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Factsheet Resilience Solutions for the Road Sector in South Africa

This Factsheet is a part of the Private Markets for Climate Resilience (PMCR) project to evaluate systematically the potential market for climate resilience solutions in the private sector. Focusing on agriculture and transportation, current practices and opportunities highlight products, services and finance in six emerging markets — Colombia, the Philippines, South Africa, Nicaragua, Kenya, and Vietnam.

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Road sector in South Africa

South Africa's road network is generally regarded as extensive and well-maintained by African standards. Roads are essential for economic development and have been closely correlated with local community access to markets and opportunities in South Africa. Roads form an important part of the agricultural system, transporting agricultural products and factors of production between suppliers and consumers. Accordingly, road construction accounts for 26% of the capital budget of Metropolitan Municipalities and 7.3% of their operating budget.

While roads play an important role in the South African economy, these are expected to be affected adversely by changing temperatures and precipitation patterns caused by climate change. The same roads are recognised simultaneously as being exposed to climate change and as a contributor to the negative impacts of climate change. Construction activities in the road sector use extensively fossil fuel intensive products, such as bitumen, and roads tend to divide ecological systems in ways that inhibit species migration and adaptation.

South Africa has a proud engineering and road construction history, however the development of technologies and practices in the sector has not kept track with the impacts of changing climate conditions. Pre-emptive upgrades, regular maintenance of gravel roads and adjustments to construction materials and technologies are among the various alternatives that accordingly implemented can offer greater resilience to road networks. However, investing in the resilience of the road network requires significant public funds, which are difficult to mobilise due to fiscal constraints in the government budget. While all the evidence suggests that early action on both upgrades and maintenance saves money in the long-run, pre-emptive actions are difficult to implement.

There are many opportunities for private sector actors in building resilience in the road sector. Particularly, research and development of road construction technologies can pay dividends in reducing costs, extending the life of roads and provide business opportunities for private companies offering road construction technologies and services. For example, as identified in the PMCR analysis, the re-use of plastic waste in road construction materials offers a solution that simultaneously contributes to the climate resilience of roads and reduces the negative impacts of plastic waste in landfills. In order to achieve the necessary scale, there is scope for investors, financiers and infrastructure planners to apply their leverage within the industry to incentivise and finance collective action, research and the uptake of resilience enhancing activities.

In a time of rapid climate change and intensifying natural disasters, road infrastructure systems can support resilient and reliable services.

Sector facts (2018)

Road network size:
approximately 750,000 km of roads, valued at more than R2 trillion (~USD 140 billion)

Sector size, contribution to the country economy:
An estimated 76% of the total freight tonnage in South Africa is transported on roads. The balance is transported by rail, but rail's contribution has decreased over the past two decades. Transport accounts for 11.4% of agricultural commodity costs in South Africa, roads are critical to this transport. Export fruit and wine relies on sea-freight that is serviced by roads.

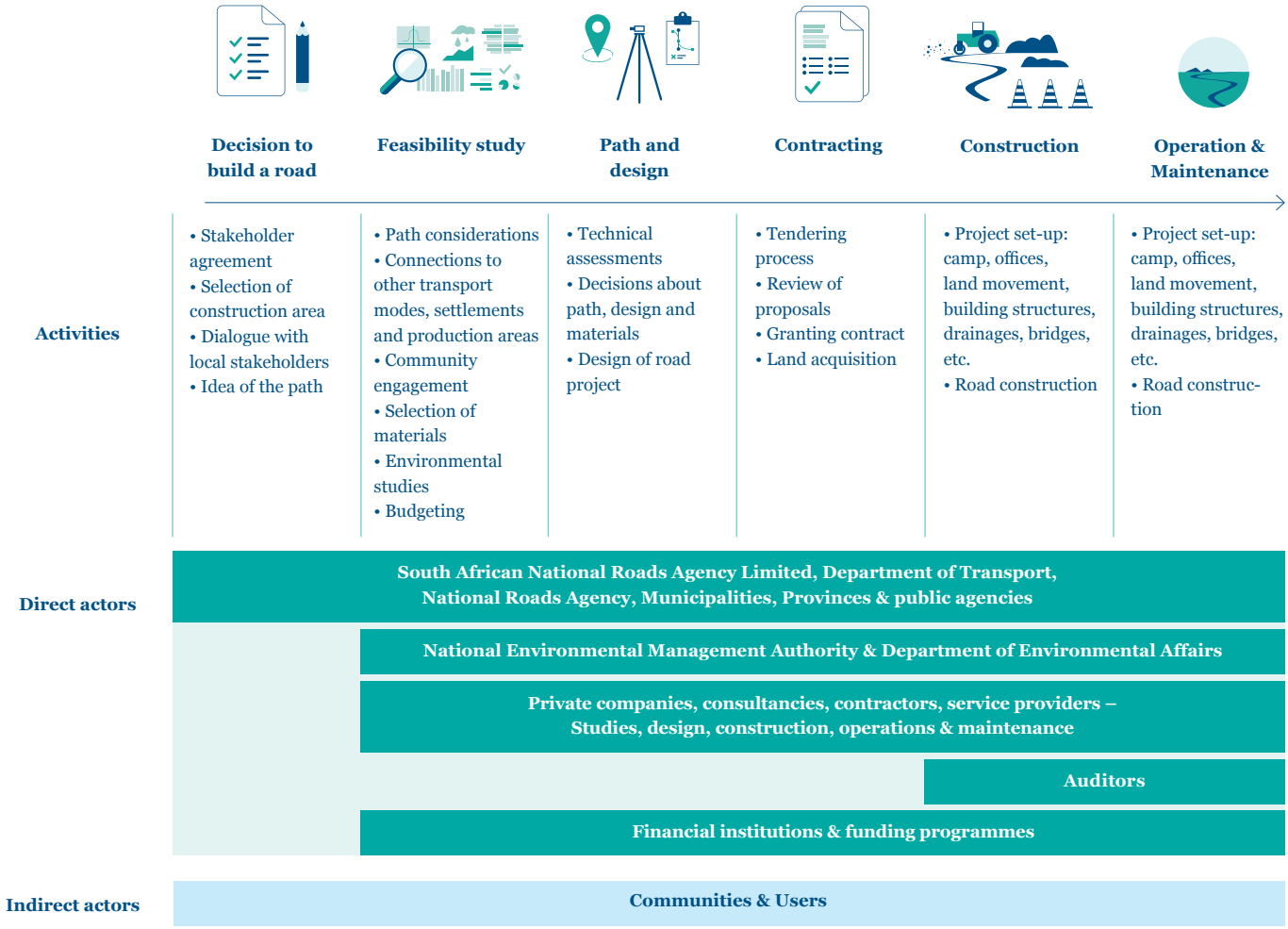
Highlighting features: Only 25% roads are "paved" (mostly asphalt with a small proportion of concrete) with the balance being gravel or "dirt" roads.

Key road sector stakeholders
Public authorities: Roads in South Africa are built under contract and managed by either South African National Roads Agency (SANRAL) or 270 district and local municipalities – roughly 40%.
Private road owners: A small proportion of roads are owned by game parks or privately owned by farmers, businesses or housing estates in South Africa.
Public-private partnerships: Six of the nine provinces in South Africa have "toll roads" that are managed in public-private partnerships with private sector contractors.
Rural communities: An estimated 17% of roads are "un-proclaimed" and managed by rural communities.
Private companies: The construction of roads is typically undertaken by the private sector and relies on a complex set of industries. There are hundreds of private civil engineering and road contracting companies involved in road building and maintenance on behalf of SANRAL and municipalities. Larger companies typically subcontract smaller companies depending on the size of the contracts.

For a list of references, see the References Section of the PMCR Report.

The road sector - processes, activities and actors

Below are presented the main decision processes, activities and actors in the South African road sector.



Changes in climate conditions affecting the sector

• The combination of *higher temperatures*, *greater diurnal range* (difference between day and night temperatures) in some regions, more *intense rainfall* and *hail events*, and *coastal storm surge* are expected to accelerate the rate at which roads depreciate and cause higher rates of emergency road repairs.

• Climate change impacts will increase the *total cost* of the transportation system and its users. These impacts can be reduced through the rerouting of existing roads, modal shifts towards public transport, new infrastructure design standards and early-warning systems that encourage road users to avoid at-risk routes during severe weather.

• It is estimated that the potential impact of climate change in terms of *additional annual costs* on South Africa's national road network may be as high as USD 96 million in 2030, USD 229 million in 2050, and USD 390 million in 2090, if no adaptation measures are taken.

Adaptation challenges in the sector

• While there is strong evidence that *pre-emptive upgrades* of roads, by adapting the design and changing the material used, can save money in the long run, currently, most road construction models assume a stationary climate, based only on historical data for regional climates in South Africa.

• The main problem for most authorities involves *financing pre-emptive adaptation*, particularly given the high cost of road construction and maintenance.

• The other key 'real-world' constraint on adaptation in the roads sector is that most of the investment and responsibility is allocated to the government. National and sub-national governments struggle to combine accountable public procurement and budget management with the flexible, innovative and adaptive responses required to respond to climate change.

• Timely, which in most instances involves earlier, road maintenance is crucial in managing the cost of climate change on South African roads. The expected costs can be reduced by implementing a proactive *adaptation strategy*.

• The *benefits* from adapting road infrastructure proactively include direct savings linked to decreased maintenance on unpaved road infrastructure, decreased vulnerability to climate change impacts, and a more robust and reliable road infrastructure and indirect savings linked to fewer disruption in economic activity.

Resilience solutions

The PMCR project has identified climate threats to the South African road network, as well as solutions that would enhance the resilience of the road network, ensuring sustained road services in the face of climate change.

Leading resilience solutions: *Road Management, through upgrading and maintenance, and climate-relevant road design and materials.*

Road Management, through upgrading and maintenance

The evidence from road maintenance standards clearly supports the argument that early and preventative action saves money in the long-run and ensures the security of road network users. Road upgrades and maintenance represents a long-term option with immediate benefits and high economic multipliers. Specifically, pre-emptive upgrades of gravel roads and the more regular maintenance of paved roads would hasten the transition to climate resilience, while saving money and creating new employment.

Road upgrades represents financial business opportunities for private-sector companies providing products and services and creates job opportunities as it is labour intensive.

Co-benefits include:

i) a mobile economy that creates more jobs

ii) greater access to markets for all producers

iii) sustainable and resilient upstream and downstream value chains of raw materials, processed goods, services, tourism etc.

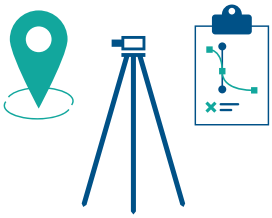
The fact that additional up-front investment would save money represents a significant financing opportunity for South Africa's roads and banks. As climate change exacerbates the rate and nature of road deterioration, maintenance costs are expected to rise significantly in the future. If the road network is not kept up, then the system suffers, at great cost to the economy.

Resilience contribution: Increased resilience of roads to higher temperatures, water damage, sea-level rise, and other climate change impacts. The combination of maintaining gravel roads more frequently, upgrading gravel to tar, and building better tar roads, in conjunction with modal transport shifts to public transport and rail, could assist the country with its transition to a more labour intensive, climate resilient economy.

Opportunities and challenge

• *Research and development*, and greater *science-policy interactions*, would increase the skill with which road construction and upgrades can be tailored to changing climates. This will require better *projections, monitoring* of weather-related impacts, *research* into new construction materials (e.g. polymers) and their resilience to climate variability, and new *engineering and design skills* that factor climate change into road construction and maintenance.

• There is a recognized gap in the available *information* on the state of roads and the cost and processes for repairing and building roads. Better *communication* of the extent and state of the roads could systematically improve the resilience of the road network.



• *Investment* in the road construction and pavement sector in South Africa is constrained by the overwhelming concentration of *government ownership*. Whereas public taxes are funnelled into road infrastructure and maintenance, it is clear that the allocated budgets are insufficient to keep ahead of the desired quality of maintenance and replacement curve. Government infrastructure *procurement* is also notoriously difficult to innovate.

• Uptake of the resilience solution could be supported by a *funding model* whereby local and national governments could access upfront finance for *resilience interventions*. The need to *spend more now to save later*, is counterintuitive to budget-constrained administrations, therefore, an alternative financial model would be a very welcome resilience option. Whether a *green bond*, a beneficial *trade agreement* or another instrument, is the adequate leveraging tool would depend on the financier, the commitment of the lender and the urgency of the project.

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Climate-resilient road design

Most road construction assumes stationary climate conditions and designs are largely based on historical weather data. Given the rapid acceleration of changing weather and climate conditions, this approach is clearly inappropriate. Climate-resilient road design and materials have been identified as a resilience solution that could provide resilience benefits to the road sector in the face of accelerated road depreciation due to increased temperature, changing rainfall, increased sea level, and other climate change impacts.

The Weinert N-value, developed in 1984 and used to assist the selection of appropriate materials for road construction, is one example of a design parameter that, if not adjusted, becomes inappropriate under climate change. The parameter considers the evaporation in the warmest month divided by the total annual precipitation. Both parameter inputs, temperature and precipitation, are affected by changing weather and climate conditions. Consequently, when using the parameter in the design specifications of new and existing roads, it is critical to take into account changing conditions and potential climate impacts. Moreover, special care would need to be taken to incorporate the new values into the maintenance and replacement design specifications.

Resilience contribution: Road investment would be more secure and require less expensive repair and maintenance. Climate-sensitive design and construction parameters, such as the Weinert scale, are expected to strengthen the preparedness

for changing conditions and more extremes and, consequently, increase the resilience of the road network in the medium and the long term.

Main challenges related to the resilience solution

- High upfront initial costs associated with "bringing forward" road upgrades and replacements.
- Possible resistance based on the additional uncertainty introduced though the inclusion of climate change forecasts in road design.
- A standard formula for climate resilient road construction may obscure local nuance or variation, and undermine local observation and adaptation. Climate scenarios would need to be integrated into road design parameters on a regional basis.
- In addition to research and development of climate-resilient construction materials, there is a need to ensure that available road maintenance services are adequate and apply to changing conditions.

Example of Resilience Solution *- Adjustment of bitumen binder content in asphalt*

Surface temperature is a key factor determining the operability and usage of paved roads. For example, hotter temperatures can mean changing asphalt properties. Increasing temperatures are expected to affect road surfaces and lead to degradation and reductions in the life span of the road network. The use of modern modified bitumen binders, in the production of asphalt, can maximize the suitability of road surfaces to changing weather and climate conditions.

Benefits from binder modification may include reduced temperature susceptibility and improved consistency, stiffness and cohesion, flexibility, resilience and toughness, binder-aggregate adhesion and resistance to in-service ageing. Modified binders can offer improved performance over conventional binders, but are not a solution or panacea for all situations. Whereas the materials used will impact the cost of the road, the correct materials will ensure a longer life.

The use of waste plastic is now being promoted as a twofold solution. Firstly, using plastic as a binder enhances the qualities of road construction materials, by increasing the flexibility and resistance to temperature variations of road pavement. Secondly, the solution provides a sustainable re-use option for plastic waste that would be committed to landfill, where it would be subject to the usual risks of leaching chemicals into the soil and escaping as litter.

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