
# Environmental variables for surfacing policies in South Africa

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# Problem statement

- South Africa is vulnerable to key climate change /environmental risk variables that will influence surfacing decisions for unsealed roads:
  i. Negative rainfall patterns
  ii. Flooding risks
  iii. Water scarcity

# Objective

- Survey and assess the ways and degree (works frequencies and costs) to which unsealed road maintenance will be affected by increasing incidences of:

  i. High rainfall areas;

  ii. Flood risk;

  iii. Water scarcity

# The Townshend model for road upgrade prioritisation

**The Townshend model identifies the following:**

1. **Over 20-year outstanding road maintenance backlog valued at R409.8billion (Townshend, 2017) due to:**

- ✓ underfunding of road maintenance
- ✓ inadequate systematic road maintenance practices

**2.The network is too large and costly to be adequately maintained:**

- ✓ SA road network =750 000kilometres, valued at R2.1 trillion (SANRAL, 2022)

**3. Prioritisation of road infrastructure investments:**

- ✓ identifies an optimal order in which roads should be maintained or upgraded given a pre-determined budget envelope.
- ✓ it motivates road infrastructure investments which benefit the labour force, small and emerging contractors, and road users.

# The importance of restoring rural road network

- Every citizen /child is guaranteed access to a well maintained road within 5 km of a school (Government Gazette 33283, 2010
- Deteriorated rural roads lead to missing opportunities to contribute to the nation's economic growth
- SDG 9: industry, innovation, and infrastructure, explicitly includes a measure of access by rural populations to well-maintained roads.

# Cost elements to consider when maintaining unsealed roads

**Input costs for maintaining unsealed roads**

**1. Selected gravel in large quantities for re-gravelling is required**.

-2280 tones of gravel are required to re-gravel a km.

**459 957km** require **1 048.7 megatonnes** .

-Gravel is a scarce resource

150mm of gravel usually last for 6-10 years. Routine gravel replacement required .

**2. Cost of** diesel for hauling and transporting gravel to the site

**3. Pollution cost** – Co2 emitted through diesel for hauling and transporting gravel to the site

**4. Road users' cost**- fuel cost is high on poor unsealed roads, wear and tear of tires, time consuming, risk of accidents due to reduced efficiency in vehicle braking system. Accident cost of R73. million>sealed roads (Townshend, 2020) 20-27% fuel consumption>sealed roads (SABITA, 2021).

**5**. Large volume of **water** is required for compacting soil.

# Projections in regions vulnerable to floods and high rainfall due to climate change

**Assumption:**
Environmental risk event costs for maintaining unsealed roads in areas vulnerable to flooding or high rainfall.
-the gravel surface material is washed away, shortening the re-gravelling cycle from 6-10 years to in some instances less than a year

- CSIR projections: once in a day in the next 50 years
  -rainfall values of 235.4- 409.7mm
- **High risk regions:**

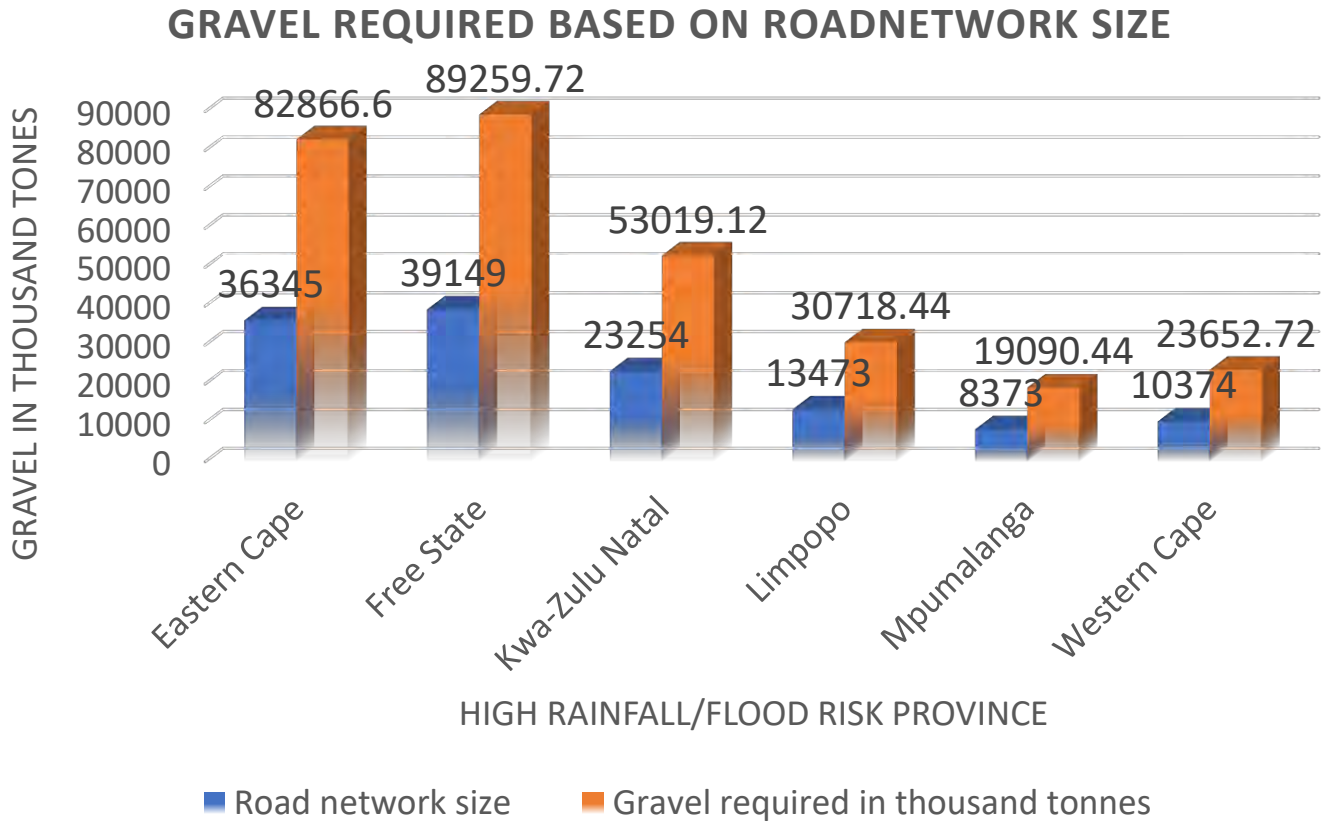
East London through to the Mozambique border, Mpumalanga, Limpopo

- CSIR projection: Once in 10 years
  -Stormflows values: 429.1- 1233.2mm

**High risk regions:**
Mossel Bay(Western Cape) to Nelson Mandela Bay(Eastern Cape), in the Boland (Western Cape) and Groot Winterhoek (Western Cape) some parts of the Eastern Cape, KwaZulu-Natal, and the Free State.

# Ways in which maintaining unsealed roads in flood/high rainfall vulnerable regions will be increasingly costly

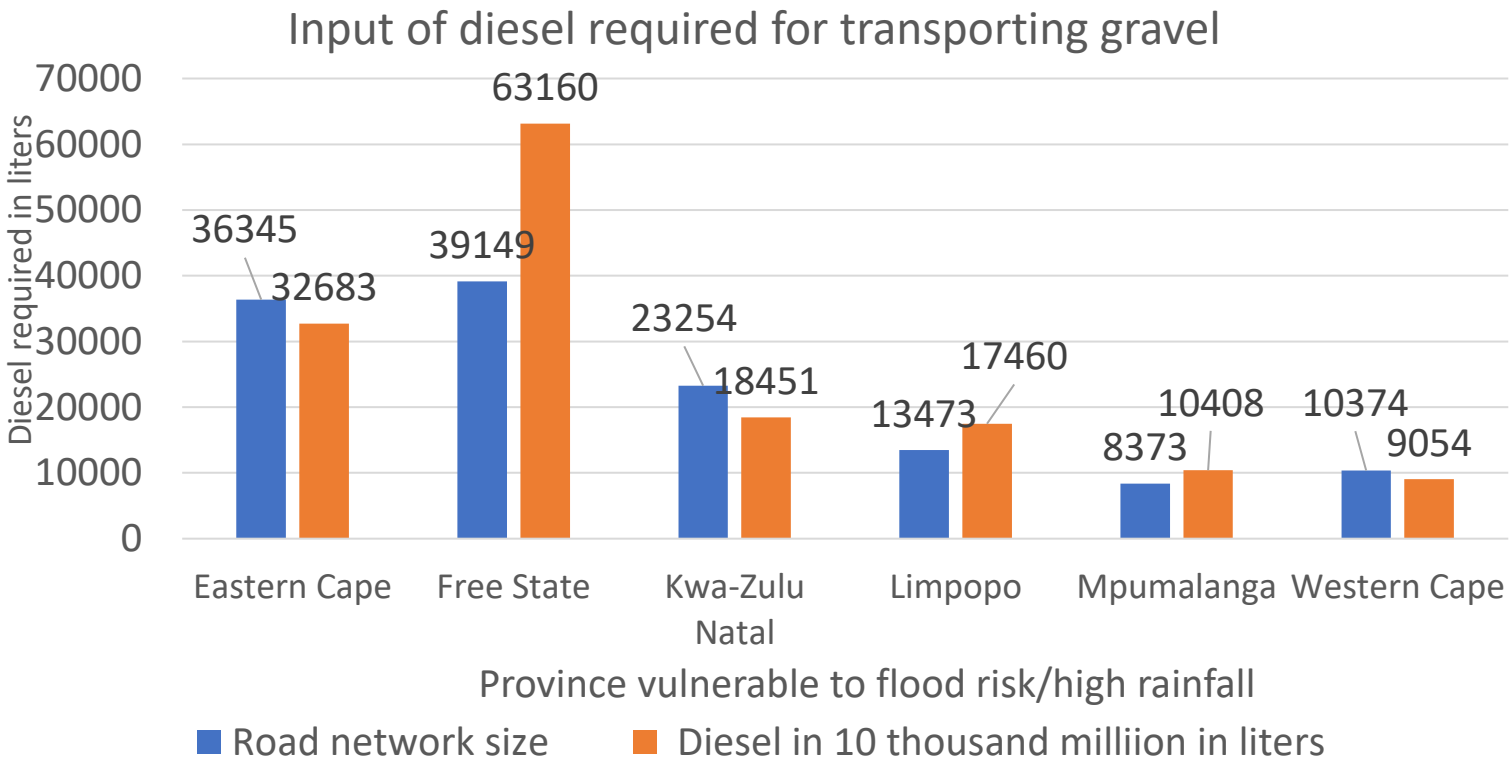
Total gravel (nonrenewable) required= 299 million tones




Own calculations

# Ways in which maintaining unsealed roads in flood/high rainfall vulnerable regions will be increasingly costly cont.

- **Total diesel required for transporting gravel in liters = 1.5billion litres= 12.4% of the total diesel South Africa requires in a year.**
- **People need diesel to run generators, so is Eskom.**




**Own calculations**

# Ways in which maintaining unsealed roads in flood/high rainfall vulnerable regions will be increasingly costly cont.

- **Borrow pit distance impact cost**

| Province | Borrow pit distance in km | Diesel in liters@ 2.9l/km | Cost per trip in Rand | Roadnetwork in km |
|---|---|---|---|---|
| Eastern Cape | 34 | 98,6 | 2134 | 36345 |
| Free State | 61 | 176,9 | 3828 | 39149 |
| KwaZulu-Natal | 30 | 87 | 1883 | 23254 |
| Limpopo | 49 | 142,1 | 3075 | 13473 |
| Mpumalanga | 47 | 136,3 | 2950 | 8373 |
| Western Cape | 33 | 95,7 | 2071 | 10374 |

**Own calculations**

# Ways in which maintaining unsealed roads in flood/high rainfall vulnerable regions will be increasingly costly cont.

## Co2 estimation from diesel = 4.08 Mt
## SA is already one of the biggest Co2 emitters due to its reliance on coal for power generation.

| Province | Road network size | Co2 emissions from diesel in kg | Cost of diesel in liters |
|---|---|---|---|
| Eastern Cape | 36345 | 882429850 | 326825870 |
| Free State | 39149 | 1705324803 | 631601779 |
| Kwa-Zulu Natal | 23254 | 498167652 | 184506538 |
| Limpopo | 13473 | 471429755 | 174603613 |
| Mpumalanga | 8373 | 281018913 | 104081079 |
| Western Cape | 10374 | 244465053 | 90542612 |
| **Total** | **130968** | **4082836025** | **1512161491** |

**Own calculation**

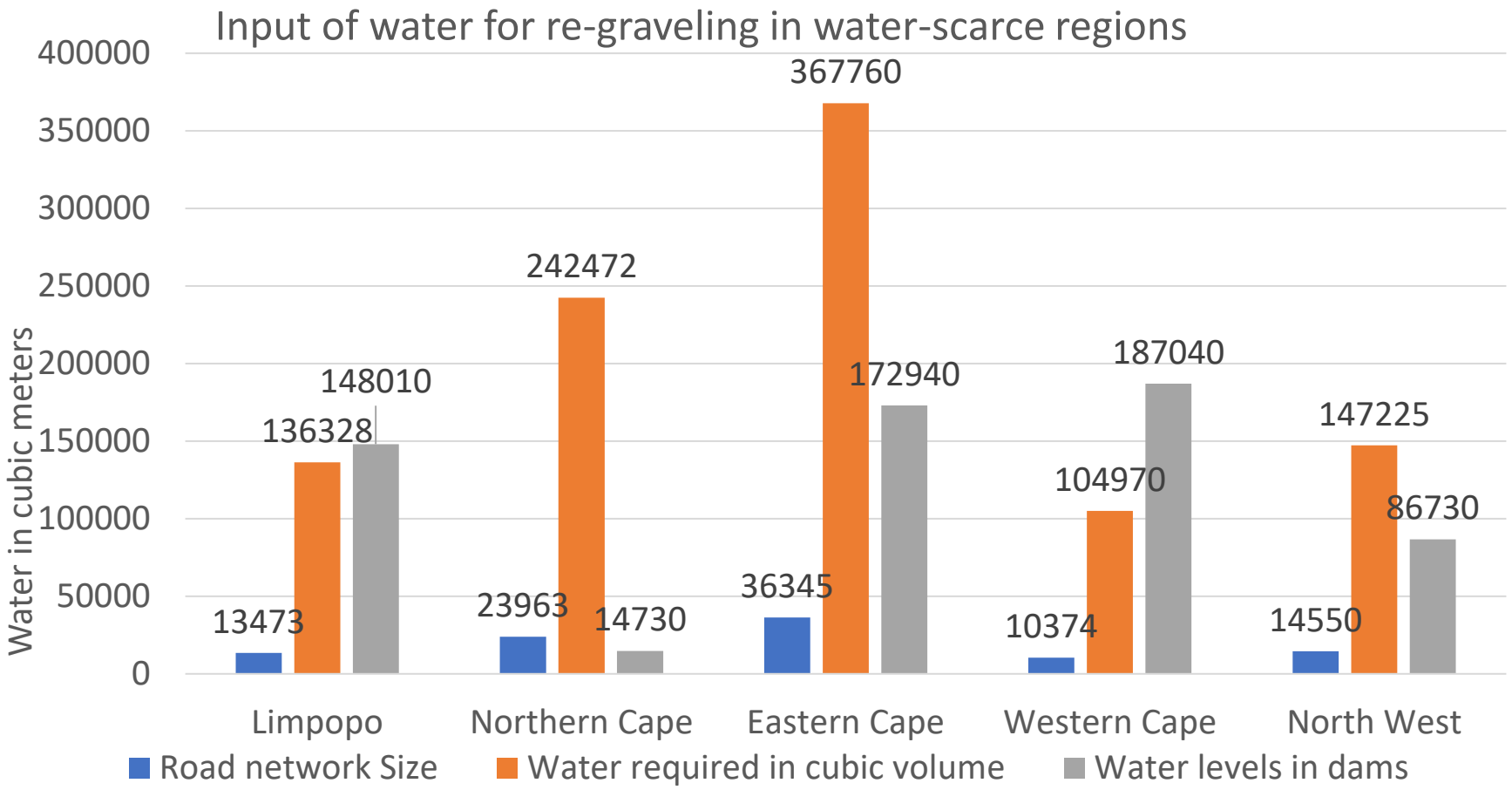
# Cost of maintaining unsealed roads in water-scarce regions

CSIR projections:The South Western region of South Africa, especially the Western Cape province, will remain vulnerable to severe drought at least up to 2059. Other vulnerable regions are: Limpopo valley, the interior of the Northern Cape, Eastern Cape, and the North Western region.

**Cost of water:**

- CIDB(2007) prescribe 150-170l of water per $m^3$ of gravel for compaction. Average gravel loss of 10mm per km in a year=10.12$m^3$ of water for re-graveling.
- **Required water for re-graveling in dry regions = 9987.5million $m^3$**
- **Available water levels = 6094.5million $m^3$**
- **Short fall -3893.million $m^3$**
- NB: Not re-gravelling annually; the gravel loss is lower in areas prone to drought, e.g. the Northern Cape. The main variable that drives gravel loss in dry areas with low traffic volumes is the wind, and some gravel roads in dry areas (like Namibia) can keep their surface materials for very long periods.

# Unexpected stress on required water in dry regions in South Africa




Own calculations

# Alternative surfaces

- **Sealed roads:**
- **Only costly at the beginning, and at major rehabilitation events – but these occur in outer years, typically year 10**
- **Can hold materials for longer period**
- **Resistant to all weather disruption**
- **Cut cost of air pollution**
- **Benefits emerging or small contractors**
- **Cut unemployment level**
- **Cut road user's costs including: time and transportation**

# Conclusion

- Unsealed roads consume a lot of scarce (water, gravel)/costly (diesel) inputs, and these requirements are expected to increase due to forecast environmental changes.

- My next step is to calculate the changing cost profile of unsealed roads, factoring in the forecasts for these key environmental variables.


# THANK YOU

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