Phosphorus, Governance, and the Law

Summary

This article broaches the legal treatment of the non-substitutable nutrient phosphorus, which is indispensable for life and its major n, non-renewable source, phosphate rock. We not only address the case of a highly important resource problem that has hitherto received little attention in the legal discourse, but also focus on the excessive and wasteful entry of phosphorus in the environment. This leads to significant harmful effects on ecosystems, which are particularly evident in the long-term and subtle impacts of P accumulation in waters and soils. The paper presents this problem field and demonstrates that European and German fertilizer and soil regulations are at best weak when opposing the existing resource and pollution trends. Insufficient regulations in the above mentioned legal domains lack concreteness, real enforcement, prevention of relocating problems and a safeguard for absolute quantity reductions in phosphorus use. Without, it will not be possible to effectively address ecological and resource problems because policies related to phosphorus use will otherwise be constrained to constant consideration on an individual basis, where every individual case might be deemed to entail ”few negative consequences“. Yet it is the sum of multiple minor actions of phosphorus users, that can lead to ecologically and resource-related fatal consequences. We hence argue that it is not sufficient to increase efficiency in phosphorus uptake “per individual plant” if at the same time crop cultivation is expanded to previously unused areas, for instance for greater animal feed crop (due to a globally rising meat consumption) or bioenergy plant production. It will be impossible to achieve the necessary absolute phosphorus use reduction. We conclude that this will lead to a new fundamental perception in environmental policy at large: “Technical solutions”, ”command and control” law and resource efficiency alone do not tend to solve resource problems or quantity problems if at the same time, (global) production increases or remains on a constant high level.

Keywords: sustainability, resource policy, phosphorus, soil protection, eutrophication

I. Problem statement: phosphorus and sustainability – environmental and resource aspects

The sustainability principle constitutes a starting point for modern soil protection, and in more general terms, for modern environmental policy at large. Sustainability, as the terminological fusion of the claim for more intergenerational justice and global justice, has experienced a remarkable path over the last 15 years.[1] However, western societies are currently pursuing a

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[1] For detailed information on the sustainability principle and against the widely occurring suppression of the decisive space-time-dimension as well as its replacement by the three-pillar-formula, see Ekardt 2010, Ekardt 2009a, p. 223 et seq. These works stress sustainability not as a meaningless term representing everything good and desirable in the world but rather as a concept which transmits the following relatively concrete content: Justice (the requirement for „fair“ regulations and organization structures for cohabitation) ought to incorporate time-space remote interests and concerns in a more potent way. This does not exclude other relevant interests such as ”economic growth here and now“ since weighing all relevant interests is crucial in finding justice. Yet concrete sustainability calls for lasting and globally maintainable lifestyles. A similar argumentation direction (albeit in part less clear) is taken in: World Commission on Environment and Development 1987, p. 43; Lee

lifestyle that is neither maintainable in the long term nor globally applicable. At the same time, a major proportion of the world population lives in stark poverty. Key elements of sustainability are related to a stronger focus on use of renewable resources in agreement to natural renewal rates as well as more conservative use of non-renewable resources. The essential nutrient phosphorus is indispensable for plant, human and animal life. And phosphorus plays an essential role in soil fertility (Schröder et al. 2011). Phosphate rock is mined in geological deposits and these deposits provide an finite amount of Palso. To date, phosphorus has not received the adequate public attention: Neither as a resource in form of phosphate rock, nor as environmental issue. For a long time, discussions have been mostly limited to its role as an environmental pollutant. However, over the last five years, evidence has emerged that phosphate rock might become scarce in the foreseeable future (Dery& Anderson 2007, Cordell et al. 2009; Vaccari 2009; Gilbert 2009). Similar to "peak oil" for oil's peak production prognosis, researchers predict a peak in phosphorus production in twenty (Cordell et al. 2009) to several hundred years (Van Kauwenbergh, 2010) depending on the data and calculation. Predictions as to how long global resources will last depend among other variables on the profitability of mining, and henceforth on the market price and its fluctuations. The finite nature of phosphate rock and its importance for global food security is now increasingly discussed and debated (Mew 2011, Schröder et al. 2010; Seyers et al. 2011, Van Kauwenbergh 2010; Van Vuuren et al. 2010). Intensive agriculture (both crop farming and animal husbandry which requires considerable amounts of feed) regulalry applies substantial quantities of mineral phosphate fertilizer. This fertilizer is being manufactured from phosphate rock, and the main deposits are located in northern Africa (Harben and Kurzvart 1996). Although the assured reserve base amounts to 47 billion tons (Jasinski 2009), its mining is currently considered to be economically and technically feasible only on a very rudimentary level. In 2008, 80% of all mined phosphate rock in the world was being synthesized to industrial fertilizer for agricultural application (IFA 2008). In 2009, this amounted to 158 (Jasinski 2010) million tons. This makes modern agriculture highly dependent on phosphate fertilizer and at the same time also vulnerable to shifts in supply. Germany, for example, does not have any deposits and therefore must import its necessary supply for industry and agriculture. In 2005, this corresponded to a total of 87 000 tons of unground phosphate rock, 79.9 % of which originated from Israel and 17.3 % from Russia (Röhling 2007, p. 23). Developed countries import great quantities of phosphorus from developing or emerging countries via inexpensive animal feed to cover the immense demand arising from intensive animal husbandry. The export of P bound in feedstuff, energy crops or any other plants from often marginal soils in developing countries to highly loaded soils in industrialised countries will favour P mining of soils under the constraints of limited P resources as access to the essential resource P is costly. In contrast, P surpluses in soils of developed countries are enforced and contribute further to the eutrophication of water bodies. Ahvenharju et al. (2010) showed that national programmes on nutrient reduction in the Baltic Sea Region were initiated but are in action only in a limited number of countries, and permit systems for animal farms are under way but it remains to be seen whether the quota are sufficient to efficiently reduce nutrient surpluses.

This paper is hence dedicated to the issue of sustainability in soil protection, exemplified by the macronutrient phosphorus. In doing so, it takes on the resources problem as the second

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2006, p. 1.; Ott/ Döring 2004; see also for critics on the current sustainability discourse Siemer, in: Ekardt 2006.

important global issue after climate change.[2] Our goal is to excerpt and highlight problems in phosphorus use from a legal and policy perspective, taking into account the feasibility of long-term and global (hence sustainable) practice in handling.[3] Overall, we present an aggregated perspective on how sustainability in soil protection can be moved forward.

Soil represents, together with water and air, an elemental prerequisite for life. As part of the natural livelihood for humankind, soil serves as the nutritional basis for plants and animals and is the production basis for foodstuff and animal feed (Sparwasser et al., 2003; §9 No. 2 et seq.) As a non-renewable resource, its utilization must be aligned with the precept of sustainable management. Sustainable soil utilization calls for use that is adjusted in manner and scope to the needs of the current generation; yet such global utilization 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 fulfill their needs and choose their lifestyle freely. The German federal soil protection legislation declared soil maintenance and restoration as a goal. (Bundes-Bodenschutzgesetz/ BBodSchG).[4] Since its implementation more than ten years ago, still ongoing, hardly reversible soil degradation remains alarming (SRU 2008, No. 533).

For years, one of the most significant problems with soils have been intensive and locally not well adapted soil management and cultivation practices, primarily carried out by conventional agriculture. Intensive livestock farming is still the major source for non-point nutrient pollution of water bodies and atmosphere (Isherwood, 1998). Environmentally harmful nutrient surpluses are characteristic of livestock farms, not of arable farms and this problem is known since long (Schumann et al. 1997; Vermeulen et al., 1998).The studies of Schumann et al. (1997) showed impressively that nutrient surpluses were extraordinarily high on livestock farms as farmers used in addition higher mineral fertilizer rates. A site-specific nutrient management employing precision agriculture technologies would improving the nutrient efficiency, and additional value could be added to this basic application. A very important side effect of a site-specific nutrient management could be the control of the whereabouts of recycled wastes, both from animal production and industry outside agriculture (Haneklaus and Schnug, 2006). The obligatory use of Precision Agriculture technologies would therefore ensure an efficient documentation of the whereabouts of these residues.

In Germany for instance, 52 % of all land is used for agricultural purposes. Next to the deposition of airborne pollutants and the application of waste, relevant diffuse input of contaminants and nutrients occurs in the form of pesticide and fertilizer application in agriculture (SRU 2008, No. 485, 492). For the global context it is estimated that more than half of agricultural land can no longer be deemed fit for unrestricted use because of soil degradation (Giger et al. 2008; Bongert and Albrecht 2008).

Agricultural crops require a pool of different mineral nutrients in different quantities for growth (Schnug et al. 2008). While these nutrients are present in most soils, only some frac-

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[2] 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, livestock farming, among others) present the climate problem in its very core.

[3] The paper presents a governance analysis; for details on its methodological combination of empirical investigations (however not in this case) as well as observations, secondary evaluation of empirical data by other researchers, thoughts on plausibility, theoretical conclusions, among others, see Ekardt et al. 2010, chapter II.

[4] Legislation on the protection against harmful soil modifications and clean up of contaminated sites (Bundes-Bodenschutzgesetz), dating from 17.03.1998, BGBl. I 1998, p. 502 et seq.

tions are directly available to plants. Moreover, with every harvest, the soil is being further depleted of its nutrients. Without their replacement, soils would become nutrient depleted and could no longer provide their natural functions (Sattelmacher and Stoy in: Blume 2004). Nutrients such as phosphorus, which are either unavailable in certain soils or consumed, need to be replaced by fertilizer application. For this purpose, different types of fertilizer are available, and can generally be classified as industrial fertilizer, farm fertilizer and secondary fertilizer (Kloepfer 2004, §19, No. 228; Härtel 2002, p. 48; Finck 1979, p. 15 et seq., SRU 1985, No. 406 et seq.). Industrial fertilizers are those that do not originate from farms. Rather, they are being produced commercially as soil additives for the purpose of fertilization and need to be bought by farmers. Most industrial fertilizer is mineral fertilizer and is mainly for nutrient supply, providing high, precise concentrations of the main nutrients. These are nitrogen, phosphorus, potassium, calcium, magnesium and sulfur. In contrast to industrial fertilizer, the term farm fertilizer comprises on-farm-accumulating and applicable residues such as animal excrement, manure, slurry and similar by-products. These residues, predominantly of animal origin, are suited for fertilization due to their nitrogen, phosphorus and potassium content. The third category of fertilizers, secondary fertilizers, comprises human excreta, sewages sludge, struvite, and similar materials from municipal waste and other sources.

Ecological problems from intensive phosphorus application also arise in respect to the energy and climate balance. Phosphorus mining, processing and marketing from the extraction site to the farm require substantial amounts of energy and other resources such as water, causing considerable emissions. Various adverse effects result for soils and water bodies. On the one hand, these are ascribed to heavy metals and radioactive substances often contained in fertilizers. In fertilizers with a P_2O_5-content of <5%, Cd concentrations of > 1 mg/kg Cd are obliged to be labelled. The corresponding limit value is 1.5 mg/kg Cd. For P-containing fertiliser materials with >5% P_2O_5 the obligation to label is a threshold of 20 mg Cd per kg P_2O_5 and the limit value is 50 mg Cd per kg P_2O_5. Compliance with this regulation is not controlled in every batch, but rather is the responsibility of the Düngemittelverkehrskontrolle (DMVK) of federal states in Germany. While the problem of cadmium contamination of mineral P sources is well-known, less attention has been paid so far to uranium. In this respect, it is important to note primarily uranium, which represents a direct (toxic and cancerous) peril for soil quality as well as for ground and drinking water (SRU 2008, No. 494, 497, 913 et seq; SRU 2004, No. 300 et seq.; Schnug and de Kok 2008; Ekardt and Seidel 2006, 420 et seq.). On the other hand, fertilizer application often leads to additional nutrient accumulation in soils because nutrient uptake of plants is limited. On average, substantially higher amounts of phosphorus and nitrogen are being applied for yield growth than what plants actually require. Over the years, such practices have resulted in considerable phosphorus accumulation in German soils.[5] High natural levels of phosphorus in soils are already being steadily increased by consistently higher than required fertilizer supplies of phosphorus (SRU 2008, No. 494; SRU 2004, No. 291; SRU 2000, No. 474; Härtel 2002, p. 51). The main reason for these soil loadings are excessive farm balances generated by the application of inexpensive mineral fertilizer application, especially in intensive farming operations, and the increasing industrialization of animal husbandry and its related necessary waste disposal of enormous amounts of produced slurry (SRU 2008, No. 1004; SRU 2004, No. 298). In soils, overapplication of fertilizers adds to soil

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[5] Currently, the overall application of fertilizers in Germany is slightly declining compared to an increase until the late 1990s. Yet it still remains at early 1990s levels (SRU 2008, No. 1004).

acidification, which in return results in reduced capacities of soils to filter and buffer nutrients and contaminants. Moreover, it impairs soil fertility. Exceeding site-specific absorption capacities generally leads to long-term, sometimes even irreversible impairments. Further, it derogates ground water, surface water, climate and the natural environment (SRU 2008, No. 494; Härtel, 2002, p. 52). Fertilizer application enhances the growth of particular plants only, but leads to the loss of other less-responsive plants and dependent animals. This is also one reason why intensive agricultural practices are blamed for the loss of biodiversity (Sparwasser et al. 2003; § 6 No. 14; Giger et al. 2008; Weins 2001; Schink 1999). If phosphorus input exceeds the adsorption capacity of soils, then phosphorus can be transported within the soil matrix, for instance into the ground water (SRU 2004, No. 317). Even more than groundwater, surface water is being affected by diffuse phosphate entry. Half of this load originates from diffuse sources, of which approximately 90 % emanate from agricultural lands (Schink 1999; for older data cf. Hoffmann 1979, p. 58 et seq).[6] One consequence of this increased, anthropogenic phosphorus entry is the massive bloom of toxic blue-green algae in freshwaters (Carpenter and Bennett 2011) and oceans (Selman et al. 2008), or generally speaking, eutrophication, which also substantially harms biodiversity (Schink 1999; Scheffer and Carpenter 2003). This can be observed for example in the Baltic Sea.[7]

Phosphate-deficient soils in some world regions and undesirable phosphate accumulations in soils in others, ecosystem degradation through considerable phosphorus losses into aquatic ecosystems, different interacting dynamics such as population growth, land use and climate change which alter demand and supply patterns, and human health implications can eventually lead to ramifications for ensuring universal peace (which is often addressed within the odd phrase of “geopolitical aspects”) as well as for social distributive justice, on the national and on the global level. We will come back to the latter aspect in the final section.

From environmental and resources perspectives, closed-loop phosphorus cycles as well as recycling phosphorus back to the land from various waste streams along the phosphorus supply chain will need to play a central role in the future. Compared to conventional agriculture, organic farming aims at closed nutrient cycles (it also tends to have a better profile in respect to uranium contamination). Moreover, animal density is lower, animal feed is possibly produced on-site (and imports are limited), and the use of mineral nitrogen and water-soluble phosphorus fertilizers is completely prohibited.. Obviously, the uranium problematic is nonetheless existent, insofar as that current EU regulation permits the application of (non plant-available) phosphate rock in organic farming. However, the ratio is smaller because fertilization is carried out to maintain soil fertility rather than to correspond to expected plant needs. In contrast, it is difficult to recycle phosphorus back into the system without causing harmful effects, such as is the case when sewage sludge is applied to agricultural land in order to preserve mineral phosphorus fertilizer. Despite these barriers, improved technological methods are increasingly

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[6] Phosphorus enters water bodies mainly by water and wind erosion. Problems of soil erosion have become worse over the last years. One contributory factor was the vast transition of grasslands to arable land in many parts of Germany as well as the resulting removal of hedges and wind breaks against wind erosion during the last decades. Current agricultural practices accelerate soil erosion since crop cultivation often does not allow for year-round vegetation cover. The existing risk is even increased by inappropriate cultivation practices (Sattelmacher and Stoy 2004, p. 280).

[7] One of the largest dead zones worldwide is located in the Baltic Sea. Dead zones are areas characterized by an oxygen content too low to sustain aquatic life due to eutrophication. Since their first appearance in the 1970s, the number of dead zones has increased to over 400 in 2008 (NASA 2009, Pelley 2004). Together with other nutrients, 36.000 tonnes of phosphorus from agriculture enter the Baltic Sea each year (Paulsen et al. 2002).

in place (Schnug et al. 2008). These processes are based on a thermo-chemical treatment of for instance sewage sludge and meat and bone meal (MBM) which eliminates organic contaminants completely and which delivers an end-product that has a sufficiently high plant availability of P. This is an important aspect of recycled and mineral P fertilizers in order to warrant a full utilization of phosphorus by crop plants on a long-term basis. For the following it is important to keep all these aspects in mind when we analyze the challenges and limits of legislative regulations. We will further consider possible additional positive effects on soil, water, nature conservation and health resulting from a change in agriculture that goes beyond conventional practices.

II. Administrative regulation in phosphorus fertilization

How does legislation respond to this issue? Unlike nitrogen, phosphorus from agricultural sources is not subjected to a European regulatory approach. Also, at the national level, there are only isolated environmental regulations; conservation and protection of natural resources is even less considered. This will be demonstrated in the following section. Further, we will illustrate how overall limitations of possible administrative regulations (command and control/ Ordnungsrecht) in respect to the issue (and later alternatives thereof) can be interpreted.[8] Regulations on phosphorus use 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"). Since EU and German regulations on water protection, soil protection and waste management do not deal with questions of phosphorus (for more details see Ekardt, 2011, § 6 E. V. 3. and Valentin and Beste, 2010), the question on resource and environment-related phosphorus regulations is directed towards fertilizer legislation:

1. Concrete legal requirements for fertilizer application – regulation deficits and its reasons

In German law, pursuant to § 3 para. 2 DüngG, fertilizers are only allowed to be applied in accordance to the "code of good practice". The intended purpose of fertilization according to this principle is to ensure necessary nutrient supply to the plant as well as to maintain and enhance soil fertility. According to § 3 para. 2 DüngG, fertilization alignment must correspond with type, quantity and timing of plant and soil needs in consideration of existing plant-available nutrients and organic substances in soils as well as location and cultivation preconditions. Whereas high quality and low cost products should be produced. This is concretized in the DüngV[9], which was enacted on the basis of § 3 para. 3 DüngG. There it is specified that the appropriate fertilization needs to be determined before every fertilization application (§ 3 Abs. 1 DüngV) and that application timing and application quantity should be chosen in such a manner that plants obtain nutrients in a timely and quantitative manner, which corresponds to the identified need (§ 3 Abs. 4 DüngV). Moreover, there is an obligation to carry out soil

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[8] Where appropriate, we will refer to a number of other publications (mainly in respect to climate protection) where the question of "quantitative control or administrative criteria regulation" as well as questions on the theory of sustainability, justice and governance are further elaborated.

[9] Regulation on the application of fertilizers, soil additives, cultural substances, and plant additives according to the principles of the code of good practice in fertilization (Fertilizer Ordinance) [Düngemittelverordnung] of February 27, 2007, BGBl. I 2007, p. 221 et seq.

analysis to determine the soil-inherent available nutrient quantity (§ 3 Abs. 3 DüngV), a ban on applying fertilizers with high nitrogen or phosphate content during winter months (§ 4 Abs. 5 DüngV) as well as on water-saturated, flooded, snowcovered 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).

In order to prevent an over-supply, especially with phosphorus, the following regulations are additionally provided: According to § 3 Abs. 3 no. 2 DüngV, available phosphorus contents in soils must be identified by the farm at least every six years. In addition, the farmer must prepare an operational nutrient comparison on an annual basis, amongst others, for phosphorus. This can be done either in the form of a balance sheet or as an aggregated "Schlagbilanz". Both must be provided to the appropriate agricultural authority upon request, as is stated in §§ 5 Abs. 1 and 6 para. 1 DüngV. As long as this nutrient comparison does not exceed, on average, an operational nutrient surplus of 20 kg per hectare during the last six fertilization years, it is being assumed according to § 6 para. 2 no. 2 DüngV that the application quantity corresponded with plant requirements and, as a result, was carried out in accordance with the code of good practice.

With respect to the application of the overriding fertilization legislation it is encouraging that the amendment of the DüngV has led to the tightening of current legislation in several points. At this time, for example, more stringent regulations are in place in respect to obligations for more appropriate fertilization, periods when fertilizers cannot be applied, and the minimum safety distance to water bodies has been extended. Admittedly, many regulations of the DüngV are too general and too poorly defined (SRU 2008, No. 971) to fulfill the code of good practice. Simply speaking, they do not go far enough. We want to illustrate this with the example of nutrient balance implementation, where nutrient input and output are compared to a certain reference value and time period. The resulting total is an important indicator for the environmental impact by nutrients. It is regulated by § 5 para. 1 DüngV to establish a nutrient balance sheet for a certain area. Such a balance sheet compares the nutrient input in the form of industrial or farm fertilizer on a given area to the output in the form of crops. Since this approach does not require a livestock balance sheet (Stallbilanz), and since for its calculation guide values can be used, it is only of limited value for animal husbandry (which is the major environmental problem with regard to phosphorus) and is difficult to check (SRU 2008, No. 1005).[10]

Furthermore, current administrative law has not taken account of any resources regulation in respect to phosphorus. Using farm and secondary fertilizers such as sewage sludge can help to conserve phosphorus resources and add to a stable nutrient balance. However, their application threatens to trigger nutrient excess and accumulation of harmful substances in soils because fertilizers are often loaded with organic pollutants and heavy metals. Moreover, the acceptable discharge is aligned to heavy metal content in dry matter and how much of dry matter is deployed per hectare. This allows for loads, which can be significantly higher than what is being extracted. In case of organic pollutants, critical values have been defined only for a strictly limited number of putative relevant components. Furthermore, there is no real regulation for the problem of increasingly excessive levels for ecosystems – not for excessive re-

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[10] Apart from this, not all operations are obliged to establish a balance. The exemptions in § 5 Abs. 4 DüngV note that due to the area size, on average, 47 % of the operations and at least 5 % of agricultural area are exempted from complying with the obligation to establish a nutrient balance, SRU 2004 (No. 309).

source deprivations resulting from high user rates in feed and strongly expanded livestock farming; ecological regulations do exist, however they are inadequate. The resource problem is tackled with the use of sewage sludge, but in a very limited manner and with considerable ecological and potentially health-threatening side effects. This could be said to an even greater extent for the production and the subsequent use of animal secondary resources resulting from intensive animal husbandry. All these points do not contribute to come to terms with the analyzed long-term risks and to prevent further ongoing deterioration of soil quality (SRU (2008), No. 516; Peine (1998); Ekardt et al. (2008)).

A further point of criticism is the still inadequate implementation of the - already weakly ambitious - legal prerequisites. These implementational shortcomings exist on the one hand toward the normative addressee, i.e. the individual farmer. The farmer is in the middle of a trade-off between economic and ecological interests. This conflict of aims might well be even more pronounced than in other areas of economic activity due to the income situation in agricultural soil cultivation. Because long-term quality conservation of soils represents the necessary basis for securing lasting yields, one would generally assume farmers being motivated to maintain good soil conditions. Instead, their behavior will often be oriented towards short-term profit expectations.[11] Moreover, the European agricultural subsidy system still rewards a short-term perspective by primarily counting on quantity in agricultural production. This encourages animal husbandry, which is problematic from an ecological and resource policy perspective. Shortcomings in implementation continue on the applied normative level. If monitoring takes place at all[12], then such action resulting from implied responsibilities of the DüngV is assigned to the agricultural administration, whose primary task is to represent the interests of agricultural operations. Since administrations give priority to realizing sectoral interests when it comes to implementation of legislation, one can hardly expect increased commitment on their part in respect to resources or environmental policy goals; existing loopholes are mostly used in favor of other interests, and enforcement of the incredibly modest legal requirements is neglected (SRU 2008, No. 484, 533; SRU 2004, No. 306; Ekardt 2001, § 6; Ramsauer 2008, p. 96). Sadly but unsurprisingly, consumers are often quite pleased with the alleged (short-term) low price of food.

The reasons for short-sightedness and the subordination of ecological and resource-political questions go deeper than the explanation of economic and administrative self-interests might indicate. Ultimately, it is a multi-layered vicious circle involving farmers, consumers, politicians, law applicants, fertilizer producers and others that mutually strengthens certain basic attitudes contributing to this context, since all participants are jointly dependent on each other.[13] This is why agriculture in its current orientation towards increasing short-term profit besides economic self-interests is also aligned to traditional values (such as “production increase”, illustrating the underlying concept of the omnipresent growth paradigm). Further, anthropogenic constants such as the “narrow” space-time focus of human emotionality on what is

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[11] It would otherwise be hard to explain why farmers have not taken preventive action towards the diagnosed ecological and resources-political phosphorus problem on their own accord.

[12] The federal government and the German Länder have agreed, upon pressure from the EU Commission, that the implementation of parts of the DüngV will be controlled within 5 % of those operations which are funded by the EU (Weins 2001). Substantial findings of fertilizers in the environment are however a clear indication that control and monitoring of good practice is so far obviously only insufficiently taking place in Germany; this can only be limitedly resolved by checks of the (weaker) Cross Compliance which are required by EU subvention regulation (SRU 2008, No. 971).

[13] On the double vicious circle and generally on reasons for non-sustainability see Ekardt 2009b, chapter II.

"here" and what happens "now" as well as habits, suppressions, and convenience will presumably make it rather difficult for most of those involved to face a long-term and currently "not visible" phosphorus problem in a resolute manner. Moreover, there is a problem with public goods: All those involved know that possibly the ecological problem dimension and definitely the resource-problem dimension in respect to phosphorus cannot be resolved by single individuals, which makes action often less appealing. These are generally the same problems that prevail within every societal transition towards increased sustainability.

2. Reformation options and limitations of the administrative law approach in soil protection

Hoping for a free play of actors and markets without government control (or the self-regulation of farmers, which also does not function: Ekardt et al. 2009, chapter 3) in respect to the phosphorus question has proven unsuccessful. Our root cause analysis strives to explain why. One way of dealing with this issue could be to demand stricter, more ambitious, and more concrete command and control legislation, which appears to make sense on first sight from a transparency, motivation and ecology perspective. Preferentially, the EU-level would appear to be appropriate since phosphorus does not solely represent a national issue, either from a resource-political or from an environmental policy perspective. Although phosphorus contributes essentially to eutrophication, the EU nitrate directive[14] only regulates nitrate application in agriculture. Perhaps regulations on the application of phosphorus could be implemented in the nitrate directive, or a separate phosphorus directive also taking on the resource aspect could be established (Härtel 2002, p. 387). All of this and hence a European precautionary concept for soil and resource protection is so far lacking. Similar steps could be required on the national level, for instance a redefinition of the term "code of good practice", since the boundary between fertilization and overfertilization has so far been drawn where further yield and quality increase is no longer possible by simply applying more fertilizer. The required amount of fertilization from an ecological and resources-policy point of view then is already exceeded because that limit stands below the agriculturally-defined optimal fertilization intensity (Kloepfer 2004, § 19 No. 232; Sattelmacher and Stoy 2004, p. 265; Salzwedel 1983, p. 41). From a resources and environmental policy perspective, this could be normatized accordingly. From a consumption perspective, decreased yields are quite justifiable in the face of the wasteful food handling in western societies (disposal rate, high meat consumption).[15] Moreover, instead of using the surface balance in order to measure the nutrient balance, the more comprehensive and implementation-friendly enterprise balance should be applied, since the latter includes all nutrients going into and leaving the pool, such as seeds, fertilizer, feed, animal, crop yield and farm fertilizer (SRU 2008, No. 1005; Frossard et al. 2004, p. 107 et seq.). Last but not least, slurry as a by-product of factory farming as well as phosphorus use in feed ought to be reduced structurally. As an alternative, lower limits in applying farm fertilizer as well as refraining from using additional mineral fertilizer could be discussed in order to en-

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[14] Directive No. 91/676/EWG on the protection of waters against pollution by nitrate from agricultural sources, December 31, 1991, ABl. L No. 375, p. 1 et seq.

[15] New studies show that approximately 40 % of global food production is not consumed. For the uneconomical handling of foodstuff in western societies compare Stuart (2009); FOE (2005); Henningsson et al. (2004). This number might be estimated quite conservatively, since reports state that alone one third of food in households is thrown away.

courage faster closed-loop cycles such as those in organic agriculture.[16] In addition, it would be necessary to improve enforcement of the respective regulations. This could be achieved by concrete norms, stricter monitoring and a legal basis not subject to administrative discretion (SRU 2008, No. 971; Ekardt 2001, § 21).

Although such (and perhaps also other) reform options in respect to phosphorus fertilization would be quite welcome, and have been discussed in part for a long time (of course without implementing them). There are a number of reasons for assuming that the administrative regulatory approaches will eventually not succeed in solving the resource and environmental problems related to phosphorus:

- First, the enforcement problem in agriculture can hardly be solved with a command and control regulatory approach, since an endless multitude of minimal processes would need to be monitored. The vision of a "policeman on every tractor" is hardly realistic.[17] Also, as has been shown, one cannot solely count on self-regulation in agriculture and elsewhere.
- Administrative approaches (command and control) often have the disadvantage that they unexpectedly shift environmental problems to other areas (Ekardt and von Bredow 2010). If the EU were to decrease phosphorus use, this might trigger intensified cultivation outside of the EU – or a massive increase in the likewise problematic use of green genetic engineering.[18]
- 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, p. 543 et seq).
- This leads to our central point: The essential problem of the ecological impact and even more so for the resources issues is demonstrated not so much with one single fertilizer application. Rather, it is the cumulation of many, and when taken separately, insignificant fertilizer applications and the resulting excess fertilization, as well as mass production. This also holds true for the significant contribution of agriculture to climate change by energy-intensive fertilization, methane-releasing livestock farming and other

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[16] It is important to mention that agriculturally applied phosphorus is 100 % plant available, which must be considered accordingly when determining the supply rate.

[17] In 1998, the evaluation of European environmental-agrarian actions showed that despite annual administrative expenses of 700 Mio Euro, no effective controls were possible and that some responsibilities in the practical field were just not controllable; compare Möckel (2007); on general legal regulations in agriculture and enforcement deficits in Germany, SRU (2008, No. 971); SRU (2004, No. 306, 322); Ekardt et al. (2008).

[18] Perhaps green genetic engineering can contribute to a more efficient phosphorus use in the field of animal feed by producing transgenic corn types. Nonetheless, using genetic engineering often proves to be at best a „second-best" solution. The use of genetic engineering collides on a principle level 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 and less pesticide as well as less fertilizer-dependent, less industrialized agriculture practices. Irrespective of the finiteness of phosphorus as fertilizer, the application of genetically modified products (such as seeds) is limited in developing countries due to high pricing. On some problems related to the legal treatment of genetic engineering compare Ekardt et al. (2009c, p. 157 et seq.).

environment-affecting issues. Regarded individually, the single adverse effects on the natural and aquatic environment often seem not to be sufficiently relevant, yet in total, they add up to substantial relevant adverse effects.

- It is therefore necessary to find a regulatory approach that captures the required holistic perspective. Only a real decrease in the total quantity of all phosphorus used (ultimately on a global scale) and at the same time much more enhanced phosphorus recycling can actually achieve the necessary resource conservation while at the same time alleviating ecological impacts. Absolutely central to this thinking is the realization that creating regulations solely focusing on efficient phosphorus application will not be sufficient. Indeed, any reduced phosphorus 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 e.g. feed crop cultivation (triggered by globally rising meat consumption) or for bioenergy plants, the required absolute reduction in phosphorus 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 problematic (Ekardt and von Bredow 2010; Ekardt 2009b, chapter II-III). It should further be pointed out that the resource issue can ultimately only be solved on a global scale. A reduction of phosphorus in the EU would certainly help the ecological problem of waterways and soils, yet the resource issue would remain – finite global phosphate rock supplies would likely be used elsewhere.

Our global food security would not be put at risk by that means. If the production of food of animal origin becomes less attractive (one calorie of food from animal origin requires four to twelve plant-based calories), food security would probably be improved (also because of the gained phosphorus savings). In this context it is important to mention that awareness rising and behavioral change of dietary habits is of utmost important with a view to food security as people in developed countries have a meat-based diet and consume too many calories with their diet because of energy, protein and fat-rich food products. The best option – which would be forced by the discussed design – is 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 phosphorus 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-act the impending overload of soils with heavy metals and organic pollutants through new, recycling and treatment concepts (Schnug et al. 2008)[19], 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 behavioral changes of those involved. Rather, they seemingly provide "technical problem solving" (Valentin and Beste 2010). Apparently, most people involved fear nothing more than some sort of debate on "abdication", in which the durability and global realization of our occidental resource use (for example our high meat consumption) would need to be discussed

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[19] Relevant examples for such concepts are the EU-project SUSAN which is devoted to the nutrient recovery from sewage sludge, phosphorus recycling from municipal sewage sludge at Berliner Wasserbetriebe in Germany, and respectively the Ostara project.

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) behavior of concrete people in politics, administration, the public and farming community, for which all these would need to take responsibility, especially in respect to resulting consequences. Further, one should then (2) plainly admit that a real solution to the phosphorus problematic thus probably cannot be attained, with all the highly negative long-term consequences of such a "business as usual" policy.[20]

III. Soil protection through economic instruments such as subsidy reform, charges, and certificate markets? Also on social justice

A global approach to quantity control is simpler to enforce, prevents shifts in location, – because the normative addressees cannot avoid quantity control anyway -, removes the rebound problem and ideally tackles a given problem (also in the case of phosphorus) at its roots. Global quantity control can therefore be, where necessary, less bureaucratic and democracy-friendly since the legislative body and not the administration with their multifaceted actions for concretization make the real decisions. Further, quantity control potentially provides more freedom since within a given quantity frame it leaves the freedom of decision to the citizen (Ekardt 2007, chapter VI E). 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, as for instance for the use of sewage sludge, which on the one hand should be increasingly used, yet this is only possible under certain ecological and technical premises.

An obvious tool for phosphorus quantity regulation[21] could be a clear rearrangement of EU subsidies for the agrarian sector towards subsidies of environmental services, away from mass production and livestock farming. This stands to reason also from a fiscal perspective and for world trade legislative reasons. An alternative or even better cumulative effect would be the introduction of a fee on mineral fertilizer. Such a possibility has been discussed for some time already for the nutrient nitrate (SRU 2004, No. 324 et seq.; SRU 2008, No. 1006 et seq.; Ekardt et al. 2009a), but it is also plausible for phosphorus (Möckel 2007). Instead, one could practice friendly enforcement with respect to fertilizer producers (SRU 2004, No. 324; Möckel 2007). If in the case of phosphorus resources implications should be covered apart from ecological ones, taking also generally into account the global agrarian market and the

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[20] It is possible to pose the additional question why these issues hardly broach in the legal, political and environmental discourse. Just as in practical politics, one can often observe that fundamental problems are not really being picked out as central themes. On the other hand, the "practical" *real* implementation of e.g. certain existing regulations receives not enough attention too. The discussion therefore often remains on a "middle level" as concrete new thresholds, without systemically asking to which extent a given set of problems can be solved with such an approach and what enforcement will finally look like.

[21] We are using the term quantity regulation here for tools that specifically influence the quantity of a resource (here: phosphorus). In contrast to many environmental economists, the term is also used for describing approaches that do not specifically assess the quantity but convey this indirectly via pricing (e.g. fees, taxes or eliminating subsidies).

extremely important animal feed market, then certainly a European or even global fee would be appropriate. Due to the time lag of effects it is important to start as soon as possible with these suggested measures. First results, particularly in respect to eutrophication, are likely to be visible only in several years or decades; and also the resource problem demands quick action.

An approach focusing on raising taxes would simultaneously tackle many other problems beyond the phosphorus issue. The same affect as that 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 phosphorus and by gradually reducing phosphorus 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 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) – however, they will be even more apparent in administrative legislative global solutions (Ekardt 2009b, chapter III; Ekardt et al. 2009). The easiest approach might well be to establish a parallel global certificate market for phosphorus 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 on the imperative of rendering tasks economical, already suggests an economic solution for the phosphorus issue especially in respect to waterways. According to current prevalent belief, fertilization is considered only as a form of water use, not as a water service since it does not comply with the definition given in article 2 no. 38 WFWD. Article 9 section 1 sub-section 1 WFWD demands that also those which are not water services must take on an appropriate share for the cost recovery of providing such water services if they are to some degree responsible for these costs. Accordingly, sectors such as for example agriculture, in fact need to bear the (additional) costs that result from overapplication of fertilizers in wastewater treatment for the provision of drinking water (this also includes extracting e.g. uranium). Finally, water quality impairments linked to fertilizer production could also be taken into account.

Phosphorus use and, in general, any administrative law or quantity control approach eventually leads to implications for social distributive justice. This not only refers 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 2010b). 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 phosphorus application do not always align. This problem has a national and global dimension (Ekardt et al. 2010, chapter III-VI; Ekardt 2009b, chapter III-V). Eventually declining phosphate rock reserves are likely to result in higher prices and potential quality degradation due to higher heavy metal loads. While industrialized countries are still able to pay prices for higher quality and fertilizer in general, developing countries can face severe availability, accessibility and quality issues. Moreover, soils in the southern hemisphere are currently exposed to substances such as heavy metals 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 since in the former case it is not problematic to side 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.[22]

V. Conclusions

In any case, the combination of waiting, self-regulation and pointing to the codes of good practice should prove to be unsuccessful in the case of the phosphorus problem complex. The different problematic aspects need to be ultimately tackled at their roots. One can argue that the nutrient phosphorus - in contrast to phosphate rock - is ultimately a “renewable” resource. But recovery of phosphorus from diffuse sources can be expected to be extremely costly as at the moment no suitable technology is available to extract for example phosphorus from seawater. Anyway, even renewable resources can be overused and, as such, can be considered finite in their own way. This takes us back to the major results with regard to phosphorus: It is the sum of multiple minor actions of farmers etc. that can lead to ecologically and resource-related severe consequences. It is not sufficient to increase efficiency in phosphorus uptake “per individual plant”. If at the same time crop cultivation is expanded to previously unused areas, for instance for greater animal feed crop (due to a globally rising meat consumption) or bioenergy plant production, it will be impossible to achieve the necessary absolute phosphorus use reduction (and it means that sustainability of P use in the context of food security) and social justice is abandonned. We conclude that this will lead to a new fundamental perception in environmental policy at large: ”command and control” law and efficiency alone tend not to solve resource problems or quantity problems if at the same time (global) production increases or remains at a constant high level.

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[22] Social reconciliation is especially important because phosphorus fertilizer in developing or emerging 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), 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.

Congress in Bucharest in 2010.

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