Article:

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Supplementary Methods

A. Map accuracy assessment

The tentative land use map derived from the interpretation process is then assessed to generate an accuracy value. Slovin's formula is used to calculate the number of sample points such as follows (Sevilla, 1984 in Handayani, 2020):

$$n = \frac{N}{1 + N.e^2} \quad \text{.................................} \quad (5)$$

where n = minimum number of samples

N = number of population

e = tolerance limit of error (10 per cent)

By using this formula, the required sample points for accuracy assessment are 100 points based on 187,465 sqm of population size (N) using 10 per cent of the tolerance limit of error (e).

Table 1. Land use area of the tentative map

No	Land use	Area (sqm)	Σ Sample points (n)
1	Building	1,081	1
2	Mangrove	15,218	8
3	Meadow	22,748	12
4	Other vegetation	1,966	1
5	Pond	2,518	1
6	Rice field	80,215	42
7	River	63,201	34
8	Sandbar	518	1
	Population size (N)	187,465	100

We use the image-to-image correction technique (Short, 1986 in Danoedoro, 2012) with high-resolution satellite images acquired in 2013 released by Badan Informasi Geospasial (Geospatial Information Agency/BIG) of Indonesia as a reference map. The sample points distribution (Figure 1) is defined by purposive stratified sampling considering the area with the most stable land use/not easily changed and the representation of each land use (Danoedoro, 2012).

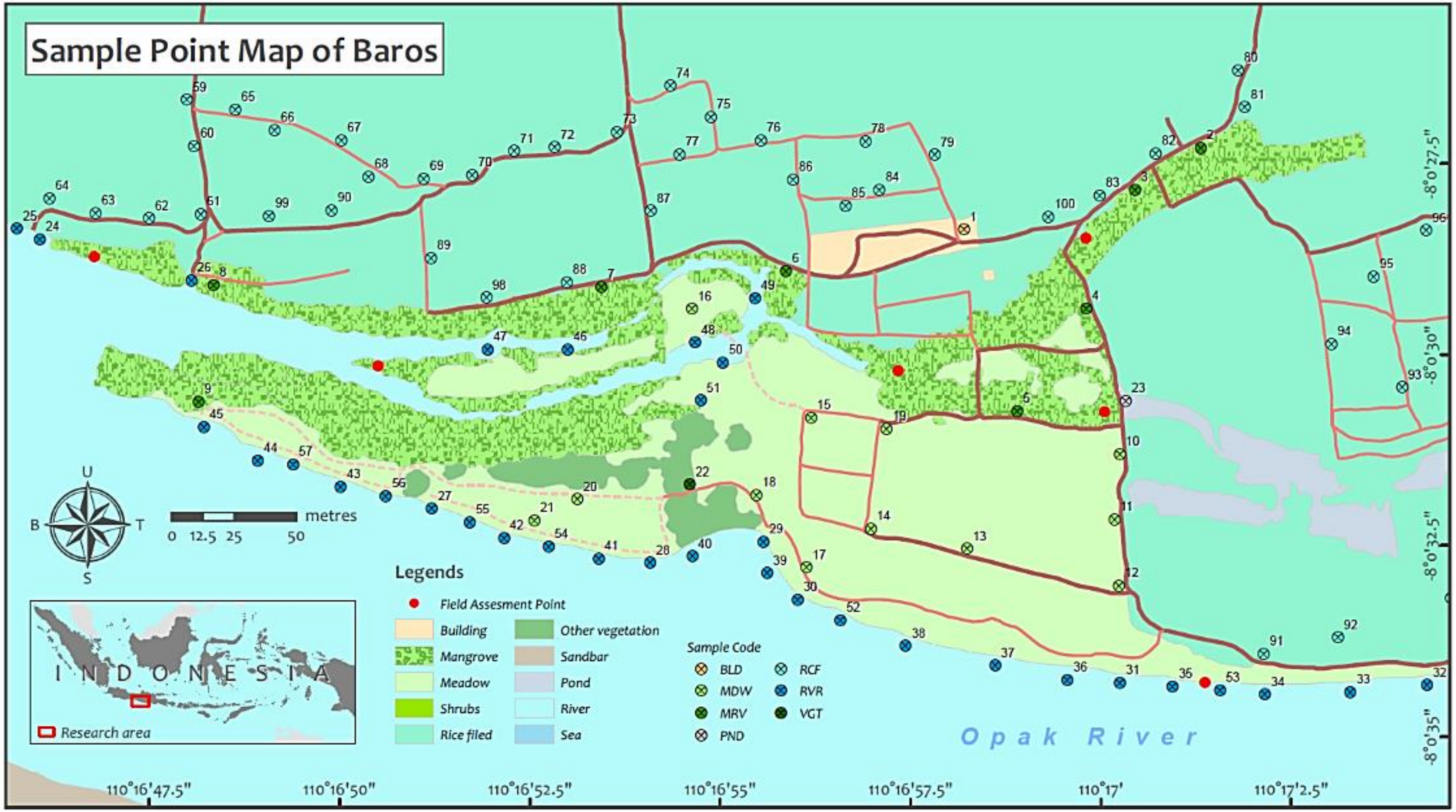

Figure 1. Sample point map of Baros

We plot all the sample points result in the error matrix as follows:

Land use class		Producer								
		Building	Mangrove	Meadow	Other vegetation	Pond	Rice field	River	Sandbar	Total
User	Building	1								1
	Mangrove		6					3		9
	Meadow			8						8
	Other vegetation		1		1		2			4
	Pond					1				1
	Rice field		1				41			42
	River			1				30		31
	Sandbar			3				1	0	4
	Total	1	8	12	1	1	43	34	0	100

The result above is then used to generate the Kappa coefficient with formula such as follows (Mather & Tso, 2016):

$$\hat{k} = \frac{N \sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r} (x_{i+} \times x_{+i})}{N^2 - \sum_{i=1}^{r} (x_{i+} \times x_{+i})} \quad \text{.......................... (6)}$$

where $\hat{k}$ = the Kappa coefficient

r = the number of columns (and rows) in a confusion matrix

x_{ii} = entry (i, i) of the confusion matrix

x_{i+} and x_{+I} = the marginal totals of row i and column j, respectively

N = the total number of observations

This formula resulted Kappa coefficient ($k\hat{}$) as 0.83 with the overall accuracy of 88 per cent.

B. Mangrove survey

Data were collected using a quadrant sampling method within a $100m^2$ area in each sample location. The sample area was marked using 40m rope, mangrove data such as tree species, individual tree counts and diameter of each tree were collected to calculate several values, following Curtis and McIntosh (1950):

$$Fi = \frac{Pi}{\sum P} \quad \text{...(7)}$$

$$FRi = \left(\frac{Fi}{\sum F}\right) x\ 100 \quad \text{.................................(8)}$$

Where, Fi = frequency of species i

Pi = number of plots where species i occurs

FRi = relative frequency of species i
∑F = total number of all species
∑P = total number of plots

$Ci = \frac{BA}{A}$, where BA = $\frac{\pi DBH2}{4}$ .... (9)

$RCi = \left(\frac{Ci}{\sum C}\right) x\ 100$ .... (10)

Where,
Ci = covered area for species i
BA = basal area (cm)
DBH = diameter of mangrove (cm)
A = total area of the plot (m2)
∑C = covered area for all species
RCi = relative coverage of species i

$Di = \frac{ni}{A}$ .... (11)

$RDi = \left(\frac{ni}{\sum n}\right) x\ 100$ .... (12)

Where,
Di = density of species i (individual/ha)
ni = counts per species i
∑n = total number counts for all species
A = total area of sample
RDi = relative density of species i

Important value index = RD + FR+ RC .... (13)

The important value index of mangrove area ranged between 0-300. This number showed the dominance level of individual mangrove species in a particular area. The calculation above (11) follows Curtis (1959).

C. Water quality survey

Table 2. Method for assessing water quality

Parameter	*Method*	*Equiptment*	*Material*
Temperature	Insitu	Termometer Hg scale 0-100ºC	-
pH	-	pH meter	-
Salinity	-	Refractometer	-

TSS	Gravimetric	Paper filter (2,5µm), analytic scale	-
DO	Winkler	Erlenmeyer, oxygen bottle, pipette	$MnSO_4$, oxygen reagent, H_2SO_4, starch, and 1/80 N $Na_2S_2O_3$.
CO_2	Alkalimetric	Erlenmeyer, oxygen bottle, pipette	Phenolphthalein (PP) and 1/44 N NaOH
Alkalinity	Alkalimetric	Erlenmeyer, oxygen bottle, pipette	Phenolphthalein (PP), 1/50 N H_2SO_4 and methyl orange (MO).
Nitrate	Spectrophotometry		
Phosphate	Spectrophotometry		

D. Susceptibility assessment

We categorised the level of susceptibility to abrasion in Baros as follows:

(1) High level: shore area with a distance of 0–100 metres from the shoreline and elevation of 0-25 metres above sea level

(2) Moderate level: beach area with a distance of >100-400 metres from the shoreline and an elevation of 25-35 metres above sea level

(3) Low level: beach area with a distance of >400-500 metres from the shoreline and elevation of >35 metres above sea level

E. Questionnaire

GENERAL

1) Did you help develop the mangrove area of Baros mangrove?
   If so, what kind of assistance did you contribute? _________________
2) Are there any changes that occurred before/after the mangrove area in Baros mangrove?
   ____
3) What are the benefits of the mangrove area in Baros mangrove that you feel?
   ____
4) Do you use the mangrove area in Baros?
   If yes, proceed to question number 5. If not, it is enough.
5) What kind of use do you do?
   ____
6) Where is exactly the part of mangrove area that you use?
   ____
7) How long have you been using the mangrove area for this activity?

____

8) Are the results of your use of the mangrove area used to increase your income?

____

FARMER

1) How much area of paddy field/plantation do you have (m2)?

____

2) What types of plants do you produce on the land?

____

3) How much does it cost to buy/rent rice fields/plantations (per m2)?

____

4) In one year how many times do you do planting activities (from planting seeds to harvesting)?

____

5) Has the area changed after the mangrove area was in Baros mangrove?
   If yes, from ________ m^2 to __________ m^2
6) Did the amount of production (harvest) change after the mangrove area was located in Baros mangrove?
   If yes, from ________ kg to __________ kg
7) What is the frequency with which you irrigate your fields/plantations (per week)?

____

8) How much does it cost you to irrigate your fields/gardens?

____

Operational Cost (one planting period)

Type of plant	Number of seeds	Price of seeds	Amount of fertilizer	Price of fertilizer	Number of harvests (kg)	Price of plants harvested (Rp/kg)

CATTLEMAN

1) Do you feed your livestock in the mangrove area?
   If yes, the question is continued to number 2. If not, it is completed.
2) What kind of livestock do you have?
   ____
3) How many cattle do you have?
   ____
4) When exactly do you go to the mangrove area to feed your livestock?
   ____
5) How much feed does your livestock need at a time (kg/day)?
   ____
6) What is the price of animal feed that is usually sold in the market (Rp/kg)?
   ____

AQUACULTURE

1) What types of fishery commodities do you cultivate in the mangrove area?
   ____
2) How much mangrove area do you use for cultivation activities?
   ____
3) How many fishery commodities do you cultivate?
   ____
4) What is the size of the commodity that you are cultivating?
   ____
5) What components do you need to set up a cultivation unit?
   ____
6) What components do you need to run a cultivation business every day?
   ____
7) How much do you have to spend to buy the components mentioned above?
   ____

Cultivation Production

No.	Type of commodity cultivated	Quantity	Size (kg)	Selling price (Rp)

*one harvest period

FISHERS

1) Do you carry out fishing activities in the mangrove area?
   If yes, continue to question number 2. If not, it is sufficient.
2) How many trips/fishing activities do you take in one month?
   ____
3) How much time do you spend doing fishing activities?
   ____
4) When exactly do you do fishing activities? (morning, evening, afternoon)
   ____
5) What components do you need to carry out fishing activities? (example: supplies, gasoline)
   ____
6) How much do you have to pay for these components each time you catch fish?
   o Supplies, Rp ____________
   o Gasoline, Rp________________
   o Others, Rp________
7) Where do you sell the catch?
   ____

Catch Production (average in one day fishing)

No.	Type of fishing gear	Type of catch (type of fish, crab or shrimp)	Quantity (kg)	Selling price (Rp)

F. Matrix calculation

1) AHP matrix on Natural Value of Coastal Environment (NVC) criterion

	Water quality	Chlorophyll	Important value index of mangrove
Water quality	1	5	8
Chlorophyll	1/5	1	3
Important value index of mangrove	1/8	1/3	1

	Priority	Rank
Water quality	0.742	1
Chlorophyll	0.183	2

Important value index of mangrove	0.075	3

CR = 0.046 (4.6%)

2) AHP matrix on Commercial Value (CMV) criterion

	Feedlots	Traditional fishing	Aquaculture
Feedlots	1	5	3
Traditional fishing	1/5	1	1
Aquaculture	1/3	1/1	1

	Priority	Rank
Feedlots	0.659	1
Traditional fishing	0.156	3
Aquaculture	0.185	2

CR = 0.03 (3%)

3) AHP matrix for zoning scenario

Zoning	Criteria	NVC Natural Value of Coastal Environment	CMV Commercial Value	RCV Recreational and Cultural Value	APD Accessibility and Potential Disturbance
Restricted Access Zone	NVC Natural Value of Coastal Environment	1	7	6	5
	CMV Commercial Value	1/7	1	4	2
	RCV Recreational and Cultural Value	1/6	¼	1	1
	APD Accessibility and Potential Disturbance	1/5	½	1	1
Sanctuary Zone	NVC Natural Value of Coastal Environment	1	2	6	5
	CMV Commercial Value	½	1	1	3
	RCV Recreational and Cultural Value	1/6	1	1	2
	APD Accessibility and Potential Disturbance	1/5	1/3	½	1
Habitat Protection Zone	NVC Natural Value of Coastal Environment	1	2	4	5
	CMV Commercial Value	½	1	1	3
	RCV	¼	1	1	5

	RCV Recreational and Cultural Value				
	APD Accessibility and Potential Disturbance	1/5	1/3	1/5	1

Zoning	Criteria	Priority	Rank
Restricted Access Zone	NVC Natural Value of Coastal Environment	0.658	1
	CMV Commercial Value	0.075	4
	RCV Recreational and Cultural Value	0.091	3
	APD Accessibility and Potential Disturbance	0.177	2
CR = 0.094 (9.4%)			
Sanctuary Zone	NVC Natural Value of Coastal Environment	0.554	1
	CMV Commercial Value	0.150	3
	RCV Recreational and Cultural Value	0.082	4
	APD Accessibility and Potential Disturbance	0.214	2
CR = 0.051 (5.1%)			
Habitat Protection Zone	NVC Natural Value of Coastal Environment	0.508	1
	CMV Commercial Value	0.213	2
	RCV Recreational and Cultural Value	0.068	4
	APD Accessibility and Potential Disturbance	0.211	3
CR = 0.064 (6.4%)			

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