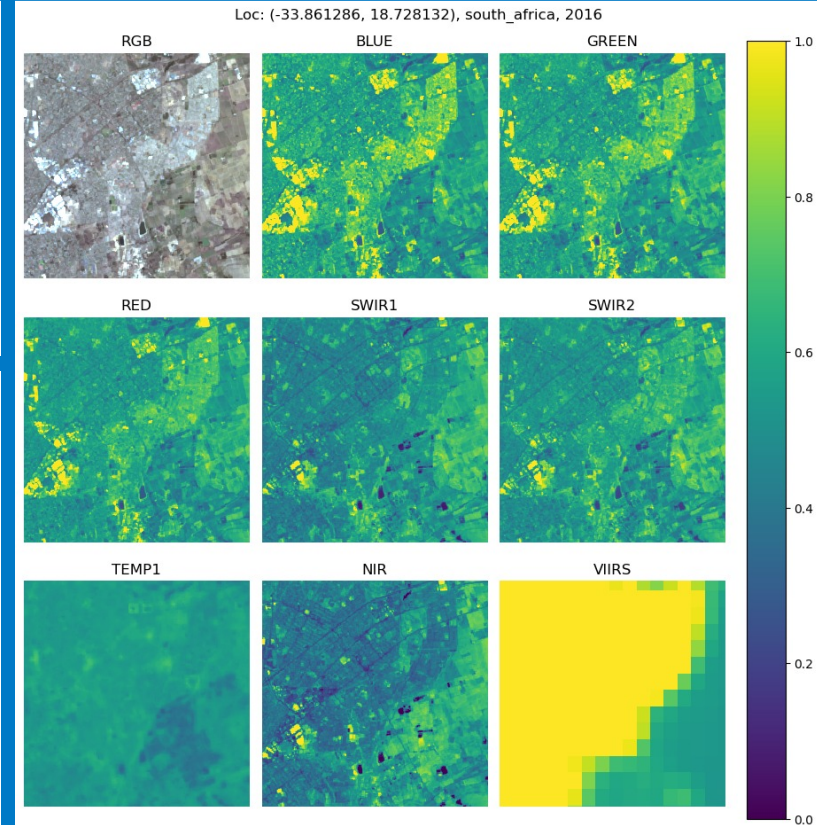


Background

The first of 17 UN sustainable development goals for the year 2030 is to end poverty everywhere. There is currently a shortage of available poverty indicators in African countries. As a result, a fast and efficient solution is needed to replace the existing census data collection process. With census data available from the past 13 years, a machine learning algorithm such as a Convolutional Neural Network can be trained and tested to make poverty predictions for specific locations. The implementation of the Convolutional Neural Network is experimented with and analysed to find the best algorithm to predict poverty from space in Africa and more specifically South Africa.

Temporal poverty maps of South Africa (2016 and 2020)

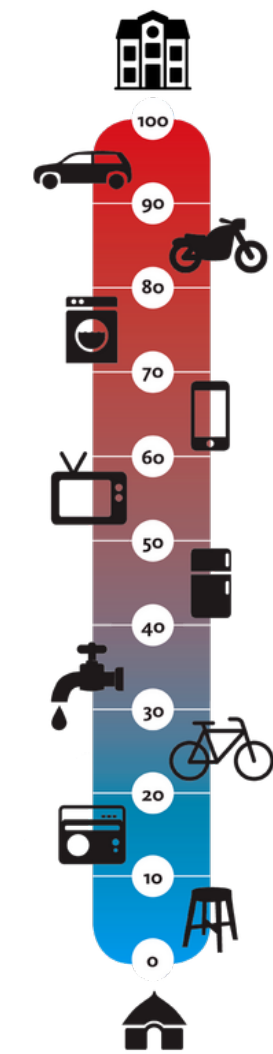
- Correlation between the GDP and temporal poverty maps is shown below.
- A CNN ResNet-18 model is used to predict the economic landscape of South Africa.
- The model predicts accurately with an r^2 value of 0.6 and a mean square error of 0.36.
- South Africa is trained separately to other African countries as it is an outlier.



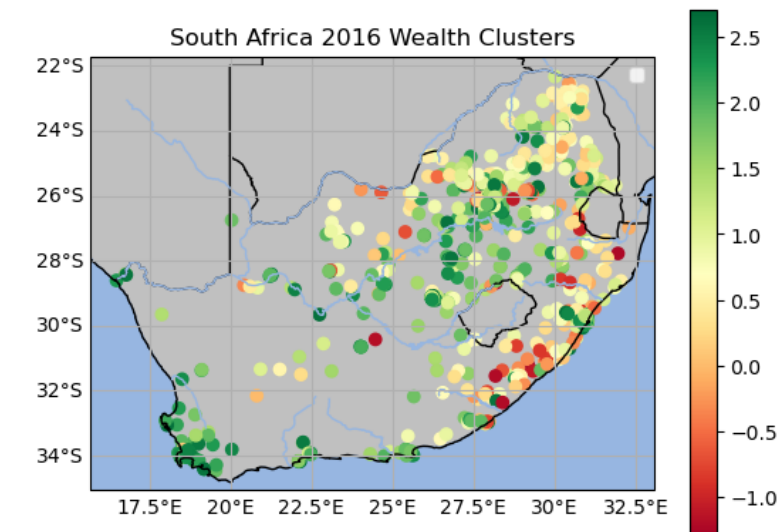
- The satellite image data has 9 spectral bands available.
- These bands are used to train our deep learning models.
- For all band images, the lighter the pixels in the image, the more yellow they are highlighted in the given diagram.

International Wealth Index (IWI)

- The IWI is an asset based wealth index
- Based on data for over 2.1 million low and middle income countries.
- IWI score ranges from 0 - 100.
- Constructed from household surveys.
- We normalised our IWI data to match the AWI in the existing Stanford research.

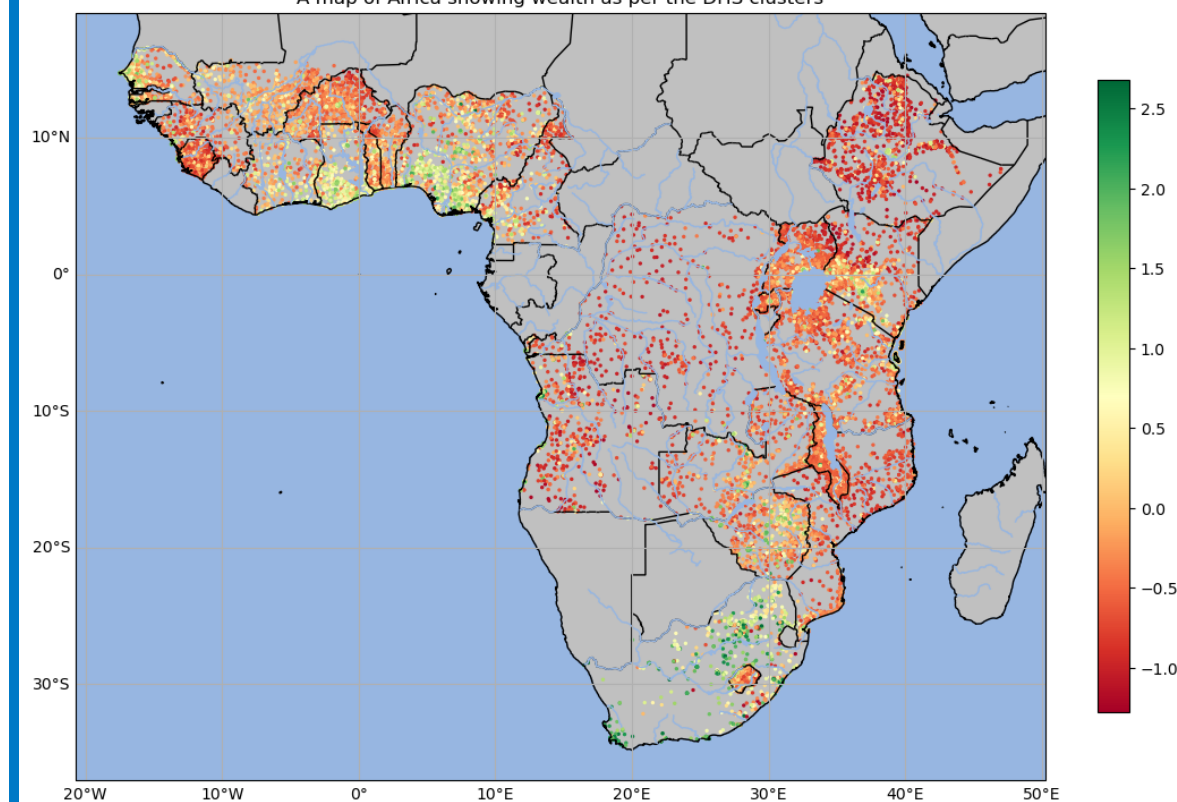


- Exact economic situation of South African clusters in 2016 used for training the model.
- The Western Cape has the most wealth while the Eastern Cape and KwaZulu-Natal have the least wealth.
- There are 464 urban clusters and 282 rural clusters.



- The map of Africa below shows 24 countries including South Africa.
- The markers on the map show the economic situation of 20415 clusters. Clusters are roughly equivalent to villages in rural areas or neighborhoods in urban areas.
- Cluster data is obtained from the Demographic and Health Surveys (DHS).
- The colour of each cluster represents the Asset Wealth Index (AWI) score with areas in red being comparatively poor and green areas being comparatively wealthy.
- South Africa and Nigeria are outliers as they are by far the wealthiest African countries.
- The census and survey data is limited and thus the entire content cannot be plotted exactly. Our models allow predictions for surveyed areas.

A map of Africa showing wealth as per the DHS clusters



Additional Applications

- Monitoring water supply and quality throughout Africa especially in rural areas.
- Smart farming: Predicting crop yield, soil health, vegetation cover estimation and other farming uses.
- Mapping road networks to determine access to villages and other remote locations.