# Legal perspectives on regulating phosphorus fertilization

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## Summary

This article addresses the legal treatment of the limited and non-renewable resource phosphorous (P), which is essential for all forms of life. We raise a highly important resource problem that has hitherto received little attention in the legal discourse. Furthermore, excessive and dissipative P discharge into soils and water bodies has significant negative effects on ecosystems. Currently neither European nor German fertilizer legislation and soil conservation legislation provide adequate regulatory approaches for a sustainable use of P in agriculture. A precautionary concept on the European level is basically non-existent. Existing regulations lack specificity, real enforcement, precautious measures against a relocation of problems, and protective measures for limiting P usage. If these factors are not taken into account, it will remain impossible to address ecological and resource problems effectively because P politics will otherwise be constrained to constant consideration on an individual basis, where every individual case might be deemed to entail "few negative consequences". It is not sufficient to increase efficiency in P uptake per individual plant, because if crop cultivation is expanded to previously unused areas at the same time, for instance via higher animal feed crop production (due to globally rising meat consumption) or via bioenergy plant production, it will be impossible to achieve the necessary absolute reductions of P input by higher efficiency per plant. We conclude that this will eventually lead to an important new strategy in environmental policy: "Technical solutions", "efficiency", and "command and control" alone will not solve resource problems or quantity problems if at the same time (global) production increases or remains at a constant high level.

*Keywords: Administrative regulations, biodiversity, certificate trading, eutrophication, legislation, phosphorous, resources, sustainability*

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## Zusammenfassung

### Rechtsprobleme der Regulierung der Phosphordüngung

Der Beitrag thematisiert den rechtlichen Umgang mit der knapper werdenden, aber lebenswichtigen (nicht-erneuerbaren) Ressource Phosphor. Dabei geht es nicht nur um den Fall eines extrem bedeutsamen – im Recht aber bisher kaum beachteten – Ressourcenproblems. Vielmehr hat der übermäßige Eintrag in Natur, Böden und Gewässer auch in hohem Maße schädliche ökologische Auswirkungen, die gerade auch in der langfristigen und schleichenden Akkumulation von Gewässer- und Bodenbelastungen liegen. Der Beitrag zeigt diese Problematik auf und dokumentiert, dass das europäische und nationale Düngemittelrecht und Bodenschutzrecht dem bisher kaum etwas entgegensetzen. Ein diesbezügliches ressourcen- und umweltschutzbezogenes EU-Vorsorgekonzept erweist sich dabei als im Wesentlichen inexistent. Den in den vorgenannten Rechtsbereichen angesiedelten unzureichenden ordnungsrechtlichen Regelungen mangelt es an Konkretheit, realem Vollzug, einer Vermeidung von Verlagerungsproblemen sowie an einer Sicherstellung absoluter Reduktionen in der Phosphornutzung. Ohne all dies kann das ökologische und das Ressourcenproblem nicht effektiv angegangen werden, denn sonst droht die Phosphorpolitik stets von Einzelfällen her betrachtet zu werden, in denen je für sich genommen „keine schlimmen Folgen drohen". Für all dies – so soll zentral gezeigt werden – genügt es auch nicht, Phosphor „pro Pflanze" effizienter einzusetzen; denn wenn gleichzeitig immer mehr bisher ungenutzte Flächen z. B. für den Futtermittelanbau (angesichts eines global wachsenden Fleischkonsums) oder für Bioenergiepflanzen künftig genutzt werden, wird die nötige absolute Verringerung des Phosphoreinsatzes gerade nicht erreicht. All dies wird zu einer Grunderkenntnis für die Umweltpolitik insgesamt führen: Ordnungsrecht und Effizienz allein lösen tendenziell kein Ressourcen- und Mengenproblem, wenn gleichzeitig die Produktion (weltweit) steigt oder auf hohem Niveau konstant bleibt.

*Schlüsselworte: Biodiversität, Eutrophierung, Gesetzgebung, Nachhaltigkeit, Phosphor, Ressourcen, Verwaltungsrecht, Zertifikathandel.*

## 1 Phosphorous and sustainability

Point of origin for modern soil protection, and this holds true for current environmental policy in general, is the sustainability principle. Sustainability, as the terminological fusion of the claim for more intergenerational justice and global justice, has experienced a remarkable career within the last 15 years. Ekardt (2009a) provides detailed information on the sustainability principle and against the widely occurring suppression of the decisive space-time-dimension and its replacement by the three-pillar-formula. This and other studies (World Commission on Environment and Development, 1987; Lee, 2006; Ott and Döhring, 2004; Siemer, 2006) define sustainability not as a meaningless term representing everything good and desirable in the world but interpret it as a concept which transmits the following relatively concrete content: Justice (the requirement for fair regulations and organization structures for cohabitation) ought to incorporate temporally and spatially remote interests and concerns in a more potent way. This does not exclude other relevant interests such as economic growth here and now because weighing all relevant interests is crucial in finding justice. Yet tangible sustainability calls for a lasting and globally maintainable lifestyle.

Western societies are currently pursuing a lifestyle that is neither maintainable on a long term basis nor on a global scale. At the same time, a major proportion of the world population lives in extreme poverty. Key elements of sustainability are the increased usage of renewable resources according to natural renewal rates as well as conservative usage of non-renewable resources. The essential major nutrient phosphorous (P), being indispensable for plant, human, and animal life, is such a non-renewable resource. To date, P scarcity has not received adequate public attention as a resource or environmental issue. Discussions have been restricted to its role as an environmental pollutant. However, P is first and foremost a non-renewable, essential resource, which depletion is a severe threat to global food security (Cordell et al., 2009). This article focuses on analysing sustainability in soil/water protection in order to ensure resource conservation, which is the second most important global issue after climate change. The resource issue has many links to climate change. For example, the excessive use of finite fossil fuels as well as problematic forms of land use (e.g. deforestation and livestock farming) reflect the climate problems in its very core. Our goal has been to excerpt and highlight problems in P usage from a legal and policy perspective, taking into account the feasibility of a long-term and global (hence sustainable) practice of its handling. Within this discourse, we briefly include, in a comparative manner, yet another neglected issue: soil biodiversity. Overall, an aggregated perspective will be developed on how sustainability in soil protection can be promoted.

Soils are an elemental prerequisite for life as are water and air. Soil is part of the natural living space of humankind, serves as the nutritional basis for plants and animals, and is production basis for foodstuffs and animal feed (Sparwasser et al., 2003). As a non-renewable resource, its utilisation must be aligned with the precept of sustainable management. Sustainable soil utilisation calls for a usage that should be adjusted in manner and scope to the needs of the current generation; yet such global utilisation requirements also call for soil functions to remain intact or to be improved on a long-term basis in order to secure their potentials and to enable future generations to fulfil their needs and choose their lifestyle freely. It is a declared goal of national legislation to maintain or restore soil functions on a long-term basis. In Germany, it is part of the federal soil protection legislation (Bundes-Bodenschutzgesetz/ BBodSchG (1998a)). Nevertheless, soil protection is not satisfactory and hardly sustainable. A prime example in this context is soil degradation (SRU, 2008). It is estimated that globally more than half of all agricultural land is affected by soil degradation (Giger et al., 2008).

In Germany, about 53 % of all land is used for agricultural purposes (Statistisches Jahrbuch 2007). Next to the deposition of airborne pollutants and the application of wastes, relevant diffuse inputs of contaminants and nutrients are introduced into agriculture by pesticides and fertilizers (SRU, 2008). Severe problems with respect to soil fertility are pronounced on livestock enterprises.

Agricultural crops require essential plant nutrients for growth. While some nutrients are plant available in quantities that satisfy the nutrient demand of the plant, others need to be fertilized regularly at crop-specific rates in order to warrant crop productivity and crop quality. Fertilisation is essential to avoid nutrient mining which adversely affects soil functions. Without the replacement of nutrients, soils would become depleted and could no longer provide their natural functions (Sattelmacher and Stoy, 2004). Different types of fertilizers exist, for instance, mineral and organic fertilizers and recycled products (Kloepfer, 2004).

Arable and particularly livestock farms consume and apply significant amounts of P. Easily accessible and available P resources are limited, geographically highly concentrated and declining both in terms of quantity and quality (Harben and Kurzvart, 1996). Though P resources are many times higher than the actual P reserves, it can be assumed that access to P will be restricted increasingly by various constraints, amongst others, economic factors (Ulrich et al., 2009). Approximately 80 % of all mined rock phosphate in the world is processed to mineral fertilizers. In 2009, this amount equalled 158 million tonnes (IFA, 2008). Agricultural production depends on the availability of P fertilizers and thus is highly vulnerable to shifts in P supply.

Use of P causes ecological problems, for example, with respect to energy and climate. P mining, processing, marketing, and application require a significant amount of energy and cause considerable emissions of gases that have an impact on climate. Besides, various adverse effects affect soils and water bodies. These are caused, for instance, by heavy metals and radioactive substances. In this respect, it is important to highlight uranium, which is a radioactive heavy metal with a chemical and radioactive toxicity. Thus cumulative uranium loads by P fertilisation affect soil quality by enrichment of uranium in soils and uranium contamination of ground and drinking water by leaching (Schnug and De Kok, 2008). Regularly, P is often fertilized at rates which exceed the off-take by harvest products. This leads to P accumulation in agricultural soils. Currently, the overall application of fertilizers in Germany is slightly declining (SRU, 2008).

P fertilisation that exceeds the P off-take of crop plants will cause an accumulation of P in soils (Härtel, 2002; SRU 2000, 2004 and 2008). Major problems are high P surpluses on intensive livestock enterprises; here, slurry needs to be disposed of rather than being fertilized on a demand-driven basis (SRU, 2004 and 2008). Imbalanced fertilizer application has been addressed as being one reason for the loss of biodiversity (Sparwasser et al., 2003; Giger et al., 2008; GAIA 2008; Weins, 2001; Schink, 1999). The major pathways for P losses from agricultural soils are by run-off and erosion. From these diffusion sources, approximately 90 % emanate from agricultural lands (Schink, 1999). One consequence of such elevated anthropogenic P discharge is eutrophication, which causes the massive bloom of toxic blue-green algae in surface waters and oceans. Eutrophication is another threat to biodiversity (WRI, 2009). This can be observed, for example, in the Baltic Sea. One of the largest *dead zones* worldwide is located in the Baltic Sea. Dead zones are areas characterized by an oxygen content that is too low to sustain aquatic life due to eutrophication. Since their first appearance in the 1970s, the number of dead zones increased to more than 400 in 2008 (Selman et al., 2008; see also Pelley, 2004). Together with other nutrients, 36,000 tonnes of P from agriculture are discharged annually into the Baltic Sea (Paulsen et al., 2002).

Closed P cycles in agriculture and P recycling will play a fundamental role in minimising negative environmental impacts from agriculture and in conserving P resources. Organic farming aims at closed nutrient cycles. In addition, livestock densities are lower and animal feed is predominately produced locally. P may be applied as rock phosphates so that the problem of uranium contamination affects organic farmers, too.

The use of sewage sludge on conventional farms bears the risk of non-reversible soil contaminations with organic and inorganic xenobiotics. Meanwhile technological procedures have been developed that deliver safe fertilizer products (Schnug et al., 2008). When analysing challenges and limits of legislative regulations it is important to consider the previously addressed aspects. We will examine possible positive effects on soil, water, nature conservation, and health resulting from changes in agricultural production.

## 2 Administrative regulation of P fertilisation

How does legislation respond to P fertilisation? Unlike nitrogen, P from agricultural sources is not subjected to a European regulatory approach. Also on the national level, there are only isolated environmental regulations; conservation of natural resources is even less considered. The problem will be demonstrated in the following section. Further, we will illustrate how overall limitations of possible administrative regulations with respect to P fertilisation and alternatives can be interpreted.

### *2.1 Applicability of diverse regulations in soil conservation, water, waste and fertilizer legislation to P fertilisation*

Regulations on P usage could be set up at the interface of soil protection, water, fertilizer and waste legislation. Technically speaking, these domains work with regulatory requirements, hence with orders and prohibitions ("command and control"). No soil framework directive has been enacted so far on EU level though it had been planned several times (Valentin and Beste, 2010). For this reason, our focus is on the national level with Germany serving as an example. From an environmental point of view the P issue should be integrated into soil protection legislation. The purpose of the BBodSchG stated in § 1 is the sustainable safeguarding or rehabilitation of soil functions (Bioabfallverordnung, 1998). To achieve these goals, § 1 S. 2 BBodSchG claims that "harmful soil alterations need to be held off"; moreover, "provisions need to be taken against adverse soil impacts" (precautionary principle). Basically, this law is just applicable for adverse soil changes and brownfields according to § 3 para. 1 BBodSchG. While the scope of application is positively described, numerous soil-related activities are directly excluded. This affects the regulations stated in numbers 1 to 11 of the exclusion catalogue insofar as they regulate soil impacts. This may have direct or indirect consequences for soil functions with respect to § 2 para. 2 BBodSchG if such a behaviour is subject to these special regulations. Then they obtain primary application. This is also the case if the overriding regulation lags behind the standard of the BBodSchG (Sondermann/Hejma, 2005).

Focusing on fertilisation in agriculture, two normative complexes become relevant to which the BBodSchG is subsidiary when impacts on soils are regulated. According to § 3 para. 1 no. 1 BBodSchG, these are regulations concerning the effect of recycling management and waste legislation on the application of waste as approved secondary fertilizers or as farmyard manures and slurries, and laws enacted on the basis of the recycling management and waste legislation as well as the sewage sludge regulation. The second relevant normative complex is § 3 para. 1 no. 4 BBodSchG, "regulations of the fertilizer and plant protection legislation".

Requirements for recycling management for fertilizer production are covered in § 8 KrW-/AbfG (Kreislaufwirtschafts- und Abfallgesetz, 1994). According to § 8 para. 1 KrW-/AbfG, the German federal government may enact a non-parliamentary regulation that determines the requirements to secure the correct and inoffensive application in accordance with para. 2. In individual cases it is possible, pursuant to § 8 para. 2 KrW-/AbfG for the application of secondary fertilizers, farmyard manure and slurry on agricultural, silvicultural or horticultural soils, to mandate "prohibitions or limitations according to characteristics such as constitution and composition of soils, area and timing of application, and natural habitat" as well as "analysis of waste or farm fertilizer or soils, methods to pretreat these materials or other appropriate methods." By using the term "inoffensive application", it is referred to § 5 para. 3 sentence 3 KrW-/AbfG. Accordingly, an application is deemed to be inoffensive "if waste composition, level of pollution and method of disposal are not likely to impair the public interest".

A definition of public interest, without which the term inoffensive application would be meaningless (Ekardt, 2007) , is given within the principles of waste disposal. It is compatible with common welfare, stated in § 10 para. 4 sentence 1 KrW-/AbfG. An impairment of the public interest is particularly given when the soil is affected in a destructive manner. This also holds true for waste disposal (Frenz, 2002). Therefore, § 8 KrW-/AbfG regulates impacts on soils. With the enacting of the BioAbfV (Bioabfallverordnung, 1998), which states the requirements for application of bio-waste and compost on soils, this has recently led to a priority handling that proceeds soil protection legislation (Frenz, 2000; Hipp et al., 2000).

The same conditions apply for the AbfKlärV (Klärschlammverordnung, 1992) on the grounds of § 15 para. 2 AbfG a.F. The regulation subject is the usage of sewage sludge according to § 1 para. 1 no. 2 AbfKlärV. Prerequisite for its legitimate application is according to § 3 para. 1 section 1 AbfKlärV "not to impair the public interest and that application methods, timing and quantity are aligned to the plant nutrient requirement under consideration of soil nutrient content and organic substances as well as of location and cultivation conditions". Accordingly, soil protection against P-induced ecological damage is addressed by both BioAbfV and AbfKlärV (Frenz, 2000; Brinkmann, 2008; Meinert, 2005).

Besides regulations of the waste legislation relevant to slurry and sewage sludge, regulations of fertilizer legislation and hence regulations on mineral fertilizers also precede the BBodSchG insofar as they regulate impacts on soils. Among these are DüngG (Düngegesetz, 2009a), which has replaced DüngMG (Düngemittelgesetz, 1977) without substantially altering its content, and those regulations which were enacted on its basis. DüngG contains regulations with respect to the marketing and application of fertilizers. Fertilizers are legally defined in § 2 no. 1 DüngG as substances which are applied directly or indirectly to crops in order to enhance and improve their growth, yield or quality. According to § 5 para. 1 DüngG, they are only allowed to be marketed commercially if they comply with the stated requirements, conform to the specifications of European law, and most importantly do not compromise the natural environment. The requirements for fertilizer approval are specified in DüMV (2008). Accordingly, fertilizers must not cause damage to plants, plant products or soils. The same is true for the application of approved fertilizers. Pursuant to § 3 para. 2 DüngG, they are only allowed to be applied according to the codes of good agricultural practice (GAP). This implies that fertilizer practice, quantity, and timing must be aligned to plant and soil needs. This implies that plant-available nutrient pools, soil organic matter content, and location and cultivation practices are taken into account for dosage calculations. Regulations have been developed for the use of fertilizers and its impact on soils; these imply that fertilizer directives override the BBodSchG.

Regulations on secondary, farm and mineral fertilizers within BioAbfV, AbfKlärV, DüngG, and DüMV take precedence over the BBodSchG (Landel et al., 2000). In § 17 BBodSchG only GAP codes are postulated. According to this legislative concept, it is only possible to quote BBodSchG when soils have been impaired already (Härtel, 2002; Ekardt and Seidel, 2006; Ekardt et al., 2008). This basically means that BBodSchG disclaims any precautionary requirements, which are the subject of this norm from the outset (incidentally based on the authorisation for official assertion of such requirements) (Ekardt et al., 2008).

European and German water legislation (regulated particularly in the European Water Framework Directive (WFWD, Directive 2000/60 EG, Wasserrahmenrichtlinie (2000) and in the Federal Water Act (WHG) in Germany (Wasserhaushaltsgesetz, 2009b)) are not explicitly subsidiary to fertilizer or waste legislation with a view to ecological hazards (Ekardt et al., 2008; Ekardt et al., 2009a). However, the current status of WHG (Wasserhaushaltsgesetz, 2009b) does not include precise regulations for agriculture and fertilisation. Those passages on drinking water quality and various thresholds refer to obligations towards compliance with certain standards by the drinking water supplier, which have to clean (only) the drinking water. Farmers take no responsibilities yet. Further, general regulations on the quality of surface waters and groundwater were only applied for P fertilisation if fertilisation itself would be considered as water usage. This is contrary to common legal belief. *A priori*, neither water, nor soil protection legislation address the resource aspect of P.

### *2.2 Tangible legal requirements for P fertilizer application – reasons for regulation deficits*

Regulations for P with respect to resource limitations and the environment direct towards waste and fertilizer legislation. Pursuant to § 3 para. 2 DüngG, fertilizers are only allowed to be applied in accordance to the GAP codes. Fertilisation based on this principle aims at satisfying the nutrient demand of the crop, and to maintain and enhance soil fertility. According to § 3 para. 2 DüngG, fertilisation management must correspond with type, quantity, and timing of plant and soil needs whilst taking plant-available nutrients and soil characteristics into account. Location and cultivation conditions are inasmuch considered as aspects of crop quality and production costs. This is stated in the DüngV (Düngemittelverordnung, 2007), which was enacted on the basis of § 3 para. 3 DüngG. There it is specified that fertilizer rates need to be determined before each application (§ 3 Abs. 1 DüngV). Timing and dose calculations should match the requirements of the crop plants (§ 3 Abs. 4 DüngV). Regular soil analyses are obligatory in order to determine the plant available nutrient pool (§ 3 Abs. 3 DüngV). The application of fertilizers with high nitrogen or P content is prohibited during winter months (§ 4 Abs. 5 DüngV) or on water-saturated, flooded, snow-covered or frozen soils (§ 3 Abs. 5 DüngV). In order to prevent nutrient run-off, a minimum-distance from surface waters must be maintained (§ 3 Abs. 6 DüngV).

The following regulations are additionally provided in order to prevent a P surplus: According to § 3 para. 3 no. 2 DüngV, available P contents in soils must be determined at least every six years. In addition, the farmer must prepare annually a nutrient balance. This can be done for instance on the basis of a surface balance. The nutrient balances must be provided to the appropriate agricultural authority upon request. This is stated in §§ 5 Abs. 1 and 6 para. 1 DüngV. As long as the nutrient comparison does not exceed a nutrient surplus of on average 20 kg per hectare, it is assumed according to § 6 para. 2 no. 2 DüngV that the fertilizer rate met plant requirement and, as a result, was carried out in accordance with the GAP codes.

It is encouraging that the amendment of the DüngV led to the tightening of fertilizer legislation in several points. Currently more stringent obligations exist for a crop-specific, demand-driven fertilisation, periods when fertilizers cannot be applied, and the minimum safety distance to water bodies has been extended. However, many regulations of the DüngV are too general and too poorly defined (SRU, 2008) for realising good agricultural practice. A good example is the calculation of nutrient balances. It is regulated by § 5 para. 1 DüngV to establish a nutrient balance sheet for a certain acreage. Such a balance sheet compares the nutrient input in the form of industrial fertilizers and farmyard manure per acreage with the output in the form of harvest products. Because this approach does not require a livestock balance sheet and because guide values can be used for its calculation, the outcome is only of limited benefit on livestock farms which have the strongest problem with P surpluses. A verification of the calculated value proved to be difficult (SRU, 2008).

Current administrative law does not address the issue of regulating P resources. Using farmyard manures and secondary fertilizers such as sewage sludge (its use is regulated in the BioAbfV and AbfKlärV), contributes to preserve P resources. In case of farmyard manure, excessive nutrient loads occur regularly on intensive livestock enterprises and need to be regulated more stringently. The application of sewage sludge has been evaluated critically as undesired organic and inorganic compounds are applied to the soil.

§ 3 BBodSchG with its eleven amendments was created in order to define the functions of the BBodSchG. Thus vital areas of quantitative and qualitative soil conservation and also fertilizer use have been exempted from legislation (Peine, 1997; Peine, 1998; Peine, 2003; SRU, 2000 and 2008; Ekardt and Seidel, 2006; Ekardt and Lazar, 2003). Similarly, water legislation relies upon regulations of the waste and fertilizer legislation. As it has been shown previously, fertilizer legislation hardly aims at environmental protection and a sustainable use of resources (SRU, 2008; Ekardt and Seidel, 2006; Peine, 2003; Kloepfer, 2004). Fertilizer rates are based favourably on economic criteria (Sattelmacher and Stoy, 2004). Regulations take soil conservation and P application only rudimentarily into account. As a consequence, P surpluses are regularly excessive on intensive livestock farms.

The issue of a potential P scarcity has not yet been implemented in law at all. The contamination of soils, with uranium for instance, is not regulated (Ekardt and Schnug, 2006). There is also a deficit in addressing the environmental and resource aspects of P in waste management. An insufficient approach to tackle the resource problem is the use of sewage sludge, but relevant ecological and potentially health-threatening side-effects are regularly underestimated.

A further point of criticism is the still inadequate implementation of legal prerequisites. These shortcomings exist in case of the normative addressee, that means the individual farmer. The farmer is in a conflict between economic and ecological interests. The maintenance of soil fertility is the basis for crop productivity so that farmers are obliged to maintain soil functions. However, farmers often decide on the basis of short-term profit expectations. The European agricultural subsidy system supports such short-term, output-oriented perspectives. Shortcomings in implementation continue on the applied normative level. Agricultural administration monitors agricultural operations in line with the DüngV (Weins, 2001; SRU, 2008). Because administrations give priority to sectoral interests when it comes to implementation of legislation, their commitment to convey policy goals with a view to resources and environment is only marginal (SRU, 2004 and 2008; Koch 2007). Expectedly consumers are generally pleased with the alleged low price for food.

The reasons for the subordination of ecological and resource-political questions are a multi-layered vicious cycle involving farmers, consumers, politicians, law applicants, fertilizer producers, and others (Ekardt, 2009a). In addition, anthropogenic constants such as the narrow space-time focus of human emotionality on the here and now as well as habits and convenience will make it difficult to increase the awareness of a long-term and currently hardly visible P resource problem in a resolute manner. Another counter-productive fact is that the environmental and resource P problem can not be solved by individuals, but requires general acceptance by society.

*2.3 Options for reformation and limitations of administrative law in soil conservation*

Unrestricted action without government control or the self-regulation of farmers has proved to be not successful to solve ecological problems (Ekardt et al., 2009b). A solution might be a stricter command and control legislation. This seems to make sense from the point of view of transparency, motivation, and ecology. Preferentially, this should be realized on the EU level because P is a global rather than a national issue. Actions should imply a resource-political and environmental policy perspective. However, the EU nitrate directive (Directive No. 91/676/EWG , 1991) only regulates nitrate application in agriculture although P contributes essentially to eutrophication. It is suggested to implement regulations on the application of P in the nitrate directive. An alternative is a separate P directive, which should cover also the resource aspect (Härtel, 2002). Besides regulations for P, a national and European precautionary concept for soil and resource protection is missing. On the national level, the term "codes of good agricultural practice" could be amended, for instance by providing site-specific and crop demand-based upper P input values (Kloepfer, 2004; Salzwedel, 1983). From a resource and environmental policy perspective, fertilizer rates could be stated accordingly.

Even if such limitations in P use would decrease crop yields this would be justified from the viewpoint of consumption because vast amounts of food are simply wasted in western societies (Stuart, 2009; Henningson et al., 2004); another aspect is the over-proportional meat consumption in western countries. It is recommended to use the farmgate rather than the field balance because it includes all nutrient fluxes such as seeds, fertilizer, feed, animal, crop yield and farm fertilizer (SRU, 2008; Frossard et al., 2004). Last but not least, P use in animal feeding ought to be reduced structurally and the upper limit of 170 kg/ha N for the application rate of slurry in combination with the unlimited use of mineral N fertilizers needs to be reconsidered. As an alternative, a maximum input of N by organic and mineral sources for various crops should be discussed in order to close nutrient cycles and reduce nutrient losses to the environment. The enforcement of the respective regulations would have to be improved by concrete norms, stricter monitoring and a legal basis not subject to administrative discretion (SRU, 2008).

Although such (and perhaps also other) reform options with respect to P fertilisation would be quite welcome, and have been discussed in part for a long time (of course without their being implemented), there are a number of reasons for assuming that the administrative regulatory approaches described in this paper will not succeed eventually in solving the resource and environmental problem of P:

- The enforcement problem in agriculture can hardly be solved with a command and control regulatory approach because an unmanageable number of small processes need to be monitored. The vision of a policeman on every tractor is hardly realistic (Möckel, 2007; SRU, 2004 and 2008; Ekardt et al., 2008). Also, as it has been shown, one cannot solely count on self-regulation in agriculture and elsewhere.
- Administrative approaches (command and control) often have the disadvantage of shifting environmental problems to other areas unexpectedly (Ekardt and von Bredow, 2010). If the EU were to decrease P use, this might trigger intensified cultivation outside the EU or initiate a massive enhancement of research in genetic engineering. Green genetic engineering may contribute to a more efficient P use in the field of animal feed by producing transgenic crop types. Nonetheless, using genetic engineering often proves to be at best a second-best solution. In principle, the use of genetic engineering collides with the sustainability aspect of not triggering any irreversible processes. Yet the use

of genetic engineering mainly distracts from important concerns about a healthier, less meat-based diet, less pesticide-focussed, less fertilizer-dependent, and less industrialized agricultural practices. Irrespective of the finiteness of P, the application of genetically modified products (such as seeds) is limited in developing countries due to high pricing (Ekardt et al., 2009c; Ekardt, 2011).

- There is one more problem inherent to all similar command and control solutions: administrative legal systems are often prone to individual case-based exceptions, discretion, or weighing. These expectations can often thwart the spirit of the legal norm through frequent application.
- Further, it is difficult to translate aspects such as long-term preservation of food security into administrative legal criteria (command and control) since they do not directly correspond to individual fertilizer application (Ekardt and Hennig, 2009).
- The essential problem of the ecological impact and particularly the resource problem of P is that a *single* fertilizer application is not critical. It is the overall P consumption in agriculture and a high P surplus on intensive livestock farms that has to be reduced.
- It is therefore necessary to find a regulatory approach that captures the required holistic perspective. Only a limitation in the total quantity of all P used (ultimately on a global scale) and at the same time much more enhanced P recycling can actually achieve the necessary resource conservation while at the same time alleviating ecological impacts. Absolutely central to this thinking is the realisation that creating regulations solely focusing on efficient P application will not suffice. Indeed, any reduced P application "per plant" in the current food crop system represents *prima facie* a gain. However, if at the same time the area of currently unused land is increasingly used for example for feed crop cultivation (triggered by globally rising meat consumption) or for bio-energy plants, the required absolute reduction in P use cannot be met. This problem of impending rebound effects is currently being realized in the climate change discourse – and even here not often enough – yet it also exists within the resource problem. It should further be pointed out that the resource problem can ultimately be solved on a global scale only. A reduction of P in the EU would certainly help the ecological problem of waterways and soils, yet the resource problem would remain – increasingly declining global P supplies would likely be used elsewhere.

Our global food security would not be put at risk, because any genuine quantity regulation that includes manure measurement would make the production of food of animal origin unattractive. Important to note is that one calorie of food from animal origin requires four to twelve plant-based calories. Thus food security would probably be stabilized, partly because of the obtained P savings. This is likely to result in the promotion of ecologically advantageous, cycle-oriented forms of land use such as organic farming. Apart from natural circulation systems on farms, the agenda could be set for consistent efforts to recycle P from residues such as from the sewage sector or the waste industry back into agriculture. From an ecological and health perspective, this implies to clearly counter-acting the impending overload of soils with heavy metals and organic pollutants through new recycling and treatment concepts, a task which has not been sufficiently integrated in the past.

The fact that thoughts on small-scale regulatory improvements almost exclusively dominate the debate, despite the obvious frictions presented, might seem more remarkable than it actually is. The previously described individual types of motivation of the public, entrepreneurs, legal practitioners, and politicians do indeed promote approaches which may demand no substantial behavioural changes of those involved. Rather, they seemingly provide technical problem solving. Apparently, most people involved fear nothing more than some sort of debate on "abdication", in which the durability and global realisation of our occidental resource use (for example our high meat consumption) would need to be discussed in depth and not only in the language of euphemistic speeches. If at this point (predictably) many administrators, lawyers, and others might possibly try to avoid the debate by pointing out that such a new approach might not be politically enforceable, and thus cannot be further discussed, then the existing majority options in western countries are, of course, correctly described. Admittedly, this would then (1) not be an objective practical constraint, but an (explainable, see above) behaviour of concrete people in politics, administration, the public and farming community, for which all these would need to take responsibility, especially with respect to resulting consequences. Further, one should then (2) admit that thus a real solution for the P problematic probably cannot be attained, with all the highly negative long-term consequences of such a business as usual policy.

## 3 Soil protection through economic instruments such as subsidy reform, charges, and certificate markets

A global approach to quantity control (see Ekardt, 2011 and 2009b) is simpler to enforce than "command and control" approaches, prevents shifts in location (because the normative addressees cannot avoid quantity control anyhow), removes the rebound problem, and ideally tackles a given problem (also in the case of P) at its roots. Global quantity control can therefore be, where necessary, less bureaucratic and democracy-friendly because the legislative body and not the administration with their multifaceted actions for concretisation make the real decisions. Further, quantity control potentially provides more freedom because within a given quantity frame it leaves the freedom of decision to the citizen. However, what is not implied is that such a quantity regulatory approach should generally replace any other soil protection; even in those areas where it would be appropriate to have such an approach (such as in the context given), it might become necessary to develop additional administrative law regulations, for instance, for the use of sewage sludge: On one hand it should be increasingly used, on the other hand this is only possible under certain ecological and technical premisses.

A clear re-arrangement of EU subsidies in the agrarian sector towards subsidies for environmental services seems to be an appropriate tool for a quantity regulation of P. This stands to reason also from a fiscal perspective and for world trade legislative reasons. An alternative would be the introduction of a fee on mineral (P) fertilizers. Such a possibility has been discussed before for nitrate (SRU, 2004 and 2008; Möckel, 2007; Ekardt et al., 2009a). Alternatively, friendly enforcement from fertilizer producers might be feasible (Möckel, 2007; SRU, 2004). A global or European fee is an option if the P resource problem is addressed separately from the ecological problem whilst taking the global agrarian market, particularly the animal feed market into account. It is important to start as soon as possible with these suggested measures because of the time lag of effects. First results, particularly with respect to eutrophication, are likely to be visible only after decades.

An approach focusing on raising taxes would simultaneously tackle many other problems beyond the P issue (see IV below). The same effect that is provided by a tax could perhaps be achieved with a certificate-approach similar to the global greenhouse gas emission trading system, by creating entitlements to P and by gradually reducing P certificates on the global scale. A further alternative might be provided by a general certificate approach on land use, which could be linked to a completely newly designed European and global greenhouse gas emission trading system. The latter approach would establish different, typified land use type certificates depending on the degree of their ecological relevance and would then again gradually reduce them on the global scale. From a climate-policy perspective, including land use in the climate regime is in any case on the agenda. However, severe enforcement difficulties are expected (also on the operative level due to determining the ecological value of certain areas and land use types). Yet they will be even more apparent in administrative legislative global solutions. The easiest approach might well be to establish a parallel global certificate market for P and for greenhouse gas emissions. A subsequently resulting price and cost pressure and the resulting changes in land use would certainly also be indirectly beneficial to other land use problems (this is further elaborated in the following section).

In European law, article 9 WFWD suggests an economic solution for the P issue, particularly with respect to water bodies. Here, fertilisation is considered as being a form of water usage, not a water service because it does not comply with the definition given in article 2 no. 38 WFWD. Article 9 section 1 sub-section 1 WFWD postulates that all services that are (partly) responsible for P recovery costs must contribute financially. For agriculture, this approach concerns any surplus P fertilisation; costs for P and uranium extraction have to be taken fully into account. Fertilizer production needs to be considered where it impairs water quality.

P use and, in general, any administrative law or quantity control approach eventually leads to implications for social distributive justice. This does not only refer to conflicts between economic freedom and the protection of physical preconditions of freedom (in parts also guaranteed by fundamental/ human rights), which are always present in environmental protection (Ekardt, 2009a). Rather, it refers to secondary effects that arise from the resulting compromises between these different rights in environmental policy. In other words, harm and benefit arising from P application do not always align. This problem has a national and global dimension (Ekardt, 2009a; Ekardt et al., 2010). Declining P reserves are likely to result in higher prices and quality degradation due to higher heavy metal loads. While industrialized countries are still able to pay prices for higher quality and fertilizers in general, developing countries are likely to face severe availability and accessibility problems. Moreover, soils in the southern hemisphere are currently exposed to substances such as uranium for a production that is mostly consumed in industrialized countries. However, especially these questions on distribution speak for quantitative regulation rather than administrative law regulation because the former can be combined with social adjustment payments such as paying higher prices for foodstuffs and other commodities. Such compensation payments could, for instance, distribute the revenues arising from a charge or from a certificate system auctioning per capita to the citizens of every state. Another option would be to partially or completely frame them as a North-South transfer.

Social reconciliation is especially important because phosphorus in developing countries is often used in large quantities. However, products are to some degree also being exported so that fertilizer costs could be passed on to western importers. The example of phosphorus (and more precise of phosphate rock) also shows that different resources cannot be considered in isolation from each other. If a quantity control of phosphorus would be realized without the climate gas quantity control including both primary energy and land use (which would make land use more expensive than today; for details see Ekardt, 2011), then this would risk using less phosphorus and in contrast an increase in forests clear cutting. Moreover, and similar to the carbon debate, one could also consider if phosphorus allocation or respectively fees should be linked to the primary resource, phosphate rock, or rather to the end product, such as meat.

## 4 Soil biodiversity – another problem in sustainability

A strict quantity control of P input or land use will most likely tackle several problems such as mass production of livestock, deforestation, land consumption, and climate change. Yet another soil protection domain concerns the interaction between soil (protection) and biodiversity. The loss of biodiversity is a major problem which is closely related to the deterioration of soils. The last key inventories in agriculture are for example the World Development Report (2008). The current *status quo* analysis in these reports confirms a manifold increase in land and labour productivity in European agriculture over the last century. The main reasons for the increase in productivity are the mechanisation of agriculture and the intensive use of fertilizers and pesticides together with the cultivation of high-yielding crop varieties.

The conversion of natural habitats to agricultural land is the most important reason for the loss of biodiversity on a global scale (Giger et al., 2008). With respect to genetic variation, only ten crop plants cover 90 % of the world's crop production. Subsidy strategies, industrialisation of crop production and processing, with only a few globally active food production companies are the main reasons for this development. During the last fifty years, availability and subsidy of pesticides and fertilizers have essentially led to an irrecoverable loss of about 70 % of genetic variety in agricultural crops (Bongert and Albrecht, 2008).

The European Union and the German government obliged themselves to end the loss of biodiversity by 2010. On the national level, the majority of species which are typically found in the German cultural landscape are supposed to be protected by 2015. It is the aim to increase biodiversity in agro-ecosystems by 2020 (Düngemittelverordnung, 2007). More research is required to establish a solid basis for political actions. For this purpose, the EU put out a tender on July 19, 2008 for a research contract on the evaluation of tools within the scope of policies for protecting biodiversity within the 27 EU member states. In Germany, measures should include a more stringent integration of relevant standards into agronomic legislation. Then, the principle of the GAP codes must be expanded by integration of biodiversity. In theory, by 2010 integrative strategies for increasing agro-biodiversity shall be compiled and by 2015 adequate consulting, funding, and monitoring instruments shall be established.

Biodiversity is not recognized as a subject of protection itself. In contrast, biodiversity has extensive economic implications and additional service functions for humanity. Issues such as resource use and biodiversity do not primarily compromise freedom. Rather, they seem to be of real value for mankind in various ways. This certainly does not mean that the overall relevance of biodiversity for humankind, its freedom, and its freedom prerequisites can be expressed in monetary values. Economists may claim such a viewpoint. Certainly, it would be easier to communicate the eligibility of biodiversity protection if an exact economic value could be defined (for instance with respect to productivity or climate relevance of soils). However, to define an artificial monetary value of biodiversity on its own would distract from the idea that securing the basis of life on a long-term basis relates to the life and health of people. Even economic value calculations on a hypothetical willingness of people to pay for biodiversity will not change this perspective since such calculations deserve harsh criticism for many reasons: Any hypothetical willingness to pay is fictive and hence not significant; the willingness is also limited by the individual ability to pay (hence Bill Gates' vote would count a million times more than that of an unemployed person) (Ekardt, 2011).

Lessons to be learned from the P problems are that waiting, self-regulation, and implementation in GAP codes will not be successful. Again, the different predicaments need to be ultimately tackled at their roots even if critics consider (soil) biodiversity as renewable resources.

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