Structured internal project application 2024-2025

Project Overview

Project name: *(Short title)*	Calibration of the CLUES model for TN, TP and E. coli
Staff: (who will be completing the work?)	Reza Moghaddam
Project Manager: (usually a Group Manager)	Annette Semadeni-Davies (with support from Andrew Hughes as Project Director)
Region:	Auckland
Centre:	Freshwater
Type: (science, operations activity, or other - explain)	Science
Budget: (attach costing prepared by your project coordinator)	
Project objective: *(30 words max)*	This SIP aims to complete the regional calibration of the CLUES model for E. coli, Total Nitrogen
Project outline: (150-300 words max)	In this SIP, we are requesting funding to complete regional calibration of the CLUES model for E. coli and TN. Calibration for TP is a lower priority but may also be progressed as part of this SIP, time permitting. CLUES is based on the United States Geological Survey SPARROW model, which is one of the most widely cited annual load models in the world. CLUES also contains the outputs of the OVERSEER and SPASMO models. The CLUES model (and its associated progenitor model SPARROW) has been applied in New Zealand for over 25 years, for and by regional councils and central government agencies such as the Ministry for Primary Industries and the Ministry for the Environment. CLUES continues to be used by NIWA both for internal and commercial projects. We currently have two commercial proposals pending that will use CLUES if successful and the model is at the heart of a new mitigation catchment modelling tool being developed under the Mitigation Programme ((project FWRP2507), which is itself being used commercially. A review of freshwater quality models from the Parliamentary Commission for the Environment last year named CLUES as being one of the most widely known and applied water models in New Zealand. However, this same review had criticisms of CLUES that need to be addressed, specifically: - CLUES relies on an out-of-date version of OVERSEER to estimate TN and TP yields from pasture. OVERSEER model that has itself become notorious over the last few years for lack of transparency. - CLUES relies on SPASMO to estimate TN yields from horticulture and crops. This is a largely unknown, poorly documented empirical model that has gaps in its representativity in some regions. - CLUES was calibrated nationally in 2014 using data collected largely from before 2010. This calibration does not reflect current land use or the current state of water quality and has poor fit in some regions. - CLUES lacks transparency by incorporating OVERSEER and SPASMO.

	Largely in response to the PCE review, we have prioritised regional calibration of the model as part of the transition of CLUES to the Arc Pro GIS platform. This aims to ensure that CLUES remains a credible, contemporary modelling tool capable of contributing significantly to growth in NIWA's provision of water quality modelling services in the face of growing competition in this field. An example is given as an appendix to this application that demonstrates the importance of regional calibration and the progress we have made in regionally calibrating *E. coli*. We are seeking SIP funding to complete calibrations for *E. coli* and TN (and, if possible, make progress on TP) without Overseer or SPASMO ahead of a public release of the CLUES Pro model package at the end of this financial year. Reza Moghaddam will undertake the bulk of the remaining work with the supervision of Annette Semadeni-Davies and Sandy Elliott under the CLUES SIFF (FWWQ2510).
Project outputs: (e.g., a journal paper or an App, or a safe operating procedure or guidance document for operations activities)	• Regional calibrations of CLUES for *E. coli* and TN • A memo documenting the calibrations that can be supplied to model users or included in client reports.
Project impact: (choose an SCI impact area that the project aligns with, see graphic below)	Protecting our diversity Improved environmental health
Alignment: (with a programme and/or National Centre outcomes or KPIs)	This project aligns with: 2 freshwater programmes: • Freshwater Centre Mitigation Programme (project FWRP2507 mitigation systems in catchment models) • Cause and effects of water quality degradation (project FWWQ2510 CLUES transition to Arc Pro)
Outcomes for Māori: (may include partnerships, resourcing, alignment with aspirations)	Supporting catchment planning and policy development that enhance water quality for cultural values such as mahinga kai.
Operations alignment: (for non-science projects, how does this work contribute to inputs or enablers from the graphic below)	Not applicable

WORK PROGRAMME AND TIMELINE

Outline the tasks to be done, who will do what and by when. Be as specific as possible.

Task	Specific activity (who, what)	By when	Hours
Completion of E. coli calibration	Assess calibration outputs (e.g., identify issues and outliers) Rerun calibration if required	31/03/2025	22.5
TN calibration without OVERSEER or SPASMO	Set up parameter groupings Modify code to include optimisation tools Run calibration and assess outputs Rerun calibration if required	31/03/2025	45 - 90
Lower priority, time permitting: TP calibration without OVERSEER	Set up parameter groupings Modify code to include optimisation tools Run calibration and assess outputs Rerun calibration if required	31/03/2025	45 (if unused from TN task)
Supervision by Annette Semadeni-Davies	Oversight and guidance in relation to all of the above	31/03/2025	30

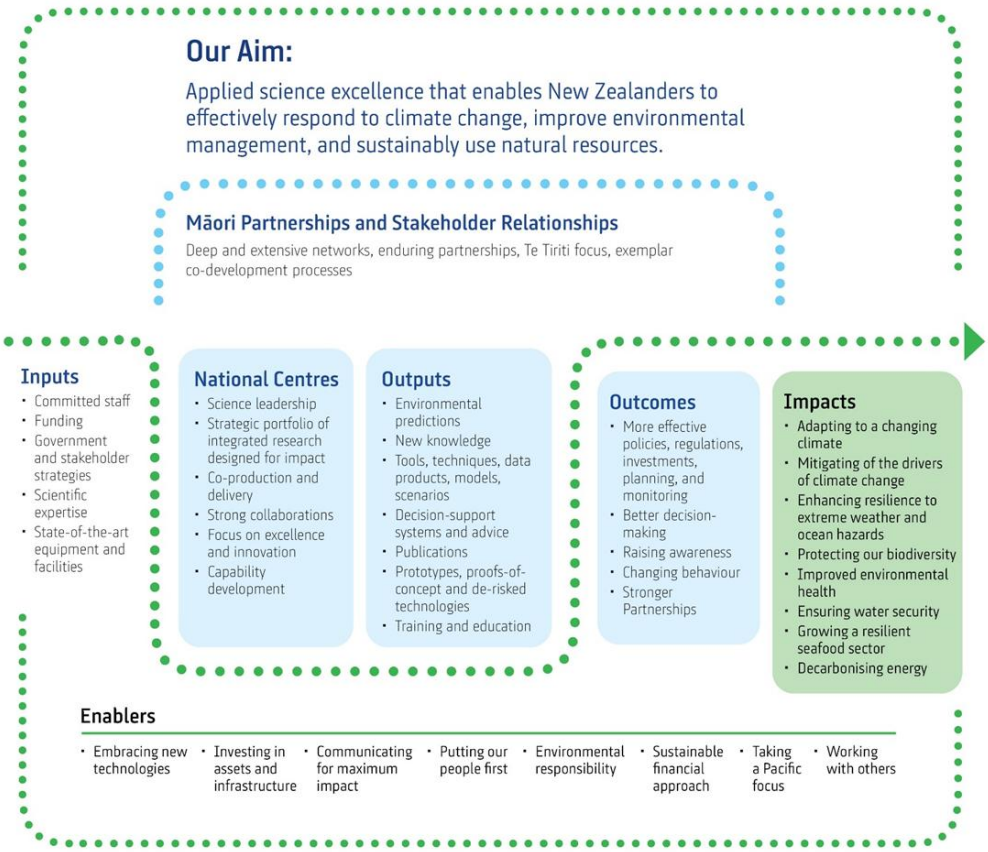
CHIEF SCIENTIST SUPPORT

Chief Scientist comment: (For example - If agreement that project required, indicate why SIP mechanism versus Centre Funds; What is/are the key output(s) and how will NIWA/National Centre/programme/individual benefit from that; note that there must be an output at the end of the project)

The output(s) will be of value to NIWA and will achieve impact aligned to our SCI. Yes, the regional calibration of CLUES will increase it's usefulness as a water quality model and importantly the use of the new mitigations system model which is just starting to be used with clients.

Signature

For reference: NIWA Impact Strategy, also see Statement of Corporate Intent



Example of E. coli Calibration for North Is North (Northland and Auckland)

Our experience calibrating CLUES for Northland in 2020 (NRC20101) demonstrates why recalibration at a regional level is required. We used a manual iterative method for the calibration using an Excel version of CLUES, which was a slow and laborious process. The calibration tool developed for the CLUES SIFF speeds up the process. The national calibration of CLUES from 2014 had very poor fit for TN (R^2 -0.06, NSE -0.06, RMSE 0.79), TP (R^2 -0.10, NSE -0.13, RMSE 0.94) and E coli (R^2 -0.29, NSE -0.69, RMSE 1.61). The E. coli calibration resulted improved fit (R^2 0.29, NSE 0.29, RMSE 1.04). Using our new automatic calibration too, we were about to improve the fit for the north of the North Island (Northland and Auckland) considerably (R^2 0.45, NSE 0.45, RMSE 0.65).

The TN Northland calibration found OVERSEER overestimated pastoral nitrogen loads leading to compensating errors in the model calibration. This was resolved by removing both SPASMO and OVERSEER from the model and calibrating the pastoral and horticultural TN loads. The regional calibration gave a good fit for the region (R^2 0.54, NSE 0.64, RMSE 0.38). The TP Northland calibration for Northland (R^2 0.36, NSE 0.36, RMSE 0.45) did not remove OVERSEER derived yields from the model.