

Interactive
Comment

***Interactive comment on* “Linking an economic model for European agriculture with a mechanistic model to estimate nitrogen losses from cropland soil in Europe” by A. Leip et al.**

Anonymous Referee #2

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This work is an ambitious study which attempts to develop the framework for a tool for determining the socio-economic linkages with environmental assessment over a very large region. The authors provide detailed technical aspects involved in allocating and disaggregating much of the data necessary for both the economic and environmental assessment portions of the model, however, weather variability and tillage intensity are important activity data that could be useful to the assessment. Greenhouses gas emissions are known to be highly variable from year to year depending on regional change in weather patterns. The grammar in the manuscript needs to be cleaned up, the paper should be shortened where possible, and the introduction does not provide a clear and concise background and objectives for the paper. As well the paper should

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place a more focus on the appropriateness of using DNDC versus another mechanistic model for this study. The manuscript shows promise but requires substantial work. I've included below several comments and specific changes which should be addressed.

Specific comments:

1. The use of “agricultural soils” in the title will better accommodate livestock coverage in the study than “cropland soils”
2. The abstract suggests broader coverage in terms of outputs to include GHGs and carbon fluxes whereas the title restricts coverage to N-fluxes. Some reconciliation is needed.
3. In places it can be difficult to understand the intention of the authors. More proof reading is required. Also, attempts should be made to shorten the document, perhaps in some of the methods and results sections.
4. The author states they used statistical production data for yields as inputs values for the potential yields in DNDC. Would this not underestimate the maximum potential yield achievable for DNDC if it was based on average measured yield data?
5. One climate year does not encapsulate the climate variability necessary for estimating N₂O emissions. (100 year spin up with one climate file + 30 year of climate data would be a better approach). Tillage intensity is also of importance whereby the authors should compare emissions from intensive, minimum and no-till agriculture. This is of importance within the economic model.
6. Based on your methodology I assume a small amount of manure is applied across all land area. I realize that it is not possible to place manure on land where it is actually applied, however, a better strategy may be to apply manure at maximum recommended rates on some crops until all is applied then apply fertilizer to the rest of the land. Soil C change and GHG emissions results may not be as seriously compromised if this methodology was employed.

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7. In a quality control process the work would be strengthened if more comparison could be made between measurements and DNDC output within the study region.

8. In section 2.2 where spatial mapping units are defined, a fourth database, presumably a database of administrative units should be enumerated for completeness.

9. Section 2.4.4: Number and timing of fertilizer and tillage applications were taken from defaults in DNDC farm libraries. This would seem to have a significant impact on the estimate of N₂O. These values should be replaced with actual agricultural activity data from specific regions, where available.

10. In section 2.6.1 it is mentioned that with the default version of the DNDC model, the farm library is constant at provincial level. However, it is not made explicit how the province relates to either NUTS2/3 or the HSMUs. A flowchart for the linkages for the data down to the HMSU's would be helpful.

11. It will help to predefine all acronyms before they are used in a stand alone form in the rest of the text.

Technical comments (Authors need to carefully proof read the document):

Page 2216, line 6: replace “model DNDC” with “Denitrification-Decomposition (DNDC) model”

Page 2216, line 8: change to “impacts on a wide range of”

Page 2216, line 12: change to “consists of four steps”

Page 2216; line 22: change “uses” to “use”

Page 2217 lines 3-4: replace “- setting” with “that sets” and replace 2nd dash with a comma

Page 2217 line 11: remove “for example”

Page 2217 lines 12-13: suggested change “ranging from the differentiation of regional

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conditions to the accommodation of the effects of proposed mitigation measures.”

Page 2217 line 16: change “to (i)” to “(i) to” to be consistent with the other 3 points

Page 2217 lines 18-19: sentence is awkward “for example” is not needed and what does “in the frame of GHG inventories” mean?

Page 2217 lines 20-21 replace “they are able to cope with Ě” with “they are able to model the complex interactions between the environment and anthropogenic activities.” Cope may not be an appropriate word for describing a model.

Page 2217, lines 22-27: The sentences are a bit awkward. I would consider rewriting to something like this, if the meaning is still relevant: “The main obstacle of using process-based models as tools for policy impact assessment of agricultural, from the regional to national scale, is the difficulty in matching agricultural activities with environmental circumstances (references). The accuracy of simulating fluxes with process-based models, such as the DNDC (Denitrification Decomposition) model, is largely dependent on the quality of input data. DNDC has been shown to be especially sensitive to soil organic matter (SOM) content and nitrogen fertilizer application rates.”

Page 2218, line 4: define NUTS

Page 2218, line 10: replace “possibly” with “possible”

Page 2218, line 13: “However” can be removed. Starting a paragraph with “however” is not a good idea anyhow

Page 2218, line 27: change to “There are only a few examplesĚ”

Page 2218, line 22: “Examples of policy-related”

Page 2218, lines 23-24: But at a much lower scale than what? This project?

Page 2218, line 25 change to “(e. g., Grant et al., 2004). Examples of studies”

Page 2219, lines 1-3: Suggested change/corrections: “This paper focuses on the

methodology developed to link the large-scale regionalised economic model CAPRI to the DNDC biophysical model in order to develop a new policy impact simulation tool.”

Page 2219, lines 8-9: Suggested change/corrections: “trade-off between the different pillars of sustainability of such policies is inherently built into the policy tool”

Page 2219, line 11: replace “but also” with “as well as”

Page 2219, line 13: “important” is not required

Page 2219, line 17: The first sentence in the methodology should instead provide a range of what the DNDC model can predict. The opening sentence is a bit awkward.

Page 2219, lines 18-19” suggested change: “DNDC was developed in 1992 and since then has been subjected to several improvements”

Page 2219, line 21: change to “It consists of two components. The first component calculates the state”

Page 2220, lines 6-7: suggested change: “DNDC has been widely used for regional modeling studies in the USA (Tonitto et al., 2007), ChinaĚ.” Page 2220, line 8: remove “e.g.,” before “Brown”

Page 2220, lines 9-10: change to “Our simulations are done using a modified version of DNDC V.89, allowing a more flexible simulation”

Page 2220, line 14: change to “to be simulated within a specific calculation unit.”

Page 2220, lines 21-22: suggested change: “The main purpose of CAPRI is to carry out a Pan-European ex-ante impact assessment” Sentence structure is poor.

Page 2220, line 25: change “and had been applied” to “and has been used”

Page 2220, lines 27-28: Sentence “in the exerciseĚ” is awkward

Page 2221, line 2: “trough” should be “through”

Page 2221, line 3: change “were” to “have been” and change “Additionally” to “Also”

Page 2221, line 6: This sentence can be incorporated into the next paragraph.

Page 2221, line 20: replace “calculation unit, which in the following is also denoted as” with “calculation unit which is denoted as”

Page 2221, line 8: change to “to drive the economic model”

Page 2221, line 10: change to “The environmental database also contains the”

Page 2221, line 25: You state that “The HSMUs are built from four major data sources” then only three databases are provided below.

Page 2222, line 13: change “we can speak from the HSMU as of “pixel cluster.”” to “we can speak of the HSMU as a “pixel cluster.””

Page 2223, line 1: change to “as a function”

Page 2223, line 5: change “maximizing” to “which maximizes”

Page 2223, line 14: change to “allows for a transparent”

Page 2224, line 6: change to “Unlike for crops, there is no common Pan-European data base available with high spatial”

Page 2224, line 10: add (FSS) after Farm Structure Survey

Page 2224, lines 19-20: change “a Member States” to “a Member State”

Page 2224, lines 21-22: Is “livestock unit” used as a common denominator for accounting for all animals? Sentence not clear.

Page 2225:, line 2: change “then” to “than”

Page 2226, line 3: change “deduction” to “reduction”

Page 2226, line 8: change “in the conjunction of input demand” to “in conjunction with

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input demand”

Page 2226, line 19: change “consists in defining” to “consists of defining”

Page 2226, line 21: change to “to a plausible”

Page 2227, line3 2-3: change “which provides as well statistics” to “which also provides statistics”

Page 2227. line 10: please reword because the meaning is not clear

Page 2227, lines 16-28. Does this approach mean that some manure is being applied to all land units? It is more likely that manure is applied to only specific land areas. This type of generalized application may result in much different soil C dynamics than is actually occurring. What are the constituents of the applied manure?

Page 2228, line 3: “case” should read “cases”

Page 2228, line 8: suggest; “Scheduling of tillage and fertilizer applications”

Page 2228, line 10-11: please reword, unclear

Page 2228, line 11: replace actually with actual

Page 2228, lines 14-19: What was the pre-defined setting for irrigation, field capacity? Also, what was the frequency of irrigation events?

Page 2228, 21-23: Considering the highly variable effect that tillage has on GHG emissions it would be a good idea to simulate intensive, minimum and no-tillage systems and apply results back to the percent of each tillage practice in the land area.

Page 2229, line 10: “were” should be “was”

Page 2229, line 11: “originate” should be “originates”

Page 2229, line 10: MARS was not previously defined

Page 2229, lines 10-11: It is a concern that GHG estimates are only being determined

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using one year of weather data. Interannual variation in emissions can be very large, even for a large land mass.

Page 2229, line 15: suggested change; “rasters were processed using pedo-transfer functions”

Page 2229, line 20: “contains under others” is unclear

Page 2230, line 1: replace “has been” with “was”

Page 2230, line 10: “was done according to”

Page 2230, lines 20-21” suggested change “However, the practicality of this is compromised by the high number of units and scenarios and more so when a multi-year simulation is carried out..”

Page 2230, line 25: suggested change “can better fit the objectives of the study”

Page 2231, line 2: change to “in order to enable the assessment of the impact”

Page 2231, line 5: “were included in the model”

Page 2231, line 10: remove “however”

Page 2231, line 10: remove “the”

Page 2231, line 12: “values differed by less”

Page 2231, lines 15-16: change to “region, which translates into 11,438”

Page 2231, line 17: suggest; “Each of the simulations ran for over 99 years to smooth out unrealistic estimates of topsoil organic carbon in the original map.”

Page 2232, lines 9-10” suggested; “minimum area of 1 km² to some very large areas”

Page 2232, lines 14-15: suggested; “In total, 206,000 HSMUs covering almost 4.3 million km² in Europe were used.”

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Page 2232, line 24: suggested; “relationship between topography and UAAR.”

Page 2233, line 9: replace “surface area has less or equal than 5% ” with “surface area has 5% or less”

Page 2233, lines 12-13: change to “found in Europe as a result of differences”

Page 2234, line 12: refer to previous statements regarding manure

Page 2233, line 16-17: change to “are found featuring both ruminants and non-ruminants, and with fattening”

Page 2233, line 18: change “were” to “where”

Page 2233, line 19: change to “where, over time, large-scale arable farming under favorite conditions has developed.”

Page 2233, line 22-24: change to “products through the fattening processes. Here, stocking densities are often in average ranges, but have declined over time in areas where part-time farming is prevalent.”

Page 2233, line 2: “account for semi-natural”

Page 2234, line 10: “renders it somewhat”

Page 2234, line 25: change to “subdivided into a minimum of 2 and a maximum of 10 NUTSIII regions.”

Page 2234, line 28: “comparison, the distribution results at HSMU”

Page 2235, line 5: “obtain” should be “obtained”

Page 2235, line 6: “data at NUTS III”

Page 2235, lines 8-9”: “between 2 and 35%.”

Page 2235, line 15: “might not be appropriate”

Page 2236, lines 7-9: I am not sure what this sentence means, but it definitely needs rephrasing

Page 2236, line 10: “regions are very”

Page 2237, line 1: “over a range”

Page 2237, line 1: “class for? rice”

Page 2237, lines 14-15: suggest; “the stocking density is between -0.46 or +0.43 live-stock units per hectare.”

Page 2237, line 23: “of the estimator is more peaked as can be seen also from the distribution”

Page 2238, line 18: “countries like France”

Page 2239, line 3-4: suggest; “simulated nitrogen uptake is approximately equal to the total input of nitrogen by fertilizer application, nitrogen fixation and nitrogen deposition Ě” Also, what about manure N?

Page 2239, line 8-9: change “only a half” to “only half” Page 2239 line 15: change “crop residuals were left” to “crop residues were left”

Page 2240 line 12: “studied by applying”

Page 2240, line 26: suggest; “On the other hand, 15%”

Page 2241, line 102: suggest; “more than 50% of the initial value occurred only for maize in ca.” Also, what does ca represent?

Page 2241, lines 7-9: suggest; “Ěmodeling units, in a similar manner to what we had seen for carbon stocks. While initial N₂O fluxes were 17 kg N-N₂O ha⁻¹ y⁻¹, they were reduced after the 100yr simulation to” Note that this section could be condensed to a couple of sentences.

Page 2241, line 15-16: suggest; “Ěconditions), but declined quickly thereafter, dimin-

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ishing..”

Page 2241, lines 26-27: suggest; “we restrict the presentation of the simulated nitrogen budget to the national scale.”

Page 2242, line 3-4: “export by plant material either through plant products or crop residues as opposed to the input of nitrogen via nitrogen application, deposition, fixation, and release of nitrogen through” Is the meaning lost with these changes?

Page 2242, line 9-10: Suggest; “difference between nitrogen inputs and outputs”

Page 2242, line 19: “DNDC recognises different”

Page 2242, line 20: “very labile (C/N=5) through labile”

Page 2242, line 27: “simulation year, gave results ranging between 26%”

Page 2243, line 5: “for example worked on predicting”

Page 2243, line 7: “grid; while Kesik et al”

Page 2243, line 10: “grasslands, but due to”

Page 2243, lines 11-12: “are efficient for fast responses to possible developments or for delivering”

Page 2243, line 21: “probability to capture the true value.”

Page 2243, line 26: “within a single modeling unit.”

Page 2244, line 20: define or cite reference for HRU/ISU

Page 2245, line 8: “in the near future.” I assume you mean near.

Page 2245, line 19: “units are an integral part”

Page 2245, line 21: “environmental policy impact assessment”

Page 2245, line 27: “pattern is 20,731 km²”

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Page 2246, line 2: “accounting for 45%”

Page 2246, lines 5-6: “crops and cereals in Spain account for 35%”

Page 2246, lines 9-10: “beside lacking thematic”

Page 2246, lines 19-20: “with shares of up to 75%”

Page 2247, line 2: “9 Mio ha of grassland”

Page 2249, line 9: “impact on the fate”

Page 2250, line 6: “farmers and what”

Page 2250, lines 8-10: (ii) highest emissions occur on high-productivity sites, expressed relative to the cultivated area or production unit.

Page 2250, line 21: “with a defined”

Page 2250, line 23 “information on land use”

Page 2250, line 25-26: you state “from the land use that had defined the soil Characteristics” I don’t think land use defines soil characteristics. Shouldn’t it be the other way around?

Page 2251, line 6: “It will therefore be of highest”

Page 2251, lines 23-24: “gas emission coefficients”

Page 2252, line 18: “is built into the model design”

Page 2252, line 27: “as need from improvements”

Page 2253, line 8: “simulation also with” or remove the “a” before posterior

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