Bachelor Thesis

Economic Development and Resource Boom in Southern Africa: Consequences for Port Developments in Mozambique

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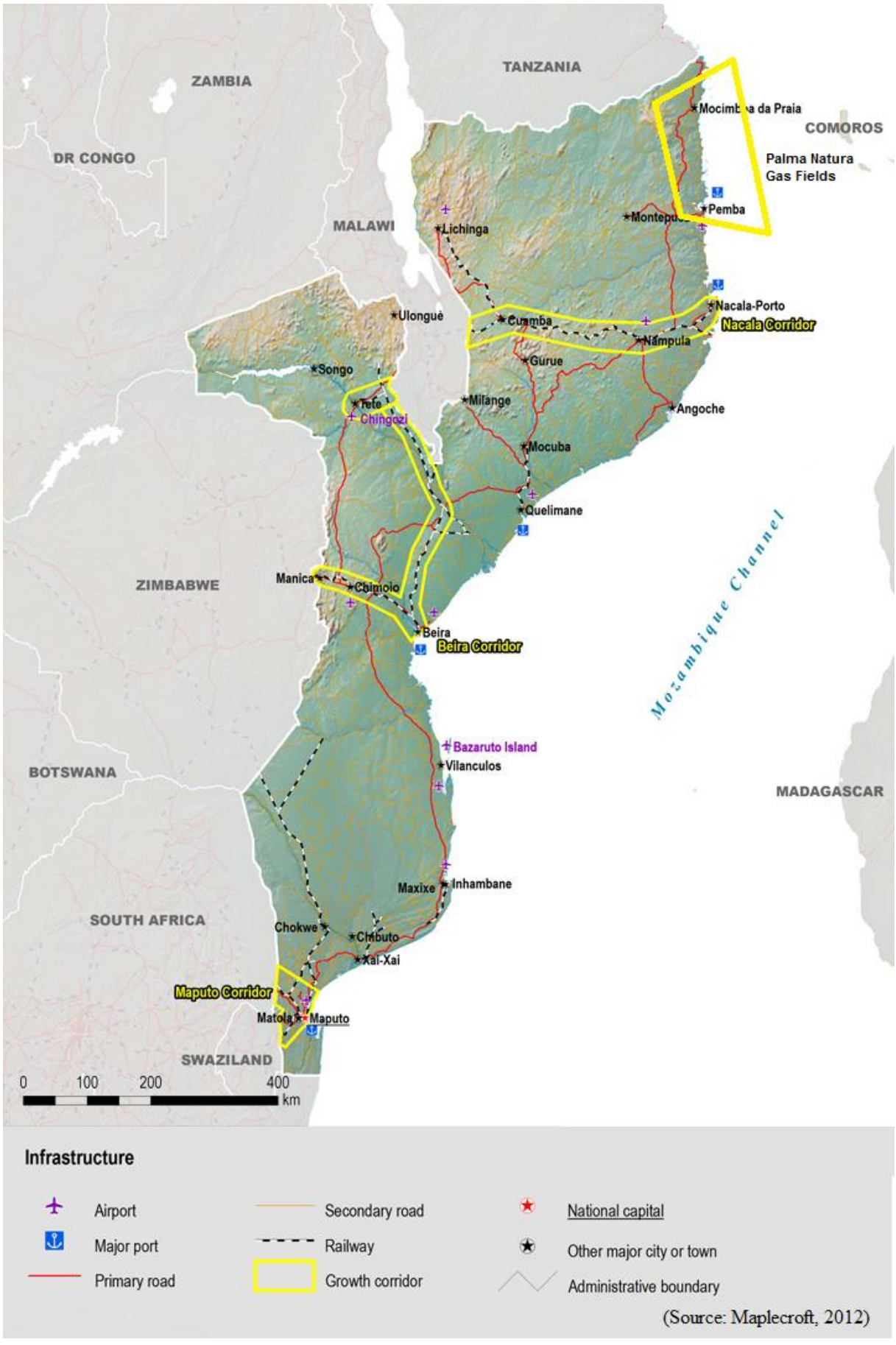
Map of Mozambique and its Transport Corridors, and neighboring Countries



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List of Abbreviations

AICD	Africa Infrastructure Country Diagnostic
BAGC	Beira Agricultural growth Corridor
CEAR	Malawi's Central East African Railway
CLIN	Northern Integrated Logistical Corridor
DWT	Dead weight tons
ENI	National Hydrocarbons Authority Italy
FDI	Foreign Direct Investment
FRELIMO	Front for the Liberation Army
GDP	Gross Domestic Product
GJ	Gigajoule
HDI	Human Development Index
JICA	Japanese aid agency
JSPL	Jindal Steel and Power Limited
LNG	Liquid Natural Gas
LPI	Logistics Performance Index
MDC	Maputo Development Corridor
mtpa	million tons per annum
NRCP	Nacala Road Corridor Project
PPPs	Public Private Partnerships
SADC	South African Development Community
SDCN	Northern Corridor Development Company
Tcf	trillion cubic feet
TEU	Twenty-foot equivalent units
TFR	Transnet Freight Rail
TSP	Transport Sector Master Plan
TTRI	Trade Tariff Restrictiveness Indiex
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
USD	United States Dollar

Chapter 1: Introduction

In an article published by the World Bank titled "Yes Africa Can: Success stories from a Dynamic Continent" Mozambique is one of the first countries that is mentioned as a positive example. In 1992, after an economically crippling Civil War it was one of the poorest countries in the world and second lowest on the Human Development Index. It still is one of the poorest countries in the world but economically a lot has changed in the last 20 years. It has become the fastest growing non-oil economy in Sub-Saharan Africa. The gross domestic product (GDP) growth rate from 1993 to 2010 has averaged 8 percent, and in a country report by the Economist Intelligence Unit (2012) it is forecasted to remain at the same level at least until 2015. This growth rate has mostly been backed by its political and macroeconomic stability. High levels of foreign direct investment, in particular the mining sector, have allowed for increase in output, consumption and export. In recent years, Mozambique has been blessed with promising discoveries of natural resources. Large fields of coal and natural gas have been discovered. Mozambique is developing an emerging role as one of the world's most important coal exporters, and it is on its way to become the first liquid natural gas supplier in Sub-Saharan Africa (Ford 2012). The future appears to be promising; however, the main challenge currently is to ensure that sufficient rail and port capacity is in place in order to ensure all exports can be handled.

1.1 Problem Definition

Underdeveloped ports and other transport infrastructure are major constraints to economic growth. The transport sector is vital because an economy cannot be productive, allocative and overall pareto efficient without an effective, well functioning transport sector (de Langen et al., 2010). Especially the importance of ports for a healthy economy has been understood. Even at a time where the global financial crisis in 2009 was at a high and almost every sector in every country was suffering, the African port sector was one of the few genuine examples of optimism, growth and new investment (Ford 2009). Ports are a vital part in a supply chain, but it would be wrong to assume that investments in such transport infrastructure alone would lead to economic growth.

The demand for ports and its services is derived from the demand for transport services and the demand for transport services depends on trade flows. Hence, ports do not influence the characteristics of demand but instead have to be able to adapt to changes in the port environment (de Langen et al., 2010). Such a port environmental change is, for example, the natural resource boom in Mozambique. Ultimately, the majority of its resources are planned to be exported through the ports available, and sold on the world market.

1.2 Research Question

This leads to the research question of this paper:

> *What are the consequences for Port Developments in Mozambique, in light of the current natural resource boom and strong economic developments?*

In order to provide an answer for this question it is the plan for this paper to describe and determine the factors that influence the port developments in Mozambique, using a theoretical framework developed from academia in the field of port development. By doing so, it is the goal to evaluate the transport infrastructure, with a special focus on maritime infrastructure, which is required in order to meet the export goals of the companies of the extractive industry.

The following sub-questions are formulated to help answer the research question:

- What is the current port infrastructure situation?
- What are the relevant factors that influence port developments in Mozambique?
- What is the expectation of the resource extraction industry on the ports of Mozambique and what quantities are they expected to be able to handle in the future?
- What are the (maritime) infrastructure developments required to bring Mozambican ports in line with future needs of the extractive industry?

In order to provide appropriate answers to these questions a framework developed from a research paper distributed by the *Erasmus University Centre for Contact Research and Business Support B.V.* is adapted according to this country specific case.

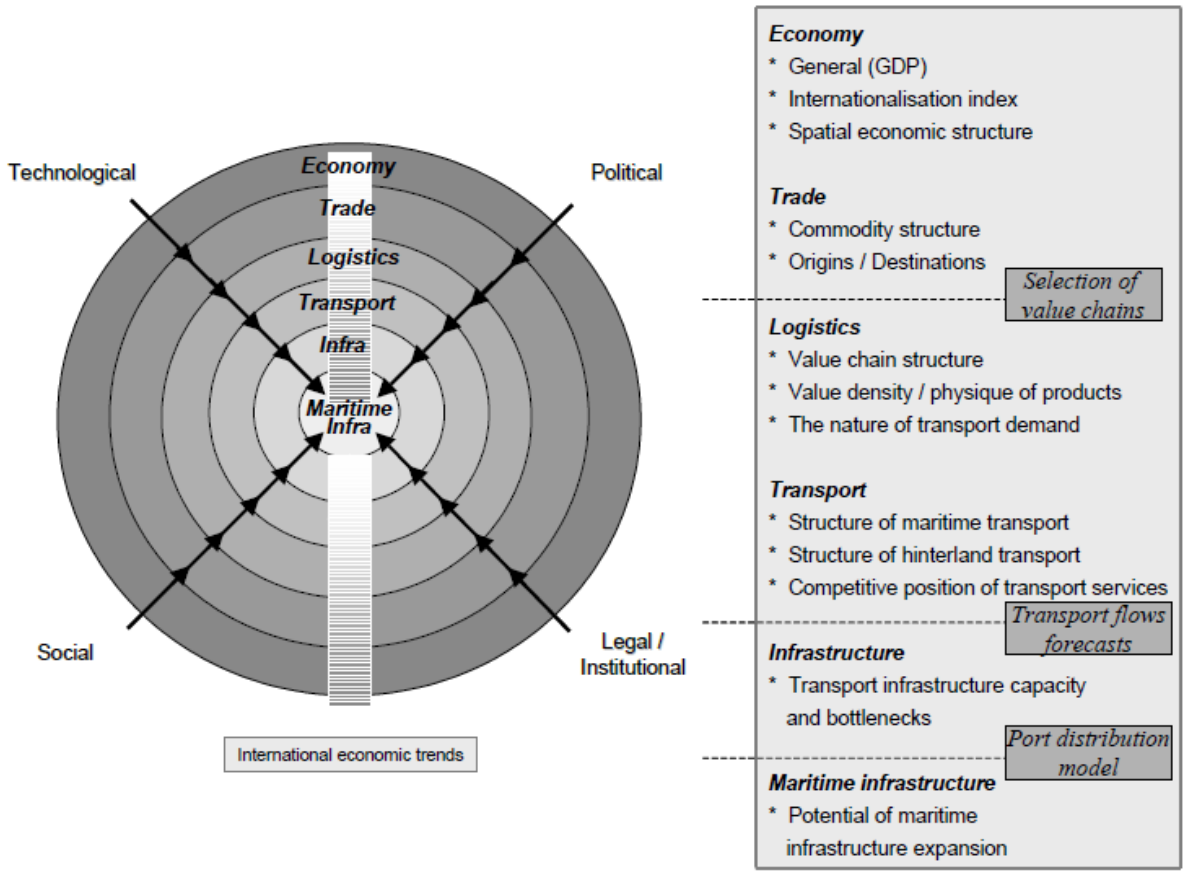
Chapter 2: Theoretical Background

In this chapter, the paper takes a look at an approach on how to analyze Mozambique's port infrastructure situation and the relevant factors that influence it. In addition, further literature is reviewed in order to review the factors that influence port development.

2.1: Framework to Analyze Maritime Infrastructural Needs

In a study for a dredging company by P. De Langen, L.M. van der Lugt and J. Eenhuizen (2000) analyzed all seaports in India to predict which one would become the largest and require the most dredging, so it would be the most profitable for the firm to invest in. A framework was created that would be appropriate to analyze maritime infrastructural needs. The objective was to figure out the major determinants of growth for port developments. The resulting framework that has been established consists of six layers of influence on port development. A graphical representation can be seen in the Figure 2.1 below:

Figure 2.1: Framework for analyzing maritime infrastructural needs



(source: de Langen et al., 2000)

In this model an outer layer influences the layer that lies below, where at its core lies maritime infrastructure. In addition, there are four factors that are considered non-economical that are handled exogenously: technology, political, social and institutional. All these factors are influenced by international economic trends such as usage of ICT systems, environmental friendly entrepreneurship and effective supply chain management (de Langen at al., 2000).

Layer one is the outermost layer of the framework and its purpose is to provide the economic setting a country finds itself in. The focus is how well the economy is performing, in order to make predictions of future trade flows. Economic indicators such as GDP developments, general economic structure, and industrial specializations are important components in such analysis. These significantly affect port activity, and thus are major determinants in port development (de Langen et al.). In countries with a low internal capital stock foreign direct investment (FDI) becomes crucial for investment

levels, also in infrastructure. Therefore, additionally to the framework provided by de Langen et al. this paper outlines FDI levels for Mozambique in recent history are outlined.

Layer Two discusses the trade of a country, specifically in goods and commodities that exit and enter the country. If the trade flow is large and is composed of goods that are sustainably demanded in the future, it is probable that demand for transport and hence port infrastructure and services is going to rise as well. Commodity structure is a vital part in this analysis, as this outlines the type of goods and commodities Mozambique exports and imports as well as to what extent it is an important transit destination for goods and/ or commodities. The composition of goods and commodities traded help to identify the position in the value chain. Also it is important to identify the origins and destinations of goods and commodities traded, as trade with stable or growing economies ensures a stable flow. Furthermore, import and export flows of a country are also heavily influenced by policies regarding the openness to trade of a country. Openness, in this case, refers to what extent trade barriers or trade agreements employed by the governments affect the trade flows of a country. The World Bank has developed a number of indicators that help to assess the openness to trade of a country, the ones most relevant to this study are the indicators pertaining to the ease of doing business, the logistics performance index (LPI), and the trade tariff restrictiveness index (TTRI).

Layer three covers the topic of logistics and focuses on the selection and positioning of a given port in a value chain. Such value chain analysis provides insight the types of commodities being transported and evaluates the origins and destination patterns of the trade flows of the key industries of the country. In order to determine the position of an industry within the value chain one has to take a look at given data on trade flow composition as well as the origin and destination of transported goods. The export position improves the higher up it finds itself in the value chain, as this adds value to exported goods and services (de Langen et al., 2000)

Layer four is titled the transport layer and serves to describe the transport demand generated based upon position in the value chain. The transport flows generated from the value chain and the modal split of a country could be used to create

forecasts of transport flows. The modal split determines the competitive position of ships as a transport node (de Langen et al., 2000).

Finally, the last two layers are closely linked as they cover maritime and transport infrastructure. They describe the physical infrastructure requirements relevant to the field of transport. When ports expand and build new facilities or replace old infrastructure, it is considered as port growth. These layers are influenced heavily by all the other layers, as port authorities should be able to see the development of the port according to their forecasts. So called bottlenecks, that hinder or slow the entire transport process should be taken care of through improvements of infrastructure. Examples of such bottlenecks would be: overutilization of infrastructure, mismatch between supply and demand and quality of the infrastructure towards the hinterland (de Langen et al., 2000).

2.2: Review of Further Literature

De Langen et al. (2000) developed a framework that aids the structure of analysis for this paper; however, it is not the only publication that is drawn upon. There has been quite an extensive amount of research that has been done, to answer the question of what makes ports grow. This section serves to outline further research that aides the development of this framework for port development analysis and that has a particular relevance for a developing country such as Mozambique.

Relationships between patterns of social activity, economic progress and transport have long been recognized. Taaffe et al. (1963) is a particular early work that links economic development with an expansion in transportation infrastructure. A paper by Bryan et al. (2006) empirically underlines such sentiment where the economic significance of port activity in South Wales is assessed. Taaffe et al. describe this expansion to be an irregular or sporadic process influenced by many specific economical, social or political forces. As Rodrigue (2008) points out: the real matter behind potential future traffic growth, and through that port expansion, remain macroeconomic factors that tend to be overlooked. He further underlines that transportation is after all mainly a ‘derived demand’. Transportation thus is an activity

which is dependent on other activities; an auxiliary function much like a service (Rodrigue, 2006).

In a paper written in 1981, Yehuda Hayut composed a case study on North American container ports were he outlines a phase model that shows the dynamic development of container ports and provides the reasoning to why growth occurs. In Hayut's case, this change is a technological shift to containerized cargo processing. A major factor that is identified which helped ports grow larger than its competitors is early adoption. Hayut states that the container traffic concentrates at the ports that were the earliest adopters of the system and in the end this initial advantage helped ports grow rapidly. However, for this paper the most important observation made are the factors that he considers lead to the development of a load center port: large scale local markets, high accessibility to inland markets, advantageous sites and location, early adoption of innovative logistics systems, and aggressiveness of port management. Hayut makes sure to mention that the importance of each factor is unique to every port, to some one factor is more important than to another. In Mozambique, it is important for the ports to follow the modern port standards and have the technology in place to handle planned exports for the extractive industries. Nowadays, facilities for containerization are in place but early adoption of technologies for an efficient supply chain to load coal or liquid national gas onto ships in the ports are vital. For further growth of the ports in Mozambique, local markets should increase production suitable for export, accessibility to the hinterland and inland has to be improved and the location of the ports and their strategic advantages have to be analyzed. This is what is drawn from Hayut's study and applied to the case of this paper, which also follows the initially mentioned framework.

Similarly, Loo and Book (2001) identified the growing importance of the railway connection of ports further inland as a major factor in the 1990s for the growth of ports in Europe. Pedersen (2003) summarizes such an importance for a developing country stating that 'a process of selection takes place, where some of the ports loose out and others win depending on the ease of access to resources in the hinterland and increasingly on the investments in railway or road corridors linking the ports with their hinterlands.' The situation in Mozambique should be analyzed accordingly.

Furthermore, Tongzon (1994) performed a study that elaborated on factors influencing port performance. Tongzon uses the number of containers that are moved through a port (throughput) as a measure of port performance, given that ports maximize throughput. A major reason for port expansion is to be able to handle a greater number of throughputs. Tongzon identifies five determinants of throughput. Geographical location of a port, and economic activity are similarly identified by Hayut. The other determinants are frequency of ship calls, port charges, and terminal efficiency measured in terms of the number of containers loaded and unloaded per berth hour. Any inefficiency in any one of the latter determinants can become a constraining factor but as Rodrigue (2008) clarifies that solving such inefficiencies are an issue of engineering (e.g. equipment), operations research, and management.

Pettit and Beresford (2009) point out that the common thread that linked the concepts of port development since the 1960s, occurred in the 1990s when the United Nations Conference on Trade and Development (UNCTAD) highlighted the development of the commercial function and promotion of the port area and of the port as a service center. UNCTAD model provided a framework where ports can be classified into a 'generation' according to the stage of development the port found itself in. However, Beresford et al. (2006) described this classification process as too simplistic, and argued that port development is not fixed in time and ports do not go through a development cycle. An alternative, so called WORKPORT model, was created which elaborated on UNCTAD's model, showing that change in port functions and development processes followed an evolutionary rather than revolutionary process. This means that ports develop according to individual determinants and Beresford et al. (2004) further point out that the ability of port companies to provide tailor made services has become fundamental to overall effectiveness of a port within a supply chain.

Chapter 3: Application of the Framework to Mozambique

In the previous section of this paper, a framework was introduced and described that allows for the analysis on how ports grow by identifying basic determinants that develop the ports. These determinants were picked out by reviewing academic papers written in the field of research for port development. However, as can be seen there are countless of factors that in some way or another help in the expansion and development of ports in a country. However, every country has a unique set of variables and especially ports in developing countries such as Mozambique are at very different stages of development. It is beyond the scope of this paper to analyze every single variable. The focus remains on what the effect of the resource boom will have on the major port of Mozambique. This paper follows the general framework working itself from layer to layer evaluating the determinants deemed most appropriate in order to be able to provide an answer to the questions regarding: the resource boom and how it affects the ports, and general port developments.

3.1: Layer One: Economy

The first outer layer will address the economic developments Mozambique has been making as a whole. By doing so, a good representation of the economic situation Mozambique currently finds itself in is provided. The future economic outlook as well plays a vital role. The focus of this part is to highlight the economic factors that potentially influence future developments of Mozambique's ports. Determinants that are most interesting are for example: recent GDP developments, economic demographics, and the extent of foreign direct investment. Information for this part of the paper is drawn from country reports issued by organizations such as the World Bank, the African Development bank and the United Nations. Also, the resource endowment situation is to be explained using recent information from the Africa Infrastructure Country Diagnostic (AICD) and information provided by firms involved in resource extraction, who have studied Mozambique's potential.

Mozambique's Economic Situation

Mozambique was a Portuguese colony but gained independence in 1975. Portuguese influences helped the country tremendously in developing transport infrastructure such as ports, railways, and roads. Besides agriculture Mozambique's economy was mainly a transport economy serving the hinterland. Even a tramline for public transport in the capital Maputo was in place, which is something that is rarely found in Africa. However, most of these developments could not be maintained or were destroyed after its independence through large scale emigration, a civil war that lasted from 1977 to 1992, and overall mismanagements by the socialist regime that came to power after independence. In 1987, Mozambique started to implement macroeconomic reforms to stabilize the economy. Coupled with development aid and multi-party elections in 1994, the country has experienced strong economic growth. This is underlined by data on annual gross domestic product growth provided through the World Bank database, which shows an annual GDP growth of 7.3 percent per annum from 1994 to 2011. This makes it the 7th fastest growing economy in Africa, and the fastest in Sub-Saharan Africa. Nevertheless, Mozambique still ranks poorly on the Human Development Index (HDI) compiled by the UN Development Programme. At 184th place it ranks as fourth lowest in the world, serving as a reminder that it is one of the poorest countries in the world. Such low score is due to the range of indicators that are used to compile it, which include life expectancy, years of schooling and per capita income. This weak ranking in the index is counter intuitive to the country's high rate of economic growth, documented reduction in poverty and heavy investments in social services. It underlines that improvement in social indicators, such as life expectancy or literacy, is lagging behind the substantial investments made in other sectors. These social factors have directly little to do with the development of the countries ports; they are just to serve a reminder given the positive economic developments in recent years. Although an argument can be made that improvements in HDI lead to a population that has the means to purchase imported goods, which leads a bigger market which benefits the development of ports towards becoming a load center though the principles of derived demand.

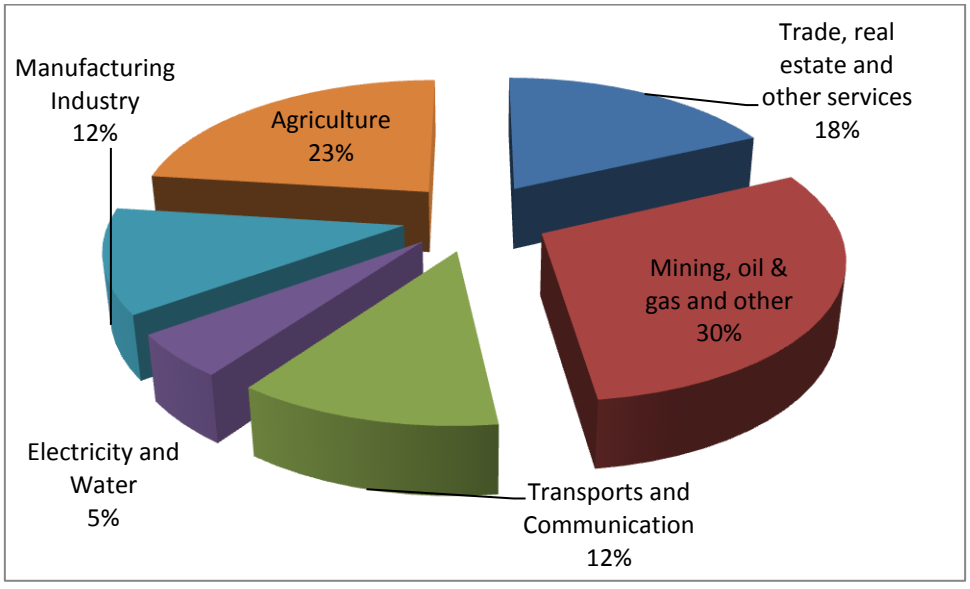
An important factor for any country that is going through major developments, especially in Africa which has historically been ridden with civil wars and oppressive

dictatorships, is political stability. A stable and trustworthy government that promotes economic development is essential for sustainable business. Mozambique's government is titled as a Republic, governed by the ruling party called the Front for the Liberation of Mozambique (FRELIMO). It has been in power since independence and according to the Economist Intelligence Unit the next national and presidential elections in 2014 FRELIMO is predicted to win comfortably. Politically, Mozambique is regarded stable. However, the report states that the main risks to political stability are spikes in consumer price inflation or a row between FRELIMO and an opposition party, as the legitimacy of elections is being and will be contested.

GDP Developments

According to the Economist Intelligence Unit, real GDP growth is to remain at an average of 8 percent per year on the back of increasing FDI inflows. Coal mining in particular, including new transport infrastructure, will drive high rates of growth.

Figure 3.1: Contribution of Selected Sectors to Mozambique's GDP, 2011



(Source: Bank of Mozambique, 2011)

In the figure above the GDP structure is divided up into six sectors and it is shown what percent each sector make up of Mozambique's GDP. Agriculture, mining and, increasingly, the oil & gas industry are the foundation of the economy as they account

for over 50 percent of the country's GDP. Much of this is exported; hence the significance of the transportation and communications sector (11.7percent), as well as trade related services (around 18percent) (UNCTAD, 2013). Mozambique's traditional sectors such as agriculture, industry and services are also predicted to grow. Agriculture will benefit from investment in commercial cash crops, and growth in the traditional smallholder sector, resulting from investment in infrastructure and efforts to raise the low rate of agricultural productivity. Transport, communications, tourism, industry and financial services will maintain strong growth (Economist Intelligence Unit, 2012).

FDI Levels

An indicator that is to show that Mozambique is considered stable, is the consistently increasing inflow of foreign direct investment. In the last recorded data from the World Bank database, FDI inflows comprised 8.23 percent of GDP. This underlines that foreign investors trust in Mozambique's political stability. Furthermore Vala (2010) summarizes that Mozambique attracts such FDI inflows because of the presence of a national, regional and international market, the availability of natural and human resources, and clearly defined macroeconomic policies that have contributed to the promising economic growth in recent years.

Foreign direct investments were an essential factor contributing to Mozambique's economic growth. These were large scale investments in the industrial sector and extractive industries which are known as 'mega-projects'[1]. Particularly Mozal, a $500 million aluminum smelter-mega project was responsible for a dramatic increase in FDI inflows in the late 1990s and again in the early 2000s during a $400 million expansion phase (UNCTAD, 2012). Mozal raised the countries profile as an investment destination and helped drive subsequent investments. Since 2007, Mozambique is experiencing a third wave of mega project investments related to coal and titanium mining projects. The Bank of Mozambique state in their Annual Review

[1]A 'mega-project is legally defined as any investment exceeding 500 million USD, regardless of economic activity. However, thus far 'mega-projects' have been only in heavy industry and extractives with the exception of two projects under development in forestry and paper pulp mills. Under common usage the term mega-project; however, can also refer to other large projects.

(2011) that the beginning of the coal mining process in Tete province increased inward FDI levels to a record of 2.1 billion USD.

Brazil, South Africa, and Mauritius account for the bulk of FDI flows to Mozambique with shares of 20 percent, 21 percent and 17 percent of total inflows in 2004-2009, respectively. Brazilian companies have invested heavily in mining, most notably in the Moatize coal mine mega-project in Tete province. Besides investing in a 170 million USD coal-processing plant, Vale has pledged an additional 130 million USD to upgrade the rail link to Beira and build a dedicated coal export terminal at the port. (UNCTAD, 2012). South Africa has historically been one of the first and key source of FDI with a well-diversified portfolio in Mozambique. South African firms have large stakes in a number of mega-projects, such as Mozal. But also are involved in smaller scale projects in various business sectors, especially in tourism and agribusinesses. Such a large share of FDI inflows stem from Mauritius as third parties invest through the country to take advantage of the bilateral investment treat (BIT) and double taxation treaty with Mozambique, mainly in agribusiness in sugar.

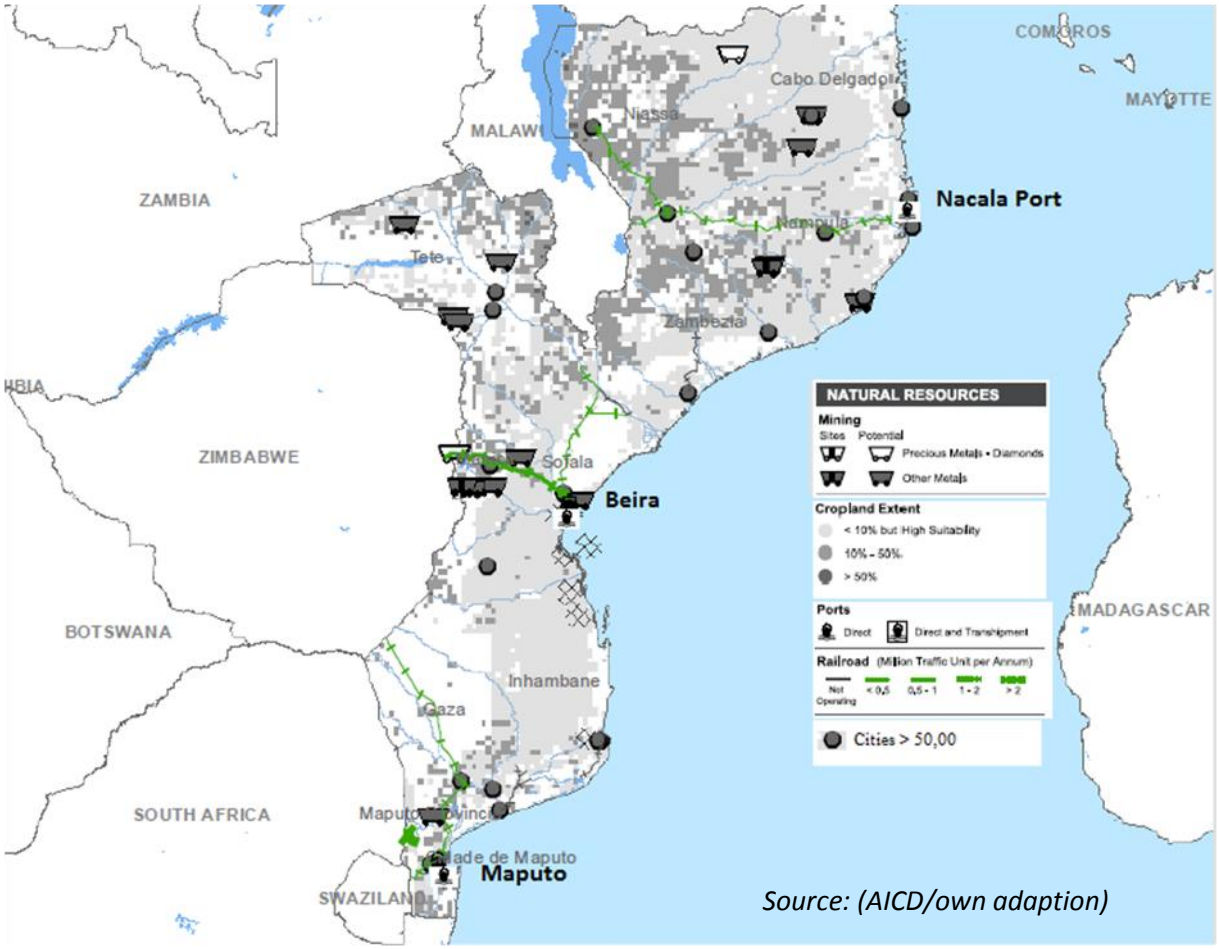
Other important investors were Switzerland with investments in food processing and pharmaceuticals, the Netherlands in cargo port management and Portugal in banking and other services.

Spatial Economic Structure

Mozambique is located on the east coast of Southern Africa, bordering Tanzania, Zimbabwe, Malawi, Zambia and South Africa. The total area of the country is approximately 802,000 square kilometers, making it a relatively vast country with a population of roughly 23.9 million people. The country is characterized by the sharp contrast between the north and the south, defined by the geographic division posed by the Zambezi River. The topography in the north consists of hills, low plateaus, and rugged highlands while the south mainly consists of lowlands. Demographically, the north has a very spatially dispersed population, whereas in the south the population is clustered around the major urban areas and transportation networks. This can be observed in figure 3.2. Economically, the northern region is predominantly agricultural

and hosts the production of the majority of export crops, while the southern region is characterized by manufacturing activities and the center by mining.

Figure 3.2: Infrastructure networks align with population density and natural resource concentration



Source: (AICD/own adaption)

Furthermore, in Figure 3.2 it can be seen that the three major ports in Maputo, Beira and Nacala are aligned with population density, as well as the natural resource concentration.

Historically, the Mozambican economy was mainly a service economy for the neighboring countries. The port hinterlands are connected through four clear railroad corridors outlined by the green lines: (i) Maputo to Gauteng in South Africa (also connecting with Zimbabwe and Swaziland through the railways branches), (ii) the Machipanda line connecting Beira to Zimbabwe, iii) the Beira to Tete (Moatize), and (iv) the Nacala to Malawi line. These transport infrastructures are primarily developed transversally going from west to east, connecting mining and agricultural clusters in

Mozambique and in neighboring countries to exit ports. In the regional context Mozambique's relevance is striking as in terms of transport, the areas around Beira, Zambezi Valley, Nacala, and Limpopo are covered by railroad corridors. There lies a vast economic potential as these corridor provide the closest access to the sea ports of Beira, Maputo and Nacala for the land locked neighbors Zimbabwe, Zambia and Malawi as well as for South Africa.

Since 1992 the spatial economic structure is in a dramatic change which can be best summarized with the terms "mega projects" and "resource boom". The following chapter describes this change and its consequences for the spatial economic structure.

Mega Projects and Resource Endowment Situation

Mozambique is not a traditional mining land but since 1992 it experiences a drastic increase of exploration activity, and begins to benefit from huge investments and exports from minerals and coal. The developments of the recent decade, production of aluminum (at Mozal smelter of imported raw material) and natural gas in the south and the center of Mozambique the development of world-class coal and heavy mineral sand deposits and the discovery of huge natural gas resources show that the structure of Mozambique's economy is gradually, but radically, changing. In total there are mining projects with investments of 11.5 billion USD, of which 7.1 billion USD alone are allocated to the mining of coal (MMEC, 2012). The largest share of investments has been done by two of the biggest mining companies in the world, the Brazilian Vale and the British-Australian Rio Tinto. Their investments lie mainly in coal mining, which also includes investments in the infrastructure requirements for its extraction. In addition huge potential for Mozambique's future stems from the discovery of massive natural gas reserves off the coast, called the Rovuma Basin, in the North of Mozambique. Anadarko, an American oil and gas exploration and production company, made verified discoveries of natural gas reserves that would place Mozambique to have the second biggest natural gas reserves of any country in Sub-Saharan Africa (Ford, 2012). Also, it is the sole exporter of natural gas on the east coast of Africa.

The last decade, Mozambique export revenues were largely due to two so called 'mega-projects'. The largest export revenues come from the aluminum smelter Mozal, and to date it still is the biggest exporter. The second largest exports stem from the Cahora Bassa Dam, were hydroelectric energy is exported to South Africa. However, Mozambique is expected to have massive growth of export revenues over the next decade in coal, natural gas and mineral sands. Predictably they will generate significantly higher export revenues. The country geology is diverse and vastly underexplored so far, so other export possibilities lie in gold, bauxite, beryllium, tantalite, copper, lead and uranium (Biggs, 2012).

Table 3.1: Current Resource Projects

Company/ Project	Sector	Location	Capacity/Reserves	Production
1. Anadarko Eni Statoil Petronas	Natural Gas	Rovuma Basin	Anadarko and Eni to discovery of 57 -70 TCF of gas discovered offshore	2018
2. JSPL	Coal	Changara, Tete	10 million tons per year	2012-2016
3. Corridor Sands	Heavy Sands	Chibuto, Gaza Province	looking for new investor, requires investment in electricity	n.a.

Table 3.2: Resource Projects Considered for Future

Company/ Project	Sector	Location	Capacity/Reserves	Production
1. Sasol/ENH 50percent expansion	Natural Gas	Pande, Temane gas fields, Inhambane	154 GJ 231 GJ	2004 2011-16
2. Kenmare	Heavy Sands	Moma, Nampula	900,000 to 1,3 million tons per year ramp up to	2007
4. Vale	Coal (Thermal and Coking coal	Moatize, Tete	Capacity (0,6million tons shipped in 2011, goal is 22m tons in 2014	2012
4. Rio Tinto/ Riverdale	Coal (Thermal and Coking coal)	Benga, Tete	Total Capacity, Benga 10 m tons, adjacent Zambezi 25 m, Tete East 10 m	2012

The tables 3.1 and 3.2 above summarize the current projects and potential future projects in the coal, natural gas, and mineral sand sector. The Moatize coal basin located in Tete province is measured to represent the world's largest untapped coal reserve with an estimated 6 billion tons (Biggs, 2012). The Moatize basin is also said to possibly contain the last big coking coal mine in the world. Adding Moatize together with other coal discoveries made—total coal reserves in Mozambique are estimated to be approximately 25 billion tons. The discoveries of natural gas off the northern Mozambican coast, is another source of potential future monetary wealth. The discoveries of Anadarko and ENI[2] in the Rovuma Basin place Mozambique in the top level of countries in the world with large natural gas reserves. Based on existing discoveries, Mozambique has proven to have probable reserves that range between 57 and 70 trillion cubic feet (tcf) of gas. Seismic information of current discovery areas suggests that there could be more than 120 tcf of possible reserves (Biggs, 2012).

3.2: Layer Two: Trade

The second layer concentrates on the size, value and composition of trade flows. This is done in order to forecast the possible future demand for port infrastructure in Mozambique. Additionally, the expected developments in the natural gas sector will be considered. Natural gas exports will require other infrastructure and port facilities than the existing ones. Also, the influence of the resource endowment situation, elaborated on in layer one, on the trade volumes and structure of Mozambique will be dealt with. Trade flows and types of commodities each port handles are to be outlined. Specifically, the factors researched are: trade flow size and value, export origins and destinations of trade flows, and openness which includes trade policies and trade barriers.

Mozambique has exported goods and commodities valuing 3,489 million USD and imported goods and commodities worth 6,176 million USD in 2012. This is a considerable growth from 2008, where the country exported goods worth 2,653 million

[2] ENI has meanwhile sold its exploration rights to China. Currently exploration rights of natural gas in the Rovuma Basin are heavily under negations between the government and multinational companies.

USD and imported goods worth 3,643 million USD. For the years 2013 to 2017 annual average growth rates for exports of goods and commodities of 6.9 percent and for imports of 8.7 percent are estimated by the Economist Intelligence Unit based on UNCTAD data.

The structure of exports of goods and commodities changed drastically from 2000 to 2010. In 2000 exports accumulated to 364 million USD only of which 43 percent were attributed to food items (mainly fish and crustaceans), 11 percent were agricultural raw materials, 21 percent electricity and gas exports, and 17 percent ores and metals. By 2010 exports accumulated to 3,000 million USD[3] and its composition was: 16 percent food items, 4 percent agricultural raw materials, 20 percent electricity and natural gas, and 54 percent ores and metals (mainly aluminum from the Mozal smelters). This already shows the impact of the first mega project Mozal to the trade structure.

Until 2010, coal did not play an important role in Mozambique's export structure with coal exports of 12 million USD only; however, this changed from 2011 onwards when coal exports already reached a value of 66 million USD. Further changes are expected and are already happening. Coal is Mozambique's second largest source of export revenue since mid-2012 and will top aluminum by 2015 (Economist Intelligence Unit, 2013). Coal export volumes are expected to grow from 4.4 million tons in 2013 to 19.5 million tons in 2017. In fact they will quadruple in just four years, assuming an upward trend in coal prices, export receipts from the commodity will reach 3.1 billion USD that year. Nonetheless, this will remain far below the sector's potential, owing to infrastructure constraints. These constraints will be dealt with in this paper under layers five and six. Exports of aluminum, as shown above, will remain at an average of 1.2 billion USD a year in 2013-2017.

Mozambique currently only exports gas through a cross-border pipeline to South Africa. The Mozambique draft Natural Gas Master Plan, published in August 2012, states that Mozambique could earn up to 5.2 billion USD per year from LNG exports by 2026. As a comparison the total GDP of Mozambique in 2012 was estimated to be 14.7 billion USD. The key to make these exports possible is the transformation of natural gas into liquid natural gas (LNG) in order to reach the main export markets overseas. This

[3] According to UNCTAD database

requires substantial investments in LNG plants and related export infrastructure. According to the study "East Africa Exports: Potential for Gas Exports" by Ledesma (2013) it is very likely that Mozambique will start LNG exports by 2020 only. Therefore it is rather unlikely that as envisaged in the Mozambique Gas Master Plan, already ten LNG plants will be in operation by 2028. The study concludes that Mozambique could reasonable expect to export 30-40 million tons of LNG per annum (mtpa) by 2028, which would represent the enormous share of 8-10 percent of global LNG supply. However, it requires as one of the most important pre-conditions huge infrastructure investments also in adequate maritime infrastructure.

The structure of imports of goods and commodities did not experience drastic changes until 2010. Among the top ten of imports in 2010 were machinery and transport equipment which accounted for 26 percent of imported goods, minerals fuels, lubricants and related materials represented 20 percent of imported goods. Other major commodity groups included commodities and transactions not classified elsewhere and manufactured goods respectively with 17.3 and 12.6 percent of imports in 2010. Top import goods between 2008 and 2010 were petroleum oils, motor vehicles, as well as electrical energy. In line with the latest statistics from Mozambican Central Bank, which now fully incorporates activity from the coal and offshore gas sector, forecasts for future imports were raised for 2012 onwards. Goods import volumes increased strongly in 2012 and will rise further throughout 2013-2017, driven by the equipment needs of gas and mining companies, rising from an estimated 6.8 billion USD in 2013 to 11.2 billion USD in 2017 (Economist Intelligence Unit, 2013).

According to EUROSTAT statistics for the year 2011, main trade partners with Mozambique are the European Union member countries (27 member countries), but mainly the Netherlands, which accounts for 46.9 percent exports. The second biggest share of exports is attributed to geographic neighbor South Africa with 28.7 percent. The emerging economies of China and India receive 6.6 percent and 3.2 percent of Mozambique's total export value. Fifth largest export destination is landlocked neighbor Zimbabwe, which accounts for 2.3 percent. In total, these 5 countries are the end destinations of 87.7 percent of Mozambican exports. The remaining shares of exports are dispersed among countries globally.

3.2.1 Openness and Competitiveness

The economic and political openness of an economy as well as the conditions for the development of private businesses as the main drivers for trade volumes can be measured by applying the World Trade Indicators. For the purpose of this paper the market access tariff trade restrictiveness index (MA-TTRI), the logistics performance index (LPI) and the Ease of Doing Business Indicator will be applied to show Mozambique's comparative position in the World and in Sub-Saharan Africa[4]. Regarding the MA-TTRI Mozambique does extremely well and shows for the period of 2006 to 2009 a tariff of 0.82 (compared to a world average of 7.17 and 11.42 for Sub-Saharan Africa). The LPI shows Mozambique with 2.29 for the same period slightly below the Sub-Saharan average of 2.43 and well below the world average of 2.81. Though this is a mixed picture it can be concluded that the the MA-TTRI even provides some room for tariff increases without jeopardizing trade volumes if they go hand in hand with an increased port efficiency. The LPI should be improved but even the existing level will not hamper trade development and hence investments in transport infrastructure including ports.

In addition, the "Doing your Business" ranking provided by the World Bank is another indicator to measure how well private businesses can do in a country. This provides an indication on the question how a country will develop its economy in the future through an enabling environment for the private sector. The consequences for trade volumes and transport infrastructure needs are obvious. At a first look, Mozambique is not doing exceptionally well in the Doing your Business ranking with rank 146 out of 185 ranked economies in the world. Taking the perspective of Sub-Sahara Africa Mozambique is ranked 20 amongst 46 countries. A second look at the sub-indicators provides a slightly more positive picture. Under the framework of large FDI inflows and big export oriented megaprojects in the mining and gas sector the sub-

[4] The MA-TTRI measure the equivalent uniform tariff of trading partners facing the exporter country. It is weighted by import values and import demand elasticities of trading partners and is expressed as a tariff rate. The lower the value the higher is the market access to the rest of the world. This indicator is a good proxy for trade openness as a country can only influence this rate through multi-and bi-lateral initiative to reduce barriers through trade agreements. The LPI intends to reflect the overall perception of a country's logistics environment based on efficiency of the customs clearing process, quality of transport-related infrastructure, ease of arranging competitively prices shipments and timeliness of shipments**.** The index ranges from 1 to 5, the higher score representing a better performance. The ease of doing business indicator shows the development conditions for private business created by respective government policies.

indicators "Protecting Investors" and "Trading across Borders" have a high relevance. Here Mozambique ranks 5 and 16 respectively in Sub-Saharan Africa. Therefore development conditions for the companies in the extractive industry and bigger investments along the natural resources value chain, including port infrastructure are not ideal but also not prohibitive.

Mozambique has always been an important transit country and provider of transport services for its neighboring countries. Mozambique's geography, particularly its extensive coast line, makes it strategically located as a potential transport and logistics hub for Southern Africa. According to UNCTAD Investment Policy Review (2012) with the right transport infrastructure in place, Mozambique's ports could increasingly serve as the primary channels for the trans-continental trade of neighboring landlocked countries. The demand for maritime transport has increased as the size of the trade of these countries has more than doubled over the past decade. Specifically, the combined extra-regional trade of Botswana, Malawi, Swaziland, Zambia and Zimbabwe went from 13 billion USD in 1999 to 27 billion USD in 2008. Mozambique is well positioned to absorb most of this growth in trade flows through transshipment services if it can upgrade its capacity to handle cargo efficiently from inland road and rail connections to ports. However, these trade flows will not be the focus of this study as the research question concentrates on the port developments with a particular regard to the resource endowment situation.

3.3: Layer Three: Logistics

This layer focuses on the selection of and position in value chains. Again this will largely depend on the types of commodities the port deals with.

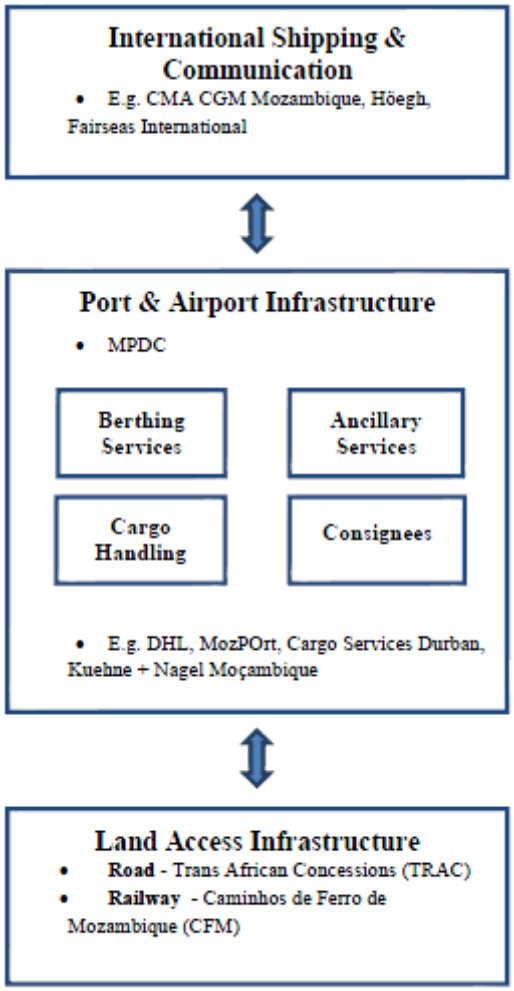
Mozambique has three major ports: Maputo, Beira, and Nacala. These ports are the exit points of the three major transport corridors. They are responsible for 96.2 percent of all cargo handled in Mozambican ports (CFM, 2011). All current developments and strategic plans predict that these transport corridors will remain the main transport channels of Mozambique. Additionally, the expected developments in the natural gas sector will be considered. Natural gas exports, particularly the export of liquid natural gas will require other infrastructure and port facilities than the existing

ones. This layer about logistics will thus concentrate on the value chains affecting those 3 ports (plus future LNG export facilities) and on the positioning of the ports in these value chains. Based on the findings presented in the trade layer on the exports and imports of Mozambique the resulting commodity structure for exports, imports and cargo in transit from neighboring countries to be handled by the ports will be shown. To show the consequences for the ports from the resource endowment situation in Mozambique the relevant value chains related to the mega projects and the exploitation of natural resources will be in the focus of this layer.

3.3.1 Maputo Development Corridor and the Logistics value chain

The Maputo Development Corridor (MDC) connects Mozambique with the economically most dynamic regions of South Africa, Swaziland and southern Zimbabwe, with the port of Maputo as its ending point. The MDC has received considerable investments along the logistic value chain. Therefore the story of the logistics value chain in the MDC is the story of infrastructure investments. In a logistics specific sector investment strategy and action paper prepared and published by UNCTAD in 2013 the investments into the logistics sector in South Mozambique were analyzed. The biggest operator of Maputo port, the Maputo Port Development Company (see figure 3.3) has shown on its website historic, current and future investments. These investments are all along concrete value and supply chains, its success also depend from other elements in the supply chain but they are key for the delivery of the respective goods and commodities. The investments will be dealt with under layer five and 6 on (maritime) infrastructure but the relevant goods and commodities are part of this layer on logistics.

Figure 3.3: The logistics value chain as applied to the Maputo Development Corridor



Source: (UNCTAD, 2013)

The country's trade as a ratio of GDP has risen from a little over 50 percent in the year 2000 to approaching 100 percent. According to UNCTAD (2013) this indicator directly reflects the principle goal of the logistics value chain, which is to generate business activity and trade in the country, region and beyond. The high ratio is also a result of MDC's effort of linking the African hinterland to international markets. For Maputo Port, 65 percent of all cargo is cargo in transit from neighboring countries (90 percent South Africa, 8 percent Swaziland and 2 percent Zimbabwe). The massive increase in trade volume following the establishment of the MDC and rising investment since the 2000s can also be seen in the 260 percent increase in cargo tonnage at the port between 2003 and 2010 (table 3.3).

Table 3.3: Maputo Port: Volume growth in cargo tonnages, 2003, 2010-2013.

Year	2003	2010	2011	2012	2013 (estimate)
Mil. Tons	5	10	12	15	17

(Source: Maputo Port Authority, 2012)

Most of the exports going through the MDC and port of Maputo are products related to the primary sector, and more specifically in coal, aluminum and base metals. The exports of base metals are mostly to international markets, but much of the aluminium output goes to regional markets, especially to South Africa using the MDC's west-east corridor with major terminals in Johannesburg and Maputo.

Products Transported along the Maputo Corridor

The paper will now state the main products going through the port of Maputo along the value chain. The transport volumes, growth potential and the consequences for infrastructure developments will be dealt with under the layers on transport and infrastructure.

Coal/magnetite exports from South Africa to India and China

Coal and magnetite were responsible for almost one third of the cargo going through the Port of Maputo. The coal is mined in the Waterberg area and the magnetite close to Phalaborwa, both in North Eastern Limpopo Province of South Africa. Magnetite is a mineral mainly used for various industrial purposes but mainly in the steel industry. Coal and Magnetite are transported via the Maputo Corridor to the port of Maputo and then shipped to India and China to the final customers. Demand since 2005, when the South African Logistics Company Grindrod acquired concession for the coal terminal and established reliable and efficient services, is stable and high. The location of the port of Maputo, it is by far the nearest port for Limpopo Province and the congestion of South African railways and partly its ports make it highly attractive for the shipping of these commodities.

Containers and General cargo

Containers and General cargo account for 11 and 12 percent respectively of total cargo in 2012. As worldwide, Container traffic is on the rise in the port of Maputo too. With a sustained high growth in Mozambique and with the Gauteng industrial hub around Johannesburg at the one end of the MDC growth expectations are high. This growth mainly depends on the improved railway line from Gauteng to Maputo and an efficient management of railway services.

Ferro Chrome to Northern Europe, Japan and China

In terms of tonnage, Ferrochrome accounts for 22 percent of all cargo. Ferrochrome is a corrosion-resistant alloy of chrome and iron, and is used to produce stainless steel. In South Africa it is mined in Middelburg in Mpumalanga province and Rustenburg in North West province. It is brought by railway to Maputo using the Maputo corridor. Again the location of Maputo port, close to the mining areas, the congestion of the railway lines in South Africa and improvements in the efficiency and capacities of Maputo port and the railway lines in the MDC make it attractive for the mining companies to ship the Ferrochrome through Maputo. Demand is steady. However, the port management does not see Ferrochrome as a big driver for cargo growth in the coming years.

The rapid rise of imports into Mozambique also reflects investment associated with the logistics value chain within the MDC. Wheat imports are increasing with substantial storage and milling capacities directly connected to the port of Maputo. Motor vehicles are now a significant import, hence a car terminal at Maputo port, caters both for Mozambique and the region. Sugar from Mozambique, Swaziland and Zimbabwe is going to two markets: the EU and the US where they have a preferential access. In 2012, sugar accounted for 11 percent of the cargo throughput in the port of Maputo.

3.3.2 Beira Corridor, the Moatize coal basin and the Value Chains of coal exports and agricultural products

The Beira corridor connects the central Mozambican port of Beira directly with its neighboring country Zimbabwe. There are also road and railway links from the Beira corridor to the economic vibrant Moatize coal basin and to Zambia and Malawi. The cargo data for the port of Beira are very rough and vary substantially from source to source. For the purpose of this paper the figures given by the Mozambican Ports and Railway Company CFM will be used. According to those figures in 2011 a total of 5.7 million tons was handled at Beira Port (3.05 million tons in 2008). 37 percent of cargos handled were exports and 63 percent imports.

Origins and destinations of cargo going through the port of Beira have changed considerably since 2000, when only 15 percent (1998) of the outgoing cargo originated from Mozambique itself. This figure stood at 54 percent in 2011. 22 percent of all outgoing cargo in 2011 came from Malawi, 15 percent from Zimbabwe (which was in 1998 still the origin of more than 60 percent of the cargo) and 6 percent from Zambia.

The main cargo segments handled in the Port of Beira are container, combined general cargo and dry bulk, coal and fuel. The general cargo and dry bulk figures are combined, because these are both handled at the same terminal. The throughput of the coal export is separately handled at a specialized terminal.

The following paragraphs will state the main cargo categories and products going through the port of Beira along the value chain. The transport volumes, growth potential and the consequences for infrastructure development will be dealt with in detail in the following layers.

Fuel

Fuel is a traditional cargo for the port of Beira. The fuel pipeline to Zimbabwe which starts at the Port of Beira is a lifeline for Zimbabwe and was protected during the civil war in Mozambique until 1992 by 10,000 Zimbabwean troops stationed along the Beira Corridor. All fuel for Mozambique is imported as the country has no oil refinery. The pipeline connects Beira Port with Zimbabwe and therefore the major share of the

fuel imports of 1.6 million tons per year is transported through Mozambique to Zimbabwe (approximately 70 percent).

Containers and General cargo

Containers and General cargo account for 34 and 38 percent respectively of total cargo in 2011. Container traffic is on the rise in the port of Beira and has had an average yearly growth of 18 percent since 2008 with growth accelerating in 2010 and 2011. In only 5 years from 2006 to 2011 Container throughput in Beira has almost tripled from 54,300 TEU to 160,000 TEU. Approximately 640,000 tons import and 490,000 tons of exports in general cargo and dry bulk (except coal) have been transported through the port of Beira in 2011 (total of 1.13 million tons). This is an increase of 52 percent since 2006. The reason for this growth lies mainly with the developments of the Moatize coal basin for which Beira is not only the major export hub (see below) but also the major hub for imports of equipments, materials and spare parts. With a sustained high growth in Mozambique, a reviving Zimbabwean economy and with the strategic location to Moatize, growth expectations for both cargo categories are high to very high. However this growth mainly depends on the maintenance of the National Road number 6 connecting Beira with Zimbabwe (and Malawi) and an improved railway line from Beira to Zimbabwe and in particular on the functioning of the Sena railway line (see layers Transport and infrastructure).

Coal from the Moatize basin

As described in layer one on the economic development, the Moatize coal basin and surrounding areas hold reserves of up to 25 billion tons of coal. The coal is of an excellent quality (large shares of coking coal). The demand from China, India and Brazil, the expected main markets, depends on the growth perspectives of these countries but Mozambican Coal has a freight advantage for the west coast of India over both Australia and South Africa. Therefore a steady demand is expected even under modest growth scenarios. Coal was not exported through the port of Beira until 2011 due to the rehabilitation of the Sena railway line which after years of delays could be opened in

2011 only. The success of the Mozambican coal industry all depends on transport issues and transport infrastructure. This will be dealt with under layers 4 and 5.

Agricultural products

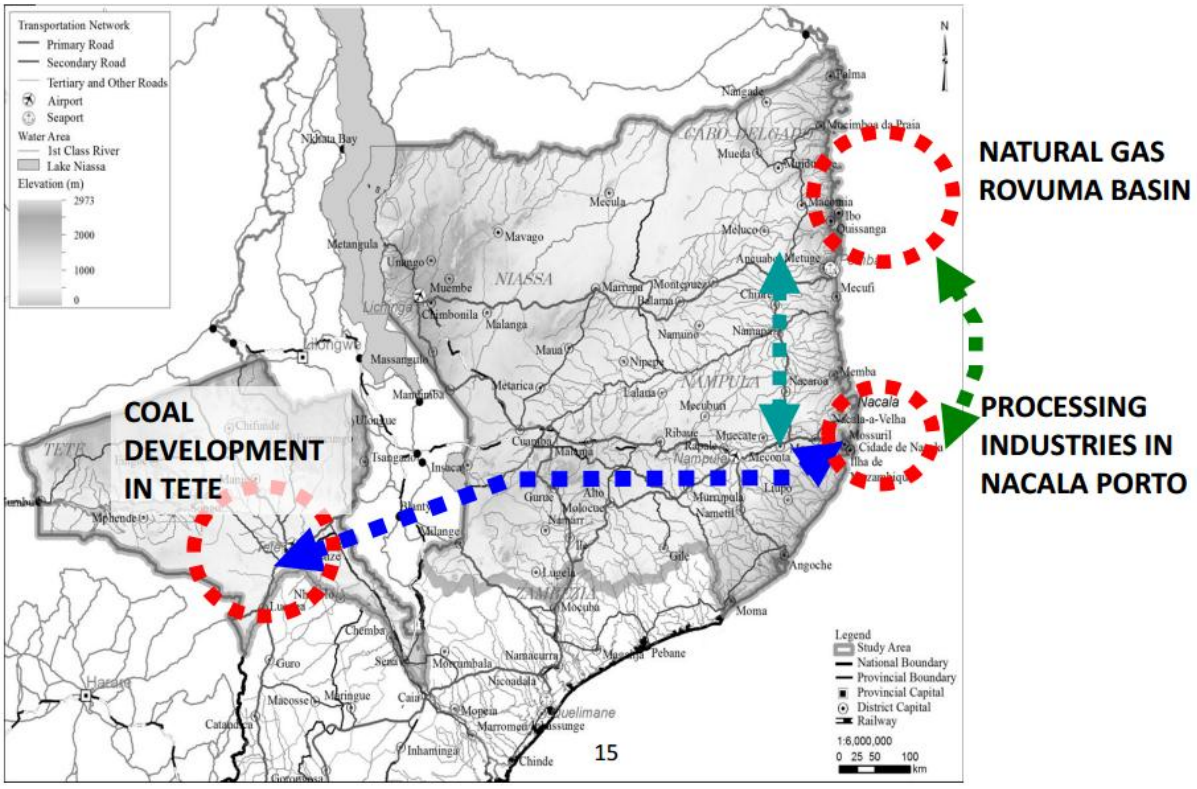
It is not known, how many tons of agricultural inputs and products are handled at the port of Beira. However, there is hardly any commercial agriculture in the Beira corridor and agricultural products going through the Port of Beira originate mostly from Zimbabwe and Malawi (mainly tobacco). Malawi in 2011 shipped 60 percent of its exports (total exports valued at 350 million USD). The Beira Agricultural Growth Corridor (BAGC) initiative is a partnership between the Government of Mozambique, the private sector and the international community and aims to stimulate a major increase in agricultural production in the Beira corridor. In Mozambique alone, there are 10 million hectares of arable land with good soils, climate and access to water along the Beira corridor. Nevertheless, this potential has not been realized. If this initiative succeeds, it will create value chains for various crops (sugar cane, banana, citrus, rice and wheat) which will affect the port of Beira.

3.3.3 Nacala Corridor and the Logistics Value Chain

The Nacala Development Corridor, also called 'Corredor de Desenvolvimento do Norte' (CDN) is an area that reaches westward from Nacala to Malawi. The port of Nacala is Mozambique's most northerly situated port. The harbor serves its own hinterland, mainly Nampula province, Malawi, and to a small extent Zambia. Malawi is, according to Nacala port authorities, currently the biggest user of the port. The port of Nacala is the main link in the Nacala Corridor that provides Malawi with access to a port and subsequently access to world markets. A CFM (2011) document lists three categories of cargoes handled at the Nacala port: fuels, general cargo and containers. These account for 16 percent, 25 percent and 58 percent of cargoes handled, respectively. Over the years there has been a consistent increase of general cargo handled. The freight traffic that occurs consists predominantly of Malawi's export commodities which are sugar, tobacco, pigeon peas, and tea. Import traffic consists of

fertilizer, fuel, containerized consumer goods, and food products such as vegetable oil and grain. These imports partly serve the national hinterland too; however, the majority of imports finally end up in Malawi.

Figure 3.4: Resource export potential for Nacala port in NDC



(Source: Gazeda, 2013)

Coal in Moatize Basin (Tete)

The resource potential in Mozambique has been outlined in layer one on economic development and been further elaborated on in layer three concerning the Beira port. The situation of Nacala port is similar to the one of Beira. In the NDC section of Mozambique the vast LNG and mineral resources have yet to be harnessed. Nacala is strategically well located to receive coal for export from the Moatize Basin in Tete, this can be seen in figure 3.4. However, this requires a new railway link from Tete to the NDC.

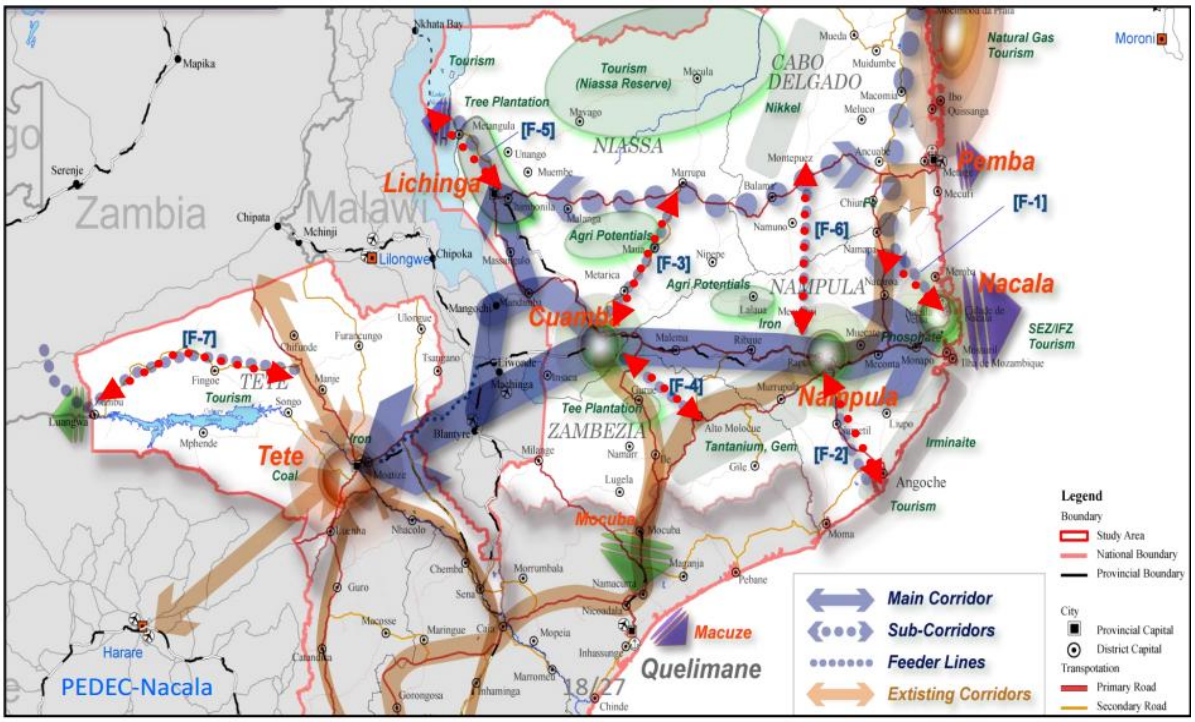
Natural Gas Rovuma Basin

As can be seen in figure 3.4, Nacala is also well situated to provide equipment and machinery for the development of the gas fields in the Rovuma Basin. However, these developments are still in an infancy stage and it still will take considerable time and massive investments to make exports feasible. This is a chance for the port of Nacala. Nacala's good road connection to the development areas of the gas fields (as can be seen in figure 3.5 below) provide good grounds that necessary investment will in fact take place.

Agriculture and Processing Industry

Generally, there is vast under-utilized development potential along the NDC. Most areas within the Nacala Corridor benefit from an excellent climate and sufficient water availability to support a wide variety of agricultural activities. Only a small part of the arable land (in Mozambique and Zambia) is currently under production, and the land used for farming often yield far below their productive potential. The production base around Nacala is narrow and under-developed, and focuses mainly on primary production in agriculture, livestock and fisheries. All the areas are currently under-utilized and considerable potential exists to create a marketable surplus for processing and export (Frey, 2010).

Figure 3.5: Nacala Corridor Feeder Roads



(Source: Gazeda, 2013)

3.3.4 The north of Mozambique and Natural Gas of the Rovuma Basin

The Rovuma Basin covers the south of Tanzania and the north of Mozambique. In layer one this paper has dedicated a paragraph to the expected development in the Natural Gas Sector for Mozambique. It was shown that 5.2 billion USD per year from LNG exports by 2026 could be earned by Mozambique. This is almost exactly the size of Mozambique's state budget in 2012 (5.4 billion USD) and more than 30percent of the current GDP. In a study "East Africa Gas-Potential for Export" by the Oxford Institue for Energy studies the authors see the Rovuma Basin as a "major new source of Gas supply which is already hailed as a future competitor for Australian and American LNG supplies to Asian markets".

BG Group, a major player in the gas market (formerly British Gas) estimated that LNG as share of global gas supplies will raise from 6 percent in 2000 to 14 percent in 2025. The authors of the Oxford Energy Institute study conclude: "there will be demand for LNG from East Africa at the right price."

From the perspective of the value chain for LNG the preconditions to export LNG are much more demanding than the ones for coal, ores, agricultural products, cars or most other cargo considered in this paper for Mozambique's main ports. Natural Gas has to be extracted on-shore and off-shore. Heavy marine equipment is needed for the off-shore exploration. After the Gas is extracted it cannot be simply transported and shipped like coal i.e. it has to be compressed from gas into liquid form, then it becomes liquid natural gas. LNG plants are necessary and infrastructure to transport the Natural gas from the gas fields to the LNG plant and from the LNG plant to the specialized ships.

The transport and infrastructure layers will deal with the LNG volumes and the investment needs for LNG plants and respective infrastructure, including marine infrastructure in order to fully establish the value chain.

3.4: Layer Four: Transport

The relevant value chains affecting those 3 ports (plus future LNG export facilities) and the positioning of the ports in these value chains have been provided. Following these findings, the transport flows generated through these chains can be analyzed. As explained in the section 2.2, review of further literature, container traffic would be the first choice for such an analysis, given its increasing role in modern logistics and its growth potential. This layer will deal with the perspectives for container traffic in Mozambican ports. Nevertheless, the transport flows originating from natural resources will be in the focus of attention in order to answer the research question. Therefore the current and expected future transport volumes of the main products handled in the ports (including containers) will be described. Also possible consequences from regional and national strategic transport plans and policies will be examined. The results of this analysis will then inform layer five on the resulting infrastructure needs, transport infrastructure to the hinterland and maritime infrastructure.

3.4.1 Transport forecasts Port of Maputo

The following data are all based on information released by the respective port operators (CFM, MPDC, Cornelder). They are cross checked with studies or academic papers and articles dealing with infrastructure developments in Mozambique and Southern Africa.

Container Traffic

In 2012 the Port of Maputo handled 150,000 TEU (for historic developments see layer three), with a sustained high growth in Mozambique and with the Gauteng industrial hub around Johannesburg at the one end of the MDC growth expectations are high. According to estimates of the Port Operator MPDC a growth to 700,000 TEU Containers until 2020 is possible.

These estimates are underpinned by a study: "Gateway and hinterland dynamics: The case of the Southern Africa container port system", Fraser and Notteboom (2012). The study builds upon traffic data economic literature and empirical studies on port competition, competitiveness and on port geography literature on the development of port systems and provides an academically-sound assessment of the development paths of the Southern African container port system, including the Port of Maputo. It does not only state that the Maputo container terminal has realized exceptional growth even through the recessionary periods of 2008 to 2010. Growth rates in 2008 and 2009 were recorded at 15 percent and 2010 growth of 35 percent occurred. It also gives an excellent outlook for the future of the container traffic through the Port of Maputo based on a comparison with the main competitor for traffic from Gauteng, Durban (4.5 million TEU in 2010).

Both the Ports of Durban and Maputo are nodal points each linked to corridors with Gauteng, the central production and consumption zone in the region, as the end points in the supply chain. The Maputo Corridor is well positioned along one of the most industrialized and productive regions of Southern Africa. Two gateways in such close proximity result in intense rivalry for market share. The extent, from a distance perspective, can be summed up in the table below.

Table 3.4: Comparative Road and Rail distances between Maputo Port and South African Competitors

	Maputo	Richards Bay	Durban
	Comparative Road Distances (km)		
Johannesburg(SA)	555	640	780
Witbank (SA)	395	622	533
Nelspruit (SA)	180	689	585
	Comparative Rail Distances (km)		
Witbank (SA)	437	819	627
Polokwane (SA)	550	935	802
Gweru (Zim)	967	1764	1684
Bulawayo (Zim)	1083	1880	1800
Matsapa (Swa)	228	544	371

(source: MPDC, 2013)

The shorter distances from Gauteng to Maputo (compared to Durban) clearly illustrates the competitive advantage the Maputo corridor has over the Durban corridor. Maputo's competitive advantage over Durban was observed during the recessionary periods, 2008-2010. In a period where most container terminals lost volumes, Maputo grew 15 percent in 2009 and 35 percent in 2010. In the same period Durban lost 6 and 4 percent of their volumes respectively. The shift towards Maputo is like to be constrained by limiting handling capabilities/capacity of the port and insufficient railway capacity. Durban was indeed still the biggest container port maintaining a regional market share of 53 percent in 2010 whilst Maputo held 3 percent. Any further gains for Maputo will, at the current state, be limited by the ports capacity constraints to handle any further incremental volumes and by the current state of the transport infrastructure (mainly railways) connecting the ports to the hinterland. Given the port of Maputo's ambitious capacity expansion plans for the future, Durban will need to find initiatives to defend its status as the primary gateway port into Southern Africa. In addition to capacity improvements, the port needs increased focus on improved operational efficiencies, more competitive tariffs and a more reliable service offering.

General Cargo

Given the growth scenario of Mozambique, the development of the mega projects requiring engineering equipment and spare parts and the competition with Durban elaborated above the MPDC estimates that 8 million tons of General Cargo are possible (from 2 million tons in 2012), by the year 2020.

Natural Resources – Coal, Magnetite, Ferrochrome from South Africa

Though these minerals are not mined in Mozambique and thus not directly part of the Mozambican resource boom, they are highly relevant for the development of the Port of Maputo. The main drivers are the same as for the coal from Moatize and the Natural Gas in the Rovuma Basin: a sustained demand from the world market, high reserves, strategic location and favourable political and economic conditions.

Coal and Magnetite

Both products are always reported together as they are handled by the same operator (Grindrod) at the same terminal. In layer three it was shown were these products are mined in South Africa, what are the main markets and that the growth potential for Maputo port, especially for coal and magnetite is high. In concrete figures this means: Coal and magnetite with 1.8 million and 2.85 million tons respectively in 2012 were responsible for almost one third of the cargo going through the Port of Maputo. Demand since 2005 is stable and high. The location of the port of Maputo, it is by far the nearest port for Limpopo Province and the congestion of South African railways to Richards Bay (biggest coal terminal in Africa with a capacity of 91 million tons per year) and the ports make it highly attractive for the shipping of these commodities. Coal and magnetite from South Africa also represent the highest growth potential for Maputo port with a possible demand of 30 million tons already in 2016, depending on a viable rail logistics solution and further investments in the port infrastructure (see also layers on transport and infrastructure).

Ferro Chrome

In terms of tons Ferrochrome with accounts for 22 percent of all cargo has the highest throughput with a total of 3.3 million tons (2006 0.5 million tons) for the Port of Maputo. Maputo will remain attractive for Ferro Chrome exports. However, the port management does not see Ferrochrome as a big driver for cargo growth in the coming years.

3.4.2 Transport Forecasts Port of Beira

Container Traffic

In a recent port master plan study for the Port of Beira growth scenarios for the port have been developed (van der Meer, 2013). This section will follow and critically review the 'most likely' medium growth scenario. The following assumptions are made:

- The economic growth initiatives of the Beira corridor reach half of the potential, with exception of sugarcane production, which reaches full potential by increase in demand of bio-ethanol worldwide.
- The proposed upgrades to the Sena railway are implemented (see layer five) and the annual capacity is increased to 12 million tons of coal. The Port Master Plan study still assumes 20 million tons but this forecast doesn't seem very realistic given the difficulties with the operation of the line and its expansion progress in the last years.

However, the Sena line only indirectly affects the container throughput of the Port of Beira as most containers are transported by road. Therefore a container throughput of 400,000 TEUs until 2020 (from 160,000 in 2011) is expected. The agricultural production is expected to reach half of the potential, meaning an additional 50,000 containers must be exported. With regard to ship sizes, approach of the Beira Port Master Plan study is followed, which mainly sees the dredging challenge for Beira's port as the limiting factor. As van der Meer (2013) states: "It is assumed that ship sizes will increase slightly to an average of 2,100 TEU, as economies of scale make it more efficient. Also, the current access channel depth can still cope with these ships' drafts.

The design ship is chosen to be one generation newer, with 2,800 TEU. Average transhipment per ship increases slightly the ship size to 400 TEU per call, resulting in 875 ships per year." The investment needs to meet those capacity targets in the Port of Beira are dealt with under layer six – maritime infrastructure.

General Cargo and Dry Bulk

General cargo and bulk throughputs are in the medium scenario 3.0 million tons, of which 1,200,000 is import and 800,000 export. Half of this throughput is transported by general cargo ships and the remaining by dry bulk ships. In addition, the medium forecast for the fertilizer imports is 1,000,000 tons. The Master Plan Study predicts these figures for 2025-2032 only but given the growth scenarios of Mozambique and Zimbabwe (not properly covered in the Master Plan Study) it can be expected that these figures are already reached by 2020. Throughputs in the general cargo sector are doubled and with the current depth limitations and additional dredging (see layer six), ships with larger drafts can be used. The average calling ship will be 10,000 DWT for both the general cargo and for dry bulk. The average transhipment will respectively increase slightly to 3,000 tons per ship.

Coal

Coal shipments from Beira only started in late 2011. Beira Port, in 2012, exported 2.42 million tons and due to the limitations of the Sena railway line this will only marginally increase to between 2.5 and 3 million tons in 2013. The current upgrade of the line shall ensure a capacity of 12 million tons until the end of 2013 but success is doubtful. However, the pressure coming from the Moatize coal basin and the financial power of the mining companies will ensure that everything will be done to reach those 12 million tons until 2020 (details layer five). The increased throughput asks for deepening of the access channel to 11.3 meters (details se layer six). Given these conditions are met the coal terminal which was upgraded in 2012 can handle these 12 million tons per year. However this falls short of the expected 20 million tons that were expected when the rehabilitation of the Sena line started in 2008. Therefore the Port of Beira will not be able to handle a bigger part of the expected yearly coal production of 70 million tons per year of coal and alternative infrastructure solutions are being sought.

Fuel

Fuel throughput is expected to reach 3.75 million tons until 2020. However, this requires an increase of the capacity for the existing pipeline. The sugarcane sector will increase its production to produce 720,000 tons ethanol for export. This export will be in liquid bulk tankers of 20,000 DWT. The average and maximum calling ship at the fuel terminal will not increase and on average 10,000 tons will be transhipped.

Table x.x: Most likely Scenario for Throughput (tons) through Beira Port for 2020

Commodity:	Import:	Export:	Empties:	Totals:
Container (TEUs)	155,000	170,000	75,000	400,000
General Cargo & Bulk	2,200,000	800,000		3,000,000
Coal		12,000,000		12,000,000
Fuel	3,750,000	720,000		4,470,000

*TEUs (Van der Meer, 2013 ; own adaption)

2.4.3 Transport Forecasts Port of Nacala

Container Traffic

Information on future traffic for the Port of Nacala is mainly taken from documents related to the Nacala Corridor Development. In March 2013 the Japanese Aid Agency (JICA) and the Government of Mozambique signed a loan agreement on the development of the port of Nacala. This agreement was preceded by an appraisal report and a feasibility study which both contain calculations with regard to future cargo volumes. The last available figure for container throughput is of 2010 and shows a figure of 51,000 TEU of which 25,550 TEU (50 percent) are estimated imports and the remaining 50 percent exports or empties. With ongoing development of the Nacala corridor and economic development in Mozambique and Malawi continuing, a throughput of 213,000 TEUs is expected for 2020 and 490,000 TEUs for 2030. With regard to ship sizes there is no dredging challenges such as at the Beira port (besides from maintenance dredging along the berth structures) for the deep sea port of Nacala. Therefore there are also no natural limitations for ship sizes and in line with Beira and

Maputo we assume that they will increase slightly to an average of 2,100 TEU, because economies of scale make transportation cheaper. The investment needs to meet the capacity targets in the Port of Nacala are dealt with under layer six – maritime infrastructure.

General Cargo and Dry Bulk

General cargo and bulk throughputs were 742,000 tons in 2010, of which 459,000 tons is import and 283,000 tons export. There is no information regarding the ship types carrying general cargo and dry bulk but it can be expected that similar to Beira half of this throughput is transported by general cargo ships and the remaining by dry bulk ships. A Japanese Feasibility study predicts a development for general cargo and dry bulk of 2.45 million tons in 2020 and 5.23 million tons in 2030 (Dimande, 2013). These developments do not include the new coal and ore terminal at Nacala-Velha for which the transport demand will be dealt with below. The given figures would mean throughputs in the general cargo sector would be more than triple in just ten years. Given that there are no major depth limitations and additional dredging along the berths is planned (see layer six), ships with larger drafts can be used. The average calling ship will be 10,000 DWT in both the general cargo as the dry bulk sector.

Coal

There is currently no coal shipped from Nacala but big plans are being proposed. As the capacity of the Sena railway line leading to the port of Beira will be limited for the foreseeable future (see section layer five), Nacala is the main alternative. There are currently plans to connect the Moatize coal basin (more than 900 km away) through a new railway line to the Nacala Coridor and to a new coal terminal at Nacala-a-Velha. Coal shipments from Moatize could start in 2016 and shall reach up to 40 million tons which is the capacity to be installed at Nacala Velha coal terminal until 2020. Like for Beira it can also be assumed for Nacala that the pressure coming from the Moatize coal basin and the financial power of the mining companies will ensure that everything will be done to reach 40 million tons until 2020. As there is no need for deepening of the access channel to 11.3 meters, risks are even lower for the Port of Nacala. However, it must be remembered here that for the Sena line and the Port of Beira the expectations stood at 20 million tons per year when rehabilitation started in 2008 but were not met.

Therefore, planning, construction and later operation of the railway link and the coal terminal have to meet this capacity. Given this capacity is met; the Port of Nacala would be able to handle 40 million tons (30 million of Vale mined coal, 10 million other mining companies) of the expected yearly coal production of 70 million tons per year in Mozambique.

Fuel

Fuel throughput is expected to reach 0.6 million tons until 2020. The fuel terminal at the Port of Nacala has been recently upgraded to receive these tons. The Port of Nacala will not only serve the North of Mozambique with fuel (appr. 350,000 tons) but is also responsible for about 50 percent of Malawi's fuel imports (250,000 tons). The average and maximum calling ship at the fuel terminal will not increase and on average 10,000 tons will be transhipped.

3.4.4 Transport Forecasts for Liquid Natural Gas

The demand for LNG is so far undisputed and as shown under layer three, natural gas has a huge potential to finance future development in Mozambique. However, there will be no use of the natural gas and no revenues if the gas products cannot be transported to the markets. So what is the actual transport demand deriving from the natural gas resources in the Rovuma basin? The Mozambican Draft Gas Master Plan is the internationally recognized reference document for development in the Natural Gas Sector of Mozambique. The Master Plan calculates with discovered gas reserves of 100 trillion cubic feet (Tcf) and undiscovered gas reserves of 150 Tcf. That would give sufficient gas to justify at least 10 LNG plants (so called LNG trains) with a total capacity to produce 50 million metric tons per year of LNG until 2026. As a comparison, Qatar is currently the biggest LNG supplier in the world with 77 million metric tons of exports in 2012. The reference study on the' East African gas Potential' by Ledesma (2013) comes to the conclusion that the schedule of the master Plan is too aggressive and does not even match with the already optimistic forecasts of the multinational companies involved in exploring the Mozambican natural gas. It seems realistic that a first two train LNG plant is operational by 2020 leading to a transport demand of 10 million metric

tons of LNG per year. Depending on various factors, amongst them the development of demand and prices for LNG, competition from new supplies currently under development in Australia, North America and China, the development of a favourable regulatory framework in Mozambique and the award of front end engineering design contracts for the necessary infrastructure, the full potential of 50 million metric tons of LNG exports could be reached by 2035.

Natural Gas to Accelerate Economic Development

Due to the immense quantities of natural gas, and also coal, a major opportunity arises for Mozambique to not only be an exporter of raw primary commodities but also it could sustain an energy intensive domestic industry. What this means is that Mozambique could make the move from a third world primary industry based economy to a first world secondary and tertiary based industrial society (Callaghan, 2011). All the mineral developments should make it possible for downstream processing in the regions. In other words, there is major opportunity for further mega-project developments as the natural gas can be used to fuel domestic heavy industries. The Natural Gas Master plan for Mozambique puts forward a recommendation for power plants, a fertilizer plant, and a gas to liquids processing plant around the Palma region (ICF International, 2012). This would result, in Mozambique to create added value to its natural gas and in turn could not only export the commodity but fuel local industry to create manufactured goods that can be exported for higher prices. The consequences on ports would be obvious, as the resulting megaprojects will further increase imports of for example material and equipment. Once construction is over, the manufactured products will be exported through the ports and put a further increase on demand for transport infrastructure. Nevertheless, this will not be dealt with in further detail as these developments are foreseeable beyond the time frame considered in this paper and are very hypothetical as first, current LNG and coal extraction developments need to be developed further. However, the opportunity should be highlighted as well as consequences on infrastructure should be considered.

3.4.5 Consequences from regional and national strategic transport plans and policies

There are two relevant types of transport sector policies and implementation plans relevant for Mozambique. These are the national policies and plans and the regional ones. These have been outlined in the "Regional Infrastructure Development Master plan" drafted by the SADC (2012). The national policies have a clear focus on transport infrastructure development. Before the resource boom started they were mainly directed towards the rehabilitation of the transport infrastructure in the Maputo, Beira and Nacala Corridors and on the south-north road link. With the resource boom this has changed since 2006. The use of the revenues from natural resources for poverty reduction and development of Mozambique are a key priority for the Government of Mozambique and infrastructure is the most important pre-condition for achievements. The national policies try to attract FDI to the transport sector and they are successful as shown by the various investments and concessions under Public Private Partnership arrangements. The main multilateral donor agencies (EU, African Development Bank and World Bank) do support Mozambique`s national development policy in the transport sector with substantial amounts of financial aid and technical assistance. With regard to the transport corridors there are now two main policy objectives: to facilitate the export of the natural resources and hence increase revenues and the improvement of the transport service function to the hinterland. The latter objective also aims at the sustainability of investments as transport services for the neighbouring countries will still generate income when the natural resources have come to an end.

Regional Integration and an inclusive regional transport sector policy are key for both the customers (from neighbouring countries) and the service provider (Mozambique). Mozambique is a member of the Southern African Development Community (SADC). The SADC is the regional body to improve regional integration. The SADC has a council of member states approved transport and cross border trade policy and a Transport Sector Master Plan (TSP). The TSP includes the different modes of transport namely road, rail, ports, maritime and inland waterways, as well as air transport. The TSP defines current and first order future (2027) infrastructure requirements, as well as an analysis of the legal, regulatory and policy environment which regulates transport operations within the SADC region. The key objective of the region is to identify key hubs and gateways for rehabilitation and development, in order

to ensure that the passenger and goods markets are adequately catered for. All three Mozambican transport corridors are covered and considered part of the strategic transport of Southern Africa. The TSP aims at the positioning of Southern Africa as a competitive hub and market. In response to demands for transport services, there is a need to develop appropriate, integrated, safe, secure and efficient infrastructure capacity along strategic transport and development corridors with regards to road and railway networks and the TSP is crucial in this regard. The vision for the SADC Regional Transport Master Plan is focussed on providing transport infrastructure, services, policy and legislature, enabling environmental and supportive institutions with the necessary human resource and institutional capacity to transform the transport sector. The TSP provides a sound basis for the development of the transport network up to 2027. Nevertheless, it is important to implement the plan and to create the political and administrative conditions for the full use of the network across the borders. In the past too often national interests prevailed and the formulated policies and plans were not implemented.

3.5: Layer Five: Transport Infrastructure

Resulting from Mozambique`s traditional role as a transport service provider for its hinterland transport infrastructure is primarily developed on the coast going east into the country. This is because historically the Mozambican ports connected its landlocked neighbors and to a lesser extend the mining and agricultural clusters in the inland of Mozambique. Mozambique has undertaken considerable effort to capitalize on these geographic advantages, integrating different transport modes within the country and with neighboring countries. With the discovery and exploration of natural resources a new dimension has been added to the infrastructure pattern of Mozambique. The mining and natural gas clusters in the inland of Mozambique need a transport connection to the coast. Already today the existing roads, railways and pipeline are not sufficient to deal with the cargo from the resource boom and the sustained economic growth. Without proper investments into transport infrastructure this situation will dramatically worsen in the future.

In order to capitalize on the opportunities provided by positive growth scenarios in Southern Africa, improved regional integration and above all the resource boom, it must be ensured that the right transport infrastructure is in place; mainly roads, railways and ports. This section strives to outline the infrastructure situation and the future needs concentrating on roads and railways. Maritime infrastructure will be dealt with in layer six. Therefore this layer five will give an overview regarding existing roads and railways in a first step. In a second step, it will outline ongoing and planned infrastructure investments connected to the three main transport corridors that have their exit points at the ports of Maputo, Beira and Nacala. This will be complemented by a description of needed infrastructure investment to cope with the natural gas resources in the Rovuma basin.

Overall, the total road network length of Mozambique is 32,500 km as of 2008. According to a World Bank paper on Mozambique's Infrastructure by Dominguez-Torres and Briceno-Garmendia (2011), the classified road network consists of 22,500 km of primary and secondary networks with less than 5,000 km each, and a tertiary network of about 12,700 km. The unclassified network is estimated to be around 6,700 km and the urban network 3,300 km. This road network can be considered as an achievement

due to reforming of the institutional and policy environments. Bottlenecks such as: insufficient investments in rehabilitation and maintenance, and lack of human resources sufficient to properly carry out road projects have kept Mozambique behind in terms of road developments. However, the efficiency of Mozambique's highway network has significantly improved since the 1990s. In the early 90s the percentage of roads in good or fair condition was a mere 30 percent. As of 2007, 83 percent of the main network is in good or fair condition. This figure places Mozambique above the average for other Sub-Saharan countries (72 percent)[5].

Even with these improvements, according to statistics from the AICD Road Sector database, Mozambique's classified network road density per land area is 42.8 km per thousand sq. km which is still below the Africa average of over 50km/1000 square km. However, one should interpret this with care as Mozambique has such a vast and diverse territory. More importantly is the fact that connectivity among urban and economic clusters is still quite limited. There are clear transport corridors that link urban and economic centers to ports but they are not well linked to each other. The only continuous road that goes from north to south is the national road N1. Other than the N1, Mozambique has no connection among the several parallel west-east corridors.

The railway system of Mozambique totals 3,130 km and comprises 3 basic networks. These networks are disconnected and are located in the north, central and southern part of the country. The railway lines align with the Nacala, Beira and Maputo corridors. The individual railway lines are managed by Ports and Railways Mozambique (CFM), a state owned entity that oversees and manages the railway systems of Mozambique or through private concessions in which CFM holds a minority share.

The Mozambican railway system with its individual rail lines are of key strategic importance for the region. The Maputo line is part of one of the most successful spatial development initiatives in Africa—the Maputo development corridor. Beira's Machipanda line is crucial for transporting agricultural products from Malawi, and agricultural and mineral products from Zimbabwe. The Sena line, which has recently been rehabilitated, connects the coal basin of Moatize with the Beira port. The Sena line is a key contributor to unlocking Mozambique's export potential for coal.

[5] (AICD Road Sector Database of 40 Sub-Saharan African countries)

Table 3.6: Cargo transported along Mozambique's railways (million ton-km)

	Maputo Corridor			Maputo Railroad Total	Beira Railroad	Nacala Railroad
	Goba	R. Garcia	Limpopo	CFM-South	CFM-Center	CFM-North
2011	65.5	396.7	297.4	759.6	294.3	139.5
2010	60.5	236.2	262.3	559.1	227.7	149.7
2009	48	240.6	194.8	483.5	119.3	169
2008	52	226	220	498	81	115
2007	40	177	237	454	157	127
2006	45	170	240	455	205	120
2005	50	180	230	460	175	128

(Source: CFM, 2011; CFM, 2009)

Productivity and efficiency of the rail lines in Mozambique are comparable to other southern African railways (except South Africa); however, these companies are rather unproductive and inefficient compared to more developed countries. Mozambique's locomotive, carriage, and wagon productivity are still low, with the exception of the carriage productivity of the Nacala line. Mozambique's rail freight tariffs are regionally competitive.

3.5.1 Transport Infrastructure of the Maputo Transport Corridor

The Maputo Corridor is the transport corridor linking the east coast port of Maputo with the highly industrialized and productive regions of the Gauteng province in South Africa. The corridor runs for more than 600 km from Johannesburg, South Africa to Maputo, Mozambique. It also provides a connection to Swaziland, Zimbabwe and Botswana.

Country	Links
South Africa	Road (En 4), Railway (Ressano Garcia Line),
Swaziland	Road (EN 5), Railway (Goba Line)
Zimbabwe	Road (A6, and through South Africa), Railway (Limpopo Line)

Roads in the Maputo Corridor

The main road linking Maputo to South Africa is the EN4 toll route. The EN4 is a 630 kilometer highway with six toll plaza and other support facilities including 24/7 roadside assistance services. The N4 has been funded through private sector involvement and has been built by Trans African Concessions Ltd. (TRAC). The concessions is to last for 30 years, during which TRAC's responsibility is to construct, operate and ultimately transfer ownership to the governments of South Africa and Mozambique under a 300 million USD contract. The EN4 provides a high quality road link of South Africa's Gauteng area to Maputo. Approximately 87,0000 trucks are using the road per year and are crossing the border into or from Mozambique (2012) with an increasing number.

Rail Connections Maputo

Three railway lines connect the Maputo port with its neighboring countries. The Ressano Garcia railway line provides a link with the border to South Africa. Limpopo line links Maputo port to Zimbabwe, and the Goba line is connecting Maputo to Swaziland.

The Ressano Garcia line has experienced major rehabilitation works which were completed in 2008. This has been done through significant investments in excess of 80 million USD in rail and rolling stock rehabilitation (Mommen, 2012). The railway line has the same size rail gauge as the South African rail tracks, allowing trade traffic to flow seamlessly. Through this network trains can serve South Africa, as well as Botswana and Zimbabwe, accommodating trains of 40 to 60 wagons capable of carrying up to 3,600 net tons of commodities such as minerals, sugar, citrus and containerized cargo.

Table 3.7: Net Tons Transported along Maputo Railway Corridor (thousand net tons)

	Maputo Corridor			Maputo Railroad Total
	Goba	R. Garcia	Limpopo	CFM-S
2011	772	4,510	723	6,005
2010	702	2,637	642	3,981
2009	577	2,679	504	3,760
2008	673	2,572	562	3,807

(source: CFM, 2011; CFM, 2009)

The upgrades experienced by the Ressano Garcia line, such as the increase of train slots from 15 to 42 per week and faster turn-round of equipment has almost doubled the freight carried on the corridor. This can be seen in table 3.7, where 2,679 thousand net tons were transported in 2010, and the following year this figure increased to 4,510 net tons—a 71 percent increase.

The Goba line, with a length of 63.5 km connects the Maputo port with Swaziland. From 2008 until 2011, freight traffic overall has increased only slightly from 673 thousand net tons (2008) to 772 thousand net tons.

The Limpopo line connects the Maputo port with Zimbabwe through a 534 km railway track. The rail freight traffic from 2008 until 2011 has also increased gradually from 562 thousand net tons to 723 net tons.

Rail capacity and services remain a key challenge, but one which is being addressed jointly by South African and Mozambican rail service providers, Transnet Freight Rail (TFR) and CFM, in a program which is to ensure that existing assets are maximized and investment prioritized to ensure that the rail services support port growth. Swaziland Rail has also entered into partnership with TFR to provide complementary services for commodities moving to the port of Maputo (Mommen,

2012). According to forecasts of the port of Maputo, it could have 36 million tons of throughputs by 2016 (see layer four). However, the major constraint is rail capacity. In 2012 wagons and locomotives were the biggest constraint allowing for 8.5 million tons of cargo being transported by rail. Rail traffic is particularly expected to continue to increase drastically on the Ressano Garcia line. However, it is close to full capacity already. Plans are currently being considered to transform the Ressano Garcia line into a dual-track route. The increasing volumes of cargo such as coal, magnetite and ferrochrome (see above) could thus be better accommodated. Given that we are already in 2013 and the procurement for the infrastructure works has not been started yet it is doubtful that the envisaged 36 million tons will be reached before 2020.

3.5.2 Transport Infrastructure of the Beira Transport Corridor

The Beira transport corridor is defined as the set of transport links between the Beira port and Zimbabwe, as well as the links between the port with Zambia and Malawi. The Beira corridor infrastructure also connects Beira port to the coal basin of Moatize. Beira is 319 km away from the Zimbabwe border called Machipanda. The road distance to Malawi is 685 km. The links to from the Beira port to its hinterland are summarized in the table below:

Country	Links
Zimbabwe	Road (EN6), Rail, Pipeline
Malawi	Road (EN 102/103), Sena Rail link, connects Moatize to Beira with extended link to Malawi
Zambia	Road (EN 102/ 221)

Roads in the Beira Corridor

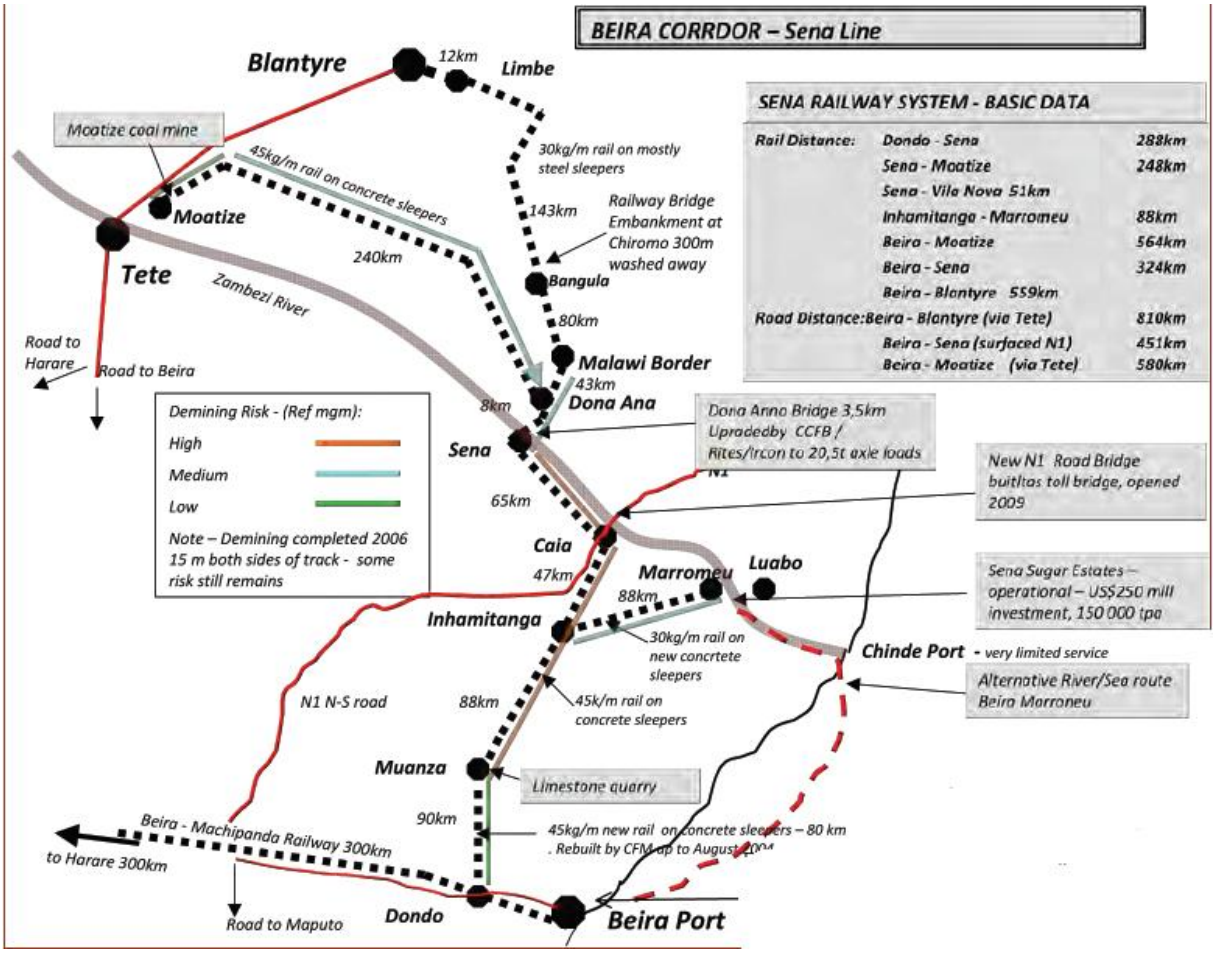
The main road routes within the Beira corridor are to Zimbabwe via Machipande (EN6) and to Malawi via Tete (En 102/103). The main road to Machipanda was rebuilt in the mid 90s, but has now deteriorated. Both routes remain in general decent good

condition, but rapidly deteriorating with some poor sections, mainly on the Pungue flats near Beira, which are subject to occasional flooding and south of Changara on the Malawi route. However, the African Development Bank has committed nearly 65 million USD towards upgrading, rehabilitating and maintenance of various road projects in the Beira Corridor region. A paper by the South African Development Community titled "Regional Infrastructure Development Master Plan: Transport Sector" (2012) identifies the regional road work infrastructure developments and investments in the Beira Corridor. Among these developments is the construction of a new toll bridge in Tete crossing the Zambezi River, running parallel to an existing bridge which has limiting load restrictions and is in poor condition. This is a vital part to improve access to the Tete region and its coal fields, as well as connectivity to Malawi. This is still in a concept stage and the necessary investment sums have not been given. However, the project is likely to be carried out. Furthermore, the EN 6 road from Beira to all the way to Mutare in Zimbabwe is subject to upgrading. The project road forms the vital part of the Beira Corridor providing links to Zimbabwe, Malawi and Zambia. The provinces in which the project is located have a paved route network of 1,148 km. The project will improve about 285 km of the primary network. Rehabilitation will contribute significantly to the generation of socio-economic development of the region. Road works are planned to commence this year and be completed by 2016. It goal is to provide opportunities for economic growth through the use of improved and safer roads with reduced vehicle operating costs.

Rail Connections in Beira Corridor

The railways network in the Beira Corridor consists of the Machipanda line from Beira to Harare, Zimbabwe, and the Sena line connecting the port with the coal fields of Moatize. These two lines make up the Beira railroad. The Machipanda line is a 317 km single-rail track line from Beira to the border town of Machipanda. The Sena rail line is 670 km in total, it emanates from the mainline at Dondo and consists of the principal branch, the Sena (587km) terminating at Moatize, a short branch (39km) extends from Mutarara and connects to Malawi at Vila Nova, and a second branch line (88km) runs between Inhamitanga and Marromeu. The entire Sena rail system is depicted in the figure3.5 below:

Figure 3.5: Beira Corridor and the Sena Railway Line



(Source: Callaghan, 2011)

All the branch lines on the Beira Corridor were in bad condition until 2011 and have been out of services since 1984. They required complete rehabilitation (Phipps, 2009).

Plans for rehabilitation of the Beira railroads date back to 2004, when the Machipanda and Sena lines were transferred to private management. Management was handed to the Beira Railroad Company (CCFB), in which 51 percent of the shares were held by the Indian consortium RICON (Rites and Icon International) and 49 percent by the Mozambican port and rail company CFM. Rehabilitation of both railway lines was scheduled to be completed by 2009. The project was mainly financed by loans obtained by the Government of Mozambique from the World Bank (104.5 million USD), and the European Investment Bank (50 million USD). The three shareholders, CFM, RITES and RICON contributed 7.2 million USD, 16.8 million USD, and 16.7 million USD respectively

(CFM, 2013). However, in 2009 it became apparent that rehabilitation targets were not being met and management was handed over back to CFM in 2010.

The main project objectives were not remotely achieved. The goal was to have the Sena line able to carry 1 million tons of cargo a year by the end of 2009. The line was only opened to coal traffic on August 8th, 2011 with freight running at 266,000 tons a year—just 27 percent of the initial target 20 months late (Fauvet, 2012).

Furthermore, all 317 kilometers of the Machipanda line were supposed to be rehabilitated; however, until 2012 not a single kilometer was upgraded causing the Machipanda line to deteriorate further.

The Sena Railway Upgrading set out with the objective to service the first phase of the Moatize exports of roughly 6 mtpa. The railway line is ultimately intended to accommodate 6-19 mtpa. Since, CFM took back over rehabilitation works in a first phase were 34 million USD. This amount was used to fund the improvement of coal transport capacity to 6.5 million tons a year. With another investment of 150 million USD, CFM set itself the goal to have the capacity to export 12 million tons by the end of 2013, and within three years, by 2016, reach the figure of 20 million tons a year.

In July 2013, Vale Mozambique reported a new monthly production record in June of 509 000 tons at its Moatize coal mine. Also a record of more than 300,000 tons transported on the Sena line was set (Campbell, 2013), which is a good indication of improvements on the Sena line. Nevertheless, because of limitation of the Sena line, Vale is undertaking a major project to develop an alternative rail route through Malawi to the Mozambican port of Nacala in order to cope with the coal transport demands (see section on Nacala corridor below).

Table 3.7: Net-tons transported along Beira Corridor Railways (thousand net tons)

Description	2011	2010	2009	2008
Linha de Machipanda	552.8	546.5	300.4	400.9
Linha de Sena	466.2	492.3	163.5	-

Source: (CFM, 2011; CFM, 2009)

Pipeline in the Beira Corridor

A 287km pipeline connects Beira port with Zimbabwe and therefore the major share of the fuel import is transported through Mozambique to Zimbabwe. It has a capacity to transport 1.28 million tons of fuel and in the past years it has been operating at close to full capacity (van der Meer, 2013). There plans to install additional pumps along the pipeline in order to increase capacity by 30 to 40 percent. Also there are plans to build a second pipeline to be built by Russian petroleum company Rosneft, costs of the first stage of the project are estimated at 700 million USD, to be funded by a consortium set up by Rosneft (allfrica, 2012).

3.5.3 Transport Infrastructure of the Northern Transport Corridor (Nacala Corridor)

Nacala corridor consists of the Nacala Port and the Nacala railroad, which connects the Nacala port to Malawi's Central East African Railway (CEAR). In January 2005 this corridor was conceded to Corridor do Desenvolvimento do Norte (CDN), a partnership between Caminos de Ferro de Mocambique and Sociedade de Desenvolvimento do Corredor do Nacala holding for 15 years.

Country	Links
Malawi	Road (EN8), Rail
Zambia	Road (EN8 through Zambia), Rail

Roads in the Nacala Corridor

Road infrastructure in the Nacala Corridor region has historically been poor. However, in 2009 the African Development Bank approved the Nacala Road Corridor Project (NRCP), with the objective to bridge the infrastructure gap and improve national and regional accessibility to the Nacala port, as well as improve accessibility of the communities in the project's zone of influence to markets and social services. Prior to implementation of this project, there was no direct surfaced road from Malawi to Nacala. The NRCP covers about 1,033 km of roads in Zambia, Malawi and Mozambique with very poor road sections. A large part of these sections are being upgraded or rehabilitated in a three phase project overseen by the African Development Bank. In this project, large

parts or road infrastructure in the corridor are being rehabilitated, specifically in Mozambique, Malawi and Zambia. Expected outcomes include reduced transport cost, improved accessibility to social services and markets as well as improved safety. The development of the Nacala road corridor will enable an increase in the volume of Zambian exports through the Nacala port, expanding the market beyond national boundaries (SADC, 2013). Investments to realize this project are financed by the African Development Bank, the Japan International Cooperation Agency (JICA), and the government of Mozambique and amount to 282 million USD in total (phase I: 70 million USD, phase II: 112 milliion USD, phase III: 100 million USD) (ADP, 2012).

Railways of the Nacala Corridor

The Nacala line extends from the port of Nacala to the frontier with Malawi at Entre Lagos, a distance of 610 kilometers. It includes two branchlines, one for 42 kilometers from Rio Monapo to Lumbo, and the other for 262 kilometers from Cuamba to Linchinga.

A portion of the mainline from Nacala to Cuamba (totaling 533 km) was rehabilitated in the late 1990's to high standards. It is comprised entirely of concrete sleepers, a 40 kg rail, and a good surface and ballast section. Between Cuamba and Entre Lagos/Nayuci (a distance of 77 km) the track is in poor condition, with 30-kg rail, and is operated with a 15km/hr speed restriction (Phipps, 2009).

Of the remainder of this northern corridor, the branch line from Cuamba to Lichinga is in poor state of disrepair. Trips on this line take weeks to complete, normally at excessively slow speeds, and are accompanied frequently by derailments. Freight volume on the line is only 4,000 tons per annum, and service is, and will continue to be, infrequent. The following depicts the tonnage levels experienced prior to the concession.

Mozambique's northern rail corridor links the port of Nacala to Malawi. The Malawi railway network is an integral part of this corridor, as this is the main traffic feed into the system. The Mozambican and Malawian governments therefore decided in 2000 to bundle the Malawi railway and the Nacala corridor in one concession. The concession of the Malawi Railway, to the Railroad Development Corporation consortium holding 51

percent and CFM holding 49 percent, in 1999 was seen as a condition precedent for the concessioning of the Nacala line. Less than 300,000 tons are moved by rail in this corridor. Freight troughput in net tons has been on a constant level from 2008 to 2011 as can be seen in the table below.

Table 3.8: Net tons transported along the Nacala Railroad (thousand net tons)

Description	2011	2010	2009	2008
Linha do Norte	241.8	272.4	296.4	244.9

With the start of coal production in the Moatize coal basin also the Nacala coridor got a new perspective. In July 2012 the Mozambican government approved the lease of a new railway line to be built between Moatize coal basin and the port of Nacala to the newly formed company CLIN (Northern Integrated Logistical Corridor). The Brazilian mining company Vale owns 80 percent of CLIN, while the remaining 20 percent is in the hands of CFM (Railways Africa, 2012).

The lease covers everything new that is to be built to ensure the export of coal form Vale's coal mine in Moatize. There are two entirely new stretches of line within Mozambique - from Moatize to Malawi, and from Mossuril to Nacala-Velha. Mossuril is on the existing northern line from Malawi to the port of Nacala, while Nacala-a-Velha is on the western side of Nacala bay, opposite the existing port of Nacala. The government also approved a lease to CLIN (mainly Vale, as they are the majority holder) of the projected coal terminal at Nacala-a-Velha.

The total cost of the new terminal and the two new stretches of railway are estimates to be 1.5 billion USD. Construction started at the end of 2012. Construction time is estimated to be 3 years but there are already delays due to the difficult geological terrain. According to Government of Mozambique expectations the new railways will be able to move 40 million tons a year - about 30 million tons of coal from the Vale mine, while the remaining capacity could be used by other coal export companies, or be for the transport of people and goods.

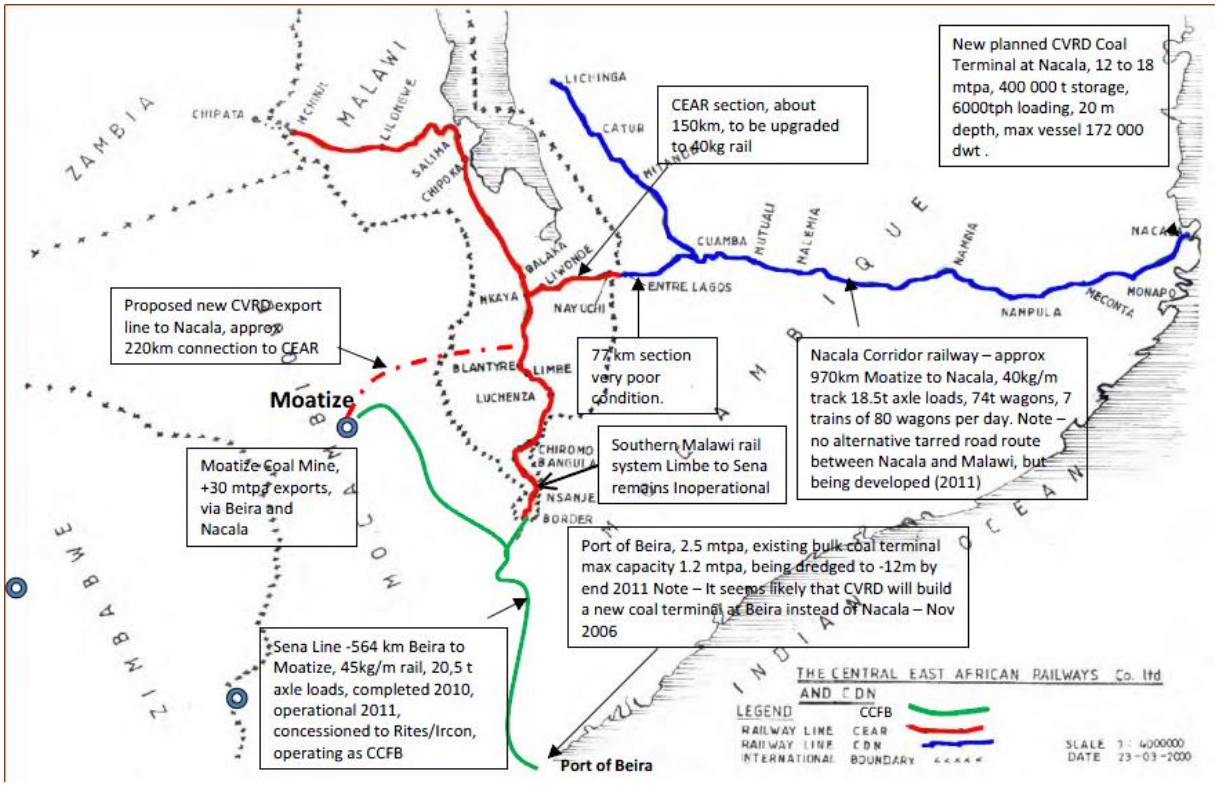
Vale also signed a rail concession contract with the Malawian government in December 2011. The new line will run from Chikwawa in the far south of Malawi for 137 kilometers to Nkaya Junction, where it will meet the Malawi-Nacala line.

To complete the railway will require rehabilitating the existing line from Nkaya to Nayuci on the border with the Mozambican province of Niassa. This line is currently operated by Central East African Railways (CEAR). Vale owns 51 percent of the shares of Mozambique's Northern Corridor Development Company (SDCN), which in turn owns 51 percent of CEAR.

The railway to Nacala-a-Velha will also require upgrading of the line from the Malawian border to Mossuril, which is operated by SDCN.

The new railways are seen as crucial to Mozambican coal exports, since the only railway that is currently carrying coal, the Sena line from Moatize to Beira, has so far a maximum capacity of 6 million tons a year. Even the projected improvements to the Sena line will only bring its capacity up to 12 million tons a year (and eventually 20 mtpa) compared to a total production capacity for coal of 70 million tons a year.

Figure 3.6: Rail Infrastructure of the Nacala Corridor



Source: (Callaghan, 2013)

3.5.4 The natural gas in the Rovuma Basin and Infrastructure Requirements

The commercialization of natural gas is a rather complex topic and it would go far beyond this thesis to describe this in detail for Mozambique. However, if the infrastructure demand resulting from the exploration of this natural resource is to be shown, some explanations are needed. For the commercialization of natural gas in Mozambique it is necessary to decide whether to take a multi centre approach or to concentrate on one LNG-centre only. The Gas Master Plan concluded that a multi-centre development of the gas centre would bring the best growth prospects to the various regions but it would take the longest time to be operational. Focussing on one LNG centre would be the easiest solution and would have the shortest time towards an early commercialization of natural gas. So it was decided to go for a LNG centre solution at the coastal village of Palma, close to the Tanzanian border. The plan provides for two LNG trains to be operational until 2018 (realistically it will be rather 2020). The infrastructure works required at the remote place include the construction of an airstrip and the respective landing facilities for ships. The cost to develop the two train LNG plant and the required additional infrastructure is estimated at USD 15 billion.

The huge natural gas reserves of Mozambique have brought all the main companies in the gas sector to the Rovuma basin. Some of them have a specific relevance for related infrastructure development as they come with innovative solutions. It is still the declared aim of the Government of Mozambique that LNG exports to start shipping in 2018. This is an ambitious deadline in a country that has no established oil and gas industry and limited infrastructure. Shell could provide a technological infrastructure solution. A floating USD 10 billion LNG vessel could produce, liquefy and transfer gas to tankers for export, removing the need for a costly and complex onshore terminal as planned in Palma for a part of the gas reserves. The technology is being used by Shell only so far on a project in Australia with a similar five-year development schedule and could be one solution for Mozambique to export LNG already in late 2018. The capacity of the floating plant would be around 5.3 million metric tons of LNG and condensate a year. In May 2013, Shell revealed it has been in talks with Anadarko about acquiring a stake in its Mozambique fields but it pulled back because of the high price. The use of the floating solution depends on the success of further talks between Anadarko and Shell, in which both have shown interest (Flynn, 2013).

The Gas Master Plan also approved calculations on delivered costs of LNG to Japan for Mozambique and its main competitors in the US and Australia. It shows the cost to deliver one million of British termal units (mBtu) to Japan. At a first look the competitive situation looks promising for Mozambique with only 9.2 USD/mmBtu compared to costs of 11.1 USD/mmBtu for the US and 12.1 USD/mmBtu for Australia. However, Ledesma (2013) rightly adds another 1.5 USD/mmBtu for infrastructure development for Mozambique and thus the competitive advantage of Mozambique becomes much smaller as the main competitors with a well developed infrastructure do not have these additional costs.

This shows the economic importance of infrastructure development for a Greenfield investment like in Mozambique for natural Gas. The formula is quite simple: without a proper and adequate infrastructure there will be no use of the natural gas reserves and no benefits from this part of the resource boom.

Figure 3.7: Diagram of Planned Anadarko LNG projects

(source: Ledesma, 2013)

3.6: Layer Six: Maritime Infrastructure

The logistics and transport layers have shown the current and future capacity requirements for ports in Mozambique. This final layer deals with the question whether ports are and will be able to handle the current and expected cargo flows. Again it will concentrate on the three major seaports of Maputo, Beira and Nacala. Additionally, newly planned port infrastructure will be considered. This layer, along with layer five, has been influenced by all other layers previously discussed. Based on current economic developments in Mozambique and Southern Africa, the current and forecasted developments in trade, logistics, transport and transport infrastructure this part serves to outline the future requirements on the port infrastructure in Mozambique. Using outlined forecasts of cargo flows, ports should be able to overcome bottlenecks in infrastructure that would allow them to accommodate these future cargo flows. Again, the consequences resulting from the resource boom will be in the focus of the analysis. It was shown in the layers three to five that there might be alternatives for the transportation of natural resources and other cargo from the hinterland to the ports but no alternatives for the ports exist to ship the cargo to the main export markets. Therefore it is assumed that ports will be able to increase port efficiency through the involvement of world class port operators. It is further assumed that trade barriers are lowered by an improved regional integration. A reasonable regulatory environment for private businesses will encourage foreign direct investment and foster economic growth. This assumed infrastructure investment will be the key for enhancing the ports capacities. This layer will analyze the ongoing planned and needed infrastructure investments for maritime infrastructure.

3.6.1 Maputo Port Infrastructure

The Port of Maputo currently includes: General Cargo pier, cabotage terminal, container terminal, sugar terminal, petroleum terminal, molasses terminal, Matola coal terminal and Matola grain terminal. Port throughput was over 12 million tons in 2011 (2003: 5 million tons). The port is managed by the joint venture Maputo Port Development Corporation, the Maputo Port. Maputo Ports capital structure is as follows: Portus Indico 51 percent and CFM 49 percent. Portus Indico consists of DP World, one of the leading global port operators with 48.5 percent, the South African company Grindrod 48.5 percent and a small group of Mozambican investors with 3%). Terminals operated by private foreign companies under sub-concession agreements with Maputo Port authority. The majority of these terminals are dedicated to the export of outputs from megaprojects such as aluminum, agricultural and mineral products (some as transshipments from neighboring countries). A few terminals also cater for the export and import of a variety of products and one is dedicated to cars.

The port can operate 24 hours, 7 days a week. It has a total of 11 berths with drafts between 7m and 12m. The total port concession area is 140.6 ha of which 134.2 ha is used, leaving little developed space for enlargements. However, the total jurisdiction area of the port is more than 5000 ha. The port processes approximately 900 road trucks per day and its services are fully integrated from landside to vessel operations. The channel depth has been a long time a severe constraint but is now of 11m due to investment in dredging. An average of 55 vessels is calling the port per month (657 vessels in 2012) (MPDC, 2013).

According to information from the Port of Maputo a total of 290 million USD were invested between 2003 and 2011 mainly for investments in infrastructure and equipment at the container terminal (113 million USD), dredging (16 million USD), investments in roads, railways, warehouses, quays, tugs, cars and equipment (99 million USD), investment in cranes and crane related infrastructure (61 million USD).

The Port of Maputo sees the main bottlenecks for port development in the low capacity of railway lines leading to the port, high berth utilization and the age of the berths (some are 100 years old), and in the lack of terminal and landside storage that is close to capacity.

To overcome the directly port related infrastructure bottlenecks investments of 1.7 billion USD are planned between 2012 and 2030 within the jurisdiction area of the port. The main investments are planned already until 2020 and consist of 834 million USD for a substantial enlargement and modernization of the coal and minerals terminal, 300 million USD for the container terminal, 104 million USD for the bulk terminal, 47 million USD for dredging to 14 m and 246 million USD shall be invested for road, rail and berth improvements.

The planned investments will not only modernize and enlarge the existing port; it will reshape the whole port area within the next 10-15 years. This current state and the planned expansion areas are depicted in figure 3.8 below. With these investments, the port of Maputo will be able handle the cargo flows predicted for 2025-2030 and shown in layer four (36-45 million tons of cargo). Main growth cargo will be coal and minerals growing from 6 million tons p.a. to 30 million tons p.a. Containers are expected to grow 150,000 TEU to 70,000 TEU and dry bulk is expected to grow to 8 million tons p.a. from 2 million tons in 2011.

However, this paper has shown under layer five that the handling of these cargo volumes will be only possible if a viable railway solution is found for transport of cargo from South Africa through the Maputo corridor to the port of Maputo.

Figure 3.8: Maputo Port expansion areas

(Source: MPDC, 2013)

3.6.2 Beira Port Infrastructure

The port of Beira is situated in the center of Mozambique on the Pungue River and historically has always been an essential transit port for handling cargoes from Zimbabwe, Malawi and Zambia. It is the second largest port in Mozambique with 12 quays assigned to a multi-purpose container terminal, general cargo terminal, fuel terminal, and a grain terminal. Since 1998, the port of Beira is under private management of Cornelder de Mozambique (CdM), which is a joint venture between Rotterdam-based Cornelder Holding (owning 67 percent) and the government entity CFM. Furthermore, the container and general cargo terminal is operated by Cornelder, and in combination account for 80 percent of the ports trade in 2011. In 2011, cargo throughputs were around 5.7 million tons, accounting for about 30 percent of cargoes handled in comparison to all the ports of Mozambique. In 2008, handled cargoes were around 3 million tons, the increase from 2008 to 2011 is indicative of prolific developments taking place in the Beira corridor as cargo throughputs have doubled. Averages of 51 vessels are calling the port per month (612 vessels in 2011) (Sutton, 2012).

Information on the port of Beira has been taken from documents found on the website of CFM, as well as from a Port Masterplan developed for the Beira port by van der Meer (2013).

The port can operate 24 hours, 7 days a week but night navigation is restricted to vessel with 7 m draft and a length of 140 m. Coming from the sea, the first of the 12 berths is assigned to fishing vessels. From berth number 2 to 5, along 646 meter quay, multipurpose and container vessels are handled. Berth number 6 to 10 have a total length of 858 meter. Berth 6, 7, 9 and 10 handle general cargo and dry bulk, number 8 (new berth) is dedicated to coal export. Berth number 11 was the official tanker berth, but it is no longer operational. The newest berth, located approximately 1 km upstream from berth 11, is a fuel jetty, operated by British Petrol (BP).

There is a functioning railway connection into the port. The container yards are large enough for current demand, though there are only two ships to shore container cranes available for 3 berths. The available coal loading equipment and the storage area for coal are sufficient to handle 5 mtpa. There are several maritime infrastructure related constraints for a further development of the port. The railway line and the station limit the room for further expansion of terminals land inward, a single access/exit gate hinder port access for trucks, port road dimensions are inadequate. For port expansion there is an area of 800x800 m available just one km upwards the existing port. The land was acquired with sand from the 2001 dredging works of the access channel and is marked for future port development. However, the main constraints for further port development of Beira are hinterland railway connection (see layer five) and the situation of the wet infrastructure. The access channel has only 8 m draft and suffers from constant sedimentation from the Pungue river. The access channel is long and only one way. The quay closest to the sea is only accessible for small ships. Current dredging is required in the access channel and along the berths in the port. There is sufficient dredging equipment for maintenance dredging in Beira, investments in deeper channels and berths would require additional equipment. The depth limitations lead to extreme waiting times for coal ships of 160,000 DWT. Wind conditions require pilotage and tug boat assistance in the port basin is mandatory.

In the Beira Port Master Plan the most likely scenario foresees investments of a magnitude of 389 million USD between 2012 and 2027 for port infrastructure only. If

one adds the 22.5 million maintenance dredging costs for this period, investments will reach 412.5 million USD.

To overcome the directly port related infrastructure bottlenecks mentioned above these investments mainly consists of 196 million USD for capital dredging to 1.3 m access channel depth, 92 million USD for quay extensions, 30 million for a new jetty, 10.5 million USD for port roads and railroads, 13.5 million USD for the relocation of the coal terminal and the workshops. The planned investments will modernize and enlarge the existing port; it will reshape the whole port area within the next 10-15 years (van der Meer, 2013).

With these investments, the port of Beira will be able handle the cargo flows predicted for 2020-2025 and shown in layer four. Main growth cargo will be again coal growing from 2.44 million tons in 2012 to 12 million tons p.a. from 2020. Containers are expected to grow to 400,000 TEU in 2020 and dry bulk is expected to grow to at least 3 million tons p.a. from 1.4 million tons in 2011. The fuel throughput can reach 3.75 million tons in 2020 but this depends on further investments in the pipeline going to Zimbabwe.

As for the Ports of Maputo and Nacala covered by this thesis, also for the port of Beira the handling of these cargo volumes will be only possible if a viable railway solution is found. For Beira there are even two challenges: to transport cargo from Zimababwe (Machipanda line) and above all for the Sena line for coal transports from Moatize.

3.6.3 Nacala Port Infrastructure

Nacala is Mozambique's most northerly port with overseas services at a large and sheltered bay 60m deep and 800m wide at the entrance. There is no draft restriction for the size of vessel that calls, except alongside a berth. The Port of Nacala currently includes: four General Cargo berths and one container berth. Port throughput was over 1.2 million tons in 2011. The port is managed by the Corporation for the Development of the Nacala Coridor (CDN). The terminals are also operated by CDN.

The port can operate 24 hours, 7 days a week however, frequent power cuts are affecting operations negatively. It has a total of 5 berths with drafts between 12 m and 14m. The container terminal has a berth length of 372m with a depth alongside of 14m. Bunkering is available by road tanker with a pipeline at the general cargo berths. An average of 17 vessels is calling the port per month (200 vessels in 2010).

The Port of Nacala sees the main bottlenecks for port development in the low capacity of railway lines leading to the port, the lack of a functioning rail container terminal, poor port infrastructure and handling equipment, and in poor port roads. Poor performance of port operations can be added. Nacala's handling efficiency is low with an average of about 7 containers per hook/hour compared to 12 containers per hook/hour as the average for Sub-Saharan Africa. This is according to a port performance study conducted for the USAID (Cronje, 2011). According to this study, causes for slow handling may include unsuitably equipped vessels, insufficient container handling equipment at the port and the lack of a recognized container operations and management system by the container terminal operator.

According to information from CDN and the Japanese Cooperation Agency (JICA) a total of 200 million USD will be invested between 2013 and 2023 for investments in infrastructure and equipment. The planned investments include: the construction of a container rail terminal with appropriate handling equipment, the construction of a 1 km by-pass road for trucks, the widening and modernization of the main entrance system, rehabilitation of port roads, modern cargo handling equipment (mainly loading arms), installation of fenders for the container berth and the general cargo berths, upgrading of the container terminal including pavement, dredging along the north quay to 18 m (GAZEDA, 2013).

The planned investments will modernize the existing port but it will not reshape the whole port area within the next 10-15 years. With these investments, the port of Nacala will be able to handle the cargo flows predicted for 2025-2030 and shown in layer four (5.3 million tons of cargo in 2030). Main growth cargo will be agricultural products, minerals and fuel. Containers are expected to grow 51,000 TEU in 2010 to finally 490,000 TEU in 2013.

New coal terminal at Nacala a Velha

The biggest change in the port infrastructure in Nacala will be the construction of a new deep water port with a coal terminal at Nacala-a-Velha. This is opposite the existing port at Nacala Bay. The Brazilian multinational Vale will invest over 5 billion USD on building a railway link with the Moatize coal basin and the port facilities at the new coal terminal in Nacala-a-Velha with a capacity of 20 million tons per year. Vale will also operate the coal terminal. Costs for the coal port are estimated to be around 1 billion USD alone. The rail route shall have the capacity to carry between 18-30 million tons of coal per annum by 2016 (Reuters, 2012). The time schedule seems to be ambitious and there are already reports that the engineering of the railway lines is delayed due to difficult geological conditions. However, it can be assumed that from 2020 between 10 and 20 million tons of coal will be shipped from Nacala.

3.6.4 Natural gas in the Rovuma Basin and Port Developments in Northern Mozambique

In layer four the transport demand for LNG Exports has been analyzed and in layer five the transport infrastructure needed to meet these demands for exports have been shown. It is obvious that there is a need for maritime infrastructure too. Basically two technical solutions are possible to export LNG from the Rovuma Basin to overseas main markets. A landside port infrastructure specialized for LNG exports and hence tankers with direct connection to landside LNG plants. Or a floating LNG vessel that could produce, liquefy and transfer gas to tankers for export. Both options have been shown in layer five. According to the plans of the multinational companies acting in the Rovuma Basin it is very realistic that both solutions will be explored. The floating LNG plant could produce 5.3 million metric tons per year for exports. As shown before it seems realistic that a first two train LNG plant is operational by 2020 leading to a transport demand of 10 million metric tons of LNG per year. Another two trains could be added every two years until 2024/2025 (total of six LNG trains) in Palma. That would result in a transport demand of 30 million metric tons per year from 2025 from Palma only. Furthermore it is a realistic option that another 5 million metric tons per year train will be built in Pemba, the capital of the northern province of Cabo Delgado until 2022

with another train following in 2024. Total capacity for LNG exports from Pemba would be 10 million metric tons.

Without maritime infrastructure the value chain for LNG will be interrupted. Subsequently, in Palma and Pemba investments in port infrastructure are an important precondition for the success of the natural gas plans. However, specific plans are difficult to obtain and concrete figures and solid and more detailed estimates could not be found. This is partly because the awards of front end engineering design contracts for the infrastructure are still not finalized. The World Bank and the government of Mozambique have commissioned a study: "The future of natural gas in Mozambique: Towards a gas Master plan" (2012). It gives some indication on maritime infrastructure needed. Port facilities for LNG ships of up to 260,000 cubic meters capacity and barges, LNG storage tanks, degasification facilities, equipment warehousing and storage yards for the LNG sites are to be built. Different port facilities for, service ships and port facilities for receiving overseas equipment and materials, equipment warehousing and storage yards, food and consumables storage facilities for approximately 500,000 people involved in construction, exploration, production and (transport) services are to be built and operated. Power supply and transmission, pipelines and roads need to be in place.

This will involve huge investments in Palma and in Pemba but real cost estimates on maritime infrastructure only are not yet known. The cost to develop the first two train LNG plant and the required additional infrastructure is estimated at USD 15 billion. It can be assumed that the port infrastructure will already be built to cater for future LNG trains too, so a considerable part of these 15 billion USD will be for maritime infrastructure. Costs for the 5.3 million metric tons LNG vessel (floating LNG train) will be 10 billion USD.

Other than for the ports of Maputo, Beira and Nacala, the construction of this port infrastructure will be greenfield investments. It will bring a totally new dimension of maritime infrastructure to Mozambique´s underdeveloped north with huge direct repercussions for the economic, social and environmental situation in this region and for the whole of Mozambique. The analysis and presentation of these repercussions are not direct part of this thesis. It concentrates on the consequences of the resource boom for port development but it can be said that without the maritime infrastructure in place, no

exports of LNG will be possible. The effect of the natural gas resources for the economy and the people of Mozambique would be necessarily very limited.

3.6.5 Future Maritime Infrastructure Megaprojects

The port at Ponta Techobanine

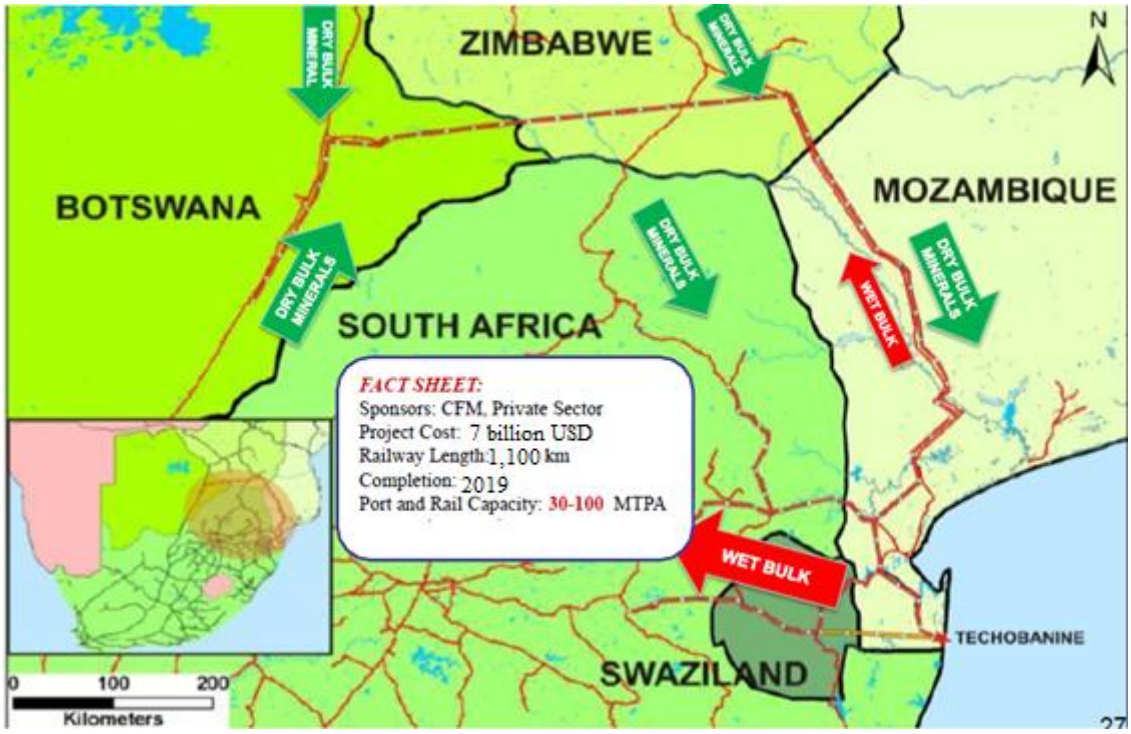
In 2010 a Memorandum of Understanding was signed between the governments of Mozambique and Botswana for mobilizing funding aimed at implementing the Ponta Techobanine project, which consists of building a deep water port and a 1,100 km railway, as a Greenfield investment, that ensures the export of cargo from Botswana, South Africa, Swaziland and Zimbabwe. The governments seek 7 billion USD in financing to build a deepwater port in Techobanine, which is located in the southern Mozambique's Maputo province (Macauhub, 2010). It is located 70 km away from the Maputo port, and the plan is to take pressures off Maputo port, which has to deal with capacity constraints already and to avoid the congested railway lines and ports of South Africa.

The port complex is planned to occupy an area of 30,000 hectares, including 11,000 hectares for industrial development, and is planned to be able to process up to 100 million tons per year of diverse cargo per year, such as general cargo, bulk, minerals, fuel and passengers (Macauhub, 2010). At Techobanine, vessels of any draft will be able to access the port and is thus to complement the Port of Maputo.

The natural deep water harbor is planned to become an important regional strategic reserve of fuel and is to provide infrastructure ideal for the export of minerals of various countries, mainly South Africa and Botswana. This project is particularly in the interest of Botswana as discoveries of high quality coal have been made, and Botswana has firm intentions to export through Mozambique.

The building of the port also includes the building of a 1,100 km railway to link Techobanine to Botswana, passing through Zimbabwe, as well as an oil pipeline between the countries. The location and the path of the railway planned to be constructed can be seen in figure 3.9.

Figure 3.9: Railway and Port Project Techobanine



(CFM, 2013)

The railway and port project has a backing for financing from Botswana, Mozambique and Zimbabwe and but according to a paper by the SADC on Regional Development Infrastructure Master plan (2012), financing of about 5 billion USD has been secured. Although the government has stated a completion of the project already by 2015, this is highly unlikely and securing the financing has been taking longer than anticipated, now the Government of Mozambique set out a date of completion by 2019. Also it should be added that construction of the facilities of the port and railways is 7 billion, terminals and their operation are up to private entities, so the costs are actually much higher than 7 billion for an operational port. Furthermore, the railway route from Botswana avoids South Africa because shipping coal across the shorter, direct route to Richards Bay or Durban would mean crossing mountainous terrain which is unfeasible.

Financing is not the only threat for this project. As the route crosses three countries, it is dependent on continuous open borders and political stability, which particularly Zimbabwe may threaten. Also, there are massive environmental issues as the area is in a conservation area, as well as a game reserve and in close proximity to a marine reserve. Additionally the position of South Africa towards the construction of

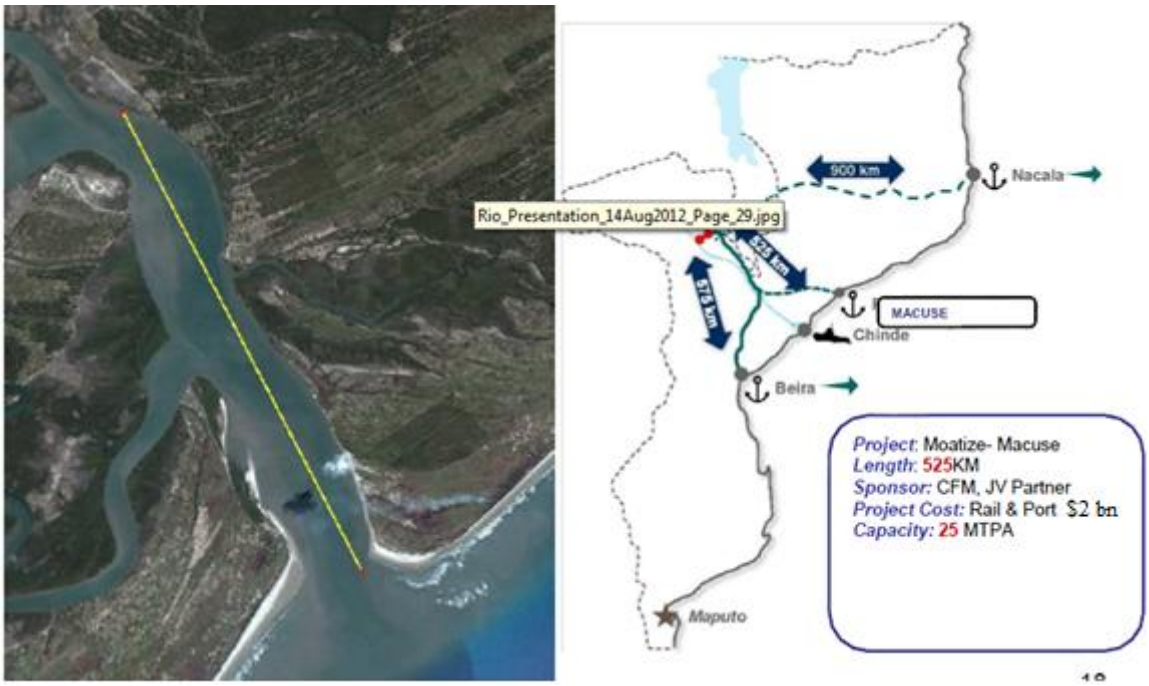
Techobanine is unclear. The port will be close to South Africa's northern border and besides environmental concerns it will be a threat to the further development of Richards bay an even Durban port. It can be assumed that no port in the region will be successful without the full cooperation of South Africa. Nevertheless, the involved countries claim that plans for this project are at an advanced planning stage.

Macuse Port

Another project, which is in the process of seeking bids for 2 billion USD, is the construction of a new port which is planned to handle around 20 million tons of coal per year and of a 525 km rail line from Tete province to Macuse, Zambezia province (Reuters, 2012).

Not much information is made public on this project yet; however, it does seem reasonable in order to overcome the infrastructure constraints for the coal exports as described under layer five for the ports of Beira and Nacala. The information available so far indicates that Rio Tinto has an interest to export coal from its Benga mine in the Moatize basin to the coast for exports mainly to India. The Mozambican Government has also signed agreements with the Government of Thailand to finance its share in the new investment. As can be seen in figure 3.10, the location is ideal for coal exports from the Moatize coal basin, providing the shortest route to sea access. Considering current state of Beira and Nacala port and their railway lines, and their inability to handle the amounts of coal to be exported, Macuse is a viable solution. Sources say that, completion of the project is aimed at 2017. This seems highly unlikely, given the track record of construction delays for other infrastructure projects in Mozambique, especially with regard to railway projects. But the project as such has a high probability to be realized as the economic interest to transport and ship the coal from Tete/Moatize to the main export markets is high.

Figure 3.10: Macuse Port and Railway logistics Option



(CFM, 2013)

Chapter 4: SWOT Analysis

The previous chapter has outlined different layers of influence that ultimately lead to a description of currently available maritime infrastructure of the three major seaports in Mozambique. Also future developments and investments that are currently being planned or undertaken have been analyzed and outlined. This all has been put into context of the natural resource wealth that has been discovered in recent years. Ultimately, what stands out is that in order to take advantage of this natural wealth, it needs to find access to world markets. A key factor is transporting the resources such as coal or natural gas from the inland or the shores of Mozambique to the major ports from where it can be shipped to the customers. In this part of the paper, a SWOT analysis is done as a conclusion on the previous chapters. The most vital characteristics of the Ports of Maputo, Beira, and Nacala are summarized. Strengths are described as those factors that are already available at the ports and will help the ports to further operate successfully. Weaknesses are factors that hinder planned developments; however, they could be turned into strengths by the port authorities. Opportunities and threats are

external factors that cannot be influenced directly by the port authorities only; however; opportunities provide a potentially favorable situation for future port developments and threats would be potentially damaging for future developments.

4.1 SWOT Maputo Port

Strength:	Weaknesses:
Location • Maputo well located to provide sea access to South Africa's industrial heartland around Johannesburg and Pretoria (closest seaport) • Maputo itself is most dynamic economic area of Mozambique besides resource clusters (growth) • Direct road and rail connections with Lesotho, South Africa, Swaziland, and Zimbabwe • Maputo Corridor Logistics Initiative (MCLI), linking the Maputo port with most industrialized areas of South Africa by road and rail • Excellent road infrastructure (privately operated toll road) in place ensuring accessibility and connectivity with Maputo port and South Africa Landside port Infrastructure and operation: • Continuous 24 hours port operation • Port authority is clearly organized with DP World, a world class port operations company, as a major shareholder with a long term concession commitment until 2033. • Modern 'Landlord Port' model implemented with a MPDC as port operator and port authority, with private companies managing various port terminals • Railway and road connection into port recently modernized • Container yards are large enough for current demand and have capacity reserves • Modern coal and ore loading equipment and storage area available to handle 6MTPA	Location • Although rail infrastructure in the Maputo Corridor is in good condition in comparison with the other transport corridors, Rail traffic is at almost full capacity on the Ressano Garcia line to/from South Africa and if it remains at current levels of will become a major constraint to growth. • No hinterland connections by river Landside port Infrastructure and operation: • Existing port infrastructure, will soon reach and some already are working at full capacity. Enlargement takes time • Berth structures are old (some 100 years) and rehabilitation is complex Wet Infrastructure • Ships of larger dimensions cannot access port • Channel depth of 11.5m and continuous dredging required due to sedimentation Traffic • Long waiting times due to high usage of berths • Railway expansion is needed and will take time • Channel conditions require pilotage • Current conditions require tug boat assistance for maneuvering inside the port basin

• All terminals with modern handling equipment Wet Infrastructure • Dredging equipment available • Ships of depth to 11.5 m can reach port (2006 only 9m) • A second new tugboat operational since 2012. Traffic • Rise of traffic in recent years • Huge potential for additional traffic from South Africa depending on viable railway solution	
Opportunity: Location • Further developments of MDC. South Africa is currently a key market for Maputo ports exports and imports handled; however, Swaziland, Zimbabwe, Zambia, as well as Mozambique have potential to grow leading to increased throughputs. Landside port Infrastructure and operation: • Port jurisdiction area of more than 5000 ha providing ground for port expansion • Planned investments (most with secured financing) in Maputo Port from 2012 -2030 amount to 1.7 billion USD . • Port and terminal operators are prepared to invest in equipment according to arising needs Wet Infrastructure • System of access channels and situation in port basin is well known, plans for capital and maintenance dredging exist, investments planned Traffic • Economic growth in South of Mozambique and in hinterland countries	Threats: Location • Competition of South African ports in Durban or Richards's bay, which have their own developments, which could cause competition between the ports to intensify. • Total port area is 140.6ha of which 134.2 ha is being used. 95 percent of available land area in use. Space constraints for medium term expansion plans. Landside port Infrastructure and operation: • Throughput demand higher (short term) than landside infrastructure can handle • Further deteoration of old quays Wet Infrastructure • Ships of increasing dimensions are not able to enter port, due to sedimentation of the access channel Traffic • Delayed railway developments, as well as general rail capacities. In all throughput growth scenarios, growth is only possible if a rail logistics solution is found to move at least 36 million tons by 2026. • Plans to build port of Techobanine only

• High potential for exports of coal, ferrochrome and magnetite from South Africa via Maputo • Good collaboration between South Africa and Mozambique to develop Maputo corridor • Increased traffic from downstream investments from firms related to natural resource boom, imports of materials and equipments, exports of potential production (fertilizer, fuel from coal and LNG, energy intensive production, methanol)	few km south of Maputo (though doubtful) could jeopardize development of Maputo port.

4.2 SWOT Beira Port

Strengths:	Weaknesses:
Location: • Nearest ports are 1000km away, little competitive hinterland • Connected to hinterland by road, rail, and pipeline Zimbabwe, Zambia • Open grounds reserved for port expansion Landside port Infrastructure and operation: • Railway connection into port • Container yards are large enough for current demand • 24 hour operation • Coal loading equipment available to handle 5MTPA • Storage area for coal available to handle throughput of 5 MTPA • Good port operator with international partner (Cornelder) Wet Infrastructure • Dredging equipment available with sufficient capacity for maintenance dredging Traffic • Rise of traffic in recent years	Location • No hinterland connections by river • Bad state of hinterland connections limiting capacities of road and railway • Pipeline capacity reached • Presence of deep sea port of Nacala (1,100 km away) • Rain season with occasional typhoons Wet infrastructure • Shallow access of -8m CD • Sedimentation of the access channel • Long access channel • One way in access channel • No night sailings possible • Quay closest to sea only accessible to small ships Traffic • Long waiting times due to daylight limitation • Long waiting times due to tidal window • Extreme waiting times due to depth limitation for coal ships of 160,000 DWT • Railway rehabilitation and expansion

• Ports and railway managed by same company • Potential for up to 20 million tons of coal from Moatize	has years delay • Wind conditions require pilotage • Current conditions require tug boat assistance for maneuvering inside the port basin
Opportunities: Location: • Closest port to estimated 2.3 billion ton coal reserve • Rehabilitation and expansion of hinterland railway line • Rehabilitation of road hinterland connection Landside infrastructure • Implementation of new container terminal equipment • Room for lengthening existing quay along river • Available area for expansion of terminal grounds along river front Traffic: • Economic growth in all hinterland countries • Fertilizer import for growth in agricultural sector • Increased traffic from downstream investments from firms related to natural resource boom, imports of materials and equipments, exports of potential production (fertilizer, fuel from coal and LNG, energy intensive production, methanol)	Threats: Location: • Typhoon hits Beira Port damaging port severely • Political situation in Zimbabwe and consequences for economy Landside infrastructure • Throughput demand higher than terminal areas can handle • Insufficient quay length Wet Infrastructure • Ships with increasing dimensions cannot access Beira Port Traffic • Coal export largely dependent on railway expansion • Large uncertainty about attracting coal export through Beira Port • Expansion of railway line from coal reserves towards Nacala Port • Initiatives to construct new ports along Mozambique coast (between Beira and Nacala) for exporting coal

4.3 SWOT Nacala Port

Strengths: Location • Serves own hinterland • Connected to Malawi by 914km railway • Large and sheltered bay, 60meters deep and 800 meter wide	Weaknesses: Location • Currently, least developed corridor in Mozambique • No railway connection yet to coal basin of Moatize

• Currently only deep sea port in North of Mozambique Landside port Infrastructure and operation • infrastructure is sufficient for current demand for containers, general cargo, fuel • modern coal teriminal with up to 30 mtpa will be build at Nacala-a-Velha Wet Infrastructure • Natural deep sea port with virtually no draft restrictions for vessels Traffic • Potential for up to 20 million tons of coal from Moatize • No waiting times for ships due to tide or draft restrictions	Landside port Infrastructure and operation • Facilities and equipment in poor condition • Electricity supply unreliable • Port area lacks paved roads, and ground is not level. • Current port operator does not guarantees efficient port operations Traffic • Initiating Corridor development has historically been slow simply because there has not been the demand, that justified rehabilitation of hinterland of port
Opportunities: Location • Port is comparatively close to 2.3 bn tons of coal reserves • Economic development in Malawi and Zambia • Closest overseas port for natural gas cluster at Rovuma basin with road connection – possible hub for equipment Landside port Infrastructure and operation • Planned investments (most with secured financing) in Nacala Port from 2012 -2023 amount to 200 million USD addressing main infrastructure bottlenecks . • Closest developed deep-sea port to LNG fields further North • rail way lines can be rehabilitated and extended • Vale initiative to upgrade railway line from Moatize coal fields to Nacala • Interest of Vale in participation in operating companies of ports and	Threats: Location • 600km Macuze port in planning phase, and could threaten Nacala port developments on the back of coal exports Landside port Infrastructure and operation • Inability to overcome infrastructure constraints • A experienced and efficient port operator needs to be contracted • Delays in construction of coal port terminal at Nacala-a-Velha Traffic • Throughputs dependent on economic developments in Zambia and Malawi, as majority of cargo going through the port has been transit cargo. • Railway solution from Moatize to Nacala is delayed or fails

railways Wet Infrastructure • No natural limitations on ship sizes, allowing ample opportunity to accommodate heavy cargos. Traffic • Port is in demand for cargo shipments from neighboring countries, in particular exports from Malawi, Zambia • Well situated for imports of materials and equipment for LNG developments further north. • Economic development initiatives in Nacala Corridor will lead to increased exports and imports through the port • Railway from coal basin to Nacala port to be built • Fertilizer imports for Malawi and Mozambique • Increased traffic from downstream investments from firms related to natural resource boom, imports of materials and equipments, exports of potential production (fertilizer, fuel from coal and LNG, energy intensive production, methanol)	

4.4 SWOT for Port Facilities at Natural Gas Cluster in Rovuma Basin

Strengths:	Weaknesses:
Location • Will serve an exploration area with what is expected to be the largest natural gas resource in Africa. • Strategically located to customers in India, China and Japan (lower costs to deliver LNG than competitors) Landside port Infrastructure and operation • Not yet existent but space for port development is available Wet Infrastructure	Location • Palma is in the very north of Mozambique at a very remote place Landside port Infrastructure and operation • Currently no port infrastructure in place • No other infrastructure (roads, pipelines, airports. Railways) in place Traffic • Natural gas cannot be exported overseas without being transformed into Liquid Natural Gas (LNG)

• Not yet existent but conditions are not complicated (no sedimentation, deep sea conditions) Traffic • Potential for up to 250 trillion cubic feet of natural gas • Up to 50 million mtpa of LNG exports are plant from 2025	• LNG production and transport is technologically complex
Opportunities: Location • Building of Port infrastructure is only alternative to transport LNG to main markets (to establish value chain) Landside port Infrastructure and operation • Planned investments will most certainly find investors and qualified operators as multinational gas companies like Anadarko and Shell are involved Wet Infrastructure • No natural limitations on ship sizes, allowing opportunity to accommodate big ships (up to 260,000 cubic metres) and heavy marine equipment Traffic • Increasing demand for LNG expected from 6 percent in 2000 to 14 percent of global gas supplies until 2025 • imports of materials and equipment for LNG developments • Further investments resulting from Natural gas resources need transport for import of equipment, material and for export of products (power plants, pipelines, fertilizer plants, fuel from gas to liquids, methanol)	Threats: Location • Remoteness of Palma, difficult to attract qualified labor Landside port Infrastructure and operation • Delays in the construction of needed maritime infrastructure due to regulatory or political problems • An experienced and efficient port operator needs to be contracted • Complex investments to be realized in a country with no experience so far Traffic • Though there is a steady demand expected, it depends largely on economic growth in India, China, other South-East-Asia and Japan

The SWOT analysis summarizes the main results of the thesis. In order to conclude the analysis the main factors for further development of the port system in Mozambique will be singled out. Weight is given to the different factors and they are linked to the different levels in the analysis.

4.5 Conclusion of the SWOT Analysis: Main factors that influence the further development of the Port System

A major factor contributing to an expansion in infrastructure developments is economic development and growth. In fact, infrastructure development and growth should go hand in hand. Mozambique's GDP developments rank it as one of the fastest growing economies in Africa and as outlined in layer one; this growth has been backed by substantial FDI inflows. FDI inflows will likely continue to increase through the presence of international oil and gas, and mining firms such as Rio Tinto, Vale, Anadarko and Shell. Growth prospects for Mozambique and the whole region of Southern Africa, the hinterland of Mozambique's ports, are good though influenced by political uncertainties. However, it would be trivial to rank economic growth and political stability as a single factor to influence port development. It is rather a necessary but not a sufficient framework condition for port system development.

If one puts weight on the factors, that influence most the development of the port system in Mozambique, the resource endowment situation (resource boom) is certainly the single most important factor. Throughout this research it has been clearly shown that Mozambique's resource endowment situation with coal and natural gas at the forefront puts it as a potential world class exporter. There seems to be ample opportunity, given the strategic location of Mozambican ports and relative proximity to India, China and the Far East including Japan. These regions have a fast rising demand for coal, natural gas and other minerals. They are likely key markets for Mozambique's resources. But requirements on transport infrastructure are straight forward, without a functioning port system, it will be impossible for coal and natural gas to reach world markets. Hence, this creates the single most important opportunity for the ports in Beira and Nacala, who are situated strategically to be shipment hubs for coal exports, to receive investments in order to build the infrastructure required to deal with such

exports. These investments are outlined in layer six. For Beira and Nacala it is mainly the expansion and building of facilities to handle the amounts of coal to be exported. Furthermore, the sheer quantities that are to be exported exceed the capacities of the port of Beira and Nacala, even after planned investments and capacity targets are being kept. The value of coal resources of 70 mtpa over three decades even make investments of entirely new ports feasible, to facilitate the exports of coal (Macuze, Nacala-a-Velha). Also, the natural gas resources further north of Mozambique give the country the potential to be one of the world's top exporters in a fast growing LNG market. However, so far there is no infrastructure in place that makes LNG production and exports possible. Investments will flow into the country and given a persistent situation of peace and political stability these infrastructures will be built. They will change the landscape of maritime transport infrastructure in northern Mozambique, this has been detailed in layer five (3.5.4).

With regard to the determining factors for port system development there are important differences among the three corridors. The port of Maputo currently deals with the highest throughputs (see layer four); and in terms of port infrastructure and port operations it is by far the most advanced in Mozambique. In the future, throughputs are forecasted to increase but not on the back of coal, natural gas or other natural resources located in Mozambique but rather from coal, minerals, agricultural and industrial exports from neighboring countries such as South Africa (with the industrial heartland around Johannesburg as the main driver), Botswana and Swaziland. This has been outlined in layer three and four—Maputo's success is largely based as its function of a transshipment hub for South Africa. Particularly, transports of coal from coal discoveries made in Botswana (which has not be detailed in this thesis) may catalyze the building of the Port of Techobanine, which has been analyzed in layer six.

The second most important factor influencing the further development of the Mozambican port system will be the development of transport infrastructure to bring the resources to the ports. Given that the vast coal and natural gas resources as well as cargo from South Africa and other neighboring countries, need to find their way from the inland to the coast of Mozambique from where it can be shipped across the Indian Ocean to world markets. As has been outlined in Section 3.4.5 on transport plans and policy, government policy objectives for transport infrastructure prior to the first

developments concerning the natural resource potential in 2006, was directed at rehabilitation of transport infrastructure of the three transport corridors dealt with in this paper. Since 2006, after which Mozambique's resource potential has seriously started to be discovered and developed, the issue of transport infrastructure for the region has drastically gained in importance. Revenues of the natural resource endowments could help drastically with the reduction of poverty and boost overall developments in Mozambique, a country heavily dependent on international donors. However, the most important pre-condition is transport infrastructure. A primary goal by policy makers is to facilitate exports of the natural resources and hence increase revenues and the improvement of the transport service function to the hinterland. Again, infrastructure requirements are straightforward: if the natural resources cannot be transported to the ports in an efficient manner natural resource export revenues cannot be achieved. Therefore the hinterland connections from the ports, particularly by railway, carry a major importance. This has been extensively looked at in layer five, particularly the sections on the corridors railways. The mining companies ultimately seek to export 70 million tons per annum through Mozambican ports. Currently the Sena Railway line to the Beira port with a current nominal capacity of 6 mtpa and actual transports under 3 mpta in 2012 is the only railway line currently transporting coal from Moatize. To close this enormous gap, rail lines are to be built, and operated as outlined in layer five.

The third most important factor for port system development in Mozambique are professional port and railway operators. They do not only guarantee a safe, efficient and effective cargo handling but also contribute to port development itself by dedicated investments in port infrastructure and modern port handling equipment. This has been shown in layer six. In particular the port of Maputo, but also the port of Beira, have proven that Public Private Partnerships can lead to successful port concessions. Good port operators will attract cargo (as shown in layer four) and they are able to compete with other ports in the region. Good operators are also a key factor for the success of railways. Mozambique's experience with railway concessions is mixed but experiences from port PPPs could be used to shape future concessions. There are, of course a number of preconditions to attract world class partners for PPPs such as the potential for cargo, the regulatory framework, foreign investment protection, the availability of trained labour and a flexible labour law, political stability, good contracts establishing

clear rules for both the private and public partners and a transparent and fair mechanism for conflict resolution. This thesis was not about PPPs, but for the development of the port system they are, and have been, crucial as can be seen from the successes of the Maputo Corridor. The prospect for Mozambican ports and railways to attract further world class private operators to acquire concessions is rather good. Again, the multinational companies of the natural resource cluster set the scene in a partnership with Government of Mozambique based on mutual interest.

Putting further weight on influencing factors the fourth most important factor for port system development in Mozambique is the progress of regional integration and cross border cooperation based on sound national transport policies (see layer four, 3.4.5). This is true for all three transport corridors totally independent of the resource endowment situation in Mozambique. All three transport corridors, and their ports, are essential transshipment hubs for its landlocked neighbors or industrial, agricultural and natural resource clusters of South Africa (mainly Maputo). The Maputo corridor is operating at a much larger and advanced scale when compared to Beira and Nacala as concrete implementation of measures to improve regional integration have taken place (i.e. the toll road Maputo-Johannesburg, cooperation in the development of the Ressano-Garcia railway line, 24 hours border post). For the development of all ports it is necessary to pursue a policy that aims at the sustainability of investments in transport services for the neighboring countries. Flourishing economies in Southern Africa can still generate cargo for Mozambique´s ports even after the natural resources has come to an end.

Number five of the factors influencing port system developments in Mozambique are the outcomes of the plans of Government of Mozambique on what to do with the natural resources in Mozambique itself. There is so far no consistent strategy on how to use the resources to develop national industries and to place Mozambique further up in the value chains of coal and natural gas (see layer three). The focus on logistics services is one important factor directly affecting port development but there are also plans to build power plants, pipelines, fertilizer plants, steel mills, cement factories, amongst others. This will generate cargo directly because equipment and materials have to be imported and the products of these ventures will be exported to a large extent. Agriculture could get a boost by the availability of nationally produced fertilizers and in

fact growth expectation for cargo from agriculture are high (see also layer four). The thesis does not concentrate on those developments as they are further up the development timeline. However, for the sustainable development of the port system of Mozambique they might be of equal or even bigger importance than the resource boom itself.

There are many more factors that influence port development in Mozambique. These factors reach from world market developments for key commodities to the effects of climate change which threaten i.e. the port of Beira. It would have gone far beyond the pretension of this thesis to analyze all of these possible factors in detail. Nevertheless, the author of this thesis believes that with the six layer approach and the SWOT analysis the main factors influencing port system development could be singled out, based on solid facts, weighted and put into a broader perspective.

Chapter 5: Overall Conclusion

This paper set out to show the consequences of Mozambique's strong economic development over the past decade along with discoveries of vast amounts of natural resources in Southern Africa on the port infrastructure of Mozambique. The approach is based on the principle of derived demand and the analysis involved six layers of influence from economic development to maritime infrastructure which ultimately influences the development of the Mozambican Port system. The base for this research method came from the framework for analyzing maritime infrastructural needs created by de Langen et. al. (2000).

The first two layers analyze the current stage and the prospects for Mozambique`s general economic development and trade with a link to the neighboring countries in the hinterland. These two layers show that general economic development in Southern Africa is promising with Mozambique as a very good performer with growth rates among the highest in Africa since over a decade. This is again reflected in growing trade volumes and a positive outlook for further increases of trade as described in layer two. A sub chapter under layer one then introduces the resource endowment situation to the paper and the numbers presented here for commodity reserves in Mozambique and in South Africa show that future infrastructure and port developments will be determined by the question of how to bring these resources to its main overseas markets.

In layers three and four it was analyzed, which value chains are most relevant for Mozambique's ports and what are the prospects for these value chains to generate cargo. Layer four than analyses the current and future transport demand for the existing transport corridors and for any new possible investments in infrastructure. Again the analysis proves the magnitude of the natural resources for the ports. There is more potential cargo resulting from drivers such as logistics initiatives for a better link of Maputo to Johannesburg area, agricultural developments in Mozambique and its hinterland, demand for equipment and materials and in general from economic growth. However, these factors will by far not reach the significance of the natural resources.

Layers five and six than examine the transport infrastructure situation in Mozambique and the current situation of the port infrastructure. Again this is based on

the three transport corridors, but also new planned infrastructure developments are listed and described. Not surprisingly, the figures presented and the investment plans confirm the picture given in the previous layers. The need to transport the resources to the ports and to ship them to the customers is the main driving force. Coal exports from the Moatize basin in central Mozambique, LNG production and exports from a completely new port system in Northern Mozambique as well as coal and mineral transshipments from South Africa are the driving commodities. As a consequence, the ports of Mozambique require massive investments in maritime infrastructure as described in layer six. These infrastructural needs have been determined by this thesis through the help of the framework applied to Mozambique.

The six layer approach subsequently leads to a SWOT analysis of the ports. The analysis summarizes the findings of the layers and puts them into the perspective of port system development in Mozambique. The SWOT analysis concludes on the main factors influencing the Mozambique port systems by ranking these factors.

It is now time to conclude on the research question: What are the consequences for port developments in Mozambique in light of the current resource boom and strong economic developments? The conclusion will be given by answering the sub-research questions one by one and by presenting the findings of the thesis in a nutshell.

What is the current port infrastructure situation?

There are differences between Maputo port, which is more developed and well operated in order to serve the transport demand of its mainly South African customers, than Beira and Nacala. This is analyzed under layers three to six. A major reason for this is that the Maputo port is in proximity to South Africa's strongest industrial heartland, whereas Beira and Nacala do not have such an economically developed hinterland which would generate equivalent throughputs as Maputo port is receiving. Beira is the only port so far shipping coal from Moatize. Beira's coal terminal has a capacity of up to 12 mtpa after rehabilitation in 2011. However, less than 3 mtpa reached the port and were shipped in 2012 due to the constraints of the Sena railway line which has a nominal capacity of 6 mtpa after rehabilitation works completed in 2011. For natural gas the current port infrastructure situation is non-existent. There are no port facilities so far to transport natural gas to its potentially main markets in India and the Far East. However, the gas can only be transported by special ships if it is transformed into liquid form,

which requires huge investments in infrastructure and processing plants. Respective production capacity is not expected before 2019/2020 (10 mtpa) and the needed port facilities will be built in parallel to the LNG trains. Maputo could handle up to 36 million tons of cargo in 2015 already as terminals are modernized and efficient port operations by PPP concessions are in place. However, the big constraint again is a viable railway solution. In a nutshell: The current port infrastructure is already insufficient to deal with the natural resources that need to be shipped already. It is by far insufficient for future transport demand, at its current state.

What are the relevant factors that influence port system developments in Mozambique?

There are various factors described which influence a port system but the five most relevant factors to Mozambique have been singled out and weighted in the conclusion of the SWOT analysis (see Chapter 4). The resource endowment situation (resource boom) is certainly the single most important factor. It is followed by necessary developments of transport infrastructure: mainly railways, and to a lesser extent road, to bring the resources to the ports. Number three factor for port system development in Mozambique are professional private port operators. They are required to guarantee a safe, efficient and effective cargo handling but also contribute to port development itself by dedicated investments in port infrastructure and modern port handling equipment. Maputo Port is a good example to back this conclusion. Regional integration and cross border cooperation based on sound national transport policies is the fourth most important factor. It is followed by the fifth factor which consists in the outcomes of the plans of Government of Mozambique on how to use the natural resources in Mozambique to create industries further up in the natural resource based value chains. The latter two factors are also of special importance for the sustainability of the port system developments as they lay the ground for a more diversified economy once the resource boom is over.

What is the expectation of the resource extraction industry on the ports of Mozambique and what quantities are they expected to be able to handle in the future?

Expectations of the resource extraction industry operating in Mozambique, South Africa and the region are very high. South Africa is a traditional mining country with multinational mining companies which are successfully operating for decades. Mozambique has no significant mining tradition so far but the magnitude of resource

endowments has attracted world class mining companies with economic and financial power. They are heavily investing in the coal mines and gas fields and of course they expect that the mining products can reach the world markets. Companies like Vale, Rio Tinto, Anadarko or Shell are also prepared to invest in transport infrastructure, including ports and to engage in partnerships for efficient port operations because the quantities expected to be transported and handled are enormous. Annual productions of 70 mtpa of coal in 2015, from 10 to 50 mtpa of LNG between 20120 and 2030, more than 30 mtpa of coal and minerals from South Africa for Maputo, the multiplication of container traffic in the next 5-10 years require the respective (maritime) transport infrastructure.

What are the (maritime) infrastructure developments required to bring Mozambican ports in line with future needs of the extractive industry?

Maritime infrastructure developments are enormous. They need to be complemented by other transport infrastructure, particularly railway investments. Expected and required port system investments for the three corridor ports of Maputo, Beira and Nacala amount to up to 2.2 billion USD. These are mainly planned capital investments in terminal upgrades, rail links, dredging of the ports, additional equipment, warehouses and more (see layer six). But all rehabilitation modernization and enlargement of existing ports will not be sufficient to deal with the future needs of the extractive industry. Therefore new ports are necessary and projects for an LNG centre at Palma, a new coal terminal at Nacala-a-Velha, a new coal port terminal at Macuze, Zambezia and a new deep seaport at Techobanine, South Mozambique are in the pipeline. All of these projects except for the LNG facilities include investments to build either new or rehabilitate and enhance capacity of existing railway lines. These investments have also been presented under layer five and six. Figures given for these investments amount to a total of up to 27 billion USD, which 185 percent of Mozambique's GDP in 2012 (GDP 2012, 14.6 billion USD).

Finally, it can be stated, that port infrastructure in Mozambique will undergo major developments in the coming years. It is shown by this thesis that the natural resources mainly discovered and mapped in the last ten years will bring a paradigm shift to the transport infrastructure and in particular to the port systems of Mozambique.

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