

R.W. Scholz and F.-W. Wellmer:

Comments to comments by Joost Edixhoven (Referee) ESD Discussion , 6. C33-C34, 2015 on: „Interactive comment on “Comment on: “Recent revisions of phosphate rock reserves and resources: a critique by Edixhoven et al (2014)—Phosphate reserves and resources: what conceptions and data do stakeholders need for sustainable action?” by R.W. Scholz and F.-W. Wellmer”

We, Roland Scholz and Friedrich-Wilhelm Wellmer, have written a comprehensive, critical review (Scholz & Wellmer, 2013) on the first version of the Edixhoven, Gupta, and Svanije (2013) and a (non-published) second review on a (non-published) second revision. These papers review appreciated that the Edixhoven et al. paper (2015) identifies the fuzzy use phosphate rock (PR) for describing resources and reserves, in particular the mixture of tons of phosphate rock ore (PR-ore) and tons of marketable phosphate concentrate with about 30% P2O5 (PR-M). This is why we recommended that the paper of Edixhoven et al. should be published.

However, we (see Scholz & Wellmer, 2013; Scholz & Wellmer, 2015)—as well as other reviewers (Cook, 2014; Hilton, 2014)—strongly criticized the Edixhoven et al. paper due to some severe specific failures as well as due to a number of misleading statements or conclusions. The latter revealed, for instance, that basic knowledge about the dynamics of reserves¹ or state of the art knowledge on the misapplication of reserve data for predicting global P scarcity (or ultimate recoverable resources) have been insufficiently or even misleadingly presented. The tone and wording of certain formulations (see below) may be taken as a component of an implicit level which asks for some comments.

In principle, our comment deals with two domains where you still find some wrong, biased or misleading statements of the Edixhoven et al. (2013). The first level refers to explicit and implicit statements on the resources system (i.e., scarcity, Peak P, mixing finiteness and staticness, the dynamic nature of reserve data, and unrealistic demands with respect to granularity or drilling grids for providing for reliably estimating reserves (under certain constraints). We may call this level a **data and resources system level**. The second level refers to assumptions on how some key actors of the supply demand chain work, decide and operate. This concerns in particular mining companies, industrial agents, organizations or

¹ This may be taken as a nice example for the sloppy use of concepts by Edixhoven et al. (2014) and as an indicator that the dynamic nature of basic concepts is not really acknowledged. Section 2.1.3 of the comment runs under the heading “Our paper did not “confuse finiteness and staticness.” But in line 5 (point 15) you find the sentence “From a geological viewpoint, the world’s PR **deposits are fixed, or static.**” A deposit can be defined “accumulation of ore or other valuable earth material of any origin.” (EduMine, 2015). There is no purely geological natural science definition what amount and/or concentration or what other factors make something to become a deposit. Deposits such as reserves are entities that are economically defined. This is reflected in the definition that a deposit shows „sufficient extent and degree of concentration to invite exploitation“ (EduMine, 2015, see Appendix of this response paper). Thus, a deposit is genuinely dynamic, depending on prices (i.e., supply-demand characteristics), technology development and other factors (such as mining). Thus, considering deposits or reserves as fixed or static is scientifically wrong.

even institutions such as USGS. This has been stressed by Julian Hilton who wrote that the first version of Edixhoven et al. paper is applying a “tone of moral indignation with . . . the intention to shame PR producers into disclosure of the reserves and resources they hold” (Hilton, 2014). We call this an **actor or human system level**. We refer to judgments and assumptions about the actors which generate, own and communicate certain data.

We want to mention, that some issues have improved in the course of the two revisions of the Edixhoven et al. (2015) paper. However, we would not have written an extensive comment if the published paper would not include **explicit** and **implicit** misleading, biased or wrong statements, interpretations and causations. As already indicated in footnote 1, such formulations are also around in the Edixhoven review to the Scholz and Wellmer comment.

We think that the current discourse on reserves is of some general interest as today—in the age of the anthropocene—Earth System Science has to scientifically cope with both levels of systems (i.e., the material resources systems and the system of main actors who affect this systems). The assessment of reserves, for instance, is not a pure science issue. Natural science data have to related to economic estimation (which makes reserves assessment an art) and to social science data about the constraints of mining. This includes geologic, mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. Resource sciences has to learn how both—the data of material and the data and knowledge of the human system (e.g., the actors)—should be properly treated and related.

In order to explain why our comment on the Edixhoven paper (which first has the title “comments and thoughts”; unfortunately this could not be realized because of format constraints of ESDD) we will not go into a detailed text-exergese of each of 96 points 15.000 words response of the Edixhoven (Edixhoven, 2015) here². In order to explain why and from what perspectives we wrote “comments and thoughts”³ we just discuss the statements of point 1. We want to thank the reviewer for identifying a couple of wrong phrasings and errors, e.g., when calculating the amount of PR-M for Australia (see supplementary information, Point 94).

(1) The prerequisites of utilizing methods, concepts, and conclusions have to be reflected

We explained already in the comment to the anonymous Referee #2 that any scientific reasoning indispensably asks for checking, validating and clarifying the pre-requisites which are linked to the use of a concept, statement, conclusion or causation: A „main principle of

² Though the extension of the itemwise reply goes far beyond a normal review, the reader may look at a detailed answer go most of the 96 points of the “review” of Edixhoven (<http://www.earth-syst-dynam-discuss.net/6/C32/2015/esdd-6-C32-2015.pdf>) can be found under ([http:// ...](http://...)). This itemwise reply is also the basic for the revisioning.

³ Instead of “**Comment on: “Recent revisions of phosphate rock reserves and resources: a critique by Edixhoven et al (2014)—Phosphate reserves and resources: what conceptions and data do stakeholders need for sustainable action?”**” The new title reads: “**Comment on: “Recent revisions of phosphate rock reserves and resources: a critique by Edixhoven et al (2014)—Clarifying comments and thoughts on key conceptions, conclusions and interpretation to allow for sustainable action?”**”

scientific reasoning is that it works with “true/valid” prerequisites, which only allow for valid/true conclusions. Thus, if we look, for instance, at a mathematical proof or any other causal reasoning, the lemmata and corollaries, i.e., the implicit prerequisites, have to be examined for their “validity.” (Scholz & Wellmer, 2015)

This means, for instance, that someone who refers to global Peak P and to the Cordell et al. (2009) paper is making inextricably reference to the misapplication of Hubbert curve analysis which used reserve estimates as a substitute or proxy for the ultimate recoverable resources (URR). Thus we reject that the statement of Edixhoven that “Our paper did not use Peak Phosphorus/Hubbert Analysis.”

The Edixhoven et al. paper refers to the Peak P a couple of times. There is no statement that this application is scientifically wrong. If you read the text (see footnote⁴, part 2.1.2 of the comment) Edixhoven state indeed that

“One point of criticism to the peak phosphorus hypothesis is that the modeling was based essentially on PR estimates sourced from the mineral commodity summaries (MCS) issued by the US Geological Survey (USGS).”

This is certainly a highly misleading statement. Instead of clarifying that the use of reserves as a proxy of URR is wrong, the formulation suggests that the use “PR estimates. issued by the US Geological Survey” has been a problem. The text does even not specify what estimates (reserves or resources are meant). But then the text continues in discussing and criticizing the definitions and data of the USGS MCS resources data—which then become subject criticism of the paper—are defined and reported.

We acknowledge that a follow up paragraph (page 492, 1st column last paragraph) incorporates arguments which have been put forward by our recent review on the first version of the paper. Here the Edixhoven et al. (2014) paper clarifies that “currently identified reserves” are “by no means amounts to a depletion of the P available for extraction.” But then the text continues with the again misleading sentence “*the peak phosphorus debate remains hotly debated*” or seen as “disputed” (see Edixhoven et al. 2015). There is no indication that

⁴ The third paragraph in the Edixhoven et al. (2014, p. 492) paper reads “One point of criticism to the peak phosphorus hypothesis is that the modeling was based essentially on PR estimates sourced from the mineral commodity summaries (MCS) issued by the US Geological Survey (USGS). USGS uses a resource classification system which it devised in the 1970s together with the former US Bureau of Mines (USBM). The USGS classification reports currently demonstrated economically viable resources as reserves and a larger bracket of demonstrated resources as the reserve base. The aggregate of the reserve base and uneconomic deposits which have a reasonable potential of becoming economic in the future are reported as resources. Deposits with no reasonable prospect of economic viability in the foreseeable future are listed as “other occurrences” in the USGS classification. Importantly, the reserve base and the reserves include only those deposits which are demonstrated (measured and indicated), i.e., which have been established with sufficient geological assurance (USGS, 2014). For a schematic overview of the main elements of the USGS classification, including reserves and the reserve base, reference is made to Figs. S1 and S2 in the Supplement.” (Edixhoven et al. 2014)

Edixhoven et al. consider the global Peak P analysis which refers to (any current) reserve data as refuted.

As mentioned—the follow up argumentation targets to show that the USGS reserve estimates are unreliable. Thus the possible interpretation (factually such an argumentation has been even more implicitly suggested in the Problem statement of the unrevised version, see Edixhoven, et al., pp. 1007, line 1015 - p. 1008, line 1022). Thus the text misleadingly suggests: ‘Peak phosphorus has been criticized because of the using USGS reserve data’ and ‘the update of the USGS data are unreliable’ given that ‘Peak phosphorus remains hotly debated’ asks for some comment and clarification.

We acknowledge that Edixhoven agrees that the words on the Peak P “may not have been entirely adequately chosen” and “that our views are no different from those of Scholz and Wellmer”⁵. Our comments targets to unanimously clarify why the global Peak P analysis using reserve data is fundamentally wrong and that this is not due to that USGS made these estimates.

We will clarify in some more detail in a brief section, why the clarifying comments on the Peak P are included in the comment. In particular, we have to clarify that the “*criticism to the peak phosphorus hypothesis is that the modeling*” (Edixhoven et al.) is **not** due to the issue that “*the modeling was based essentially on PR estimates sources on the Mineral Commodity Summaries.*” This has been formulated in an opposite way in the Edixhoven et al (2014) paper (see the quote above in Part (1), section 3). The Peak P has been taken as a motivator for the analysis of the paper in a way which asked for a clarifying comment.

(2) The stories between the lines have to be avoided

One of the problems which we had with the previous three versions of the paper is that the texts suggests causalities or causalities which are not substantiated. Thus it is telling stories between the lines. This also holds true for the point 1, of the “review” of Edixhoven which may be considered as a background summary of the paper. There are three example which may be found in the first out of 96 points (see the bold printed statements, bold and numbering A, B, C not in the original text).

1. *The discussion paper by Scholz and Wellmer responds to a paper which I published together with Prof H.H.J. Savenije and Prof. J. Gupta (Edixhoven et al, 2014). Our paper investigates the major increase of reserves as reported in a report by IFDC (the IFDC report; Van Kauwenbergh, 2010), (A) which report was published following the recent debate on peak phosphorus (Cordell et al. 2009). IFDC reported a 4-fold increase of global reserves. In the IFDC report, the increase of global PR reserves based was on an increase of Moroccan PR reserves, from 5,700 Mt PR in the USGS Mineral Commodity Summary to 51,000 Mt PR in the IFDC report, reported as upgraded concentrate. (B) The increase was based on one single publication (Gharbi (1998)). In its report, IFDC indicated that it would not use the definitions in the USGS classification, which poses requirements for reserves and the reserve base in terms of the economic viability of a deposit and the degree of geologic assurance. (C) One year later, this increase in reserves was accepted by USGS, based on the IFDC report and*

⁵ Thus the last lines of point 15 such as the arguments of the Anonymous Reviewer #2 are strongly rejected.

information from the Moroccan producer, OCP (USGS, 2011). Shortly afterwards, reserve for a number of other countries were increased in the USGS records, one of which (Iraq) was downgraded again shortly afterwards (see, our paper and the discussion paper).

- (A) Given the first bold statement, one may suspect that the IFDC 2010 paper has been published because of the Cordell et al. paper. But is this the real reason? Are we talking about the causal relationships or (incidental) temporal order?

Did IFDC publish this to calm a Peak P discussion? It insinuates that the author of the IFDC report did not work according to professional standards and increased reserves purely to calm the speculation on a looming scarcity of phosphate.

Factually, the IFDC report by van Kauwenbergh makes reference to the Peak P speculation and the hypothesized peak in 2033-2034 (van Kauwenbergh, 2010, p. vii). But much of the Morocco data and analysis have already been published by IFDC in 2006 (van Kauwenbergh, 2006). Mew (2015, pp. C6-C7) provides a different explanation for why USGS 2011 (Jasinski, 2011) updated the Morocco data:

Given the major change to industry economics (PR-M price changes) in the 2006-2014 period, one would expect there to have been increases in phosphate reserve levels as more ore in the reserve base category becomes viable at 'today's economics'. The realignment of Moroccan reserves suggested by the IFDC in 2010 is therefore not counter intuitive.

There is the feedback control system rule of economics which states that with an increase of prices an increase of reserves is induced. Factually, after the price peak in 2007-2009 (with prices of more than 200 USD/PR-M), the phosphorus prices came down to a level of about 120 USD. This is roughly four times the level of the pre-2008 price peak level of 30-35 USD (<http://www.indexmundi.com/commodities/?commodity=rock-phosphate&months=300>) and close to experts' estimations of the real production costs. Given the increasing knowledge about the Morocco resources by continuous exploration, it is absolutely understandable—and due to the dynamic nature of reserves—that the OCP reserves were upgraded by USGS in 2011 from 5.7 Mt, a value which remained unchanged since 1991 to 2010 (Christesen, 2014).

- (B) The statement “**The increase was based on one single publication (Gharbi (1998))**” is absolutely misleading. What story does this sentence tell? That there has been one paper published in a French scientific paper which is the only source, data and evidence for increasing the Morocco reserves 12 years later. The journal was the official natural resources journal of the French Geological Survey BRGM and OCP officially invited to contribute to this issue. Gharbi was the Chief Geoscientist at that time. As stated again and again: reserves are a dynamic concept. Every responsible mining company continues exploration and defining new reserves in parallel with mining activities. Therefore, the latest report is always the most relevant. What better data can there be than the latest report by a chief geologist of a mining company? In addition—as outlined below—the IFDC report examined earlier reports for plausibility of the most recent data.

Frankly, we are a little startled about the “single publication” statement. In general companies do not publish in scientific journals but in annual reports and similar documents. Mew (2015, p. C7), who worked for more than 40 years as editor of books and professional as owner and CEO of one of the leading global (independent) commodity enterprises on phosphorus states:

In each of its Annual Reports, going back at least to 1979, OCP gives an overview of exploration work it has carried out in the previous year, together with a table of total ore volumes in cubic metres. In the 1979 report, the data are split by regional deposit, with the “explored and studied” portion of the three producing regions, Oulad Abdoun, Gannour and Oued Eddahab (BouCraa), containing a total of 14.03 Gm³ of ore.

The one-paper statement may be seen (as T3 argument and well attributed to what we describe; we describe below what we mean by T3 argument below) as a “scepticist view.” If the authors Edixhoven et al would have done a thorough research of sources and would have asked IFDC, the ‘one paper argument’ would read like the following:

“In addition to Gharbi (1998), the IFDC technical bulletin/publication (van Kauwenbergh, 2010) relied on several earlier publications that recognized the vastness of the mineable reserves and the incomplete exploration of the Moroccan phosphate basins. Such publications included: Savage (1987); the OCP (OCP, 1989) contribution entitled “The Phosphate Basins of Morocco” in Notholt et al., Eds. (1989) and various other publications (Belkhadir & Chaoui, 1986; Fertilizer International, 2006; IFDC, 2006). Full references for Savage (1987), OCP (1989) and Notholt et al., (1989) are in the IFDC 2010 publication.

The IFDC 2010 publication also drew from IFDC’s PR knowledge base that has accumulated over 35 years of research and PR assessments including collaborative assessments with public international/national organizations and private sector companies along with the recognition that reserve figures are strongly influenced by the cost of PR/ton (IFDC, 2006, p. 43).“ (IFDC, 2015)

(C) Likewise ununderstandable is the repeated stressing of the upgrading of the Iraq data. We explained in our comment that the downgrading was due to the delayed noticing of USGS that the Iraq reserves were classified according to the Russian classification system. Factually slide 18 of the public presentation of the Iraq data included that “reserve and resources classification followed Soviet terminology” (Al-Bassam, Fernet, & Jasinski, 2012). This has been an error which was obviously overseen. But the error got corrected. We explained this in our comment (after asking USGS why the data were changed).⁶

⁶ Section 5.2 of our comment reads: “Nevertheless, conformity among the different national classifications seems reasonable.” The case of the Iraq reserves may be taken as an example, where “USGS restated from zero to 5800 Mt PR overnight in 2012” (Edixhoven et al., 2013, p. 1021) and “downgraded again by 93% to a mere 430 Mt PR . . .” (p. 500). ... The uptake and correction of the Iraq data was neither a clandestine directive nor did 5370 Mt PR-Ore disappear. As has been well reported (Al-Bassam et al., 2012), the exploration of the 22 Iraq occurrences including 7 deposits and a resource estimate of 9.5 Gt PR Ore has been underway since 1965 by the Iraq Geological Survey and its predecessor organization. Exploration and drilling began in 1963. For all deposits, “pilot scale beneficiation” was done “using simple beneficiation techniques” to check whether PR-M could be produced with the available technology (Al-Bassam et al., 2012). The story of the USGS data is that the exploration in Iraq obviously reached a certain level of maturity in 2011. Unfortunately, for historical reasons the classification system labeling the Iraq reserves was the Russian system (Gert, 2007). In addition, this system distinguishes between “reasonably assured, identified, estimated, and inferred” recoverable reserves. A second look revealed that, only some fields fulfilled the USGS criteria for reserves. The downgraded reserves did not disappear, but some reserves were down graded to resources (Jasinski, 2013) and may appear as resources in the future after further exploration or increases in prices.”

Finally, we want to briefly refer to formerly wrong and ongoing biased treatment of actors and persons. In the first version of the paper, Edixhoven et al. (2013, p. 2008) stated- “Following its report, IFDC created a network, Global TraPs (<http://www.globaltraps.ch>).” We clarified that this is definitely a speculative, wrong statement (as ETH-Zurich launched the Global TraPs project without any Peak P reference). We further explained (also in the non-published second review) that Global TraPs is a transdisciplinary discourse among all key stakeholders ranging from global phosphorus traders to Greenpeace participate in a process mutual learning for jointly identifying options of mutual learning. Amit Roy as practitioner and Roland Scholz as scientist took the role as *facilitator* of this learning process. Now, we can find the statement followed “Mr. Scholz is the initiator and CEO of the Global TraPs project.” What does this phrasing besides the lines convey? The phrasing “CEO of a research project” is absolutely uncommon. But Global TraPs has not been a “research project” (as again wrongly stated in the Review; Edixhoven, 2015, footnote 2) but a transdisciplinary process in which a process of representative of key stakeholder groups and scientists was launched. This project also served in elaborating a better understanding of the genesis and function of reserves and resources data. Here geological surveys from the US and Germany, various mining companies, mineral consultants such as Greenpeace and researchers from sustainability science were included. A main role of the leaders of a transdisciplinary project is the moderators and facilitation of the process. The phrasing CEO of a transdisciplinary process may be seen as an inaccurate journalist formulation. It also may reveal that the writer has no understanding what a transdisciplinary process is. But, it may also be seen as a phrasing which conveys that Global TraPs is something such as an industrial or non-profit organization? This would be coherent with the formulation in the first version of the paper in which fallaciously was written: “Following its report, IFDC created a network, Global TraPs”. For us, this formulation can be well interpreted as an attempt to put Global TraPs in a wrong light and to discredit transdisciplinarity. This is disappointing, given the many informations which have been given to Edixhoven in previous documents and the thorough documentation of Global TraPs.

Most of above text just deals with point 1. We think that just these few lines are full of speculation, suspects, implicit negative assumptions about why certain action have been taken and why data have been published. We expressed this in our comment in the following way: „the paper by Edixhoven et al. looks like a strange academic desktop study that is missing the interaction with practitioners to understand (i) the knowledge gained in exploration and mining operations/companies and (ii) the constraints faced by different stakeholders when dealing with reserve data.“ (p. 55).

How to proceed with the revision of the comment

We want to contribute to a constructive debate on the question of “what conceptions and data do stakeholders need for sustainable action?” This has been the subtitle of our comment. A proper definition, use and interpretation of reserves and resources data is part of this. This is why we wrote the comment. And just the above considerations show why this is meaningful. And we think it has also become clear why we included a section 7.2 on “Why do we have so different estimates of reserves and resources” including a section on that “sceptics/pessimist and optimist/realist should talk to each other.” The reader should note that such a talk already started in March 6, 2015 at roundtable 17 of the European Sustainable Phosphorus

Platform Conference on “Phosphorus resources, supply and demand.” The discussion among Edixhoven, Rosemarin, Scholz and Wellmer took a constructive turn and also dealt in a productive way with what is subject of the intense ESDD story.

Based on this meeting, we offered that the revised comment may be checked by the Edixhoven et al. team in order to identify formulations which unnecessarily include ambiguous (between the lines stories) or leave unclear why and from what perspective certain comments and thoughts are provided. For doing this, we will in particular distinguish between three types (T) of argumentation.

T1: Comments and critique on wrong, biased and unreasoned statements which has been directly argued in the Edixhoven et al. paper (the above example of “deposits are fixed and static may be taken as an example”).

T2: Criticism on fuzzy and misleading statements or dealing with issues (such as Peak P, see above) which ask for clarification.

T3: Thought and comments which help to understand why there are so discrepant views and statements on reserves and resources

In order to avoid unnecessary disputes (based on minor misunderstandings) and in order to initiate a dialogue, we will send the revised version to Dr. Edixhoven. We will then adapt the text. This will allow that the follow up discussion focuses essentials.

The editors and the reader may take from the annotated comment what arguments of Dr. Edixhoven are reflected in the revisions and which one not (for instance as they are sufficiently dealt with or they are not reasoned/accepted).

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