Challenges for Rail Projects in the Southern Africa Region

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By: Dr FJ Mülke

The Southern African Region

Challenges for rail projects in this presentation are categorized for sub regions:

- Mozambique;
- South Africa;
- Namibia.

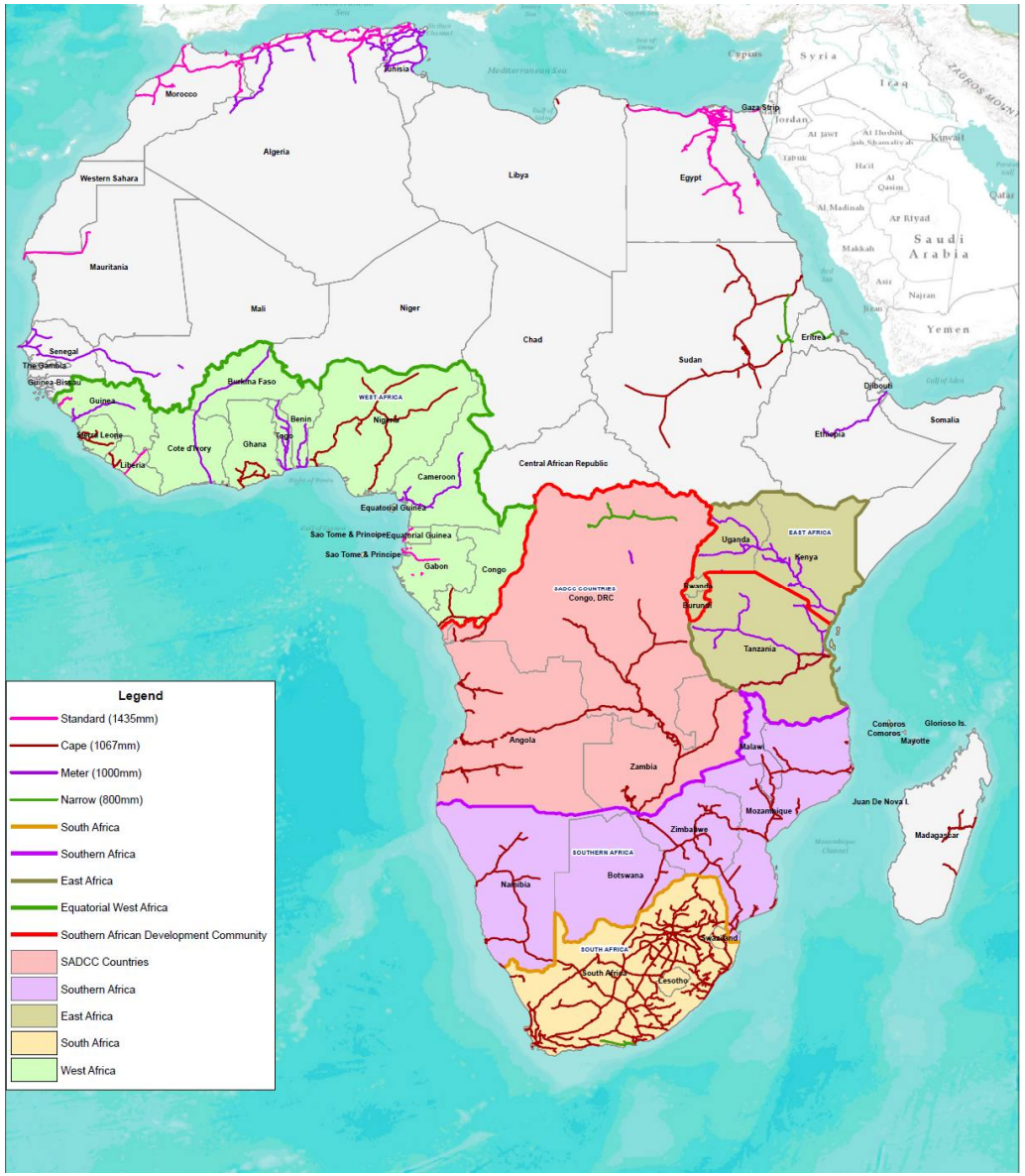
Railways in Africa and the Southern Africa Region

The Southern African Region consists of the following countries with a rail network:

- South Africa;
- Namibia;
- Botswana;
- Zimbabwe;
- Mozambique;
- Malawi
- Swaziland.

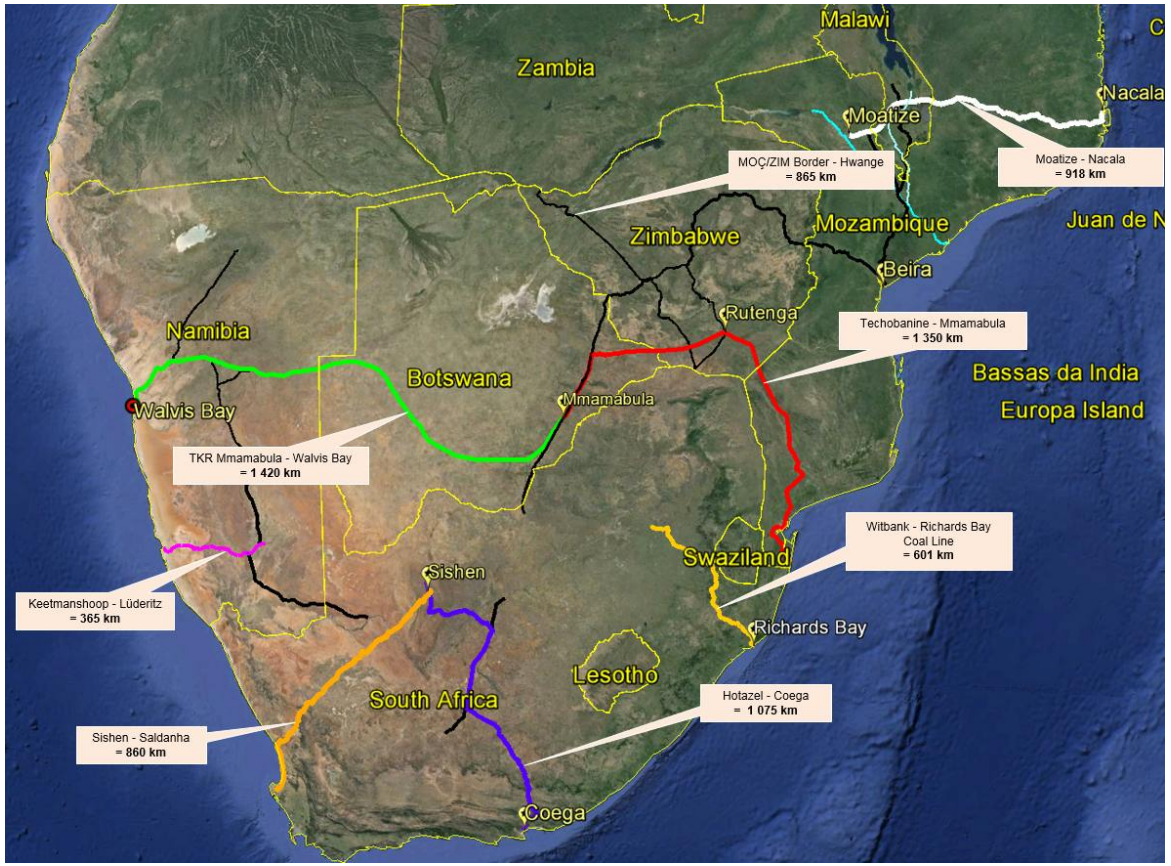
The rail networks of Africa primarily lead from the hinterland to Ports. The South-North rail axis feeds from Southern Africa to the DRC.

The South-East Tazara line connects this network with the rail network in East Africa.



Existing and Planned Heavy Haul Routes in Southern Africa

- The existing railway network in Southern Africa primarily consists of the Cap-gauge (1 065mm).
- The permissible axle loads have been increased since construction of the colonial rail networks in Southern Africa to 20 ton/axle. The heavy haul lines of South Africa namely the Coal line, was upgraded to 26 ton/axle and the Orex iron ore line to 30 ton/axle.
- The 1350km railway line planned as from the Coal fields in Botswana, through Zimbabwe to the Port of Techobanine in Southern Mozambique, is to be constructed as a standard gauge rail network.
- The planned 1420km Trans Kalahari Railway line to Walvis Bay is planned to be Cap gauge.

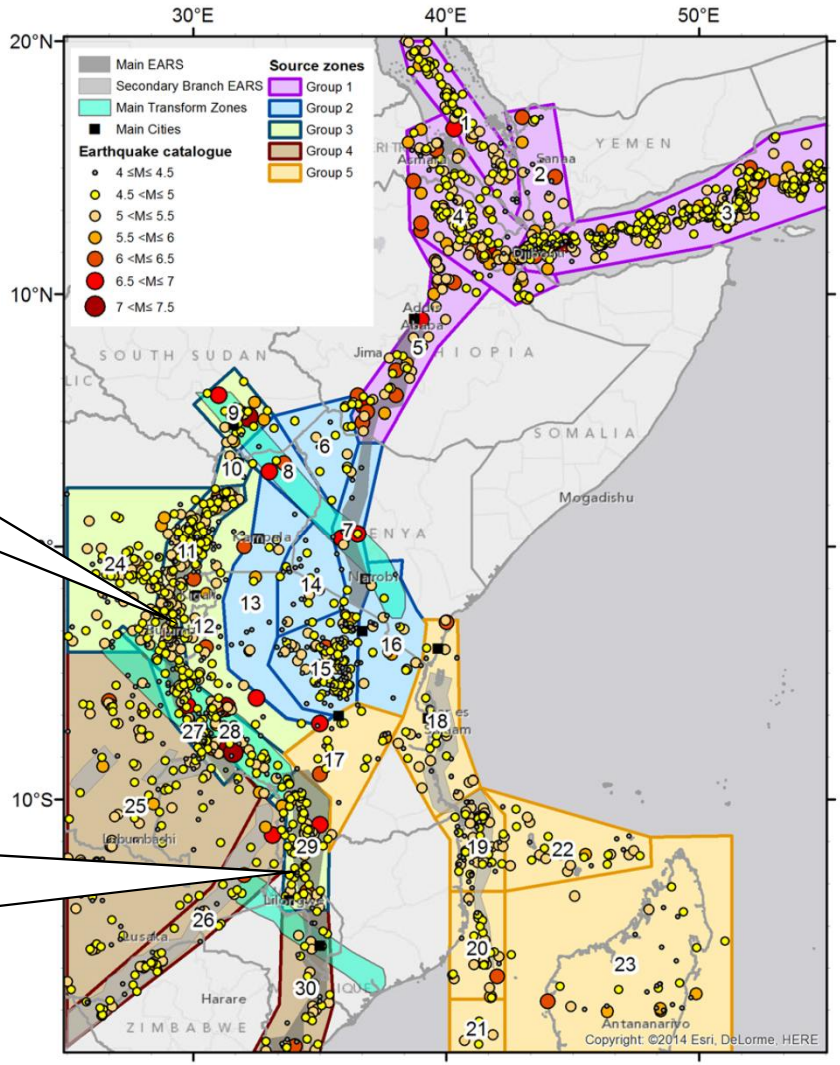


- The Moatize-Nacala line (918 km) is in the process to be completed

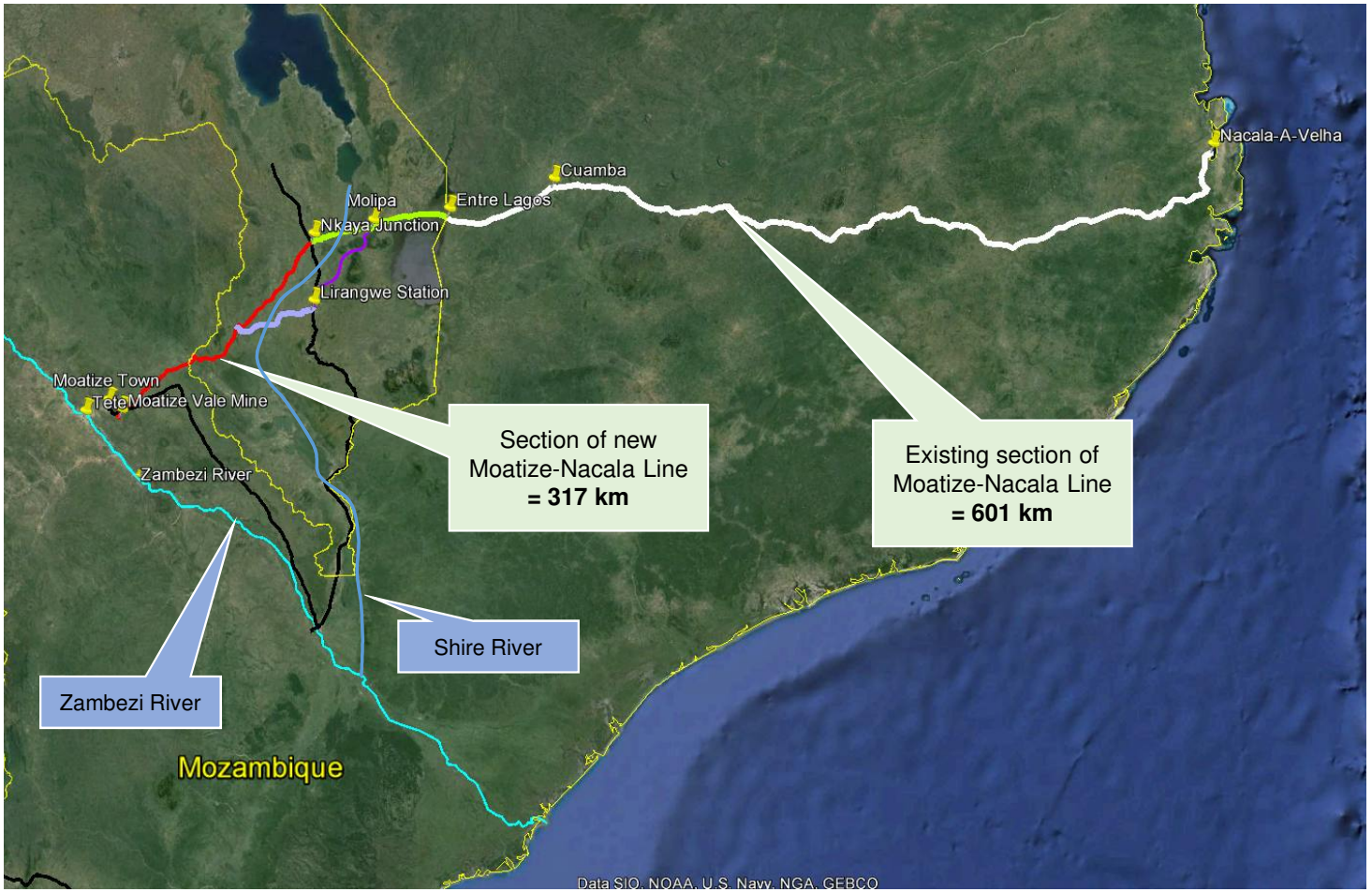
Geological Challenges in Southern Africa

A significant geological phenomenon that impacts on railway projects in the Southern African Region is the divide of the Indian and African plates that forms the fault or “rift” as from the Red Sea through the Rift Valley in East Africa, down through the lake districts and the Shire River in Malawi, onwards into the Zambesi river.

The original alignment of the Moatize-Nacala line to cross the Shire River with a new bridge, was changed so as to link up with the existing rail network northwards and thereby avoiding the crossing of the Shire River in the “rift” zone.



New Moatize to Nacala Coal Export line in Malawi and Northern Mozambique



The alignment of the new section of the Moatize-Nacala railway line was originally determined to cross the Shire River and link up with the existing rail network at Lirangwe

Newly Constructed Moatize-Nacala Line: Mozambique - Malawi

The heavy earthworks, mostly consisting of side cuts and side fills on the Malawian escarpment, experienced failures of the unstable cut slopes on the hillside with the result that major earth reinforcing measures had to be undertaken.

Newly Constructed Moatize-Nacala Line

The planning, design and construction of the new 918 km Moatize-Nacala railway line, is an example of the nature of latest railway project built on the East Coast of Africa.

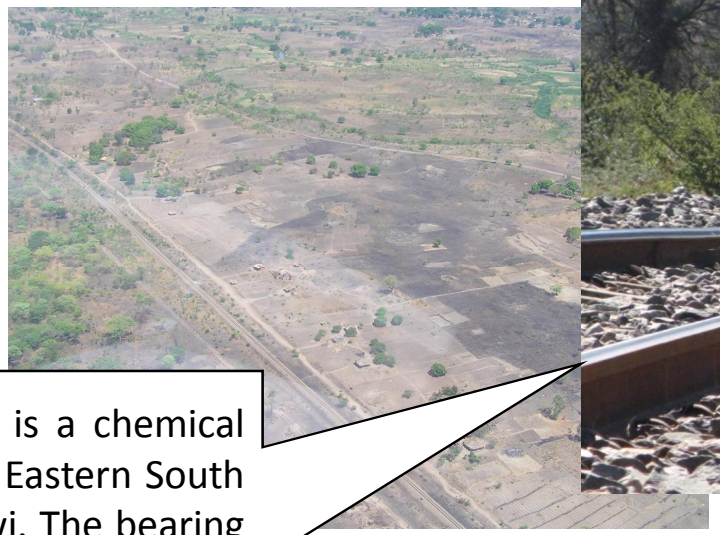
Geological and Climatic Challenges in Southern Africa

The Region of Geological Formation is represented by chemical weathering of rock in contrast to the areas of mechanical weathering of rock. The divide of these areas is identified by the Weinert-N values for climatic conditions in Southern Africa.

Climate does not only determine the mode of weathering but also the rate of weathering. A climatic N-value >5 is associated with arid conditions and an N-value <5 is associated with humid warm areas and the surplus of water where chemical decomposition is a predominant rock weathering mode.

The Region of sediment deposits manifests on the Western area of the Southern Africa Region. This area is notorious of experiencing droughts and fluvial transportation of sediment whereas chemical decomposition of pedogenic rocks and formation of clays occur on the Eastern region of Southern Africa.

Southern Africa: black cotton soil track formation



The black cotton soils of Southern Africa is a chemical decomposition of Norite and is located in Eastern South Africa, Swaziland, Mozambique and Malawi. The bearing capacity of this clay soil is very low and the swelling index very high.
The track work built directly on black cotton soil in South Africa has proved to be very costly to maintain and the alignment deteriorates rapidly during rainy seasons

To ensure the stability of the substructure of the track, black cotton soil was excavated and removed below embankments so as to ensure bearing capacity of heavy haul axle loadings.

The Coal Line in South Africa

The Coal line in South Africa collects coal from 45 mines before trains are consolidated into a train configuration of 200 wagons to be dispatched to the Port of Richards Bay.

In the 1980's, subsequent to the upgrading of the coal line, the ballast stone from a quarry near Sheepmoor, underwent rapid weathering in the track.

This quarry was located near the N-5 Weinert contour area. The ballast stone had to be removed by on-track mechanical ballast cleaning processes.

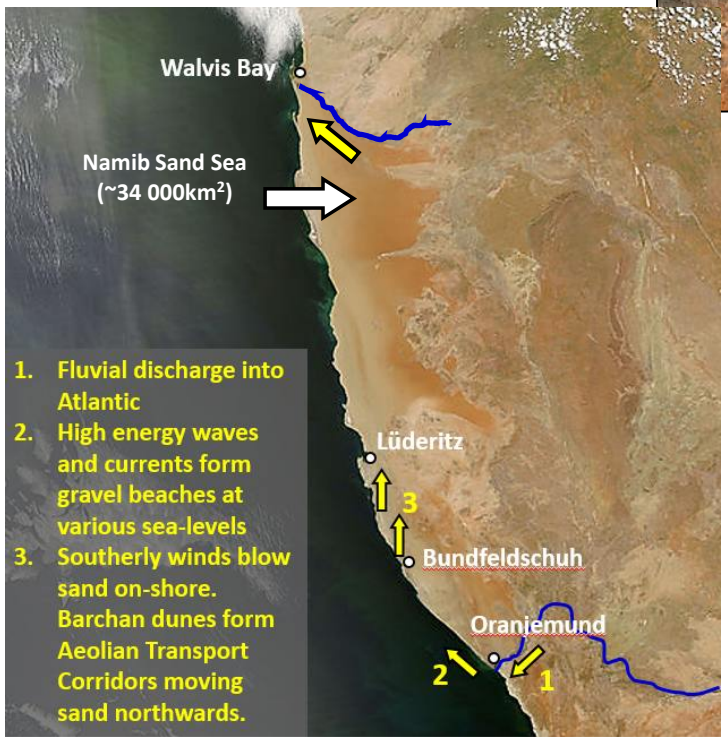
Geomorphology of Southern Africa

- The Orange River Catchment basin is located on the Central and Western coast of Southern Africa. The Orange River partly forms the boundary between South Africa and Namibia.
- The Orange River conveys sediment to the Western coast of Namibia and flows into the Atlantic Ocean at Oranjemund.
- The Indian Ocean currents and wind action carry the sediment northwards along the Namibian coast and through wave and wind action create the diamond bearing sand dunes of the Sperrgebiet on the Coastline of Namibia.

Namib Sand Sea

- Nowadays the Orange River discharges a modest sediment load of about $17x10^6$ tonnes/year into the Atlantic Ocean. This can increase x 4 during floods.
- During earlier geological times Southern Africa had wetter climates and the Orange River Drainage system was significantly larger. This is evident in the size and shape of the massive diamond bearing gravel deposits on the banks of the lower Orange River Valley.
- Diamonds eroded from Kimberlite pipes in the interior of Southern Africa, were transported to the coast with the sediment load.
- The Namib Sand Sea presents challenges to existing and planned railway lines.

Orange River discharge into Atlantic Ocean



Desert sand on track between Aus and Lüderitz in Namibia

- The sand dunes formed by wind action move from South to North across the Sperrgebiet and bury roads and rail lines under huge volumes of sand.

Sand removal from track

A sand plow was introduced as a measure to remove excess sand from the track.

Newly Constructed line on Tubular Track:

Aus to Lüderitz in Namibia

A ballast-less (Tubular track) structure was built on sections of the Aus to Lüderitz line.

Pedestal type sleeper

A sleeper type with small pedestals was developed by Prof. Dr. Klaus Riessberger and installed by TransNamib on a section at Walvis Bay in Namibia.

The object was to test the effectiveness of the sleeper type to allow sand to pass underneath the rail.

The sand movement by the wind is a paramount challenge to track maintenance for track networks leading to ports on the Namibian coast. This challenge was taken into consideration in the design of the Trans Kalahari Railway line to Walvis Bay.

End

Thank You