Biogeosciences Discuss., 9, C7196–C7199, 2013
www.biogeosciences-discuss.net/9/C7196/2013/

Biogeosciences Discussions

Interactive comment on "The distribution of soil phosphorus for global biogeochemical modeling" *by* X. Yang et al.

Anonymous Referee #2

Received and published: 11 January 2013

In a changing world where phosphorus (P) is a finite resource, there is a strong need for understanding and predicting the amount of global P for biogeochemical modelling and evaluation of P crisis in future to feed the world.

In general, the manuscript is well written and addresses an important, broad area of research by providing initial estimates of the distribution of different forms of soil phosphorus at the global scale. The authors did a good job of putting different information together and synthesising. The authors tried to make use of the available soil P measurement databases to provide the global map of spatially explicit estimates of different forms of soil P. Therefore the paper is appropriate for inclusion in Biogeosciences upon considering following comments/suggestions.

Although Yang et al. have claimed that results of this study provide the initial estimates

of the available soil P for plant uptake in global biogeochemistry models, they have not considered the impact of fertilizer application that play a significant role for plant uptake and growth. The authors have mentioned in the manuscript that they are aware of this, but without considering the effect and impact of fertilizer application within a reasonable time scale, the distribution of different forms and accessibility of soil P for plant (Page 16378, Figure 3) might be less useful.

Between different forms of P, inorganic labile P is the most available P for plants. The map of distribution of labile P given in Figure 3 does not give enough information since the level of labile P is changing between 0-125 g P m-2 only in three steps for the entire world. Coupling this map with the global map of agronomic P and agricultural soil P budget (Bouwman et al., 2009; MacDonald et al., 2011) could be a great achievement to show the total availability of P for plants.

While, many processes govern soil P transformations and they interact across a huge range of spatial and temporal scales. Pedogenic Phosphorus Depletion Index has been calculated or provided from different references (Table S1) at different times over more than 20 years (from 1988 till 2011). The form of P may change in time and transfer of P to the different soil P pools is a dynamic process (Sattari et al., 2012). When the data have been presented in the same map, it is assumed (implicitly) that the data have been taken at the same time, which is not valid. It is useful to discuss about the kinetics of soil P pools and how important is the un-synchronized data gathering in making the final maps.

There are also uncertainties in estimation of Hedley fractions and soil strains (page 16374 Table 3; high uncertainty in strain value specially in Intermediate range of soil type) that cause a large uncertainty –up to 70%- in estimating of the total P. Although the uncertainties in estimations have been discussed in the manuscript, authors should provide sensitivity to this analysis in the conclusion.

The manuscript could also benefit from some minor comments before final publication.

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- It would be useful to define PgP in the first use as Petagrams P

- Page 16351 line 11 &12; Batjes 2010 is not in the reference list

- It seems to me that the dimension of both sides of Eq.2 does not match. Please make clarification.

- Page 16359 line 10; Smil (2000) is correct Not Smil et al.

- Page 16360 line 13; “soil P is” should be "soil P in”

- Page 16363 line 28 and 16364 line 3; PPPI should be PPDI

- Page 16372 Table 1, make it clear which type of P?

- Page 16379, Figure 4, you may add (a) reference(s) for field measurement in the legend of Figure 4.

- Table S1:

a. In Temperature column sometimes there is a “C” and sometimes is not, keep it in consistent way.

b. Precipitation is referring to which year? Or period of time?

c. Is “Waitutu” referring to a chronosequence study? If so, please mention it in the Table.

d. I couldn’t find “Sheldon,2012” in the references list of Supplementary material.

e. Selmants and Hart, 2010 is correct.

- You may add the reference to the table S2

- Table S3 is not well structured. ”Slightly weathered soil” should be removed from the heading and only a general term “e.g weathering category” should be allocated in the heading of the table. Then “Slightly weathered soils” can be moved under the heading line as the same position as “Intermediately” and “Highly Weathered soils”.

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- Table S3, The reference “Yousefifard et al, 2012” is correct. Not 2015,2016,2017 and 2018!

Bouwman A., Beusen A., Billen G. (2009) Human alteration of the global nitrogen and phosphorus soil balances for the period 1970–2050. Global Biogeochemical Cycles 23. DOI: doi:10.1029/2009GB003576.

MacDonald G.K., Bennett E.M., Potter P.A., Ramankutty N. (2011) Agronomic phosphorus imbalances across the world’s croplands. Proceedings of the National Academy of Sciences 108:3086-3091. DOI: 10.1073/pnas.1010808108.

Sattari S.Z., Bouwman A.F., Giller K.E., Van Ittersum M.K. (2012) Residual soil phosphorus as the missing piece in the global phosphorus crisis puzzle. Proceedings of the National Academy of Sciences of the United States of America 109:6348-6353.

Interactive comment on Biogeosciences Discuss., 9, 16347, 2012.