The (South) African Soil Microbiology project

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3 Academic staff
(Cowan, Makhalanyane, Coutinho)

1 Administrator
1.5 Technicians
14 Postdocs
23 PhDs
15 MSc
Soil Microbiology 101

• The soil microbiome
  – $10^4$ bacterial, $10^2$ fungal, $10^2$ archaeal, $10^5$ virus and phage, $10^3$ microinvertebrate species
  – Contribute to ecosystem services (C and N cycling)
  – Direct role in plant performance and productivity
  – Contribution to soil stability

• Microbiome structure influenced by soil type, soil physico-chemistry, vegetation, macroclimate, land-use
“There is no comprehensive survey of the national soil microbiome in South Africa, or across Africa (or anywhere else in the world)”!
The Project

• A ‘low resolution’ microbial community survey of soils across sub-Saharan Africa

  ◆ Acquisition of soil samples from participating nations
  ◆ Phylogenetic fingerprinting of bacterial communities using NG sequencing of 16S amplicon sets
  ◆ Physicochemical analysis of soil samples
  ◆ Interpretation of community composition in terms of soil physicochemical properties and macro-environmental parameters
The basic numbers

• 10 nations: South Africa, Namibia, Botswana, Zimbabwe, Mozambique, Zambia, Kenya, Ethiopia, Cote D’Ivoire, Benin

• Plus a limited number of random samples from Angola, Tunisia

• Total budget: $435,000

• 1000 samples

• Samples per nation defined by land area

• Sampling intervals: 50 km
Site data capture

- Sample number/code
- Time and date
- GPS location (decimal degrees)
- Altitude
- Aspect/Slope
- Local vegetation type
- Local ground characteristics
- Other notable characteristics
- Representative photographs of site and location
Analysis: Phylogenetics

• Metagenomic DNA extraction
• DNA concentration and quality
• 16S rRNA gene amplification
• Next Generation Sequencing (Illumina MiSeq)
• Bioinformatics: Phylogenetic assignments
• Correlation analysis with macro- and microenvironmental parameters
Data Interpretation

• Phylogenetic assignments (at various taxonomic levels)
• Estimates of $\alpha$ and $\beta$ diversity, diversity indices
• Correlation analyses with physicochemical properties, regional and national locations, climate zones, biome types, land and agricultural use, etc.
• Identification of differentially abundant taxa (biomarkers)
• Identification of core taxa
• Putative interaction between taxa: Network analysis
Outputs and Evidence

• The ‘first ever’ survey of African soil microbiomes

• Correlation of microbiome fingerprints with region, biome, soil type, macroclimate, land-use

• Primary phylogenetic dataset for future re-analysis, comparison etc.

• The role of microbes in ecosystem services, ecosystem sustainability and resilience to climate change

• The soil microbiomic genetic resource
Future Evidence-Based Outcomes

• New ‘soil health’ metrics for guiding fertilization practice
• Recommendations for soil emendation (with specific microbial preparations)
• Recommendations for crop selection (from pathogen presence/absence)