Changes to ETI Tool 1

Amy Whitehead & Bruce Dudley

06 December 2023

This document outlines updates and changes that have been made to *ETI Tool 1: Determining susceptibility of estuaries to eutrophication*. Please read the documentation below carefully to understand the implications that these changes may have on the calculated results of the tool. For further clarification, please email the ETI Team at eti-tools@niwa.co.nz.

Version 2.1.2

Release Date: 06 December 2023
The following changes are likely to result in changes to the outputs from Tool 1, including banding for macroalgae.

- Potential TN bands for macroalgal susceptibility were revised based on an expanded data set of macroalgal ecological quality rating (EQR) observations provided by Salt Ecology Ltd. Potential TN concentrations were calculated from estimated annual total nitrogen loads and dilution modelling. Potential TN bands have been set at the 25% exceedance risk; i.e., there is a 25% probability that the EQR is worse than predicted. Further information on the rationale for these changes can be found in the reference below, available from Environment Southland:

ETI macroalgae susceptibility	Previous threshold (mg/m3)	New threshold (mg/m3)
A	TN $\leq$ 250	TN $\leq$ 175
B	250 $<$ TN $\leq$ 450	175 $<$ TN $\leq$ 335
C	450 $<$ TN $\leq$ 650	335 $<$ TN $\leq$ 495
D	TN $>$ 650	TN $>$ 495

Reference

- Plew, D. (2023) Updated total nitrogen load limits for Southland Estuaries. NIWA Client Report, 2023296CH: 17 pp.

Version 2.1.1

Release Date: 01 May 2023
The following changes are likely to results in changes to the outputs from Tool 1.

- The TN thresholds for banding macroalgae have been re-adjusted using additional EQR data and revised tidal prisms. This may change an estuary's banding for macroalgae.

ETI macroalgae susceptibility	Previous threshold (mg/m3)	New threshold (mg/m3)
A	TN $\leq$ 80	TN $\leq$ 250
B	80 $<$ TN $\leq$ 200	250 $<$ TN $\leq$ 450
C	200 $<$ TN $\leq$ 320	450 $<$ TN $\leq$ 650
D	TN $>$ 320	TN $>$ 650

Version 2.1.0

Release Date: 4 July 2022

The default input data for ETI Tool 1 were updated with the following changes that will likely affect the results.

- Total nitrogen (TN) and total phosphorus (TP) loads for all estuaries were calculated using the latest version of CLUES (CLUES Pro) on 2 March 2022 under a project for the Ministry for the Environment (Semadeni-Davies et al. 2021). This version of CLUES used a national calibration (Elliot et al. 2016; Semadina-Davies et al. 2019; Semadina-Davies et al. 2020) except for Northland, where a regional calibration was used.
- Data for 141 Maunagawhio Estuary, 148 Wairoa Estuary, 152 Aharoa Estuary, 153 Waitangi Estuary/Ngaururoro Estuary and 156 Porangaha River were updated, and 153.5 Tukituki Estuary was added, based on work conducted for Hawke's Bay Regional Council (Plew 2021).
- Data for 1049 Shag River, 1060 Kaikorai, 1063 Tokomairiro and 1066 Catlins were updated based on surveys conducted by NIWA for Otago Regional Council in 2018/2019.
- Data for 1072 New River Estuary were updated based on survey data collected between 2013-2015 by TrueSouth Ltd and Environment Southland, and modelling by NIWA (Measures 2016; Plew et al. 2018).
- Data for 1073 Toetoes Estuary were updated based on survey data 3 Sep 2019 by TrueSouth Ltd on behalf of Environment Southland and analysis by NIWA (Plew et al. 2020).
- Data for 1031 Horseshoe Bay (Canterbury) were updated to correct an error in the coordinates and ocean salinity, nitrate and phosphorus.
- Data for coastal hydrosystems in the Canterbury region were updated based a summary of coastal data collated for Environment Canterbury by NIWA in 2021 (Leduc et al. 2022). The estuaries of Okains Bay and Le Bons Bay were also added, based on surveys conducted for Environment Canterbury by NIWA in 2017 (Plew et al. 2017).

References

- Elliott, A.H., Semadeni-Davies, A.F., Shankar, U., Zeldis, J.R., Wheeler, D.M., Plew, D.R., Rys, G.J., Harris, S.R. (2016) A national-scale GIS-based system for modelling impacts of land use on water quality. Environmental Modelling & Software, 86: 131-144. http://dx.doi.org/10.1016/j.envsoft.2016.09.011
- Leduc, D., Plew, D., Mountjoy, J., Wadhwa, S., Anderson, O., Milne, J., Mackay, K., Sykes, J., Anderson, T., Brough, T., Tait, L., Thompson, D., Stephenson, F., Bigham, K., Neill, K., Schnabel, K., Seaward, K., Rowden, A., Lundquist, C., Bowden, D. (2022) Marine habitats, ecosystems and biodiversity in the Canterbury coastal marine area. A stocktake of existing information. NIWA Client report, 2021342WN: 202.
- Measures, R. (2016) New River Estuary Hydrodynamic Modelling. Model build, calibration and tracer simulations. NIWA Client Report, 2016077CH: 52.
- Plew, D., Dudley, B., Bind, J. (2017) Canterbury region estuary eutrophication susceptibility assessment. NIWA Client Report, 2017154CH: 26. https://api.ecan.govt.nz/TrimPublicAPI/documents/download/3208268

- Plew, D. (2021) Estuarine Trophic Index Susceptibility Screening for Hawke's Bay. NIWA Client Report, 2021108CH: 39.
- Plew, D., Dudley, B., Shankar, U. (2020) Eutrophication susceptibility assessment of Toetoes (Fortrose) Estuary. NIWA Client Report, 2020070CH: 58.
- Plew, D.R., Zeldis, J.R., Shankar, U., Elliott, A.H. (2018) Using simple dilution models to predict New Zealand estuarine water quality. Estuaries and Coasts, 41(6): 1643-1659. 10.1007/s12237-018-0387-6
- Semadeni-Davies, A.F., Jones-Todd, C.M., Srinivasan, M.S., Muirhead, R.W., Elliott, A.H., Shankar, U., Tanner, C.C. (2019) CLUES model calibration: residual analysis to investigate potential sources of model error. New Zealand Journal of Agricultural Research: 1-24. 10.1080/00288233.2019.1697708
- Semadeni-Davies, A., Jones-Todd, C., Srinivasan, M.S., Muirhead, R., Elliott, A., Shankar, U., Tanner, C. (2020) CLUES model calibration and its implications for estimating contaminant attenuation. Agricultural Water Management: 105853. https://doi.org/10.1016/j.agwat.2019.105853
- Semadeni-Davies, A., Elliott, S., Shankar, U., Huirama, M. (2021a) Memorandum on modelling nutrient, sediment and E. coli loads to estuaries, Memorandum to Ministry for the Environment. NIWA client report: 2021366HN.

Version 2.0.4

Release Date: 1 June 2022

Fixed error that prevented the report from generating correctly. This change will not result in changes to the calculated results from Tool 1.

Version 2.0.3

Release Date: 4 April 2022

Fixed two errors relating to the incorrect assignment of the dilution modelling bands. These changes will result in changes to the calculated results from Tool 1.

1. Phytoplankton bands (typically A bands) were inadvertently being set for estuaries where nutrient data were not provided. This has been corrected to return an NA value as it is not possible to calculate the chlorophyll concentration (CHLA) without information about TN in rivers.

2. The ETI Susceptibility (SusceptibilityBand and SusceptibilityBand_ICOE) was set to D for all estuaries where the percentage of the intertidal area was between 5 - 40. This has been corrected so that the SusceptibilityBand is now the worst banding for macroalgae and phytoplankton for that estuary. The ETI Susceptibility for estuaries where % intertidal < 5 or > 40 are still set to the Phytoplankton Band and Macro Algae Band, respectively.

Version 2.0.2

Release Date: 26 January 2021
ETI Tool 1 has been redesigned to improve the user workflow. However, none of the updates are likely to result in changes to the calculated results from Tool 1.

- The results table has been redesigned to highlight the key results, with clearer differentiation between the dilution modelling and ASSETS results. Users can choose whether to view and export just the key results or all calculated variables. In most cases, the key results should be sufficent for most users.

- Hovering the mouse

- Updated available metadata.
  and the functionality of the tables to improve the user experience. These changes are cosmetic only and will not affect the calculated results.

Version 2.0.1

Release Date: 17 December 2020

- What was formerly know as the *CLUES Estuary Approach* as been renamed the *dilution modelling approach* throughout Tool 1 to reflect the fact that the model does not need to use nutrient estimates derived from CLUES. This change is cosmetic only and will not affect the calculated results.

Version 2.0.0

Release Date: 25 November 2020
ETI Tool 1 has been redesigned to improve the user workflow. However, none of the updates are likely to result in changes to the calculated results from Tool 1.

- Users can now choose to use the provided default data to calculate susceptibility scores without needing to download it first or upload their own data. If you choose to use your own data, we recommend that you download the default data first to use as a template.
- After calculating the susceptibility scores, users can now download an html report summarising the analysis, as well as a csv file of the calculated results. The report includes information about the data used in the analysis, a summary and plots of the results and a metadata table describing the columns in the results file.
- Sediment load has been added to the default input data provided in the app (and the results download) as this information may be helpful when using ETI Tool 3.
- ETI Tool 1 has been updated to reflect changes to NIWA's branding.

Version 1.1.5

Release Date: 20 May 2019
The following changes are likely to result in changes to the outputs from Tool 1.

- The macroalgae susceptibility banding for all estuaries where salinity < 5 ppt has been set to *Band A*. This change reflects the fact that estuaries with a low salinity do not grow macroalgae. This change brings ETI Tool 1 into line with the recently published MfE report by Plew et al (2018). It is likely that the macroalgae susceptibility banding for estuaries that fall into this category will have improved.
- The phytoplankton susceptibility banding has been adjusted to reflect that estuaries of different salinities will have different susceptibilities to phytoplankton growth. This change will alter the phytoplankton susceptibility bandings for euhaline and oligohaline/freshwater estuaries. However, this will not change the phytoplankton susceptibility bandings for meso/polyhaline estuaries as Versions 1.1.4 and earlier used the meso/polyhaline estuary thresholds shown below for all estuaries.
- *EstuarySalinity* has been added as a column in the downloadable results and the metadata table as a result of the above changes.

Table 1. Phytoplankton susceptibility bands based on ranges of chlorophyll-*a* (μg/l) in high (>30 ppt) and other (<30 ppt) salinity ranges.

ETI phytoplankton susceptibility	Euhaline estuaries (>30 ppt)	Meso/polyhaline estuaries (5-30 ppt)	Oligohaline/freshwater estuaries (<5 ppt)
A	CHLA $\leq$ 3	CHLA $\leq$ 5	CHLA $\leq$ 10
B	3 < CHLA $\leq$ 8	5 < CHLA $\leq$ 10	10 < CHLA $\leq$ 25
C	8 < CHLA $\leq$ 12	10 < CHLA $\leq$ 16	25 < CHLA $\leq$ 60
D	CHLA > 12	CHLA > 16	CHLA > 60

Plew D., Dudley B., Shankar U., Zeldis J. 2018. Assessment of the eutrophication susceptibility of New Zealand Estuaries. *NIWA Client Report 2018206CH prepared for Ministry for the Environment.* NIWA, Christchurch. (download pdf)

Version 1.1.4

Release Date: 27 November 2018
The following changes are likely to results in changes to the outputs from Tool 1.

- The phytoplankton net growth rate was altered from 0.4 day-1 to 0.3 day-1. This lower value slows the growth rate of phytoplankton and reduces the potential susceptibility to phytoplankton for estuaries with short residence times.
- The TN thresholds for banding macroalgae have been re-adjusted using additional data and brought in line with recent work for MfE and Regional Councils. The revised values are closer to those used in the original version of Tool 1. This may change an estuary's banding for macroalgae.

ETI macroalgae susceptibility	New threshold (mg/m3)	Previous threshold (mg/m3)
A	TN $\leq$ 80	TN $\leq$ 40
B	80 < TN $\leq$ 200	40 < TN $\leq$ 120
C	200 < TN $\leq$ 320	120 < TN $\leq$ 380
D	TN > 320	TN > 380

Version 1.1.3

Release Date: 17 October 2018

- Added updated Hume (2018) reference and link to pdf.
- Changed units of river_n_load_mg in metadata from mg to mg/day. This will not change the results of the calculations.

Version 1.1.2

Release Date: 25 June 2018

- Fixed error in susceptibility calculation that meant results would not display if there were no coastal lakes in the dataset. This will not change the results of the calculations.

Version 1.1.1

Release Date: 12 January 2018

- Added additional information and more variables to the metadata table. This change will not affect the calculated results.

Version 1.1.0

Release Date: 3 November 2017

This release combines the CLUES Estuaries and ASSETS approaches into a single calculation, hopefully making it easier for the user. The following changes are purely cosmetic and should not change the calculated results.

- The CLUES Estuaries and ASSETS approaches tabs have been combined into one tab called *Run Tool 1*.
- The two downloadable datasets have been combined into one dataset that contains all information required to run both the CLUES Estuaries and ASSETS calculations.
- The downloadable metadata dataset now contains information about the input and output variables for both the CLUES Estuaries and ASSETS approaches.
- The calculated and downloadable results dataset now contains the outputs for both the CLUES Estuaries and ASSETS approaches.
  - Where estimates of CLUES Estuaries bandings or ASSETS susceptibility scores cannot be made due to missing data, we have identified the source of the error in the appropriate column.
- The app citation is now available as a downloadable *.xml* file.

We have also made some changes to the calculations as listed below. These are likely to change the results.

- The phytoplankton half saturation coefficient and net growth rates were altered from 35 mg/m^3 and 0.43 day^{-1} to 45mg/m^3 and 0.4 day^{-1}. These changes bring the coefficients in line with accepted values for NZ (see references below), slowing the rate of phytoplankton growth and reducing the potential susceptibility to phytoplankton.
  - Gibbs, M.M., and W.N. Vant. 1997. Seasonal changes in factors controlling phytoplankton growth in Beatrix Bay, New Zealand. New Zealand Journal of Marine and Freshwater Research 31: 237-248.
  - Vant, W.N., and R.G. Budd. 1993. Phytoplankton photosynthesis and growth in contrasting regions of Manukau Harbour, New Zealand. New Zealand Journal of Marine and Freshwater Research 27: 295-307.
- The TN thresholds for banding macroalgae have been recalculated based on updated dilution models for the estuaries. This has resulted in lower A/B and B/c thresholds and a higher C/D threshold as shown in the table below. This may change an estuary's banding for macroalgae.

ETI macroalgae susceptibility	New threshold (mg/m3)	Old threshold (mg/m3)
A	$TN \leq 40$	$TN < 56$
B	$40 < TN \leq 120$	$56 \leq TN < 178$
C	$120 < TN \leq 380$	$179 \leq TN < 350$
D	$TN > 380$	$TN \geq 351$

Version 1.0.2

Release Date: 3 August 2017

- Added suggest citation. This change will not affect the calculated results.

Version 1.0.1

Release Date: 20 June 2017

- The input data provided in the ASSETS and CLUES Estuary Approach data templates was standardised across the two parts of Tool 1 to make the data more internally consistent and to correct some known errors. These changes will affect the provided input data and may affect the calculated results.
- Data provided in ASSETS has been filtered such that only estuaries that have a volume greater than 2.8 million m^3 are now provided. This change was made to ensure that users don't run ASSETS on estuaries for which it is not appropriate. These changes will affect the provided input data but will not affect the calculated results for the estuaries where data is provided.
- Calculations within ASSETS now use Qf (m^3/s) as a measure of freshwater inflow instead of freshwater_inflow_12.4_hr (m^3/12.4hr) in calculations requiring information about freshwater inflow. This change was made to make the calculations in ASSETS and the CLUES Estuary Approach more internally consistent. Values for Qf are provided in the updated data template for ASSETS. Users will need to be careful if they use old versions of the data template as the units and column name for freshwater inflow will be incorrect. These changes will affect the provided input data and may affect the calculated results.
- Made a minor change to the way that an estuary's volume is calculated in the CLUES Estuary Approach to ensure that Volume - Tidal Prism cannot be less than 1. This change may affect the calculated results.
- The term *export potential* was changed to *physical susceptibility* in the results and metadata tables to bring it in line with the literature. This change will not affect the calculated results.
- Flipped the order that the CLUES Estuary Approach and ASSETS are presented in the app to encourage users to use the CLUES Estuary Approach. This change will not affect the calculated results.
- Added the ETI email address eti-tools@niwa.co.nz to the app. This change will not affect the calculated results.
- Added link to change log and updated version control number. This change will not affect the calculated results.

Version 1.0.0

Release Date: 1 April 2017

- Initial release of ETI Tool 1 on NIWA's external shiny server.