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Corrigendum

Corrigendum to "A model to assess microphytobenthic primary production in tidal systems using satellite remote sensing" [Remote Sens. Environ. 211 (2018) 129–145]

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The authors regret that an error has been made in the calculation of chlorophyll-*a* (chl-*a*) concentrations of the sediment samples used for validation of the presented model. The error has no implications for modelled primary production rates and only concerns the observed chl-*a* concentrations and primary production rates used for validation of the model. Furthermore, respiration rates have accidentally not been included in the calculation of modelled and observed (validation) primary production rates. Therefore, the presented primary production rates are gross primary production rates instead of net primary production rates. A detailed explanation and the correct figures are given below.

Chlorophyll-*a* concentrations of validation samples

The chl-*a* concentrations of the sediment samples used for validation of our modelled chlorophyll-*a* concentrations (sample dataset of 2015) have not been calculated correctly, for two reasons. In the conversion of chl-*a* in μg/g to mg/m^2, a sampled volume of 1 syringe was used in the calculation instead of the volume of 3 syringes. Moreover, as we were interested in the amount of microphytobenthos present in the upper 2 mm of the sediment, the total amount of chl-*a* in the samples, that were sampled to a depth of 1 cm, was divided by 5. This implicitly assumed that the sampled chlorophyll-*a* was homogeneously distributed within the upper 1 cm of the sediment. However, as described in the paper, our intention has been to assume that all microphytobenthos sampled in the upper 1 cm is present in the upper 2 mm. As a result, the chl-*a* concentrations of the validation samples should be a factor 5/3 = 1.666 higher. The correct chl-*a* concentrations are displayed in Fig. 2C below. This implicates that the model, which retrieves chl-*a* concentrations from the NDVI, underestimates chl-*a* concentrations somewhat more than expected. The $RMSE_{ramses}$ and $RMSE_{sat}$ values mentioned in paragraph 3.1.1 should be: $RMSE_{ramses}$ = 82.7 and

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$RMSE_{sat}$ = 81.3, respectively.

Secondly, as the chl-*a* concentrations used for model validation were also used in the calculation of primary production validation data, primary production rates used for model validation are not correct. Recalculation of primary production rates with correct chl-*a* concentrations (a factor of 1.666 higher) demonstrated that production rates should increase with a fixed factor of 1.4, with a small range of variation (1.37–1.52, σ_{diff} = 0.03, see Fig. 5, Fig. 7 and Table 3). This variation is due to the fact that the vertical distribution of chl-*a* within the sediment depends on the mud content. Therefore, the relative amount of chl-*a* that receives light may increase and this proportion may slightly vary among stations. The fixed factor of 1.4 is dependent on local environmental conditions, i.e. the mud content, surface irradiance and emersion duration. At all sites except Paulinapolder, modelled primary production rates calculated per hour are not statistically different from observed (recalculated) primary production rates (Wilcoxon signed rank test, $p > 0.05$, Fig. 5). Primary production rates calculated per day using the primary production and tide module can be predicted quite accurately at four out of seven sites, and were underestimated by the model at sites with high measured primary production rates (Paulina, Waarde and Hellegat, Fig. 7).

Net versus gross primary production

Lastly, an error was made in the calculation of the respiration rate (RES). We assumed that the respiration rate can be approximated by 5% of Pmax (where Pmax was normalised to chl-a, so expressed as mg C/mg chl-a/h). Therefore, in the calculation of the total amount of respiration, RES needs to be multiplied with the chl-*a* concentration at each vertical layer. However, this multiplication with chl-*a* has not been done. Furthermore, RES was only calculated for the upper layer of the sediment (0–0.01 mm) and not for each vertical layer within the sediment. As a consequence, the total calculated RES at each point in both modelled and observed primary production rates is only ± 1% of the actual respiration rate and has a negligible effect on the presented primary production rates. Therefore, the calculated primary production rates should be considered an estimate of gross primary production rates instead of net primary production rates. We therefore propose to leave out the RES term altogether and consider gross primary production rates only. The correct formula in paragraph 2.2.1 should then be:

$$P = EE * \frac{E_{PAR}}{\frac{1}{\alpha * E_{opt}^2} * E_{PAR}^2 + \left(\frac{1}{ps} - \frac{2}{\alpha * E_{opt}}\right) * E_{PAR} + \frac{1}{\alpha}} * chla \quad (1)$$

α = photosynthetic efficiency (mg C mg^{-1} chl-*a* h^{-1} [μmol photon m^{-2} s^{-1}]$^{-1}$).

chl*a* = chlorophyll-*a* concentration (mg m^{-2}).

EE = ETR efficiency for C fixation, here taken as 0.04

E_{PAR} = photosynthetically active irradiance (μmol photon m^{-2} s^{-1}).

E_{opt} = optimal light intensity (μmol photon m^{-2} s^{-1}).

P = net hourly carbon fixation rate (mg C m^{-2} h^{-1})

P_s = photosynthetic capacity (mg C mg^{-1} chl-*a* h^{-1}).

Goodness of fit of the model has improved for the gross primary production rates modelled for the moment of sampling (mg C m^{-2} h^{-1}, Fig. 5). Furthermore, model fit for gross primary production rates calculated over an entire month using the tide module is comparable to previous results (mg C m^{-2} d^{-1}, Fig. 7). Gross primary production rates are predicted quite accurately at most sites, and are somewhat underestimated at three sites. This can be attributed to accumulated errors in the estimation of the chl-*a* concentration. Chl-*a* concentrations are underestimated by the model, especially at concentrations > 150 mg/m^2 (Fig. 2).

The authors would like to apologise for any inconvenience caused.

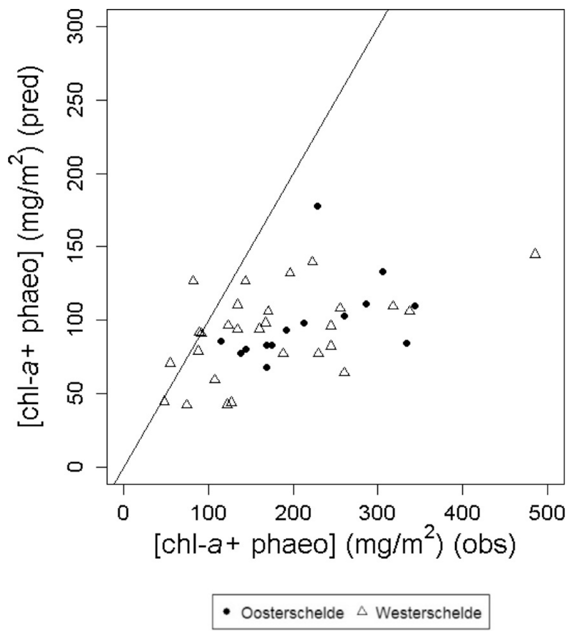

Fig. 2. (c) Sampled chl-*a* concentrations in the upper 1 cm of the sediment and predicted chl-*a* concentrations from the NDVI derived from a validation image (Landsat 8, 12-03-2015) using the radiometer-derived regression formula (Pearson's r = 0.49, $p < 0.001$, n = 42). A 1:1 line is shown.

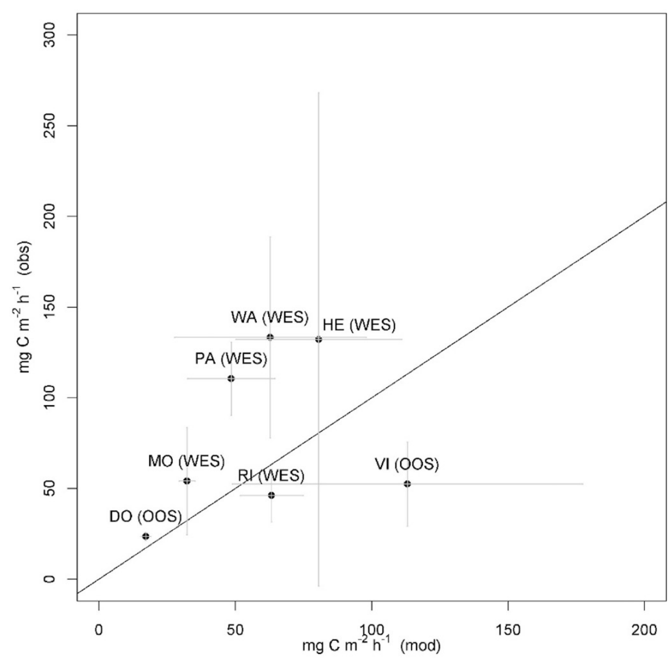

Fig. 5. Hourly primary production rates (mg C m^{-2} h^{-1}) per site at the moment of sampling calculated with the primary production module described in section 2.2.1 in the Oosterschelde (OOS) and Westerschelde (WES). Production rates were calculated from (1) chl-*a* concentrations and mud content derived from Landsat and the photosynthetic capacity from ambient temperature (mod) and (2) chl-*a* concentrations and mud content from sediment samples and photosynthetic parameters derived from PAM measurements (obs). Only plots for which PAM measurements were available (Ft > 200) were included in both modelled and observed primary production rates; sites Middelplaat (MI) and Rattekaai (RA) were therefore omitted. Sites in the Oosterschelde: Dortsman (DO, n = 2) and Viane (VI, n = 4). Sites in the Westerschelde: Hellegat (HE, n = 4), Molenplaat (MO, n = 4), Paulinapolder (PA, n = 4), Rilland (RI, n = 3) and Waardepolder (WA, n = 5).

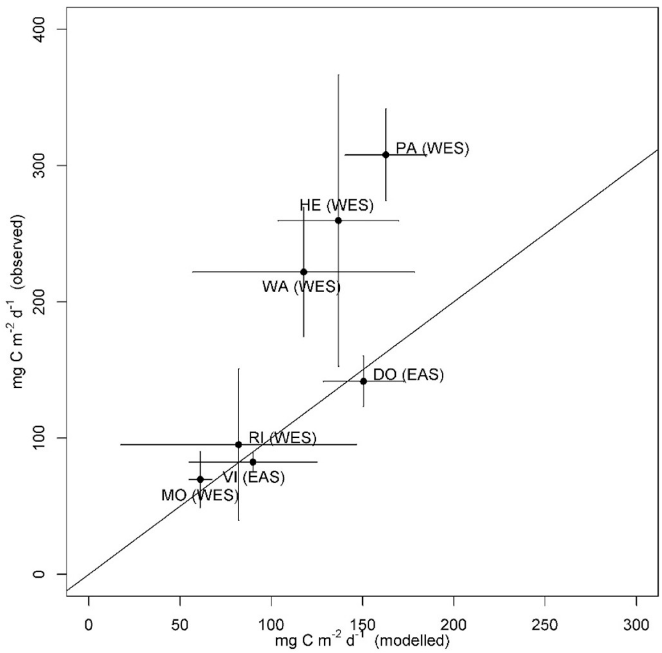

Fig. 7. Modelled and observed average daily production (± SE) per site. Daily production values were calculated by running the model for one month (12-03-2015 to 10-04-2015). Primary production rates were modelled with chl-*a* concentrations and mud content derived from Landsat 8 (12-03-2015) and the photosynthetic capacity from ambient temperature (mod). Observed primary production rates were calculated using chl-*a* concentrations and mud content based on field samples and photosynthetic parameters derived from PAM measurements (obs). Only plots for which PAM measurements were available (Ft > 200) were included in both modelled and observed primary production rates. Sites in the Oosterschelde: Dortsman (DO, n = 2) and Viane (VI, n = 4). Sites in the Westerschelde: Hellegat (HE, n = 4), Molenplaat (MO, n = 4), Paulinapolder (PA, n = 4), Rilland (RI, n = 3) and Waardepolder (WA, n = 5).

Table 2
Site characteristics (mud content, chl-*a* concentration and mean emersion) of validation plots measured in spring 2015. Mean emersion is here defined as the average percentage of time the sites were emersed during the study period (12-03-2015 to 10-04-2015).

Estuary	Site	Mud content	Chl-*a*	Mean emersion
		(% < 63 μm)	($mg\,m^{-2}$)	(%)
Oosterschelde	Dortsman	2.4 ± 2.7	175.4 ± 56.3	62 ± 20
	Rattekaai	4.9 ± 4.3	244.3 ± 64.6	53 ± 16
	Viane	2.9 ± 2.4	208.2 ± 89.1	47 ± 16
Westerschelde	Hellegat	29.3 ± 12.5	294.8 ± 113.5	36 ± 10
	Middelplaat	2.5 ± 2.9	83.6 ± 29.6	37 ± 9
	Molenplaat	4.2 ± 2.2	156.3 ± 75.5	36 ± 10
	Paulina	54.6 ± 11.2	157.3 ± 64.4	35 ± 12
	Rilland	16.9 ± 16.3	113.5 ± 50.8	43 ± 15
	Waarde	34.5 ± 14.7	215.7 ± 95.1	31 ± 18

Table 3
RMSE, mean error and a cost function of modelled mud content, chl-*a* concentration, photosynthetic capacity (Ps) and primary production rates at the moment of sampling per estuary (W: Westerschelde; O: Oosterschelde) in validation plots measured in spring 2015.

	Estuary	Mud content	Chl-*a*	P_s	Production
		(% < 63 μm)	($mg\,m^{-2}$)	($\mu mol\,m^{-2}\,s^{-1}$)	($mg\,C\,m^{-2}\,h^{-1}$)
Modelled (μ ± σ, n)	O	5.9 ± 6.9 n = 15	113 ± 39.4 n = 15	36.5 ± 9.4 n = 10	79.3 ± 66 n = 8
	W	24.0 ± 19.2 n = 29	95.4 ± 30.8 n = 29	42.5 ± 17.5 n = 24	59.9 ± 31.4 n = 22
Observed (μ ± σ, n)	O	3.8 ± 3.4 n = 15	222.0 ± 73.2 n = 15	35.5 ± 14.3 n = 10	38.0 ± 19.9 n = 8
	W	24.2 ± 22.1 n = 29	172.2 ± 97.7 n = 29	52.9 ± 23.6 n = 24	105.2 ± 79.7 n = 19

(*continued on next page*)

Table 3 (*continued*)

	Estuary	Mud content	Chl-*a*	P_s	Production
		(% < 63 μm)	($mg\ m^{-2}$)	($\mu mol\ m^{-2} s^{-1}$)	($mg\ C\ m^{-2} h^{-1}$)
RMSE	O	8.9	69.7	12.2	66.8
	W	17.5	85.4	30.1	89.8
Mean error	O	2.1	−109.1	0.98	41.3
	W	−0.16	−77.2	−15.9	−45.2
Cost function (χ)	O	2.6	1.74	0.85	3.3
	W	0.8	1.17	1.27	1.1

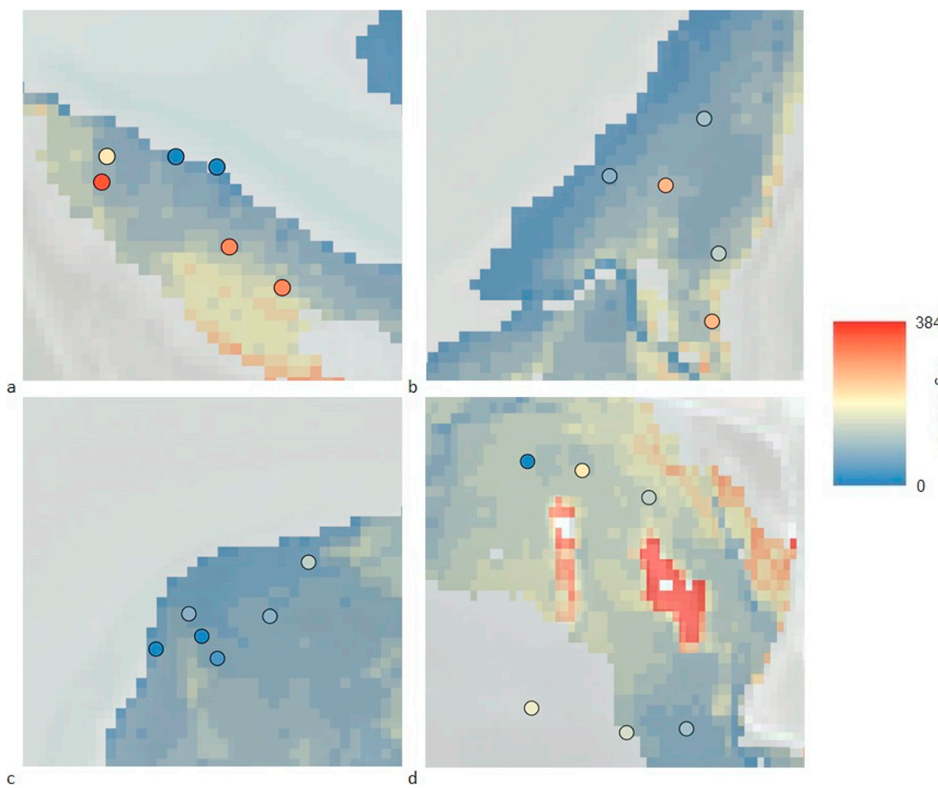

Fig. 8. Modelled (raster) and observed (dots) average daily production at four different sites. a. Paulinapolder, Westerschelde, b. Hellegat, Westerschelde, c. Molenplaat, Westerschelde, d. Dortsman, Oosterschelde. Daily production values based on Landsat 8 (map) and field measurements (dots) were calculated by running the model for one month.