Electronic Supplementary Material (ESI) for Environmental Science: Processes .

Supplementary Information for Integrating algaculture into small wastewater treatment plants: Process flow options and life cycle impacts

Muriel M. Steele, Annick Anctil, David A. Ladner

Department of Environmental Engineering and Earth Sciences
Clemson University
342 Computer Court, Anderson, SC, 29625

Nutrient removal values were generated using the gamma distribution, where alpha and beta (shape and rate parameters, respectively) were set to best fit the data reported in literature. First, histograms of data obtained from the literature were plotted for each wastewater type (primary treated, secondary treated, and sidestream wastewaters), and the percent of instances when removal was >95% and 75-95% were determined. The function 1-GAMMA.INV(RAND(),α,β) in Excel was used to generate 1000 values of removal, and alpha and beta parameters were varied until the percent of instances when removal was >95% and 75-95% matched that of the literature data. Histograms for data and model are shown in Figures S1-S6. Alpha and beta parameters and resulting nutrient removal values for TANR, PANR, and SANR models are shown in Tables S1-S3.

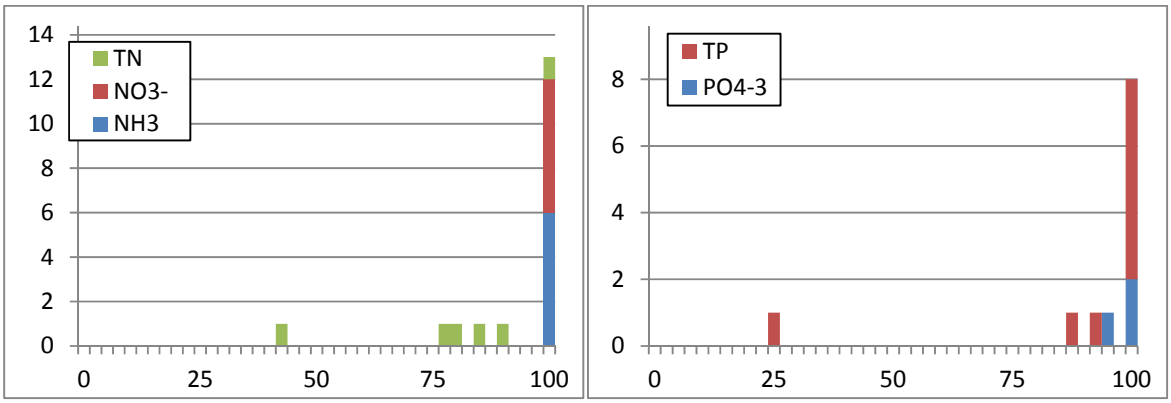

Figure S1: Histograms of nitrogen (left) and phosphorus (right) removal reported in literature for secondary treated wastewater.

Table S1: Final gamma distribution parameters and resulting removal values for TANR model.

	TN	TP
alpha	0.75	0.75
beta	5	5
Mean	96.3	96.4
Max	100.0	100.0
Min	69.6	73.3
St Dev	4.2	4.1

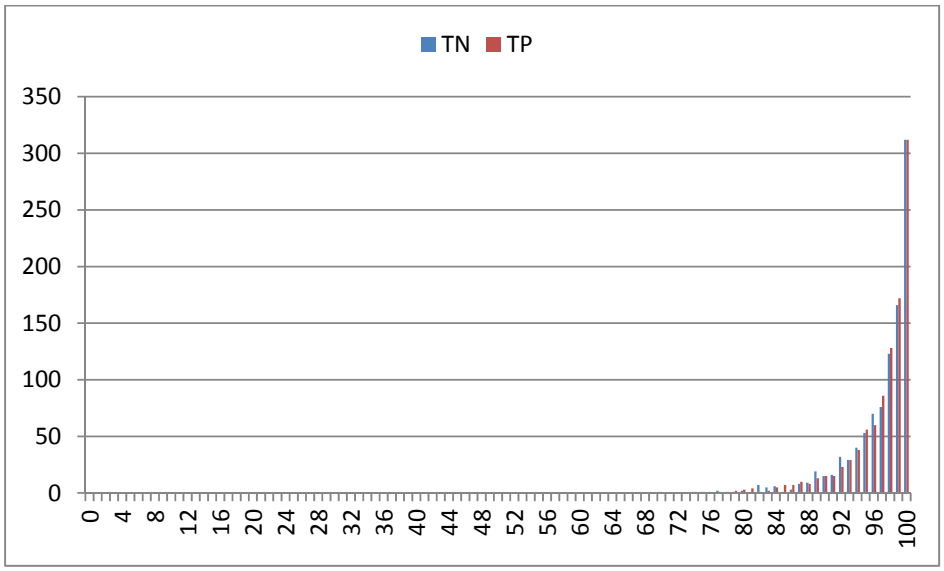

Figure S2: Histogram for TN and TP removal values used in TANR model.

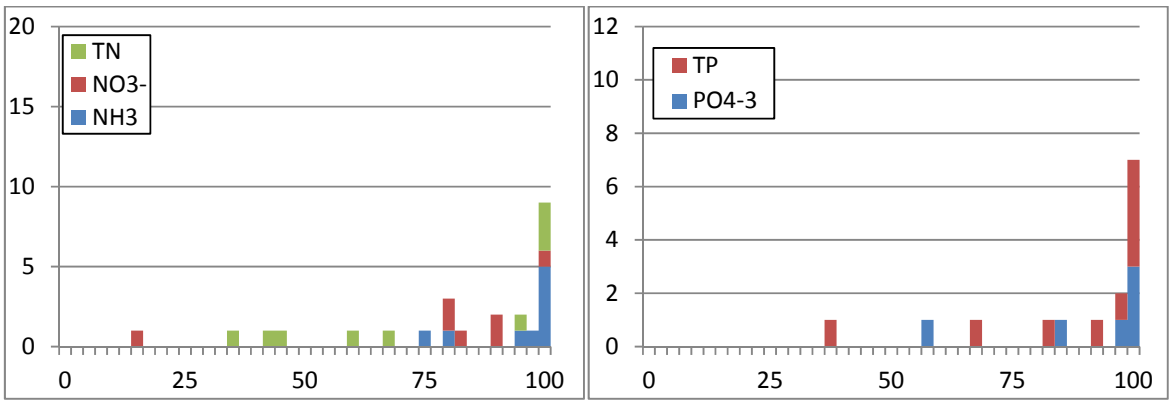

Figure S3: Histograms of nitrogen (left) and phosphorus (right) removal reported in literature for primary treated wastewater.

Table S2: Final gamma distribution parameters and resulting removal values for PANR model.

	TN	TP
alpha	1	0.75
beta	10	6
Mean	89.9	95.5
Max	100.0	100.0
Min	40.1	47.8
St Dev	9.7	5.4

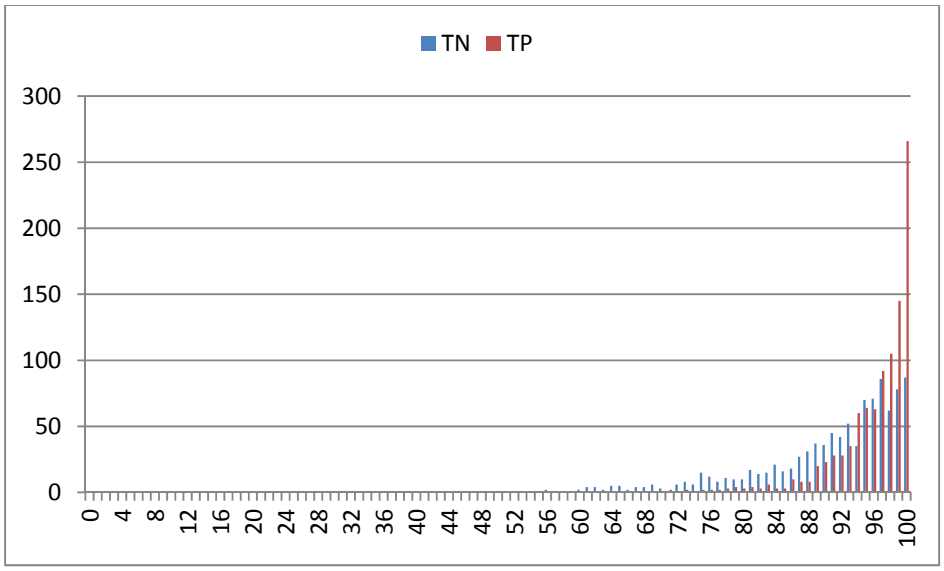

Figure S4: Histogram for TN and TP removal values used in PANR model.

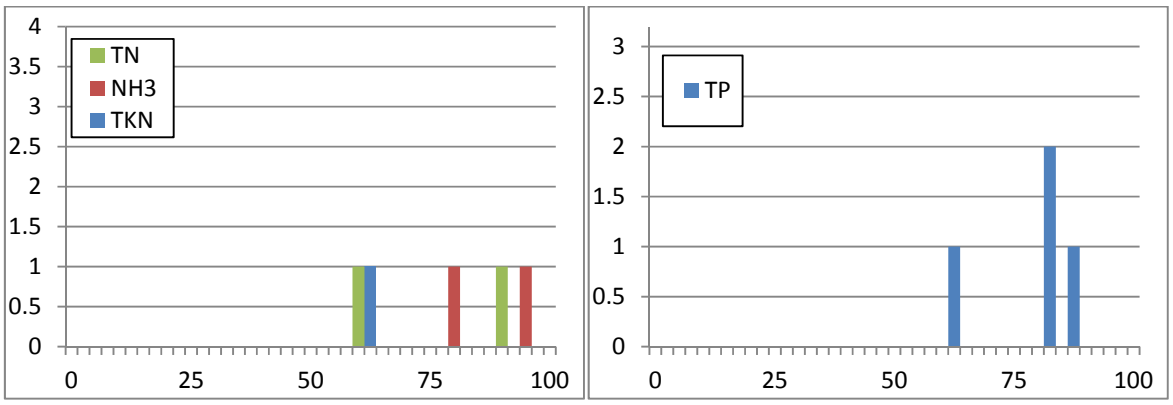

Figure S5: Histograms of nitrogen (left) and phosphorus (right) removal reported in literature for sidestream wastewater.

Table S3: Final gamma distribution parameters and resulting removal values for SANR model.

	TN	TP
alpha	3	3
beta	8	6
Mean	**76.0**	**82.3**
Max	**99.3**	**98.6**
Min	**10.5**	**39.8**
St Dev	**14.0**	**9.9**

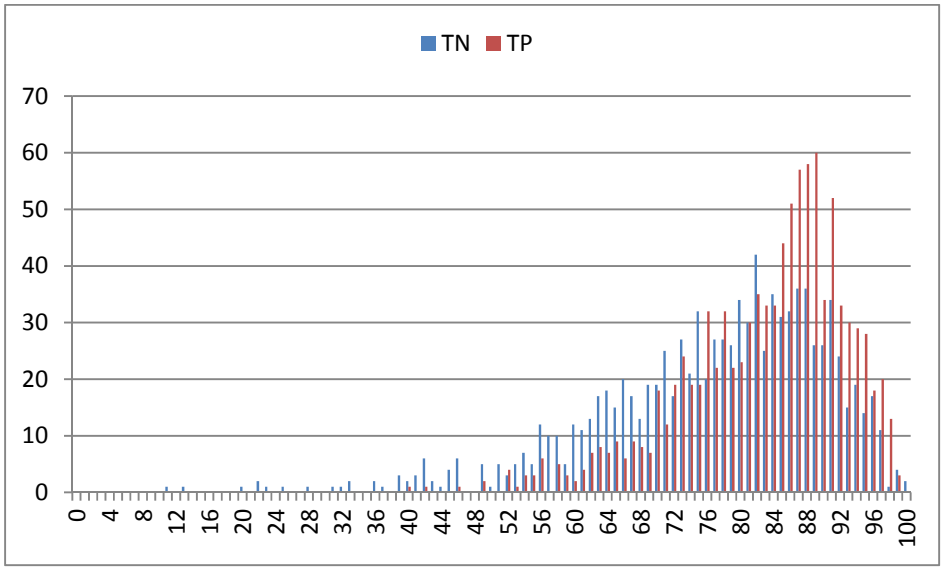

Figure S6: Histogram for TN and TP removal values used in SANR model.

Sensitivity of the algaculture models to each parameter in the model (TN removal, TP removal, and stoichiometric coefficients for H, P, C, O, and N of algal biomass) was determined using Monte Carlo analysis, where parameters were varied one at a time and impacts to algal biomass production and N and P uptakes were determined. Tornado plots for this analysis are shown in Figures S7-S9. Each bar is centered on the mean of the distribution and extends two standard deviations from top to bottom.

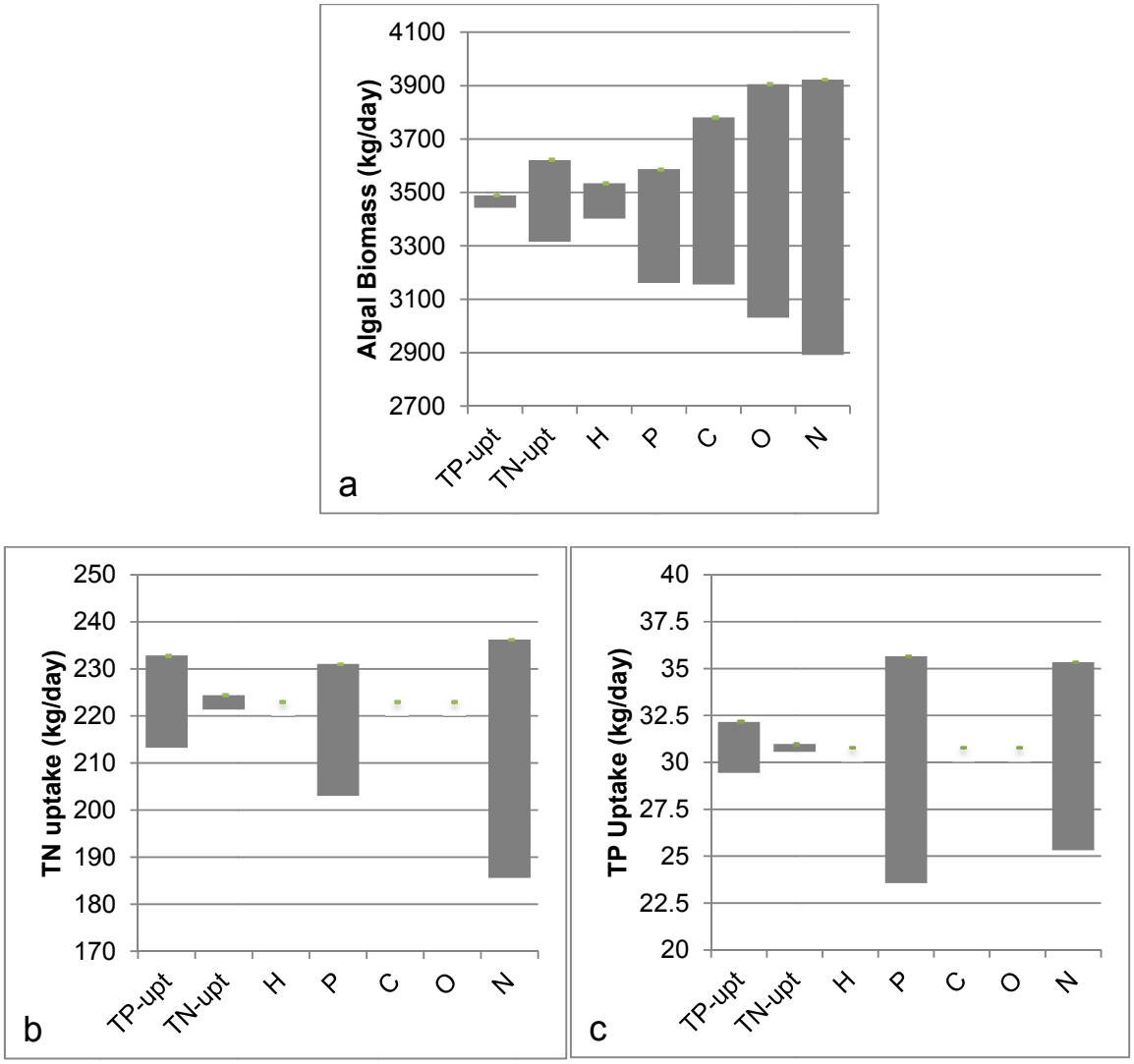

Figure S7: Tornado plots of the sensitivity of (a) algal biomass production, (b) nitrogen uptake, and (c) phosphorus uptake to seven input parameters in the TANR model.

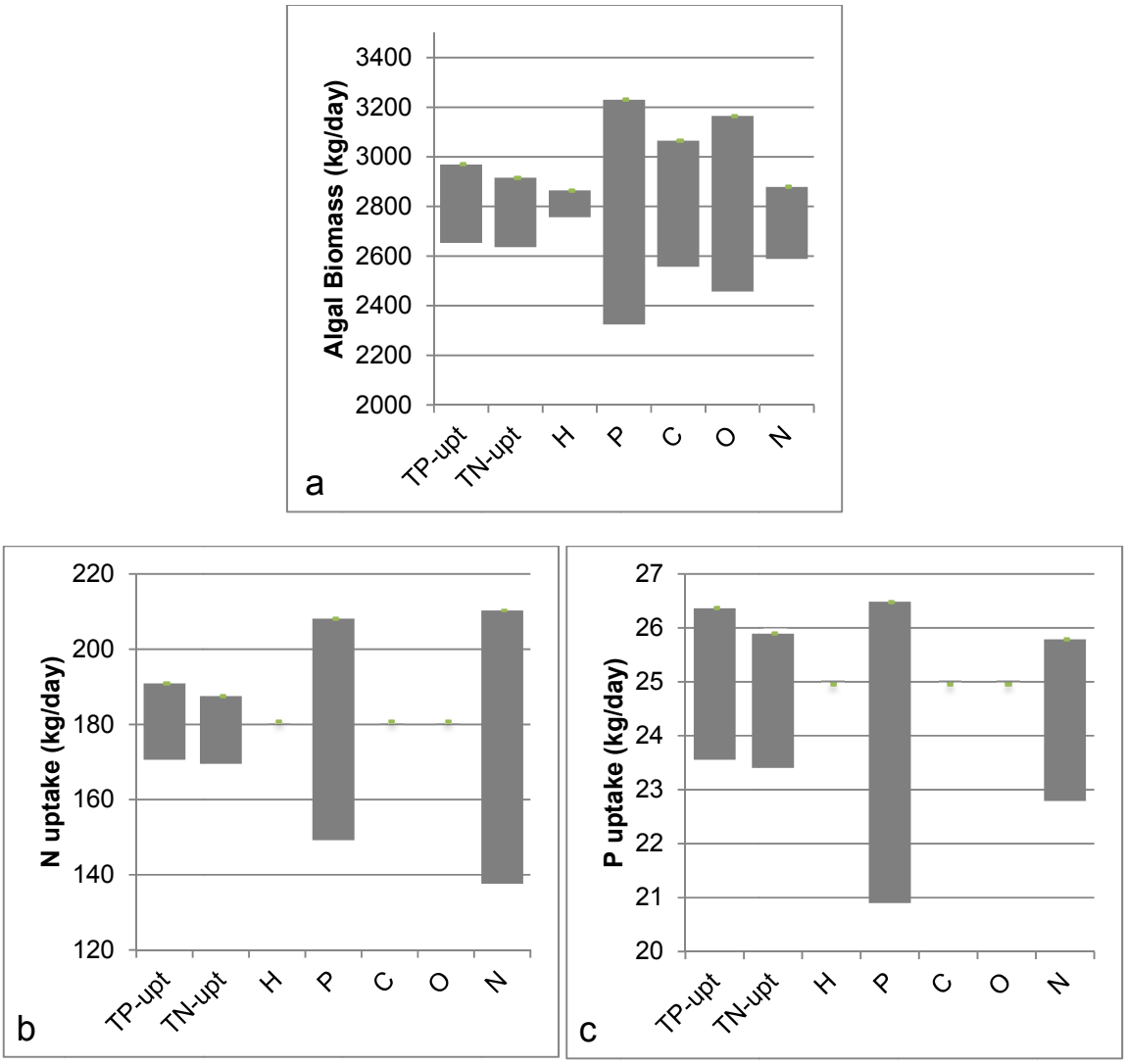

Figure S8: Tornado plots of the sensitivity of (a) algal biomass production, (b) nitrogen uptake, and (c) phosphorus uptake to seven input parameters in the PANR model.

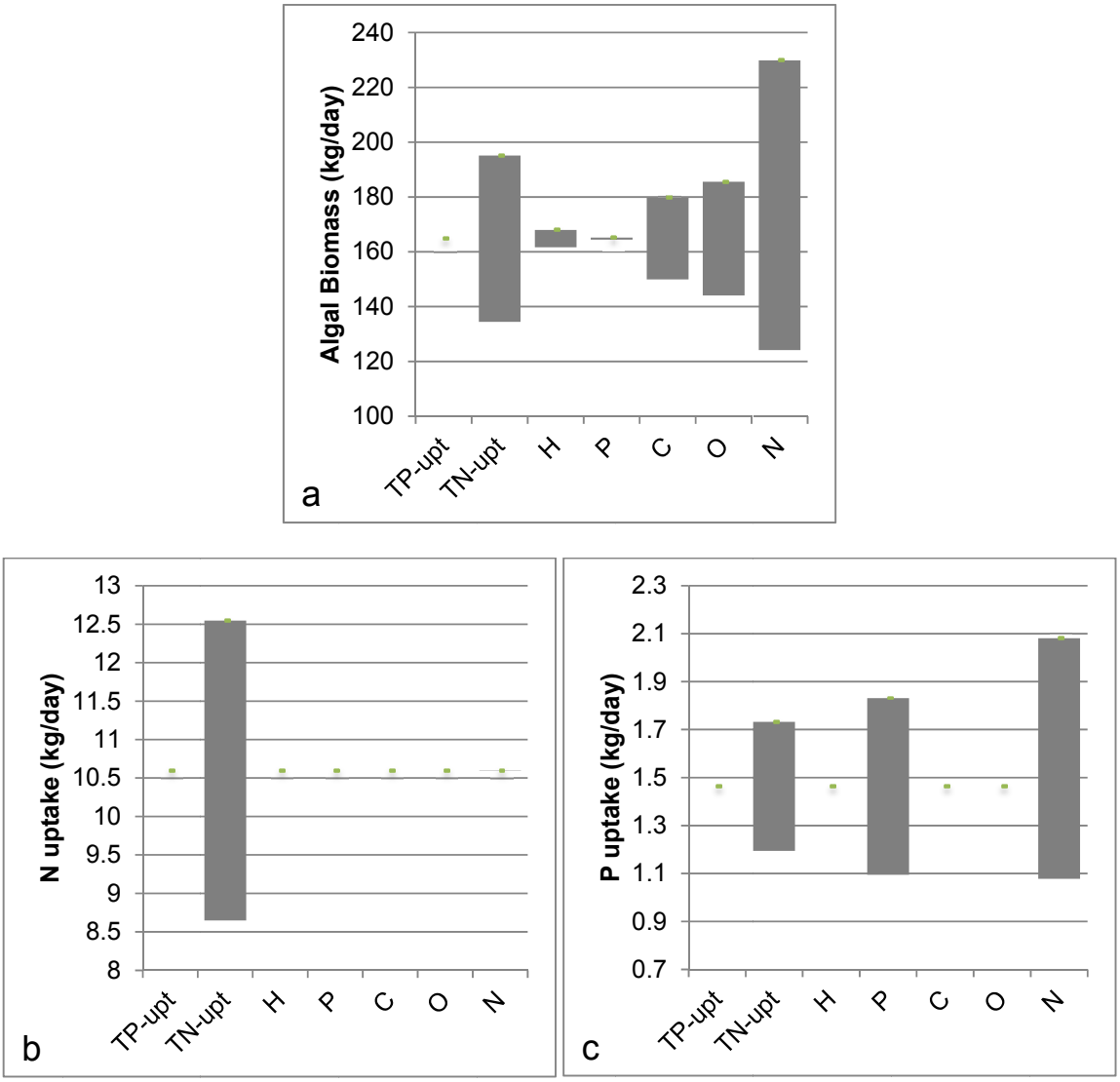

Figure S9: Tornado plots of the sensitivity of (a) algal biomass production, (b) nitrogen uptake, and (c) phosphorus uptake to seven input parameters in the SANR model.