2.22	1.10	127.01	1.14	131.89
2022	576	0.200	1.03	118.66	1.05	120.96	1.07	123.26
2023	576	0.200	1.00	115.20	1.00	115.20	1.00	15.20
2024	576	0.195	0.97	109.05	0.95	106.97	0.93	104.97
2025	576	0.190	0.94	103.16	0.91	99.27	0.87	95.59
2026	576	0.185	0.92	97.52	0.86	92.05	0.82	86.98
2027	576	0.180	0.89	92.12	0.82	85.30	0.76	79.10
2028	576	0.175	0.86	86.95	0.78	78.98	0.71	71.87
2029	576	0.170	0.84	82.01	0.75	73.07	0.67	65.25
2030	576	0.165	0.81	77.28	0.71	67.54	0.62	59.19
2031	576	0.160	0.79	72.75	0.68	62.38	0.58	53.64
2032	576	0.155	0.77	68.43	0.64	57.55	0.54	48.56
2033	576	0.150	0.74	64.29	0.61	53.04	0.51	43.92
2034	576	0.145	0.72	60.34	0.58	48.83	0.48	39.68
2035	576	0.140	0.70	56.56	0.56	44.90	0.44	35.81
2036	576	0.135	0.68	52.95	0.53	41.24	0.41	32.27
2037	576	0.130	0.66	49.50	0.51	37.82	0.39	29.04
2038	576	0.125	0.64	46.21	0.48	34.63	0.36	26.10
2039	576	0.120	0.62	43.07	0.46	31.66	0.34	23.41
2040	576	0.115	0.61	40.08	0.44	28.90	0.32	20.97
2041	576	0.110	0.59	37.22	0.42	26.33	0.30	18.75
2042	576	0.105	0.57	34.49	0.40	23.93	0.28	16.72
2043	576	0.100	0.55	31.89	0.38	21.71	0.26	14.88
2044	576	0.095	0.54	29.41	0.36	19.64	0.24	13.22
2045	576	0.090	0.52	27.05	0.34	17.72	0.23	11.70
2046	576	0.085	0.51	24.81	0.33	15.94	0.21	10.33
2047	576	0.080	0.49	22.67	0.31	14.29	0.20	9.08
2048	576	0.075	0.48	20.63	0.30	12.76	0.18	7.96
2049	576	0.070	0.46	18.70	0.28	11.34	0.17	6.94
2050	576	0.065	0.45	16.86	0.27	10.03	0.16	6.03
2051	576	0.060	0.44	15.11	0.26	8.82	0.15	5.20
2052	576	0.000	0.42	0.000	0.24	0.000	0.14	0.000
		Total Discounted service hectar-year lost (DSHaYS)		**1,837.16**		**1,589.81**		**1,407.50**

Table 9.6 Production Crab Discharge with Discount rate of 3%, 5% and 7%

Year	3%	5%	7%
2021	2.22	127.01	131.89
2022	118.66	120.96	123.26
2023	115.20	115.20	15.20
2024	109.05	106.97	104.97
2025	103.16	99.27	95.59
2026	97.52	92.05	86.98
2027	92.12	85.30	79.10
2028	86.95	78.98	71.87
2029	82.01	73.07	65.25
2030	77.28	67.54	59.19
2031	72.75	62.38	53.64
2032	68.43	57.55	48.56
2033	64.29	53.04	43.92
2034	60.34	48.83	39.68
2035	56.56	44.90	35.81
2036	52.95	41.24	32.27
2037	49.50	37.82	29.04
2038	46.21	34.63	26.10
2039	43.07	31.66	23.41
2040	40.08	28.90	20.97
2041	37.22	26.33	18.75
2042	34.49	23.93	16.72
2043	31.89	21.71	14.88
2044	29.41	19.64	13.22
2045	27.05	17.72	11.70
2046	24.81	15.94	10.33
2047	22.67	14.29	9.08
2048	20.63	12.76	7.96
2049	18.70	11.34	6.94
2050	16.86	10.03	6.03
2051	15.11	8.82	5.20
2052	0.000	0.000	0.000

Graph 9.3 Production Crab Discharge with Discount rate of 3%, 5% and 7%

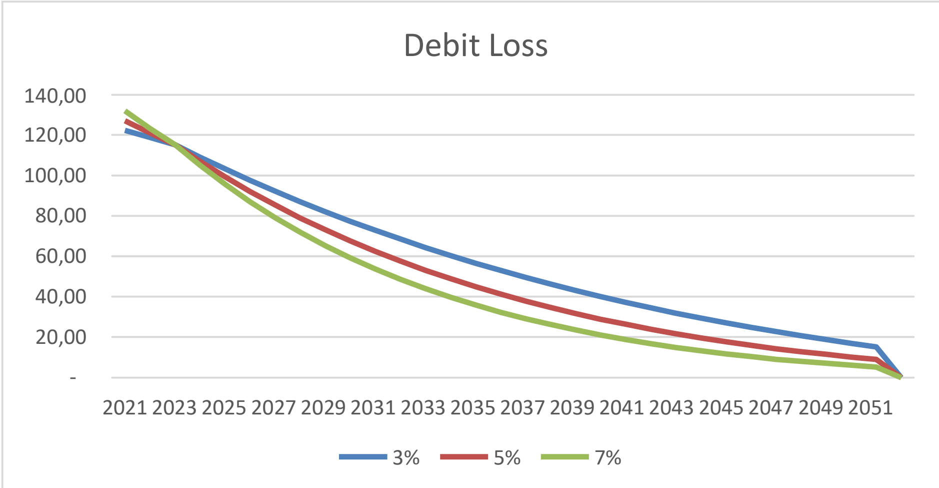


Table 9.7 Calculation of HEA Credit Crab Benefits

Year	Crab benefited (Kg)	Degree of Benefit (% Increase)	Discount rate 3%		Discount rate 5%		Discount rate 7%	
			Discount Factor	**Debit (DSHaYS)**	**Discount Factor**	**Debit (DSHaYS)**	**Discount Factor**	**Debit (DSHaYS)**
2021	115.20	0%	1.06	0.00	1.10	0.00	1.14	0.00
2022	115.20	10%	1.03	11.87	1.05	12.10	1.07	12.33
2023	115.20	20%	1.00	23.04	1.00	23.04	1.00	23.04
2024	115.20	25%	0.97	27.96	0.95	27.43	0.93	26.92
2025	115.20	30%	0.94	32.58	0.91	31.35	0.87	30.19
2026	115.20	35%	0.92	36.90	0.86	34.83	0.82	32.91
2027	115.20	40%	0.89	40.94	0.82	37.91	0.76	35.15
2028	115.20	45%	0.86	44.72	0.78	40.62	0.71	36.96
2029	115.20	50%	0.84	48.24	0.75	42.98	0.67	38.38
2030	115.20	55%	0.81	51.52	0.71	45.03	0.62	39.46
2031	115.20	60%	0.79	54.56	0.68	46.78	0.58	40.23
2032	115.20	65%	0.77	57.39	0.64	48.27	0.54	40.73
2033	115.20	70%	0.74	60.00	0.61	49.51	0.51	40.99
2034	115.20	75%	0.72	62.42	0.58	50.52	0.48	41.05
2035	115.20	80%	0.70	64.64	0.56	51.32	0.44	40.92
2036	115.20	85%	0.68	66.68	0.53	51.93	0.41	40.63
2037	115.20	90%	0.66	68.54	0.51	52.37	0.39	40.21
2038	115.20	95%	0.64	70.25	0.48	52.64	0.36	39.67
2039	115.20	100%	0.62	71.79	0.46	52.77	0.34	39.02
2040	115.20	100%	0.61	69.70	0.44	50.26	0.32	36.47
2041	115.20	100%	0.59	67.67	0.42	47.87	0.30	34.08
2042	115.20	100%	0.57	65.70	0.40	45.59	0.28	31.85
2043	115.20	100%	0.55	63.78	0.38	43.42	0.26	29.77
2044	115.20	100%	0.54	61.93	0.36	41.35	0.24	27.82

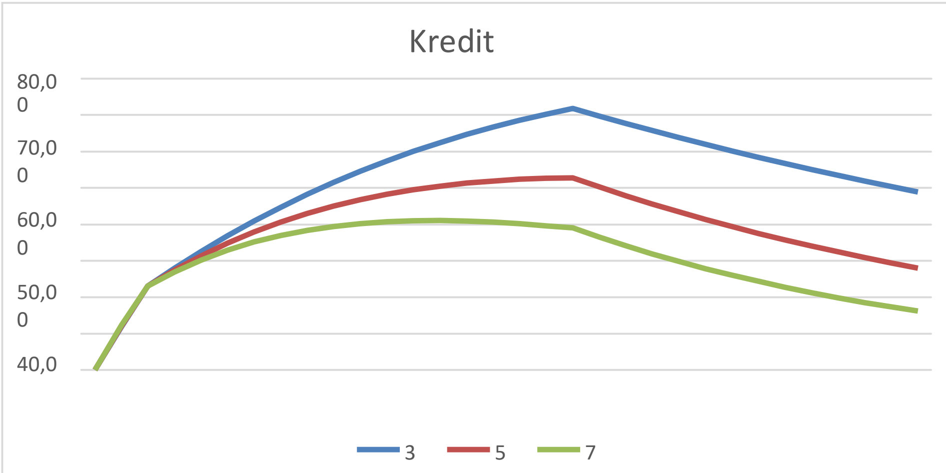
2045	115.20	100%	0.52	60.12	0.34	39.38	0.23	26.00
2046	115.20	100%	0.51	58.37	0.33	37.51	0.21	24.30
2047	115.20	100%	0.49	56.67	0.31	35.72	0.20	22.71
2048	115.20	100%	0.48	55.02	0.30	34.02	0.18	21.23
2049	115.20	100%	0.46	53.42	0.28	32.40	0.17	19.84
2050	115.20	100%	0.45	51.86	0.27	30.86	0.16	18.54
2051	115.20	100%	0.44	50.35	0.26	29.39	0.15	17.33
2052	115.20	100%	0.42	48.885	0.24	27.987	0.14	16.193
		Total Discounted service hectar-year lost (DSHaYS)		**1,657.50**		**1,247.12**		**964.92**

Table 9.8 Credit Crab benefits with Discount rates of 3%, 5% and 7%

Year	**3%**	**5%**	**7%**
2021	0.00	0.00	0.00
2022	11.87	12.10	12.33
2023	23.04	23.04	23.04
2024	27.96	27.43	26.92
2025	32.58	31.35	30.19
2026	36.90	34.83	32.91
2027	40.94	37.91	35.15
2028	44.72	40.62	36.96
2029	48.24	42.98	38.38
2030	51.52	45.03	39.46
2031	54.56	46.78	40.23
2032	57.39	48.27	40.73
2033	60.00	49.51	40.99
2034	62.42	50.52	41.05
2035	64.64	51.32	40.92
2036	66.68	51.93	40.63
2037	68.54	52.37	40.21
2038	70.25	52.64	39.67
2039	71.79	52.77	39.02
2040	69.70	50.26	36.47
2041	67.67	47.87	34.08
2042	65.70	45.59	31.85
2043	63.78	43.42	29.77
2044	61.93	41.35	27.82
2045	60.12	39.38	26.00
2046	58.37	37.51	24.30
2047	56.67	35.72	22.71
2048	55.02	34.02	21.23
2049	53.42	32.40	19.84
2050	51.86	30.86	18.54

2051	50.35	29.39	17.33
2052	48.885	27.987	16.193

Graph 9.2 Credit Crab benefits with Discount rates of 3%, 5% and 7%



The next step in calculating the restoration scale is as follows:

The result of the discharge analysis is 3% = 1.837,16 DSHaYs
Credit analysis result 3% = 1.657,50 DSHaYs
3% restoration scale = <u>**11.837,16**</u>
1.657,50
= 1.11 hectares

Restoration Scale	3%	5%	7%
	1.11	1.27	1.46

By:

a. Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No 23 of 2021 concerning the Implementation of Forest and Land Rehabilitation
b. Decree of the Director General of Watershed Management and Forest Rehabilitation Number: SK.19/PDASHL/SET.4/KEU.0/10/2021 dated October 18, 2021 concerning the Price of the Main Unit of Activities (HSPK) for Watershed Management and Forest Rehabilitation (PDASRH) in 2022.

Planting activities using the Silvofishery Pattern of 1,600 trunks / hectare, if the calculation results of HEA analysis the area to be restored is 1.11 ha with the following calculation results:

Unit price of planting = Rp. 10.303.341.77/ha x 1.1 ha = Rp. 11.436.709.37
First year maintenance = Rp. 2,396,873.42 / ha x 1.1 ha = Rp. 2,660,529.49
Second year maintenance = Rp. 1,468,215.19/ ha x 1.1 ha = Rp. 1,629,718.86

The value of Crab losses is:

Crab Price Rp. 50.000/Kg.

Discount rate	3%	5%	7%
Restoration Scale	1,11	1,27	1,46
Restoration Value	**55.419,77**	**63.738,98**	**72.933,76**

CONCLUSIONS

1) After credit and debit calculations are obtained, the next step in HEA analysis is to calculate the restoration scale. From the results of the debit analysis, a figure of 1,837.16 DSHaYs was obtained while the amount of credit was obtained at 1,657.50 DSHaYs. The distribution of debit to credit was obtained at 1.11 ha. In other words, to compensate for the loss of 1,837.16 DSHaYs with remediation activities, 1.11 ha is needed. This figure describes the number of hectares needed each year, starting from remediation in 2023, for the provision of ecosystem services for 30 years that will compensate for interim losses of 1,837.16 ha.
2) According to Lipton et al. (2018), remediation requires a smaller area (1.11 ha) than the total damaged area (5 ha). However, it should be noted that this number is the result of summation over time. In the above case, the discharge occurred for thirty years during which service fell by 20% during the first fifteen years, then recovered thereafter. Meanwhile, the benefits or credits derived from restoration projects occur over a relatively long period of time of 30 years during which ecosystem services recover gradually in the first seven years to 50% of the baseline and last until the end of the remediation period.
3) 3) Total restoration cost of Rp. 15,726,957.72
4) 4) Crab restoration value for 3% discount rate of Rp. 55,419.77, 5% discount rate of Rp. 63,738.98, and 7% discount rate of Rp. 72,933.76.

Suggestion

1. The Tarakan government must be stricter in safeguarding its assets so that land grabbing by customary institutions does not occur again.
2. The government must prepare a budget for mangrove forest replanting in 2023

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