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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Hydro-climatological non-stationarity shifts patterns of nutrient delivery to an estuarine system" *by* A. L. Ruibal-Conti et al.

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The authors would like to thank the reviewer for the constructive comments and suggestions made regarding our manuscript.

In response to suggestions by the reviewer, the authors will re-organise the manuscript and will enrich the discussion of results to more clearly relate findings with the overall aim and to clarify the issues raised by the reviewer.

A more detailed response to each comment within the review is given below.

1.1 This paper attempts to understand the factors that govern long term changes in nutrient delivery from 3 subcatchments in WA. Unfortunately this paper, while present-

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ing some interesting analyses requires a re-write to enable the reader to fully understand the implications of the findings. There were a lot of correlations and associations between rainfall, streamflow and anthropogenic factors presented but these were not clearly related to the overall objective of the work. In summary, the paper has presented some interesting analysis/results that should be presented more clearly in another draft. Perhaps a number of papers might be better than trying to cram all the data into this one.

We acknowledge the amount of information presented in the paper was substantial and requires a stronger organization of the ideas to convey a clearer message to the reader. This concern will be addressed by restructuring the paper to better frame the problem and to highlight new insights gained from the analysis. In particular these changes aim to: 1) simplify the paper by placing less emphasis on the information that, though important to describe the context, is not strictly linked to the objectives of the paper. 2) Improvement of relationships to better describe the effect of climate and land use conditions on nutrient delivery. 3) provide more refined explanations to clearly link the results with the overall objective of the work; and 4) Elimination of figures that present redundant information (e.g. land-use maps).

1.2 I'm unconvinced that the relationship between non-stationary hydroclimatological shifts and nutrient delivery was well described or explored in this paper.

The authors acknowledge that the term non-stationarity as used in the title may bring confusion to the reader. Although the study period of this research has been described as non-stationary by other authors (cited within the paper), the idea of the paper is not to compare effect of stationarity and non-stationarity on nutrient delivery (as the title may imply). The authors will alter the title of the paper to better reflect the specific focus of the study: "Effect of a drying climate trend on the export rate and ratio of total and dissolved nutrients".

1.3 The mechanisms for the different relationships were not clearly identified – partic-

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ularly the relationship with change in population growth (for example).

The mechanisms behind this relationship will be further explored and discussed as highlighted in our response also to Reviewer 1.

A possible explanation is that The Peel has previously had a relatively small population and the increase in population has more recently been in “green-fields” developments where farming land and some remnant vegetation has been converted to residential use. Small developments are generally characterised by limited land disturbance but as the demand for more housing has increased, very large scale development has taken place with land disturbance and reforming of land being economically viable. The proportionally large increase in soil disturbance has resulted in mineralisation of nutrients from residues of predominantly permanent pastures that have built up nutrients and have not been disturbed for decades. Rather than the activities of people coming into the catchment being the dominant reason for increased inputs of nutrients, the relatively higher impact of soil disturbance has much greater effect. The soil reserves of nutrients are many times greater than the annual application rates of nutrients by the population.

1.4 The paper states data from some years was not analysed (e.g. low DIP, years with insufficient data points). It would be good to know which years these were and were they the same years for all the nutrients.

The information about the years will be included

1.5 Some of the suggested relationships might be backed up with simple mass balance calculations. For example pg 11059 lines 20-30. The discussion about reduction in fertilizer – this data should be available and allow testing of the two potential mechanisms.

We agree and will add this data where available and test for this hypothesis.

1.6 In addition (particularly) in this section, results of modelling scenarios are used as evidence. The results of a model will be based on the assumptions going into the

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model – are these correct? And does this paper suggest anything about the model assumptions?

Modelling exercises were done for two periods: a) 1990-2004 (Zammit et al 2006), b)1997-2007 (Kelsey et al 2011). There are differences between the results of each of the models and between the model results and our results in terms of the magnitude of the load. Indeed some error is contained in these estimates but the mechanisms for these differences are known and due to: a) different methodology for nutrient load quantification b) assumptions made on seasonality of the river flow. However, the three pieces of work together indicate a reduction in nutrient loads due to a drier climate. For predictions for the rest of the century, when the modelling exercise sets a scenario of no climate change and land use change equivalent to the current rate, the results of the modelling and this paper are coincident: an increase in nutrient load will occur.

1.7 Other minor edits include:

1.7.1 tyr-1 should be t yr-1

This will be amended

1.7.2 Don't present changes in landuse as an #fold increase or decrease- this is meaningless.

We acknowledge this issue and this will be modified.

1.7.3 Also present this data in a consistent manner – for example mining increase was presented as 100 fold increase in one section but then as 6% of land for ag and mining later (line 15, pg11059).

This will be amended

1.7.4 Explain the different indices – SIO, IPO, etc why are they different and why would correlations be expected.

The different indices have been widely used by climatologists to capture different

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modes of variability in the climate of this region. They primarily relate to hydrology as the all are a measure of sea surface temperature variability in the coast to the west and south of the catchment being studied, and generally sea surface temperature links to rainfall potential.

1.7.5 Last line pg11051 – Water and mining: I think this should be water storage.

The word water has been used according to the Australian land-use and management classification version 6.

1.7.6 Line 16 pg 11054 coast should be coastal Line 9 pg 11050

Will be amended

1.7.7 target load? What target? Water quality objective?

Agree, this must be better explained - In 1992 several water quality targets were set (mostly related to P) and outlined in a statutory Environmental Protection Policy (EPP) (EPA 1992). The EPP requires all government and private activities in the catchment to contribute to reaching these targets. The environmental quality objective to be achieved and maintained is an annual median load of P flowing into the estuary of less than 75 tonnes. Additionally, each sub-catchment has its own load target.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 11035, 2013.