Lake phosphorus load apportionment and seasonal impacts

LUCY CROCKFORD[1, 2], PHIL JORDAN[1] & DAVID TAYLOR[2]

[1]Teagasc, Wexford, Ireland and [2]Geography, School of Natural Sciences, Trinity College Dublin, Ireland

crockfol@tcd.ie, lucy.crockford@teagasc.ie [www.teagasc.ie/agcatchments]

AGRICULTURAL CATCHMENTS PROGRAMME

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1. INTRODUCTION

Aim: to investigate the phosphorus (P) load apportionment patterns and processes to an *at risk* inter-drumlin lake (figure 1). The current study is comparing the sources of P loads to evaluate how rates of recovery may be modified.

Lakes may become eutrophic as a result of three nutrient loading processes:

- increasing external P loads from the catchment, the net mass of which remains in the water column and increases production
- accumulation of external P load as bed sediments may become biologically available due to sediment resuspension following hypolimnetic anoxia and mixing
- wind induced rolling of the water column may also resuspend sediments, depending on the lake morphology.

The null hypothesis is that internal loading events are insignificant in the annual cycle of chemical-ecological relationships in this lake.

Namachree Lough (17ha surface area, 14.5m max depth), a sensitive meso-eutrophic inter-drumlin lake in Co. Monaghan, is showing (palaeolimnological) signs of ecological recovery possibly from reductions in external P loads.

2. METHODS

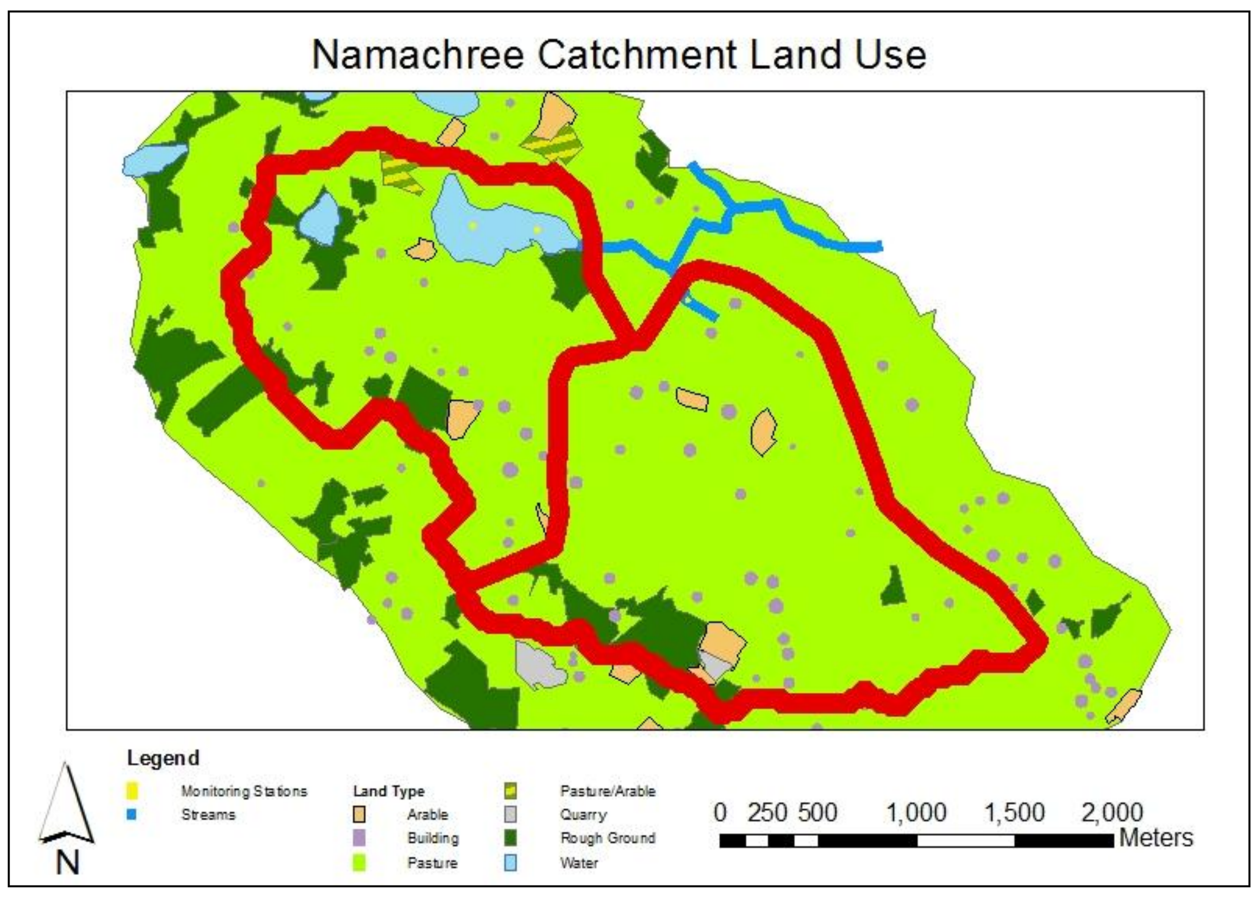

Fig. 1 Land use map of Namachree Lough

P Apportionment & Lake Ecology

monthly manual sampling
Nutrients & Ecological
West Surface,
East Surface and
9m deep at the West location

Hourly measurements
epi- and hypolimnetic
lake water quality
DO/temp/Chl a/conductivity/
pH/redox/turbidity
profiling using Hydrolab
(5X-DS5X) data-sondes

sub-hourly measurements
precipitation,
wind-speed and direction
(on site)
TP, TRP, discharge
(neighbouring catchment)

3. INTERIM RESULTS

a. Loading

- figure 5a shows P export from the neighbouring catchment monitoring station (total P export load of 0.27kg ha^{-1} Oct 2010 to Sept 2011) with very little in terms of summer loads.
- seasonal anoxia is occurring with dissolved oxygen (DO) depletion in hypolimnetic water due to thermal stratification (figure 5a).
- gross internal release from sediment, shown in figure 5a, when it occurs, is estimated at 10 times that of the yearly external load.
- breakdown of the thermocline and temporary overturn observed may be a feature of summer trophic impacts.
- recent monitoring results have indicated high P in the photic zone during April but a drop in concentration by July.
- loading rate as a result of resuspension in the east sampling location remains inconclusive.

b. Response to Loading

- high chlorophyll a (chl-a) values (max in excess of 51 ug l^{-1}).
- two blooms for water year 2010-2011 indicating three possible scenarios: zooplankton grazing during spring, starvation of N (as first bloom is N fuelled) or turnover of lake causing dilution of chl-a (figures 5a and c).
- first chl-a bloom in April is likely related to mixing from high external P and N loads,
- sustained chl-a bloom during high summer appears more related to internal processes (increase of SRP concentrations during summer reflected in the cumulative internal load of figure 5a).

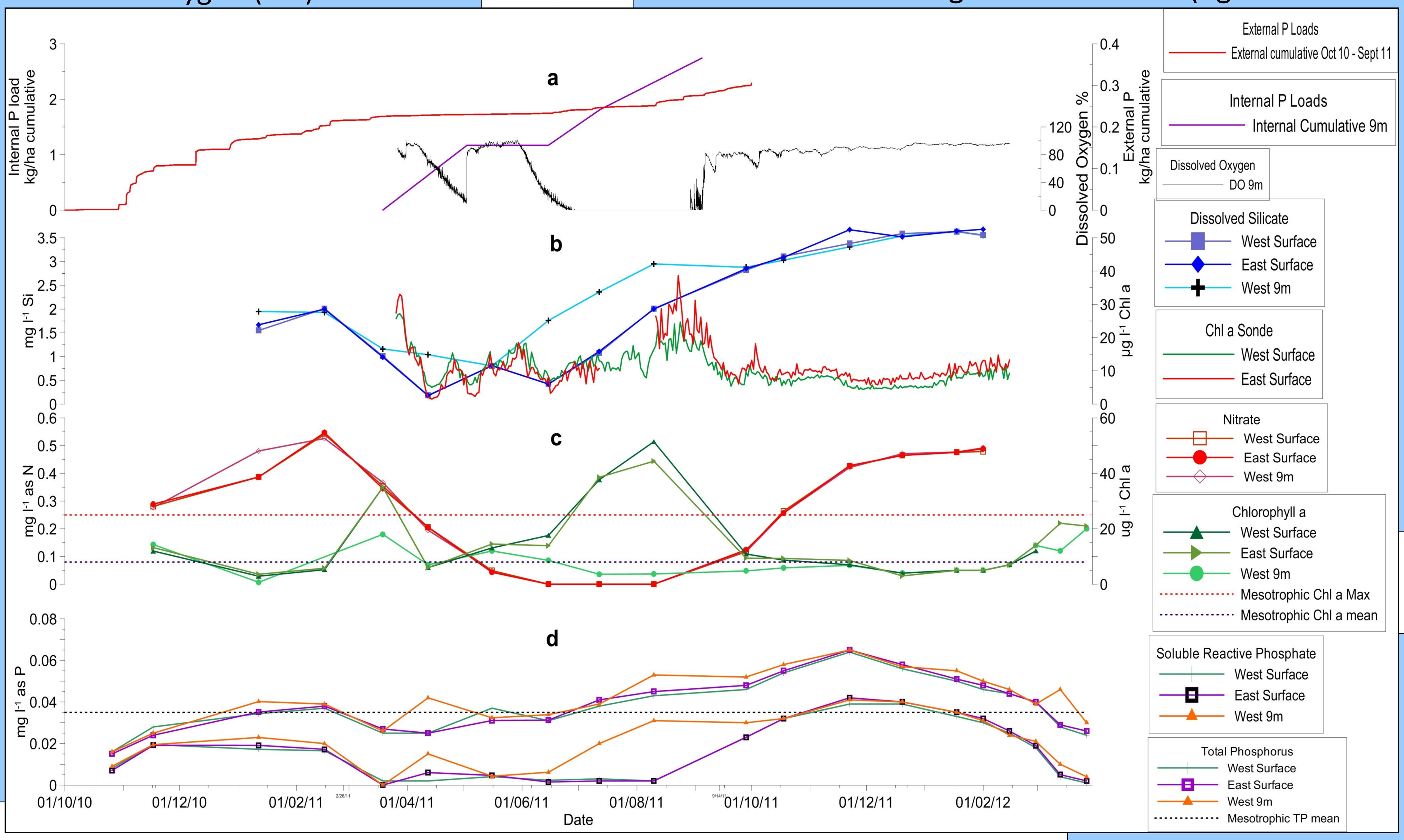

Fig. 5 a - d Preliminary results from Namachree Lough (Oct 2010 – March 2012)

c. Ecological Reflection

- crash of dissolved silicate concentration in figure 5b during the spring bloom indicates diatom presence.
- conversely summer bloom, little decrease in silicate concentration – not diatom abundant.
- In addition, summer bloom has resulted in little reservoir of P or N in the lake.
- Redfield Ratio of 30:1 in favour of N during spring to a low of 3:1 in early summer and finally to a complete absence of N and P during the height of the summer bloom in surface waters.

d. High Frequency Monitoring

- midnight values of chl-a (figure 5b) show a response that was missed during the manual sampling regime.
- late Sept 2011, chl-a peak as a result of warm dry weather occurred before the monthly occasion of sampling. As a result, the data from the chl-a sensor proved important in analysing the response of phytoplankton and algae to loading events (lake turnover early Sept 2011).

4. FUTURE WORK

Namachree Lough is susceptible to eutrophication during the spring and summer from a combination of external and internal P loads, respectively. Using this information of the source of P in the lake, P dynamics within the lake, abstraction rates and flow measurements of the tributaries to the lake a water balance and overall P load apportionment will be produced for Namachree. This will provide the basis to determine the rate of recovery of the lake (and contextualised with similar lakes such as Ozkundakci, D., et al. (2011)) from eutrophication and the significance of this in relation to the targets set by the Water Framework Directive.

5. ACKNOWLEDGEMENTS

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