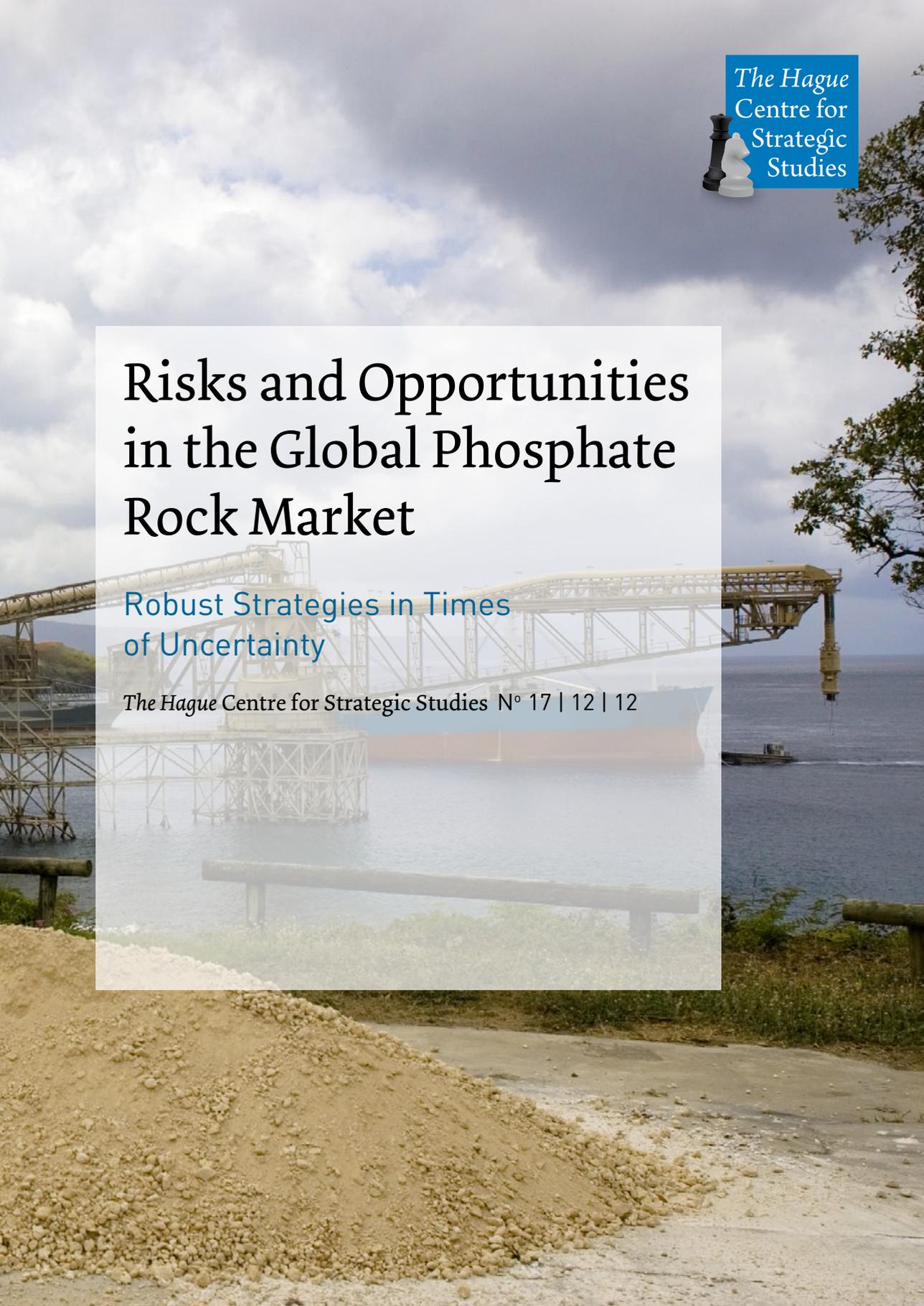


# Risks and Opportunities in the Global Phosphate Rock Market

Robust Strategies in Times  
of Uncertainty

*The Hague Centre for Strategic Studies* N° 17 | 12 | 12





Risks and Opportunities in the Global Phosphate Rock Market  
*The Hague Centre for Strategic Studies (HCSS)*

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HCSS helps governments, non-governmental organizations and the private sector to understand the fast-changing environment and seeks to anticipate the challenges of the future with practical policy solutions and advice.

# Table of contents

	Management summary	9
	Introduction	19
1	Today's global phosphate rock market	21
1.1	Definitions and terminology	21
1.2	Phosphorus scarcity	22
1.3	Current and future supply of phosphate rock	25
2	A changing global phosphate rock market: trends and developments	37
2.1	Supply, demand and price developments	37
2.2	Policies and industry strategies	42
2.3	Geopolitical developments	48
2.4	Emerging technical issues	52
2.5	Increased environmental awareness	57
3	Implications for the EU	61
3.1	What political-economic risks threaten the EU's phosphate supply security?	61
3.2	What technical issues hinder the EU's phosphate security?	65
3.3	Policy responses within the EU	67
4	Conclusion: perspectives for action for Europe	73
4.1	Influencing the primary market: no easy game	73
4.2	Robust strategies in times of uncertainty	76
	Bibliography	83
	Appendix: exploration projects	99

## List of figures

Figure 1	Peak of global phosphate rock production in 2033 based on peak phosphorus curve calculated in 2009	23
Figure 2	Map of countries by phosphate production in 2011	27
Figure 3	Main producers in 2011 in mmt by percentage share of global production	27
Figure 4	Phosphate rock exports by region	28
Figure 5	Phosphate rock exports by country in mmt	29
Figure 6	Phosphate rock imports by region	30
Figure 7	Countries by imports of phosphorus within fertilizer	30
Figure 8	Main sources of phosphate rock in the EU in mmt imported per year	31
Figure 9	Map of countries by phosphate rock reserves	33
Figure 10	Reserves of phosphate rock per country in mmt	33
Figure 11	Map of main exploration projects into phosphate rock mining	35
Figure 12	Price of phosphate rock, \$/mt	38
Figure 13	Theoretical price dynamics for phosphate rock	39
Figure 14	World phosphate demand development by 2020	41
Figure 15	Historical and future sources of phosphorus fertilizer	42
Figure 16	Net import reliance of the US on phosphate rock as % of apparent consumption	43
Figure 17	Simplified overview of the main uses and sinks in phosphate use	56
Figure 18	Number of exploration projects in 2011 by origin of firm	62
Figure 19	Cooperate or agitate? A typology of scenarios characterizing the world system	74

# Management summary

The European Union (EU) is almost entirely dependent on imports of phosphate rock from the rest of the world. Trends and developments on the global phosphate rock market are putting the EU's security of supply of phosphate rock under increasing pressure. This report aims to increase awareness that import reliance makes Europe vulnerable to disruptions in the supply of this important commodity. It means that European food security and the agricultural sector, for which phosphate is an essential resource, are at risk. This report formulates robust strategies for the EU to adequately deal with developments on the global phosphate rock market.

## **Global phosphate rock market dynamics**

The buyers' market for phosphate rock is becoming increasingly crowded, causing the EU to face higher prices and mounting competition in securing its supply of phosphate rock. Global phosphate rock demand is rising due to a growing world population and associated food demand, increasing the demand for phosphate fertilizer. The intuitive conception that growing demand for phosphate is exhausting existing deposits has caused fears that we are approaching so-called peak phosphorus—the point in time when world production of phosphorus has reached its peak and will slow down, despite growing demand. Concerns about peak phosphorus, however, are based on the flawed assumption that the world reserve of phosphate rock is a static figure. Market dynamics could make it possible that phosphate reserves increase over time.

Growing demand and limited supply caused phosphate rock prices to soar in 2008. After years of low and relatively stable prices, phosphate rock prices are expected to remain high in the coming years. High prices in combination with improved technology may render resources economically viable for mining. The majority of global phosphate rock reserves are located in Morocco, including Western Sahara. Other major holders of phosphate rock reserves (ranked

according to the size of their reserves, from large to small) are Iraq, China, Algeria, Syria, Jordan, South Africa, the US and Russia. High prices also trigger exploration projects, which may uncover new reserves, such as in Saudi Arabia, and offshore projects off the coasts of New Zealand and Namibia.

Although the world is not running out of phosphate rock any time soon, the EU should nonetheless be concerned about phosphate rock shortages. It takes many years to prepare new reserves for active mining, which means that increases in supply lag far behind increases in price. Europe possesses only limited domestic phosphate rock reserves. France, Germany, Italy, Spain, and the UK account for over three-quarters of the Union's imports of phosphorus within fertilizer products. EU imports come mainly from Russia and countries in the Middle East and North Africa. As a consequence of this import dependence, the EU is vulnerable to disruptions in the supply of phosphate rock.

### **Political-economic supply disruption risks**

Supply disruptions may occur for reasons other than depletion alone, such as the concentration of production in a small number of countries. Currently, production mainly takes place in China, the US and Morocco, including Western Sahara. Together they accounted for over two-thirds of global production in 2011. Middle Eastern and North African countries account for 80% of global exports. Morocco is the world's largest exporter by a significant margin, typically accounting for about one-third of total exports. Given the distribution of world reserves it is likely that oligopolistic or even monopolistic tendencies will become more pronounced in the future, which could further entrench the concentration of market power in the hands of a limited number of players. The risk of supply disruptions is also high because important producing countries are suffering from geopolitical turmoil. The Arab Spring, for example, had a heavy impact on global phosphate rock production. A stable supply to the EU from Tunisia, Jordan and Syria is no longer guaranteed, as political instability and troubled labor relations hamper the phosphate industry in these countries. The EU's reliance on Moroccan phosphate is expected to increase in the future. The ongoing stalemate over the status of Western Sahara creates uncertainties surrounding the stability and affordability of supply from this region. This makes relations with Morocco particularly delicate for the EU, also because of the political understanding between Morocco and Europe on a variety of issues, such as migration and fisheries.

Producing countries are also increasingly implementing access restrictions, trade barriers, and export quotas, and are showing other signs of growing protectionism and resource nationalism. For example, for the past two years China has maintained such high export tariffs on phosphate fertilizer that trade has practically ground to a halt. Syria has also virtually stopped its exports to Europe because of ongoing conflict.

Another trend is that the phosphate rock industry shows a tendency toward vertical integration, where mining companies increasingly also produce fertilizers, phosphoric acid and other derivatives of phosphate rock. As a result of vertical integration, phosphate imports into the EU will increasingly take the form of phosphate fertilizer, rather than raw rock. Existing trade restrictions may then also be applied to phosphate fertilizer.

### **Technical hindrances**

In addition to these politico-economic challenges, the EU's security of phosphate supply is also undermined by technical hindrances. Many producer countries are facing a lack of water available to the mining industry due to competing claims for water for drinking and for agricultural purposes. In addition, the pollution of phosphate with heavy metals like cadmium and uranium is leading to shortages of the right quality of phosphate rock.

Cadmium buildup in EU soils due to the use of fertilizer made with contaminated rock is raising concerns about human health and environmental damage. Decadmiation, a practice that aims to reduce the cadmium content of fertilizer, is still a fledgling technology. There are concerns that decadmiation will add to the price of phosphate fertilizers and generate toxic waste. Market dynamics suggest that Moroccan phosphate, which is high in cadmium, is going to become increasingly dominant in the future. The EU therefore needs to consider not only how to secure its supply of phosphate, but also its supply of low-cadmium phosphate.

Awareness is also increasing about the environmental damage caused by phosphate rock mining and processing and the flow of phosphate fertilizer from the land into freshwater resources and coastal areas. Inefficient use, especially in the agricultural sector, and loss of phosphate in waste and wastewater is further undermining the EU's phosphate security. Programs for recovery and recycling of

phosphate from the sludge from human sewage are underway, however existing infrastructure and governance mechanisms are still an obstacle in EU countries.

### **Robust strategies in times of uncertainty**

The future of the global phosphate rock market is beset with uncertainty. The EU's ability to influence the market for phosphate rock depends on whether the international system is dominated by a small number of state actors or rather a large number of players alongside states, and on whether there is an atmosphere of cooperation or competition. Under each of the future world scenarios (multipolar, multilateral, fragmentation or network) the possibilities for the EU are highly diffuse and uncertain. In light of this uncertainty, there are two robust policy strategies available to the EU.

First, the EU should reduce its import dependence by promoting efficient use of phosphate throughout the value chain and by creating the necessary preconditions for its recovery and reuse. To this effect, a number of concrete measures should be implemented, such as improving efficiency of phosphate fertilizer used in farming, reducing or substituting phosphorus use where possible, and preventing the loss and dilution of phosphorus in water, land and waste. In addition, the EU should promote recovering phosphorus from its various 'sinks' and stimulate its reuse in the fertilizer and chemical industry. In order to institutionalize this practice in the long term, the Union should create the right (legal) conditions for a sustainable European market of recycled phosphorus, including a new regulation for fertilizers and a level playing field for fertilizers made out of primary and secondary sources of phosphorus. Knowledge exchange through networks of excellence can facilitate these developments.

Second, the EU should mitigate supply disruptions by forging strategic partnerships with phosphate rock-producing countries, in which the Union utilizes its technical expertise as a bartering tool to gain access to phosphate rock supplies. If a confrontation between markets and industries for primary and secondary phosphates is to be avoided, it is crucial for the EU to adopt an inclusive European strategy toward producing countries, as well as their mining and fertilizer companies. Rather than merely acting as a buyer, the EU should aim to create win-win situations and help producers overcome key challenges, such as water scarcity and environmental pollution as a result of mining and processing activities. Close knowledge cooperation between the EU and

producing countries will promote a transition to sustainable mining and the supply of the right quality of rock, and possibly enhance the cooperative nature of the global phosphate rock market. In addition to forging strategic bilateral partnerships, the EU should continue to promote free trade and unrestricted access to natural resources in multilateral forums such as the WTO and the OECD—in line with the reasoning put forward in the EU Raw Materials Initiative.

# Introduction

The EU is almost entirely dependent on phosphate rock from the rest of the world. Securing phosphate is crucial for the long-term food security of Europe.<sup>1</sup> Recent trends and developments on the global phosphate rock market are putting the EU's security of supply of phosphate rock increasingly under pressure. Phosphate rock is the primary source of phosphorus. Phosphorus is an element which is *essential, critical, and scarce*.<sup>2</sup>

Phosphorus is *essential* to life. Phosphorus is present in all living things and is required for cell growth. Together with nitrogen and potassium, phosphorus is one of the most important elements for plant life. In agriculture, the growth of crops is dependent on the phosphorus content of soil. Phosphorus is usually a *limiting factor* in agriculture, which means that even if all other conditions and nutrients are plentiful, only phosphorus can make crops thrive.<sup>3</sup>

Phosphorus is *critical* to the functioning of our society. There is no substitute for phosphorus and there never will be. Soil is often depleted of phosphorus by the plants that use it and by washing away by rain. Modern farming is therefore reliant on phosphate-derived fertilizers to enrich the soil in order to produce

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- 1 Dana Cordell, The story of phosphorus: sustainability implications of global phosphorus scarcity for food security (Linköping: Department of Water and Environmental Studies, [The Tema Institute], Linköping University, 2010), <http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-53430>.
  - 2 Roland W. Scholz and Friedrich-Wilhelm Wellmer, 'Approaching a Dynamic View on the Availability of Mineral Resources: What We May Learn from the Case of Phosphorus,' *Global Environmental Change* (October 16, 2012).
  - 3 Mark van Loosdrecht, 'Role of Biological Processes in Phosphate Recovery,' *Natural History Museum*, 2012, <http://www.nhm.ac.uk/research-curation/research/projects/phosphate-recovery/loosdr.htm>.

sufficient quantities of food. About 90% of global phosphate rock demand is used for food production.<sup>4</sup>

Phosphorus is *scarce*. Phosphate rock is a non-renewable resource. Market forces and political decisions can have a profound impact on its availability. Securing a stable supply of phosphate is therefore of paramount importance.

### Challenges facing the EU

Global phosphate rock demand is rising due to a growing world population and increasing food demand. The United Nations (UN) estimate that by 2050 the global population will reach over 9 billion people. In addition, due to continuing urbanization and economic growth, more people will live in cities and enjoy higher incomes. To feed an ever larger, more urban and richer population, world food production needs to increase by 70% in the coming decades.<sup>5</sup> Increasing food production will increase the demand for energy and water and phosphate fertilizer, making phosphate rock an increasingly scarce resource.

Although identified reserves of phosphate rock are believed to be sufficient to meet the growing demand, the risk of price volatility and supply disruptions is high due to the concentration of phosphate rock mining in a limited number of countries. Morocco, China, the US and Russia are among the most important producers of phosphate. The majority of global phosphate rock reserves are located in Morocco, including Western Sahara. Other major holders of phosphate rock reserves are Iraq, China, Algeria, Syria, Jordan, South Africa, the US and Russia.<sup>6</sup> In response to growing phosphate demand, several producing countries have taken measures to restrict the export of phosphate rock in order to ensure sufficient availability of phosphate to meet their own needs in the future. China, for example, imposed a 135% tariff in 2008 to discourage exports and protect domestic supplies.<sup>7</sup>

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4 OECD, *Material Resources, Productivity and the Environment* (Paris: OECD, November 15, 2011), 104.

5 FAO, *How to Feed the World in 2050* (Rome: FAO, 2009), 2, [http://www.fao.org/fileadmin/templates/wsfs/docs/expert\\_paper/How\\_to\\_Feed\\_the\\_World\\_in\\_2050.pdf](http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf).

6 Arno Rosemarin, 'Peak Phosphorus: The Next Inconvenient Truth' [presented at the Phosphorus Shortage: European Challenges, European Parliament, Brussels, 04 2010].

7 OECD, *Material Resources, Productivity and the Environment*, 107.

Furthermore, geopolitical developments are threatening the EU's security of supply of phosphate rock. The EU imports a substantial part of its phosphate rock from Morocco, Tunisia, Jordan and, until recently, Syria. Political instability in the Middle East and North Africa (MENA) may disrupt trade flows to the EU. Troubled labor and wage relations between workers and phosphate companies within countries impacted by the Arab Spring led to significant reductions in mining operations and exports.<sup>8</sup> The current conflict in Syria has virtually halted phosphate rock exports to the EU. An important share of the world's phosphate rock reserves are located in Western Sahara, a disputed territory where a separatist movement, the Polisario Front, claims independence from Morocco. Since Morocco is estimated to hold approximately two-thirds of the global phosphate rock reserves and is an important supplier to the EU, an escalation of this dispute could negatively impact the Union's phosphate security.

In addition, the EU's phosphate security is being undermined by the decreased quality of phosphate rock, which can be contaminated with pollutants such as the heavy metals cadmium and uranium. Other technical issues are also contributing, such as water shortages in the mining industry due to competing claims from agriculture and drinking water for growing populations; inefficient use; and the loss of phosphate in land, water and waste.

Finally, the EU is concerned with the developments on the global phosphate rock market for environmental reasons. Phosphate rock mining demands large amounts of other scarce resources, such as water and energy, and contributes to water, air and soil pollution, greenhouse gas emissions, landscape degradation and solid waste generation. The flow of phosphate fertilizer from the land into freshwater bodies and coastal areas is also causing serious environmental damage. Eutrophication, or nutrient surplus due to excess phosphorus, is a widespread problem which leads to excessive growth of algae and toxins that can be dangerous to human and aquatic life.

### **Background and objective of the report**

For the reasons mentioned above, phosphate is moving up the policy agenda. The European Commission has planned to publish a Green Paper on phosphorus

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8 James Wellstead, 'Political Risks in MENA Phosphate Markets,' *Potash Investing News*, February 16, 2012, <http://potashinvestingnews.com/4799-political-risks-mena-phosphate-markets-tunisia-morocco-jordan-syria-afric.html>.

before the end of 2012, which will outline some of the key questions regarding phosphorus management in Europe. The publication of the Green Paper will stimulate further debate about phosphorus in general and the EU's position on the global phosphate rock market in particular. One of the central questions is how the Union should respond to the trends and developments that are negatively affecting its phosphate security of supply while simultaneously meeting its objectives regarding the environment, sustainability and resource efficiency.

The Dutch Ministry of Infrastructure and the Environment finds it important from a sustainable policy perspective that the political discussion on this matter is based on a thorough assessment of the current phosphate rock market and of the trends that will shape the market in the near future. Thus, the Dutch Ministry of Infrastructure and the Environment commissioned this report written by *The Hague Centre for Strategic Studies (HCSS)*, an independent think tank specializing in geopolitical analysis and policy advice. The objective of this report is to inform the EU policy-making process by providing an integral and fact-based analysis of the risks and opportunities related to the developments on the global phosphate rock market. In the months leading up to the first European Sustainable Phosphorus Conference in March 2013, the findings of this report will be disseminated to stakeholders from academia, industry and the policy world.

The report aims primarily to raise awareness within Europe that the EU is almost entirely dependent on imported phosphate rock from the rest of the world and consequently vulnerable to disruptions in the supply of this important commodity. This means that the European food security and agricultural sector are at risk. The report formulates several perspectives for action on how the EU could deal with developments on the phosphate rock market and reduce its vulnerability to potential shocks.

### Research questions and structure of the report

Although this report refers to related developments on the markets for phosphate fertilizers, the scope of research is limited to the global market for phosphate rock. The **main research question** of this report is:

*What is the situation of the global phosphate rock market of today, in what direction may this market develop in the future, and what are the consequences for the supply security of the European Union?*

To answer the first part of the main research question, **Chapter 1** makes an inventory of the global phosphate rock market by looking at worldwide reserves, mining and exploration activities, import and export flows, and the position of the EU therein. This section of the report asks the following subquestions:

- Where is current supply and demand coming from? Which countries are the most important producers, exporters and importers of phosphate rock?
- Where may future supply come from? Which countries are the most important holders of reserves and where are exploration activities taking place?
- What is the position of the EU on the global phosphate rock market? How much does the Union import and who are its main suppliers?

Next, the report looks at the changes that are occurring on the global phosphate rock market. **Chapter 2** discusses trends and developments that affect the supply and demand of phosphate rock. This section of the report looks at price developments; government policies and industry strategies; the effects of social unrests and political instability in producing countries; the competing claims for water and energy that may hamper the mining industry; concerns about the grade and quality of phosphate rock; and environmental considerations.

The following subquestions are posed:

- What shifts will occur in the balance of global phosphate rock supply and demand and what will be the impact on phosphate prices and trade flows?
- How are countries and industries responding to the developments on the global phosphate rock market and, in turn, how are their policy measures and strategies affecting the market?
- What will be the effects of geopolitical, technical and environmental developments on the global phosphate rock market?

To answer the third part of the main research question, the report looks into the implications for the EU. **Chapter 3** looks at the risks that could undermine the Union's security of supply of phosphate and gives some examples of policy responses of EU Member States. The subquestions are:

- What political-economic risks threaten the EU's phosphate security of supply?
- What technical issues hinder the EU's phosphate security of supply?
- What has been the policy response at EU and Member State level?

Finally, the report concludes with a section on perspectives for action for the EU. **Chapter 4** assesses what 'no-regret' policy measures the EU could take to secure its phosphate rock supply in light of four different scenarios on what the world

may look like in the future. Each scenario has implications for the EU's ability to influence the global phosphate rock market. This section responds to the following subquestions:

- What are the risks and opportunities in the global phosphate rock market for the EU in the four different future-world scenarios?
- What robust strategies could improve the EU's phosphate security of supply in times of uncertainty?
- What concrete measures should the EU implement to mitigate the various risks to its security of supply of phosphate rock?

### Methodology

To answer the research questions, HCSS used primary sources from EU bodies and Member States and international organizations, and a wide array of secondary sources from academia, research institutes, industry, and online media. In the past, data on phosphate rock deposits were available in conventional scientific literature, but according to experts reporting on phosphate rock, the amount published has dropped since the 1990s.<sup>9</sup> Data on global phosphate rock reserves, resources and trade flows vary between sources. To offer an accurate picture of the global phosphate rock market, HCSS triangulated information from several sources, including the United States Geological Survey (USGS) and the International Fertilizer Development Center (IFDC).

In addition, HCSS conducted seven interviews with experts from the phosphate industry, academia and the European Commission. We are very grateful to all interviewees for taking the time to speak with us and share their insights and experiences.

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<sup>9</sup> Steven van Kauwenbergh, *World Phosphate Rock Reserves and Resources* (Muscle Shoals, Alabama: International Fertilizer Development Center (IFDC), September 2010).

# 1 Today's global phosphate rock market

This chapter makes an inventory of the global phosphate rock market and offers data on worldwide phosphate rock reserves, production, exploration activities, global imports and exports, and, more specifically, flows to the EU. These data are presented to identify where current supply is coming from and where supply will come from in the future (1.3). To facilitate interpretation of this data, the chapter first gives an overview of the definitions and terms that are used in the report (1.1) and a short review of the debate on 'peak phosphorus' (1.2). This allows a better assessment of the question of whether and why the EU should be concerned about phosphate scarcity.

## 1.1 Definitions and terminology

This section sets out some of the chemical and geological characteristics and economic concepts that are used to classify the availability and quality of phosphate rock. First, it is important to distinguish between phosphate rock, phosphate and phosphorus. Phosphate rock contains phosphate, which is used to make fertilizer that contains phosphorus, the essential element for crop growth. The difference between phosphate and phosphorus is their chemical composition: while phosphorus is a single element (P), phosphates are compounds in which atoms of phosphorus are bonded with oxygen.

Second, phosphate rock deposits can be differentiated by their grade and quality. Phosphate fertilizer uses the chemical phosphorus pentoxide ( $P_2O_5$ ).<sup>10</sup> The grade of phosphate rock refers to the  $P_2O_5$  concentration of the rock. To make fertilizer, phosphate rock must contain at least 28%  $P_2O_5$ , otherwise it must undergo further processing to increase the concentration. The quality of phosphate rock is determined by both the grade and level of impurities.<sup>11</sup>

<sup>10</sup> Ibid.

<sup>11</sup> Stephen Jasinski, 'Phosphate Rock,' in *Mineral Commodity Summaries 2012* (Washington: U.S Government Printing Office, 2012), 118–119; Peter Van Straaten, *Rocks for crops : agrominerals of sub-Saharan Africa* (Nairobi: ICRAF, 2002); Jasinski, 'Phosphate Rock.'

Third, the availability of phosphate rock can be expressed in various terms, including reserves, reserve base and resources. This report follows the International Fertilizer Development Center (IFDC), which uses only two categories for reasons of simplification. The term reserves indicates the amount of phosphate rock that can be mined economically using existing technologies at the time of determination. This means it is an economic variable that can vary over time. The term resources refers to the amount of phosphate rock that can potentially be mined at some point in the future, making it a more static variable.

The most common measure to express phosphate rock reserves, resources, production and trade flows is million metric tonnes (mmt).

Fourth, the exploitation of phosphate rock encompasses two activities that need to be differentiated.

- **Exploration** involves a number of stages of sampling and analysis based on rock drilled and extracted from deep below the surface to determine the existence and qualities of a resource, followed by an assessment of its viability as a reserve.
- **Mining** takes place once exploration is complete and a feasible reserve is confirmed. It involves the actual extraction of phosphate rock from the earth to be processed and sold for profit.<sup>12</sup>

## 1.2 Phosphorus scarcity

The availability of phosphate rock and the question of whether the world is running out of phosphate has been the topic of ongoing debate. Two different paradigms are behind this.

The so-called static paradigm is based on the intuitive conception that growing demand for phosphate is exhausting existing deposits and that the speed of extraction and consumption determines the rate of reserve depletion.<sup>13</sup> This means that at a certain point in time world production of phosphorus will have

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12 Jordan Phosphate Mines Company, 'Exploration & Geological Reserves,' *Jordan Phosphate Mines Company*, accessed August 8, 2012, <http://www.jordanphosphate.com/Content/PC/PageContent.aspx?ItemID=4>.

13 Jaakko Kooroshy et al., *Scarcity of Minerals. A Strategic Security Issue*.

reached its peak and will slow down, despite growing demand.<sup>14</sup> In the literature this moment is called 'peak phosphorus'. The calculations of peak phosphorus are based on estimates of phosphate rock reserves. Since there is no consensus on the size of these reserves, experts disagree on when peak phosphorus will occur.<sup>15</sup> Peak phosphorus has been calculated and recalculated in recent years by the Global Phosphorus Research Initiative (GPRI) among others.<sup>16</sup> In 2009 the GPRI calculated that phosphorus production would peak around the year 2033 and that afterward production will continuously decrease until reserves are depleted within the next 50-100 years (see Figure 1).<sup>17</sup>

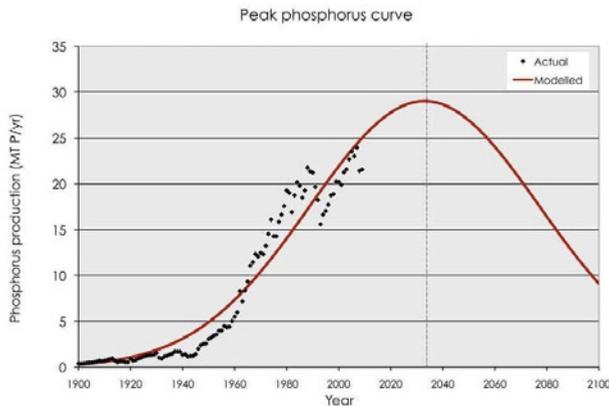


FIGURE 1: PEAK OF GLOBAL PHOSPHATE ROCK PRODUCTION IN 2033 BASED ON PEAK PHOSPHORUS CURVE CALCULATED IN 2009<sup>18</sup>

14 Dana Cordell and Stuart White, 'Peak Phosphorus: Clarifying the Key Issues of a Vigorous Debate About Long-Term Phosphorus Security,' *Sustainability* 3, no. 10 (October 24, 2011): 2027–2049, doi:10.3390/su3102027.

15 Ibid.

16 Ibid.; D. Cordell, S. White, and T. Lindstrom, 'Peak Phosphorus: The Crunch Time for Humanity?,' *The Sustainability Review* 2, no. 2 (2011): 1–1; Dana Cordell, Jan-Olof Drangert, and Stuart White, 'The Story of Phosphorus: Global Food Security and Food for Thought,' *Global Environmental Change* 19 (2009): 292–305, doi:10.1016/j.gloenvcha.2008.10.009.

17 Cordell, *The story of phosphorus*.

18 Ibid., 87.

Calculations of peak phosphorus are based on estimates of phosphate rock reserves. When the United States Geological Survey (USGS) re-estimated reserves at 60,000 mmt up from previous estimates of 16,000 mmt, the IFDC stated that 'there is no indication there is going to be a 'peak phosphorus' event within the next 20-25 years'.<sup>19</sup> Based on the new estimates the GPRI recalculated peak phosphorus: 'If the 60,000 mmt IFDC reserve estimates are indeed correct [...] peak [occurs] between 2051 and 2092 with a mean of 2070.'<sup>20</sup>

Besides the uncertainty about the point in time when peak phosphorus will occur, the concept of peak phosphorus itself is contested. The main criticism is that calculations of peak phosphorus are based on phosphate rock reserves only (not resources), which provide the basis for estimates of static ranges. Reserves for phosphate rock have been stable or even rapidly expanding at times, despite ongoing and constantly growing production.<sup>21</sup> This cannot be explained in the static paradigm. The explanation for stable or growing reserves is the fact that reserve data by national geological surveys do not indicate the absolute quantity of an element that is available for extraction, as the static paradigm would suggest. Instead, reserve data provide an estimate of the small fraction of the resources which is profitable for extraction now or in the near future with existing technology and under current market conditions.

According to the 'dynamic adaptive paradigm', the scarcity of phosphate rock responds to changes in economic feasibility of phosphate production. According to this paradigm, scarcity is a permanent feature of human existence: minerals are scarce as long as they are valued in society and cost time and effort to extract from the environment. The crucial questions are how much they are valued, how much time and effort it takes to extract them, and how scarce they are relative to all other goods and services in society. According to this paradigm, it is unlikely

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19 Van Kauwenbergh, *World Phosphate Rock Reserves and Resources*.

20 Dana Cordell, Stuart White, and Tom Lindström, 'Peak Phosphorus: The Crunch Time for Humanity?,' *The Sustainability Review* 4, no. 2 (April 4, 2011), <http://www.thesustainabilityreview.org/2011/04/04/peak-phosphorus-the-crunch-time-for-humanity/>.

21 According to the USGS data the phosphate reserves remained stable between 2004 and 2008 at a level of 18,000mmt. Further, a revision of these estimates led to an enormous increase between 2010 and 2011. While the estimated amount of phosphate reserves was 16,000mmt in 2010 it increased to 65,000mmt in 2011. Jasinski, 'Phosphate Rock.'

that the world will run out of phosphate any time soon because of large remaining resources that may become economically viable to mine in the future. That said, it should be pointed out that the issue of scarcity is not limited to the depletion of phosphate rock resources alone. Phosphate rock scarcity is a pressing issue when judged from perspectives other than relative availability. For example, if countries rely on a small number of exporters for their supply of phosphate rock, this could potentially lead to situations where supplier countries use their 'market power' for the realization of non-market goals (see section 2.2).

Scarcity could also be the result of geopolitical turmoil in supplier regions, causing a fall in phosphate rock exports (see section 2.3).<sup>22</sup> Similarly, scarcity could result as a consequence of a lack of water available to the mining industry due to competing claims for water coming from agriculture, mining and the general population (see section 2.3) or a shortage of the right quality of phosphate rock, caused, for example, by contamination with cadmium and other heavy metals (see section 2.4). The heavy ecological impact of the mining industry equally prompts us to rethink the overall efficiency of the global phosphorus cycle (see section 2.5).<sup>23</sup> Price-inelasticity of supply is also a problem: time and investments are often limiting factors which can lead to scarcity as it takes a long time and requires significant investment to open up new mines or set up an industry aimed at recovery and reuse (see sections 2.1 and 3.3).<sup>24</sup>

### 1.3 Current and future supply of phosphate rock

Phosphate rock production, its import and export, as well as exploration aimed at uncovering future reserves, are all strongly interlinked processes. For example, some countries are large producers of phosphate rock. However, depending on domestic consumption and export policies in place, this need not automatically translate into high figures of exported rock. Similarly, some countries may export large amounts of phosphate rock, despite possessing only limited

22 See also Arno Rosemarin and Ian Caldwell, 'The Precarious Global Geopolitics of Phosphorus', 2007.

23 D. Cordell et al., 'Toward Global Phosphorus Security: A Systems Framework for Phosphorus Recovery and Reuse Options,' *Chemosphere* 84, no. 6 (August 2011): 747–758; J. J. Schröder et al., 'Improved Phosphorus Use Efficiency in Agriculture: A Key Requirement for Its Sustainable Use,' *Chemosphere* 84 (2011): 822–831.

24 Arnoud Passenier and Maarten Lak, *Scarcity and Transition: Research Questions for Future Policy*, November 2009, 17, 19, 20 and 26, [www.clingendael.nl/resource scarcity](http://www.clingendael.nl/resource scarcity).

reserves. Also, a high consumption of phosphate rock may prompt countries to strongly focus on exploration to uncover future reserves, with the aim of alleviating pressure on their security of supply. The following paragraphs provide an overview of the current production and trade in phosphate rock, as well as the potential future supply of phosphate rock subject to available rock reserves and exploration currently underway.

### Current production

The USGS estimated global phosphate rock production at 181 mmt in 2010 and 191 mmt in 2011.<sup>25</sup> Figure 2 and Figure 3 show graphics of the world's major phosphate rock-producing countries. In 2011, the major producers were the US, China and Morocco, including Western Sahara. Together they accounted for over two-thirds of global production. Other important producing countries are Russia, Brazil, Jordan, Egypt and Tunisia. Major firms include Moroccan-owned OCP, US company Mosaic, Russian-owned PhosAgro and the Chinese Yuntianhua Group.<sup>26</sup> OCP is the world's premier exporter of phosphate and phosphate derivatives (see below). OCP announced in 2010 that it expects to double its production capacities from 28 to 55 mmt and triple its production of fertilizers from 36 to 100 mmt. A key component of OCP's growth strategy is the creation of a fertilizer, phosphate and sulfur terminal in the port of Jorf Lasfar, which should be completed by 2020.<sup>27</sup>

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25 Jasinski, 'Phosphate Rock.'

26 James Wellstead, 'Phosphate Mining in North America,' *Potash Investing News*, January 30, 2012, <http://potashinvestingnews.com/4673-phosphate-mining-north-america-mosaic-arianne-resources-agrium-price-market.html>.

27 N-P-K World, 'Morocco: OCP to Double Phosphate Production by 2020,' April 27, 2012, <http://npk101.wordpress.com/2012/04/27/morocco-ocp-to-double-phosphate-production-by-2020/>; FLSmidth, 'FLSmidth Jorf Lasfar Site Update,' August 1, 2012, <http://www.flsmidth.com/en-US/Services+and+Capabilities/Case+Stories/Increasing+capacity/Jorf+Lasfar+Site>.



FIGURE 2: MAP OF COUNTRIES BY PHOSPHATE PRODUCTION IN 2011<sup>28</sup>

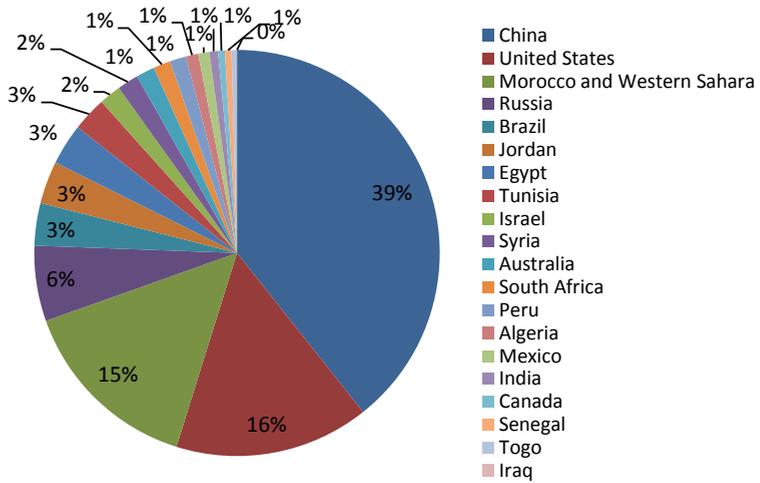


FIGURE 3: MAIN PRODUCERS IN 2011 IN MMT BY PERCENTAGE SHARE OF GLOBAL PRODUCTION<sup>29</sup>

28 Jasinski, 'Phosphate Rock.'

29 Ibid.

### Exports of phosphate rock

Figure 4 shows that the major regions in terms of phosphate rock exports are Africa and West Asia with a share of 53.65 % and 27.7% respectively in global phosphate rock exports. This is the result of changes in export trends that occurred between 1999 and 2010. During this period, Eastern Europe and Central Asia halved their exports and East Asia reduced its exports by 30%. Exports from West Asia, by contrast, increased by around 30%. The share of African phosphate rock exports remained constant at around 50%.

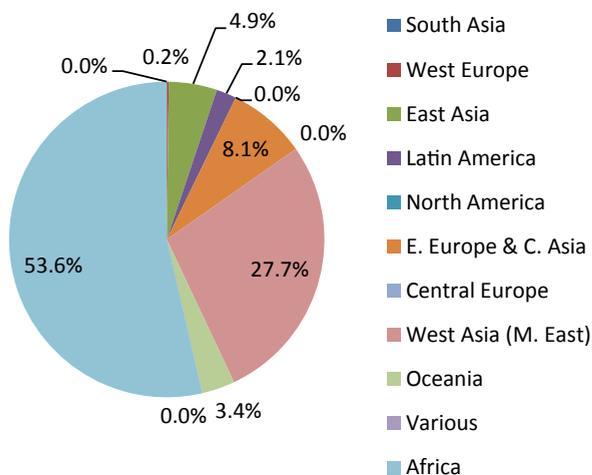


FIGURE 4: PHOSPHATE ROCK EXPORTS BY REGION<sup>30</sup>

Looking at country-level data, there is a striking dominance of Middle East and North African countries in the market, accounting for 80% of total exports. Morocco is the world's largest exporter by a significant margin, typically accounting for about one-third of total exports.<sup>31</sup> Figure 5 shows that Jordan and Syria were also among the major exporters in 2011. Moroccan firm OCP currently

30 International Fertilizer Industry Association, 'Statistics,' IFA, 2010, <http://www.fertilizer.org/HomePage/STATISTICS>.

31 PotashCorp, 'What Matters in Phosphate,' PotashCorp, 2011, [http://www.potashcorp.com/annual\\_reports/2011/our\\_nutrients/phosphate/overview/](http://www.potashcorp.com/annual_reports/2011/our_nutrients/phosphate/overview/).

accounts for some 35% of global phosphate rock exports.<sup>32</sup> Although production figures put countries such as China and the US among the top producers of phosphate, their domestic consumption largely eclipses their exporting activities.

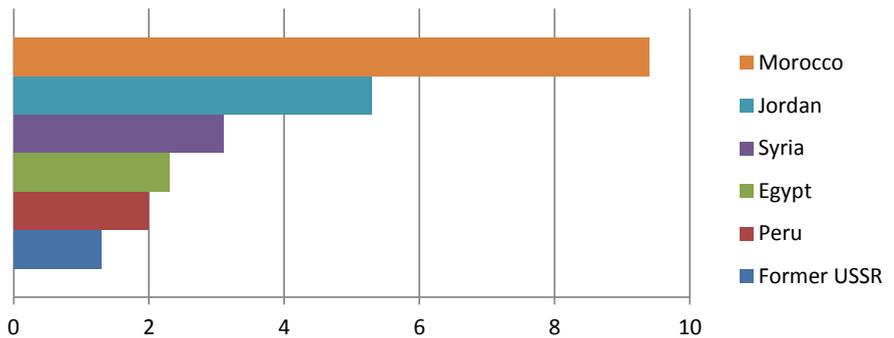


FIGURE 5: PHOSPHATE ROCK EXPORTS BY COUNTRY IN MMT <sup>33</sup>

### Imports of phosphate rock

As data were not available for individual countries' imports of phosphate rock, Figure 6 shows phosphate rock imports by region. South Asia, Western Europe and East Asia have the largest share in global phosphate rock imports, with 22.7%, 16.2% and 14.5% respectively. Between 1999 and 2010 South Asia's imports doubled, whereas the EU reduced imports by 30%. Although Asia as a whole imports more phosphate than Europe, it meets most of its demand with domestic production. Europe is the only region in the world that imports more phosphate than it produces and it does so by a considerable margin.<sup>34</sup>

<sup>32</sup> N-P-K World, 'Morocco: OCP to Double Phosphate Production by 2020.'

<sup>33</sup> PotashCorp, 'What Matters in Phosphate.'

<sup>34</sup> PotashCorp, 'Graph Gallery,' *PotashCorp 2010 Online Annual Report*, 2010, [http://www.potashcorp.com/annual\\_reports/2010/graph\\_gallery/49/](http://www.potashcorp.com/annual_reports/2010/graph_gallery/49/).

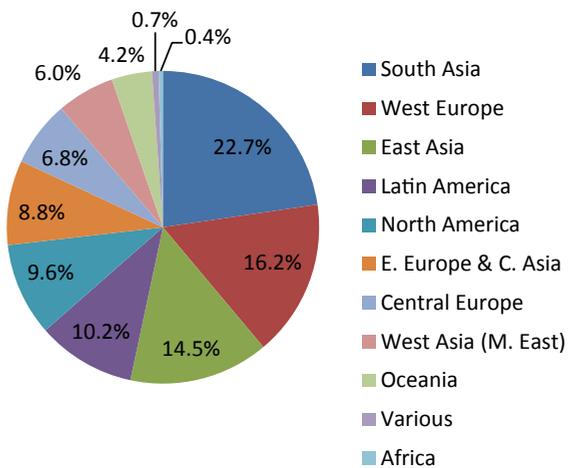


FIGURE 6: PHOSPHATE ROCK IMPORTS BY REGION<sup>35</sup>

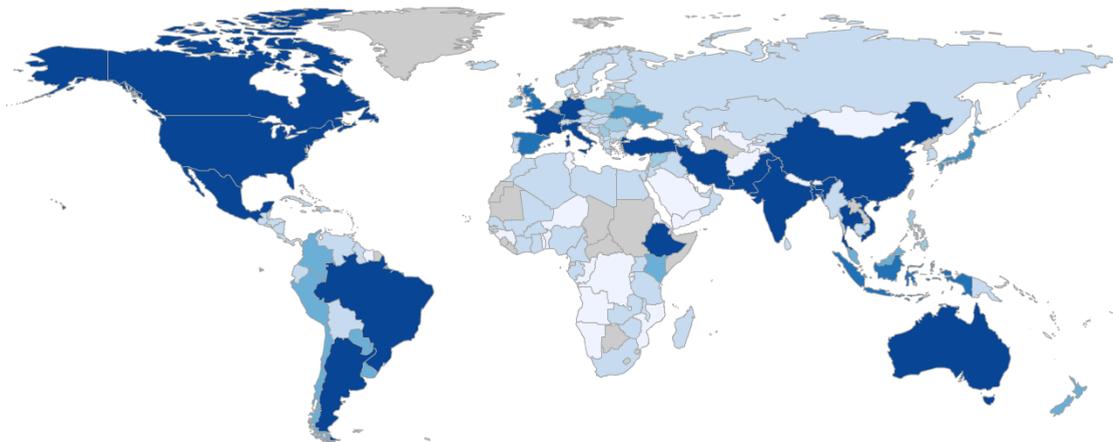


FIGURE 7: COUNTRIES BY IMPORTS OF PHOSPHORUS WITHIN FERTILIZER<sup>36</sup>

35 International Fertilizer Industry Association, 'Statistics.'

36 Based on data from Food and Agriculture Organization, 'FAOSTAT,' accessed August 8, 2012, <http://faostat.fao.org/site/575/DesktopDefault.aspx?PageID=575#ancor>.

Due to the absence of country-level data on imports of phosphate rock, a proxy measure is used to gauge the extent of import reliance per country. Since the overwhelming majority of phosphate rock is eventually turned into fertilizer products, import of phosphorus within fertilizer products is a viable alternative indicator. Figure 7 shows in darker shades the countries with highest imports of phosphorus in fertilizer. India has an overwhelming lead, with 23%, followed by the EU with 12%. Brazil comes in third at 8%. France, Germany, Italy, Spain, and the UK account for over three-quarters of the EU's imports of phosphorus within fertilizer products.

The EU is a net importer of phosphate rock. According to the International Fertilizer Association (IFA), the EU exported 62,000 metric tonnes of phosphate rock and imported 7,518,000 in 2010. Figure 8 shows the main sources of the EU's phosphate rock imports and highlights the Union's reliance on phosphate rock from Russia. Jordan and Algeria also supply phosphate rock to the EU.<sup>37</sup>

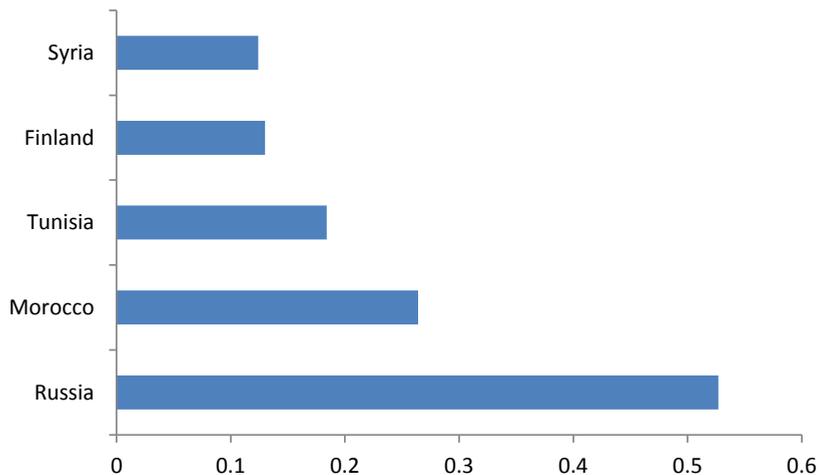


FIGURE 8: MAIN SOURCES OF PHOSPHATE ROCK IN THE EU IN MMT IMPORTED PER YEAR<sup>38</sup>

<sup>37</sup> Public data on the precise amount imported are not available.

<sup>38</sup> Rem Korteweg et al., *Op Weg Naar Een Grondstoffenstrategie. Quick Scan Ten Behoeve Van De Grondstoffennotitie* (The Hague: The Hague Centre for Strategic Studies, TNO & CE Delft, 2011), <http://static.hcss.nl/files/uploads/780.pdf>.

### Future Supply

Future supply of phosphate rock depends both on the size of available phosphate rock reserves, and on exploration projects which may uncover new reserves. Until 2010 the USGS functioned as the primary source for projections on phosphate reserves and resources. This changed when the IFDC published its study 'World Phosphate Rock Reserves and Resources'.<sup>39</sup> This study questioned the data of the USGS, which estimated global phosphate rock reserves at 16,000 mmt in 2010. The IFDC estimates worldwide phosphate rock reserves at 60,000 mmt out of approximately 290,000 mmt of global phosphate rock resources. The response of the GPRI was that these new data should be interpreted with great caution: 'IFDC phosphate rock reserve figures are still estimates based on secondary sources and shrouded in much uncertainty.'<sup>40</sup> In response to the IFDC study the USGS reviewed its own estimates.<sup>41</sup> In 2012 the USGS estimated global phosphate rock reserves at 71,000 mmt.<sup>42</sup> Table 1 shows these data from various sources for the years 2010–2012.

	2010	2011	2012
Resources (IFDC)	290,000		
Reserves (IFDC)	60,000		
Reserves (USGS)	16,000		71,000
Production (USGS)	181	191	

TABLE 1: ESTIMATED WORLD RESOURCES, RESERVES AND PRODUCTION IN MMT

On the basis of the latest USGS estimates, the majority of global phosphate rock reserves are located in Morocco, including the disputed territory of Western Sahara (see Figure 9 and Figure 10). The other major holders of phosphate rock reserves are Iraq, China, Algeria, Syria, Jordan, South Africa, the US and Russia. New discoveries of significant quantities of phosphate rock have put Iraq second

39 Van Kauwenbergh, *World Phosphate Rock Reserves and Resources*.

40 Global Phosphorus Research Initiative, *GPRI Statement on Global Phosphorus Scarcity* (Global Phosphorus Research Initiative, September 26, 2010), [http://phosphorusfutures.net/files/GPRI\\_Statement\\_responseIFDC\\_final.pdf](http://phosphorusfutures.net/files/GPRI_Statement_responseIFDC_final.pdf).

41 Global Phosphorus Network, 'USGS Revises World Phosphate Rock Reserve Estimates Based on IFDC Study,' 2011, <http://globalpnetwork.net/news/2011-01-26/usgs-revises-world-phosphate-rock-reserve-estimates-based-ifdc-study>.

42 Jasinski, 'Phosphate Rock.'

only to Morocco in terms of size of reserves. Some of its individual reserves are thought to be among the largest 10% in the world.<sup>43</sup>



FIGURE 9: MAP OF COUNTRIES BY PHOSPHATE ROCK RESERVES<sup>44</sup>

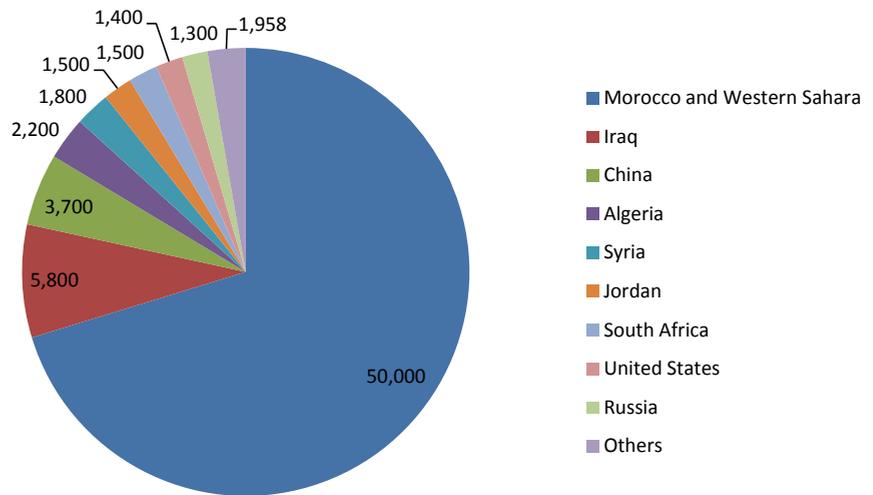


FIGURE 10: RESERVES OF PHOSPHATE ROCK PER COUNTRY IN MMT<sup>45</sup>

43 David Blair, 'US Finds 'world-class' Phosphate in Iraq,' *Financial Times*, September 7, 2011, <http://www.ft.com/intl/cms/s/0/a7b82096-d969-11e0-b52f-00144feabdc0.html#axzz2CsALJ9zL>.

44 Based on USGS 2012 data.

45 Based on USGS 2012 data.

## Exploration

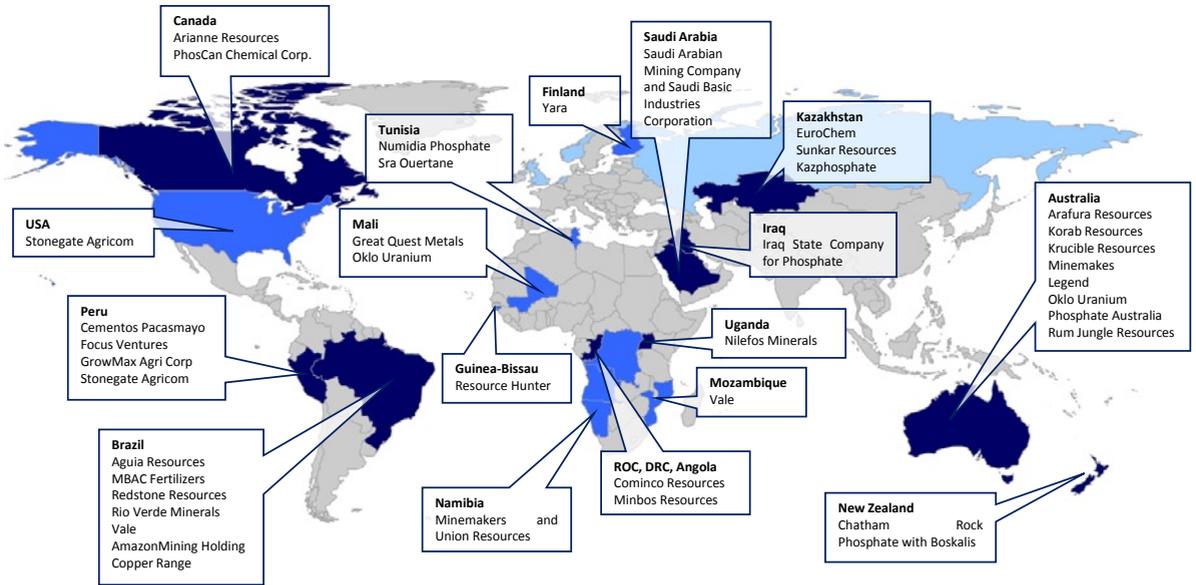
What is clear from the data on production and reserves is that the global phosphate rock market is characterized by a small number of influential players. Whether this situation will remain over time depends to a large extent on exploration activities that may lead to the discovery of new reserves. Such discoveries could cause a shift in market shares of suppliers.

Exploration involves sampling and analysis based on rock drilled and extracted from deep below the earth's surface. The grade of the rock is determined according to whether it contains a minimum required concentration of  $P_2O_5$ . A reserve is designated and classified according to how close together the satisfactory samples are: in order of certainty, 'proven', 'indicated' or 'inferred'.<sup>46</sup> Once the presence of a reserve is confirmed, the financial feasibility of mining is evaluated. Figure 11 shows the locations and firms involved in major exploration projects currently underway. The map highlights exploration projects by site of exploration. It excludes established mining operations, which explains the absence of countries such as Morocco and China from the map. The selection of exploration projects is based on the CRU Independent Authority's 2011 presentation of key current exploration activities.<sup>47</sup>

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46 Jordan Phosphate Mines Company, 'Exploration & Geological Reserves.'

47 Steve Markey, 'N, P & K Fertilizer Market Outlook' (presented at the GPCA Fertilizer Convention, Doha, September 2011).



SITES AND FIRMS ● SITES ONLY ● FIRMS ●

FIGURE 11: MAP OF MAIN EXPLORATION PROJECTS INTO PHOSPHATE ROCK MINING

Some of the projects indicated in Figure 11 could potentially affect the global phosphate rock balance or carry particular prospects for Europe. A detailed description of these projects can be found in the Appendix. A number of more general observations can also be made:

First, Finland is the only country in Western Europe with active phosphate rock mining and exploration underway. The reserve being explored by Norwegian company Yara in Sokli, central-southern Finland, is estimated to contain enough 15% phosphate rock for the next 20 years and lower-concentration 4% rock for up to 100 years.<sup>48</sup> Although this makes the project appealing, it constitutes only a small percentage of total global supply. And since the phosphate concentration

48 Kasper Viita, 'Yara To Decide On Sokli In The Coming Weeks, Kauppalehti Says,' *Bloomberg*, January 23, 2012, <http://www.bloomberg.com/news/2012-01-23/yara-to-decide-on-sokli-in-the-coming-weeks-kauppalehti-says.html>.

of the rock is only half the concentration required to make fertilizer, subsequent processing is required. Estonia represents a second location of phosphate deposits within the EU but no mining or exploration activity is currently taking place due to concerns over the ecological impact of phosphate rock mining.<sup>49</sup>

Second, as a result of improved technologies and higher phosphate prices, hitherto inaccessible reserves are now becoming available, as exemplified by offshore projects off the coasts of New Zealand and Namibia (see Appendix).

Third, exploration activities in Tunisia carried out by other firms indicate that the monopoly of state-owned Gafsa Phosphate Company is becoming more contestable. This could also be viewed as a sign that the political climate may become increasingly favorable for European phosphate firms to do business.

Fourth, the Ma'adan project (see Appendix) is set to significantly expand Saudi Arabia's production of phosphate, making Saudi Arabia an increasingly influential player on the global phosphate rock market.

Finally, it should be pointed out that exploration involves substantial costs, high risks and lengthy delays. Even the early stages run into the millions of euros (for example in the New Zealand project); the total cost of the project in Finland is expected to significantly exceed half a billion euros (see the Appendix for a full description of both projects). There is a considerable proportion of sunk costs (expenses which can never be recovered once they are incurred). This makes exploration a risky investment, as unexpected problems (whether of a technical, political or environmental nature) can confront firms with a difficult choice between pursuing exploration with potentially greater costs than planned or cancelling the project and losing the money invested. Furthermore, the exploration process takes many years to complete. It is therefore difficult to determine at this stage what the precise impact will be of ongoing exploration activities on the future supply of phosphate rock. This also explains why changes in the supply of phosphate rock are very slow to respond to changes in price; this is referred to as price-inelasticity of supply.

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49 Ain Lääne and Rene Reisner, 'Water Sector Reforms in Estonia. A Background Paper for the OECD Global Forum on Environment: Making Water Reform Happen,' 2011, 6; United Nations Economic Commission for Europe Committee on Environmental Policy, 'Environmental Performance Reviews. Estonia Second Review' (United Nations, 2001), 2.

## 2 A changing global phosphate rock market: trends and developments

This chapter looks at the changes that are occurring on the global phosphate rock market. Whereas the previous chapter presented data that together offered a picture of the situation on the global phosphate rock market of today, chapter 2 discusses trends and developments that will shape the global phosphate rock market of tomorrow. First, this chapter looks at demand and supply and the effect of phosphate rock price developments (2.1). Second, the chapter analyzes trends in policy measures and industry strategies that could potentially alter the structure of the global phosphate rock market and affect the availability of phosphate traded on the market (2.2). Third, the chapter reviews the effects of certain geopolitical (2.3), technical (2.4) and environmental developments (2.5).

### 2.1 Supply, demand and price developments

Broadly speaking, phosphate rock used to be a relatively cheap commodity.<sup>50</sup> After years of low and relatively stable prices, the price of phosphate rock soared in 2008, as can be seen in Figure 12. Following this spike, prices dropped again in 2009, remaining nonetheless well above pre-2008 prices. Prices have been rising again in recent months, inter alia due to political turmoil in producer countries (see section 2.3). The figure shows that phosphate rock prices have been prone to sudden shocks. This is particularly problematic for countries heavily reliant on imports, such as Member States of the EU. There is also a heightened risk for small-scale farmers, who are disproportionately affected by even small changes in price of phosphate-containing fertilizer.<sup>51</sup>

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50 Scholz and Wellmer, 'Approaching a Dynamic View on the Availability of Mineral Resources: What We May Learn from the Case of Phosphorus.'

51 Ibid.

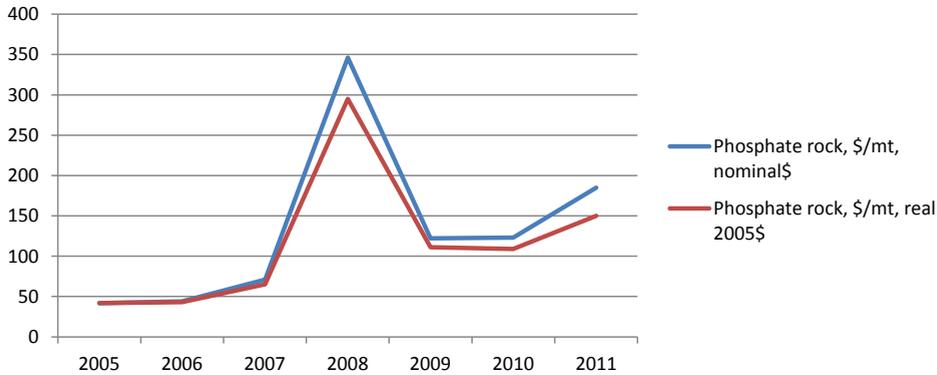
FIGURE 12: PRICE OF PHOSPHATE ROCK, \$/MT<sup>52</sup>

Figure 13 illustrates the mechanism underlying the sudden price increase of 2008.  $P_1$  shows the initial situation where demand ( $D_1$ ) and supply ( $S_1$ ) result in price equilibrium. In 2007–2008, world agriculture increased, leading to a strong rise in demand for phosphate-derived fertilizers.<sup>53</sup> Fertilizer production was insufficient, causing greater derived demand for phosphate rock ( $D_2$ ).<sup>54</sup> Meanwhile, supply tightened, with production and transport costs going up ( $S_2$ ).<sup>55</sup> Some attribute the restricted supply of phosphate rock also to speculation and heightened awareness among producer countries that they could ‘set the price’.<sup>56</sup> This resulted in a higher price ( $P_2$ ). Eventually, higher prices made more

<sup>52</sup> Based on WTO data.

<sup>53</sup> Stephen Jasinski, *Phosphate Rock*, Mineral Commodity Summary (U.S. Geological Survey, January 2010), [http://minerals.usgs.gov/minerals/pubs/commodity/phosphate\\_rock/mcs-2009-phosp.pdf](http://minerals.usgs.gov/minerals/pubs/commodity/phosphate_rock/mcs-2009-phosp.pdf); Mosaic, *Why the Surge in Phosphate Prices?* (Illinois: United Prairie, January 18, 2008), [http://www.unitedprairieilc.com/PDFs/phosphate\\_prices.pdf](http://www.unitedprairieilc.com/PDFs/phosphate_prices.pdf).

<sup>54</sup> ‘Interview with Expert on the Global Phosphate Rock Market (1),’ September 10, 2012.

<sup>55</sup> Stephen Jasinski, *Phosphate Rock (Advance Release)*, 2008 Minerals Yearbook (U.S. Geological Survey, March 2010), [http://minerals.usgs.gov/minerals/pubs/commodity/phosphate\\_rock/myb102008-phosp.pdf](http://minerals.usgs.gov/minerals/pubs/commodity/phosphate_rock/myb102008-phosp.pdf).

<sup>56</sup> Stockholm Environment Institute, ‘Discussion Brief. Pre-consultation for EU Green Paper on Sustainable Phosphorus Use: Exploring Governance Innovations in the Baltic Sea Region Agricultural-food System’ (Stockholm Environment Institute, 2012); Bloomberg Businessweek Magazine, ‘Phosphate: Morocco’s White Gold - Businessweek,’ *Bloomberg Businessweek*, November 4, 2010, [http://www.businessweek.com/magazine/content/10\\_46/b4203080895976.htm](http://www.businessweek.com/magazine/content/10_46/b4203080895976.htm).

exploration and recycling activities economically feasible.<sup>57</sup> It therefore became possible to restore supply ( $S_1$ ). As demand remained stronger than before ( $D_2$ ), new prices ( $P_2$ ) reached a slightly higher level than originally.

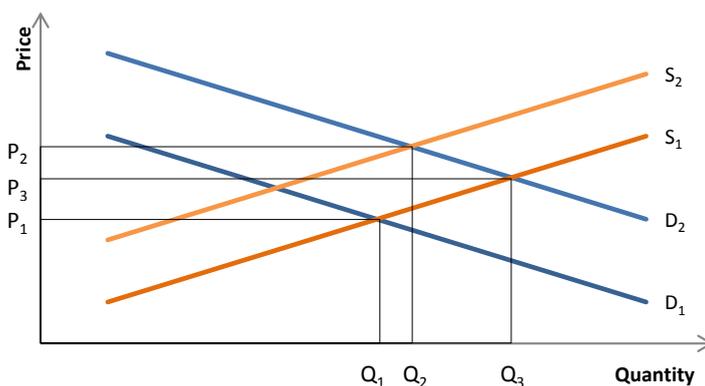


FIGURE 13: THEORETICAL PRICE DYNAMICS FOR PHOSPHATE ROCK

### Price scenarios and determinants of demand

Figure 12 and Figure 13 made clear that the price of phosphate rock has risen steadily in recent months. However, in order to have a greater insight into price developments in the long term, it is important to distinguish the drivers behind the global demand for phosphate rock, as well as the parts of the world where the largest increase in demand is expected to materialize. Prices are expected to remain at their new higher level.<sup>58</sup> The government of Morocco predicts little change in the near future.<sup>59</sup> Experts confirm that prices are likely to remain high or rise and certainly will not fall.<sup>60</sup> Two important factors support this conclusion: price-inelasticity of supply (see section 1.3), and price-inelasticity of demand.

57 R.J. van Enk and J.G. de Wilt, *The phosphate balance: current developments and future outlook* (Utrecht: InnovationNetwerk, 2011).

58 The World Bank, 'World Databank GEM Commodities,' accessed August 9, 2012, <http://databank.worldbank.org/ddp/home.do?Step=12&id=4&CNO=1175>.

59 Souhail Karam, 'Morocco Sees Phosphate Prices Steady Through 2012,' *Reuters*, November 3, 2011, <http://af.reuters.com/article/investingNews/idAFJ0E7A20BJ20111103>.

60 'Interview with Expert on the Global Phosphate Rock Market [2],' September 11, 2012.

On supply, because of the high risks, substantial costs, and lengthy delays involved in setting up new mines, it will always be difficult to absorb shocks, and any future ones will inevitably lead to price rises. Examples of such shocks include political instability in producer regions (see section 2.3), technical issues (see section 2.4) and environmental considerations (see section 2.5).

On demand, as no adequate substitute for phosphorus in fertilizer exists, demand for phosphate rock is relatively resistant to price developments.<sup>61</sup> Figure 14 shows that by 2020 demand for phosphate rock is expected to increase in every major part of the world compared to 2010 levels, with the strongest increase expected in Latin America and Oceania. Major producers becoming net importers is one reason (see section 2.2). A growing world population is also a major factor (see section 2.3). Europe and North America have gradually reduced their consumption of phosphate in recent years due to more efficient use of fertilizer and a buildup of phosphate in the soil, but this trend is not expected to last as increased efficiency has its limits.<sup>62</sup> Moreover, it is possible that the growing market for biofuels will offset efficiency gains as growing plants for fuel will add to the demand for phosphate.<sup>63</sup>

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61 Von Horn and Sartorius, *Impact of Supply and Demand on the Price Development of Phosphate (fertilizer)*.

62 Chemicals Unit of DG Enterprise, *Extended Impact Assessment: Proposal for a Regulation of the European Parliament and of the Council Relating to Cadmium in Fertilizers* (European Commission, July 31, 2003), [http://ec.europa.eu/enterprise/newsroom/caf/\\_getdocument.cfm?doc\\_id=2967](http://ec.europa.eu/enterprise/newsroom/caf/_getdocument.cfm?doc_id=2967).

63 Von Horn and Sartorius, *Impact of Supply and Demand on the Price Development of Phosphate (fertilizer)*.

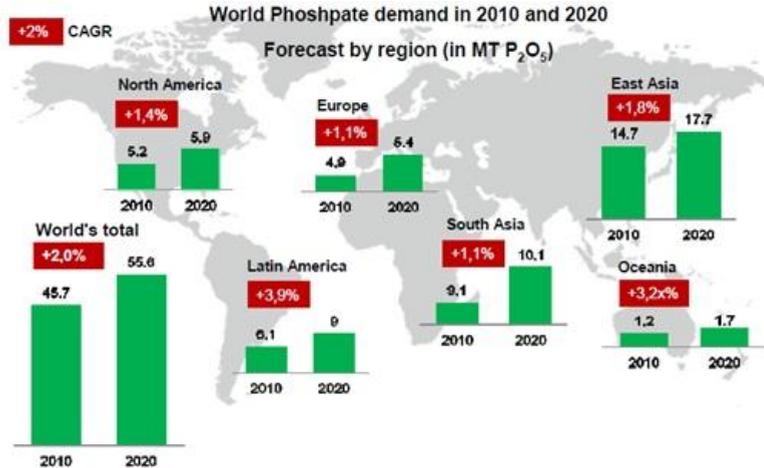


FIGURE 14: WORLD PHOSPHATE DEMAND DEVELOPMENT BY 2020<sup>64</sup>

That said, a scenario of continuing high phosphate rock prices fails to take into account the possibility that in the long term significant changes in the supply and demand for phosphorus can be achieved if phosphorus in sources other than phosphate rock were to be recycled and reused for the production of phosphorus fertilizer, especially *in combination* with measures aimed at changing our diets and improving the efficiency of agriculture and overall food chain management (see Figure 15).

64 Lars Stoumann Jensen, 'A Global Perspective on the Resources and Future Supply of Phosphorus for Agriculture' (presented at the Conference on the Nitrates Directive and Phosphorus, Danish Ministry of the Environment, Copenhagen, May 10, 2012).

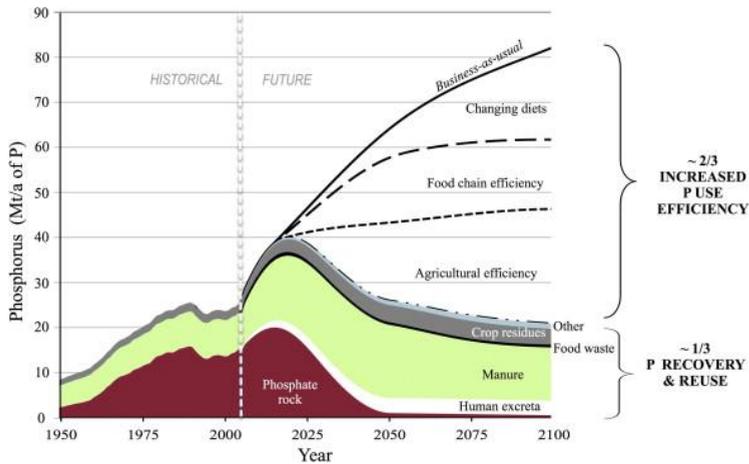


FIGURE 15: HISTORICAL AND FUTURE SOURCES OF PHOSPHORUS FERTILIZER<sup>65</sup>

If the EU took such action, the demand for imported phosphorus within Europe would decline, prompting a drop in the Union’s reliance on imported phosphate rock as the primary input for the production of phosphorus fertilizer, possibly contributing to a reduction in the global price of phosphate rock.

## 2.2 Policies and industry strategies

Increased demand, higher prices and perceived future scarcity of supply of phosphate rock have placed phosphate on the agenda of policymakers and heads of industries. Governments and firms are formulating strategies to deal with the developments on the global phosphate rock market. Consequently, the structure and functioning of the global phosphate market are changing. Supply and demand of phosphate rock are less and less a solely economic matter regulated by the market and international free trade; they are increasingly shaped by deliberate government policies and the strategies of state-owned firms. Increased government intervention *in response* to the changes on the global phosphate market may *in turn* have an effect on the availability of phosphate rock on the market.

65 Cordell et al., ‘Toward Global Phosphorus Security: A Systems Framework for Phosphorus Recovery and Reuse Options.’

### Producers turning net importers

One of the consequences of the growing demand for and limited supply of phosphate rock is that important producers are turning into buyers.<sup>66</sup> The US and China, for example, have large domestic reserves and used to produce phosphate for the global market. Increased domestic demand for phosphate rock and phosphate fertilizer, however, has turned them into net importers. China and the US actively use strategies to reduce their dependence on imports.<sup>67</sup> China has implemented policies that aim to protect its domestic reserves of phosphate rock and to maintain phosphate fertilizer within its borders. Figure 16 shows a sudden drop in US import reliance in 2008–2009, which suggests the US is able to meet growing demand and sudden price spikes with a flexible response. After 2008, however, the US returned to an even higher level of import reliance. This suggests that its strategies to reduce its import dependence are not yet sustainable. Moreover, the US does not yet recycle phosphate, which indicates that the US is likely to be slow in the near future at finding an alternative to its increased import reliance. This trend of large phosphate-producing countries becoming net importers means that there will even be less competition on the supply side of the market and more on the demand side, where the EU is situated.

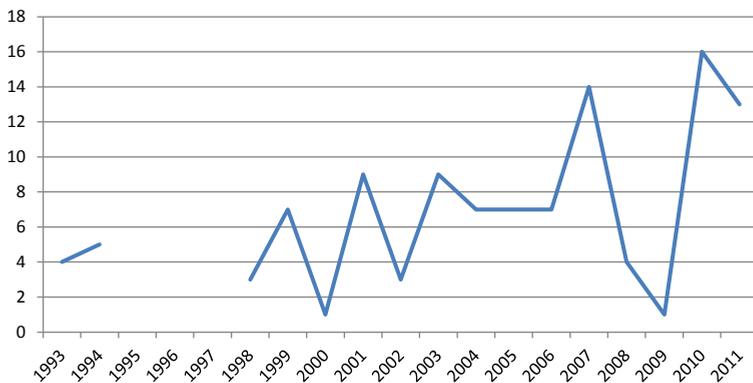


FIGURE 16: NET IMPORT RELIANCE OF THE US ON PHOSPHATE ROCK AS % OF APPARENT CONSUMPTION<sup>68</sup>

<sup>66</sup> Robert Handfield, 'The Global Phosphate Supply Market: Risky and Getting Riskier,' *Supply Chain View from the Field*, April 24, 2012, <http://scm.ncsu.edu/blog/2012/04/24/the-global-phosphate-supply-market-risky-and-getting-riskier/>.

<sup>67</sup> Rosemarin, 'Peak Phosphorus: The Next Inconvenient Truth'

<sup>68</sup> Jasinski, 'Phosphate Rock.'

### State intervention and protectionism

The international system is in transition to one in which state-capitalist tendencies are more prominent.<sup>69</sup> In the mineral sector, this is resulting in increased access restrictions, trade barriers, export quotas, and other manifestations of growing protectionism and resource nationalism. Resource nationalism refers to a situation in which control over natural resources shifts from foreign to domestic state-owned companies. It also means governments align their natural resource policies more explicitly with the national interest. Government intervention in the resource sector has been widespread in non-democratic states for decades. Since the economic crisis, however, government intervention is also becoming more prominent in liberal market democracies.<sup>70</sup>

A number of recent developments suggest phosphate supply may be increasingly be affected by state intervention and restrictive measures in the future. In China for example, the government is concerned with future food security in the context of a growing demand for meat, dairy and cereals. Therefore, China's Ministry of Commerce has listed phosphate—the key ingredient to increase yield from under-fertilized farm fields—as the country's third-most important strategic resource.<sup>71</sup> To protect its domestic phosphate rock sources, China has for the past two years maintained such high export tariffs on phosphate fertilizer that trade practically ground to a halt.<sup>72</sup> Due to this measure, phosphate exports from China have decreased by over 60,000 tonnes, from 102,346 tonnes in 2005 to 39,665 tonnes in 2010.<sup>73</sup> In favor of Western consumer states, the WTO ruled in

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69 Roland Dannreuther, *Understanding Conflict and Cooperation in Access to Oil, Gas and Minerals*, European Policy Brief (Polinares, January 2011), [http://ec.europa.eu/research/social-sciences/pdf/policy-briefs-polinares\\_en.pdf](http://ec.europa.eu/research/social-sciences/pdf/policy-briefs-polinares_en.pdf).

70 Islam Qasem, Teun Van Dongen, and Marjolein de Ridder, *The Global Financial Crisis and the End of the Free Market* Issue Brief 03 (The Hague: World Foresight Forum, 2011), <http://static.hccs.nl/files/uploads/888.pdf>.

71 James Wellstead, 'Remaking China's Phosphate Industry,' *Business Insider*, May 3, 2012, <http://www.businessinsider.com/remaking-chinas-phosphate-industry-2012-5>.

72 Monica Baker, 'China's Phosphate Industry in Major Supply/demand Shift,' *Integer Research*, March 28, 2012, <http://www.integer-research.com/2012/fertilizers-chemicals/news/chinas-phosphate-industry-major-supplydemand-shift/>.

73 China Economic Review, 'Rubbed Raw,' *China Economic Review*, August 1, 2011, <http://www.chinaeconomicreview.com/content/rubbed-raw>.

early 2012 that Chinese policies distorted free trade and must be lifted.<sup>74</sup> At the beginning of 2012, however, China imposed a new export quota for phosphate. Against the background of China's growing domestic demand, it is likely that China will continue to restrict its phosphate exports in the future.

Recently also, Israel has announced it is contemplating placing a cap on the exports of locally mined phosphates in order to maintain the country's reserves and increase state supervision over the country's natural resources. The reason is that Canadian-owned Potash Corp—the world's largest fertilizer maker—is looking into the possibility of acquiring all, or a part, of Israel Chemical (ICL). This prompted concerns in the Israeli Energy and Water Ministry that the Canadian company may increase mining on ICL's part, eventually compromising Israel's reserves.<sup>75</sup>

### **Oligopolization and monopolistic tendencies**

Increased state involvement is also likely to contribute to a global phosphate rock market in which the power is increasingly concentrated in the hands of a few suppliers. First, there is a trend of oligopolies forming. This entails a movement from a large number of small producers to a small number of large producers. Measures are in place that shut down or encourage the takeover of smaller firms, such as minimum extraction rates and restricted access to mining rights. China appears to be pursuing a policy of oligopolization with respect to its domestic phosphate industry and has been shutting down phosphate operations beneath 150,000 tonnes.<sup>76</sup> For example, the Hubei province in eastern China has seen a halving of its number of phosphate firms in the last year.<sup>77</sup> Rationalizing many small outfits into fewer larger ones brings about economies of scale, which

74 Keith Bradsher, 'In Victory for the West, W.T.O. Orders China to Stop Export Taxes on Minerals,' *The New York Times*, January 30, 2012, [http://www.nytimes.com/2012/01/31/business/wto-orders-china-to-stop-export-taxes-on-minerals.html?\\_r=1&pagewanted=all](http://www.nytimes.com/2012/01/31/business/wto-orders-china-to-stop-export-taxes-on-minerals.html?_r=1&pagewanted=all).

75 Ben-David Amir, 'Energy Ministry Mulls Phosphate Export Caps,' *Ynet News | Environment*, November 11, 2012, <http://www.ynetnews.com/articles/0,7340,L-4302941,00.html>; Sara Toth Stub, 'Israeli Government Blow to Potash Corp. Merger With ICL,' *The Wall Street Journal*, November 2, 2012, <http://online.wsj.com/article/SB10001424052970204712904578094500002270228.html>; Reuters, 'Potash Corp Appeals to Israel to Allow Deal for Rival,' October 31, 2012, <http://ca.reuters.com/article/idCABRE89U0E720121031>.

76 James Wellstead, 'Remaking China's Phosphate Industry,' *Business Insider*, n.d., <http://www.businessinsider.com/remaking-chinas-phosphate-industry-2012-5>.

77 *Ibid.*

promise greater efficiency and cost reductions. On top of this, it allows for better environmental and safety oversight as fewer mines need to be reviewed and professionalized.<sup>78</sup> By reducing the number of active players in the Chinese phosphate market, Beijing can strengthen the role of the government in the phosphate industry.<sup>79</sup>

Second, monopolistic tendencies are becoming more pronounced. Depending on the market outlook for viable reserves in key producer countries, some analysts predict that Morocco's market share could increase to 80–90% of global phosphate demand by 2030.<sup>80</sup> Sources familiar with Morocco's plans also suggest that current production is being kept intentionally below capacity in preparation for a greater market share in the future.<sup>81</sup> A control of 80–90% of global supply could potentially create a situation in which Morocco's state-owned firm OCP (already the world's largest exporter) could exhibit price-setting behavior, although the advent of such a scenario depends to a large extent on the impacts of new exploration projects, phosphate recovery and reuse, as well as the possibilities of strategic cooperation with Morocco (see also section 4.2).

A similar situation exists in Tunisia, where the state-owned Gafsa Phosphate Company equally has a strong market position as one of the world's largest producers.<sup>82</sup> However, this monopoly is set to be challenged by the Celamin exploration project (see section 1.3 and the Appendix). National monopolies are a widespread phenomenon and also a key feature of other major phosphate producers such as Syria and Jordan.<sup>83</sup>

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78 Xinhua English News, 'China Launches Campaign to Improve Mining Safety,' August 4, 2012, [http://news.xinhuanet.com/english/china/2012-08/04/c\\_123524682.htm](http://news.xinhuanet.com/english/china/2012-08/04/c_123524682.htm); Mark Gregory, 'BBC News - Why Are China's Mines so Dangerous?,' October 7, 2010, <http://www.bbc.co.uk/news/business-11497070>.

79 Wellstead, 'Remaking China's Phosphate Industry.'

80 Handfield, 'The Global Phosphate Supply Market: Risky and Getting Riskier.'

81 'Interview with Expert on the Global Phosphate Rock Market (1).'

82 Bernard Yaros, 'Ministry of Industry Denies Removal of Gafsa Phosphate Company's CEO,' *Tunisia Live*, August 7, 2012, [http://www.tunisia-live.net/2012/08/07/ministry-of-industry-denies-removal-of-gafsa-phosphate-companys-ceo/?utm\\_source=feedburner&utm\\_medium=twitter&utm\\_campaign=Feed%3A+tunisia-live%2FyMtB+%28Tunisia+Live%29](http://www.tunisia-live.net/2012/08/07/ministry-of-industry-denies-removal-of-gafsa-phosphate-companys-ceo/?utm_source=feedburner&utm_medium=twitter&utm_campaign=Feed%3A+tunisia-live%2FyMtB+%28Tunisia+Live%29).

83 Wellstead, 'Political Risks in MENA Phosphate Markets.'

### Vertical integration

Another trend in response to increased demand for phosphate rock is vertical integration. This refers to a process in which large parts of the supply chain are brought under the ownership and control of a single firm. In the case of phosphate, the mining industry is becoming more closely integrated with the industries that process phosphate rock and produce fertilizer. 70% of phosphate rock producers are already integrated firms in the sense that the processing of the rock and the manufacturing of fertilizer or other phosphate products happens within the same company.<sup>84</sup> The Russian PhosAgro Group is an example of a vertically integrated business in the phosphate industry. PhosAgro produces phosphate rock, feed phosphate and phosphate fertilizers. In 2010 the group was the largest phosphate fertilizer producer in Europe and the largest producer of high-grade phosphate rock worldwide.<sup>85</sup> That the fertilizer trade is indeed proving a lucrative area of business for many large phosphate producing companies is shown by the increasing numbers of foreign acquisitions by companies such as OCP, Norwegian Yara and Egyptian-owned OCI.<sup>86</sup> On top of this, the Ma'aden project in Saudi Arabia demonstrates the significant investment that rock-producing countries are also channeling into the production of processed phosphate products (see Appendix).

Because the overwhelming majority of phosphate rock eventually is turned into fertilizer, vertical integration can result in significant efficiency gains. It allows wastage to be minimized and economies of scale to be exploited, which ultimately helps to keep fertilizer prices low. It also has environmental

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84 PotashCorp, 'Graph Gallery.'

85 PhosAgro, 'Apatit Restarts Production at Apatite-Nepheline Plant #2,' November 28, 2011, <http://www.phosagro.com/media/news/text1557.html>.

86 Christian Lowe, 'Morocco's OCP Eyes Foreign Acquisitions,' *Reuters*, October 18, 2012, <http://www.reuters.com/article/2010/10/18/us-ocp-interview-idUSTRE69H1ZX20101018>; Reuters, 'Moroccan-Turkish Fertiliser JV Targets Big Markets,' June 13, 2012, <http://af.reuters.com/article/idAFL5E8HDEA420120613>; Metalbulletin, 'TOP STORIES: Vertical Integration Drives M&A Activity,' *Metalbulletin.com*, February 25, 2010, <http://www.metalbulletin.com/Article/2399308/TOP-STORIES-Vertical-integration-drives-M-A-activity.html>; Muluken Yewondwossen, 'Yara Takes over Ethiopotash,' October 1, 2012, [http://www.capitalethiopia.com/index.php?option=com\\_content&view=article&id=1733:yara-takes-over-ethiopotash-&catid=54:news&Itemid=27](http://www.capitalethiopia.com/index.php?option=com_content&view=article&id=1733:yara-takes-over-ethiopotash-&catid=54:news&Itemid=27); Reuters, 'Egypt's OCI Expands in US Fertilisers, Construction,' September 5, 2012, [http://article.wn.com/view/2012/09/05/Egypt's\\_OCI\\_expands\\_in\\_US\\_fertilisers\\_construction/](http://article.wn.com/view/2012/09/05/Egypt's_OCI_expands_in_US_fertilisers_construction/).

advantages, since reduced transport and other synergies in the production process reduce the overall impact of the industry.<sup>87</sup> Vertical integration is furthermore a well-proven method for gaining access to resources and strengthens supply security. As security of supply, economic efficiency and environmental impact will remain key concerns for firms and countries in the years to come, vertical integration is likely to become a more widespread phenomenon. This means that phosphate imports into the EU will increasingly take the form of phosphate fertilizer rather than the raw rock itself.<sup>88</sup>

## 2.3 Geopolitical developments

Geopolitical developments have a significant impact on the dynamics of the global phosphate rock market and affect the availability of phosphate on the market. Political and social instability in important producing countries can threaten the security of supply, especially of highly import dependent countries. Developments in the Middle East and North Africa (MENA) region, which is an important source of EU imports, are of particular significance for the future supply of phosphate. Furthermore, substantial water use in the production of phosphate rock is of increasing concern in a world where water is becoming scarcer.

### Arab Spring and labor protests

The Arab Spring, which started in December 2010, has had important implications for the global supply of phosphate since it affected several important producing countries in the MENA region. In Tunisia, for example, phosphate exports fell from €1 billion to just €0.6 billion as a result of the political and social unrest.<sup>89</sup> With the political turmoil slowly calming down, there are signs of improvement. Tunisia's foreign trade observatory has expressed optimism that the 6.7% increase in exports last year marked the beginning of a resurgence of the Tunisian phosphate trade.<sup>90</sup> Private firms have also indicated increasing confidence in the market and are investing in ongoing exploration activities.<sup>91</sup>

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87 Van Kauwenbergh, *World Phosphate Rock Reserves and Resources*.

88 Chemicals Unit of DG Enterprise, *Extended Impact Assessment*.

89 Yaros, 'Ministry of Industry Denies Removal of Gafsa Phosphate Company's CEO.'

90 Babnet, 'Tunisie: Commerce extérieur Hausse de 6,7% des exportations tunisiennes en 2011,' *Babnet Tunisie*, January 19, 2012, <http://www.babnet.net/cadredetail-44180.asp>.

91 Alessandro Bruno, 'Celamin Holdings More Confident About Its Phosphate Exploration Prospects in Tunisia,' *Potash And Phosphate Blog*, 13 2012, <http://potashandphosphate.com/celamin-holdings-more-confident-about-its-phosphate-exploration-prospects-in-tunisia/>.

Nonetheless, troubled employment relations remain a continuing threat to a stable supply of phosphate from the MENA region.<sup>92</sup> In Tunisia the unrest among industrial workers has caused disruptions on a regular basis in recent months and has involved miners as well as rail workers who have obstructed the transport of phosphate rock from mines.<sup>93</sup> Due to these employment disputes, Gafsa has issued tempered figures for the previous year, saying that 2011 production was only 45% of 2010 levels and 30% of its total capacity.<sup>94</sup> Employment relations also remain difficult and a source of instability in Morocco and Jordan. The former has seen strikes and threats of mass suicides, though little actual disruption to production;<sup>95</sup> the latter has also experienced strikes, though mining companies are keen to assert that these have now been resolved.<sup>96</sup>

The political and social situation in the countries affected by the Arab Spring remains volatile. Considerable uncertainty in the market remains a problem and every two steps forward are followed by one step back.

### **Protracted conflict in Syria**

Syria is suffering from an ongoing political struggle between the reigning regime of president Assad and the opposition, dogged by violence and uncertainty. The conflict has important implications for the supply of phosphate. Before the

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92 Wellstead, 'Political Risks in MENA Phosphate Markets.'

93 Babnet, 'Phosphate: Les Recettes Ne Vont Pas Dépasser 200 MD En 2011,' *Babnet Tunisie*, December 28, 2011, <http://www.babnet.net/cadredetail-43156.asp>; Babnet, 'Activité Du Transport Du Phosphate En Baisse Et Paralysie Du Trafic Des Passagers Et Des Marchandises à Gafsa,' *Babnet Tunisie*, March 13, 2012, <http://www.babnet.net/cadredetail-47024.asp>; Babnet, 'Reprise Des Activités De La Compagnie Des Phosphates De Gafsa à Métaoui,' *Babnet Tunisie*, May 9, 2012, <http://www.babnet.net/cadredetail-49348.asp>; Businessnews, 'SNFCT De Gafsa: Une Grève De 3 Jours Qui Coûtera Un Demi-million De Dinars De Pertes,' *Businessnews.com.tn*, July 11, 2012, <http://www.businessnews.com.tn/Tunisie---SNFCT-de-Gafsa--Une-gr%C3%A8ve-de-3-jours-qui-co%C3%BBtera-un-demi-million-de-dinars-de-pertes,520,32241,3>.

94 Babnet, 'Phosphate: Les Recettes Ne Vont Pas Dépasser 200 MD En 2011.'

95 Alex Feytis, 'Morocco's OCP Phosphate Output Unaffected by Strike in Safi,' *Industrial Minerals*, January 30, 2012, <http://www.indmin.com/Article/2969747/Moroccos-OCP-phosphate-output-unaffected-by-strike-in-Safi.html>; Souhail Karam, 'Seventy Moroccans Threaten Suicide in Jobs Protest,' *Reuters*, January 21, 2012, <http://af.reuters.com/article/topNews/idAFJOE80K02120120121>.

96 Muath Freij, 'Phosphate Workers End Strike After Deal with Management,' *The Jordan Times*, February 14, 2012, <http://jordantimes.com/phosphate-workers-end-strike-after-deal-with-management>.

outbreak of the conflict, up to 40% of Syrian phosphate went to the EU.<sup>97</sup> The EU has imposed sanctions against Syria, but has stopped short of targeting Syrian mineral exports, partly due to the reliance of Greece on Syrian phosphate imports.<sup>98</sup> It is clearly unwise for Europe to increase its dependency on Syrian phosphate at this time. Already before the conflict, the Assad regime appeared keen to reduce its reliance on the EU as a consumer. To this end, in early 2011 the Assad administration agreed to increase its sales of phosphate rock to Iran twenty-fold in 2012 and to make it a chief beneficiary of what was then an industry recording strong growth.<sup>99</sup> The volatile nature of the situation in Syria will deter investors in the country's phosphate industry. The political and military resolve of the Syrian regime in this intransigent conflict make the future of phosphate supplies from this country a rather uncertain factor.

### Western Sahara

Morocco has not been affected by the Arab Spring to the same extent as some of its neighbors have. OCP is planning solid growth, including the acquisitions mentioned above and considers itself a beneficiary from the political collapse in other phosphate-producing countries.<sup>100</sup> Nonetheless, Morocco has its own area of political contention that may affect future phosphate supply, namely the non-self-governing territory of Western Sahara. Since the UN brokered a ceasefire to a long-running conflict in 1991, most of the territory has been controlled by Morocco, although this is strongly contested, not least by separatist movement the Polisario Front, which aims to gain independence for Western Sahara.<sup>101</sup>

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97 Wellstead, 'Political Risks in MENA Phosphate Markets.'

98 Bruno Waterfield, 'EU Agrees Further Syria Sanctions,' *The Telegraph*, February 27, 2012, <http://www.telegraph.co.uk/news/worldnews/middleeast/syria/9108153/EU-agrees-further-Syria-sanctions.html>.

99 Linda Ibrahim, 'Syria Agrees to Sell 400,000 Tons of Phosphate to Iran in 2012,' *Bloomberg*, April 27, 2011, <http://www.bloomberg.com/news/2011-04-27/syria-agrees-to-sell-400000-tons-of-phosphate-to-iran-in-2012.html>.

100 Alessandro Bruno, 'Morocco's Phosphate Industry Will Benefit from The 'Arab Spring' in North Africa,' *Potash And Phosphate Blog*, March 14, 2012, <http://webcache.googleusercontent.com/search?q=cache:ldpapfV2W1gJ:potashandphosphate.com/moroccos-phosphate-industry-will-benefit-from-the-arab-spring-in-north-africa/+morocco%27s+phosphate+industry+will+benefit+from+the+arab+spring+in+north+africa&cd=1&hl=nl&ct=clnk&gl=nl&client=firefox-a>.

101 Western Sahara Resource Watch, 'WSRW,' accessed August 24, 2012, <http://www.wsrw.org/LEN>.

Phosphate rock reserves are contributing to the intricacy of the dispute. Western Sahara is rich in phosphate rock,<sup>102</sup> and it is one of the most important natural resources in the area.<sup>103</sup> The part administered by Morocco includes a large phosphate mine. Western Sahara accounts for around 10% of Morocco's phosphate production and thus provides an incentive for Morocco to claim sovereignty over the territory, both to benefit from the resource and prevent a challenge to the monopoly of OCP.<sup>104</sup>

There is doubt surrounding Morocco's moral right to exercise sovereignty by exploiting its natural resources. The UN has responded to this dilemma by concluding that any use of phosphate that emanated from Western Sahara must benefit the people who live there.<sup>105</sup> Determining this is a difficult ethical question and one that is further complicated by Morocco's policy of settling Moroccan laborers in the region and placing them in jobs that could have otherwise been taken by locals.<sup>106</sup> For its part, OCP considers its presence in the region a non-profit endeavor for the good of the people of Western Sahara, where 1,700 families get their livelihood from phosphate extraction.<sup>107</sup> Others however are less convinced, and Norway has recently excluded trading partners of OCP from its sovereign wealth fund, specifically citing ethical concerns surrounding Western Sahara.<sup>108</sup>

The process of resolving the dispute is exceptionally slow. Talks take place regularly but fundamental disagreement over what should be discussed ensures

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102 This is contested by the Moroccan government

103 BBC, 'Western Sahara Profile,' *BBC News*, December 9, 2011, <http://www.bbc.co.uk/news/world-africa-14115273>; Fred Pearce, 'Phosphate: A Critical Resource Misused and Now Running Low,' *Yale Environment 360*, July 7, 2011, [http://e360.yale.edu/feature/phosphate\\_a\\_critical\\_resource\\_misused\\_and\\_now\\_running\\_out/2423/](http://e360.yale.edu/feature/phosphate_a_critical_resource_misused_and_now_running_out/2423/).

104 Aidan Lewis, 'Morocco's Fish Fight: High Stakes over Western Sahara,' *BBC News*, December 15, 2011, <http://www.bbc.co.uk/news/world-africa-16101666>.

105 Hans Corell, 'Letter Dated 29 January 2002 from the Under-Secretary-General for Legal Affairs, the Legal Counsel, Addressed to the President of the Security Council,' February 12, 2002, [http://www.un.org/ga/search/view\\_doc.asp?symbol=S/2002/161](http://www.un.org/ga/search/view_doc.asp?symbol=S/2002/161).

106 Bruno, 'Morocco's Phosphate Industry Will Benefit from The 'Arab Spring' in North Africa.'

107 Lowe, 'Morocco's OCP Eyes Foreign Acquisitions.'

108 ICIS, 'Norway Sells Canada PotashCorp Stock over Western Sahara Phosphate,' *ICIS.com*, December 7, 2011, <http://www.icis.com/Articles/2011/12/07/9514870/norway-sells-canada-potashcorp-stock-over-western-sahara-phosphate.html>.

they invariably result in a stalemate.<sup>109</sup> A national referendum intended to settle the issue never took place and is unlikely to in the near future. The future of Western Sahara remains decidedly unresolved, increasing the likelihood that an escalation of the dispute may impact global phosphate production and supply.

### **Water scarcity**

The mining sector relies heavily on the use of water throughout all of its stages. Because of competing claims over water coming from the agriculture and drinking water sectors, water scarcity is a potentially serious limiting factor for the phosphate mining industry. Water use has been growing at over twice the rate of population increase in the last century. According to the United Nations Environment Programme (UNEP), by 2025, 1,800 million people will be living in countries or regions with absolute water scarcity and two-thirds of the world population could be under water-stress conditions. Growing populations, economic development and unpredictable rainfall have left many countries struggling to close the gap between supply of and demand for water.<sup>110</sup> Most countries in the MENA region, including many important producers of phosphate rock, suffer from acute water scarcity, where irrigated agriculture represents the bulk of the demand for water.<sup>111</sup> Such competing claims over water also prompt the application of desalination techniques, a well-established but expensive and energy-intensive technology, which can drive up the costs associated with phosphate rock mining.<sup>112</sup> That such trade-offs matter is indicated by the construction of desalination plants in Algeria and Tunisia. More plants are currently under construction in Morocco and Namibia.<sup>113</sup>

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109 Reuters, 'Still No Breakthrough in Western Sahara Talks,' *Top News*, March 14, 2012, <http://af.reuters.com/article/topNews/idAFJOE82D00K20120314>.

110 Emilie Filou, 'Water - Desalination Projects for a Thirsty Continent' (The Africa Report No 24, 2010), 86.

111 Duncan Clark, 'Water Scarcity in Africa and the Middle East: Get the Data,' *The Guardian: Environment*, June 28, 2011, <http://www.guardian.co.uk/environment/datablog/2011/jun/28/water-scarcity-africa-middle-east>; The World Bank, 'Dealing with Water Scarcity in MENA,' August 15, 2008, <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/MENAEXT/0,,contentMDK:21872903~menuPK:247603~pagePK:2865106~piPK:2865128~theSitePK:256299,00.html>.

112 Filou, 'Water - Desalination Projects for a Thirsty Continent,' 86, 88.

113 Nau Agencies, 'Jorf Lasfar Phosphate Hub,' May 14, 2012, [http://www.northafricaunited.com/Jorf-Lasfar-Phosphate-Hub\\_a1458.html](http://www.northafricaunited.com/Jorf-Lasfar-Phosphate-Hub_a1458.html); Filou, 'Water - Desalination Projects for a Thirsty Continent,' 88.

An additional factor to take into account is that the agricultural sector is usually also the first one affected by water shortages. This makes it difficult to maintain per-capita food production while at the same time meeting water needs for domestic and industrial purposes.<sup>114</sup> If food security in phosphate producing countries were to come under pressure as a result of difficulties to balance water demand for agriculture and the mining industry, further instability should not be ruled out in the future.

## 2.4 Emerging technical issues

In addition to water scarcity, four other more technical challenges could also affect the dynamics of the global phosphate rock market of tomorrow. First, concerns are rising about the  $P_2O_5$  grade of available phosphate. Second, pollution, especially by cadmium, is increasingly considered an important technical challenge because of cadmium's negative effects on human health and the environment. Third, scarcity of phosphate is contributing to emerging awareness about inefficient use and loss of phosphate, especially against the background of urbanization.

### Grade

Experiences from other extractive industries, such as the oil, gas and metals sector, tell us that at a given price level and with ever-increasing exploration the 'easily recoverable' resources (in terms of required technical expertise, energy use and general profitability) are the first to be exhausted. With respect to phosphate this would suggest that the availability of phosphate rock with a high  $P_2O_5$  concentration is steadily declining and that ever-increasing levels of processing will become necessary in order to compensate for the declining phosphate grade. Figures for the past 30 years show only minor changes in quantities produced of various grades of phosphate rock.<sup>115</sup> However, a decline in the grade of phosphate rock is a scenario that cannot be ruled out a priori.

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114 UN Water, 'Coping with Water Scarcity. A Strategic Issue and Priority for System-wide Action,' August 2006, 2.

115 Steven van Kauwenbergh, 'World Phosphate Rock Reserves and Resources' (Center for Strategic and International Studies, Washington, DC, September 22, 2010), [http://csis.org/files/attachments/100922\\_Kauwenbergh\\_Presentation\\_0.pdf](http://csis.org/files/attachments/100922_Kauwenbergh_Presentation_0.pdf).

### Cadmium pollution

Of greater concern is a trend toward phosphate that contains higher traces of cadmium.<sup>116</sup> Cadmium is a toxic element often present in phosphate rock and one that remains in the final product when phosphate is made into fertilizer. Therefore it is feared that over time fertilizers containing it could present a serious pollution risk.<sup>117</sup> Cadmium tends to accumulate in soil and is damaging to the environment and human health. Through fertilizer use cadmium enters the food chain. Cadmium contamination is associated with kidney failure and cancer.<sup>118</sup>

The issue of cadmium buildup in European soils will increasingly gain attention from both the EU and its Member States for two reasons. First, the expected increasing reliance of the EU on phosphate rock from Morocco will prompt concerns about cadmium pollution. The level of cadmium in phosphate rock varies considerably. Rock sourced in Finland or the former Soviet Union contains virtually none, whereas rock from Morocco generally contains much more.<sup>119</sup>

Second, more is being learned about the human health risk of cadmium from phosphate fertilizer. The link between fertilizer use and cadmium in food was confirmed in a study undertaken by the Finnish Environment Institute. This study claims that if phosphate fertilizers containing the average EU level of cadmium were to be used in Finland, the dietary intake of cadmium would increase by more than 40% over 100 years.<sup>120</sup> Whether such an increase would cause serious health damage remains difficult to ascertain. The tolerable weekly intake (TWI) of cadmium as established by the European Food Safety Authority

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116 'Interview with Expert on the Global Phosphate Rock Market [2]'; 'Interview with Expert on the Global Phosphate Rock Market [1].'

117 Chemicals Unit of DG Enterprise, *Extended Impact Assessment*; Finnish Environment Institute, 'Cadmium in Fertilizers. Risks to Human Health and the Environment,' October 2000, iii, iv and vi.

118 Recently, a high incidence of kidney disease among farmers in Sri Lanka was also associated with cadmium in fertilizers. See Rhitu Chatterjee, 'Sri Lanka Kidney Disease Blamed on Farm Chemicals,' *BBC News*, September 18, 2012, <http://www.bbc.co.uk/news/uk-19628295>.

119 Chemicals Unit of DG Enterprise, *Extended Impact Assessment*.

120 Finnish Environment Institute, 'Cadmium in Fertilizers. Risks to Human Health and the Environment,' vi.

is set at 2.5 µg/kg of body weight.<sup>121</sup> Although TWI represents a pragmatic risk assessment tool based on the principle that below a certain exposure limit there is low risk to human health, additional human exposure to cadmium should be eyed with caution.<sup>122</sup> In addition, the level of uranium in the soil is rising due to the use of fertilizer containing traces of it. German fertilizer tests have shown an increase in the levels of uranium in the top-soil, sparking fears that the contaminant could threaten food crops and drinking water supplies and lead to health problems over time.<sup>123</sup>

### Inefficient use and loss of phosphate

Phosphate is increasingly considered a strategic resource whose supply is unstable and could become severely limited in the future. As a result, there is a growing discourse in which phosphate is viewed as a precious asset.<sup>124</sup> The trend to increasingly value phosphate has raised awareness about inefficient use and loss of phosphate.<sup>125</sup> During the course of mining, processing and use, considerable amounts of phosphate are lost, making the overall life cycle of phosphate rather wasteful. This has triggered questions into how phosphate is used, where it is wasted and whether it can be recovered.

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121 In early 2011, the EFSA was requested by the European Commission to assess the TWI for cadmium as the Joint Food and Agriculture Organization (FAO)/World Health Organization (WHO) Expert Committee had recommended a less strict threshold than the EFSA had originally set in 2009. The EFSA concluded that the current TWI of 2.5 µg/kg b.w. established in 2009 should in fact be maintained in order to ensure a high level of protection of consumers. See The European Food Safety Authority Panel on Contaminants in the Food Chain (CONTAM), 'Scientific Opinion. Statement on Tolerable Weekly Intake for Cadmium,' *EFSA Journal* 9, no. 2 (2011): 2–3.

122 Finnish Environment Institute, 'Cadmium in Fertilizers. Risks to Human Health and the Environment,' v; M. Rennen et al., *Toxicological Assessment of Complex Chemical Mixtures Using the Threshold of Toxicological Concern Concept* (Zeist, Netherlands: TNO, n.d.).

123 Geerd A. Smidt et al., 'Cadmium and Uranium in German and Brazilian Phosphorous Fertilizers,' in *The New Uranium Mining Boom*, ed. Merkel Broder and Mandy Schipek, Springer Geology, 2012, 167–175; The Local, 'Most Fertilizers 'Contain Too Much Uranium',' *The Local. Germany's News in English*, March 20, 2012, <http://www.thelocal.de/national/20120320-41435.html>; W. van Hengel, 'Kunstmest Met Een Snufje Uranium,' *Reformatorisch Dagblad*, November 13, 2007, [http://www.refdag.nl/kunstmest\\_met\\_een\\_snufje\\_uranium\\_1\\_235452](http://www.refdag.nl/kunstmest_met_een_snufje_uranium_1_235452); Piet Kuiper, 'Fosfaatmest Bron Van Uraniumvervuiling,' *Bionieuws*, October 6, 2007, <http://www.bionieuws.nl/artikel.php?id=3497&print=1>.

124 Cordell, *The story of phosphorus*; 'Interview with Expert on the Global Phosphate Rock Market (1).'

125 Cordell, *The story of phosphorus*.

Figure 17 outlines the main uses and points of loss (known as ‘sinks’) within the phosphate cycle. The size of bubble represents the amount of phosphate lost. The largest flows of phosphate are lost in agricultural runoff, erosion and animal wastes.<sup>126</sup> In the mining sector, mine ‘tailings’—the materials left over after the valuable resource has been extracted from the uneconomic portion of earth mined—are generally stored on-site so that when economic and technological circumstances change they may be used for recovery and recycling.<sup>127</sup> Although 90% of global phosphate rock demand is used for food production, the conversion efficiency in the areas of food processing, distribution, and consumption is a mere 40%.<sup>128</sup>

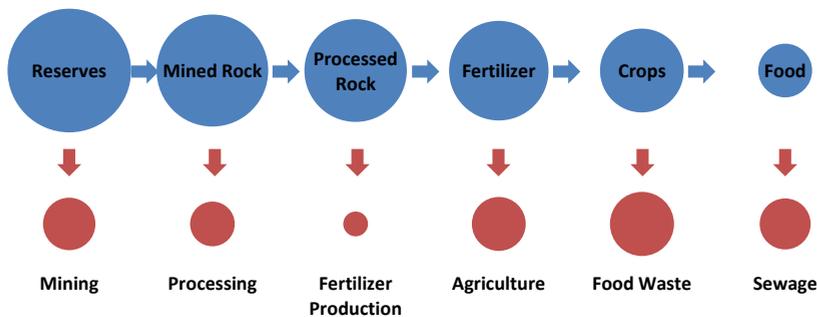


FIGURE 17: SIMPLIFIED OVERVIEW OF THE MAIN USES AND SINKS IN PHOSPHATE USE<sup>129</sup>

This figure illustrates that there are many ways to improve the efficient use and to reduce the loss of phosphate throughout the entire life cycle. Research and development into new technologies to optimize efficiency and reduce waste is already in an advanced stage (see section 3.3). As the price of phosphate will continue to be high, it can be expected that the technical and economic

126 A. Rosemarin et al., ‘Future supply of phosphorus in agriculture and the need to maximise efficiency of use and reuse,’ *Proceedings of the International Fertiliser Society* 685 (2011): 2 and 21.

127 ‘Interview with Experts on the Global Phosphate Rock Market (4 & 5),’ September 18, 2012.

128 Cordell, *The story of phosphorus*; OECD, *Material Resources, Productivity and the Environment*, 104; Rosemarin et al., ‘Future supply of phosphorus in agriculture and the need to maximise efficiency of use and reuse,’ 2 and 21.

129 Based on calculations in Rosemarin et al., ‘Future supply of phosphorus in agriculture and the need to maximise efficiency of use and reuse’; Cordell, *The story of phosphorus*.

challenges related to the large scale implementation of these technologies will be overcome in the near future.

The discourse on phosphate as a precious resource will become even more important in the future given the trend of urbanization, which is associated with the loss of phosphate.<sup>130</sup> Increasing urbanization means that cities are becoming phosphorus ‘hotspots’. Urine is the largest phosphorus sink in cities. Whereas in the past nutrient flows from food via human excreta typically found their way back to land, today they more often end up in waterways via wastewater from urban centers or as sludge in landfills.<sup>131</sup> This strengthens the argument to increase efficiency and wastewater treatment whereby phosphate is recovered from sewage sludge.

## 2.5 Increased environmental awareness

Public awareness of environmental challenges related to phosphate rock mining and the use of phosphate fertilizer is rising. Companies’ appreciation of environmental issues is growing and several new environmental policies and recent mine closures are indicative of a general trend toward higher environmental awareness.

### Negative environmental effects

Negative environmental effects occur both during the production and consumption stages of phosphate. The main effects of phosphate rock mining are air emissions, land surface disturbance, and water contamination.<sup>132</sup> These negative environmental effects occur at all stages of the mining life cycle, from mine development, extraction, handling, beneficiation, and waste disposal, to mine closure.<sup>133</sup> Increased awareness about the negative environmental impact of phosphate rock mining and phosphate processing is affecting the structure of the global phosphate market. Experts point to the closure of phosphate mines in the US due to environmental pressures.<sup>134</sup> In addition, environmental pressures are also reinforcing the process of vertical integration highlighted

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130 European Commission, ‘EXPERT SEMINAR ON THE SUSTAINABILITY OF PHOSPHORUS RESOURCE,’ 2011, [http://ec.europa.eu/environment/natres/pdf/conclusions\\_17\\_02\\_2011.pdf](http://ec.europa.eu/environment/natres/pdf/conclusions_17_02_2011.pdf).

131 Cordell, Drangert, and White, ‘The Story of Phosphorus.’

132 United Nations Environment Programme and International Fertilizer Industry Association, *Environmental Aspects of Phosphate and Potash Mining* (UNITED NATIONS PUBLICATION, 2001).

133 Ibid.

134 ‘Interview with Expert on the Global Phosphate Rock Market [2].’

above. For example, Fertiberia, a leading non-mining company in the Spanish fertilizer industry and one of the leading fertilizer producers in the EU, has permanently closed its phosphoric acid production as a result of environmental pressure and is expected to buy phosphoric acid from OCP (an integrated mining and phosphoric acid company) instead.<sup>135</sup>

Generally speaking, the use of phosphorus (for example in fertilizers) is linked to other unwanted environmental effects, including the loss of landscape quality, greenhouse gas emissions, excessive fresh-water consumption, radioactivity, cadmium accumulation and fluorine emission, further underlining the need to increase efficiency of use.<sup>136</sup> According to a study carried out by the UNEP, the environmental performance of the fertilizer raw materials industry has improved over recent decades, although significant challenges remain.<sup>137</sup> The most-frequently cited issue relating to the environmental impact of phosphate fertilizer use is the harmful phenomenon of eutrophication.

### Eutrophication

Eutrophication refers to a number of processes set in motion when phosphorus (and other nutrients in fertilizers) leaches into surface waters, such as lakes and seas. This removes the limiting factor for the growth of many organisms such as algae, which proliferate to the point that they threaten other life forms present in the water. When algae populations die, their decomposition depletes oxygen in the water, suffocating fish and other organisms.

The use of phosphate fertilizer in the agricultural sector is an important cause of phosphate reaching surface waters. In addition, urban waste water contains large amounts of phosphate. In the EU urban waste water contains about 1.14 mmt P<sub>2</sub>O<sub>5</sub> per year. This equals a share of 34% of imported phosphate (3.4 mmt P<sub>2</sub>O<sub>5</sub>) in 2011 in the EU.<sup>138</sup>

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135 EuroChem, 'The Importance of Phosphates | EuroChem,' 2012, <http://ar.eurochem.ru/2010/5-importance-phosphates>.

136 Christian Fischer and Birgitte Kjær, *Recycling and Sustainable Materials Management - Analytic Paper for the Danish Ministry of the Environment* (Copenhagen Resource Institute, January 2012); J.J. Schröder et al., *Sustainable Use of Phosphorus* (Wageningen: Plant Research International, Wageningen University and Research Centre, 2010), 3.

137 United Nations Environment Programme and International Fertilizer Industry Association, *Environmental Aspects of Phosphate and Potash Mining*.

138 Rosemarin et al., 'Future supply of phosphorus in agriculture and the need to maximise efficiency of use and reuse.'

Many studies highlight the need to arrest or recover phosphate before it reaches water bodies. The loss of phosphate in water is a potential threat to water quality and a general alarm bell on efficiency. High phosphate concentrations in water and eutrophication are also associated with higher costs and difficulties of drinking water purification.<sup>139</sup>

The EU emphasizes the need to balance input and output (soil balance) to reduce nutrient losses to surface water and groundwater in order to meet European water quality targets.<sup>140</sup> Examples of policy initiatives in this direction are the Directives on Bathing Water (76/160/EEC), Sewage Sludge (86/278/EEC), Urban Waste Water Treatment (91/271/EEC), Nitrates (91/676/EEC), and on Integrated Pollution Prevention Control (96/61/EEC), all of which are part of the EU Water Framework Directive.<sup>141</sup>

The environmental dimension may at times become somewhat overshadowed by the emerging discourse on the value of phosphate as a strategic resource and the concurrent attention for efficiency gains as a means to improve supply security. Nonetheless, eutrophication is policy concern in Europe and around the world that is likely to remain on the agenda. Increased awareness about the negative effects of eutrophication may potentially reduce the use of phosphorus by promoting greater efficiency and recovery.

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139 Gregory Mullins, 'Phosphorus, Agriculture & The Environment' (Communications and Marketing, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, 2009).

140 Enk and Wilt, *The phosphate balance*.

141 Schröder et al., *Sustainable Use of Phosphorus*.

## 3 Implications for the EU

The previous chapter identified a number of trends and developments, which each impact the EU's ability to secure its supply of phosphate rock in their own way. This chapter analyzes the implications for Europe's security of supply that stem from political-economic risks (3.1) and technical hindrances (3.2). Section 3.3 discusses some of the policy initiatives currently underway in Europe, both in the EU and at the Member-State level.

### 3.1 What political-economic risks threaten the EU's phosphate supply security?

#### **High prices and increased competition to secure supply**

The strong fluctuations in the global price for phosphate rock have a profound impact on regions such as Europe, which are highly dependent on imports and have little domestic mining activity of their own. A further compounding factor is that economic development and population increases in India and Africa cause a rise in demand for arable land and fertilizer, driving up prices of phosphate rock as a result. It is also possible to imagine a scenario in which China's activities in Africa combined with the continent's economic development could lead to a greater demand for phosphate products, particularly from nearby producers such as Morocco. This would intensify competition to secure supply. The US's import reliance shows no signs of decreasing, China is becoming a net importer, and India's growth is cementing its position as the biggest importer. This means the buyers' market for phosphate rock is becoming increasingly crowded. This causes the EU to face mounting competition in securing the supply it needs. Meanwhile, export limitations in producer countries (as implemented by China), political turmoil (as in Syria) and dwindling reserves (as in the US), further tighten supply. The EU needs to design strategies to cope with these developments, especially since it is not heavily involved in exploration. Exploration can contribute to phosphate security of supply, either through the discovery or development of new domestic reserves or through the acquisition of reserves abroad.

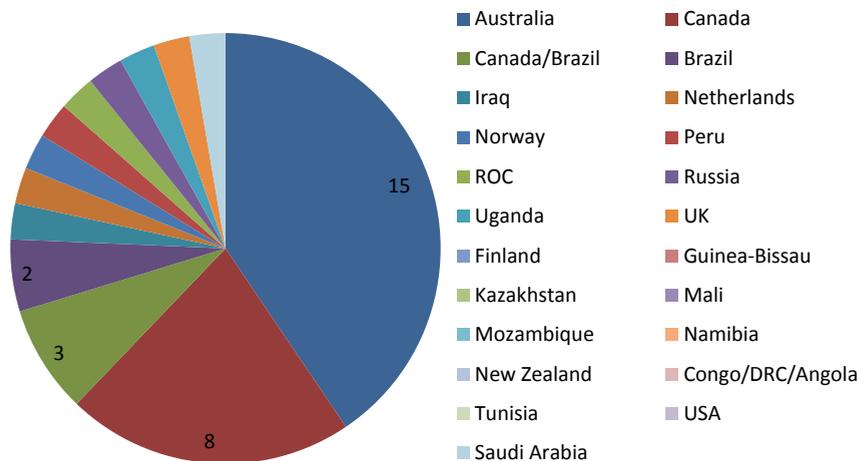


FIGURE 18: NUMBER OF EXPLORATION PROJECTS IN 2011 BY ORIGIN OF FIRM

Canadian and Australian firm are dominating exploration activities (see Figure 18). Both the Canadian and Australian governments have policies to support mineral exploration.<sup>142</sup> European examples of such policies are limited in number.

**Vertical integration and protectionist measures**

Vertical integration in producer countries has the unfortunate consequence of potentially further exacerbating existing trade restrictions. As the final product exported by producers moves up the value-added chain, so could states’ policies, including restrictive practices.<sup>143</sup> This may have consequences for European

142 Christian Paradis, *Report on Plans and Priorities 2010-2011* (Natural Resources Canada, 2010); Australian Government, *Statement 4: Benefitting from Our Mineral Resources: Opportunities, Challenges and Policy Setting.*, Budget Strategy and Outlook 2010-2011. [Australian Government, 2010], [http://www.budget.gov.au/2010-11/content/bp1/download/bp1\\_bst4.pdf](http://www.budget.gov.au/2010-11/content/bp1/download/bp1_bst4.pdf).

143 ‘Interview with Experts on the Global Phosphate Rock Market (4 & 5).’

industries (see Box for an example).<sup>144</sup> Another example of the potential effects of vertical integration is that the new mines in Saudi Arabia are likely to set their sights higher than selling rock to the EU directly and rather aim to be a possible source of fertilizer exports for the European farming sector.<sup>145</sup> Some countries and firms are already beginning to take steps to avoid the potentially detrimental consequences. The CEO of Boskalis, for example, highlights the importance of the exploration project in New Zealand for overcoming Morocco's price-setting power.<sup>146</sup>

#### **Box: A European Producer Under Pressure**

Dutch firm Thermphos, the EU's sole producer of white phosphorus (a derivative of phosphate rock), was declared bankrupt on 21 November 2012. Thermphos attributed this to competition with a rival firm in Kazakhstan that sold white phosphorus on the EU market at a very low price. Thermphos lodged a complaint with the European Commission in December 2011, which initiated an anti-dumping proceeding. The definitive outcome of this procedure is due in March 2013, though it is unclear whether the action will be pursued. What this case illustrates is that a EU firm may suffer the consequences of actions by a (state-owned) phosphate rock producing company that also participates in the market for processed phosphorus products (vertical integration). The allegation of dumping indicates also the potentially significant impact that the policies of other states can have on the European phosphorus market.

144 European Commission, 'Procedures Relating to the Implementation of the Common Commercial Policy,' *Official Journal of the European Union* 2011/C, no. 369/07 (December 17, 2011), <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2011:369:0019:0024:EN:PDF>; Gerben Jan Gerbrandy, 'Europese Commissie Te Traag Met Maatregelen Thermphos,' *D66 Gerben Jan Gerbrandy*, October 24, 2012, <http://gerbenjangerbrandy.nl/>; NOS Nieuws, 'Thermphos Failliet Verklaard,' November 21, 2012, <http://nos.nl/artikel/442961-thermphos-failliet-verklaard.html>.

145 'Interview with Expert on the Global Phosphate Rock Market [2].'

146 Yteke de Jong, 'Boskalis gaat zoeken naar fosfaten in zee om de bedrijfsactiviteiten te verbreden,' *Financieele Dagblad* (Amsterdam, August 17, 2012).

### Supplier instability

The Arab Spring not only caused phosphate production to dwindle, but also lay at the heart of recurring employment disputes. These employment disputes are a source of tension that may have an impact on the EU's ability to rely on these countries as stable trading partners. Wider instability still looms and analysts fear that delays in political restructuring and persistent unemployment could continue to hamper the phosphate industry.<sup>147</sup>

At this point in time, it is unclear when Syria is able to restart its exports and whether the agreement to increase exports of phosphate rock to Iran will come to fruition. If the Assad regime remains in place, it is good news for Iran and bad news for the EU.<sup>148</sup> Even if the Syrian government were to collapse, enduring uncertainty is likely to follow and hamper Syria's phosphate industry. As such, the EU would be wise to consider alternatives.

Western Sahara represents a particularly delicate area for the EU, given the Union's high dependence on Moroccan phosphate and the political understanding between Morocco and Europe on a variety of other issues, such as migration and fisheries. Moreover, given that OCP mines in Western Sahara, the EU will have to take into account the UN's decision that phosphate mining in Western Sahara must benefit the local population. In this regard, three issues are particularly important for the EU to be aware of. One is the challenge Morocco is facing of how to deal with competing claims for water for mining, agriculture and drinking water. Water scarcity could hamper Morocco's export of phosphate rock and fertilizers to Europe. As water scarcity may be exacerbated by political instability, Morocco may be reluctant to devolve control over the region's water management. The other issue is that Morocco is nonetheless increasingly willing to offer Western Sahara greater autonomy to better serve the interests of the Western Sahara people. Though rejected by the Polisario Front, greater autonomy may yet enable the people of Western Sahara to benefit more

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147 Wellstead, 'Political Risks in MENA Phosphate Markets.'

148 Thomas Erdbrink and Rod Nordland, 'If Syria Collapses, Iran Faces Loss of Valued Ally,' *The New York Times*, July 19, 2012, [http://www.nytimes.com/2012/07/20/world/middleeast/if-syria-collapses-iran-faces-loss-of-valued-ally.html?\\_r=1](http://www.nytimes.com/2012/07/20/world/middleeast/if-syria-collapses-iran-faces-loss-of-valued-ally.html?_r=1); Jonathan Marcus, 'Syria Crisis: Iran Pledges Support for 'Vital Partner', *BBC News*, August 7, 2012, <http://www.bbc.co.uk/news/world-middle-east-19160410>.

from the resource extraction in their region.<sup>149</sup> The third issue is the agreement reached at UN talks in 2011 that a database would be compiled to catalogue known natural resources and how they are being exploited at present.<sup>150</sup> The results of this project could have a considerable influence on the political situation and reveal information with the potential to change the phosphate market for the EU.

### 3.2 What technical issues hinder the EU's phosphate security?

#### Loss, waste and dissipation

Phosphate is lost and wasted during several stages of its use (see section 2.4). Some industries already place a high value on phosphate, especially agriculture, which is unsurprising given how important phosphate is to farmers' production. However the use of phosphate remains inefficient in many respects.<sup>151</sup> A proxy measure for the loss of phosphate in agriculture is 'phosphorus balance': the amount of phosphate applied to the land minus the amount harvested in the form of useful crops. This tells us whether agriculture is operating at a phosphate deficit or surplus. A larger surplus implies greater loss and waste of phosphate.<sup>152</sup> A glance at the phosphate balance shows that all but three EU countries experience phosphate surpluses, indicating that more can be done to ensure that the phosphate applied to land is used in the most efficient way.<sup>153</sup>

Outside of agriculture, phosphate is often wasted in a number of different ways. Many phosphate-rich products are even treated as waste. For example, over the period 2005–2007 on average only slightly more than 40% of sewage sludge within the EU 15 was reused in agriculture, or approximately 0.12 mmt of phosphorus.<sup>154</sup> The remaining 60% was wasted. Had all 9 mmt of dry sludge been reused, this would have supplied around 0.3 mmt of phosphorus, or about 23%

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149 Bruno, 'Morocco's Phosphate Industry Will Benefit from The 'Arab Spring' in North Africa.'

150 United Nations Security Council, *Report of the Secretary-General on the Situation Concerning Western Sahara* (United Nations, 13 2012), <https://docs.google.com/file/d/0BvYLPNZ-eSjJdckticUs5V3ZJZzQ/edit?pli=1>.

151 Schröder et al., 'Improved Phosphorus Use Efficiency in Agriculture: A Key Requirement for Its Sustainable Use.'

152 This measure is limited, however, since not all surplus phosphate is lost and a deficit does not mean that none is lost.

153 Schröder et al., 'Improved Phosphorus Use Efficiency in Agriculture: A Key Requirement for Its Sustainable Use,' 824.

154 Rosemarin et al., 'Future supply of phosphorus in agriculture and the need to maximise efficiency of use and reuse,' 17–18.

of the amount added as chemical fertilizer within this region. In other words, a more optimal use of animal manure and reuse of organic waste could mean a significant reduction of the EU's dependency on imported mineral phosphorus fertilizer.<sup>155</sup> Next to phosphate recycling as a solution to ongoing environmental damages (see section 2.5), focus on efficiency is key.<sup>156</sup> Better efficiency due to technological innovations can improve environmental performance as a by-product.<sup>157</sup>

### Impurities

A point of concern is the buildup of cadmium in European soils stemming from cadmium-rich phosphate rock and fertilizer (see section 2.4). Market dynamics suggest that Moroccan phosphate—a source high in cadmium—is going to become increasingly dominant in the future.<sup>158</sup> Given that Syria, a key supplier of low-cadmium phosphate, is no longer a viable source due to its political turmoil, Moroccan dominance is set to increase.<sup>159</sup> Moreover, it also appears likely that the amount of cadmium in mined phosphate will increase over the coming years as sources of low-cadmium rock run out faster than those with more of the contaminant.<sup>160</sup> Industry statistics indicate that global production of low-cadmium phosphate is roughly equal to the EU's consumption. That said, the Union's share in the global low-cadmium phosphate market (despite significant low-cadmium rock imports from Russia; see 1.3) is extremely low (only around 10%), so future prospects are limited.<sup>161</sup> Hence, the EU needs to consider not just how to secure its supply of phosphate, but also its supply of low-cadmium phosphate.

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155 Ibid., 18.

156 European Commission, 'EXPERT SEMINAR ON THE SUSTAINABILITY OF PHOSPHORUS RESOURCE.'

157 United Nations Environment Programme and International Fertilizer Industry Association, *Environmental Aspects of Phosphate and Potash Mining*.

158 Handfield, 'The Global Phosphate Supply Market: Risky and Getting Riskier.'

159 'Interview with Expert on the Global Phosphate Rock Market [2].'

160 Von Horn and Sartorius, *Impact of Supply and Demand on the Price Development of Phosphate (fertilizer)*.

161 Chemicals Unit of DG Enterprise, *Extended Impact Assessment*.

### 3.3 Policy responses within the EU

The risks to Europe's security of phosphate supply are a matter which hitherto has rarely sparked intense political fervor.<sup>162</sup> Where the issue has been addressed, it has often been in response to other regulatory measures that make phosphorus recovery a more attractive option.

#### Recycling already underway

One of the most basic ways of recovering phosphate is the application of manure to farmland. This practice is widespread and accounts for a large percentage of the phosphate in European soils. In addition to manure, sludge from human sewage has been used in some cases and applied directly to farmland. However this is a controversial practice and is restricted by EU law due to the high concentration of pollutants in sludge.<sup>163</sup> Furthermore, several countries (including the Netherlands in 1995 and Switzerland in 2006) have outright banned the practice because of environmental and food-safety concerns. This has led to increased use of incineration of sludge and subsequent experiments into recovering phosphate from the ashes.<sup>164</sup> Similar experiments are underway in the Swiss canton of Zürich, which aim to determine the economic feasibility of phosphate recovery from the ashes of incinerated sludge.<sup>165</sup> In Germany, where sludge is still permitted on farmland in certain Länder and under certain conditions, recovery technology is under research but a functioning market where these technologies and related end-products are used has not yet fully

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162 'Interview with Expert on the Global Phosphate Rock Market (2)'; 'Interview with Expert on the Global Phosphate Rock Market (3)'; September 12, 2012; 'Interview with Experts on the Global Phosphate Rock Market (4 & 5)'; 'Interview with Expert on the Global Phosphate Rock Market (6)'; September 19, 2012; 'Interview with Expert on the Global Phosphate Rock Market (7)'; October 2, 2012.

163 Europa, 'Use of Sewage Sludge in Agriculture,' *Summaries of EU Legislation*, February 22, 2010, [http://europa.eu/legislation\\_summaries/agriculture/environment/l28088\\_en.htm](http://europa.eu/legislation_summaries/agriculture/environment/l28088_en.htm).

164 K. Stark, *Phosphorus Recovery: Experiences from European Countries* (Stockholm: Department of Land and Water Resources Engineering, Royal Institute of Technology, 2004), <http://www2.lwr.kth.se/forskningsprojekt/Polishproject/rep12/StarkSthlm19.pdf>.

165 Baudirektion Kanton Zürich, *Ohne Phosphor Kein Leben*, May 2012.

developed. Recovery from sludge ash is planned for the future, however this is not yet economically feasible everywhere.<sup>166</sup>

There are also direct targets in place in a small number of countries for the percentage of the phosphorus in wastewater which should be recovered: Sweden's Environmental Protection Agency has proposed 60% by 2015 and Germany has also announced a national objective for phosphorus recovery from sewage.<sup>167</sup> Meanwhile, the Dutch firm Thermphos, Europe's only producer of white phosphorus (a derivative of phosphate rock) until its bankruptcy in November 2012, aimed to source its phosphate entirely from recycled sources.<sup>168</sup>

In the Netherlands, an agreement was signed on 4 October 2011 among companies, knowledge institutes, governmental and non-governmental organizations in the agricultural, water, and waste sectors. The agreement aims to develop, within two years, a market in which as many of the phosphate flows as possible can be recovered in a sustainable manner and where the secondary (recycled) phosphate—for as long as there is a surplus of phosphate on the Dutch market—can be re-exported so as to contribute to soil improvement and food production elsewhere.<sup>169</sup> Parties to this agreement among others were two firms already involved in phosphate recovery in the Netherlands: Slibverwerking Noord-Brabant (SNB) and ICL Fertilizers. SNB processes treatment sludge for its shareholders and for external clients. As part of its environmental initiatives it has the capacity to recover phosphate from the ashes of burned sludge. ICL Fertilizers cites stringent environmental standards in its decision to support

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166 Johannes Pinnekamp, Wibke Everding, and Institut für Siedlungswasserwirtschaft. Lehrstuhl für Siedlungswasserwirtschaft und Siedlungsabfallwirtschaft, „Förderinitiative 'Kreislaufwirtschaft für Pflanzennährstoffe, insbesondere Phosphor': Schlusspräsentation der durch das Bundesministerium für Bildung und Forschung geförderten Vorhaben; am 14. September 2011, Umweltforum Auferstehungskirche Berlin' (Ges. zur Förderung d. Siedlungswasserwirtschaft an d. RWTH Aachen, 2011); Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), *Deutsches Ressourceneffizienzprogramm - Programm Zur Nachhaltigen Nutzung Und Zum Schutz Der Natürlichen Ressourcen*, May 14, 2012.

167 Stark, *Phosphorus Recovery*; Scholz and Wellmer, 'Approaching a Dynamic View on the Availability of Mineral Resources: What We May Learn from the Case of Phosphorus.'

168 Gerbrandy, 'Europese Commissie Te Traag Met Maatregelen Thermphos.'

169 'Phosphate Value Chain Agreement,' October 2011, <http://www.nutrientplatform.org/>.

initiatives to recycle. At the moment ICL Fertilizers is participating in several projects to recycle nutrients into fully functional fertilizers.<sup>170</sup>

What these early attempts at phosphate recovery have in common is their location in northern European countries. Since the process of recovering phosphorus from waste water depends to a large extent on the technical quality of water management systems in place, it is likely that future recycling programs in the EU will be concentrated in countries with the infrastructure and governance in place to spearhead such initiatives.

### Cadmium

The issue of the high cadmium content of phosphate used to fertilize European farmland has firmly hit the EU's radar screen (see section 2.4). A number of options have been explored, including proposals to regulate, tax, or ban cadmium-containing fertilizers outright.<sup>171</sup> Those familiar with the subject talk of the need for cooperation with producer countries to bring cadmium levels down, especially in the case of Morocco because of its preeminence in the industry.<sup>172</sup> One key proposal in 2003 involved setting maximum concentrations, which would become increasingly strict over a period of time.<sup>173</sup> Though Member States are not permitted to impose limits on the cadmium content of fertilizer of their own accord, some (Sweden, Finland and Austria) have in the past been granted derogations to do so.<sup>174</sup> Partly in response to this, there has been an interest in introducing a similar limit on an EU-wide level.<sup>175</sup> The European

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170 N.V. Slibverwerking Noord-Brabant, 'Who's SNB?,' *SNB Phosphate Recovery*, 2012, <http://www.phosphaterecovery.com/who-s-snb/29>; ICL Fertilizers, 'Environment,' *ICL Fertilizers*, 2012, <http://www.iclfertilizers.com/Fertilizers/Amfert/Pages/Environment.aspx>.

171 F. H. Oosterhuis, F. M. Brouwer, and H. J. Wijnants, *A Possible EU-wide Charge on Cadmium in Phosphate Fertilisers: Economic and Environmental Implications*. (Vrije Universiteit Amsterdam, April 2000); Chemicals Unit of DG Enterprise, *Extended Impact Assessment*.

172 'Interview with Expert on the Global Phosphate Rock Market (2).'

173 Chemicals Unit of DG Enterprise, *Draft Proposal Relating to Cadmium in Fertilizers* (European Commission, 2003), [http://ec.europa.eu/enterprise/newsroom/ct/itemdetail.cfm?item\\_id=3176&fosubType=r&lang=en](http://ec.europa.eu/enterprise/newsroom/ct/itemdetail.cfm?item_id=3176&fosubType=r&lang=en).

174 Scientific Committee on Health and Environmental Risks, *Opinion on 'Cadmium in Fertilisers: Request for a SCHER Opinion on the Risk Assessment Report from the Kingdom of Sweden'* (European Commission, February 27, 2012), [http://ec.europa.eu/health/scientific\\_committees/environmental\\_risks/docs/scher\\_o\\_156.pdf](http://ec.europa.eu/health/scientific_committees/environmental_risks/docs/scher_o_156.pdf).

175 Chemicals Unit of DG Enterprise, *Draft Proposal Relating to Cadmium in Fertilizers*.

Commission held a public consultation on its 2003 proposal and the responses suggest profound consequences for the EU's involvement in the phosphate industry.<sup>176</sup> Most of the responses (39/65) came from industry, with the remainder from public authorities, distributors, agricultural cooperatives and miscellaneous sources. Industry was overwhelmingly opposed to proposals to introduce a maximum cadmium threshold that would be lowered over time, with 37 out of 39 responses expressing disapproval. Unsurprisingly, the favorable responses came from Finland and Russia. Finland has already imposed cadmium limits, and both Russia and Finland produce phosphate that is virtually free from cadmium.<sup>177</sup> OCP, as a producer of phosphate that would risk exceeding the proposed cadmium limits, was strongly opposed to the plans.<sup>178</sup>

It is unclear what level of investment will be required for an industry-scale implementation of decadmiation technologies and how much the cost of this and the additional processing would add to the eventual price of decadmiated phosphate fertilizers.<sup>179</sup> One analysis estimates an increase of at least US \$10 per tonne, or 5–10% above today's price.<sup>180</sup> Moreover, the application of this technique may encounter practical difficulties as the toxic waste generated would still have to be disposed of somehow. This is a costly process and it may further drive up the price of fertilizer as a result.<sup>181</sup>

On a more strategic level, the EU's concern over cadmium levels has major consequences for its phosphate supply and for the market at large. The decisions under consideration in Brussels with respect to the limitation and reduction of cadmium levels in phosphate fertilizer could create significant advantages and disadvantages for certain market players. Without additional measures,

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176 Chemicals Unit of DG Enterprise, *Summary of the Results of the Public Consultation* (European Commission, 2003), [http://ec.europa.eu/enterprise/newsroom/cf/\\_getdocument.cfm?doc\\_id=2968](http://ec.europa.eu/enterprise/newsroom/cf/_getdocument.cfm?doc_id=2968).

177 Chemicals Unit of DG Enterprise, *Extended Impact Assessment*.

178 OCP Group, *OCP Group's Stand Concerning the Draft Proposal For The EU Regulation on Cadmium in Fertilizers*, 2003, [http://ec.europa.eu/enterprise/newsroom/cf/itemdetail.cfm?item\\_id=3176&fosubType=r&lang=en](http://ec.europa.eu/enterprise/newsroom/cf/itemdetail.cfm?item_id=3176&fosubType=r&lang=en).

179 A.L. Smit et al., 'Phosphorus in Agriculture: Global Resources, Trends and Developments' (Plant Research International B.B. Wageningen, September 2009), 10.

180 Chemicals Unit of DG Enterprise, *Summary of the Results of the Public Consultation*; von Horn and Sartorius, *Impact of Supply and Demand on the Price Development of Phosphate (fertilizer)*.

181 Smit et al., 'Phosphorus in Agriculture: Global Resources, Trends and Developments,' 10.

the limits proposed could restrict the EU's involvement with high-cadmium Moroccan phosphate and increase reliance on low-cadmium Russian rock. The EU can take measures to mitigate the effects of policies to limit cadmium content in fertilizer, for example through collaboration with Morocco with the aim of neutralizing the cost of decadmiation and maintaining Morocco's competitiveness. Collaboration on decadmiation could take the form of EU-funded trials, providing funds to stimulate innovation on the topic and assistance with the implementation of the technology.

## 4 Conclusion: perspectives for action for Europe

The previous chapter discussed a number of political-economic risks, technical hindrances and environmental considerations that negatively affect the EU's security of supply of phosphate rock. This chapter discusses how the Union can mitigate these risks and enhance its security of supply. This chapter consists of two sections. Section 4.1 discusses four different scenarios for the future world system and assesses the implications of each scenario for the global phosphate rock market. Section 4.2 builds on these scenarios and provides a number of concrete strategies and recommendations for the EU on how to mitigate the various risks to its security of supply of phosphate rock.

### 4.1 Influencing the primary market: no easy game

Figure 18 depicts a typology of four different scenarios of the world system. Each scenario affects the EU's ability to influence global phosphate rock market in a different way depending on whether the world is dominated by a small number of state actors or by a large number of players alongside states, and on whether there is an atmosphere of cooperation or competition. The following sections describe each scenario in detail, including the implications they carry for the EU.

#### Cooperative scenarios

In the **multilateral scenario**, international cooperation is the main means to resolve conflicts and conflicts of interests. Changed economic and political power relations, inter alia as a result of the rise of emerging economies, are more accurately reflected in the UN and other international forums, which function better as a result. A strengthened system of global governance does not prevent states from asserting their national interests, yet agreement is often reached on a collective approach to international issues.<sup>182</sup>

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182 Ministerie van Defensie, 'Eindrapport Verkenningen. Houvast Voor De Krijgsmacht Van De Toekomst.', March 30, 2010, 131–135.

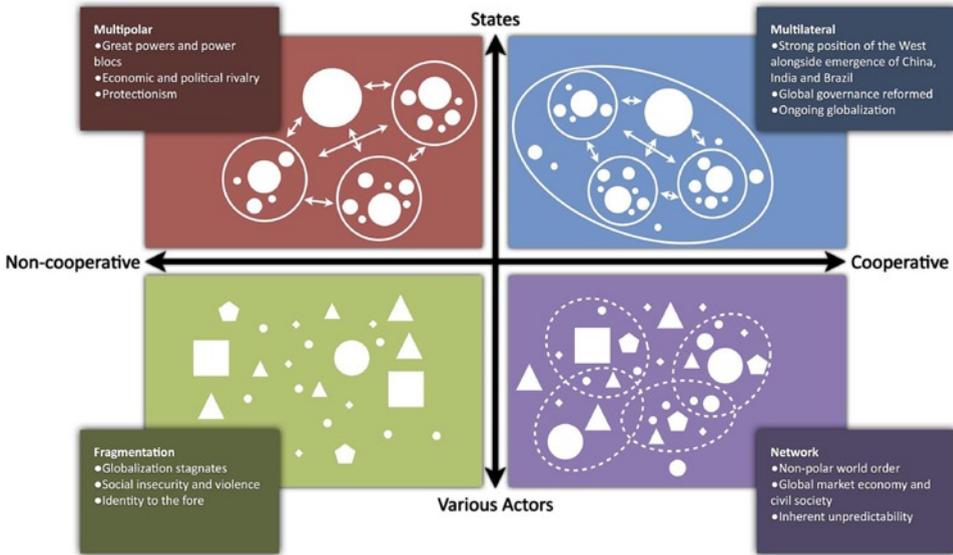


FIGURE 19: COOPERATE OR AGITATE? A TYPOLOGY OF SCENARIOS CHARACTERIZING THE WORLD SYSTEM<sup>183</sup>

Under this scenario, it is not unthinkable that a lasting solution to the issues of Western Sahara and Syria will be found, and a global agreement will be reached on sharing phosphate rock resources, using less, recycling more and mining sustainably. This could dampen global prices as ‘new’ reserves become available, allowing the EU to diversify in its trading partners. Under this scenario, free trade will be the dominant rule by which global markets abide. This creates a more conducive environment for the EU to secure the imports it needs.

In the **network scenario**, the global market, major capital and technological innovation are the major driving forces. The nation-state will have eroded further and global and regional networks play a key role in regulating social traffic. These networks are comprised of a wide range of non-state actors: multinationals, non-governmental organizations (NGOs), trading

183 Ministerie van Defensie, 'Eindrapport Verkenningen. Houvast Voor De Krijgsmacht Van De Toekomst.', March 30, 2010, 127.

conglomerates, metropolises, philanthropists, environmentalists, transnational criminal and terrorist networks, terrorist organizations, etc. National borders will not be able to limit the activities of the above-mentioned actors and economic, political and military forces in this open global system are so diffuse that they are unable to impose their will. In such an essentially ‘non-polar’ system, instability is primarily connected to groups and/or countries that have been unable to join the global network. The friction between those losers and the winners represents a risk to international security and stability.<sup>184</sup> However, the dominance of the global market economy and civil society ensure a tendency toward cooperation in global trade. In this scenario, non-state actors may play an important role in increasing awareness for the environmental dimensions of phosphate production and consumption, potentially increasing the public support for reduction, efficiency and recycling.

### **Non-cooperative scenarios**

In the **multipolar scenario**, a formation of power blocs has occurred and international conflicts of interests have become more pronounced. This world is dominated by the US and China, who clash frequently over hegemony in the Pacific region and the Indian Ocean region, and over access to energy reserves in Central Asia and the Middle East. The EU, India, Japan and Brazil are also significant powers under this scenario, as is an authoritarian Russia, which, due to structurally high raw-material prices, is wealthy and autonomous.<sup>185</sup> Under this scenario, competition over phosphate rock is likely to intensify. Exporting countries will strategically limit their exports so as to benefit from high prices. Existing export restrictions in consumer countries with reserves of their own (e.g. China and the US) will be kept in place and increasingly moved up the value chain into processed products such as fertilizer. On top of this, demand for fertilizer from emerging economies (India in particular) is likely to increase. With international disputes and conflicts, such as in Western Sahara and Syria, unlikely to be resolved through multilateral means, the options for the EU to diversify its suppliers or forge strategic partnerships with producer countries are limited.

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<sup>184</sup> Ibid., 143–148.

<sup>185</sup> Ibid., 136–142.

In the **fragmentation scenario**, globalization is stagnating because the opposing forces have succeeded in getting the upper hand—including in the political systems of many countries. Belief in the advantages of international cooperation and an international market economy has diminished substantially. In many countries, people no longer trust their ‘own’ country to provide them with security and well-being, which leads to political and social division and unrest. Individuals take the initiative for innovation and change.<sup>186</sup> The inherently unstable and non-cooperative nature of this scenario means that political turmoil and social unrest in phosphate rock producer countries is likely to increase, inter alia, as a result of a reduced influence of the state and upward pressures generated by the demands of large amounts of non-state actors—fuelled by a lack of trust in the government—for more equitable control over the phosphate industry. The reduced ability of the state to effectively resolve internal tensions means that situations such as in Tunisia where tensions continue to linger on will not be uncommon. Escalation of conflict should not be ruled out. Under this scenario, both diversification and the forging of strategic partnerships are difficult, if not impossible.

What these four different scenarios make clear is that the future of the global phosphate rock market is marred by uncertainty. The following chapter identifies two sets of robust strategies that will enable Europe to secure its supply of phosphate rock in these circumstances.

#### 4.1 Robust strategies in times of uncertainty

In light of the above-described uncertainty about the direction in which the world system is headed, there are two robust policy strategies available to the EU. First, Europe should reduce its import dependence by promoting efficient use of phosphate throughout the value chain and by creating the necessary preconditions for its recovery and reuse. Second, the EU should mitigate supply disruptions by forging strategic partnerships with phosphate rock-producing countries, whereby the Union utilizes its technical expertise as a bartering tool to gain access to phosphate rock supplies.

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<sup>186</sup> Ibid., 149–153.

### **Promote the efficient use of phosphate and set the stage for its recovery and reuse**

Although the use of phosphate has become ever more efficient in Europe in recent years, much remains to be done. One of the main reasons why it is important to increase efficiency is that market dynamics suggest prices are unlikely to return to pre-2008 levels and could be subject to various other shocks in the future. Furthermore, food-safety concerns are likely to limit the cadmium content allowed in fertilizers used throughout Europe and possibly lead to the application of decadmiation technology. In this case, demand and prices for low-cadmium fertilizer will increase.<sup>187</sup> For this reason, it is recommended that the EU champion the view that phosphate is a valuable resource that ought to be used efficiently and initiate a ‘no-regrets’ strategy of creating the necessary preconditions for phosphate recovery and maximizing the efficiency of its use. To that effect, a number of concrete measures should be implemented.

### **Improve agricultural efficiency**

Many steps have already been taken to improve the efficiency of phosphate fertilizer used in farming. In a 2011 paper, Schröder et al.<sup>188</sup> outline a number of measures that can be taken within agriculture to further improve the efficiency of phosphate use. Some of the recommendations are general approaches, such as optimizing land use and maintaining soil quality; others can be translated into clear policy measures that should be considered. First, a good deal of manure is already used to recover phosphorus, however it could be used more efficiently (see section 3.3). At present, manure is often distributed unevenly, such that areas near where it is produced have phosphorus surpluses, while areas further from livestock experience deficits.<sup>189</sup> Second, leaching can be mitigated considerably by several agricultural methods, such as minimum tillage that does not remove the residues of previous crops; this allows the phosphorus present in crop waste to biodegrade back into the soil. A European ban on spreading fertilizers and

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187 Yariv Cohen, Holger Kirchmann, and Patrik Entfalt, ‘Management of Phosphorus Resources - Historical Perspective, Principal Problems and Sustainable Solutions,’ in *Integrated Waste Management*, ed. Sunil Kumar, vol. II (Rijeka, Croatia: InTech Europe, 2011), 252.

188 Smit et al., ‘Phosphorus in Agriculture: Global Resources, Trends and Developments.’

189 Anna Bateman et al., ‘Closing the Phosphorus Loop in England: The Spatio-temporal Balance of Phosphorus Capture from Manure Versus Crop Demand for Fertiliser,’ *Resources, Conservation and Recycling* 55 (2011): 1146–1153, doi:<http://dx.doi.org/10.1016/j.resconrec.2011.07.004>.

manures on frozen or snow-covered land is already in place to prevent wasting these sources of phosphorus at times when they would not be efficiently used. Third, the bioavailability of phosphorus (the amount of phosphorus in the soil that plants and livestock can actually absorb) can be improved by discouraging blanket application of fertilizer and promoting precision approaches which take into account the existing presence of phosphorus in soil and the specific areas where more will be required and by measuring and adjusting the amount of phosphorus in animal feed according to the production which results.

### **Reduce or substitute phosphorus use where possible**

In agriculture there is no substitute or way to do without phosphorus. However in other applications, substitutes and alternatives do exist. For example, in laundry and kitchen detergents, phosphorus content has been considerably reduced following legislation in many jurisdictions (including within the EU).<sup>190</sup> The main goal of phosphorus-reducing measures has usually been to prevent eutrophication caused by excess phosphorus in waste water, but it has the added benefit of reducing phosphate consumption. There may be more 'low-hanging fruit' in terms of phosphate use which can be easily discontinued, reduced, or substituted. For example, a number of food products use phosphoric acid as an additive to improve flavor. The EU should encourage firms to look for alternatives.

### **Prevent the loss and dilution of phosphate**

Phosphorus is lost because it is flowing back into rivers and oceans, causing eutrophication. Also, practices where phosphorus is used or diluted in other materials (for example when used in the cement industry) make it impossible to recover used phosphorus. It is for this reason that the EU should implement legislation that forbids the dilution or landfilling of waste streams rich in phosphorus.

### **Promote phosphate recovery and facilitate the creation of a sustainable European market of recycled phosphorus**

Phosphate is found in a variety of different sources, such as household waste, wastewater and products used in the food and feedstock industry. In order for

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190 Ned Stafford, 'EU Looks to Expand Ban on Phosphates in Detergents,' *Royal Society of Chemistry*, June 24, 2011, <http://www.rsc.org/chemistryworld/News/2011/June/24061105.asp>.

Europe to reduce its dependence on imported phosphate, the EU should promote the recycling of phosphate by recovering it from the above mentioned ‘sinks’ and reuse it in the fertilizer and chemical industry. In order to institutionalize this practice in the long-term, the Union should create the right (legal) conditions for a sustainable European market of recycled phosphorus to flourish, including a new regulation for fertilizers and a level playing field for fertilizers made out of primary and secondary sources of phosphorus.

### **Facilitate knowledge exchange through networks of excellence**

In order for recycling activities to become firmly established and operate effectively in the long term, it is imperative that the various stakeholders involved are able to benefit from each other’s expertise. To that effect, the EU should promote the establishment of ‘networks of excellence’ comprised of European companies, knowledge institutions, NGOs and governmental organizations to learn from each other and to create the right enabling and innovative environment for further development of efficient technologies and the maturing of the recycling market.

### **Foster strategic cooperation with phosphate rock-producing countries and companies**

In addition to measures aimed at increasing efficiency of phosphate use and to enable its recovery, the EU should foster strategic cooperation with phosphate rock-producing countries. However, section 4.1 makes clear that the possibilities for Brussels to influence the global market for phosphate rock are highly diffuse and uncertain. Therefore, rather than merely acting as a buyer, the EU should aim to solidify existing relations with producer countries in the form of partnerships whereby the Union utilizes its technical expertise to help rock producers overcome key challenges, such as water scarcity and environmental pollution as a result of mining activity. Such a strategy will create win-win situations, possibly enhancing the cooperative nature of the global phosphate rock market.

### **Form an inclusive strategy toward phosphate rock-producing countries and their mining and fertilizer industry**

As explained in section 3.3, policy initiatives taken at EU level can have an impact on phosphate rock producers. Similarly, decisions taken within producing countries have a bearing on large phosphate rock-importing regions such as the EU (see for example the discussion on vertical integration in section 3.1).

If a confrontation between markets and industries for primary and secondary phosphates is to be avoided, it is crucial that the EU adopt an inclusive strategy toward producing countries and their (mining and fertilizer) companies that promotes more sustainable mining practices and establishes a close knowledge cooperation between the EU and producing countries. Such an inclusive strategy would pave the way for a smooth transition toward a sustainable use of phosphate in the world.

Several areas in which the EU holds key expertise should form an integral part of such a strategy. Freshwater management remains one of the key challenges in phosphate-producing regions. In Morocco for example, 80–90% of freshwater resources are used for irrigated agriculture. Of the total agricultural area equipped with irrigation systems, around 30% is irrigated from groundwater, often in an unsustainable manner.<sup>191</sup> Furthermore, as highlighted in section 2.3, such competing claims over water prompt the construction and use of (expensive) desalination plants. Another challenge is the treatment of waste originating from heavily urbanized areas in the MENA, which, often as a result of inadequate waste-management systems, causes environmental damage and impacts adversely on the quality of drinking water and human health.<sup>192</sup> Finally, wastewater reuse in agriculture is common throughout the MENA region. However, in most countries of the region, wastewater treatment plants are not operated and maintained adequately, making wastewater unsuitable for unrestricted irrigation even where it has passed through a treatment plant—which is not always the case. Low freshwater prices also lead to a preference among farmers to rely on freshwater resources, undermining wastewater reuse and placing additional stress on already scarce freshwater.<sup>193</sup>

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191 United Nations Environment Programme (UNEP) Finance Initiative, 'Chief Liquidity Series. Water-related Materiality Briefings for Financial Institutions. Issue 1 Agribusiness,' October 1, 2009, 55.

192 Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, 'Regional Network for Integrated Waste Management in the MENA Region,' accessed November 22, 2012, <http://www.giz.de/themen/en/30607.htm>.

193 The World Bank, 'Wastewater Re-use,' accessed November 22, 2012, <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/MENAEXT/EXTMNAREGTOPWATRES/0,,contentMDK:22357054~pagePK:34004173~piPK:34003707~theSitePK:497164,00.html>.

One possibility to enable the conditions for such strategic cooperation to flourish is to incorporate EU assistance in the above areas into existing association treaties that the Union holds with important suppliers of phosphate rock.<sup>194</sup>

**Continue to promote free trade and unrestricted access to natural resources in multilateral forums**

Above all, and in addition to the forming of bilateral strategic partnerships as described above, the EU, its Member States, and its industry (in the areas of fertilizer, feed and food stock, water treatment, waste management and many others) should continue to promote free trade and unrestricted access to natural resources in multilateral forums such as the WTO and the OECD—in line with the reasoning put forward in the EU Raw Materials Initiative.<sup>195</sup> Reciprocal free trade has the benefit of increasing the availability of phosphate rock on the world market and may stabilize the supply to large consuming areas, including the EU. The benefit of free trade for rock-producing countries lies in the opportunity to gain access to valuable technology and expertise of consuming countries that can assist producers in overcoming key challenges to the sustainability of their mining operations.

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194 Udo de Haes et al., 'Fosfaat - Van Te Veel Naar Tekort. Beleidsnotitie Van De Stuurgroep Technology Assessment Van Het Ministerie Van LNV' (ministerie van LNV, September 2009), 10.

195 European Commission, 'The Raw Materials Initiative – Meeting Our Critical Needs for Growth and Jobs in Europe COM(2008) 699 Final,' November 4, 2008; European Commission, 'Tackling the Challenges in Commodity Markets and on Raw Materials COM(2011) 25 Final,' February 2, 2011, 11.

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# Appendix: exploration projects

## Finland

Norwegian company Yara currently already extracts several hundred thousand tonnes per year in Sillinjärvi, central-southern Finland. It further plans to develop a mine in Sokli, in Lapland near the Russian border, with production of 1.5 mt per year beginning in 2015 at the earliest.<sup>196</sup> The total investment in the project is expected to range from US \$600 million–1 billion (€475 million–800 million).

## New Zealand

Chatham Rock Phosphate (CRP) is a firm set up with the purpose of exploring and eventually mining offshore phosphate a few hundred kilometers south-east of the North Island of New Zealand. Royal Boskalis Westminster N.V., a Dutch company specialized in dredging, has a 19.9% stake in CRP.<sup>197</sup> The offshore deposit was discovered in 1952 and extensively explored in the 1970s and 1980s. Improved technologies and higher phosphate prices have now made this a financially viable reserve. The deposit is estimated to contain 100 mmt of rock phosphate. The project aims to provide the New Zealand market with a locally produced and cheaper alternative to imported phosphate.<sup>198</sup> The exploration project is now halfway through, having done two years already. Plans are to spend a further US \$2 million on the next round. The partners hope to get a license to begin mining at the end of this period.<sup>199</sup>

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196 Lauri Siirama, 'The Sokli Mine Project' (presented at the Fennoskandian Mining and Exploration Congress, Rovaniemi, December 1, 2009), [http://fem.lappi.fi/c/document\\_library/get\\_file?folderId=48927&name=DLFE-2796.pdf](http://fem.lappi.fi/c/document_library/get_file?folderId=48927&name=DLFE-2796.pdf).

197 De Jong, 'Boskalis gaat zoeken naar fosfaten in zee om de bedrijfsactiviteiten te verbreden.'

198 Chatham Rock Phosphate, 'The Project,' *Chatham Rock Phosphate*, 2012, <http://rockphosphate.co.nz/the-project/>.

199 Simon Hartley, 'Phosphate Exploration Equipment Tested at Sea,' Otago Daily Times Online News, 02 2012, <http://www.odt.co.nz/news/business/196413/phosphate-exploration-equipment-tested-sea>.

### Namibia

Another example of offshore exploration, the Namibian Marine Phosphate project has located a resource of 1,835 mmt of phosphate at 19.1% concentration in a deposit about 60 km offshore. The joint venture is shared between two Australian companies: Minemakers, and Union Resources—and a Namibian partner: Tungeni Investments. In October 2012, Minemakers announced its decision to sell its direct equity in the project to Mawarid Mining LLC, an Oman mining company.

### Kazakhstan

Sunkar Resources is a British-based firm which owns mining operations at Chilisaï in north-west Kazakhstan. The deposit is estimated to contain around 800 mmt of phosphate rock at a concentration of 10%. Recent figures show an annual production of around 1 mmt per year, the annual target. Sunkar is a public limited company which has been operating at a loss for the past four years.<sup>200</sup> Kazakhstani firm Kazphosphate also carries out exploration activities.

### Saudi Arabia

The Saudi Arabian Mining Company Ma'aden is carrying out extensive exploration in Umm Wual, near the Iranian and Jordanian borders. Plans are in place for a 'significant expansion' of its existing operations.<sup>201</sup> The new mines are anticipated to add 1.5 mmt of  $P_2O_5$  per year to Saudi Arabia's production.<sup>202</sup> The company is vertically integrated, dealing with both primary resource extraction and further processing into final products. The US \$5.6 billion planned for investment will cover initial exploration and mining plus the building of seven new plants to produce processed phosphate products, such as chemical precursors for fertilizer. The project is seen by some as evidence of Saudi Arabia's desire to diversify away from its reliance on oil.<sup>203</sup>

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200 Financial Times, 'Sunkar Resources PLC,' *Financial Times*, August 28, 2012, <http://markets.ft.com/Research/Markets/Tearsheets/Business-profile?s=SKR:LSE>.

201 Ma'aden Saudi Arabian Mining Company, 'Phosphate,' *Ma'aden*, 2012, <http://maaden.com.sa/en/business/phosphate>.

202 Reuters, 'Saudi's Maaden to Invest \$5.6 Bln in Phosphate Project,' *Reuters*, February 21, 2012, <http://www.reuters.com/article/2012/02/21/maaden-phosphate-idUSL5E8DL7VG2102221>.

203 Ibid.

## Tunisia

Celamin Holdings NL, an Australian company, is carrying out exploration activities in Tunisia. Analysts have argued that the fall of president Ben Ali offers new opportunities: 'Even as Tunisia is the world's fifth largest phosphate producer, it has potential for further growth and wants to exploit a mining potential that was untapped under the administration of President Ben Ali...'<sup>204</sup> Celamin Holdings completed a prefeasibility evaluation for the Bir El Afou phosphate deposit found no impediments to starting production within the foreseeable future.<sup>205</sup>

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