

Water, Gold and People

Craig Sheridan

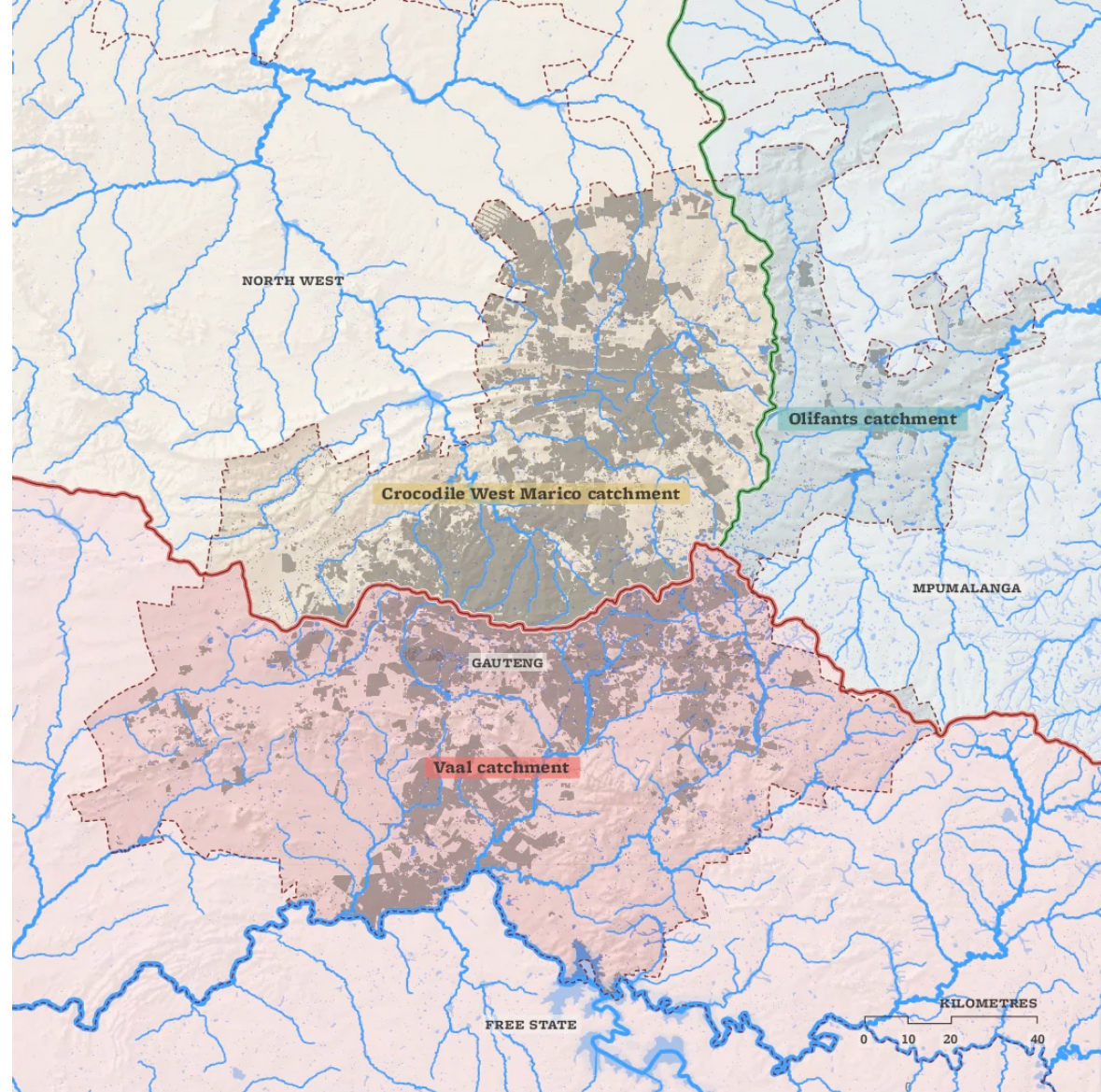
Journey

- Start with water
- Move to gold mining and mine drainage
- Proceed to people
- Back to water

Water

- The city of Johannesburg perched on the continental watershed
- Line which separates drainage to the Indian Ocean in Mozambique from that which drains to Atlantic Ocean at the border with Namibia
- This imaginary line is approximately 60m north of this venue (it is the pedestrian crossing between the Origins Centre and the PG Club
- What seems to be a geographical curiosity is of significant importance in understanding the modern city of Johannesburg

The continental divide watershed
(source GCRO)
Note all the small rivers

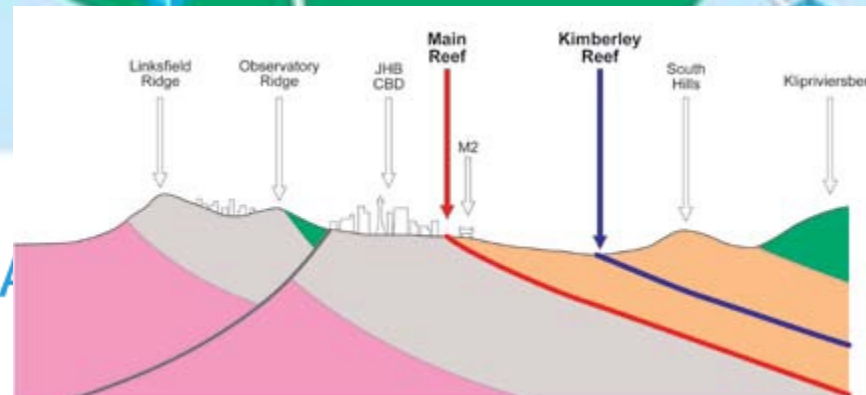
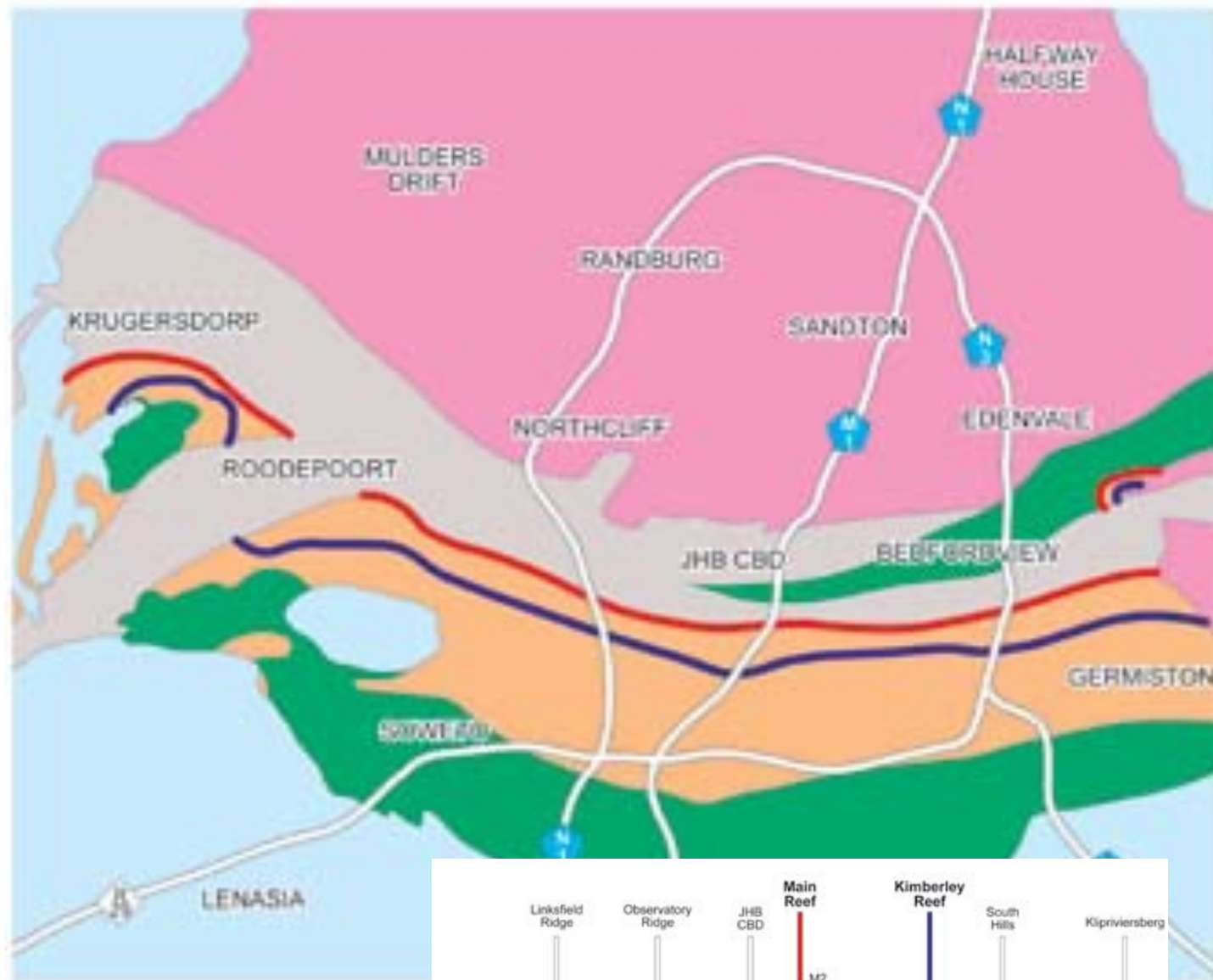


- Watershed between Vaal River and Limpopo tributaries
- Watershed between Crocodile West Marico and Olifants Rivers
- Provinces
- Rivers
- Wetlands and dams
- Urban areas

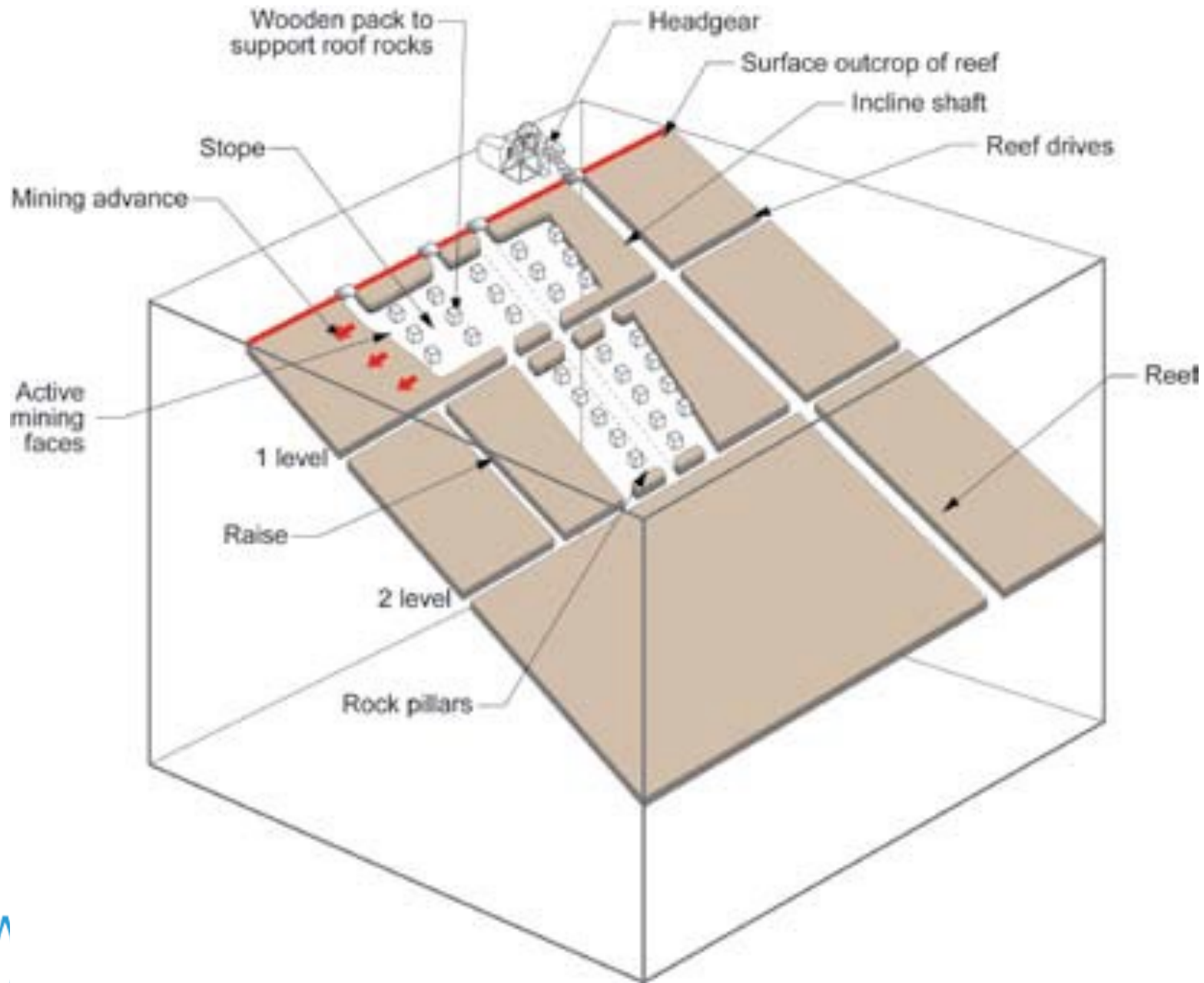
Data Source Department of Water Affairs and Sanitation, CSIR 2011, ESRI, GTI land cover 2014

The gold

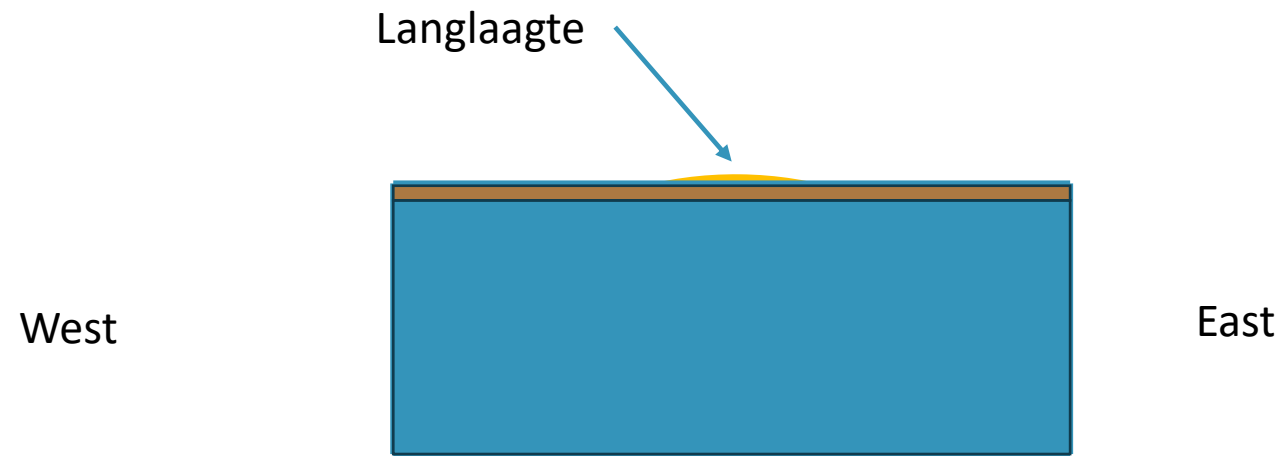
- The history of Johannesburg (and South Africa) is intimately tied to mining
- Gold discovered at Langlaagte farm in 1886 and this fuelled *THE* massive gold rush
- In part, this discovery contributed to the causes of the South African war between Britain and the Boer Republics – historically this war was the most expensive for Britain between 1815 and 1914 and had the highest number of casualties (not including disease, surpassing even the Crimean War)
- The gold reef outcropped at Johannesburg and as it was mined out, going deeper to the south, and east and west, a ‘void’ was created.
- As the reef intersected groundwater, pumps were installed and the aquifers were emptied



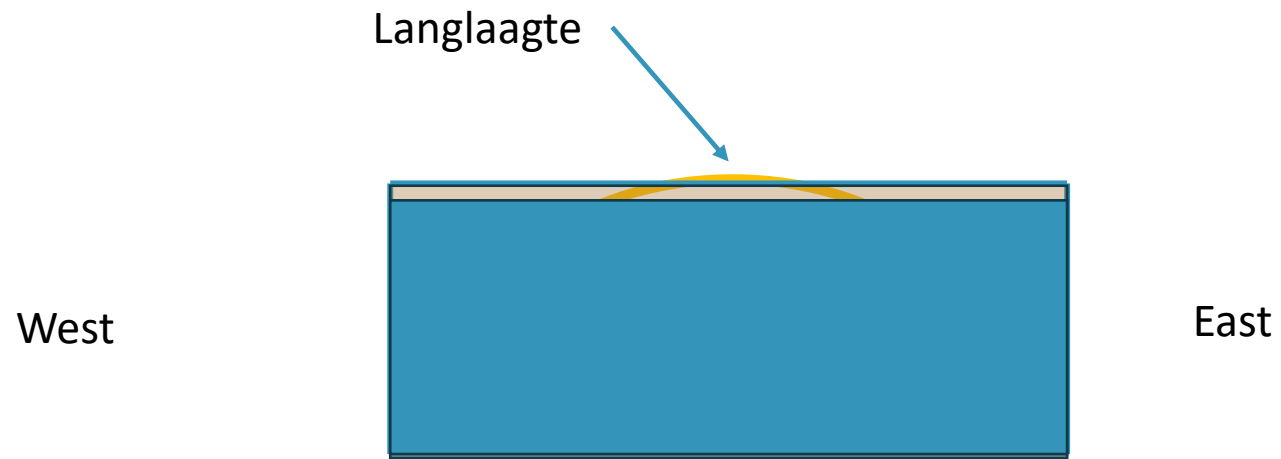
Picture credit GCRO



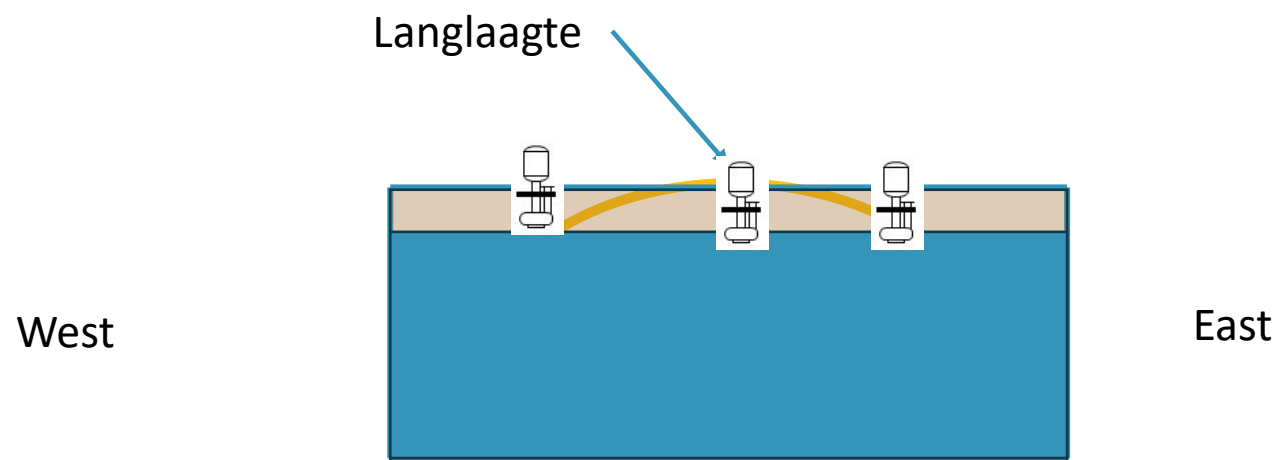
1886



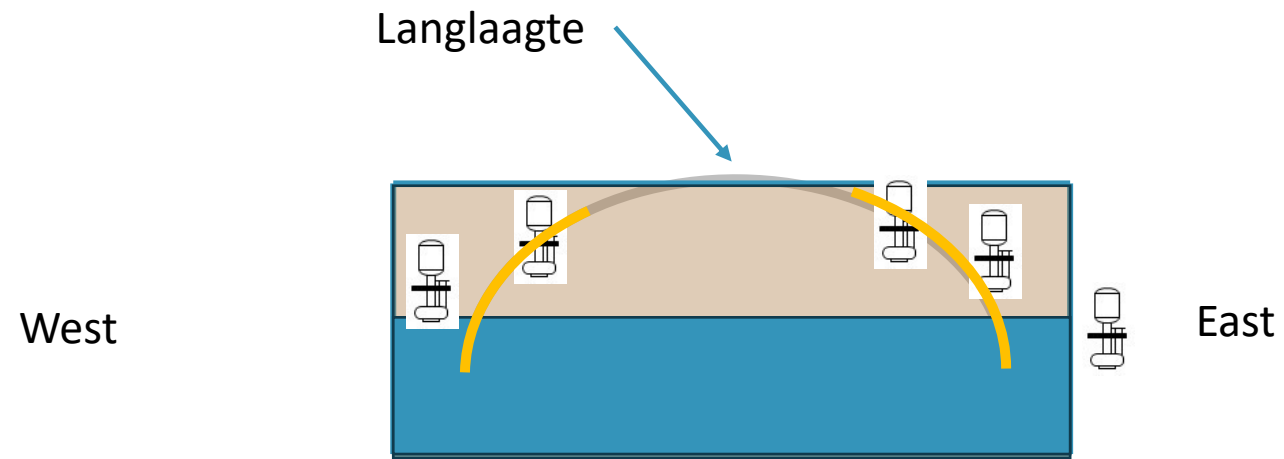
1890s



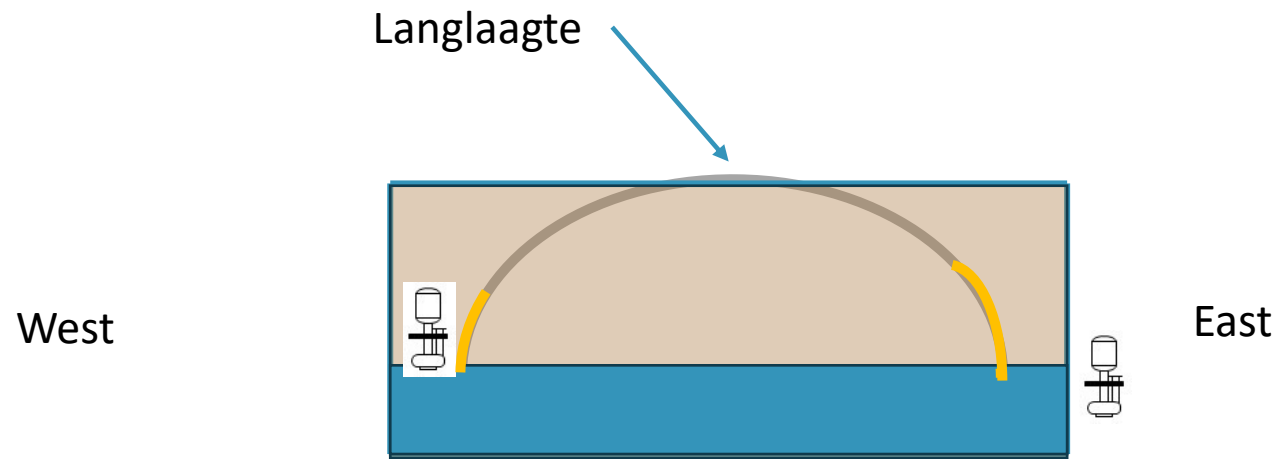
1900's



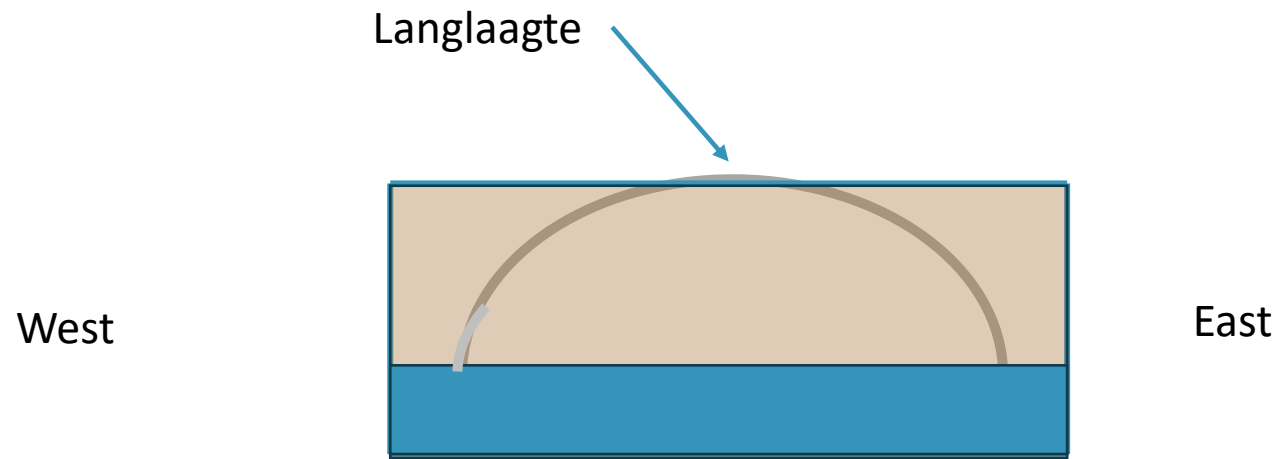
Later



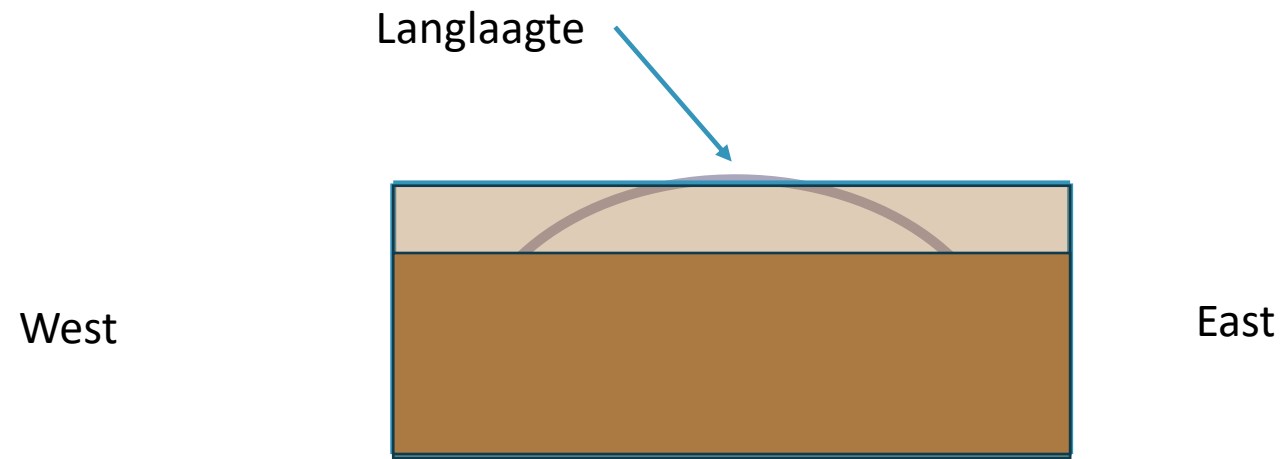
Much later



Early 2000s



2010



Acid Rock/Mine Drainage

- Acid generation occurs as a result of the exposure of sulfide bearing minerals to oxygen in an aquatic environment (can be microbially catalysed).



Fool's gold + water + oxygen + (microbes) = rusty iron + sulfate + acidity

- The decant or drainage of the acid from the mine into the environment is termed ARD or AMD. (Note: all AMD is ARD, not all ARD is AMD)
- The causes of ARD/AMD are well documented, globally and within the South African context.

What does it look like?



Johannesburg Goldfields AMD

Concentration ranges (from Tutu et al, 2008)

Sample number	pH range	Sulfate mg/L	Fe/mg/L	U mg/L
Groundwater	2.9 – 5.7	950 - 3100	4 - 55	0.039 – 0.125
Surface water	2.5 – 8.7	13 - 5080	0.008 - 1010	0.010 – 72.7

Concentrations are 'relatively' low but volumes very high – app 300 million litres per day for west, central and east basins

What about the Coalfields of Mordor?

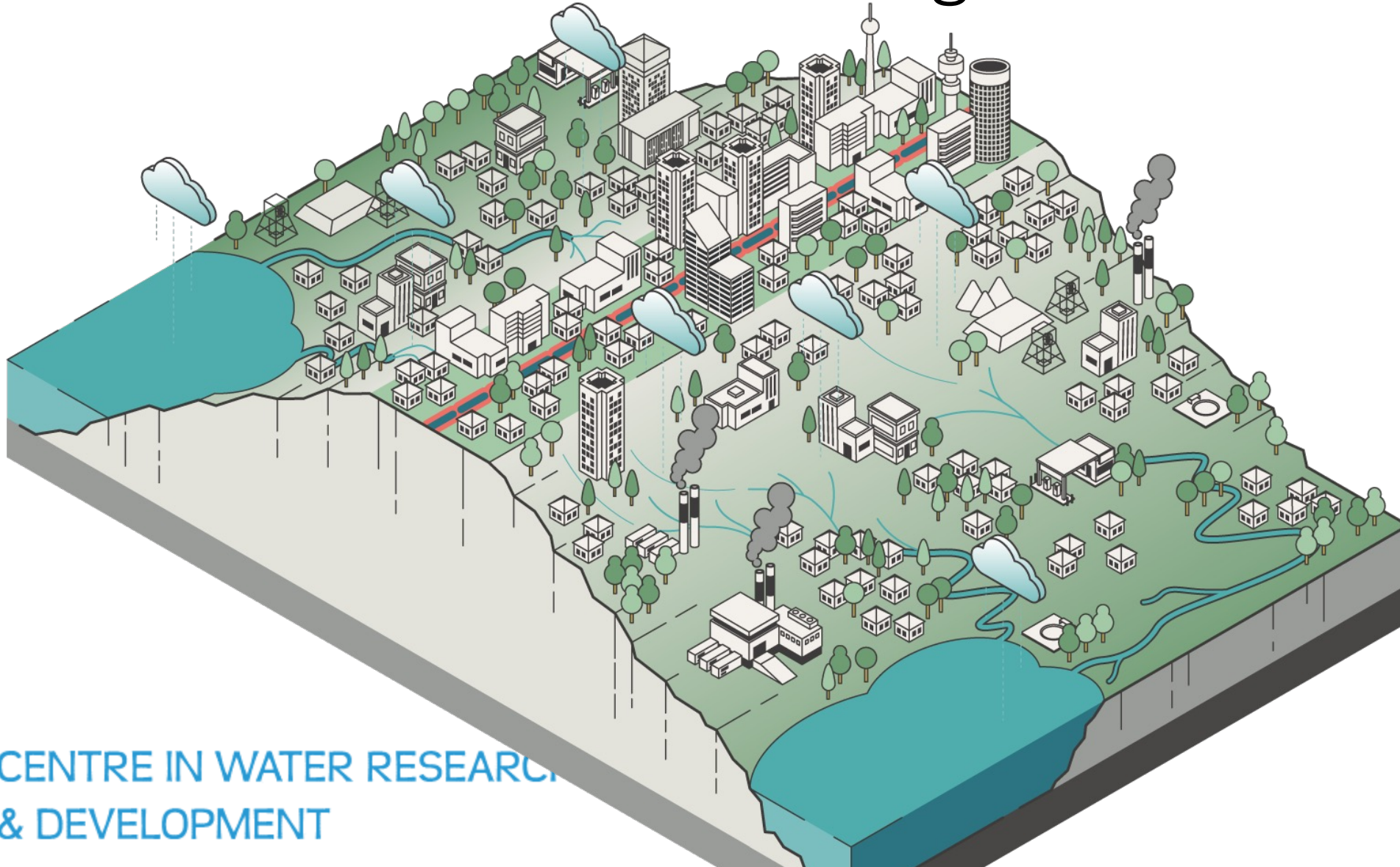


Component	Concentration (mg/L)	Component	Concentration (mg/L)
Iron	3000 - 8500	Aluminium	110 - 650
Manganese	300	Calcium	300 - 1120
Magnesium	150 - 520	Sulfate	6000 - 30800
Sodium	30 - 125	TDS	8000 - 45000
		pH	2.0 - 2.6

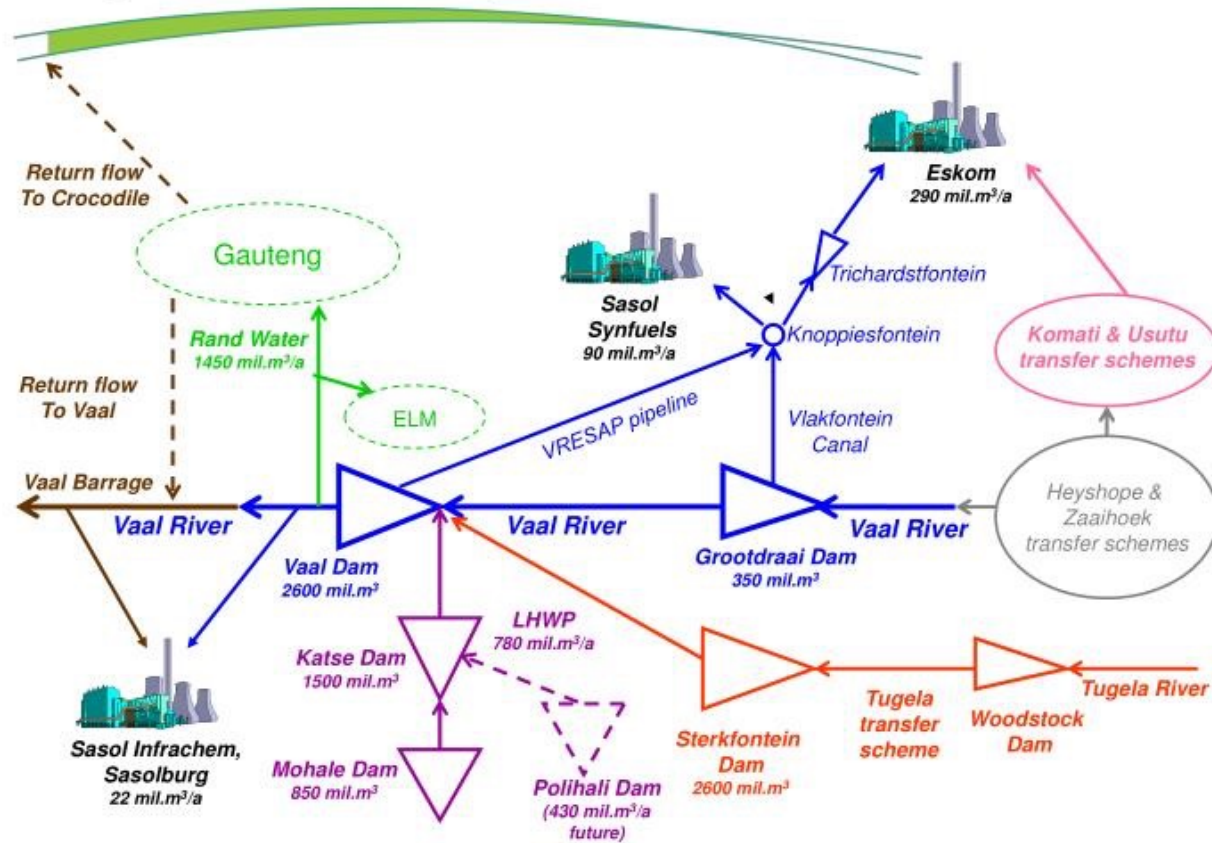
The people

- The people are here because of the gold. There is no other reason for JHB to exist. From a water scarcity perspective, this is possibly one of the worst places to settle. Reasons for this:
 1. The location of the city on the watershed/continental spine
 2. South African hydrology

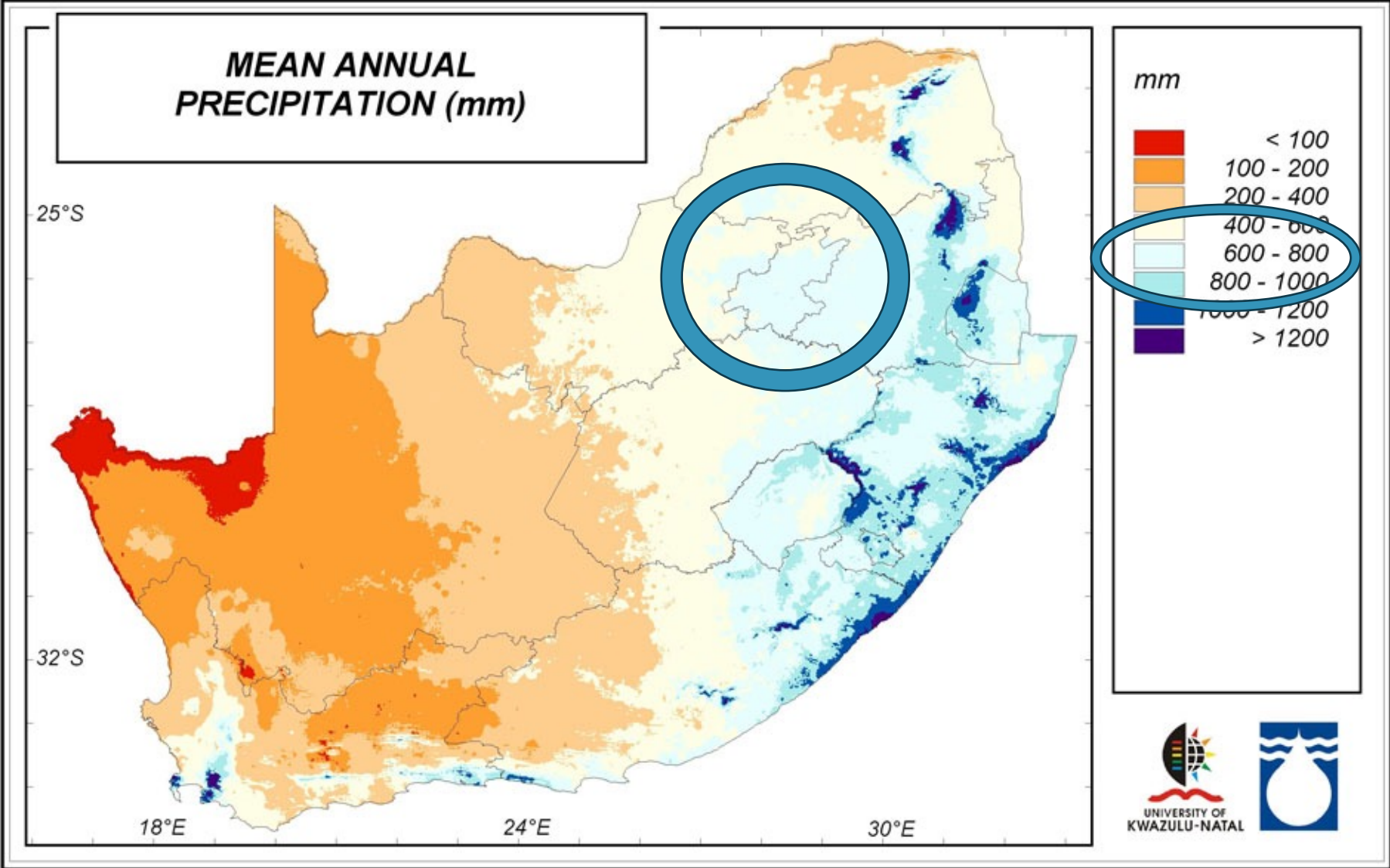
1. Location of Johannesburg

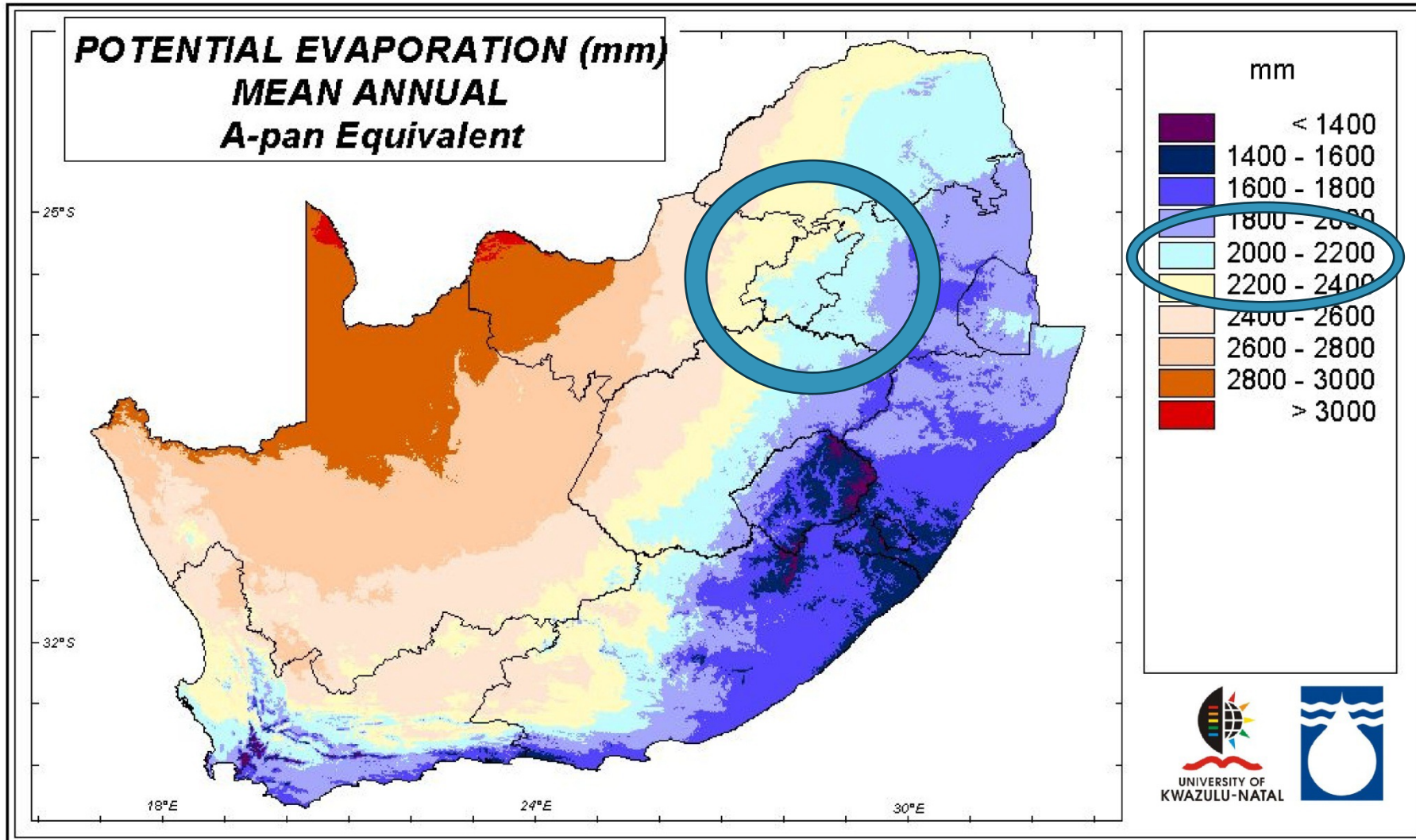


Integrated Vaal River System



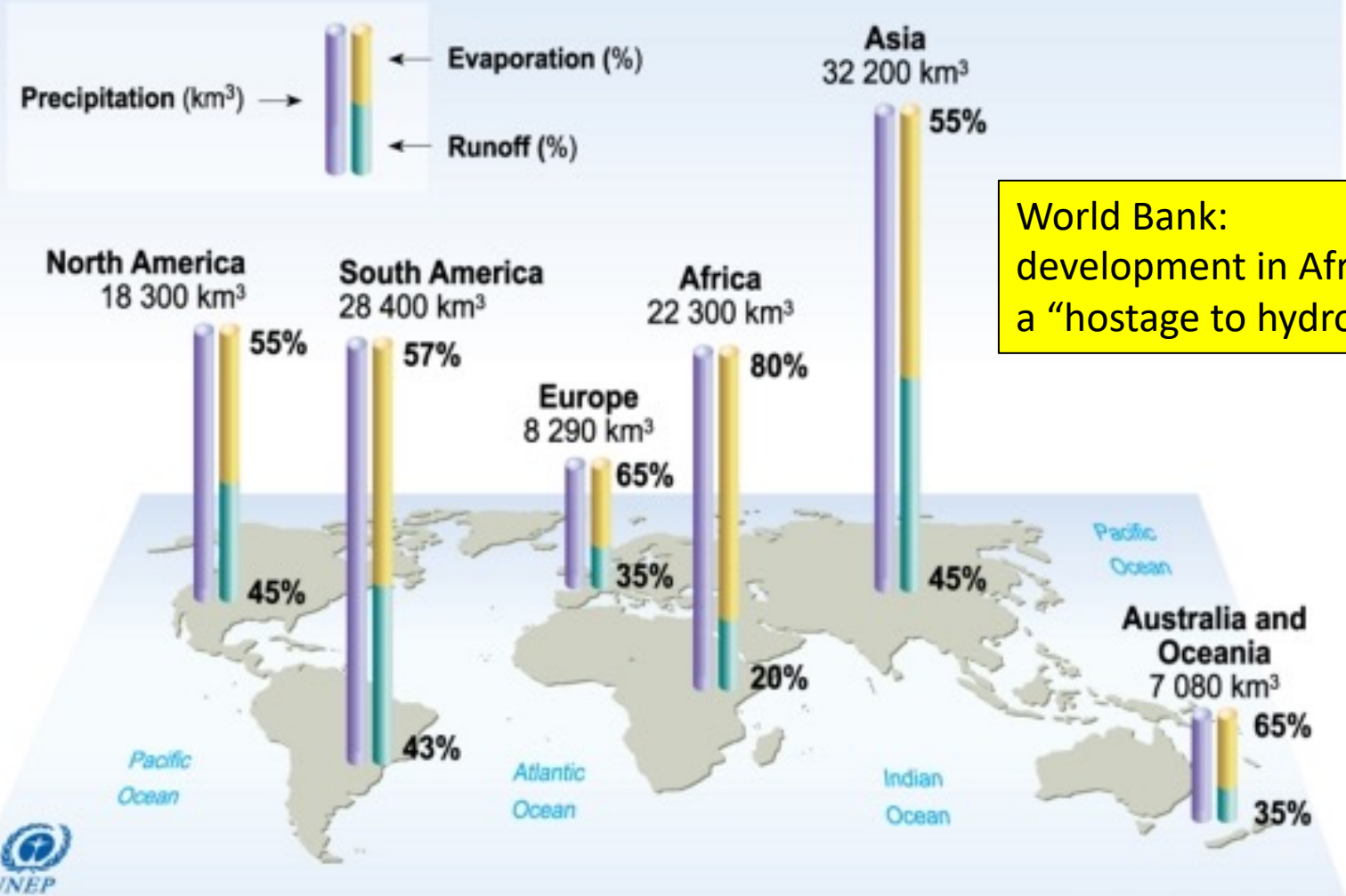
2. South African hydrology





The World's Surface Water

Precipitation, Evaporation and Runoff by Region



World Bank:
 development in Africa is
 a “hostage to hydrology”

Source: Peter H. Gleick, *Water in Crisis*, New York Oxford University Press, 1993.

Source: UNEP (<http://www.grida.no/graphicslib/>)

PHILIPPE REKACEWICZ, MARCH 2002

The problem with the people...

- Water in Gauteng is sourced from the Vaal River (primarily) and treated by Rand Water
- The allowable extractable amount has not changed in 10 years (because it is a renewable, yet finite resource)
- The population of SA has increased from 51.8m to 62.0m between 2011 and 2022
- The population of Gauteng has increased from 12.3m to 15.1m between 2011 and 2022
- In SA, we use app 780L per person per day (for all uses - 2014 data) about 50% more than the global average
- In 2023 we have more people but not more water
- Consequential challenges of potable water system failure combined with sanitation system failure and AMD leading to serious societal challenges with water security
- But... in my experience the people always make a plan.

Back to the water







We know what it should be like

Water and the different knowledge realms

- If we want to maximize our impact I believe it is *critically* important to interact with each other to understand the different realms of knowledge
 - We treat fresh water and wastewater because the law compels us to
 - The law is guided by best scientific practice (health sciences, engineering, theoretical and applied sciences)
 - These all require money (hence finances and economics)
 - They all hang on societal values
 - Humanities influence societal values the most
 - This all starts with education at the very basic level