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Interactive comment on “Groundwater nitrate concentration evolution under climate change and agricultural adaptation scenarios: Prince Edward Island, Canada” by D. Paradis et al.

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General remarks This is an important and detailed study, it is an ambitious and novel attempt using a series of models, but such a large detailed study requires more statistical analysis and a well-written manuscript from an experienced lead author, or more help from co-authors to pull it together. However with more data comparison and statistical analysis, plus a more concise, clear, critical manuscript, it could become a very good paper. The paper addresses relevant scientific questions within the scope of ESD, and the description is sufficiently complete to allow reproduction by fellow scientists. The article is clearly focussed, with the background and problem clearly described. A great

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deal of good quality work has been done. The majority of figures and tables are appropriate, but Figure 3b does not exist and there is another Figure 2c which has not been mentioned. It is odd that the co-authors have not picked this up, have they read the paper?. There is so much detail, this study needs to be written up far more concisely, retaining sufficient detail. 14 pages of method is too long and some sentences are just confusing. It needs clarity whether the modelled output was taken from previous studies or models applied by the authors. It uses old data (1996 crop yields for example) and old GCMs, samples of these need to be compared against more recent data to test if still valid. Confidence in the use of older scenarios and older data should be verified if possible by quoting studies that show there is little change in later updated information. In the case of scenarios there are comparison studies. The assumption of crop yield data based on a different GCM to the ones used needs comparison of the GCMs used with CGCM1-A. Assumptions involved with applying crop yields from Ontario to PEI, such as comparison of soil types, varieties and technology, to fertilizer recommendations should be included. A mathematical mean of 10 stochastic climate data is a wrong assumption for precipitation.. Technical terms should be explained on first use. There are a lot more references than needed, created by long lists in the introduction, suggest two or three key papers as examples instead. Specific remarks

• The series of models all need statistical validation independently: GCM simulated historic scenarios from CGCM2 and HadCM3 vs observed historic, plus separate validation of HELP, RSN, and FEFLOW simulations against observed data. Instead of graphing a lot of simulated-observed data, a more correct and concise way is to display statistical results for comparison. A very good guide is Smith P. et al. (1997) in *Geoderma*, 81, 153-225, also see L.Wu et al. (2015) *Science of the Total Environment*, 530-531, 76-86, Table 6 for the use of this in a concise Table. Try to be consistent, tabulating all models and with the same statistical indicators for comparison of weakest link in your chain of processes, which should be part of your critical assessment of the process at the end. • Results relating to different IPCC scenarios A2 and B2 should be reported separately, not averaged (p.1364, line 3-5). The scenarios are distinct and

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different situations. – The average of 10 stochastic climate simulations (p.1351, line 12-13). A mathematical mean of 10 precipitation datasets would eradicate zero rain days, and so be in error. Explain how you deal with precipitation. – Figure 3b does not exist (p.1346, line 9). – No mention of Fig. 2c: conceptualization of N transport in aquifer. – Introduction: the initial summary is good leading the reader to expect further description in that order, but confuses when the following sections do not match. Initial: GCM, downscaling, RSN, HELP, FEFLOW. Sections: downscaling, HELP, RSN, FELOW. Re-arrange to match order. Strive for consistency in a paper. – Suggest adding an extra section for discussion, including the relative uncertainty of each model used, the area of most uncertainty, and listing all the assumptions made. Comment on the fact that uncertainty or error increases, the more models you use. No comparisons with any other studies' results have been made. Compare results from other studies on each individual model, and any previous groundwater nitrate modelling results for PEI or a nearby region. – Compare results from other studies here. – Enlist co-authors to help re-write more concise. There is a lot of repetition, eg. p.1363, line 5; p.1358, line 26; p.1350, line 17-21. – This many references are not needed and they are increased unnecessarily by long lists (P.1343, line 6-10), use 3 key references as examples of your statement. – Give a reference for the statement of doubling of CO₂ by 2050 (P.1365, line 21). – Explain technical terms the first time they are mentioned, examples are the term red beds and fining (p.1345), nodes (p.1357, line 26), anisotropy (p.1359, line 22). – Describe the 6 soil classes on PEI (p.1352, line 6). – Define the term N load, is it the agricultural input to RSN or the output of RSN (p.1357, line 9)? – Figure 6c. caption error : “. . .bars span the observed concentration interval”, Fig.6c shows bars spanning simulation concentration. – P.1364, line section 4.,3 residual soil nitrogen: is this annual, should the units be in kg N / ha / year?

Interactive comment on Earth Syst. Dynam. Discuss., 6, 1339, 2015.

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