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Table S1: Parameters (value or mean ± standard deviation, SD) determined in the present study for the computation of the nitrogen (N) and phosphorus (P) budget model. (DW: dry weight)

Parameter	**Value ± SD**	**Data source**
Feed loss (%) _Formulated feed	4 ±1.41	Corner et al. (2006); Reid et al. (2009); Cromey et al. (2002); Bureau et al. (2003)
Feed loss (%) _Trash fish feed	13	Qi et al. (2019)
Feed conversion rate of formulated feed	1.525 ± 0.007	Gao et al. (2021); Qi et al. (2019)
Feed conversion rate of trash fish feed	6.745 ± 0.36	Qi et al. (2019); Gao et al. (2021)
Water in formulated feed (%)	ignore	This study
Dry matter in trash fish feed (%)	27.86	This study
Dry matter in fish (%)	31.88	This study
Soft tissue (DW) content in oysters (%)	2.35	This study
Shell (DW) content in oysters (%)	50.87	This study
Dry matter in kelp (%)	16.67	This study
Nitrogen (N)		
Assimilation efficiency (%)	85	Wang et al. (2012)
N content in formulated feed (%DW)	7.82 ± 0.07	This study
N content in trash fish feed (%DW)	10.03 ± 0.06	This study
N content in fish (%DW)	12.17 ± 0.56	This study
N content in kelp (%DW)	2.25 ± 0.01	This study
N content in oyster soft tissue (%DW)	8.07 ± 0.10	This study
N content in oyster shell (%DW)	0.16 ± 0.01	This study
Soluble fraction (%DW)	15	Chen et al. (2003)
Phosphorus (P)		
Assimilation efficiency (%)	50	Reid et al. (2009); Bureau et al. (2003)
P content in formulated feed (%DW)	1.59 ± 0.05	This study
P content in trash fish feed (%DW)	1.91 ± 0.09	This study
P content in fish (%DW)	1.17 ± 0.002	This study
P content in kelp (%DW)	0.35 ± 0.027	This study
P content in oyster soft tissue (%DW)	0.56 ± 0.002	This study
P content in oyster shell (%DW)	0.044 ± 0.000	This study
Soluble fraction (%DW)	15	Sugiura et al. (2006)

Text S1: Establishment of the annual mariculture database in Sansha Bay

Based on remote sensing data, the spatial distribution of mariculture in Sansha Bay from 1999 to 2020 was established. Firstly, data selection was carried out as follows: data from 1999 to 2014 were acquired from Landsat (https://glovis.usgs.gov/app), while high-resolution Sentinel-2 (https://scihub.copernicus.eu/dhus/#/home) imagery was used from 2015 to 2020. As the kelp harvest season spans from May to June, remote sensing imagery mainly focused on data with minimal cloud cover from August to November.

Secondly, classification was implemented as follows: mariculture in Sansha Bay primarily consists of cage culture and macroalgal culture. Cage culture was predominantly conducted in wooden or plastic rectangular grids, that showed as regular bright blocks in remote sensing images. Macroalgal culture, on the other hand, involved floating rafts, forming extensive strips that appeared black in the images and were easily distinguishable.

Finally, data processing involved using the Google Earth Engine (GEE, https://earthengine.google.com) platform, which included radiometric calibration, atmospheric correction and band fusion. The Support Vector Machine (SVM) method and Kernel theory were employed to address nonlinear classification and classify different aquaculture species (Xue et al., 2019; Lu et al., 2015).

Text S2: Method for estimation of nutrients fluxes

This study considers Sansha Bay as a single box and estimates the nutrient budget using the Land-Ocean Interactions in the Coastal Zone (LOICZ) model to shed light on the impact of mariculture on bay waters (Gordon et al., 1996). The model is based on the mass balance principle, which dictates that the water volume entering the Sansha Bay system must equal the water volume stored within the system minus that flowing out of the system. The inflows include river discharge (V_{riv}), direct precipitation (V_P), and potential other sources (V_O), such as sewage and groundwater. Additionally, there is hydrographically driven advective inflow (V_{in}). The outflows include evaporation (V_E) and advective outflow of water from the system (V_{out}). Water storage may be represented by the change in the system of interest with time (dV_1/dt):

$$\mathrm{d}V_1/\mathrm{d}t = V_{riv} + V_P + V_O + V_{in} - V_E - V_{out}, \tag{S1}$$

In many cases, it can be assumed that the system is in a steady state with $dV_1/dt = 0$. By rearranging Eq. (S1):

$$V_{in} - V_{out} = -V_{riv} - V_P - V_O + V_E, \tag{S2}$$

It is useful to consider the difference between V_{in} and V_{out} as the residual flow (V_{res}) driven by the water budget. Assuming V_P is equal to V_E, and considering V_O as negligible compared to the river discharge, Eq. (S2) can be simplified to:

$$V_{res} = -V_{riv}, \tag{S3}$$

The salt budget in the system is equal to each of the volume fluxes multiplied by the salinity (S) of each water mass. The exchange flux between the bay and coastal waters is indicated by V_{ex}. Combining Eq. (S2) and (S3), we have:

$$V_{riv} \times S_{riv} + V_{res} \times S_{res} + V_{ex} \times S_{oce} + V_P \times S_P + V_O \times S_O = V_E \times S_E + V_{ex} \times S_{sys}, \tag{S4}$$

where S_{riv}, S_{res}, S_{oce} and S_{sys} represent the average salinity of the river, residual flow, coastal water and the bay system, respectively; S_{res} equals the average of S_{oce} and S_{sys}, representing the boundary salinity. S_P, S_O and S_E are assumed to be zero. By rearranging Eq. (S4), we can solve for V_{ex}:

$$V_{ex} = (V_{riv} \times S_{riv} + V_{res} \times S_{res})/(S_{sys} - S_{oce}), \tag{S5}$$

Subsequently, non-conservative dissolved inorganic nitrogen and phosphorus (δDIN or δDIP, respectively) can be obtained from the following equations:

$$\delta\mathrm{DIN} = \mathrm{V_{res}} \times \mathrm{DIN_{res}} + \mathrm{V_{ex}} \times \mathrm{DIN_{sys}} - \mathrm{V_{riv}} \times \mathrm{DIN_{riv}} - \mathrm{V_{ex}} \times \mathrm{DIN_{oce}}, \tag{S6}$$

$$\delta\mathrm{DIP} = \mathrm{V_{res}} \times \mathrm{DIP_{res}} + \mathrm{V_{ex}} \times \mathrm{DIP_{sys}} - \mathrm{V_{riv}} \times \mathrm{DIP_{riv}} - \mathrm{V_{ex}} \times \mathrm{DIP_{oce}}, \tag{S7}$$

This model aids in understanding and quantifying the impact of mariculture on the nutrient dynamics of Sansha Bay.

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