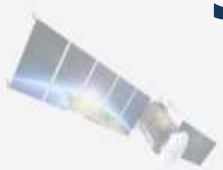
Remote Sensing in Assessing Engineering Risk



Time Series Analysis of Surface Deformation Using Sentinel 1 SAR Along Planned Railway Infrastructure Extension

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kgothatso innovations
locate • analyse • manage

Outline

- Introduction
- Background
- Statement of the problem
- Objectives
- Methodology
- Results
- Proposed Application Areas
- Acknowledgment

Introduction

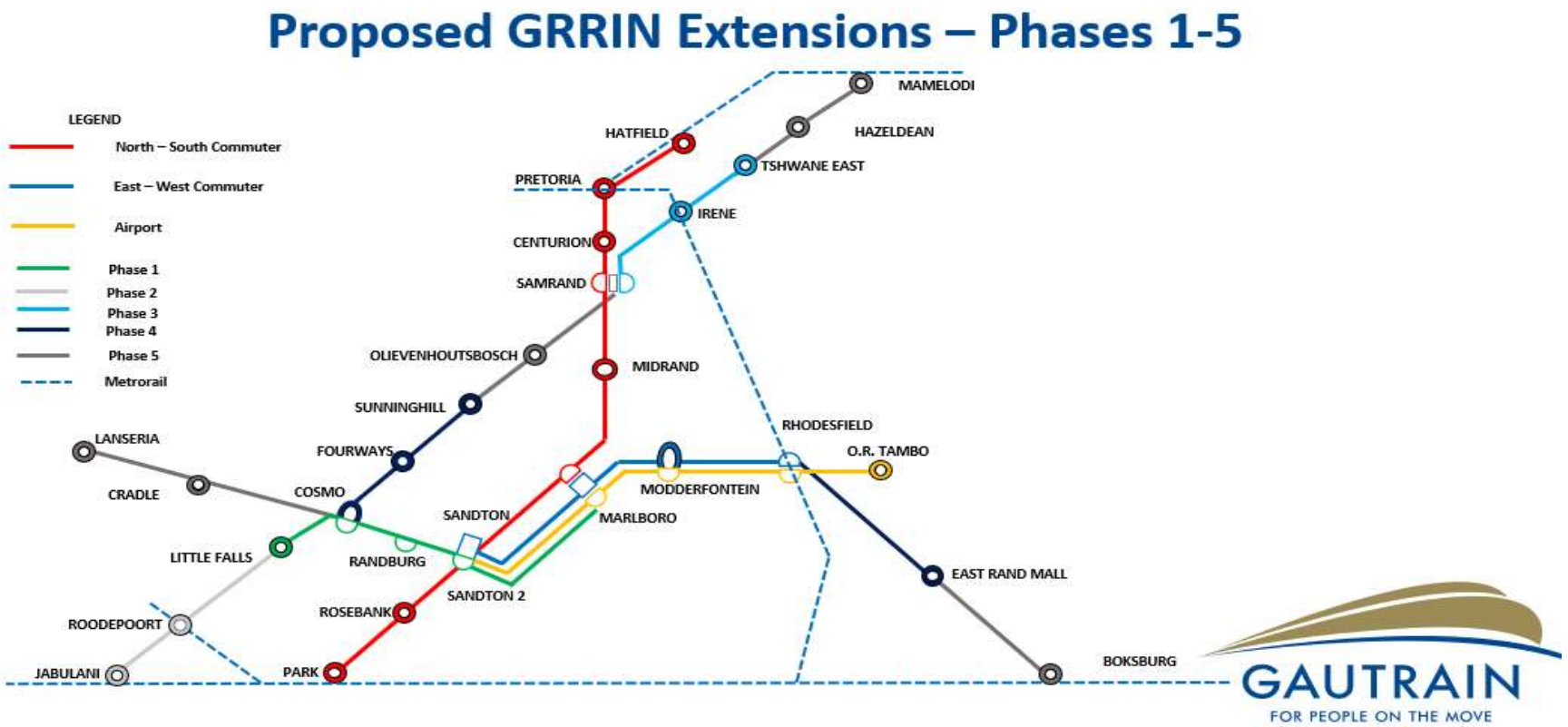
Highlights:

- Founded 2009, Operational since 2015
- Focus: Engineering, Environmental, Mining & Public Sector
- 151 successful assignments, for 30+ customers
- BBBEE Level 1, 100% Woman-Owned

How we are structured:

What we do:

Background



Source: Gautrain Management Agency website

Background

GMA therefore appointed Hatch to conduct a preliminary route alignment study on the following three routes:

- Little Falls – Jabulani (18,2km)
- Cosmo City – Lanseria (15,6km)
- Cosmo City – Samrand (31,6km)

In order to investigate route alternative options on the three routes, geology investigations and geo-sensing investigations were initiated.

This information will assist in the route option development and identify possible risky areas related to the ground conditions.

Background

Background Causes of Surface Subsidence

- Ground water extraction
- Construction and urban development
- Mining activities

Problem Statement

- Hatch wishes to know whether ground settlement and swelling occurred on the three possible rail corridors related to the GRRIN extensions.

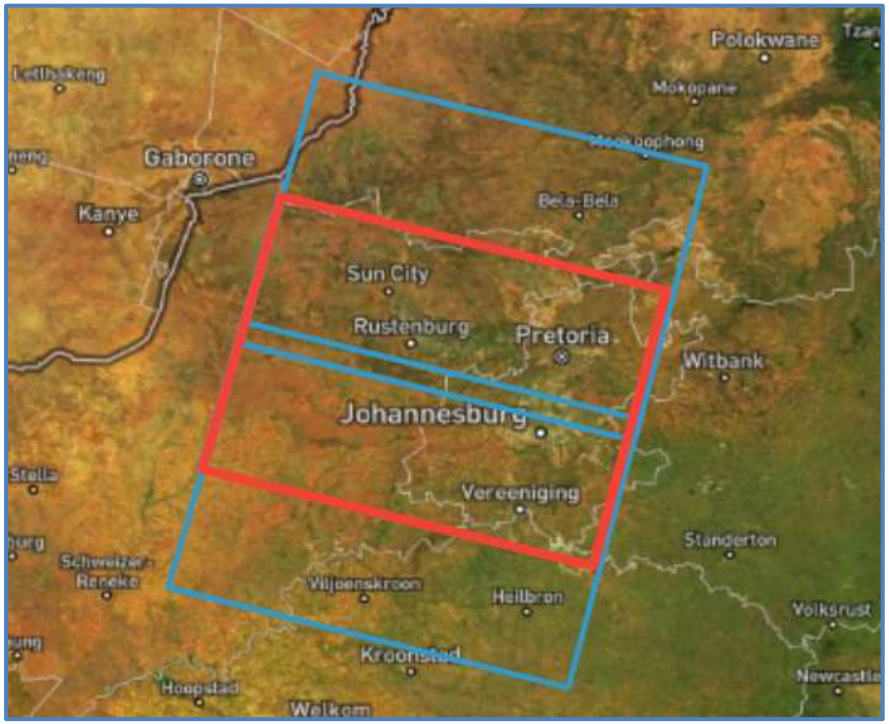
Objectives

- To investigate whether surface subsidence and swelling occurred in the three proposed railway corridors over the last five years.
- To assess the degree of surface subsidence and swelling during the last five years.
- To determine the annual rate of subsidence and upwelling for the last five years.
- Use this information as input into route option development.

Methodology

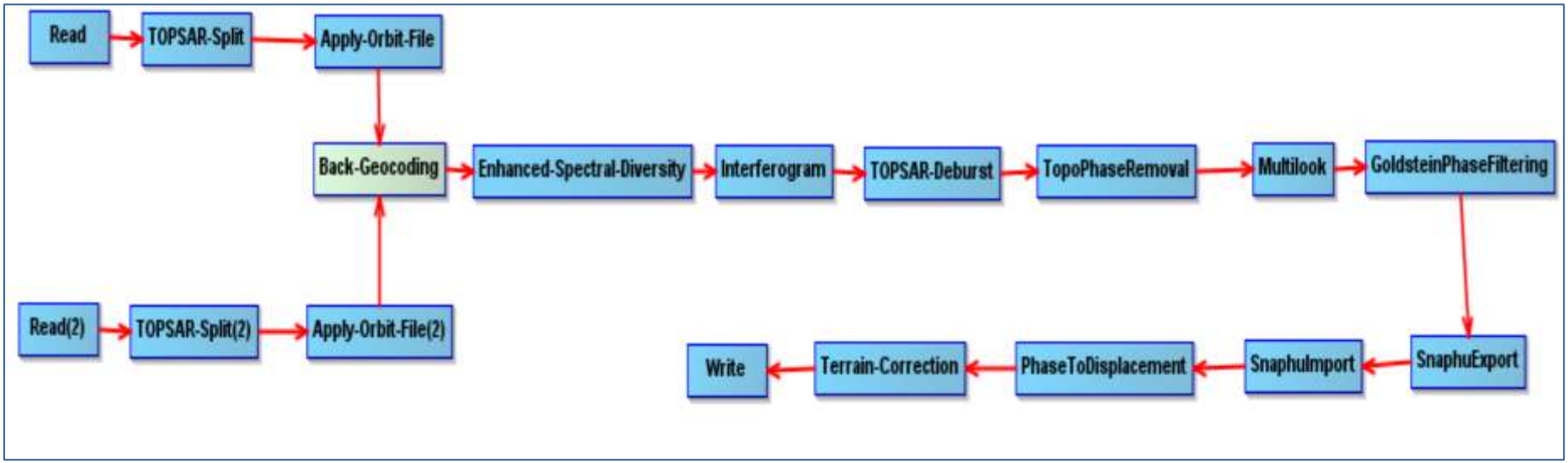
- Sentinel 1 data acquisition
  - Sentinel 1, Single Look Interferometric Wide Complex (S1 SL IWC)
  - Alaska Satellite Facility website (www.asf.alaska.edu) between 2018 and 2022

Year	Polarity	Acquisition Mode	Period
2018 -2021	VV	Descending	• February • April • June • August • October • December
2022	VV	Ascending	• May • June • August • October • November • January

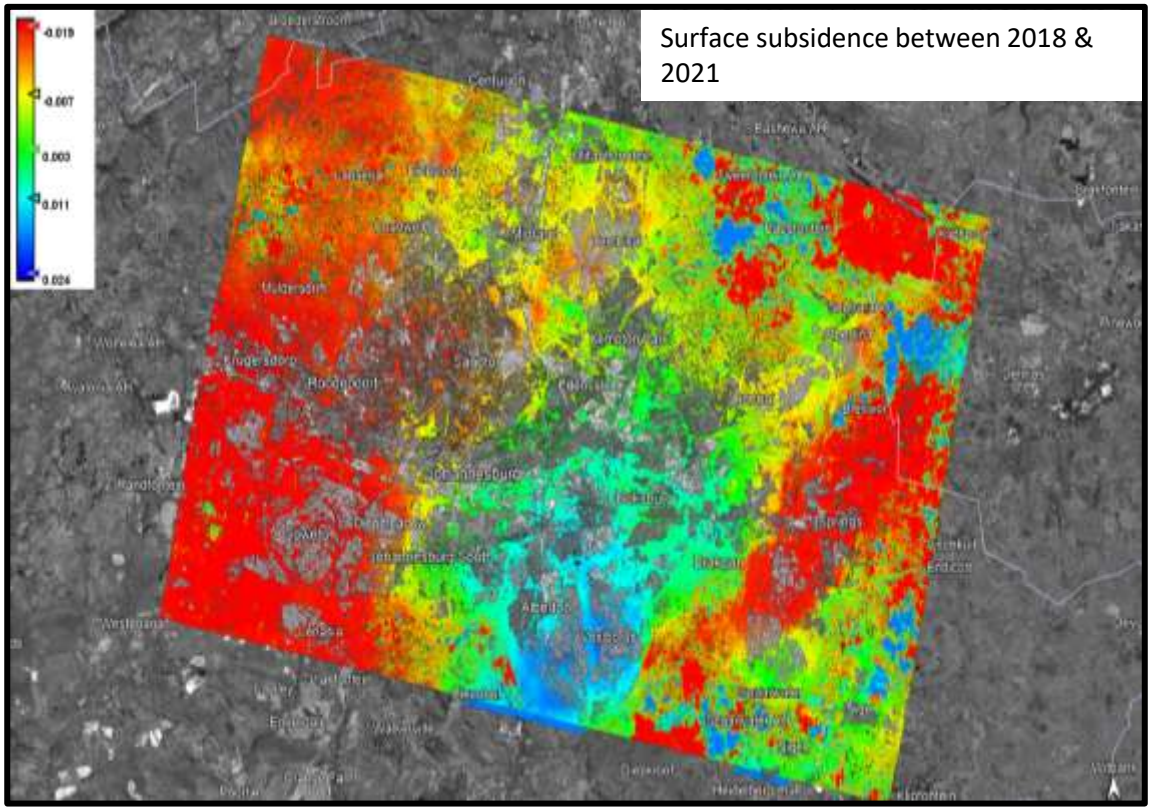


Methodology

- Development of a model to detect surface deformation



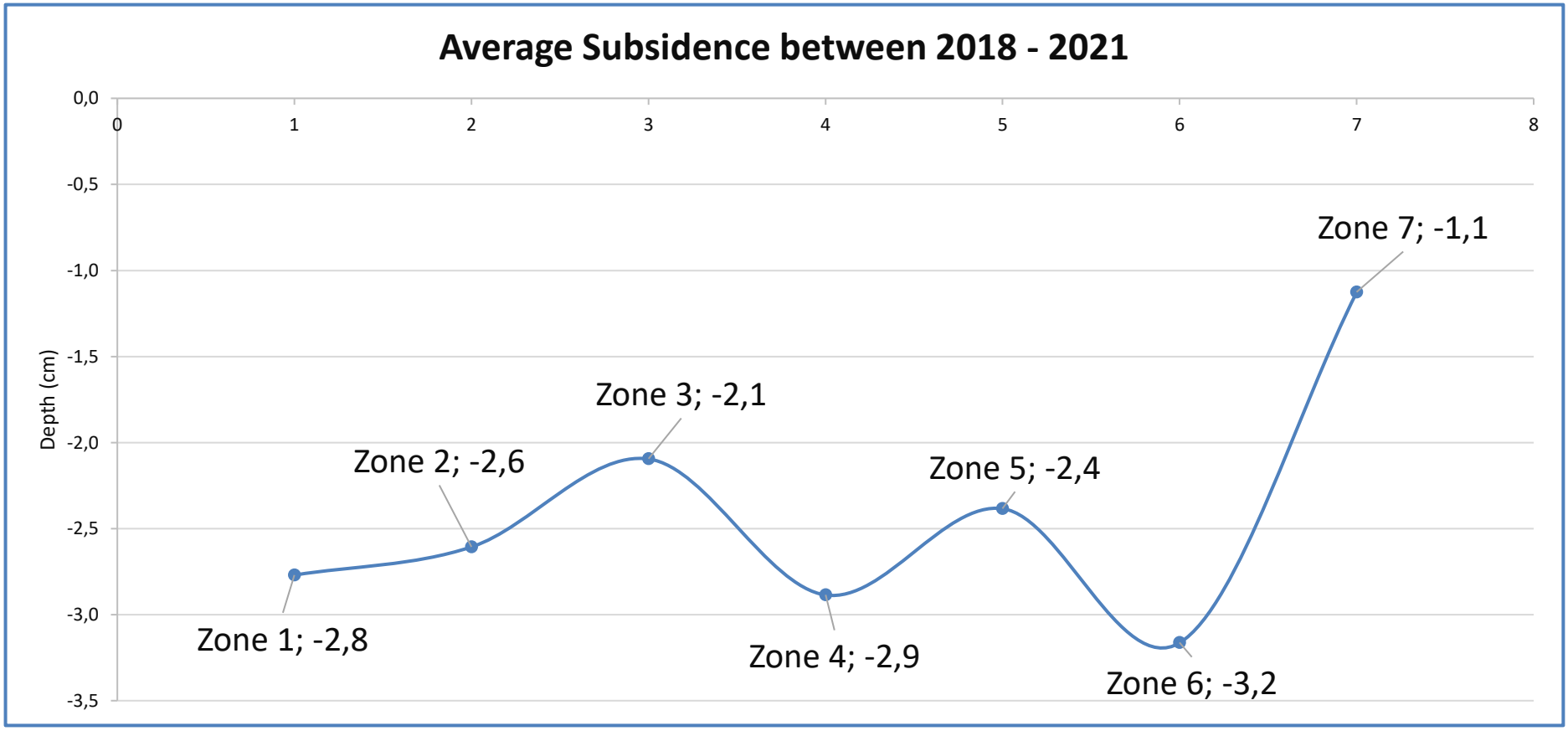
Results



Surface subsidence between 2018 & 2021

Results

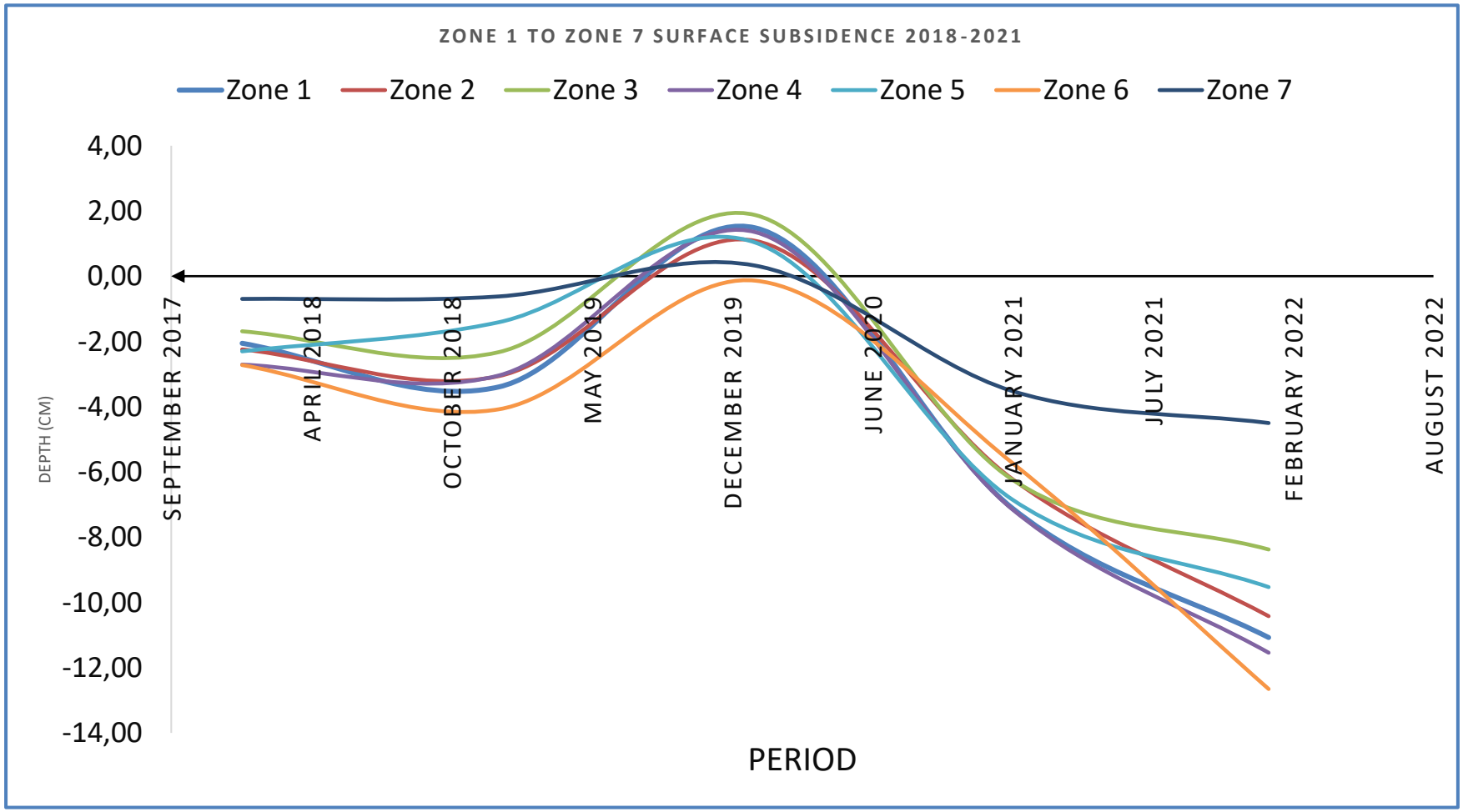
- 7 High Risk Areas were identified: Zone 1 to Zone 7
- Surface subsidence ranged between 1 .1cm – 3.2 cm/year



Results

- Zones 1 to 6 exhibited significant cumulative subsidence between 2018 and 2021
- All the zones studied experienced homogenous subsidence in late 2018, followed by a sharp surface uplift in 2019.
- After 2019, the area experienced consistent subsidence
- Zones 6 had the highest annual average subsidence of 3.2cm, followed by zone 4 with 2.9cm.
- It was therefore recommended that further ground investigations be conducted in all 6 zones.

Results


ZONE 1 TO ZONE 7 SURFACE SUBSIDENCE 2018-2021
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Zone 6
Zone 7
4,00
2,00
0,00
-2,00
-4,00
-6,00
-8,00
-10,00
-12,00
-14,00
DEPTH (CM)
SEPTEMBER 2017
APRIL 2018
OCTOBER 2018
MAY 2019
DECEMBER 2019
JUNE 2020
JANUARY 2021
JULY 2021
FEBRUARY 2022
AUGUST 2022
PERIOD

Proposed Application Areas

- Identification and monitoring of illegal mining activities
- Infrastructure development (hot spots)
- Sinkhole risk management
- Insurance

Acknowledgment

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Phila Sibandze[2]

(1) Kgothatso Innovations, South Africa.

(2) University of Fort Hare

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The client said

"...for us, its about doing our homework through **technical investigation studies** that will **inform** us in our **options development**. The geo-sensing technology is very appropriate during this early phase of the project and will assist us to avoid risky areas with high settlement or swelling.

"We want to utilize technology during the planning phase to ensure that we are proactive in risk identification and can mitigate the risks in our designs. The correct route alignment and station selection is a critical aspect of early project development and studying the geology and utilizing geo-sensing within the planned corridors is a key element to success."

Regional Director:
Rail & Transit BU
Hatch

Thank you.
Questions