**Notes on NAPI Calculator Toolbox Version 3.1.0**

Dennis P. Swaney and Bongghi Hong

July, 2017

As in previous versions, NAPI Calculator Toolbox (version 3.1.0) estimates NAPI (net anthropogenic phosphorus input) using county-level information to allow area-weighted average estimates for the watersheds of the United States. This version toolbox includes all the updates and fixes found in the NANI Calculator Toolbox, including updates of data through the US ag census data of 2012. See the documentation of the NANI toolbox is available at [http://www.eeb.cornell.edu/biogeo/nanc/nani /nani.htm](http://www.eeb.cornell.edu/biogeo/nanc/nani%20/nani.htm) for detail). In addition to the accounting tool (“NAPI\_Accounting\_Tool\_V3.1.0.xlsm”), the toolbox package includes an extraction tool for extracting fertilizer P (“NAPI\_Extraction\_Tool\_V3.1.0\_USGS.xlsm”). All other tools including the GIS tool are the same as the corresponding tools for NANI calculation, and thus are not included in the toolbox package. Any comments or questions should be sent to the authors at [dps1@cornell.edu](mailto:dps1@cornell.edu).

Where appropriate, the calculations for NAPI mirror those for calculating NANI. Unlike nitrogen, phosphorus is not fixed by plants, and we assume that atmospheric deposition of phosphorus is insignificant in most locations, especially compared to other inputs, so it is not included at this time. As a result, NAPI can be calculated as the sum of three components:

• Inputs of phosphorus fertilizer

• Net inputs of phosphorus in food/feed

• Non-food inputs of phosphorus (detergents and other materials)

Phosphorus inputs are obtained, as with nitrogen, from a national dataset (Ruddy et al., 2006). Estimates of phosphorus in net food/feed inputs to the accounting unit (i.e., county) are based on US agricultural census statistics and other databases at the USDA which provide crop areas, crop yield, and livestock statistics (<http://www.agcensus.usda.gov/>), as well as US census data which provide county level human population data (<http://www.census.gov/>). This information, together information on per capita phosphorus demand for humans and livestock, and phosphorus content for major crops (see Tables 1-4 below), following the same accounting scheme that is used for nitrogen:

P in net food and feed input = P in human and animal demands – P in crop and animal production

At present, we account for no regional variation in major crops, and include the same crops for which we calculate N in net food and feed input. We assume an additional per-capita input of phosphorus associated with detergents and other material in the waste stream, following the assumption of Han et al. (2011). See Table 4 below for detail.

For more details on the analogous calculations for nitrogen, see the NANI calculator toolbox documentation.

Table 1. Crop P content (%) in dry matter obtained from Lander et al. (1998). All other crop parameters such as percent distribution for human consumption are the same as those in NANI calculation.

|  |  |
| --- | --- |
| Crop | % P in Dry Matter |
| corn for grain | 0.317 |
| corn for silage | 0.185 |
| wheat | 0.398 |
| oats | 0.369 |
| barley | 0.419 |
| sorghum for grain | 0.352 |
| sorghum for silage | 0.210 |
| potatoes | 0.246 |
| rye | 0.372 |
| alfalfa hay | 0.261 |
| other hay | 0.660 |
| soybeans | 0.659 |
| cropland pasture | 0.551 |
| noncropland pasture | 0.441 |
| rice | 0.33 |
| peanuts | 0.35 |
| cotton | 0.410 |
| tobacco | 0.213 |

Table 2. Livestock P intake and P excretion parameters obtained from Han et al. (2011). All other livestock parameters are the same as those in NANI calculation.

|  |  |  |
| --- | --- | --- |
| Livestock group | P intake (kg-P/head/yr) | P excretion (kg-P/head/yr) |
| fattened cattle | 23.01 | 14.38 |
| milk cows | 25.11 | 19.02 |
| hogs for breeding | 6.72 | 2.98 |
| hogs for slaughter | 3.39 | 1.64 |
| chicken layers | 0.57 | 0.25 |
| breeding turkeys | 1.44 | 1.02 |
| chicken pullets | 0.15 | 0.13 |
| chicken broilers | 0.33 | 0.2 |
| slaughter turkeys | 0.67 | 0.62 |
| beef breeding herd | 32.08 | 20.05 |
| beef calves | 4.02 | 2.58 |
| dairy calves | 3.65 | 1.54 |
| beef heifers | 8.03 | 6.31 |
| dairy heifers | 9.27 | 7.66 |
| beef stockers | 8.03 | 7.02 |
| dairy stockers | 8.03 | 4.17 |
| sheep | 2.2 | 1.45 |
| horses | 11.43 | 6.86 |
| goats | 0.91 | 0.86 |

Table 3. P content (%) in edible portion of livestock products obtained from Han et al. (2011). All other livestock product parameters are the same as those in NANI calculation.

|  |  |
| --- | --- |
| Livestock product | P in edible portion (%) |
| beef | 0.198 |
| veal | 0.211 |
| pork | 0.209 |
| lamb | 0.189 |
| chicken | 0.181 |
| egg | 0.015 |
| broiler | 0.149 |
| turkey | 0.18 |
| milk | 0.091 |

Table 4. Food and non-food use of P by human obtained from Han et al. (2011).

|  |  |
| --- | --- |
| Consumption | Rate (kg-P/capita/yr) |
| P intake in food consumption | 0.6 |
| P in food waste disposal | 0.04 |
| P in detergent\* | 0.62 |
| Total | 1.26 |

\*average of 1987 and 1992 estimates

**References**

Han, H., Bosch, N., Allan, J.D., 2011. Spatial and temporal variation in phosphorus budgets for 24 watersheds in the Lake Erie and Lake Michigan basins. Biogeochemistry 102, 45–58

Lander, C.H., Moffitt, D., Alt, K., 1998. Nutrients available from livestock manure relative to crop growth requirements. Resource assessment and strategic planning working paper 98-1, United States Department of Agriculture, Natural Resources Conservation Service.

Ruddy, B.C., Lorenz, D.L., Mueller, D.K., 2006. County-level estimates of nutrient inputs to the land surface of the conterminous United States,1982−2001; U.S. Geological Survey Scientific Investigations Report 2006−5012; U.S. Geological Survey: Reston, VA; pp 17.