

Supplementary data

Assessment of Watershed Carrying Capacity for the Aesesa Flores Watershed Management, East Nusa Tenggara Province of Indonesia

Appendix A. Land resources carrying capacity

Table A1. Classification of degraded land in the AF watershed

Aesesa Flores watershed			Percentage of degraded land			
Region	Total area (ha)	Degraded area (ha)	Percentage of degraded land	Classes	Score	Classification
Upstream	43.051	34.444	80,00	PLLK $\geq$ 20	1,50	Very high
Middle	52.52	43.854	83,48	PLLK $\geq$ 20	1,50	Very high
Downstream	33.433	20.615	61,66	PLLK $\geq$ 20	1,50	Very high

Table A2. Classification of land cover in the AF watershed

Aesesa Flores watershed			Percentage of land cover			
Region	Total area (ha)	Land cover area (ha)	Percentage of land cover	Classes	Score	Classification
Upstream	43.051	9.313	21,59	20<PPV $\leq$ 40	1,25	High
Middle	52.52	7.057	16,36	PPV $\leq$ 20	1,50	Very high
Downstream	33.433	6.405	14,85	PPV $\leq$ 20	1,50	Very high

Table A3. Classification of erosion index in the AF watershed

Aesesa Flores watershed		Erosion index			
Region	Total area (ha)	Crop-Management index	Class	Score	Classification
Upstream	43.051	0,04	CP $\leq$ 0,1	0,50	Very low
Middle	52.52	0,06	CP $\leq$ 0,1	0,50	Very low
Downstream	33.433	0,06	CP $\leq$ 0,1	0,50	Very low

Appendix B. Water resource carrying capacity

Table B1. Classification of flow coefficient

Aesesa Flores debit water flow-Q (m ³ /s)			Flow coefficient			
Region	Q Max	Q Min	Flow coefficient	Class	Score	Classification
Upstream	55,95	13,89	4,03	KRA $\leq$ 20	0,50	Very low
Middle	37,06	4,15	8,97	KRA $\leq$ 20	0,50	Very low
Downstream	0,44	6.405	28,23	20<KRA $\leq$ 50	0,75	Low

Table B2. Classification of yearly flow coefficient

Aesesa Flores watershed			Yearly flow coefficient			
Region	Yearly-Q (m ³ /s)	Yearly rainfall intensity (mm/year)	Yearly flow coefficient	Class	Score	Classification
Upstream	33,70	3.449	0,65	$KAT \geq 0,50$	1,50	Very high
Middle	20,31	1.999	0,55	$KAT \geq 0,50$	1,50	Very high
Downstream	4,54	874	0,45	$0,4 < KAT \leq 0,5$	1,25	High

Table B3. Classification of sedimentation load in the AF watershed

Aesesa Flores watershed				Sedimentation load			
Region	Total area (ha)	Yearly-Q (m ³ /s)	Sediment in water flow (g/L)	Sedimentation load	Class	Score	Classification
Upstream	43.051	33,70	0,1343	35,48	$MS \geq 20$	1,50	Very high
Middle	52.52	20,31	0,0376	4,90	$MS \leq 5$	0,5	Very low
Downstream	33.433	4,54	0,0933	4,27	$MS \leq 5$	0,5	Very low

Table B4. Flood occurrence classification in the AF watershed

Aesesa Flores watershed		Flood occurrence	
Region	Flood frequency	Score	Classification
Upstream	1 time in five year	0,75	Low
Middle	never	0,5	Very low
Downstream	1 time in five year	0,75	Low

Table B5. Classification of water utilization index in the AF watershed

Aesesa Flores watershed			Water utilization index			
Region	Maximum water debit flow (L/year)	Water demand (L/year)	Value	Class	Score	Classification
Upstream	7.719.382.080.000	95.757.823.091	0,012	$IPA \leq 0,25$	0,5	Very low
Middle	2.937.578.400.000	13.647.524.091	0,005	$IPA \leq 0,25$	0,5	Very low
Downstream	615.005.920.000	64.173.211.114	0,104	$IPA \leq 0,25$	0,5	Very low

Appendix C. Socio-economic carrying capacity

Table C1. Classification of land availability in the AF watershed

Aesesa Flores watershed			Land availability index (IKL)			
Region	Agricultural land area (ha)	Number of farmer household	IKL value	Class	Score	Classification
Upstream	16.232	16.922	0,96	$0,5 < IKL \leq 1$	1,25	High
Middle	16.299	9.832	1,66	$1 < IKL \leq 2$	1,00	Moderate
Downstream	13.981	8.277	1,70	$1 < IKL \leq 2$	1,00	Moderate

Table C2. Welfare index (TKP) in the AF watershed

Aesesa Flores watershed			Welfare index (TKP)			
Region	Number of household	Number of poor household	TKP value	Class	Score	Classification
Upstream	24.492	10.987	68,31	$TKP \geq 30$	1,50	Very low
Middle	11.437	5.584	48,82	$TKP \geq 30$	1,50	Very low
Downstream	11.798	2.38	20,17	$20 < IKL \leq 30$	1,25	Low

Table C3. Regulation and governance (KKP) in the AF watershed

Aesesa Flores watershed	Regulation and governance				
	Regulation and governance status		Class	Score	Classification
Upstream	Have regulation but no implemented		Moderate	1,00	Moderate
Middle	Have regulation but no implemented		Moderate	1,00	Moderate
Downstream	Have regulation but no implemented		Moderate	1,00	Moderate

Appendix D. Water sources related carrying capacity**Table D1.** Classification of city in the AF watershed

Aesesa Flores watershed		City classification			
Region	Population	Type of city	Total population	Score	Classification
Upstream	80.581	District city	$>50.000s/d100.000$	0,75	Low
Middle	54.359	District city	$>50.000s/d100.000$	0,75	Low
Downstream	45.327	District city	$>50.000s/d100.000$	0,75	Low

Table D2. Classification of water resources in the AF watershed

Aesesa Flores watershed		Investment of water resources (Rupiah)			
Region	Investment of water resources (Rupiah)	Status of investment	Score	Classification	
Upstream	68 Billion	$NBA \geq 60$ Billion	1,50	Very high	
Middle	40 Billion	$30 < NBA \leq 45$ Billion	1,00	Moderate	
Downstream	72 Billion	$NBA \geq 60$ Billion	1,50	Very high	

Appendix E. Regional spatial planning carrying capacity**Table E1.** Classification of protected area in AF watershed

Aesesa Flores watershed			Protected area index (KL)			
Region	Total protected area (ha)	Total area planted (ha)	KL Value	Class	Score	Classification
Upstream	10.132	16.922	91,92	$KL > 70$	1,50	Very high
Middle	10.015	9.832	74,96	$KL > 70$	1,50	Very high
Downstream	9.153	8.277	69,96	$45 < KL \leq 70$	1,25	High

Table E2. Classification of agriculture-farming area in AF watershed

Aesesa Flores watershed			Agriculture-farming area index (LKB)			
Region	Total area with slope 0-25% (ha)	Total area planted (ha)	LKB value	Class	Score	Classification
Upstream	22.487	16.922	68,62	45<LKB≤70	1,25	Low
Middle	36.305	9.832	85,17	LKB>70	1,50	Very low
Downstream	18.205	8.277	74,99	LKB>70	1,50	Very low

Appendix F. Criteria and parameter for carrying capacity assessment based on the Minister of Forestry Republic of Indonesia Regulation Number P.61/Menhut-II/2014

Table F1. Land resources carrying capacity AF watershed

Sub-criteria and contribution	Parameters	Parameters value	Scoring and classes	Carrying capacity (CC)	
				Lowest	Highest
Percentage of degraded land (PLK) (20%)	$PLK = \frac{LK \times 100\%}{A}$ PLK=Percentage of degraded land (%) LK: Area of degraded land (ha) A: watershed area (ha)	PLK≤5 5<PLK≤10 10<PLK≤15 15<PLK≤20 PLK>20	Very low=0,5 Low=0,75 Moderate=1 High=1,25 Very high=1,5	10	30
Percentage of land cover (PPV) (10%)	$PPV = \frac{LV \times 100\%}{A}$ LV: total area of land cover (ha) A: watershed area (ha)	PPV>80 60<PPV≤80 40<PPV≤60 20<PPV≤40 PPV≤20	Very low=0,5 Low=0,75 Moderate=1 High=1,25 Very high=1,5	5	15
Erosion index (Crop and management index-CP) (10%)	$CP = \sum \left(\frac{A_i}{A} \times CPI \right)$ CP= Erosion index CPI: Crop index and management index of given crop-i in the watershed Ai: Area of crop-i in the watershed (ha) A: watershed area (ha)	CP≤0,10 0,10<CP≤0,30 0,30<CP≤0,50 0,50<CP≤0,70 CP>0,70	Very low=0,5 Low=0,75 Moderate=1 High=1,25 Very high=1,5	5	15

Table F2. Water resources carrying capacity AF watershed

Sub-criteria and contribution	Parameters	Parameters value	Scoring and classes	Carrying capacity (CC)	
				Highest	Lowest
Flow coefficient (KRA) (5%)	$KRA = \frac{Q_{\max}}{Q_{\min}}$ KRA=Flow coefficient Q _{max} : Maximum monthly water debit in the last 10 years (m ³ /second) Q _{min} : Minimum monthly water debit in the last 10 years (m ³ /second)	KRA≤20 20<KRA≤50 50<KRA≤80 80<KRA≤110 KRA>110	Very low=0,5 Low=0,75 Moderate=1 High=1,25 Very high=1,5	2,5	7,5

Table F2. Water resources carrying capacity AF watershed (cont.)

Sub-criteria and contribution	Parameters	Parameters value	Scoring and classes	Carrying capacity (CC)	
				Highest	Lowest
Yearly flow coefficient (KAT) (5%)	$KAT = \frac{Q_{\text{annual}}}{P_{\text{annual}}}$	$KAT \leq 0,2$	Very low=0,5	2,5	7,5
	$KAT = \text{Yearly flow coefficient}$	$0,2 < KAT \leq 0,3$	Low=0,75		
	$K: \text{conversion factor} = (365 \times 86.400) / 10$	$0,3 < KAT \leq 0,4$	Moderate=1		
	$Q: \text{Monthly average water debit (m}^3/\text{s)}$	$0,4 < KAT \leq 0,5$	High=1,25		
	$A: \text{watershed area (ha)}$ $P_{\text{annual}}: \text{annual rainfall intensity (mm/year)}$	$KAT > 0,5$	Very high=1,5		
Sedimentation load (MS) (4%)	$MS = \frac{k \times CS \times Q}{A \times SDR}$	$MS \leq 5$	Very low=0,5	2	6
	$MS = \text{Sedimentation load (mm/year)}$	$5 < MS \leq 10$	Low=0,75		
	$K: \text{Conversion factor} = (365 \times 86.400) / 10$	$10 < MS \leq 15$	Moderate=1		
	$CS: \text{Sedimentation (g/L)}$	$15 < MS \leq 20$	High=1,25		
	$Q: \text{Annual average water debit (m}^3/\text{s)}$ $A: \text{watershed area (Ha)}$ $SDR: \text{Sediment Delivery Ratio (\%)}$	$MS > 20$	Very high=1,5		
Flood occurrence (2%)	Flood occurrence	- Never	Very low=0,5	1	3
		- 1-time in the last 5 year	Low=0,75		
		- 1-time in the last 2 year	Moderate=1		
		- 1-time every year	High=1,25		
		- More than 1-time every year	Very high=1,5		
Water utilization index (IPA) (4%)	$IPA = \frac{\text{Total water utilization}}{Q_a}$	$IPA \leq 0,50$	Very low=0,5	2	6
	$IPA = \text{Water utilization index}$	$0,50 < IPA \leq 0,75$	Low=0,75		
	$\text{Total water utilization: irrigation+DMI (Domestic, municipal and Industry) (L/year)}$	$0,75 < IPA \leq 1,00$	Moderate=1		
	$Q_a: \text{Annual maximum water debit (L/year)}$	$1,00 < IPA \leq 1,25$	High=1,25		
		$IPA > 1,25$	Very high=1,5		

Table F3. Socio-economic carrying capacity of AF watershed

Sub-criteria and contribution	Parameters	Parameters value	Scoring and classes	Carrying capacity (CC)	
				Highest	Lowest
Land availability index (IKL) (10%)	$IKL = \frac{A}{P}$	$IKL > 4,0$	Very low=0,5	5	15
	$IKL = \text{Land availability index}$	$2,0 < IKL \leq 4,0$	Low=0,75		
	$A: \text{Agriculture area in the watershed (ha)}$	$1,0 < IKL \leq 2,0$	Moderate=1		
	$P: \text{Number of farmer household in the watershed}$	$0,5 < IKL \leq 1,0$	High=1,25		
		$IKL \leq 0,5$	Very high=1,5		

Table F3. Socio-economic carrying capacity of AF watershed (cont.)

Sub-criteria and contribution	Parameters	Parameters value	Scoring and classes	Carrying capacity (CC)	
				Highest	Lowest
Welfare index (TKP) (7%)	TKP = $\frac{KK-poor \times 100\%}{Total\ KK}$	TKP ≤ 5	Very low=0,5	3,5	10,5
	TKP=Percentage of poor population in the watershed (%) KK-poor: Number of poor populations in the watershed Total KK: Number of households in the watershed	5 < TKP ≤ 10 10 < TKP ≤ 20 20 < TKP ≤ 30 TKP > 30	Low=0,75 Moderate=1 High=1,25 Very high=1,5		
Regulation and governance (3%)	Regulations and governance related to the watershed management	Have regulation and heavily implemented Have regulation but limited implemented Have regulation but not implemented Have no regulations Have regulations but contradict to the watershed management	Very low=0,5 Low=0,75 Moderate=1 High=1,25 Very high=1,5	1,5	4,5

Table F4. Water related infrastructure carrying capacity of AF watershed

Sub-criteria and contribution	Parameters	Parameters value	Scoring and Classes	Carrying capacity (CC)	
				Highest	Lowest
City classification (5%)	Type of city	Non-city District-city Municipality-city Major-city Metropolitan	Very low=0,5 Low=0,75 Moderate=1 High=1,25 Very high=1,5	2,5	7,5
Water related infrastructure (IBA) (5%)	Investment on water dam, irrigation channel, water reservoir, hydroelectric power plant.	IBA ≤ 15 Billion rupiah 15 < IBA ≤ 30 Billion rupiah 30 < IBA ≤ 45 Billion rupiah 45 < IBA ≤ 60 Billion rupiah IBA > 60 Billion rupiah	Very low=0,5 Low=0,75 Moderate=1 High=1,25 Very high=1,5	2,5	7,5

Table F5. Regional spatial utilization carrying capacity of AF watershed

Sub-criteria and contribution	Parameters	Parameters value	Scoring and classes	Carrying capacity (CC)	
				Highest	Lowest
Protected area (PTH) (5%)	$PTH = \frac{\text{area of planted} \times 100\%}{\text{protected area in the watershed}}$ PTH: Percentage of protected area (%)	KL>70	Very low=0,5	2,5	7,5
		45 <KL≤ 70	Low=0,75		
		30<KL≤ 45	Moderate=1		
		15<KL≤ 30	High=1,25		
		KL≤15	Very high=1,5		
Agriculture-farming area (LKB) (5%)	$LKB = \frac{\text{total area with slope 0-25\%} \times 100\%}{\text{area of planted in the watershed}}$ LKB: Percentage area with slope of 0-25% in the watershed (%)	KB>70	Very low=0,5	2,5	7,5
		45<KB≤70	Low=0,75		
		30<KB≤45	Moderate=1		
		15<KB≤30	High=1,25		
		KB≤15	Very high=1,5		