Concept Plan SP 2022-033

Ellen Brook Catchment Nutrient Export: sources and pathways

BCS Rivers and Estuaries Science

Project Core Team

Supervising Scientist	Kerry Trayler
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Project status as of Aug. 5, 2022, 2:24 p.m.

New project, pending concept plan approval

Document endorsements and approvals as of Aug. 5, 2022, 2:24 p.m.

Project Team	granted
Program Leader	granted
Directorate	required

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Program

BCS Rivers and Estuaries Science

Departmental Service

Service 6: Conserving Habitats, Species and Communities

Background

Ellen Brook catchment (716 km^2) is a major tributary to the Swan Canning Estuary which is identified as the major contributor nutrient loads to the system (Kelsey, *et al*. 2010 & Paraska, *et al*. 2021). A nutrient stripping wetland was established at the bottom end of the catchment in 2016 with the view to reducing nutrient export from the catchment. While effective in reducing loads during winter and spring flows, the wetland is bypassed during low flow periods. This is important given the nature of soils in the catchment and shallow groundwater. Key performance indicators for nutrient (TN and TP) management of Ellen Brook have not been met in the past 5 years.

Since residential commenced in 1993s following the EPA approval, the Ellen Brook catchment has undergone significant changes in land use land cover (LULC) transitioning a landscape dominated by trees, crop and farm, animal keeping, and horticulture (>85%) to partial urban. Given its location adjacent to the Gnangara Groundwater Mound and Swan Valley, the rezoning from rural to urban have been challenging. To satisfy the environmental approval condition in drainage and nutrient management, as well as provision of water and sewer services for urban activity, key principles in drainage nutrient management, water sensitive urban design and urban water management have been adopted.

To better inform land management policy and support decision making to manage nutrient export from the Ellen Brook, a refined sub-catchment model is required. In order to be effective, the model must incorporate both surface and groundwater inputs and needs to quantify nutrient export from specific land use types, to quantify non-point sources, to identify the sources and sinks of nutrient, and how they vary in space and time.

Past studies conducted by CSIRO (e.g., Smith & Shams, 2002; Peters & Donohue, 2001; Gerritse 1995, 1996) demonstrated the importance of phosphorus (caused by fertiliser application) as point and diffuse sources and transported via regional groundwater into the Ellen Brook catchment. The release of diffuse phosphorus from the catchment varies due to a range of subsoil types and a range Phosphorus Retention Index (PRI) 2 to >100. Nitrogen species are not readily retained by soils in this catchment and move vertically downward into the underlying soil until they reach local groundwater regime.

A typical rainfall runoff model is not appropriate to Ellen Brook as it assumes that land use units along a flow path contribute nutrient in a similar fashion to how they contribute to runoff generation. This is not suited to Ellen Brook due to relatively shallow groundwater, which continues to export high concentration of nutrients from groundwater during low rainfall/runoff periods.

In addition, typical catchment models delineate hot spots of nutrient export based on a steady state nutrient export to estimate land use-specific nutrient export. However, the period of time that a land use has been present (such as crop and farm) can also be as important as estimating the land use nutrient export rate, particularly with phosphorus.

Aims

This project aims to generate a new sub-catchment model for Ellen Brook to estimate the catchment nutrient export based on sources (runoff and groundwater-derived), land use activity, and pathways from the catchment to the estuary.

Specifically, the project will address the following items:

1. Estimate the regional groundwater contribution to the Ellen Brook catchment nutrient export.
2. Estimate the relationship between nutrient export and change in land use and land cover (LULC).
3. Estimate the land-use specific nutrient export rate (with uncertainty estimates).

A novel Bayesian framework will be applied in the calibration techniques for the model that can effectively accommodate the uncertainties related to the behavior of the catchment during warmer climate events, given

that the frequency of such events is expected to increase if the current urbanization and climate change trends continue.

Models/Software to be used:

1. ArcGIS LULC model on Orthophoto Mosaic aerial photo datasets (ideally covering a period from 1970 to 2021).
2. SOURCE Catchment using Rainfall Runoff Model LASCAM & GR4J. Custom functions will be built to incorporate WSUD structures such as sub-soil drainage outflow, infiltration basin at corresponding nodes.
3. A modified 1K-DHM, a 2-D Distributed Hydrological Model with capability to estimate groundwater stored within grids.
4. Custom MATLAB model to estimate traveling time of phosphorus based on PRI using Gerritse (1996) method.

Expected outcome

1. Understanding of a relationship between a change in land use and land cover (LULC) (1970 to 2021) and nutrient export within the catchment, and relative contribution of regional groundwater to total nutrient export.
2. Understanding the effect of implementing a Drainage and Nutrient Management Plan and Water Sensitive Urban Design measures in relation to nutrient export, including the impact of different nutrient intervention approaches might have on nutrient export.

Strategic context

Strategic Direction: Discover - Develop adaptive management tools to promote ecosystem resilience to the impacts of climate change and other threats

Science Strategic Goal: Mitigation of pressures and threats to ecosystems and associated values is evidence based and effective.

BCS Approach: Undertake research to understand and mitigate the pressure and threats acting on terrestrial, aquatic, estuarine and marine ecosystems.

REScience Program objective: Providing information and science support for management action aimed at reducing nutrients, organic material, sediment and non-nutrient contaminants entering the Swan and Canning Rivers.

Swan Canning River Protection Strategy: Reduce nutrients, organic material and sediment entering the Swan Canning Rivers.

Expected collaborations

LGA within the Ellenbrook Catchment: City of Swan, Shire of Gingin, Shire of Chittering.

Proposed period of the project

Sept. 1, 2022 – Feb. 1, 2024

Staff time allocation

Role	Year 1	Year 2	Year 3
Scientist Technical Volunteer Collaborator	0.5	0.25	

Indicative operating budget

Source	Year 1	Year 2	Year 3
Consolidated Funds (RES)	3800	1300	
External Funding for scientist salary	60268	60268	