

Interactive comment on “Localising the nitrogen imprint of the Paris food supply: the potential of organic farming and changes in human diet” by G. Billen et al.

G. Billen et al.

gilles.billen@upmc.fr

Received and published: 13 January 2012

We sincerely thank referee 1 for his careful reading of our paper and the useful comments he made. We answer these comments below.

* Abstract, line 3 ff: Sentence starting “Nowadays. . .” too long, should be revised. English of the manuscript is generally very good, however, occasionally a sentence appears to be too long or interlaced.

Answer: The sentence has been shortened and made clearer: “Nowadays, the shift from manure-based to synthetic nitrogen fertilisation, have made possible a strong land specialisation of agriculture in the Seine watershed: it still provides most of the cereal

C5296

consumed by the Paris agglomeration, but exports 80% of its huge cereal production”.

* Abstract; p10981/11. Use of term (carbon) ‘imprint’ . . . why don’t you use the more established term footprint?

Answer: The term footprint, in particular in Nitrogen footprint, has a very specific meaning, referring to the standard indicator developed by Leach et al (Environmental Development, in press). This indicator is based on a complete account of the Nr introduction to the biosphere caused by the activities of an individual, or a city, or a country. We prefer here to keep using the term imprint for referring to the influence of a given activity on the nitrogen cycle in a more general way.

* Introduction, line 20 [and other locations]: ‘orientation’ . . . specialisation?

Answer: We replaced the phrase ‘orientation of agricultural development’ by ‘agricultural development’

*p10981/21. There must be weblinks/references accompanying these groups, otherwise it will be impossible for the reader to check or inform himself.

Answer: Weblinks were added for each cited organisations as well as the following reference, which presents a comprehensive analysis of the diversity of existing community-supported agriculture systems: Watts D.C.H., Ilbery B., Maye D. (2005) Making reconnections in agro-food geography: Alternative systems of food provision. Progress in Human Geography, 29: 22-40.

*p10982/2. Please check sentence “extend . . . a very long distance”

Answer: The sentence has been cut and made cleared: “Some large cities, such as New York in the US, made the choice of reserving certain nearby lands for clean drinking water production, excluding agricultural activities (Swaney et al., 2011). Others, such as Athens in Greece (Stergiouli et al. 2011) and Barcelona in Spain (Tello et al., 2011) extend their water supply areas over a very long distance, annexing the water resources of other watersheds.”

C5297

*p10982/13. It will be interesting also to distinguish between per capita intake and per capita consumption (including all wastes between delivery and intake). You should introduce the terminology as early as possible in the manuscript.

Answer: This distinction is very useful indeed. We added a sentence and the reference to the work of Gustavson et al., 2011 as follows: “. . . : its per capita N consumption rose from 5.4 to 8.0 kgN/cap/yr, and the share of animal products in the diet increased from 39 to 69% of total protein consumption. Part of the consumption increase is due to higher intake, while another part is the result of higher waste generation all along the food chain (currently estimated to about 30% of the total in Europe, Gustavsson et al., 2011).”

*p10983/11. Add comma before weblink OK

*Figure 1. The range in soybean input does not correspond to any range in the outputs of the animal-producing agland, but the upper limit is used (total output of Agland kg N/cap/yr. Please indicate which of the output fluxes are associated with uncertainty thus that the import of soybean cannot be constrained. What is the reason of the uncertainty for soybean imports: are the statistics not given good quality on feed concentrates purchases?

Answer: As explained in Billen et al. (Reg. Env. Ch. 2011) the range of soybean inputs results from the use of two different approaches for estimating the soybean imports: one based on the analysis of transport statistics, the other based on livestock ration prescriptions. Indeed, the former, upper estimate was used for the estimation of the output fluxes, because we are more confident in the data from trade and transport statistics than on theoretical ration prescriptions. We therefore redraw Fig. 1 deleting the lower estimate.

*Figure 1. The text suggests that 80% of the cereal-producing region is being “exported”. This is not indicated in the figure. Instead an export of 10.6 kg N/cap is indicated from the animal-producing area. Is this to show the balance with the soy-

C5298

imports? If so, I would suggest to also indicating the exports from the other region – or better restrict to numbers with reference of one Parisian inhabitant. Furthermore, if the 10.6 kg N/cap are exported they do not contribute to the protein consumption of inhabitants in Paris, and in the text the required area/cap of 0.054 ha instead of the used 0.2 ha/cap should be quoted (p10985/5). If on the other hand the ‘export’ of 10.6 kg N/cap in reality is the protein contained in crop products used to feed the animals, then please chose another term than ‘export’ which is confusing in the figure; also the arrow should not point out of the box, because in fact this nitrogen is recycled.

Answer: For clarity and consistency with the reasoning of the paper, we have changed Fig. 1 and expressed the supply areas in terms of total territorial area instead of agricultural area. As explained in Billen et al (Reg. Env. Ch. 2011), the cereal-producing region of the Paris Basin indeed exports 83% of its production to other regions of France or Europe. Only the area of this region contributing to Paris vegetal protein supply is taken into account in the estimate of 0.05 ha/capita. This area however does only produce 0.1 kgN/inhab/yr animal proteins. The rest of the meat and milk requirement of the Parisian (4.5 kgN/ha/yr) is supplied by 0.33 ha of the livestock breeding region. Part of the vegetal protein production of this region is not used for local livestock feeding and is exported elsewhere. This does not contribute to feeding Paris. The fact that this surplus crop production is available for feeding other regions, does not reduce the area required to supply Paris with animal proteins. The text reads now: “From these data, the environmental imprint of the Paris food supply can be approximately represented in terms of (i) the land area required and (ii) per capita nitrogen fluxes involved, exactly as is currently done for wastewater domestic effluents (Figure 1). To satisfy the needs in vegetal products of one Paris inhabitant, only 0.05ha of the territory of the Seine watershed is required, but 0.33 ha of territory in polyculture–animal farming areas such as those of Brittany, Normandy and Nord-Pas-de-Calais are required to satisfy the needs in meat and milk of the same person (although some surplus crop production in this area is available to supply other regions); in addition, an area of about 0.12 ha in South America is required to supplement the feed of the live-

C5299

stock in the latter region. This indicates that by far the largest territorial area required to feed Paris is for producing animal products. This is not surprising as for the whole of Europe, 83% of crop production is destined to feeding livestock (Sutton et al., ENA 2011) “

*p10985/19. This means that 92% of the area used for food production to feed Paris is for animal products; considering also SA imports, 94% of the area required is for food production. How does this compare with other estimates?

Answer: This is right with the caveat discussed above. For the whole of Europe, 83% of crop production is for feeding livestock (Sutton et al., ENA 2011)

*Figure 1. Inhabitant: inputs=8.0, outputs=7.3, pie diagram=7.7. Why these differences? crop fluxes. input=3.9; output=4.8. why these difference? Is this figure with the (better) figure 3 consistent???

Answer: The differences are coming from rounding the figures to the nearest tenth. It has been corrected on the new version of Fig 1. On the other hand, the figure of 1.9 kgN/cap/yr indicated for solid food waste production was wrong. It should be 2.5 according to the estimates of 30% made by Gustavsson et al., 2011. Yes Fig. 1 is now consistent with Fig 3a.

*p10985/18. Is this dilution calculated for agland surface area of for total surface area? What is the share of agland in the regions considered?

Answer: The surplus estimates and the concentration calculations concern arable land only, as stated in the text. As indicated in Fig 3, arable land area represents roughly 47% of the total territory.

*p10986/20. It were clearer if the equation would be formatted 'as equation' rather than built-in into the text. OK

*p10986/26ff. Sentence unclear. Do you mean '70% of temporary grassland is used for nitrogen-fixing crops? Please revise sentence.

C5300

Answer: We revised the sentence as follows: “The size of the nitrogen-fixing arable land (temporary grassland involved in crop succession and legume fodder crops) is adjusted so as to meet the feed requirements of livestock with (i) the production of the permanent grassland, (ii) 70% of the production of nitrogen-fixing crops (30% is considered to be used as green manure, thus not available for livestock feeding) and (iii) an adjustable fraction of the production of non-legume crops. The total fertilisation of arable land can thus be calculated as well as the yield and the nitrogen surplus of arable land. The theoretical sub-root nitrate concentration below arable land is evaluated by dividing the surplus by the infiltrated water depth.”

*Table 1. This table is very well constructed, very transparent and hugely informative!

Answer: Thank you!

*Figure 3a. What is the balance for the non-fixing crops? Total input=9905 kg N km⁻² yr⁻¹, total output=10445 kg N? Same difference also for scenario b); smaller but still existent difference in scenario c). Scenario c: 765 instead of 770 kg N vegetable products to population? This would close balances and give the same total protein intake of 1285 kg N as in the other scenarios. Please add unit to figure-caption. Would it not be more direct for the reader if the numbers were in absolute values (kt N) instead of relative (kg N km⁻² yr⁻¹)?

Answer: The apparent unbalances are because atmospheric deposition, although taken into account in the calculations, were not shown in the figure. A new figure 3 is provided, with atmospheric deposition shown and corrected figures. We prefer to keep using area specific values, for the sake of comparison with other basins: as stated by referee 2, our paper aims to “provide the basis for similar calculations to be completed for other regions”. The intensity of agricultural fluxes are more directly perceived when expressed per km² than in absolute values depending on the territorial area considered.

*p10987/10. The text cites a total population in the Paris agglomeration of 4 million

C5301

inhabitants. Table 1 indicates an area of 92381 km² and a population density of 183 cap km⁻². This would give almost 17 mio inhabitants. Please clarify.

Answer: The phrasing was indeed misleading. Paris counts 11.5 mio inhab. We rephrased as: "...to conceive a scenario of organic farming locally meeting the quantitative food requirements of the current population of the Paris agglomeration and of the other cities of the Seine watershed, totalling 16.9 million inhabitants,..."

*Figure 6. Same comment as for Figure 1 with respect to 'export'.

Answer: Same answer.

*Figure 5. This seems not to be referred to in the text??

Answer: Yes it is ! 10988/5.

*p10991.3ff. I am not sure if the comparison with the report from Westhoek et al. (2011) holds. Leip et al. (2011) have shown that there is a strong correlation between imported animal feed and N-surplus in European countries. Thus already the effect of reducing imports of protein-rich feedstuff will have a reduction of N-inputs to the hydrosphere as a consequence. Furthermore, IMAGE simulates a reduced meat-consumption in an economic framework, while economic aspects are ignored in the current analysis. Nevertheless, the restriction of import of animal feed will undoubtedly have global effects as well. The discussion of Westhoek et al. (2011) is well placed in the last paragraph, but the comparison should be done a little bit more carefully.

Answer: The correlation shown by Leip et al. (2011) between import of feed and surplus is not a direct one, but results from the fact that most European intensive livestock farming depends on feed import. Substituting imported feed by locally produced legume fodder would not per se reduce the surplus. We agree however that our analysis does not take into account neither economical aspects of the question, nor the global effects of localisation. We thus rephrased the last sentence as follows: "Our purely biogeochemical approach differs from this one not only because we are not tak-

C5302

ing into account any economic mechanisms, but also because we first constrained the local agricultural system to self-sufficiency for feed and for meat and milk products. This additional constraint explains the strong local response of the system to decreasing the animal protein consumption observed in our scenario, in particular in terms of water quality. It therefore appears that localising as far as possible the major fluxes of food and feed supply at the regional scale is a pre-requisite to get full environmental benefits from a change to lower animal products in the human diet."

Interactive comment on Biogeosciences Discuss., 8, 10979, 2011.

C5303

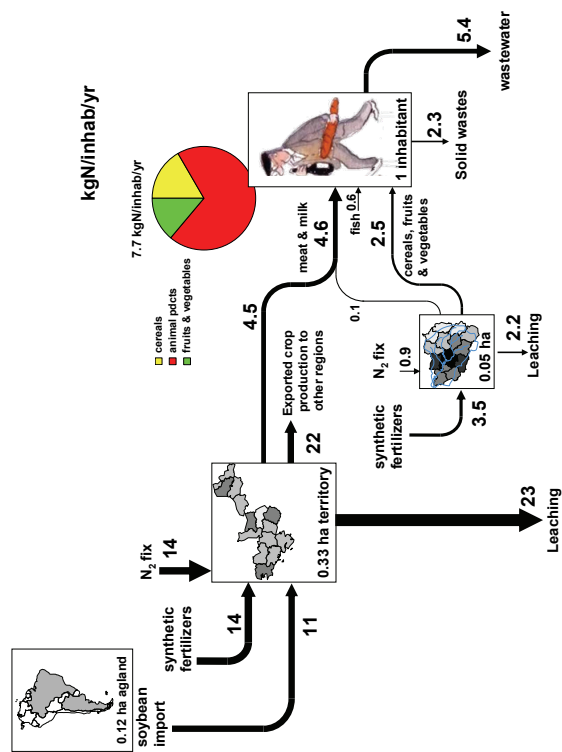


Fig. 1. Figure 1 revised. Schematic representation of the nitrogen imprint of the food supply of one Paris inhabitant. Nitrogen fluxes involved are expressed in kgN/inhab/yr. The figures are derived f

C5304

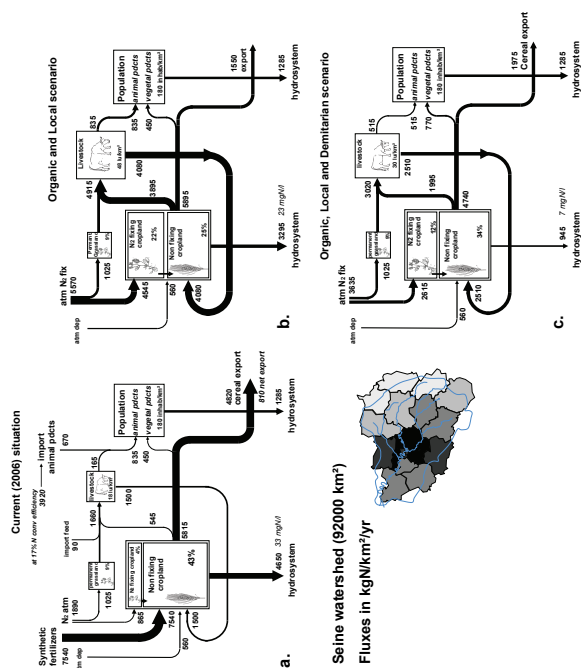


Fig. 2. Figure 3 revised. Nitrogen fluxes in the agricultural system of the Seine watershed (Fluxes expressed in kgN per km² of watershed area and per year). a. Current situation (2006). b. Organic an

C5305

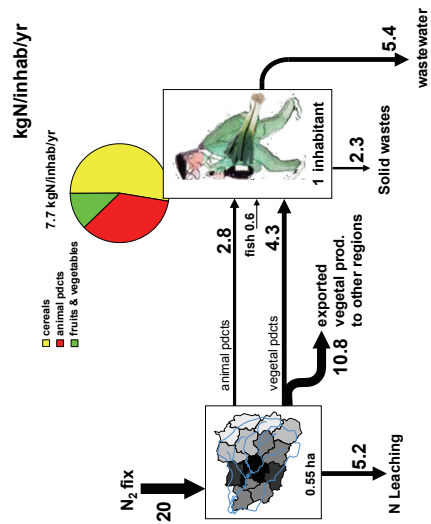


Fig. 3. Figure 6 revised. Schematic representation of the nitrogen imprint of the food supply of one Paris inhabitant in the organic-local-demitarian scenario. The nitrogen fluxes involved are expressed