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Applied Economic Research

Economic Assessment of the Development of a Phosphate Based Industry in Namibia

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Economic Assessment of the Development of a Phosphate Based Industry in Namibia

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Executive Summary

All plants and animals require phosphorus (P), an essential macronutrient. The major source of phosphorus is phosphate rock (PR), a phosphate- bearing mineral which is a finite and non-renewable natural resource. Some countries have abundant phosphate rock reserves and have benefited as a result. Morocco, the US state of Florida and Tunisia, to name a few, have employment in the tens of thousands and receive significant contributions to GDP from phosphate mining and beneficiation.

In Namibia there are known resources of phosphate rock lying on the ocean floor. This could benefit Namibia, just as it has benefited other countries with similar resources. This report sets out to analyse the economic benefits that could accrue to Namibia from opening the country to an incipient phosphate industry.

It is recognised that a complete industry is not setup over-night, it is a process which evolves over time. This would also be the case with a Namibian phosphate industry. The industry would expand in discrete steps as cost and market information becomes more certain within the Namibian context. First there would be the need for dredging and basic beneficiation. Firms would need to establish plants and secure markets. This could be followed by additional beneficiation which would also need additional expenditure on factories and securing of markets for these products. There is, finally, the option to expand into advanced levels of beneficiation.

The analysis includes:

1. The relevant Namibian policy environment. This was to ensure that the economic evaluation was done in the appropriate policy context. Vision 2030, related National Development Plan (NDP) documents and the Harambee Prosperity Plan were used for this purpose.

2. A time dimension to simulate the rolling out of the phosphate industry with increasing degrees of beneficiation. For this study, this was assumed to commence in 2012 and culminating in an integrated fertilizer industry by 2016. The purpose of making the analysis historic was to be able to base the economic estimates on known economic foundations.

3. The potential for improved agricultural productivity in subsistence farming because it is an important policy imperative.

The possible economic benefits to Namibia from a phosphate industry are set out in Tables ES1 and ES2. The first table gives the contribution to direct gross value added **(GVA)**, gross domestic product **(GDP)**, gross national income **(GNI)**, jobs and export revenues for the industry had it started in 2012 and reached full beneficiation by 2016.

Table ES1: Key Economic Benefits of Namibian Phosphate Industry (Financial Data: N$m 2016 prices)

Industry Macroeconomic Indicators	**2012**	**2014**	**2016**
Contribution to Direct GVA	3 280	5 170	7 963
Dredging	*293*	*403*	*549*
Concentrate	*2 089*	*2 749*	*3 585*
Beneficiated Products	*640*	*1 731*	*3 542*
Subsistence Farming Productivity	*258*	*287*	*287*
Contribution to GDP	5 813	9 318	14 774
Contribution to GNI	4 317	6 956	11 304
Contribution to Taxes	1 597	2 413	3 516
Total Jobs (Direct, Indirect & Induced)	18 025	30 441	51 593
Export Revenue	7 472	11 222	18 721
Net Forex Position	3 587	4 890	8 231

- Total direct GVA would have increased from **zero in 2010** to **N$3.3bn in 2012** and through industry integration to **N$8.0bn by 2016**. This would have been made up of an increase in:
  - Dredging from **zero in 2010** to **N$293m in 2012** and to **N$549m in 2016**;
  - Concentrate from **zero in 2010** to **N$2.1bn in 2012** and **to N$3.6bn in 2016**;
  - Further beneficiated products from zero in 2010 to **N$640m in 2012** and **to N$3.5bn in 2016**; and
  - Productivity gains in subsistence agriculture would have been boosted from 2010 levels by **N$258m in 2012 to N$287m in 2016**.
- The increase between 2012 and 2016 would have been:
  - GDP of N$5.8bn in 2012 **increasing to N$14.8bn in 2016**;
  - Gross National Income (GNI) of N$4.3bn in 2012 **increasing to N$11.3bn in 2016**;
  - Taxes from zero in 2010 to N$1.6bn in 2012 **increasing to N$3.5bn in 2016**;
  - New product exports worth N$7.5bn in 2012 **increasing to N$18.7bn in 2016**.

Arguably, in the Namibian context, job creation is critically important. In 2012, from a zero base, as this is a new industry, there would have been 18 000 more jobs created, **increasing to 51 600 by 2016**. The direct jobs in the phosphate industry would increase from 5 309 in 2012 to 18 109 by 2016. In 2016 these direct jobs would be distributed:

- 628 in dredging;

- 4 660 in beneficiation ore to concentrate, and
- 12 820 in manufacturing advanced products.

There would also be indirect jobs because of the backward and forward multiplier linkages. These would increase from 12 716 in 2012 **to 33 484 by 2016**.

Table ES2 shows these macroeconomic indicators relative to the actual Namibian economy in those years.

Table ES2: Relative Macroeconomic Performance

All amounts in 2016 Prices, N$ millions	2010	2012	2014	2016
Phosphate Industry Contribution to Namibian GDP	0	5 813	9 318	14 774
Namibian GDP	123 391	136 236	153 025	163 946
Phosphate Industry as % of Namibian GDP	0.0%	4.3%	6.1%	9.0%
Phosphate Industry Contribution to Mining GVA	0	293	403	549
Namibian Mining GVA	12 843	15 193	14 528	13 018
Phosphate Industry as % of Mining GVA	0.0%	1.9%	2.8%	4.2%
Phosphate Industry Contribution to Manufacturing GVA	0	2 729	4 480	7 127
Namibian Manufacturing GVA	15 396	15 159	15 812	15 597
Phosphate Industry as % of Manufacturing GVA	0.0%	18.0%	28.3%	45.7%
Subsistence Farming Productivity GVA (N$m)	0	258	287	287
Namibian Agriculture GVA (N$m)	6 295	6 877	6 164	5 564
% of Namibian Agriculture GVA	0.0%	3.8%	4.7%	5.2%
Total Jobs Created	0	18 025	30 441	51 593
Namibian Jobs	480 769	657 584	708 895	676 885
% of Namibian Jobs	0.0%	2.7%	4.3%	7.6%

The phosphate industry would have added, **from a zero contribution in 2010**:

- 4.3% to Namibian GDP in 2012 and **a notable 9.0% by 2016**;
- 1.9% to Mining GVA in 2012 and **4.2% by 2016**;
- 18.0% to Manufacturing GVA in 2012 and **45.7% by 2016**;
- 2.7% to employment in 2012 and **7.6% by 2016**.

Furthermore, increased productivity in subsistence farming would have added a further 3.8% to Agriculture GVA in 2012 and **5.2% in 2016**.

These results are presented in the figures below. Figure ES1 illustrates the potential phosphate industry contribution to real Namibian GDP, while Figure ES2 the employment opportunities.

Figure ES1: Phosphate Industry Contribution to GDP

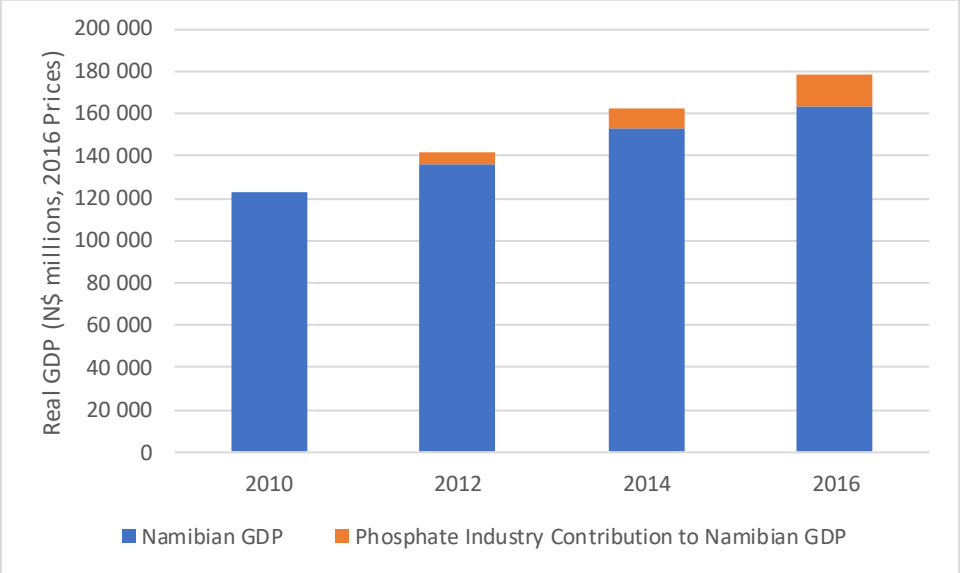
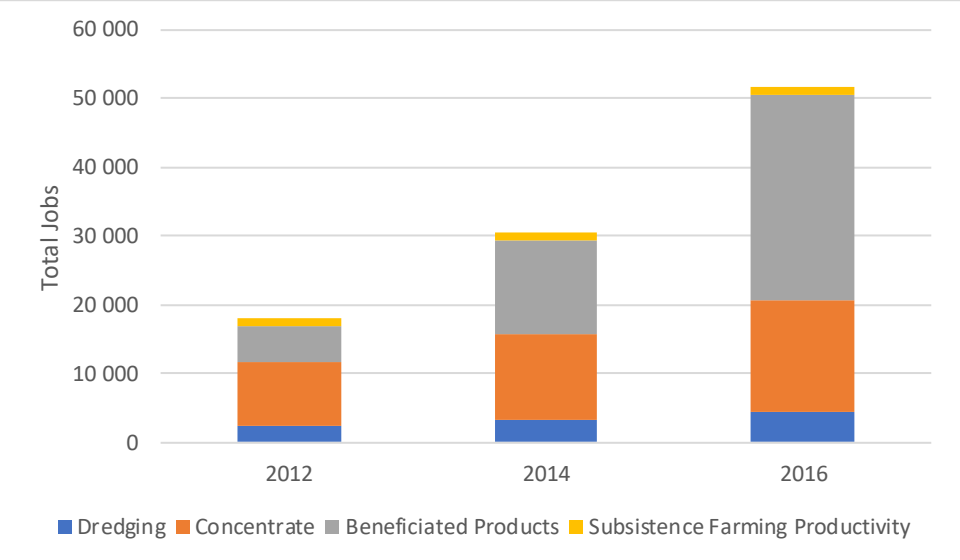


Figure ES2: Employment Potential



The results reported above are remarkable and are not out of line with the experiences of other phosphate producing countries. An **international comparison** shows:

- **Production levels**: In Florida 17Mtpa were mined in 2010. Jordan mined 8Mtpa in 2016; Tunisia 3.5Mtpa; Egypt 5.5Mtpa and Peru 4Mtpa in 2016. The proposed 8.5Mtpa in Namibia for basic beneficiation (increasing hypothetically to 16Mtpa to include advanced beneficiation) is in line with these levels of production.

- **Jobs**:
    - In Florida, part of a high wage and therefore more capital-intensive country, there were, in 2010, 387 direct jobs and 3 450 total jobs (including indirect and induced jobs) per million tons of mined and beneficiated phosphate
    - In Tunisia there were 1 574 direct jobs per million tons in 2010.
    - In Namibia there would be, per million tons:
        - 625 direct and 2 100 total jobs for dredging and basic beneficiation;
        - 900 direct and 2 900 total jobs for secondary beneficiation; and
        - 1 500 direct and 3 800 total jobs for dredging and advanced beneficiation.
- **Contribution to GDP**: the contribution to Namibian GDP would be well ahead of other countries because of the relatively small Namibian GDP compared to the other countries. The contribution to Jordanian GDP is 2.8% per ton of mined phosphate, for example, compared to Namibia which would be almost 9%. In contrast the mining (dredging) volumes are little different with Jordan, in 2011 mining 5Mtpa, and Namibian (with this analysis based on) 8.5Mtpa, in the first stage of beneficiation.

The final part of this executive summary is to reflect on the extent to which the phosphate industry could contribute to achieving the **goals of Vision 2030** and related **Harambee Plan for Prosperity (HPP)**.

- **Sector targets**: Four sectors are targeted in policy objectives: agriculture, manufacturing, tourism and logistics. NDP5 extends this by including mining that would "leverage natural resources". HPP further extents this by proposing "to support increased crop production, Government will establish fertilizer mixer plants in Namibia during year 2 of HPP to make fertilizers available to farmers at affordable prices" (Republic of Namibia, Harambee Plan for Prosperity, 2016, p. 39). A phosphate industry would promote mining that leverages natural resources, manufacturing through beneficiation and agriculture by making fertilizer.
- **Promote**: export development and competitiveness; efficient production because of the need to compete with imported fertilizer; skills development, import relevant skills to augment shortage; and help to achieve full employment.

There are five specified goals to which a phosphate industry would contribute:

1. **Make Namibia a high-income country**. A high-income country is one which has a per capita gross national income of US$12 236. In 2016 Namibia stood at US$4 607. The phosphate industry would have made a per capita contribution of US$304, increasing the total per capita income to US$4 911.

2. **Reduce unemployment to 5%.** A phosphate industry, as analysed in this study, could have increased employment by 2.7% in 2012 and 7.6% by 2016. This would have, in those years, have decreased unemployment from 27.5% to 25.5% and 34% to 29% respectively.
3. **Achieve a GDP growth of 6.2%.** In 2012 GDP growth was 5.1% and in 2016 it was 1.1%. A phosphate industry would have increased this growth to 9.5% and 4.2% respectively.
4. **Reduce the national trade deficit to 3.3% of GDP.** In 2012 the ratio of the trade deficit to GDP was 18% while in 2016 it was 19%. A phosphate industry would have reduced this ratio to 15% and 13% respectively.
5. **Reduce the government budget deficit to 1.5% of GDP.** In 2012 the ratio of the budget deficit to GDP was 7.3% and in 2016 it was 9.7%. A phosphate industry would have reduced this ratio to 6.1% and 7.6% respectively.

The overall conclusion is that a Namibian phosphate industry would have a major positive impact on the country. It could increase GDP by 9%. It could generate over 50 000 jobs from a fully integrated fertilizer industry. This would add 7.6% to 2016 employment levels. The industry would help the country achieve both general and specific Vision 2030 and Harambee PP policy goals.

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Abbreviations

DAP	Di Ammonium Phosphate
DAPR	Direct Application Phosphate Rock
DCP	Di Calcium Phosphate
FGA	Food Grade Acid
GDP	Gross Domestic Product
GNI	Gross National Income
GVA	Gross Value Added
HPP	Harambee Plan for Prosperity
LLNP	LL Namibia Phosphates Pty (Ltd)
MAP	Mono Ammonium Phosphate
Mtpa	Million tons per annum
NMP	Namibia Marine Phosphate Pty (Ltd)
NPK	Nitrogen Phosphate Potassium
SAM	Social Accounting Matrix
SSP	Single Super Phosphate
TSP	Tri Super Phosphate
WPA	Wet Phosphoric Acid

Introduction

All plants and animals require phosphorus (P), an essential macronutrient. The major source of phosphorus is phosphate rock (PR), a phosphate- bearing mineral which is a finite and non-renewable natural resource[1]. It is essential for food security and the sustainability of agriculture.

There is an uneven distribution of phosphate across the world. Those countries that are blessed with phosphate deposits, Morocco for example, have a unique advantage. Namibia is, to a lesser extent, also such a country.

There are known beds of phosphate rock lying off the shores of Namibia, accessible by dredging. This has the potential to generate income, earn foreign exchange and, most importantly, create employment.

There are currently two granted mining licences to dredge the phosphate rock for offshore phosphate mining in Namibia. These are by Namibian Marine Phosphate (Pty) Ltd **(NMP)** and LL Namibia Phosphate (Pty) Ltd **(LLNP)**. This dredging would occur in the phosphate beds off Walvis Bay and Luderitz.

The challenge facing these proposals is that the dredging is expected to occur in the general vicinity of the spawning grounds of some essential Namibian pelagic fish. An independent marine environmental impact assessment has already been conducted in accordance with the regulations of the Environmental Management Act 2007. This, it is understood, concludes that the proposed dredging poses no risk to fishing. Despite these findings there remains resistance to the proposals.

This research has been sponsored by NMP and covers a statistically developed hypothetical case study based on the development of an integrated fertiliser industry through the dredging of phosphate rock from the known resources along the Namibian Coast. Detractors may find motivation for inferring reporting bias. This is to be expected but there is no intent of bias from the authors. The authors hope that policy makers will recognise the potential importance of the available opportunity. Stratecon accepted this assignment on the clear condition that the research direction and scope would be dictated by ethical considerations and not by the wishes of the sponsors. This was accepted by NMP. Stratecon has no financial interest in NMP, LLNP or phosphate in Namibia.

Stratecon (formally Economics Information Services) is a company specializing in economic impact assessments and applied economic modelling. Stratecon has performed economic feasibility assessments for several government departments throughout Southern Africa as well as large private corporations.

The objective of this research was to conduct an analysis of a potential Namibian phosphate generated fertilizer industry, of which there is currently none in Namibia. There is no phosphate dredging despite the existing phosphate reserves. All phosphate based fertilizers are imported, mostly from South Africa.

Phosphate can be beneficiated in many ways using a variety of additional inputs all with varying degrees of financial viability and economic impacts. This research has explored the economic potential of some of these beneficiation avenues. These are strategic because they inform the Namibian policy makers of the economic potential.

Some caution is noted on two parts of the beneficiation roll-out.

First, there are potential environmental constraints which must be noted but are 'unknowns'. These environmental constraints may be problematic and include but are not limited to:

- water demand for shore-based operations and the various value-added beneficiation stages,
- electricity supply and,
- impacts on tourism.

Second, is the degree of confidence in the information used to assess the economic contribution of the roll-out. There is a high level of confidence in the information for dredging and basic beneficiation. There are lower levels of confidence in the information on which the economic analysis of secondary and advanced beneficiation is based. Some of this information is based on international experiences. Some are estimated based on extrapolated information.

This report:

- Starts with a brief background to phosphate and international experiences.
- This is followed by a brief description of the approach and limitations.
- Section 3 outlines the Namibian policy context with the objective of reporting the potential economic impacts relative to policy goals.
- Section 4 reports the findings. This is done in the context of both international experiences and Namibian policy objectives.
- Section 5 presents the limitations of the study.

- Section 6 is a conclusion.
- Section 7, which is Appendix 1, describes the detailed methodological approach.

1 Background

This section describes the use of phosphate, international distribution and the known benefits from the exploitation of this mineral for those countries with phosphate reserves.

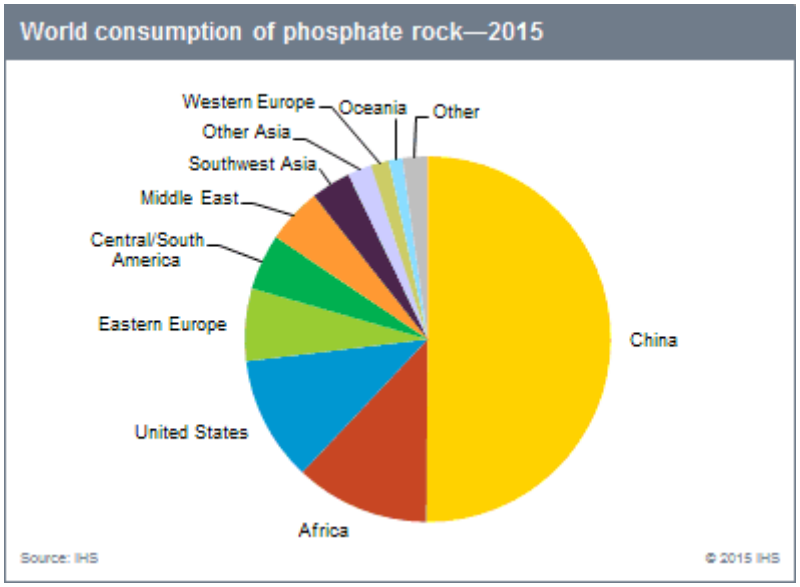
1.1 Phosphate – Uses, Distribution and Demand

Most modern P fertilizer is made from phosphate rock, a non-renewable natural resource. Phosphorus is essential for life, and the input of P fertilizer is critical to the production of sufficient food, feed, fibre, and fuel to support a growing world population. The origin of the modern P fertilizer industry can be traced back to the mid-1800s when the first patents were granted for treating “phosphoritic substances” such as apatite and bones with sulfuric acid to produce “superphosphate”. In 1842 patents were granted in England to both John Bennet Lawes and James Murray for the manufacture of P fertilizer by the process of acidulation. Although others, including Justus von Liebig, had been studying the process, Lawes and Murray have been credited as “the laymen who put the idea into permanent commercial practice” (Jacob, 1964). Practically all P fertilizers today are made by this “wet process” of treating PR with acid (e.g., sulfuric, nitric, or phosphoric) to produce phosphoric acid or triple superphosphate (TSP). Phosphoric acid is then used to produce both granular and fluid P fertilizers.

The term phosphate rock is broadly used to denote minerals commercially valued for their phosphorus content. It is estimated that 85% of the world’s annual phosphate rock supply is converted into phosphoric acid and elemental phosphorus (P4) intermediates that are further processed into various organic and inorganic chemicals consumed in agriculture and industry. An additional 15% is consumed in the manufacture of normal superphosphate fertilizer. The primary market for phosphate rock derivatives is agriculture. At least 90% of the world supply is consumed annually in the production of phosphate fertilizers, with an additional 4–6% used for livestock and poultry feed supplements and in organophosphate pesticides

Since 2010, consumption has grown on average at 6% per year and growth is expected to continue. Growth for phosphate rock and, in turn, phosphate fertilizers is dependent primarily on demand from China, India, and Brazil. Population growth governs the consumption of phosphate rock in China. Indian demand depends on government subsidies, which were reduced in 2012 along with price increases. Brazil's growth is tied to the growth of crops that are used to produce biofuels. Figure 1 shows world consumption of phosphate rock.

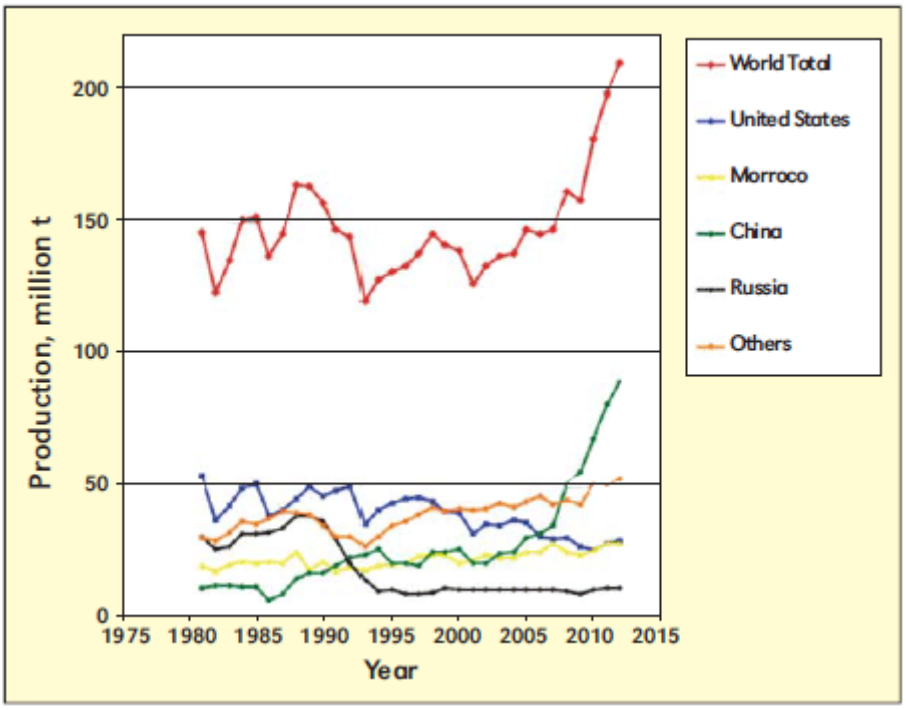
Figure 1: Phosphate Consumption 2015



World PR production has been increasing in recent years. Production has increased sharply since 2009 and, according to the latest USGS, report is at 210 million t. This same report suggests that within the next year, world PR production capacity could go from 220 to 256 million t, with the largest expansion project occurring in Morocco.

Phosphate rock production (1981 to 2012) for the world and selected countries is set out in Figure 2.

Figure 2: Phosphate Production[1]

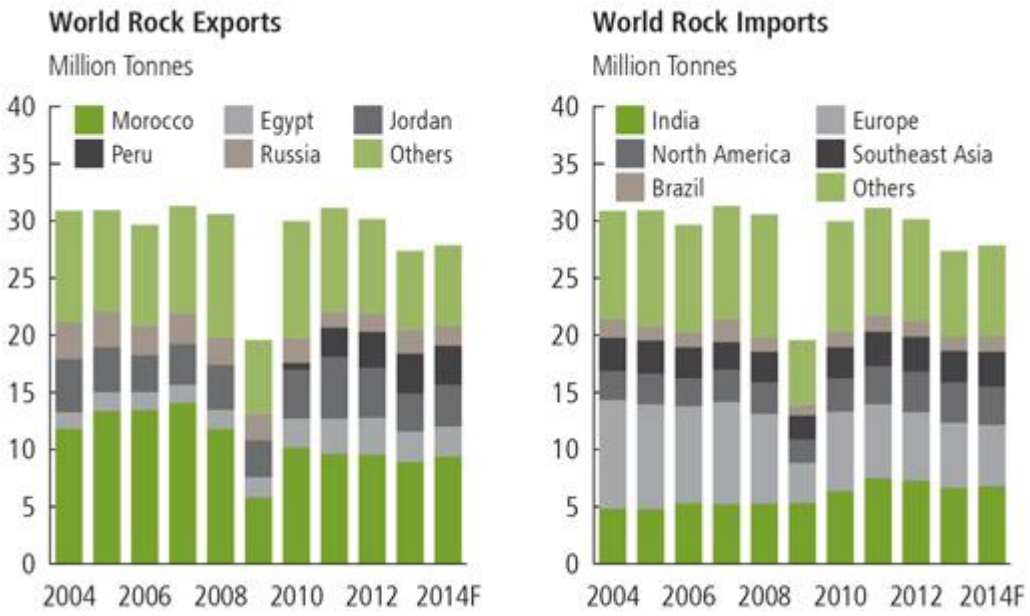


In 2011 only 15.6% of phosphate was traded internationally. Important exporters, of which the top ten accounted for 92.3% of global exports in 2011 were:

- Morocco and Algeria (9.3Mt - 31% of global exports in 2011)
- Egypt (2.7Mt)
- Peru (2.5Mt)
- Syria (3Mt)
- Jordan (5Mt)
- Russia (1.4Mt)
- Israel, Togo and Tunisia

[1]Source: USBM and USGS

Figure 3: Phosphate Rock Imports and Exports



1.2 Phosphate and Economic Benefits – International Experiences

Many countries mine phosphate. Some countries beneficiate phosphate into fertilisers of various types. There are clearly economic benefits derived from dredging and beneficiation.

The approach that was followed was to identify three countries that currently mine phosphate volumes that are not dissimilar to those proposed in Namibia. Three countries were selected – Jordan, Tunisia and Egypt. Some information was available for Jordan, less so for Tunisia and none for Egypt. As a result, the state of Florida was added to the list. Florida is the major producer of phosphate in the United States. The intention was to examine the contribution of phosphate to the economy of Florida rather than the entire US.

The relevant information that could be found is given in Table 1.

Jobs is clearly an important variable for with the only available information was for Florida. In Florida there are 6 495 direct jobs. Total jobs, which is made up of direct and indirect jobs, was only reported for Florida and is over 57 000. It is important to note the distribution of jobs between phosphate mining and fertilizer manufacturing (which is beneficiation). In Florida there were 5 800 total jobs in phosphate mining and over 52 000 in beneficiation. The lesson is clear – beneficiation has greater economic benefits that simply mining.

Table 1: Phosphate – Jobs in Florida US

	Florida 2010
Direct Jobs	6,495
- Mining	1,654
- Fertilizer Manufacture	4,841
Total Jobs	57,857
- Mining	5,816
- Fertilizer Manufacture	52,041

http://www.fipr.state.fl.us/about-us/phosphate-primer/the-phosphate-industry-and-floridas-economy/

Table 2 gives the value of phosphate relative to GDP and exports. In Florida, phosphate production makes up nearly 2% of GDP and 0.2% of exports. This is larger in Jordan where output constitutes over 7% of GDP and nearly 4% of exports. In Tunisia these values are 4% and 3.7% respectively.

Table 2: Phosphate – Relative Industry Size, Florida, Jordan and Tunisia

	Florida 2010	Jordan 2014	Tunisia 2010
Total Output/GDP	1.9%	7.3%	4.0%
Exports/GDP	0.2%	3.6%	3.7%
Ore Value/GDP	0.3%	2.6%	2.4%

Florida: http://www.fipr.state.fl.us/about-us/phosphate-primer/the-phosphate-industry-and-floridas-economy/

Jordan: https://minerals.usgs.gov/minerals/pubs/country/2013/myb3-2013-jo.pdf

Tunisia: https://www.oxfordbusinessgroup.com/overview/forging-ahead-uneven-growth-industry-subsectors-remains-challenge

There is an obvious conclusion to be drawn. Phosphate mining and beneficiation generates significant amounts of income, jobs and export revenues in those countries (and states) that are fortunate to have the resource.

2 Approach

Investments need to be planned within a given policy environment. In this case the analysis of a potential Namibian phosphate industry was done relative to the goals of Vision 2030 and Harambee Prosperity Plan. This is discussed in detail in Section 3.

The economic benefits of a phosphate industry start with dredging phosphate ore. This would be made up of the dredging and primary beneficiation proposed by NMP and LLNP. However, this is an industry analysis, so it also includes further, substantial beneficiation that could be achieved by a complete phosphate industry. This approach is illustrated in Figure 4.

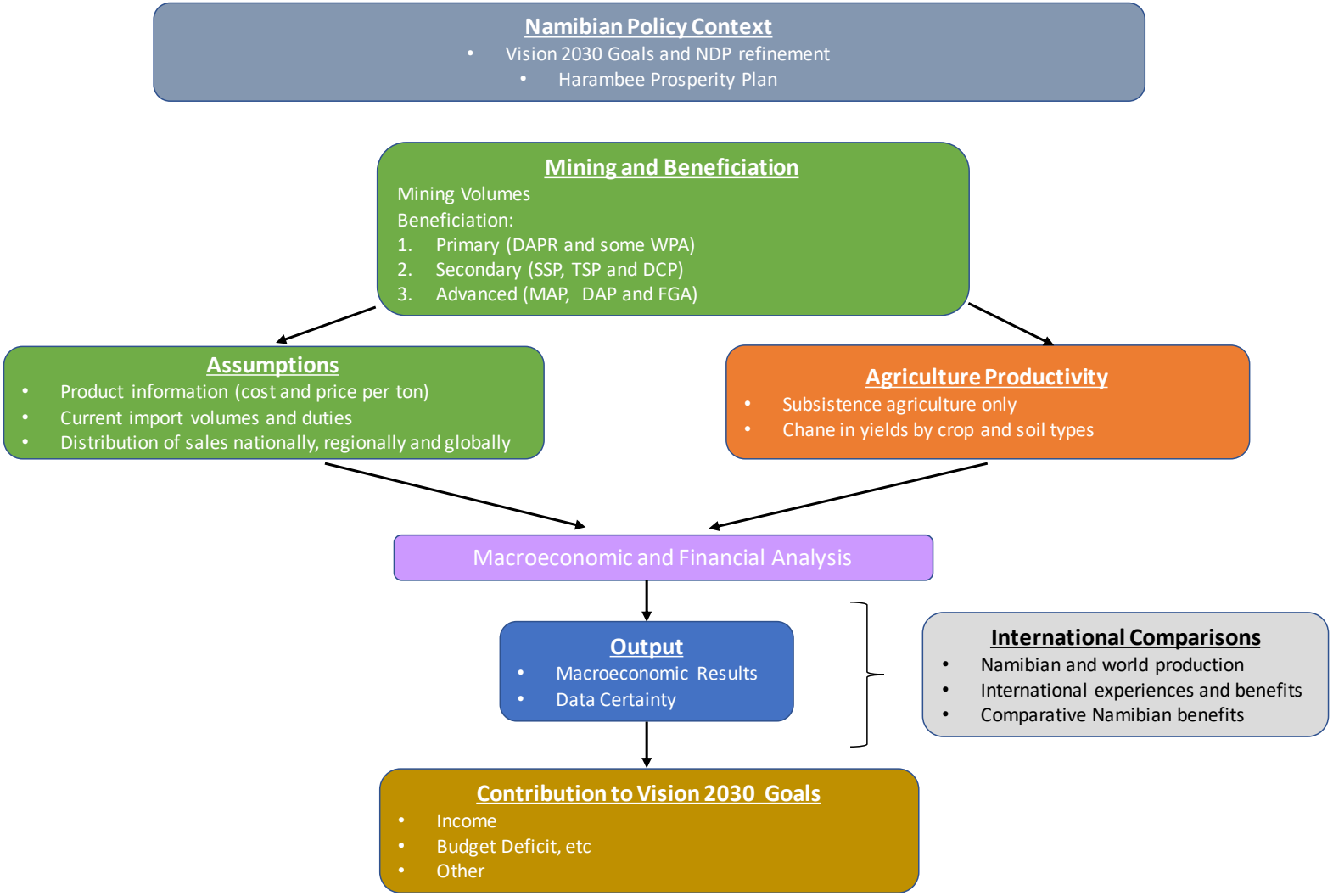
The roll-out of a new industry would have infrastructural implications which are both constrains and opportunities. Possible infrastructural constraints like transport, water and electricity could not be factored into the analysis. It will however the recognised that a value-added industry could generate the financial resources needed to overcome infrastructural constraints.

The initial dredged volume of the analysis is based on the current dredging proposals representing a combined volume of 8.5 million tons ore per annum (Mtpa)[2].

The phosphate rock cannot be used in its dredged state and requires impurities to be removed and further concentrated to a phosphate concentrate containing 27.5-28% P_2O_5. This concentrate is also called phosphate rock. The analysis used three different levels of beneficiation. The first is primary beneficiation where the concentrate/rock is used directly or converted into wet phosphate application (WPA). The next, called 'secondary' beneficiation in this report, further refines the phosphate concentrate into a variety of products. The final, advanced, level is refinement into increasingly higher-grade product. The ore, concentrate and beneficiation volumes are described in Section 7.1 of Appendix 1.

[2] *These are the NMP and LLPN proposals.*

Figure 4: Conceptual Approach



The analytical approach was to use a beneficiation ramp-up over time. The ramp-up is from simple to advanced beneficiation. The analysis period assumes the industry started in 2012 and ramps up to 2016. This was done to avoid introducing the 'unknown' of future economic growth. A realistic beneficiation ramp-up was to start with primary beneficiation, find a regular market for the product and keep that beneficiated output largely (for this analysis) constant. This is then followed with secondary beneficiation, again keeping output of that product constant, and then advanced beneficiation. Each of these three steps require increases in the dredged phosphate volumes.

The assumed dredged and beneficiated volumes are given in Table 3. The beneficiated volumes, and associated dredged volumes, were guided by the realistic volumes that Namibia could supply to world markets given existing international supplies and being cognisant of potential impacts on international prices. These volumes were given by NMP.

Table 3: Assumed Phosphate Ramp-Up Volumes

Mature Industry Volumes (Mtpa)	**2012**	**2014**	**2016**
Volume Ore Dredged from Ocean Floor	8.5	11.7	15.9
Volume Phosphate Concentrate Manufactured	4.0	5.5	7.5
Distribution of Concentrate			
Primary Beneficiation	4.0	4.5	5.5
DAPR	*3.5*	*3.5*	*3.5*
WPA	*0.5*	*1.0*	*2.0*
Secondary Beneficiation	0.0	1.0	1.0
SSP	*0.0*	*0.4*	*0.4*
TSP	*0.0*	*0.3*	*0.3*
DCP	*0.0*	*0.3*	*0.3*
Advanced Beneficiation	0.0	0.0	1.0
FGA	*0.0*	*0.0*	*0.2*
MAP	*0.0*	*0.0*	*0.4*
DAP	*0.0*	*0.0*	*0.4*

The dredged volume in the first year of production was assumed at 8.5Mtpa. This was done to align 2012 dredging volumes with the current NMP and LLNP dredging proposals. This would give 4Mtpa of concentrate which would be beneficiated as 3.5Mtpa of DAPR and 0.5Mtpa of WPA.

Dredged volumes would be increased to 11.7Mtpa in 2014 and resultant concentrate to 5.5Mtpa. This increased volume would be used to produce an additional 0.5Mtpa of WPA and 1Mtpa of SSP, TSP and DCP. Finally dredging volumes would be increased to 16Mtpa with resultant concentrate volumes of 7.5Mtpa. WPA volumes would be increased to 2Mtpa, SSP et.al. kept constant at 1Mtpa and 1Mtpa of MAP, DAP and FGA introduced.

The potential for improved agricultural productivity in subsistence farming has also been included in the analysis because it is such an important policy imperative. It can be expected, and was assumed, that commercial farmers already optimise fertiliser use relative to price and marginal benefits. This means that there would be no additional fertiliser uptake unless the local manufactured price is lower than imported price. As a result, only subsistence farming was included in this section. This analysis is presented in detail in Section 7.4 of Appendix 1.

The beneficiation impacts, and agricultural improvements are brought together into a macroeconomic and financial analysis model. The model, assumptions and degree of data confidence are presented in detail in Appendix 1.

The model was then used to estimate the macroeconomic contribution of the beneficiation process with a time dimension to give a more realistic illustration of the potential phosphate industry.

The approach concludes with two comparators:

- The first, in Section 4.4.1 assesses the economic contribution of the potential Namibian phosphate industry relative to that of a selection of countries that currently mine and beneficiate phosphate. The intention was to determine the 'reasonableness' of the assumptions and results relative to world markets.
- The second, in Section 4.4.2 assesses the degree to which the potential phosphate industry would contribute to achieving Vision 2030 and Harambee PP objectives.

As with all research studies there are some issues around data uncertainty. In this case they are limited to capital and operating costs of different beneficiation processes. These are presented in more detail in Section 5.

3 Namibia: Policy Context

Namibia, like many countries, faces numerous socio-economic challenges. These include extensive unemployment and a skewed income distribution. It also has policies in place which intend to address these challenges. This section presents this policy context. The purpose is to allow an assessment of the possible contribution of the potential phosphate industry to achieving stated policy objectives.

The key policy document that guides the future orientation for Namibia is Vision 2030 (Republic of Namibia, Vision 2030, 2004). This is supplemented by on-going National Development Plans (NDP) which refine and add to the policy objectives. They also assess the performance of the country relative to the Vision 2030 targets. As such Vision 2030 needs to be read in conjunction with the NDPs. The latest of these is NDP5, which assess the period 2017/18 to 2021/22 (Republic of Namibia, NDP5, 2016).

Vision 2030 was supplemented in 2016 by the Harambee Plan for Prosperity (HPP) (Republic of Namibia, Harambee Plan for Prosperity, 2016). The HPP takes the Vision 2030 blueprint as its starting point and says: “One of the agreed upon features of planning is that it must be flexible. While our Vision remains unchanged, we remain agile in our approach to achieving those targets. The surrounding world is dynamic, where externalities outside of our control have the ability to directly impact and throw us off balance, from time to time. This calls for flexibility in our approach to achieving set goals and targets, without losing sight of the end Vision. The HPP provides for that additional flexibility in planning” (Republic of Namibia, Harambee Plan for Prosperity, 2016, p. 6).

The overall policy objective in Namibia, justifiably, is to grow incomes and reduce inequality. The primary way of growing of income is through industrialization. To quote from Vision 2030, the over-arching objective is a “prosperous and industrialised Namibia, developed by her human resources, enjoying peace, harmony and political stability” (Republic of Namibia, Vision 2030, 2004). This prosperity is taken to mean:

- The placement of Namibia in the ‘high income’ nation category;
- All Namibians living above the poverty line;
- All Namibians having access to jobs.

The HPP takes these objectives further and turns the focus to (Republic of Namibia, Harambee Plan for Prosperity, 2016, p. 7):

- Macro-Economic Stability;
- Economic Transformation;

- Youth Enterprise Development; and
- Economic Competitiveness.

The first of these HPP objectives has context for a phosphate industry because of the potential for tax revenues. This would help with the focus on: “With regard to Macro-Economic Stability, the Plan advocates for fiscal consolidation to safeguard our fiscal sovereignty and to build up buffers for counter cyclical policies during periods of economic downturns of global recessions (Republic of Namibia, Harambee Plan for Prosperity, 2016, p. 7).

Vision 2030 (page 40) has several measurable objectives. One overriding objective (page 42) is the development and sustainable use of the ‘natural capital’ of the country to achieve the Vision 2030 targets. The objectives include:

- Manufacturing and services would make up 80% of the economy;
- Exports becoming mostly processed goods and making up at least 70% of exports;
- SMMEs contributing no less than 30% of GDP;
- Unemployment of less than 5%.

These objectives are augmented by some more detail in NDP4 which says that:

- The contribution of manufacturing should have doubled since 2011;
- “Significant strides would have been made in identifying and developing upstream and downstream economic activities in the mineral sector”.

NDP4 identifies four key sectors which are targeted for Vision 2030. These are Agriculture, Manufacturing, Tourism and Logistics. This objective is extended in two ways (page 4):

- First it says: “by modernizing its infrastructure and industries, Namibia will become less vulnerable to external shocks and will play more fully as an economic participant in the global economy”.
- Second, the NDP5 (page 4) extends the sectoral objectives and includes mining. It says: “By encouraging the development of manufacturing and mining, including artisanal crafts that leverage natural resources, Namibia can turn around its export deficit”.

The Vision 2030 sets macroeconomic targets for 2030. These are discussed in more detail in Section 3.5. The macroeconomic targets, in turn, have specific actions. Those that are relevant to this study are:

- “Promote export development and competitiveness;
- Promote efficient production and savings investment culture;
- Establish an integrated industrial strategy;

- Promote skills development;
- Import relevant skills to augment shortage;
- Promote full employment."

NDP5 (page 28) recognises that mining value added may be constrained by a lack of processing economies of scale. NDP5 suggests that consideration should be given to importing minerals to achieve such economies of scale.

3.1 Industrialization and Globalization:

Vision 2030 recognises the benefits and dangers of globalization. Vision 2030 guides this by making the following points (page 198):

- The country needs a "competitive edge upon which Namibia's position in the world economy will be based."

- "Strengthen our industrial capacity to pursue realistic goals dependent on our natural endowment."

- "Foreign direct investment, for instance, has increased to all developing countries, but Africa's share is below 5%. Such development points to a trend towards Africa's marginalisation in world trade and FDI."

This culminates in a sub-vision that says:

> "The benefits of technology, trade, investment and capital flows have contributed to a significant reduction in poverty in most regions of the world, and Namibia (will enjoy) optimal participation and integration in the global village."

The NDP5 takes this further by saying (page 5):

> "As an upper-middle income country, Namibia aims to graduate to "high income country" status. The difficulties in doing so are captured in the economic phenomenon known as the "middle income trap." According to this economic scenario, a middle-income nation like Namibia risk stalling economically if it is unable to compete against advanced economies with high levels of innovation and value-adding activities, and at the same time, is unable to compete with less developed economies that offer relatively cheaper labour.

> The remedies for avoiding the middle-income trap are diverse, but chief among them are building a pro-business infrastructure and the development of more sophisticated industries, including more robust avenues for Research and Development."

This is further elaborated (NDP page 28) that calls for the structural transformation of manufacturing through diversification; making exports more sophisticated through value-added production and good governance that promotes a positive investment climate and business environment. Phosphate beneficiation would contribute to the first two objectives and is therefore worthy of government support – the third objective.

NDP5 clearly articulates the industrialization process within the context of current trends in globalization. It says that historically most natural resources are exported as simple commodities. This is the cheapest process. The value-added beneficiation is done in other countries and then, often, purchased by Namibia. There is clearly a need to produce an environment that fosters the development of a value chain. The intention is to focus on small to medium sized enterprises to achieve these objectives.

NDP5 discusses further the need for value added production and the sectors that should be targeted (page 18). These are mining and mineral beneficiation, agriculture and agro-processing, fish and fish processing, and chemicals linked to local minerals. A value-added phosphate industry would help Namibia achieve these objectives.

3.2 Institutional Issues

There is mention in NDP4 on the institutional environment (page 42). One of identified issues is the 'difficulty of doing business'. The implications of not addressing this are: "Namibians and foreign investors alike will be discouraged from setting up businesses due to the long registration process and procedure delays." The suggested strategy to address this challenge is to: "Investigate what costs, time and procedures are involved in opening a business and improve these conditions."

NDP5 takes this further and commits to "Government will endeavour to create a conducive business environment that attracts investments and facilitates the development of value addition activities with an emphasis on involving SMEs".

The HPP adds to the policy objective: "in line with the Fourth National Development Plan, the Economic Competitiveness sub-pillar set the bold target of becoming the most competitive economy in Africa by 2020. Namibia will achieve this by addressing a number of constraints in the business environment, including reduction of red tape, simplifying the business

registration process and provision of quality skills" (Republic of Namibia, Harambee Plan for Prosperity, 2016, p. 8).

3.3 Import Substitution

NDP4 elaborates on the issue of import substitution. The document says that: "to support local producers, import replacement needs to be encouraged where feasible, amongst other things by providing preferential Government procurement and developing a preferential procurement agreement with Namibian-owned enterprises."

3.4 Game Changers

The NDP5 introduces what it calls 'five game changers'. Of these there are four to which a new phosphate industry could make a clear contribution:

- "Increase productivity in agriculture, especially for smallholder farmers;
- Invest in quality technical skills development;
- Improve value addition in natural resources;
- Achieve industrial development through Local Procurement." (page 7).

To this end the intention is for government to become far more proactive in fostering smallholder farmers with the intention of increasing production, food security and farmers' incomes. Government will help in access to credit and acquiring agricultural implements (and presumably other inputs like fertilizer). Agricultural extension services will be extended to achieve these aims. In addition, the intention is for government to procure locally. It will be noted that all these objectives would be supported by the proposed phosphate industry.

The HPP takes a more focussed approach to agriculture and food security. It says: (Republic of Namibia, Harambee Plan for Prosperity, 2016, p. 8)

"A number of actions will be implemented to ensure this essential ambition is achieved:

- Emergency relief as and when required;
- Measures to improve agricultural productivity;
- Introduction of foods banks among the urban poor;
- Raising agricultural productivity to address hunger poverty in rural/communal areas; and
- Continuation of targeted social safety nets".

The HPP makes specific reference to the need for fertiliser: "To support increased crop production, Government will establish fertilizer mixer plants in Namibia during year 2 of HPP

to make fertilizers available to farmers at affordable prices" (Republic of Namibia, Harambee Plan for Prosperity, 2016, p. 39).

3.5 Policy Targets

This section concludes the policy context by listing numerical policy targets that are relevant to this study. These are to reduce unemployment; make Namibia a 'high-income country', increase GDP growth, and reduce the trade and budget deficits.

These issues are revisited in Section 4.4 which highlights the possible contribution of a potential phosphate industry to achieving policy objectives.

3.5.1 High Income Country

The overriding objective is to make Namibia a 'high income' country. It is currently a middle-income country. Namibia is ranked 100th in World Bank income rankings with a per capita gross national income of US$5 190[3]. In 2016 the World Bank lowest category for a high-income country was a gross national income per capita US$12 236, calculated using the Atlas method[4]. Argentina is the last country in this category. This means that Namibia would have to more than double per capita incomes by 2030 to achieve this objective.

3.5.2 Unemployment less than 5%

The unemployment policy objective is to reduce this level to less than 5%.

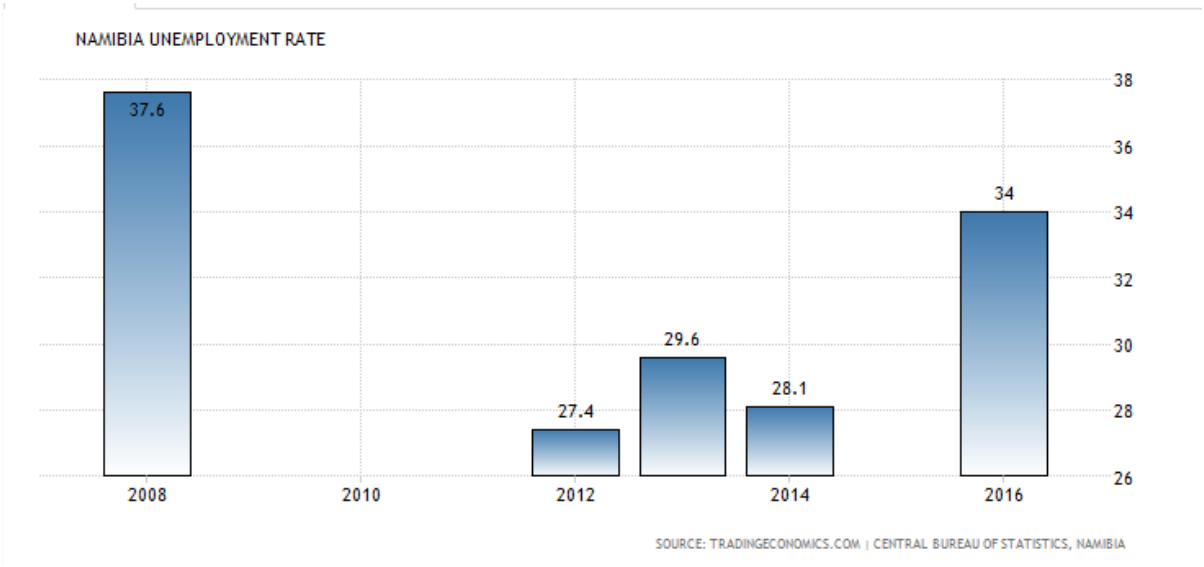
Figure 5 shows actual levels of unemployment for selected years since 2008. In 2008 unemployment was 37.6%[5]. This dropped to 27.4% in 2012 but had increased to 34% by 2016. Achieving this policy objective will be challenging.

[3] *https://en.wikipedia.org/wiki/List_of_countries_by_GNI_(nominal,_Atlas_method)_per_capita*

[4] *https://en.wikipedia.org/wiki/World_Bank_high-income_economy*

[5] *https://tradingeconomics.com/namibia/unemployment-rate*

Figure 5: Unemployment – Selected Years



3.5.3 GDP Growth of 6.2%

A key national policy objective is to have a GDP growth of 6.2%. The specific short-term objectives in NDP5 are a gradual increase in GDP growth from 2.5% in 2017/18 to the target of 6.2% by 2021/22.

Figure 6: GDP Growth by Quarter 2014 to 2017

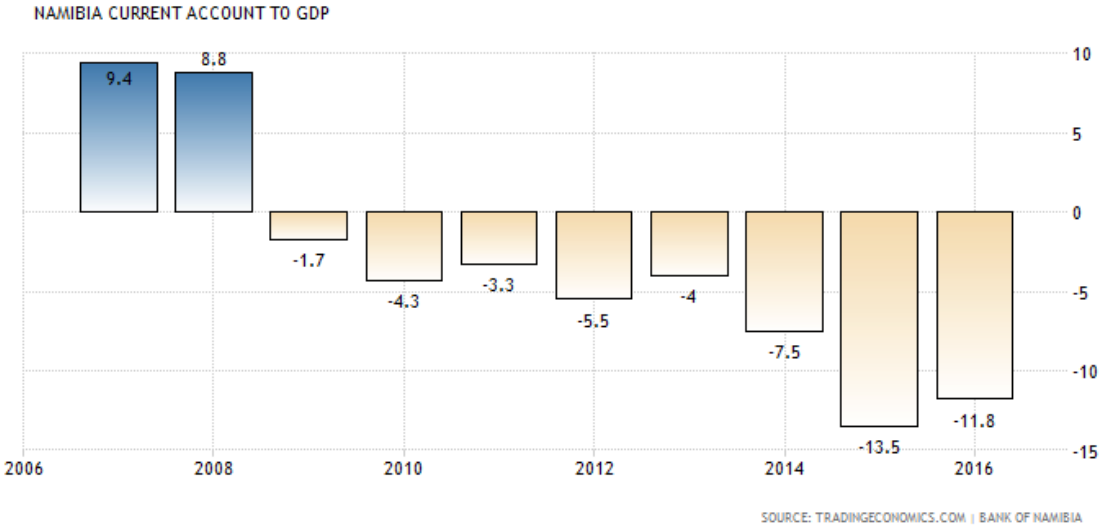
Recent growth in GDP growth is shown in Figure 6 by quarter, annualised, from mid-2014 to July 2017. The robust growth that Namibia has experienced for several years – 5.6% in 2013,

6.4% in 2014 – has declined and Namibia finds itself in a (technical[6]) recession. On average, over this period, the target of a 6.2% growth in GDP has not been met.

3.5.4 Trade Deficit of 3.3% of GDP;

One measure of a country's international exposure is the current account on the balance of payments. Until 2008 Namibia ran a current account surplus. This meant that total exports exceeded total imports. Since that time the reverse is true. The level of the current account deficit to GDP has reached alarming levels with a deficit of 11.8% in 2016. It is alarming because it requires foreign exchange to finance the current account outflows. These can come either from the Reserves account on the balance of payments or from capital inflows. Outflows from the former are not sustainable. Inflows of capital are dependent on international sentiment about the world and Namibia. They are susceptible to sudden reversals which have the capacity to have major negative impacts on peoples' standards of living.

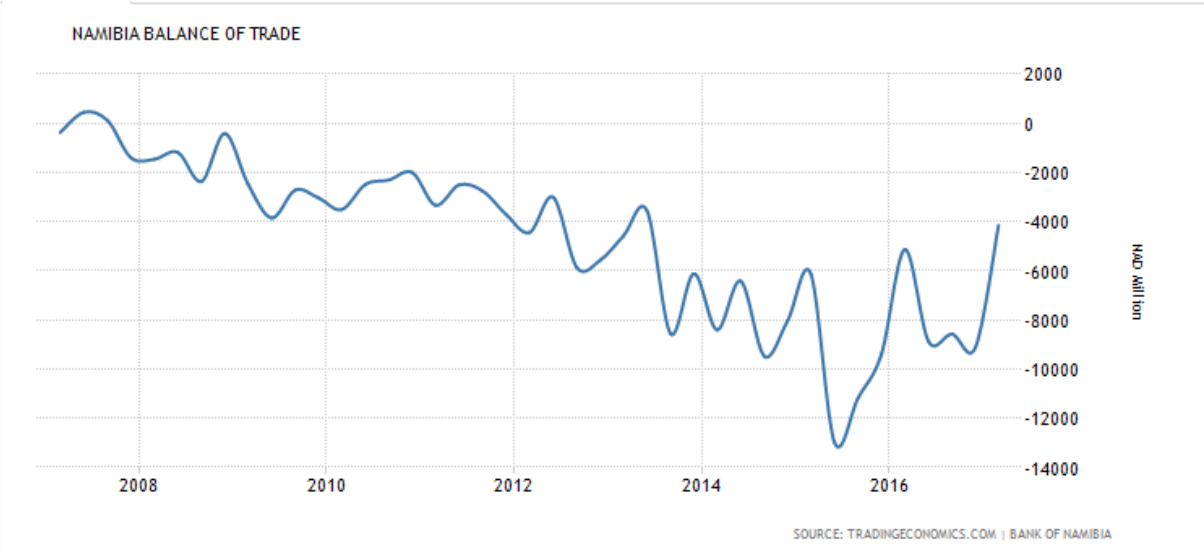
Figure 7: Namibian Current Account to GDP



A second measure of international exposure is the balance on the Trade account. The Trade account is a subset of the Current account and measures imports and exports of goods (it excludes trade in services). It will be shown below that one of the Namibian policy objectives focuses on having a Trade account surplus. The balance on Trade account since 2007 is given in Figure 8. The imports of goods have exceeded the corresponding export of goods since 2007. This is contrary to policy objectives.

[6] *A technical recession occurs with two quarters of falling output i.e. falling GDP*

Figure 8: Namibian Balance of Trade

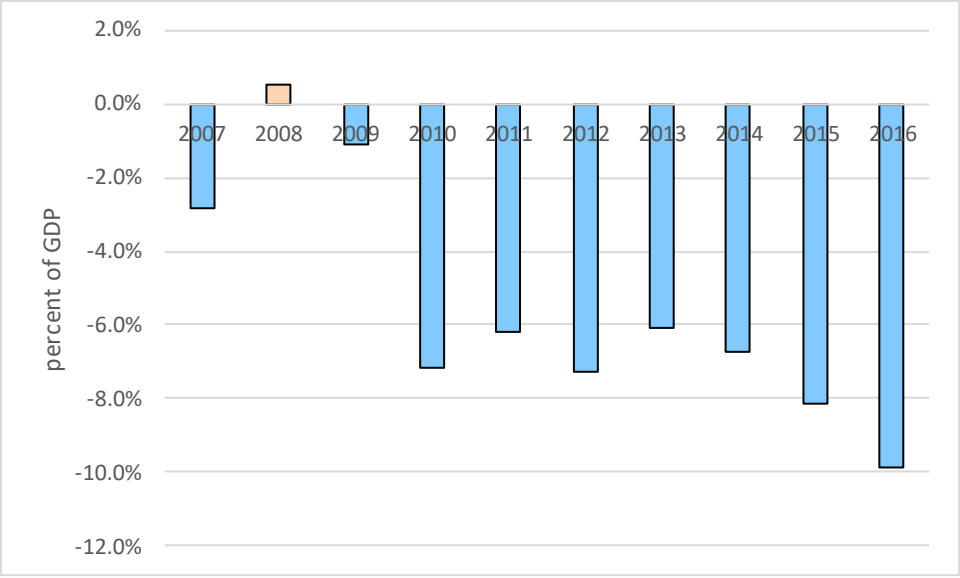


3.5.5 Budget Deficit of 1.5% of GDP.

A stated objective of Vision 2030 is a government budget deficit of 1.5% of GDP.

International and local investors always take the government budget deficit seriously. Typically, a government budget deficit of more than 3% of GDP is cause for concern. The Namibian experiences since 2006 are illustrated in Figure 9. In 2009 the budget deficit turned from a surplus to a deficit. This reached alarming proportions in 2010 and, apart from 2012, remains at dangerously high levels.

Figure 9: Namibian Government Budget Deficit to GDP



Sourced and adjusted from Table 23 of National Accounts data

This policy objective is currently out of reach and current levels of the budget deficit are not sustainable.

4 Potential Economic Contribution from Namibian Phosphate Industry

This section reports.

- The overall economic contribution that could be made from the development of a Namibian phosphate industry. This industry would be made up of the dredging and primary beneficiation proposed by NMP and LLNP. It also includes further, substantial beneficiation that could be achieved by a complete phosphate industry.
- Gives some international perspective on the expected size and contribution of the industry to show that the projected volumes and outcomes are reasonable.
- Relates this potential economic contribution to the policy goals set out in Vision 2030 and Harambee PP.

4.1 Key Indicators

The potential contribution of a phosphate industry is given separately for GDP and GVA, employment, taxes and foreign exchange.

4.1.1 Macroeconomic Contribution

The concomitant economic contribution of this dredging and industry roll-out is given in Table 4. The first set of figures are for contribution to direct gross value added (GVA). Direct GVA is the payment for factors of production used in the first round of the economic process. These are payment for labour, profit, rents and interest.

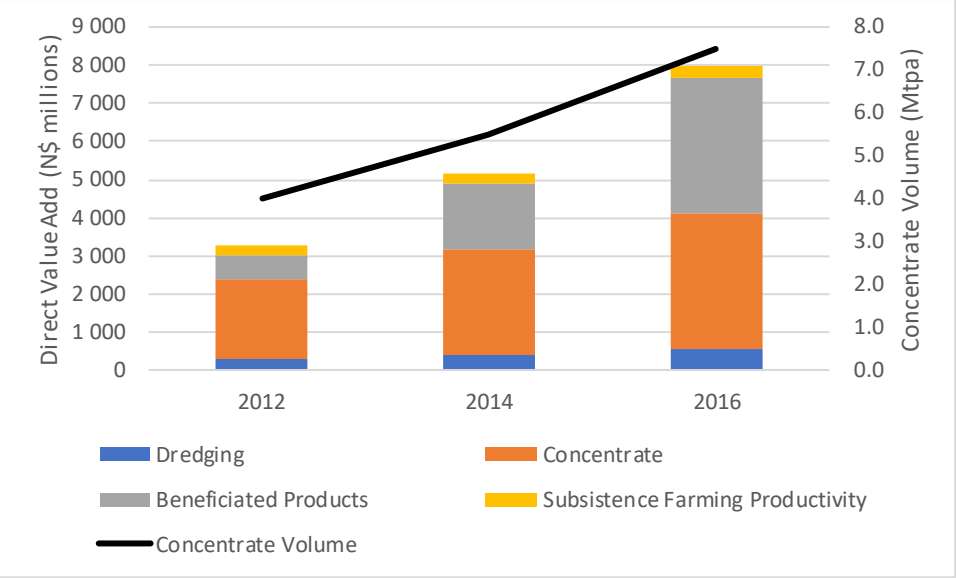
- Total direct GVA would have increased from N$3.3bn in 2012 to N$8.0bn by 2016. This would have been made up of an increase in:
    - Dredging from N$293m to N$549m;
    - Concentrate from N$2.1bn to N$3.6bn;
    - Further beneficiated products from N$640m to N$3.5bn; and
    - Productivity gains in subsistence agriculture worth N$258m in 2012 to N$287m in 2016. This may appear modest relative to the other financial impacts. However, this is the financial value of increased output of food by subsistence farmers. This is large in the context of rural poverty and the need for food security.

Table 4: Key Economic Benefits of Namibian Phosphate Industry (N$m 2016 prices)

Industry Macroeconomic Indicators	2012	2014	2016
Contribution to Direct GVA	3 280	5 170	7 963
Dredging	*293*	*403*	*549*
Concentrate	*2 089*	*2 749*	*3 585*
Beneficiated Products	*640*	*1 731*	*3 542*
Subsistence Farming Productivity	*258*	*287*	*287*
Contribution to GDP	5 813	9 318	14 774
Contribution to GNI	4 317	6 956	11 304
Contribution to Taxes	1 597	2 413	3 516

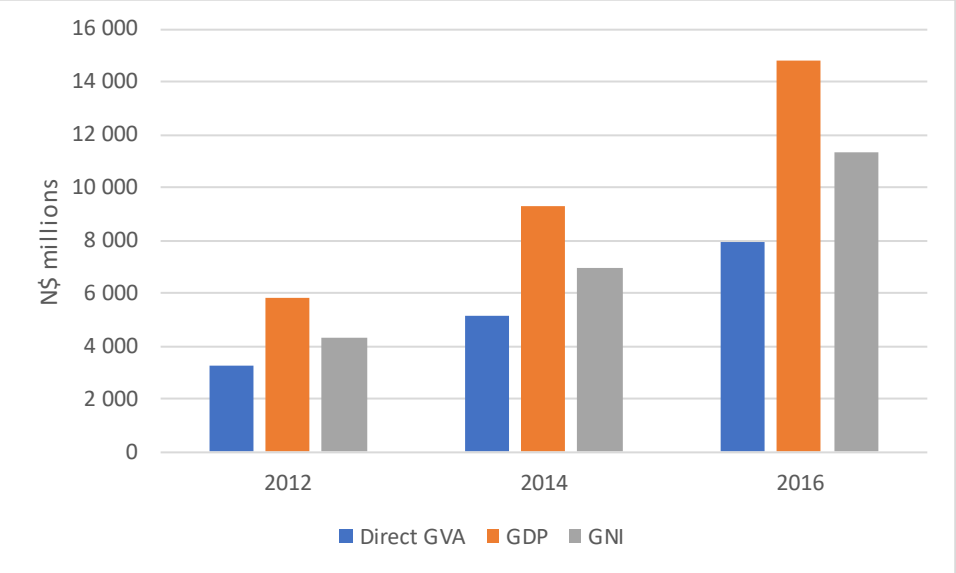
This contribution to GVA and the associated concentrate volume is illustrated in Figure 10.

Figure 10: Detailed Contribution to GVA



- Further macroeconomic contributions in 2012 would have been:
  - GDP of N$5.8bn increasing to N$14.8bn;
  - Gross National Income (GNI) of N$4.3bn increasing to N$11.3bn;
  - Taxes of N$1.6bn increasing to N$3.5bn;

Figure 11: Contribution to GVA, GDP and GNI



The relative contribution to GVA, GDP and GNI is illustrated in Figure 11. Direct GVA is always smaller than GDP because it is the first round of the GDP multiplier process. As a result, direct GVA shows the direct economic contribution of dredging and beneficiation while GDP includes the result of backward and forward linkages of the multiplier effects. GNI is GDP less foreign factor payments (in this case profit remitted offshore) plus foreign factor receipts. GNI is lower that GDP for the phosphate industry as analysed.

4.1.2 Employment Creation

Arguably, in the Namibian context, job creation is critically important. In 2012 there would have been 18 000 more jobs, increasing to 51 600 by 2016. The detail is reported in Table 5 and illustrated in Figure 12.

The direct jobs in the phosphate industry would increase from 5 309 in 2012 to 18 109 by 2016. In 2016 these direct jobs would be distributed:

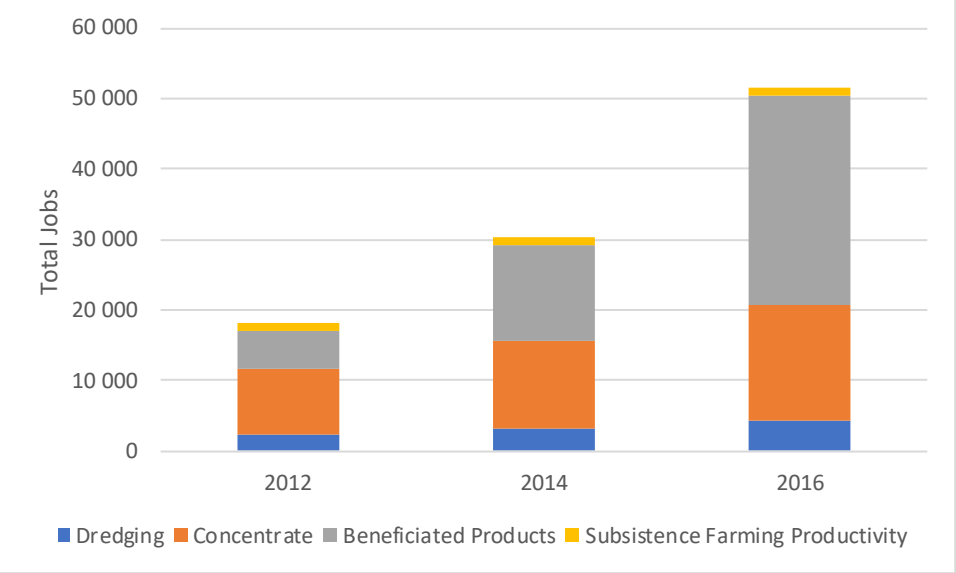
- 628 in dredging. These 628 jobs in turn consist of 516 jobs directly involved in the dredging process and an additional 112 employed by firms that would be direct suppliers.
- 4 660 in beneficiating ore to concentrate. These jobs consist of 1 131 in the factories beneficiating ore into concentrate and an additional 3 530 employed by firms that would be direct suppliers.
- 12 820 in manufacturing advanced products. This includes people in the direct beneficiation process and firms supplying goods and services for this process.

Table 5: Potential Employment

Contribution to Employment	2012	2014	2016
Direct Jobs	**5 309**	**9 841**	**18 109**
Dredging	*335*	*460*	*628*
Dredging Direct Employment	*275*	*378*	*516*
First Round Suppliers (Dredging)	*60*	*82*	*112*
Concentrate	*2 714*	*3 571*	*4 660*
Concentrate Direct Employment	*603*	*829*	*1 131*
First Round Suppliers (Concentrate)	*2 111*	*2 742*	*3 530*
Beneficiated Products	*2 261*	*5 809*	*12 820*
Subsistence Farming Productivity	*0*	*0*	*0*
Indirect Jobs	**12 716**	**20 600**	**33 484**
Dredging	*1 996*	*2 745*	*3 743*
Concentrate	*6 708*	*8 910*	*11 739*
Beneficiated Products	*2 975*	*7 793*	*16 850*
Subsistence Farming Productivity	*1 037*	*1 152*	*1 152*
Total Jobs	**18 025**	**30 441**	**51 593**
Dredging	*2 331*	*3 205*	*4 371*
Concentrate	*9 422*	*12 482*	*16 399*
Beneficiated Products	*5 235*	*13 602*	*29 671*
Subsistence Farming Productivity	*1 037*	*1 152*	*1 152*

There would also be indirect jobs because of the backward and forward multiplier linkages. This is the consequence of the economic multiplier effects from firms in the direct process procuring goods and services, on the one hand, and when their employees spend their salaries and wages. These would increase from 12 716 in 2012 to 33 484 by 2016. The distribution of the total number of jobs between dredging, concentrate, further beneficiation and the indirect consequences of improving productivity in subsistence farming are illustrated in Figure 12.

Figure 12: Potential Employment



4.1.3 Taxes and Foreign Exchange

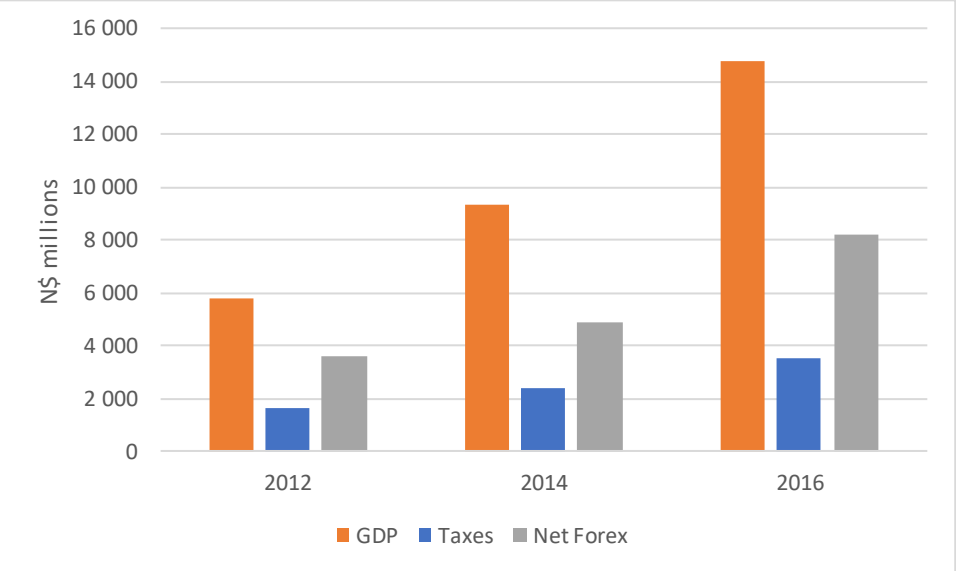
The final results are for contribution to taxes and generation of net foreign exchange which are reported in Table 6 and illustrated in Figure 13. By 2016 a phosphate industry could have made a N$3.5bn and N$8.2bn contribution to taxes and net foreign exchange respectively.

Table 6: Contribution to Taxes and Foreign Exchange (N$m 2016 prices)

Industry Macroeconomic Indicators	2012	2014	2016
Contribution to Taxes	1 597	2 413	3 516
Export Revenue	7 472	11 222	18 721
Net Forex Position	3 587	4 890	8 231

Equally important is that in 2016 for every N$1 of GDP that is generated by dredging and beneficiation there is the potential to generate N$0.26c in taxes and N$0.52c in net foreign exchange.

Figure 13: Contribution to GDP, Taxes and Net Foreign Exchange



4.2 Domestic Comparisons

This subsection shows the economic benefits in relative context to the actual Namibian economy in those years. Table 7 shows that the phosphate industry would have added:

- 4.3% to Namibian GDP in 2012 and a notable 9.0% in 2016;
- 1.9% to Mining GVA in 2012 and 4.2% in 2016;
- 18.0% to Manufacturing GVA in 2012 and 45.7% in 2016;
- 2.7% to employment in 2012 and 7.6% in 2016.

Furthermore, productivity improvements in subsistence farming would have added a further 3.8% to Agriculture GVA in 2012 and 5.2% in 2016.

Table 7: Relative Macroeconomic Performance

All amounts in 2016 Prices, N$ millions	2010	2012	2014	2016
Phosphate Industry Contribution to Namibian GDP	0	5 813	9 318	14 774
Namibian GDP	123 391	136 236	153 025	163 946
Phosphate Industry as % of Namibian GDP	0.0%	4.3%	6.1%	9.0%
Phosphate Industry Contribution to Mining GVA	0	293	403	549
Namibian Mining GVA	12 843	15 193	14 528	13 018
Phosphate Industry as % of Mining GVA	0.0%	1.9%	2.8%	4.2%
Phosphate Industry Contribution to Manufacturing GVA	0	2 729	4 480	7 127
Namibian Manufacturing GVA	15 396	15 159	15 812	15 597
Phosphate Industry as % of Manufacturing GVA	0.0%	18.0%	28.3%	45.7%
Subsistence Farming Productivity GVA (N$m)	0	258	287	287
Namibian Agriculture GVA (N$m)	6 295	6 877	6 164	5 564
% of Namibian Agriculture GVA	0.0%	3.8%	4.7%	5.2%
Total Jobs Created	0	18 025	30 441	51 593
Namibian Jobs	480 769	657 584	708 895	676 885
% of Namibian Jobs	0.0%	2.7%	4.3%	7.6%

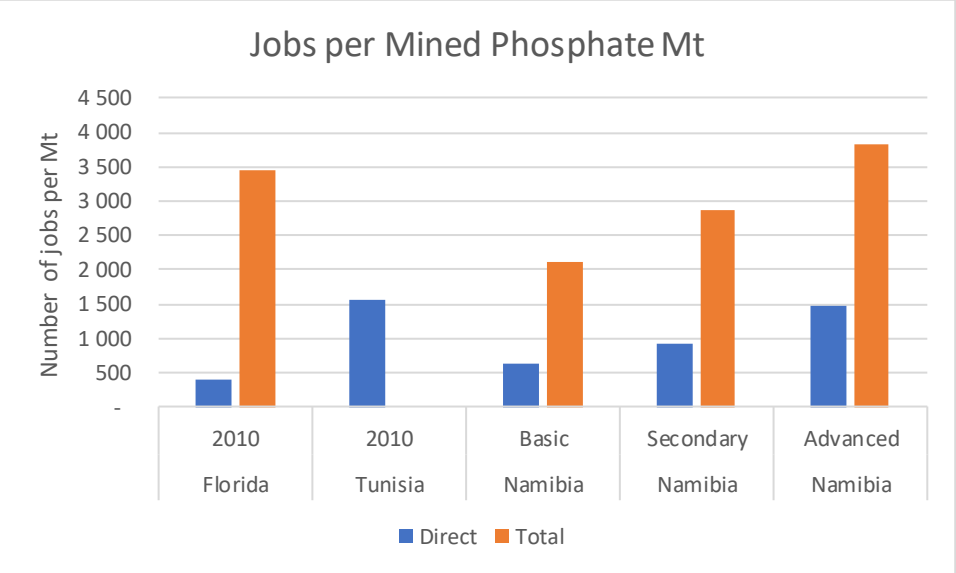
4.3 International Comparisons

This short section shows that the results of the analysis reported above are in line with international experiences. Two indicators are used. Jobs, shown in Figure 14, and contribution to GDP, shown in Figure 15, per ton of mined (dredged) and beneficiated phosphate.

- In Florida, part of a high wage and therefore more capital-intensive country, there were, in 2010, 387 direct jobs and 3 450 total jobs (including indirect and induced jobs) per million tons of mined and beneficiated phosphate.
- In Tunisia there were 1 574 direct jobs per million tons in 2010.
- In Namibia there would be, per million tons:
    - 625 direct and 2 100 total jobs from dredging and basic beneficiation;
    - 900 direct and 2 900 total jobs from dredging, basic and secondary beneficiation;
    - 1 500 direct and 3 800 total jobs from dredging, basic, secondary and advanced beneficiation.

The conclusion is that the expected jobs in Namibia are in line with experiences in other phosphate producing countries.

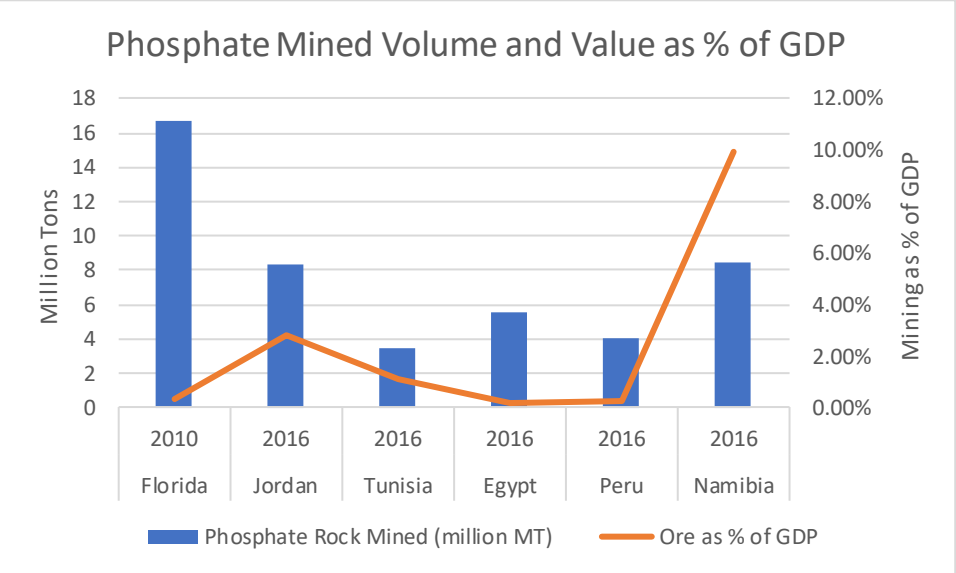
Figure 14: International Experiences: Jobs per Ton of Phosphate



A similar tale is told in Figure 15 where two variables are reported.

First, the projected phosphate volumes used in this analysis are in line with production in other countries – the bar part of the diagram. In Florida 17Mtpa were mined in 2010. Jordan mined 8Mtpa in 2016; Tunisia 3.5Mtpa; Egypt 5.5Mtpa and Peru 4Mtpa in 2016. The proposed 8.5Mtpa in Namibia for basic beneficiation (increasing to 16Mtpa to include advanced beneficiation) is in line with international production levels.

Figure 15: International Experiences: Ore mined and Phosphate Contribution to GDP



Second, is the financial contribution to GDP per ton of ore mined (dredged). Here it clear that the contribution to Namibian GDP would be well ahead of other countries. The reason for this

is because of the relatively small Namibian GDP compared to the other countries in the figure. The contribution to Jordanian GDP is 2.8% per million tons of mined phosphate, for example, compared to Namibia which would be almost 10%. This is a clear indication of the enormous economic potential that could be realised from a Namibian phosphate industry.

4.4 Contribution to Policy Goals

The potential phosphate industry would contribute to meeting Vision 2030 and Harambee PP goals.

4.4.1 General Goals

NDP4 identifies four key sectors which are targeted for Vision 2030. These are Agriculture, Manufacturing, Tourism and Logistics. NDP5 extends this by including mining that would "leverage natural resources". A phosphate industry that mines phosphate ore would promote mining that leverages natural resources. Phosphate beneficiation would promote manufacturing. The use of the resultant fertilizer would promote agriculture.

Other, non-numerical, objectives where the promotion of a phosphate industry could assist include:

- Promote export development and competitiveness. The export potential of the phosphate industry is clear. Beneficiation would make Namibian fertilizer more competitive and promote agricultural competitiveness by making fertilizer locally rather than relying on imports.

- Promote efficient production. Phosphate beneficiation would have to be efficient to compete with imported fertilizer.

- Establish an integrated industrial strategy. The integrated nature of phosphate would promote this strategy.

- Promote skills development and import relevant skills to augment shortage. It is understood by Stratecon that the dredging vessels would, at inception, be operated by expatriate personnel. This would be an essential importation of skills to unlock economic growth and income generation in Namibia. It is further understood that the intention is to train Namibians to fill these positions. This would help in skills development.

- Promote full employment. The phosphate industry cannot, by itself, achieve this objective. It would certainly increase employment and help achieve this policy goal.

NDP5 (page 28) recognises that mining value added may be constrained by a lack of processing economies of scale. NDP5 suggests that consideration should be given to importing minerals to achieve such economies of scale.

The policy imperatives recognise both the promise and dangers of globalisation. The promotion of a new phosphate industry would give:

- a "competitive edge upon which Namibia's position in the world economy will be based."

- "Strengthen our industrial capacity to pursue realistic goals dependent on our natural endowment."

- Grow foreign direct investment.

Phosphate beneficiation would contribute to policy that sees a solution for addressing the middle-income trap by "*building a pro-business infrastructure and the development of more sophisticated industries, including more robust avenues for Research and Development."* This calls for the structural transformation of manufacturing through diversification and making exports more sophisticated through value-added production.

Policy also recognises the need for import substitution including preferential government procurement of local production and developing such a procurement agreement with the private sector. The local beneficiation of phosphate and fertilizer clearly supports this policy position. These are included in the 'game changer' features recognised in NDP5. A further aspect of these game changers is to increase productivity in agriculture, especially for smallholder farmers. The preferential procurement of locally produced fertilizer clearly falls in this paradigm. The final game change is to improve value addition in natural resources which phosphate dredging, and beneficiation are clearly focussed on. This is addressed specifically in the Harambee PP.

4.4.2 Specific Goals

The Vision 2030 sets macroeconomic targets for 2030 (page 63). These include:

- GDP growth of 6.2%;
- GDP per capita growth of 4.4%;
- Unemployment of 2.3%;

- "10% primary, 42% secondary and 48% government sector of GDP"7;
- Trade deficit of 3.3% of GDP;
- Budget deficit of 1.5% of GDP.

There are four numeric goals against which the potential Namibian phosphate industry can be assessed. These are a high-income country, GDP growth of 6.2%, a trade deficit of 3.3% of GDP and a budget deficit of 1.5% of GDP.

4.4.2.1 High Income Country

A high-income country is one which in 2016 had a per capita gross national income of US$12 236. In 2016 Namibia stood at US$4 607. The phosphate industry would have made a per capita contribution of US$304, increasing the total per capita income to US$4 911. This is reported in Table 8 and illustrated in Figure 16.

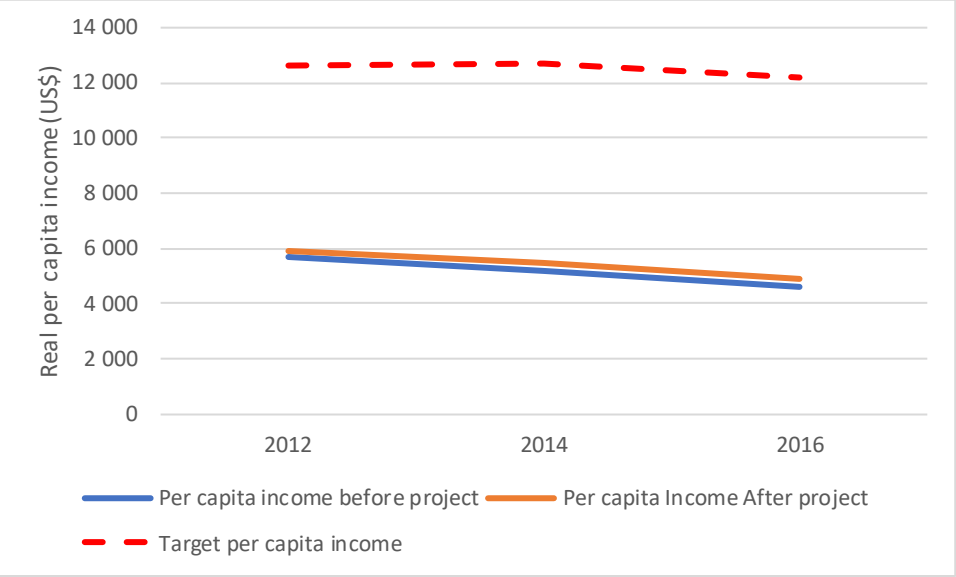
Table 8: Contribution to Achieving High-Income Country Objective[8]

High Income Country (US$)	2012	2014	2016
Target for High Income Country	12 615	12 735	12 236
Current real GNI per capita	5 715	5 213	4 607
Phosphate Industry contribution to GNI per capita	180	222	304
GNI per capita with Phosphate Industry	5 895	5 435	4 911

[7] *This reference to the 'government sector' is correct. This, in practice, may mean the tertiary sector*

[8] *The fall in per capita GNI in US$ terms is the consequence of a currency depreciation against the US$. The per capita GNI in US$ terms is calculated from Gross National Income at market prices (in current N$ per capita)* (Namibian Statistics Agency, 2017, p. Table 1) *and converted to US$ using the official exchange rate* (Namibian Statistics Agency, 2017, p. Table 30)

Figure 16: High-Income Country Objective



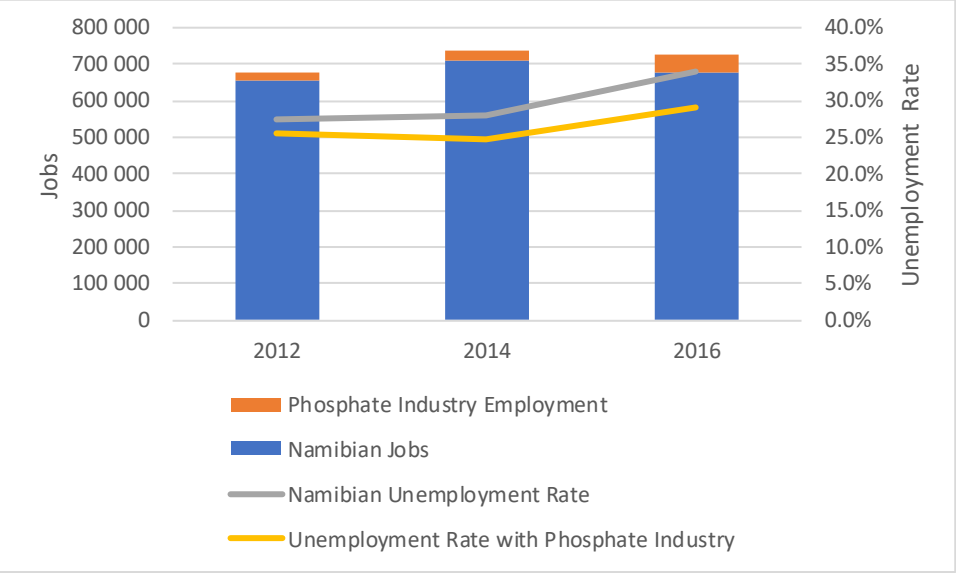
4.4.2.2 Unemployment of 5%

Vision 2030 and HPP have an unemployment target of 5%. It was noted in Section 3.5.2 that this is going to be a difficult target to achieve. As shown in Table 9 and illustrated in Figure 17 a phosphate industry could contribute to making this goal a reality. A phosphate industry, as analysed in this study, could have increased employment by 2.7% in 2012 and 7.6% by 2016. This would have, in those years, have decreased unemployment from 27.5% to 25.5% and 34% to 29% respectively.

Table 9: Contribution to Achieving Unemployment Target

Employment	**2012**	**2014**	**2016**
Namibian Jobs	657 584	708 895	676 885
Phosphate Industry Employment	18 025	30 441	51 593
% of Namibian Jobs	2.7%	4.3%	7.6%
Unemployed	248 944	274 948	349 383
Namibian Unemployment Rate	27.5%	27.9%	34.0%
Unemployment Rate with Phosphate Industry	25.5%	24.9%	29.0%

Figure 17: Contribution to Employment and Reduction in Unemployment



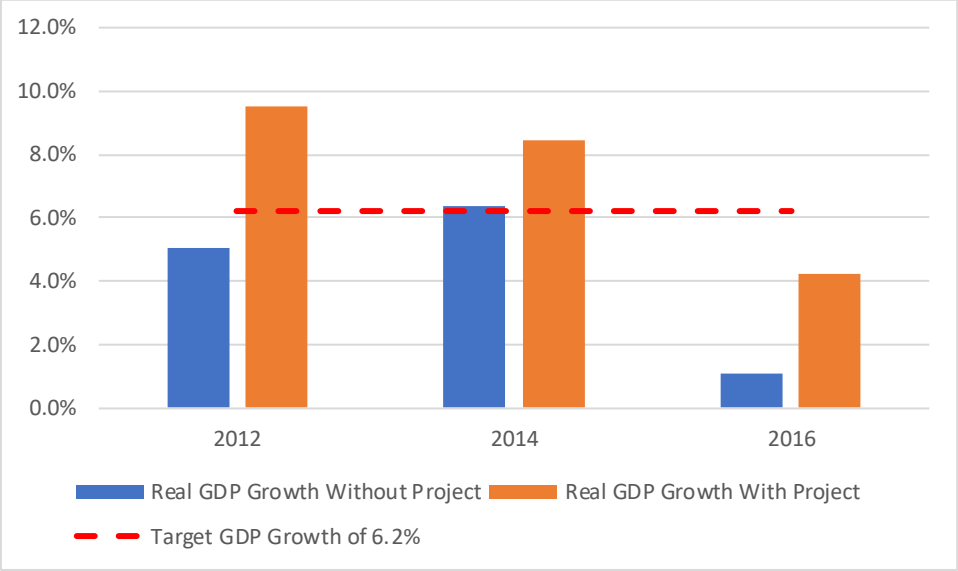
4.4.2.3 GDP Growth of 6.2%

In 2012 GDP growth was 5.1% and in 2016 it was 1.1%. A phosphate industry would have increased this growth to 9.5% and 4.2% respectively. This is reported in Table 10 and illustrated in Figure 18.

Table 10: Contribution to Achieving GDP Growth Objective

GDP Growth of 6.2%	2012	2014	2016
Target GDP Growth	6.2%	6.2%	6.2%
Growth in Real GDP	5.1%	6.4%	1.1%
Growth in Real GDP with Project	9.5%	8.4%	4.2%

Figure 18: GDP Growth Objective



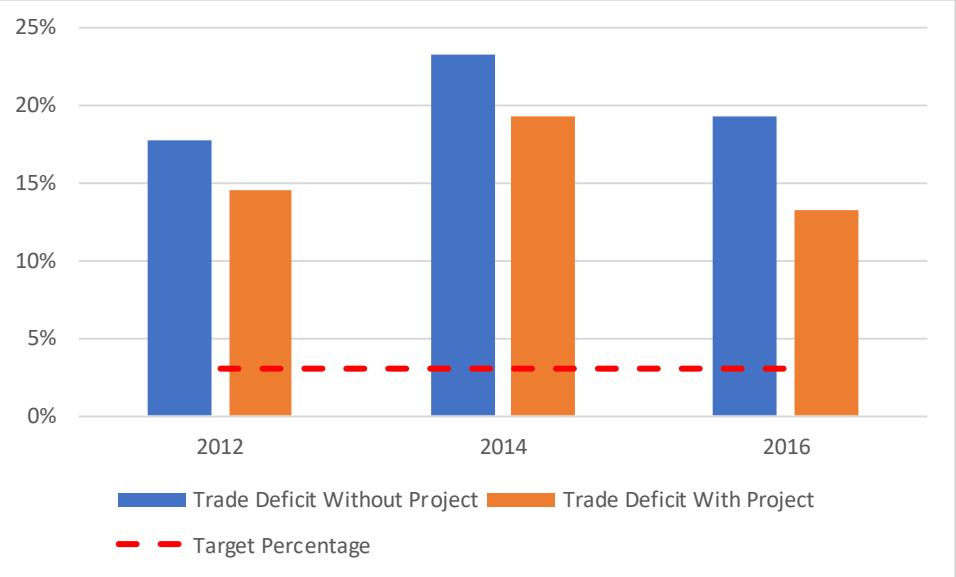
4.4.2.4 Trade Deficit of 3.3% of GDP

In 2012 the ratio of the trade deficit to GDP was 18% while in 2016 it was 19%. A phosphate industry would have reduced this ratio to 15% and 13% respectively. This is reported in Table 11 and illustrated in Figure 19.

Table 11: Contribution to Reducing Trade Deficit Objective

Trade Deficit at 3.3% of GDP	**2012**	**2014**	**2016**
Target Percentage	3%	3%	3%
Trade Deficit as % of GDP	18%	23%	19%
Phosphate Industry Contribution to Goods Forex (N$m)	4 335	6 071	9 966
Trade Deficit as % of GDP with Phosphate Industry	15%	19%	13%

Figure 19: Trade Deficit Objective



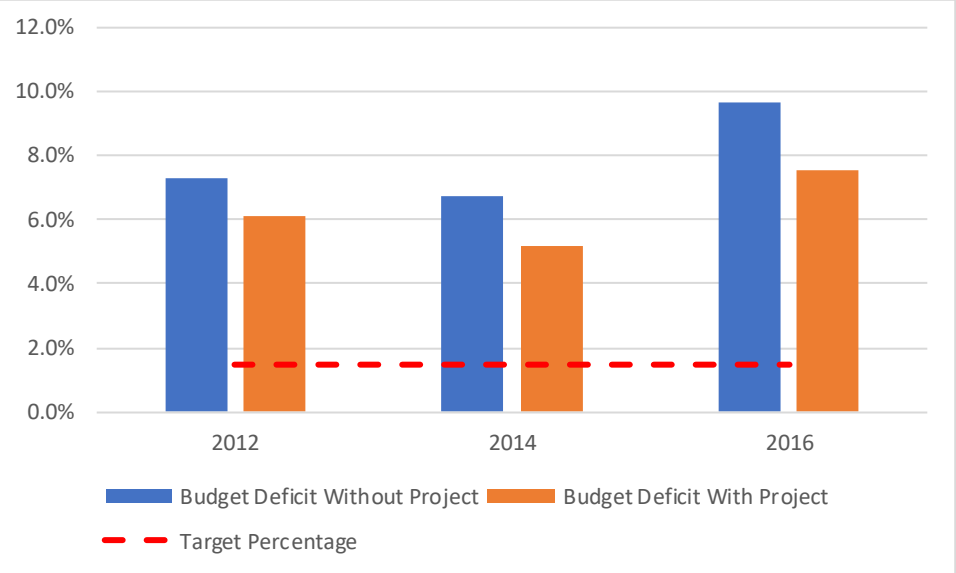
4.4.2.5 Budget Deficit of 1.5% of GDP

In 2012 the ratio of the budget deficit to GDP was 7.3% and in 2016 it was 9.7%. A phosphate industry would have reduced this ratio to 6.1% and 7.6% respectively. This is shown in Table 12 and illustrated in Figure 20.

Table 12: Contribution to Reducing Budget Deficit Objective

Budget Deficit of 1.5% of GDP	**2012**	**2014**	**2016**
Target Percentage	1.5%	1.5%	1.5%
Government Net Borrowing (Deficit) as % of GDP	7.3%	6.7%	9.7%
Taxes Generated from Project (N$ millions)	1 597	2 413	3 516
Government Deficit as % of GDP With Project	6.1%	5.2%	7.6%

Figure 20: Budget Deficit Objective



5 Limitations

There was some uncertainty about the capital and operating costs of different beneficiation processes. This was addressed by assigning varying levels of confidence for the different beneficiation processes. The confidence level was made dependent on the degree of information certainty. This is illustrated in Table 13 and the detail given in Appendix 1.

Costing information was gathered in three ways. First, from Namibia specific analysis (Bateman Advanced Technologies Ltd, 2013) (Jan de Nul N.V., 2015) which was given a high level of confidence. Second, from international case studies and other international data sources which were given a medium confidence level. Finally, estimates were made where information was unavailable. This was given a low level of confidence.

The rule followed to establish the degree of confidence by beneficiation type was to give a confidence level that was:

- High when all information was specifically for Namibia.;
- Medium when all information could be sourced internationally;
- Low when any of the information was estimated.

Table 13: Data Sources and Confidence Levels[9]

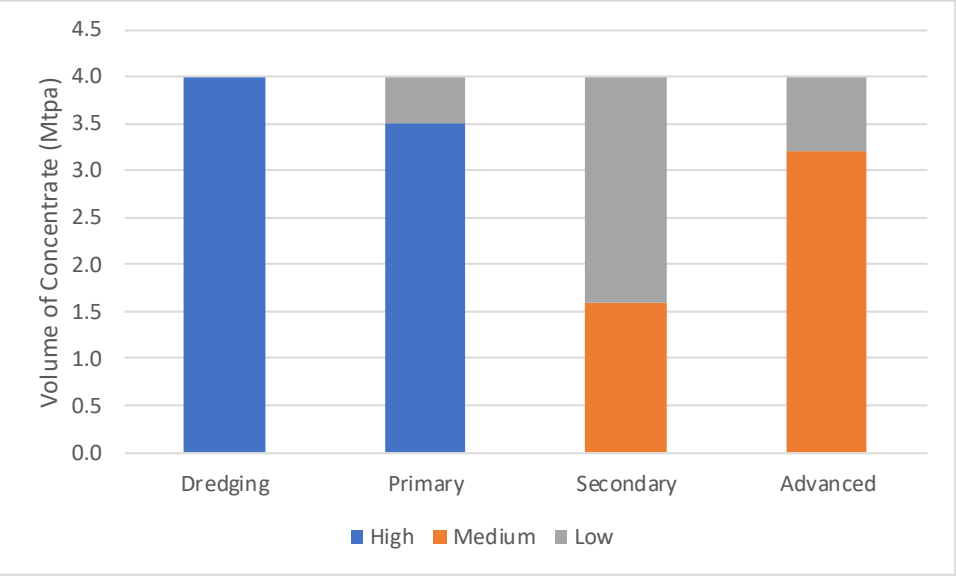
Range of Products	Level of Beneficiation	Data Source		Degree of Confidence
		Capital	Operating	
Mined Ore	Dredging	Jan de Nul N.V. Financial Model		High
Concentrate 27.5%	Primary	Bateman Advanced Technologies: Project Economic Analysis		High
Direct Application Phosphate Rock	Primary			High
Wet Phosphoric Acid	Primary	International	Estimated	Low
Single Super Phosphate	Secondary	International	International	Medium
Triple Super Phosphate	Secondary	International	Estimated	Low
Di Calcium Phosphate	Secondary	Estimated	Estimated	Low
Food Grade Acid	Advanced	International	Estimated	Low
Mono-Ammonium Phosphate	Advanced	International	International	Medium
Di-Ammonium Phosphate	Advanced	International	International	Medium

[9] *The sources are given section 7.3.1 and Table 17.*

The results are illustrated in Figure 21 for product volume at each stage of beneficiation:

- Confidence levels are high for dredging where all data has a high confidence;
- Basic beneficiation is for processing of the ore, which makes up 87.5% of the volume with high confidence and remaining volume WPA with low information confidence.
- Secondary beneficiation is for SSP, TSP and DCP. Here 40% of the processed volume has a medium and 60% a low confidence level.
- Advanced beneficiation is for FGA, MAP and DAP. Here 80% of the processed volume has a medium and 20% a low confidence level.

Figure 21: Data Confidence by Beneficiation Stage



6 Conclusion

The following conclusions are made on the potential economic contribution of a Namibian phosphate industry. Stylistically the analysis was rooted in past economic performance so that known economic parameters could be compared to potential economic benefits. As a result, the phosphate industry was modelled as if it had started in 2012 and reached full beneficiation by 2016:

- Total direct GVA would have increased from N$3.3bn in 2012 to N$8.0bn by 2016. This would have been made up of an increase in:
    - Dredging from N$293m to N$549m;
    - Concentrate from N$2.1bn to N$3.6bn;
    - Further beneficiated products from N$640m to N$3.5bn; and
    - Productivity gains in subsistence agriculture worth N$258m in 2012 to N$287m in 2016.

- The increase between 2012 and 2016 would have been:
    - GDP of N$5.8bn increasing to N$14.8bn;
    - Gross National Income (GNI) of N$4.3bn increasing to N$11.3bn;
    - Taxes of N$1.6bn increasing to N$3.5bn;
    - Exports worth N$7.5bn increasing to N$18.7bn.

Arguably, in the Namibian context, job creation is critically important. In 2013 there would have been 18 000 more jobs, increasing to 51 600 by 2016. The direct jobs in the phosphate industry would increase from 5 309 in 2012 to 18 109 by 2016. In 2016 these direct jobs would be distributed:

- 628 in dredging;
- 4 660 in beneficiation ore to concentrate, and
- 12 820 in manufacturing advanced products.

Relative to the actual Namibian economy in those years the phosphate industry would have added:

- 4.3% to Namibian GDP in 2012 and a notable 9.0% by 2016;
- 1.9% to Mining GVA in 2012 and 4.2% by 2016;
- 18.0% to Manufacturing GVA in 2012 and 45.7% by 2016;
- 2.7% to employment in 2012 and 7.6% by 2016.

Furthermore, increased productivity in subsistence farming would have added a further 3.8% to Agriculture GVA in 2012 and 5.2% in 2016.

The results reported above are remarkable. Yet they are not out of line with the experiences of other phosphate producing countries. An **international comparison** shows:

- **Production levels**: In Florida 17Mtpa were mined in 2010. Jordan mined 8Mtpa in 2016; Tunisia 3.5Mtpa; Egypt 5.5Mtpa and Peru 4Mtpa in 2016. The proposed 8.5Mtpa in Namibia for basic beneficiation (increasing to 16Mtpa to include advanced beneficiation) is in line with these levels of production in other phosphate producing countries.
- **Jobs:**
    - In Florida, part of a high wage and therefore more capital-intensive country, there were, in 2010, 387 direct jobs and 3 450 total jobs (including indirect and induced jobs) per million tons of mined and beneficiated phosphate.
    - In Tunisia there were 1 574 direct jobs per million tons in 2010.
    - In Namibia there would be, per million tons:
        - 625 direct and 2 100 total jobs for dredging and basic beneficiation;
        - 900 direct and 2 900 total jobs for secondary beneficiation; and
        - 1 500 direct and 3 800 total jobs for dredging and advanced beneficiation.
- **Contribution to GDP**: the contribution to Namibian GDP would be well ahead of other countries because of the relatively small Namibian GDP compared to the other countries. The contribution to Jordanian GDP is 2.8% per ton of mined phosphate, for example, compared to Namibia which would be almost 10%. The dredging volumes would be the same.

The final part of this conclusion reflects on the extent to which the phosphate industry is both sympathetic to, and could help achieve, the **goals of Vision 2030** and the **Harambee Prosperity Plan**.

- **Sector targets**: Four sectors are targeted in policy objectives: agriculture, manufacturing, tourism and logistics. NDP5 extends this by including mining that would "leverage natural resources". HPP further extents this by proposing "to support increased crop production, Government will establish fertilizer mixer plants in Namibia during year 2 of HPP to make fertilizers available to farmers at affordable prices" (Republic of Namibia, Harambee Plan for Prosperity, 2016, p. 39). A phosphate industry would promote mining that leverages natural resources, manufacturing through beneficiation and agriculture by making fertilizer.

- **Promote**: export development and competitiveness; efficient production because of the need to compete with imported fertilizer; skills development and import relevant skills to augment shortage; and help to achieve full employment.

There are four specified goals to which a phosphate industry would contribute:

- **Make Namibia a high-income country**. A high-income country is one which has a per capita gross national income of US$12 236. In 2016 Namibia stood at US$4 607. The phosphate industry would have made a per capita contribution of US$304, increasing the total per capita income to US$4 911.

- **Reduce unemployment to 5%.** A phosphate industry, as analysed in this study, could have increased employment by 2.7% in 2012 and 7.6% by 2016. This would have, in those years, have decreased unemployment from 27.5% to 25.5% and 34% to 29% respectively.

- **Achieve a GDP growth of 6.2%.** In 2012 GDP growth was 5.1% and in 2016 it was 1.1%. A phosphate industry would have increased this growth to 9.5% and 4.2% respectively.

- **Reduce the national trade deficit to 3.3% of GDP.** In 2012 the ratio of the trade deficit to GDP was 18% while in 2016 it was 19%. A phosphate industry would have reduced this ratio to 15% and 13% respectively.

- **Reduce the government budget deficit to 1.5% of GDP.** In 2012 the ratio of the budget deficit to GDP was 7.3% and in 2016 it was 9.7%. A phosphate industry would have reduced this ratio to 6.1% and 7.6% respectively.

7 Appendix 1: Analytical Approach

This section gives a detailed explanation of the high-level discussion of Section 2 and Figure 4. Each step and its related assumptions is described in detail.

7.1 Phosphate Ore and Concentrate Volumes

The first analytical step was to set the potential volume of ore that could be dredged and resultant concentrate. This was based on the business plans of Namibia Marine Phosphate (Pty) Ltd (NMP) and LL Namibia Phosphates (Pty) Ltd (LLNP).

The combined dredging in these two business plans would yield an annual 8.5 million tons (Mtpa) of phosphate ore. The processed ore could be turned into 4Mtpa of phosphate concentrate. The phosphate ore cannot be used in its dredged state and needs to be purified to phosphate concentrate. This concentrate is also called phosphate rock.

7.2 Beneficiation Roll-out

Step two was to develop a beneficiation roll-out to understand the economic and financial implications of increasing degrees of beneficiation. Three levels of roll-out were used from simple to complex beneficiation.

The analytical approach was to use a beneficiation ramp-up over time. The ramp-up is from simple to advanced beneficiation. The analysis period assumes the industry started in 2012 and ramps up to 2016. This was done, as explained in Section 2, to avoid introducing the 'unknown' of future economic growth. As was also explained a realistic beneficiation ramp-up was to start with primary beneficiation, find a regular market for the product and keep that beneficiated output largely (for this analysis) constant. This is then followed with secondary beneficiation, again keeping output of that product constant, and then advanced beneficiation. These three steps require increases in the dredged phosphate volumes. The assumed dredged and beneficiated volumes are given in Table 14 (this table is repeated, for convenience, from the body of the text). The beneficiated volumes, and associated dredged volumes, were guided by the realistic volumes that Namibia could supply to world markets given existing international supplies and being cognisant of potential impacts on international prices. These volumes were given by NMP.

The dredged volumes in the first year of production was assumed at 8.5Mtpa. This was done to align 2012 dredging volumes with the current NMP and LLNP proposed dredging. This

would give 4Mtpa of concentrate which would be beneficiated/sold as 3.5Mtpa of DAPR and 0.5Mtpa of WPA.

Dredged volumes would be increased to 11.7Mtpa and resultant concentrate to 5.5Mtpa once the market certainty of primary beneficiation was established. This increased volume would be used to produce an additional 0.5Mtpa of WPA and 1Mtpa of SSP, TSP and DCP. Finally dredging volumes would be increased to 16Mtpa with resultant concentrate volumes of 7.5Mtpa. WPA volumes would be increased to 2Mtpa, SSP et.al. kept constant at 1Mtpa and 1Mtpa of MAP, DAP and FGA introduced.

Table 14: Appendix: Phosphate Ramp Up Volumes

Mature Industry Volumes (Mtpa)	**2012**	**2014**	**2016**
Volume Ore Dredged from Ocean Floor	8.5	11.7	15.9
Volume Phosphate Concentrate Manufactured	4.0	5.5	7.5
Distribution of Concentrate			
Primary Beneficiation	4.0	4.5	5.5
DAPR	*3.5*	*3.5*	*3.5*
WPA	*0.5*	*1.0*	*2.0*
Secondary Beneficiation	0.0	1.0	1.0
SSP	*0.0*	*0.4*	*0.4*
TSP	*0.0*	*0.3*	*0.3*
DCP	*0.0*	*0.3*	*0.3*
Advanced Beneficiation	0.0	0.0	1.0
FGA	*0.0*	*0.0*	*0.2*
MAP	*0.0*	*0.0*	*0.4*
DAP	*0.0*	*0.0*	*0.4*

The assumptions about the volume of beneficiated product per one ton of phosphate of concentrate are given in Table 15. These values were supplied by the consulting natural scientists contracted for this study.

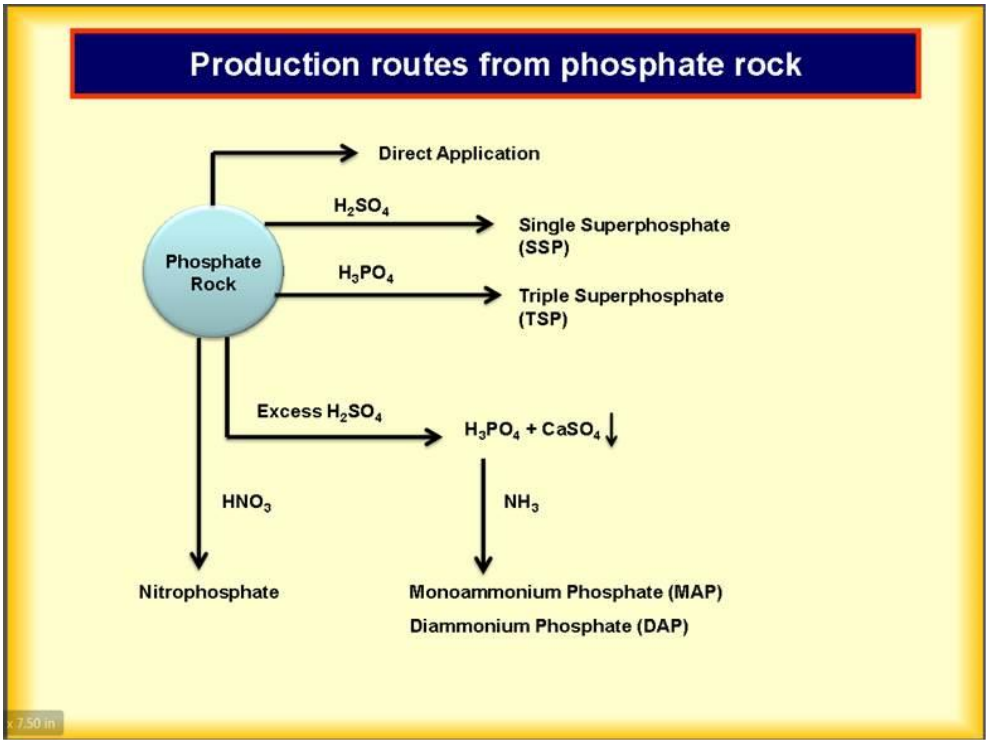
Table 15: Beneficiation Volumes per ton of Concentrate

Range of Products	**Volume Concentrate for 1t Product**
Dredged Ore	
Concentrate 27.5%	
Direct Application Phosphate Rock	1.00
Wet Phosphoric Acid	1.15
Single Super Phosphate	0.74
Triple Super Phosphate	1.77
Di Calcium Phosphate	2.15
Food Grade Acid	2.07
Mono-Ammonium Phosphate	2.07
Di-Ammonium Phosphate	1.80

The consulting scientists were not able to estimate the volume of phosphate rock for the composite NPK fertilizer due to the wide range of NPK fertilizers available. As a result, this product was excluded from the analysis.

For some products such as TSP, Di Calcium Phosphate (DCP), MAP and DAP this includes the phosphate rock required to manufacture WPA, which is then blended with further phosphate rock to generate the final product. This beneficiation and blending is illustrated in Figure 22. For TSP, for example, phosphate rock needs to be blended with phosphoric acid (H_3PO_4). The phosphoric acid itself requires phosphate rock in its manufacture, before it can be further blended with more phosphate rock to create TSP.

Figure 22: Phosphate Rock Production Routes



The final beneficiated masses, based on the dredging of 8.5 Mtpa of phosphate ore, are given in Table 16. It is noted that some products, TSP for example, need WPA as an ingredient. In this case the 800 000 tons of phosphate concentrate would not only be used for TSP but also to generate WPA.

Table 16: Beneficiation Phosphate Distribution

Concentrate Used for Product (Mt)	Level of Beneficiation		
	Basic	Secondary	Advanced
Direct Application Phosphate Rock	6 500 000	4 277 778	3 500 000
Single Superphosphate	0	800 000	400 000
Wet Phosphoric Acid	1 000 000	1 222 222	2 000 000
Food Grade Acid	0	0	200 000
Triple Superphosphate	0	600 000	300 000
Di Calcium Phosphate	0	600 000	300 000
Composite NPK Fertilizers	0	0	0
Mono-Ammonium Phosphate	0	0	400 000
Di-Ammonium Phosphate	0	0	400 000
Total	**7 500 000**	**7 500 000**	**7 500 000**

7.3 Cost, Prices and Imports

This section lists the assumptions that were used for the cost of production, product prices and import volumes.

The underlying concept behind the analysis has been to analyse the operation as an industry wide operation rather than only two firms undertaking the venture.

To explain this in more detail:

- The phosphate ore is dredged (or extracted) off the ocean floor. This process has its own capital and operating costs.

- The phosphate ore is then passed on for the concentrate beneficiation process. The revenue generated from the sale of the ore would need to cover all capital and operating costs as well as royalties, taxes and interest financing costs associated with the dredging process.

- The concentrate beneficiation process would have its own capital and operating costs, in addition to those incurred in dredging the ore. Once the concentrated phosphate rock has been beneficiated it is then sold on either as DAPR or on to further downstream firms for secondary beneficiation (normally at a discounted price because of the quality of rock). The revenue earned from this sale needs to cover all capital and operating costs (including the purchase price of the phosphate ore) as well as administration overheads, royalties, taxes and interest financing costs associated with the concentrate beneficiation. The sales could either be local or export sales.

- Firms that beneficiate the phosphate concentrate into further products would then incur their own capital and operating costs in addition to the purchase price of the concentrate. They would then sell this product on to market (either local or foreign), with the revenue needing to cover all costs including administration overheads and interest financing costs associated with their beneficiation process and taxes.

7.3.1 Production Cost:

The capital costs are shown in column 2 of Table 17. They are provided as a cost per ton of final product. The capital costs have been amortized over twenty years:

- The capital cost of dredging the ore and setting up the facilities to extract the concentrate are based on detailed financial business plans developed for NMP (Bateman Advanced Technologies Ltd, 2013, p. 61) (Jan de Nul N.V., 2015).

- Single Super Phosphate (SSP) is based on a plant developed by the Growmax Corporation (GrowMax Resources Corp, 2017, p. 18).

- The costs of WPA, Food Grade Acid (FGA) and TSP have been estimated by industry experts (Kemworks, 2017).

- DCP is the only product for which capital costs could not be sourced. They were therefore estimated by increasing the capital costs for TSP in the ratio of the market prices for the two products.

- Composite NPK fertilizers are based on the Integer report into the costs and margins in the phosphate industry (Integer Research, 2011, p. 283).

- MAP is based on the Martison Phosphate Project (Spalding, Sprott, Waters, Demidovich, & Jennings, 2011, pp. 2, 5).

- DAP is based on the feasibility study of the Legend Holdings Inc. Paradise Phosphate Project DAP plant (Legend International Holdings Inc., 2011, pp. 11, 12).

The capital costs shown in Table 17 include the costs of upstream facilities required to manufacture the product. So, for example, the capital cost of TSP includes not only the TSP plant but also the cost of the WPA plant because WPA forms part of the final product.

Table 17: Costs, Market Prices and Current Imports

1	2	3	4	5
Range of Products	**Value in US$ per ton**			**Current Imports (tons)**
	Amortized Capital Cost	**Additional Operating Cost**	**Market Price**	
Dredged Ore	$1	$20	$23	
Concentrate 27.5%	$7	$31	$101 - $121	
Direct Application Phosphate Rock			$121	0
Single Super Phosphate	$16	$19	$170	2
Wet Phosphoric Acid	$11	$160	$400	1 000
Food Grade Acid	$83	$240	$600	0
Triple Super Phosphate	$26	$55	$275	0
Di Calcium Phosphate	$35	$75	$375	0
Composite NPK Fertilizers	$11	$90	$180	22 485
Mono-Ammonium Phosphate	$34	$182	$442	780
Di-Ammonium Phosphate	$23	$208	$431	33

Additional operating costs are shown in column 3 of Table 17. These costs were not as readily available as capital costs. The costs shown in the table exclude the cost of the phosphate concentrate in the final product.

- The operating cost of dredging and setting up the facilities to extract the concentrate are based on detailed financial business plans developed for NMP (Bateman Advanced Technologies Ltd, 2013, p. 61) (Jan de Nul N.V., 2015).
- SSP is based on a plant developed by the Growmax Corporation (GrowMax Resources Corp, 2017, p. 18).
- No operating costs could be sourced for WPA, FGA, TSP, DCP and composite NPK fertilizers. Consequently, the costs (excluding the purchase costs of the phosphate concentrate) were set at between 20% and 40% of the market price of the product. The costs were varied to return similar operating margins indicated for the products in the Integer report into the costs and margins in the phosphate industry (Integer Research, 2011).
- MAP and DAP operating costs were sourced from the feasibility study of the Legend Holdings Inc. Paradise Phosphate Project DAP plant (Legend International Holdings Inc., 2011, p. 13).

7.3.2 Sales Price

Market prices are shown in column 4 of Table 17 and are given in US$ per ton of product.

- The market price for the extracted ore was assumed to be 5% more than the capital and operating cost. This 5% allows for financing costs, royalties and taxes.
- The market price for the concentrated phosphate rock and the DAPR is based on the market price for the product indicated in the NMP feasibility study (Bateman Advanced

Technologies Ltd, 2013, p. 66). When the phosphate concentrate is sold on to market as DAPR it is sold at a 5% discount (US$120.7/t), at a 9.9% discount for SSP and NPK fertilizers and at a 20% discount for all other products.

- The market prices for the remaining products are based on quoted prices on relevant websites[10] and commodity price forecasts (World Bank Group, 2017, p. 21).

Earnings before tax are calculated as the gross revenue for each process or product (based on the volume of product produced and multiplied by the market price described above), less capital and operating costs and the purchase price of the phosphate ingredient.

Earnings after taxes are based on the earnings before taxes with the following deductions:

- The financing interest costs of capital expenses. These financing costs are based on twenty-year loans and at a real interest rate of 6.5%. It is assumed that 60% of the capital costs are debt financed and the remainder through equity. Only the interest portion of the capital costs are deducted.

- Administration overheads, which have been set at 20% of earnings before taxes.

- Royalties of 2% of the value of the phosphate concentrate.

- Corporate taxes of 37.5% of earnings before taxes for the dredging process and phosphate concentrate (these are assumed to be mining products). For all other beneficiation processes a tax rate of 32% (PWC, 2017, pp. 4, 5) is applied (the further beneficiation process is no longer a mining operation but rather a manufacturing process).

- A withholding tax of 10% on all interest payments and offshore repatriated earnings (PWC, 2017, p. 4).

It has been assumed that 60% of the earnings after taxes remain in Namibia and that 40% are repatriated offshore.

[10] *www.alibaba.com, www.echemi.com, www.indexmundi.com, www.marketrealst.com and www.dtnpf.com/agriculture/web/ag/news/ crops/article/2017/01/11/retail-fertilizer-prices-start-2017*

7.3.3 Import Volumes

Current fertilizer import volumes are shown in column 5 of Table 17. These are based on statistics provided by the Namibian Statistics Agency (Namibian Statistics Agency, 2017). The data shows that nutrient fertilizers constitute the bulk of imports (by weight). SSP, MAP and DAP are also imported.

7.3.4 Sales Distribution

The assumed sales distribution of each beneficiated product is given in Table 18. This assumption is needed because product sold in Namibia are import substitutes while those exported generate foreign exchange.

Table 18: Sales Distribution

Distribution of Sales	Namibia	SADC	Global Export
Direct Application Phosphate Rock	5%	10%	85%
Single Super Phosphate	50%	50%	0%
Wet Phosphoric Acid	0%	0%	100%
Food Grade Acid	0%	0%	100%
Triple Super Phosphate	30%	50%	20%
Di Calcium Phosphate	30%	50%	20%
Composite NPK Fertilizers	30%	50%	20%
Mono-Ammonium Phosphate	5%	10%	85%
Di-Ammonium Phosphate	5%	10%	85%

7.4 Subsistence Agriculture Productivity

One of the Namibian policy objectives is to grow agricultural productivity and improve food security. The nascent phosphate industry could help by providing additional fertiliser. A high-level analysis was done to determine the potential impact of such changes.

It can be expected, and was assumed, that commercial agriculture already optimise fertiliser use relative to price and marginal benefit. This means that there would be no additional fertiliser uptake unless the local price is lower than imported price. As a result, only subsistence farming was analysed.

Currently between 2% and 6% of subsistence farmers use inorganic fertiliser. The remainder use the organic option. The exercise that was done was to analyse the result of an uptake of Namibian produced inorganic fertilizers by subsistence farmers. A key assumption was around how large the uptake might be. The approach was to use current commercial farming use of

inorganic fertilizer as a proxy for subsistence use, adjusted for land area under cultivation and the amount of fertilizer per hectare typically used to fertilize the main crop types of millet, maize and sorghum.

The approach to calculating productivity increases from the increased inorganic fertilizer use by subsistence farmers is outlined below. Most of the assumptions were derived from data in the Namibian Census of Agriculture and from the Namibian Crop Production Manual. The calculation was done in seven steps:

1. Estimate the number of people in each household. This was based on the number of agricultural households and the population of agricultural households in each region (Namibian Statistical Agency, Namibia Census of Agriculture 2013/2014 Communal Sector Report, 2015, p. 17).
2. Calculate the average household holding (hectares) for each region (household land is referred to as a holding in the Namibian Census of Agriculture). This was calculated using the people per household data and average holding size for different household size. The average holding (land area) is 3.03 hectares per household (calculated from the Namibian Census of Agriculture data) (Namibian Statistical Agency, Namibia Census of Agriculture 2013/2014 Communal Sector Report, 2015, pp. 14,17, 24).
3. Calculate land area (hectares) under cultivation for each region for the three main crop types - millet (86%), maize (12%) and sorghum (2%). This was calculated using the number of agricultural households and the average hectares of household land holding. This was reduced to account only for the area under cultivation for the three main crop types and was done by multiplying the total subsistence farm land by the proportion of land used specifically for crop, livestock and forestry. The second adjustment entailed adjusting the land used for crop, livestock & forestry to only include the land used for crop cultivation. This was estimated by multiplying the known total land used for millet, maize and sorghum cultivation by the regional proportions of land used for crop, livestock and forestry. (Namibian Statistical Agency, Namibia Census of Agriculture 2013/2014 Communal Sector Report, 2015, p. 25).
4. The Namibian Crop Production Manual gave insight into fertilizer requirements for each crop type. Using this information, a weighted average fertilizer requirement per hectare could be calculated using the crop specific fertilizer requirements and the proportion of cultivated land by crop type. Based on this estimate, it was assumed that 125kg of compound NPK fertilizer would be used per hectare for millet, maize and sorghum (Ingo Jacobi, 2008, p. 55)
5. Estimate productivity gains based on the proportional increase in fertilizer usage and the resultant yield increase by regional soil type. This needed an estimate of current

production by crop type and region which was done by dividing the total crop production tonnage by the proportion of land under crop cultivation in each region. Soil types and their suitability for crop cultivation were obtained from a map of Namibia produced by the University of Cologne. Soils were categorised into three types of suitability for crop cultivation (high, medium and low). This map was used to produce a table of soil types by region. Soils that are better suited to crop cultivation would respond better to fertilizer use than soils not suited to crop cultivation. Based on typical fertilizer induced yield increases, applying fertilizer would result in a (Matlon, 1990, p. 19):

   a. 40% increase in yield for soils with high suitability to crop cultivation;
   b. 20% increase in yield for soils with medium suitability to crop cultivation;
   c. 10% increase in yield for soils with low suitability to crop cultivation.

6. These yield increases were used by crop type and region.
7. The yield increase was converted to financial values using World Bank data (World Bank Group, 2017, p. 19).

7.5 Macroeconomic Analysis

This section describes that overall approach to the macroeconomic analysis. This includes a description of the approach, methodology and estimates of GDP, jobs, taxes and foreign exchange

7.5.1 General Description

The size of a national or regional economy is measured in terms of the total of all economic activities taking place within the area concerned, both in the public and private sectors. For countries like Namibia this includes measures of informal sector activity as well. The name given to the measure of the size of the economy is Gross Domestic Product (GDP) for the country.

Underlying the measurement of GDP is the understanding that all economic activity is dependent on the physical and institutional support systems that enable an economy to operate effectively. These include the various levels of governmental structure, the legal system, and the administrative, financial and educational infrastructure in the country. In terms of physical infrastructure, all economic activity depends on energy and water supply, telecommunication and transport infrastructure. Without these systems being in place the economy could not operate.

While there are several different types of macroeconomic effects, the two most important are contribution to GDP and creation of jobs. The importance of job creation is obvious. Increases in GDP are synonymous with increases in peoples' economic standards of living. Increased GDP – i.e. increased production – is experienced in the form of more jobs, higher wages and reduced economic hardship. It is clearly an important measure.

7.5.2 Methodology

The actual task of calculating the macroeconomic impact of the proposed project demands a detailed and multifaceted approach not least because of the so-called multiplier effects. It is well recognised that the simple act of spending – constructing and operating a processing plant for example - leads to other economic effects. Demand for steel and cement can lead to increased production in those industries. Increased demand for steel and cement, in turn, leads to increased demand for mining output which uses wood, water, electricity and so on. These are the so-called multiplier effects. While this process unfolds, each industry employs people and pays wages. Employees, in turn, spend their wages and cause further multiplier effects through the economy. Measuring this is further complicated by the fact that different industries demand different types of skills. This leads to different wage structures across the various industries. People earning different wages have different spending patterns. Thus, the change in overall spending patterns is dependent on which industries are affected.

Input-output analysis was used for the measurement of the macroeconomic impact of the proposed phosphate dredging. Input output tables have been developed from a Namibian Social Accounting Matrix (SAM) and converted into industry multipliers. This approach demanded that all expenditure in and around the project be identified and estimated. This expenditure, in turn, needs to be linked to the 25 SAM economic sectors for Namibia. In addition, if employment is part of the expenditure then estimates must be made of the likely items of expenditure because of wage payments. Allowances must also be made for the fact that workers at different income levels have different spending patterns.

Four steps were required to measure the overall macroeconomic impact of a phosphate industry:

- First, to establish national turnover for the industry for each group of products (scenario).

- Second, to identify the major items of expenditure for each product. This is disaggregated by dredging operations, concentration of the phosphate rock and

beneficiation into the various products. In each case a distinction is made between capital expenses and processing costs.

- Each of these items is then allocated to the appropriate SAM code. Each SAM code relates to a Namibian economic sector.

- Finally, all the SAM coded items are brought together. The total multiplier effect is calculated as the aggregate product of SAM coded spending on plant and material, as well as SAM coded spending by workers multiplied through the industry multipliers.

The macroeconomic estimates that are made in this analysis relate directly to the revenue and costs of the Namibian phosphate industry. Included in the macroeconomic calculations are all the backward economic linkages from this expenditure and the forward economic linkages that occur when workers spend their salaries.

7.5.3 GDP and Direct GVA

Gross value added (GVA) is defined as the value of output less the value of intermediate consumption[11] and is measured as the contribution to salaries & wages, dividends, profit, taxes and depreciation[12]. For the purposes of this analysis only the first round (or direct contribution) to GVA is reported. This is different to the estimate for total GDP, where indirect and induced effects as described in the previous section are included. The contribution to total GDP is therefore higher than the contribution to direct GVA.

GVA multipliers for economic subsectors are calculated from the Namibian SAM. This is done by determining the proportion of turnover spent on the factors of production (salaries and wages and gross operating surplus / operating profit) and on taxes. Therefore, if the turnover of any economic sector is known the GVA amount can be determined by multiplying that turnover by the relevant GVA multiplier. For example, the light manufacturing subsector has a direct GVA multiplier of 0.32. This means that a N$1m increase in turnover in this subsector would contribute, on average, N$320 000 to direct GVA. In contrast, the GDP multiplier for light manufacturing is 0.80, which means that a N$1m increase in turnover in this subsector would contribute, on average, N$800 000 to national GDP. The indirect and induced effects therefore add a further N$480 000 to GDP when compared to direct GVA.

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[11] *https://stats.oecd.org/glossary/detail.asp?ID=1184*

[12] *https://en.wikipedia.org/wiki/Gross_value_added*

The direct GVA multiplier and total GDP multiplier for any of the dredging or beneficiation processes is therefore determined as the weighted average of the direct GVA and total GDP multipliers of all the subsectors directedly affected by their spending profile.

7.5.4 Employment Estimates

Table 19 presents the employment opportunities from the potential phosphate industry. There are two types of jobs, namely direct jobs and indirect jobs. These are shown in separate parts of the table, as is the sum of the two (total jobs). Direct jobs are further subdivided into two sub-components. The first are the direct jobs on the dredging ships or in the processing factories. The second sub-component is for the first-round employees directly affected by supplying goods and services to the industry but outside of dredging and beneficiation.

Table 19: Employment Opportunities

Contribution to Employment	2012	2014	2016
Direct Jobs	**5 309**	**9 841**	**18 109**
Dredging	*335*	*460*	*628*
Dredging Direct Employment	*275*	*378*	*516*
First Round Suppliers (Dredging)	*60*	*82*	*112*
Concentrate	*2 714*	*3 571*	*4 660*
Concentrate Direct Employment	*603*	*829*	*1 131*
First Round Suppliers (Concentrate)	*2 111*	*2 742*	*3 530*
Beneficiated Products	*2 261*	*5 809*	*12 820*
Subsistence Farming Productivity	*0*	*0*	*0*
Indirect Jobs	**12 716**	**20 600**	**33 484**
Dredging	*1 996*	*2 745*	*3 743*
Concentrate	*6 708*	*8 910*	*11 739*
Beneficiated Products	*2 975*	*7 793*	*16 850*
Subsistence Farming Productivity	*1 037*	*1 152*	*1 152*
Total Jobs	**18 025**	**30 441**	**51 593**
Dredging	*2 331*	*3 205*	*4 371*
Concentrate	*9 422*	*12 482*	*16 399*
Beneficiated Products	*5 235*	*13 602*	*29 671*
Subsistence Farming Productivity	*1 037*	*1 152*	*1 152*

Direct jobs in dredging and in the concentrate beneficiation were based on actual job numbers from business plans of NMP or LLNP and scaled up to represent the full industry as analysed. 275 personnel would be required for 4Mtpa of concentrate from 8.5Mtpa of dredged ore. This is scaled up pro-rata with the volume of concentrate produced, so that 7.5Mtpa of concentrate would need almost twice the number of people.

The disaggregation of direct jobs into those directly involved in the process and the first-round suppliers is only reported for dredging and concentrate beneficiation because these are the

only two processes where actual job numbers were provided in the presentations by NMP and LLNP.

The jobs of firms that supply goods and services for dredging and concentrate are also direct jobs. These were calculated in following way. First, total turnover was estimated. Second, from the Namibian SAM, the proportion of salaries and wages to turnover was estimated. From this it was possible to estimate total salaries. Third, average wages by sector were calculated from the Namibian Labour Force Survey (Namibian Statistical Agency, The Namibia Labour Force Survey 2016 Report, 2017, p. 50). These latter two values were then used to estimate direct jobs at firms suppling goods and services for dredging and the beneficiation of concentrate. An example of this is given in Table 20.

Table 20: Example of Direct Supplier Employment

Building Costs	NAD 13 000 000
% Turnover on Salaries & Wages	9%
Amount on Salaries & Wages	NAD 1 112 399
Average Annual Salary (2017)	NAD 52 332
Direct Jobs (Full Time Equivalents)	21.3
Direct Job Multiplier per N$1m	0.6
Indirect Job Multiplier per N$1m	2.4
Indirect Jobs	31.5
Total Jobs	**52.7**

The example in the table assumes N$13m is spent on building activities in the dredging process (in 2016 the industry would spend almost US$1m on building activities, which would equate to N$13m at an exchange rate of N$13 per US$):

- The building sector would increase its turnover by N$13m.
- According to the SAM, 9% of construction turnover is spent on salaries & wages (this proportion varies by industry). This amounts to N$1.1m out of the N$13m turnover.
- According to the 2016 Labour Force Survey the average monthly salary in the construction sector was N$4 361. This is an annual N$52 322.
- The N$1.1m salary bill can therefore sustain 21.3 full time equivalent jobs at the annual average salary of N$52 332.
- The direct job multiplier for expenditure in the construction industry is 0.6.

Indirect jobs are estimated using a similar approach, except that the average salary for Namibia is used rather than the average salary for each sector. This is done because indirect

jobs generated by a sector do not only occur in that sector but economy wide. Indirect job multipliers have been extracted from the SAM in a similar manner to those for GDP and are applied to the expenditure in each economic sector.

In the example above, the indirect job multiplier for the construction industry is 2.4. This means that the N$13m spent on construction activities would create a further 31.5 indirect jobs. Total jobs is the sum of the direct and indirect jobs and totals 52.7 full time equivalent jobs for this example.

7.5.5 Tax Estimates

Taxes are made up of direct and indirect taxes. Estimates of direct tax contributions were based on operating profit. Indirect taxes were based on tax multipliers extracted from the Namibian SAM. Total taxes are the sum of the direct and indirect taxes.

For direct taxes, the operating profit for each process and product is first calculated by subtracting the appropriate capital and operating costs from the potential revenue. Allowance is made for office overheads and the repayment of debt and the remaining amount is termed earnings before taxes. Direct taxes are then calculated as follows:

- A royalty fee of 2% is levied on the value of all phosphate rock dredged from the ocean floor and processed into phosphate concentrate (PWC, 2017, p. 5).

- A tax of 37.5% is levied on the earnings before tax for the mining (dredging) process and concentrate beneficiation and 32.0% for all other products (PWC, 2017, p. 4).

- It is assumed that all loans are provided from offshore and thus the repayment of the loan is treated as an outflow of money and a 10% withholding tax is levied on this repayment (PWC, 2017, p. 4).

- The earnings after the payment of royalties and taxes is termed earnings after taxes. This represents the retained earnings or profit to the industry. It has been assumed that 40% of these retained earnings are expatriated offshore, which therefore attracts a further 10% withholding tax on the repatriated amount. The remainder of the retained earnings stay in Namibia.

Indirect taxes are based on industry multipliers extracted from the Namibian SAM and include taxes because of the supply chain effect in the economy and induced taxes when employees spend their income. This process is like that described for the contribution to GDP and GVA.

7.5.6 Foreign Exchange Estimates

There are four components to foreign exchange estimates. On the positive side, foreign exchange is earned when product is exported offshore. Also on the positive side, foreign exchange is saved through import substitution. This occurs when fertilizers that would previously have been imported (mostly from South Africa) are now manufactured locally.

On the negative side, however, there are direct and indirect imports that would use foreign exchange. Direct imports relate to equipment and machinery that need to be brought into Namibia for the various concentration and beneficiation processes and particularly for fuel during operations. Direct imports would also include foreign factor payments such as loan repayments (on the interest portion of loans) and expatriated earnings (see the description in the previous section on the calculation of taxes regarding how expatriated earnings are calculated). Then there are the indirect imports that the suppliers to the phosphate industry incur and that also need to be included in the analysis.

The net forex position is therefore the sum of export earnings and import savings less direct and indirect imports.

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