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Comment

# ***Interactive comment on “Recent revisions of phosphate rock reserves and resources: reassuring or misleading? An in-depth literature review of global estimates of phosphate rock reserves and resources” by J. D. Edixhoven et al.***

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The fourth review, dated 5 March 2014, is written by Prof. J. Hilton. The fourth reviewer indicates that his views regarding our paper accord more with the views of Scholz and Wellmer (the second review) than those of the first reviewer and that, accordingly, he has restricted his comments to those not already covered in the existing reviews. However, unlike the third reviewer, the fourth reviewer does not appear to have considered our extensive responses to the second review, which we posted on the ESD forum on 23 December 2013. The fourth reviewer has made a number of general remarks

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comments which we comment on below and which are discussed in more detail in the supplement.

The fourth reviewer agrees that the topic of PR is important and that society is at risk if it fails to take the appropriate steps to use this finite resource in a more efficient manner. He also agrees that the risk of PR depletion goes up if humanity does not change a number of industrial, consumer and agricultural behaviors.

#### ACCURATE DATA ON PR RESERVES AND RESOURCES – AN IRRELEVANCY?

The fourth reviewer raises 13 points why, in his view, it will become less and less likely that the major PR producing countries will "disclose their hands" in terms of what reserves, resources or other deposits they command. He argues that this would be particularly true for fragile developing economies in North Africa/ the Middle East whose GDP depends on the PR industry to considerable extent. The underlying message of this part of the review, it seems, is that it would be not very worthwhile to devote efforts and resources in obtaining reliable data on PR reserves, resources and occurrences. While these comments are largely beyond the scope of our research questions, we note that, particularly for countries in these regions, the recent trend appears to have been one of increased PR reporting, at least on a per country basis. For instance, USGS increased reserves reported for Morocco from 5,700 to 50,000 Mt PR in 2011 and OCP's CEO apparently recently stated that this was a conservative estimate (Scholz and Wellmer, 2013). In 2010, the Iraq government stated reserves at 10,000 Mt PR overnight (Taib, 2010 p. 47.1), even though only 430 Mt PR ore was ultimately recognized as such by USGS. As discussed in our paper, reserves for Algeria and Syria were both increased eighteen-fold in USGS' MSC between 2010 and 2011. Jordan reserves were increased over 16-fold since 1990. These and other data do not support the suggestion that the current general trend is one of underreporting. Nor does it appear evident on face value that mining companies have strong incentives to underreport reserves or resources.

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Moreover, even though it has proved difficult to obtain reliable data on PR data, we feel that the importance of PR warrants the effort to strive for better knowledge on viable and potentially viable PR deposits using generally accepted terminology. Recent literature supports this notion. Not only was the need for this recognized in the IFDC report, the issue of data reliability has also been raised explicitly in the consultative communication on the Sustainable Use of Phosphorus by the European Commission of July 2013 (EC, 2013), the in-depth Science for Environment Policy report on Sustainable Phosphorus Use of October 2013 by the European Commission DG Environment (Science Communication Unit, 2013) as well as in a high level advisory memorandum to the Netherlands Ministry of Agriculture and the European Commission (Platform LIS, 2014).

The In-Depth Science for Environment Policy Report on Sustainable Phosphorus Use devotes a multiple page section on the current discussion on PR reserves and resources. The report states the following about the recent increase of PR reserves and resources as reported by IFDC and USGS:

"According to Elser (2012) the revision by the IFDC lacks independent confirmation but has now been accepted by the US Geological Survey [...]. The scale of the revision and the debate around the reliability of the IFDC Report (see box 2) indicate the controversy and uncertainty around reserve estimates."

Chapter 9 of the report (Conclusion) contains the following conclusion:

"These drivers produce a number of PRESSURES on the availability of phosphorus as well as on the environment. There is plenty of research and scientific discussion surrounding phosphorus reserves but placing a figure on the availability of this vital element is still controversial due to data and methodological issues. More dialogue is needed between research and industry in order to ensure access to more accurate data across the world."

Box 21 of the report sums up the "research gaps in the sustainable phosphorus chal-

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lenge". The second bullet point identifies the need for:

"New and transparent scenarios on future demand and supply of phosphorus for alternative futures to support decision makers. This requires better and more data on phosphorus reserves as well as phosphorus flows in society."

In its consultative communication on the Sustainable Use of Phosphorus, the European Commission, having discussed the IFDC and USGS increases of PR reserves, poses the following question for public consultation (EC, 2013b):

"Q3 – Do you consider that the information on the worldwide supply and demand of phosphate rock and fertilizer is sufficiently available, transparent and reliable? If not, what would be the best way to obtain more transparent and reliable information at EU and global level?"

A recent high level advisory memorandum for the Minister of Agriculture of the Netherlands and the European Commission (Platform LIS, 2014) regarding the geopolitics of raw materials for agriculture and food production contains the following recommendation for the EU:

"9. Create more insight into and transparency about resources, reserves and flows of raw materials, both inside and outside one's own territory."

The advisory memorandum stresses that the EU is still too dependent on data from the USGS and IFDC. By way of an example, the advisory memorandum refers to the recent revisions of phosphate reserves and uses our paper and the current discussion on the ESD forum to place these changes into perspective (p 11, 24; see also Part B of the document (Van der Weijden et al, 2014), p 58-60). The memorandum recommends the EU to initiate an International Raw Materials Agency analogous to the International Energy Agency.

Conversely, the data in the IFDC report and the subsequent increase by USGS have been recently used to show that there are no compelling reasons to worry about PR

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supply. On 1 December 2013, on behalf of the Global TraPs project, Messrs. Roland Scholz and Amit Roy, (CEO of IFDC) issued a response to the EC Consultative Communication on the Sustainable Use of Phosphorus discussed above (Scholz and Roy, 2013). This response was based, inter alia, on input from the exploration and mining "nodes" and input from a number of individuals including Mr. F-W Wellmer. In their response, Scholz and Roy argue that the concern about reserves is "somewhat paradoxically as we are talking about an increase of a rather abundant resource". The authors base this on essentially three premises:

– I – In addition to Moroccan reserves, reserves for other countries have increased as well since 1998, to some 17 Gt PR. According to USGS data, the static lifetime of these reserves would be 85 years. However, as have discussed in our paper, some recent reserve increases appear to be no more than restatements of ore resources as ore reserves. Reserves for at least a number of large reserve holders, such as South Africa, appear to be in ore rather than in concentrate (see also: USGS, 2014: "Some world reserves were reported only in terms of ore and grade, not as marketable phosphate rock"). Given the significant reduction in volume involved in producing concentrate (roughly 2/3 for Morocco's sedimentary ore and up to 5/6th for South Africa's igneous ore; IFDC, 2010) this circumstance renders these data an unreliable basis for computing an R/C ratio.

– II – Scholz and Roy argue that the Moroccan estimate for reserves is "conservative", as the various sites have been incompletely explored. The authors argue that it is likely that "currently economically mineable reserves of PR are above 100GT", i.e. twice as high as the number reported by IFDC and USGS. However, under any of the classification systems we reviewed, a deposit can only be termed a reserve if it is demonstrated economic and has been established with a high degree of geologic assurance (using USGS criteria, a reserve must be measured or indicated; USGS and USBM 1980). Therefore, a lack of exploration can never signify that "reserves" are understated. At best, the assumed extension of deposits over large surfaces could

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point at the existence of undiscovered hypothetical resources. As we noted in our paper, these assumed extensions of the Moroccan ore fields are known to be very complex as the unexploited parts have been severely disturbed geologically are located at depths up to 400 meters and Service Géologique du Maroc, 1986, p. 64 and 217, cautions that it may be hard to draw conclusions from them.

– III – Scholz and Roy argue that the assumed high static lifetime of global reserves reported by IFDC and USGS (approximately 350 years) mitigates the geopolitical vulnerability (i.e. the high dependency of one country, being Morocco and West Sahara). We do not agree this is necessarily the case. More importantly in the context of our paper, as long as the current reserve estimates are uncertain and validly disputed, the high static lifetime of reserves cannot be accepted as a given fact, either.

In our view, these documents and the discussion reflected above, testify that the research questions posed in our paper, deemed important by the first and third reviewers, indeed address a timely and relevant topic. Previously, some authors have stated that the increase of Moroccan may in fact be no more than a restatement of the reserve base as reserves (for instance, Rosemarin et al, 2011). Our paper provides significant evidence, in the form of various documents, that the majority of recent increases of PR reserves is probably due to a restatement of ore resources as reserves. As explained in our response to the second review by Messrs. Scholz and Wellmer, more particularly cell C.4.10 to the supplement to that response, only part of our analysis has been challenged in this regard and our conclusions have hardly been discussed in the second review.

#### RELIABLE DATA ON PR RESERVES AND RESOURCES – PART OF A SOLUTION

Under the header "A Solution?", the fourth reviewer appears to argue that it is more useful to invest resources in closing the P cycle than to invest efforts in obtaining reliable data on PR deposits. This section of the review argues in favor of recycling of wastewater, increased industrial and mining efficiency, achieving dietary changes (less

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meat and dairy), increased agricultural efficiency and, more particularly, fertilizer dose control in order to achieve an optimal P level for plant growth. While outside the scope of our research questions, we agree that it is of paramount importance to bring these solutions into practice, as has also been acknowledged in EC 2013 and EC Science Communications Unit, 2013, discussed above and many other publications. However, it has also been observed in the literature that bringing such changes into practice may be difficult. For instance, in a previous paper, the reviewer argued that at present, the market is unlikely to exert pressure on the need to recover and recycling of P through natural pricing mechanisms (Dawson and Hilton, 2011).

Likewise, it has often been pointed out that a range of climatic, socioeconomic and biochemical soil factors render it difficult to achieve optimum soil P levels in practice while poor nutrient efficiency remains common (for instance, Townsend and Porder, 2012). P losses are for the most part determined by the rate of soil erosion, which remains a significant issue in agriculture globally and which may worsen as high input agriculture spreads to the equatorial regions (Townsend and Porder, 2012, McDonald et al, 2010). It is argued that food production may need to increase by 70% over year 2000 levels by the year 2050, the majority of which will need to be achieved in developing countries (McDonald et al., 2010, Bruinsma, 2009). While efficient management may theoretically go a great length to reduce P losses, it may be very difficult to achieve these solutions on a global scale for climatic, socioeconomic, cultural and political reasons as well as biochemical soil factors. This is why, in our paper, we discussed a number of papers which analyzed the impacts of P use under environmentally pro-active and environmentally re-active scenario's or assumptions (namely: Rosemarin et al. 2010, Van Vuuren et al, 2010, Sattari et al, 2012 and Townsend and Porder et al, 2012).

Moreover, even if P could be applied with optimal efficiency on a global level, this does not reduce the need to obtain more accurate and complete data on global PR deposits available for extraction. In Dawson and Hilton, 2011 the reviewer argued that, in order to extend the lifetime of the available PR deposits to a planning horizon of thousands

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of years, which he considered necessary from an intergenerational perspective, annual mining rates must be progressively reduced to a fraction of the then current 160 Mt PR. To achieve this, he called for "a revised social contract between producers and consumers" which, arguably, would also be required to achieve the agricultural changes envisioned by the reviewer. In our view, fostering transparency and reliability of reserves and resource data and knowledge of potentially viable PR deposits are important factors to validly determine the urgency of reducing PR demand and in creating the awareness required to achieve such reduction.

#### REFERENCES:

Bruinsma J.: The resource outlook to 2050: By how much do land, water and crop yields need to increase by 2050? Food Agric Org UN, Rome, 2009.

Dawson C.J. and Hilton J.: Fertilizer availability in a resource-limited world: Production and recycling of nitrogen and phosphorus. Food Policy 36 S14-S22, 2011.

EC Consultative Communication on the Sustainable Use of Phosphorus. Communication from The Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions. <http://ec.europa.eu/environment/consultations/pdf/phosphorus/EN.pdf> Brussels, 8.7.2013. Accessed: 2 April 2014

Science Communication Unit, University of the West of England, Bristol (2013). Science for Environment Policy In-depth report: Sustainable Phosphorus Use. Report produced for the European Commission DG Environment, October 2013. Available at: <http://ec.europa.eu/science-environment-policy> Last accessed: 2 April 2014

MacDonald, G.K., Bennett, E.M., Potter, P.A., Ramankutty, N.: Agronomic phosphorus imbalances across the world's croplands. Proc Natl Acad Sci USA 108:3086–3091. 2011

Platform Agriculture, Innovation and Society (2013). The geopolitics of raw



materials for agriculture and food production. Part A: Advisory memorandum for the Minister for Agriculture of the Netherlands and the European Commission. Culemborg. [http://www.platformlis.nl/rapporten/Food\\_rawmaterials\\_geopolitics-Report\\_PlatformLIS-2014-web.pdf](http://www.platformlis.nl/rapporten/Food_rawmaterials_geopolitics-Report_PlatformLIS-2014-web.pdf) Last accessed: 2 April 2014

Rosemarin, A., Schröder, J., Dagerskog, L., Cordell, D., and Smit, B.: Future supply of phosphorus in agriculture and the need to maximise efficiency of use and reuse, IFD proceedings 685, Leek, United Kingdom, 2011.

Service Géologique du Maroc. Géologie des Gîtes Minéraux Marocains, 2nd. Edn., volume 3, Rabat, Ministère de l'énergie et des mines, Direction de la géologie, Rabat, Morocco, 1986

Sattari, S. Z., Bouwman, A. F., Giller, K. E., and van Ittersum, M. K.: Residual soil phosphorus as the missing piece in the global phosphorus crisis puzzle, Proc. Natl. Acad. Sci. USA, 109, 6348–6353, 2012.

Scholz R.W. and Roy A.H., Response of the Global TraPs Project ("Transdisciplinary Processes for Sustainable Phosphorus Management") to the EC Consultative Communication on the Sustainable Use of Phosphorus. Global TraPs' primary feedback – besides stressing the role that the EU may take in global phosphorus management – related to inaccurate data and resulting conclusions.

Townsend A. R. and Porder S.: Agricultural legacies, food production and its environmental consequences, Proc. Natl. Acad. Sci., 17 April 2012, 109, 5917–5918, 2012.

USGS and USBM: Principles of a Resource/Reserve Classification for Minerals, Geological Survey Circular 831, Alexandria, Virginia, USA, 1980.

Van der Weijden, W.J., E. Hees, T. Bastein & H.A. Udo de Haes (2013). The geopolitics of raw materials for agriculture and food production. Part B: Analysis. Platform Agriculture, Innovation and Society, Culemborg. [http://www.platformlis.nl/rapporten/Food\\_rawmaterials\\_geopolitics-](http://www.platformlis.nl/rapporten/Food_rawmaterials_geopolitics-)

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Van Vuuren, D. P., Bouwman, A. F., and Beusen, A. H. W.: Phosphorus demand for the 1970–2100 period: a scenario analysis of resource depletion, *Global Environ. Change*, 20, 428–439, 2010.

Please also note the supplement to this comment:

<http://www.earth-syst-dynam-discuss.net/4/C691/2014/esdd-4-C691-2014-supplement.pdf>

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