Assessing the GHG mitigation potential of habitat restoration and afforestation in the City of Cape Town

Dr Ryan Blanchard

CSIR, Smart Places

June 2021

Presentation outline

- Background
- Methods:
  - Data sources and terminology
    - South African Terrestrial Carbon Sinks Atlas
- Results:
  - Carbon Storage and Sequestration
    - The role of natural and existing vegetation
  - Additional carbon dioxide removal activities
    - Natural habitat restoration
    - Tree planting
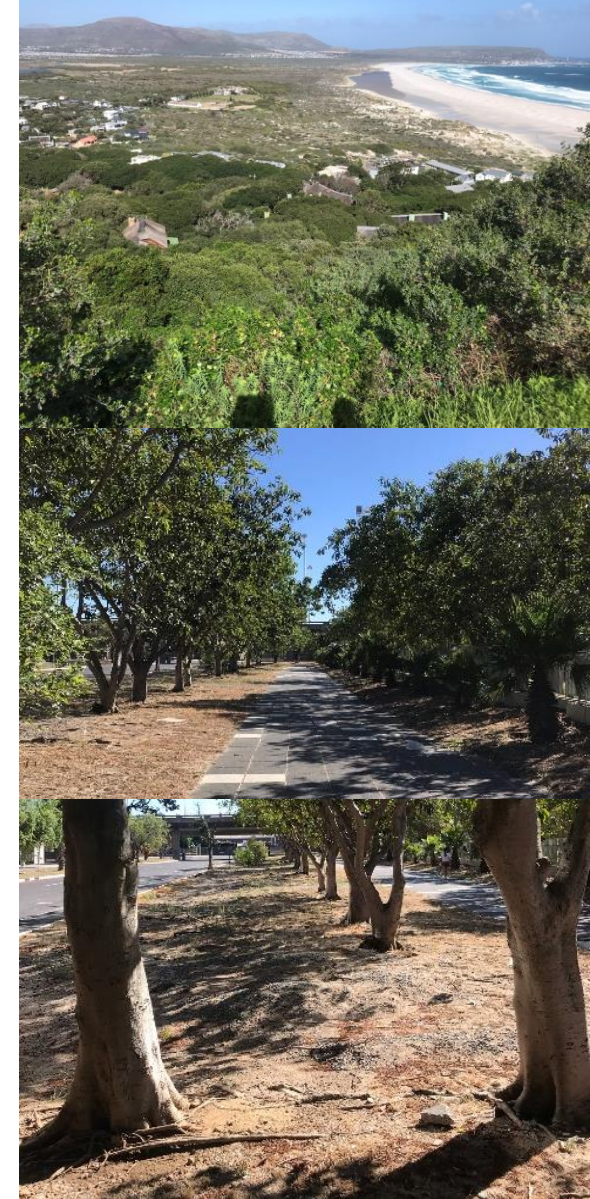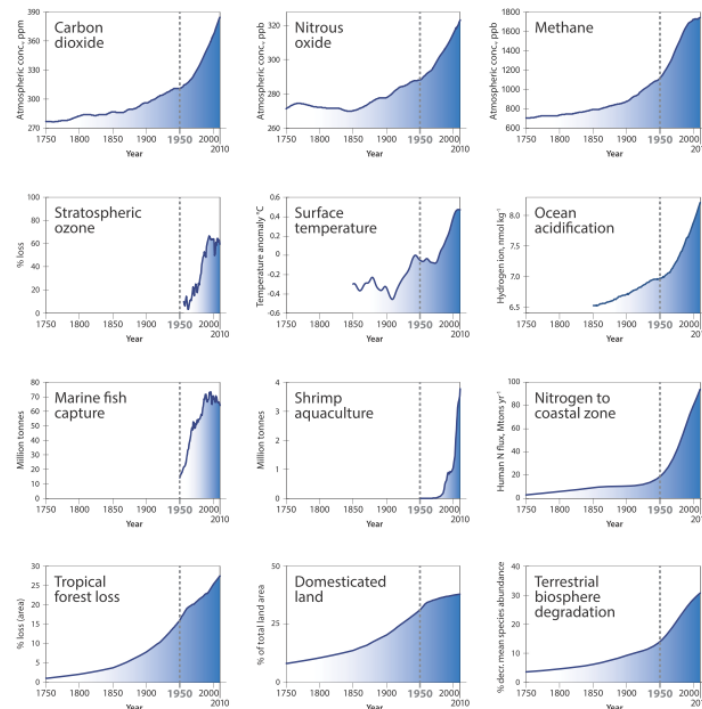- Conclusions
- Recommendations

Background

- Growing pressure on global biophysical processes that regulate the stability of the earth systems.


Socio-economic trends
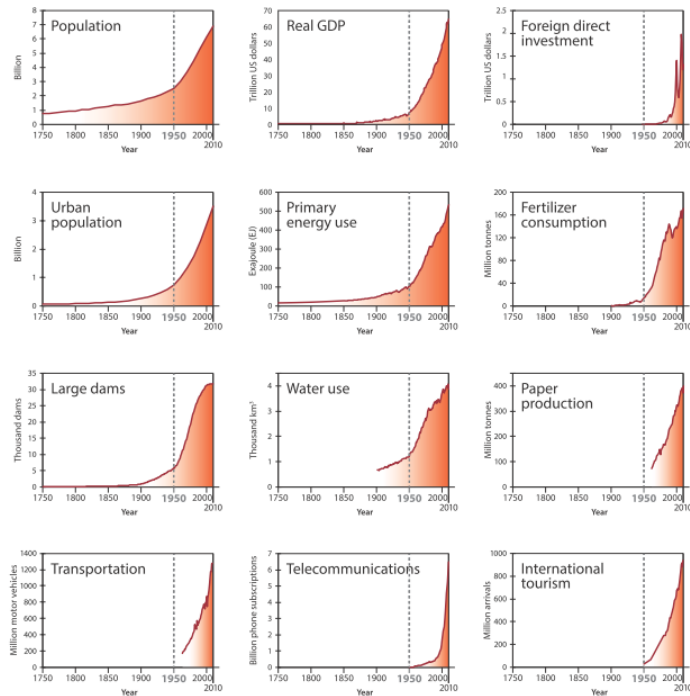
Earth system trends

Steffen et al 2015

Background

- Deliberate actions are required to offset the accelerating pace of global emissions.
- Cape Town's emissions 21 million tCO_2eq or 5.5million t/C

- What to do?
  - Reduce emissions
  - Reduce greenhouse gases by capturing and storing the carbon
   - Afforestation, Restoration

  Examples:
  - **UN Decade of restoration**
  - **Bonn Challenge: 3.5 million km² of forest landscape restoration**
  - **AFR100: 1 million km² of forest landscape restoration targeting Africa**
  - **UN Trillion trees campaign (e.g. Bastin et al 2019 Science)**

CSIR
Touching lives through innovation
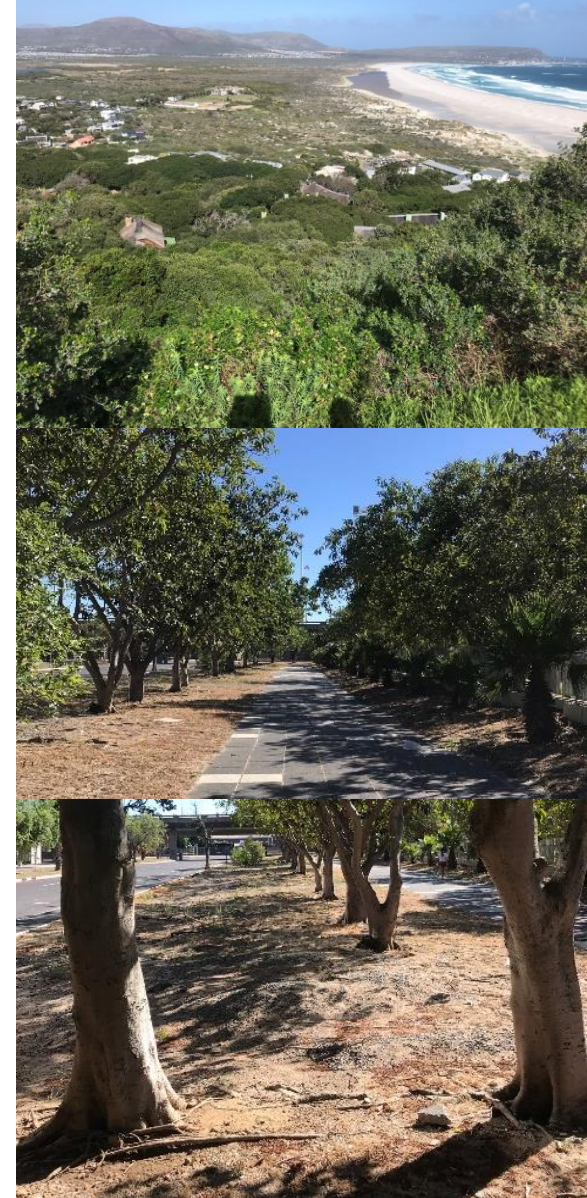
Background

- Deliberate actions of increasing carbon dioxide removal activities are required to offset the accelerating pace of global emissions.

- What to do?
  - Reduce emissions
  - Reduce greenhouse gases by capturing and storing the carbon
    - Afforestation, Reforestation

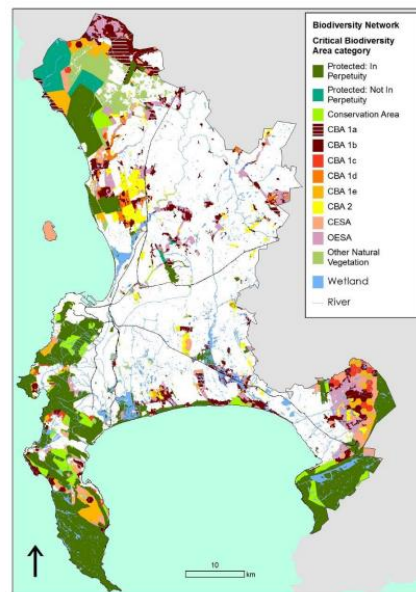What does this mean for Cape Town which occurs in a treeless biome?
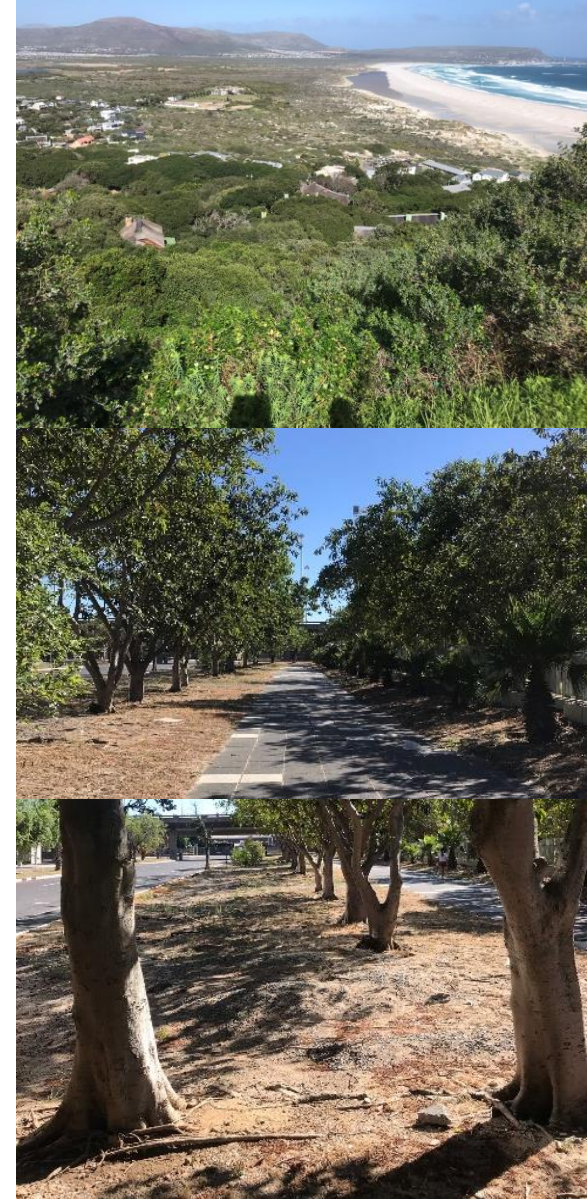
Background

- The City of Cape Town recognizes the limitations regarding biodiversity and water

City of Cape Town
BIODIVERSITY REPORT 2018
Celebrating a decade of biodiversity management 2008-2018

Learning from Cape Town's water crisis

The Biodiversity Network for the Cape Town Municipal Area
C-PLAN & MARXAN ANALYSIS: 2016 METHODS & RESULTS

Science & Society

The Trouble with Trees: Afforestation Plans for Africa

William J. Bond,[1,2,*]
Nicola Stevens,[3] Guy F. Midgley,[3]
and Caroline E.R. Lehmann[4,5,6]

Extensive tree planting is widely promoted for reducing atmospheric CO_2. In Africa, 1 million km^2, mostly of grassy biomes, have been targeted for 'restoration' by 2030. The target is based on the erroneous assumption that these biomes are deforested and degraded. We discuss the pros and cons of exporting fossil fuel emission problems to Africa.
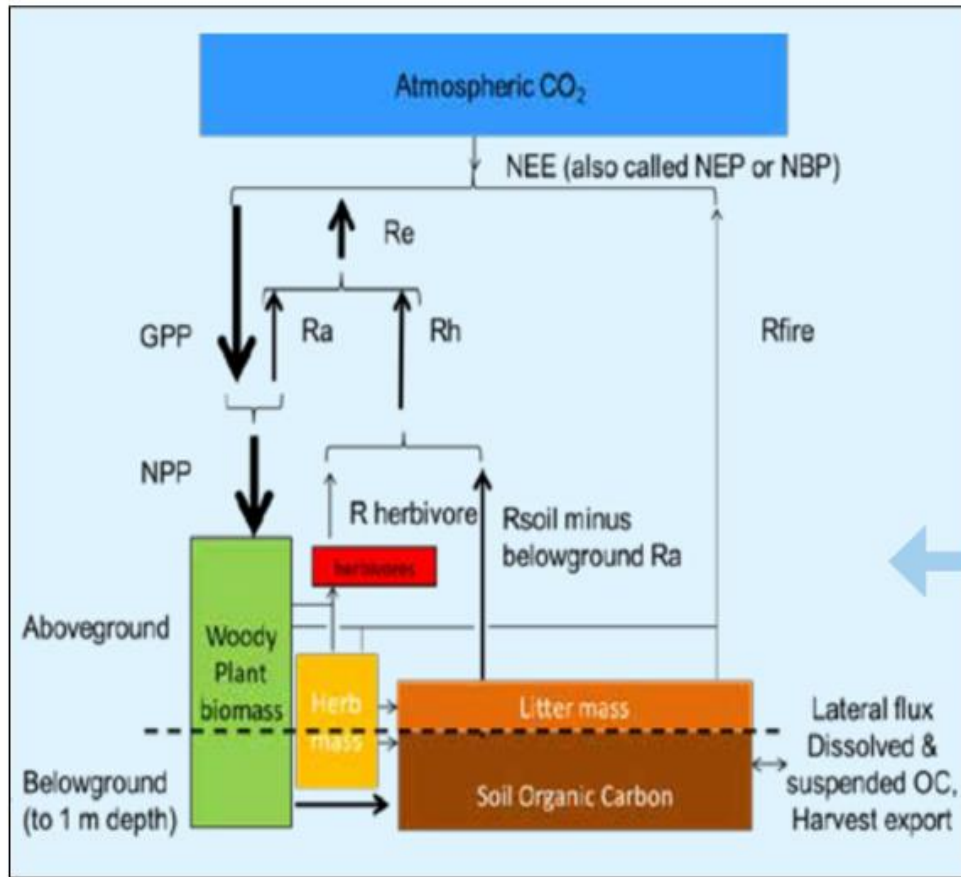
Research questions

- Where is the carbon stored in the city?

- What are the rates of carbon sequestration?

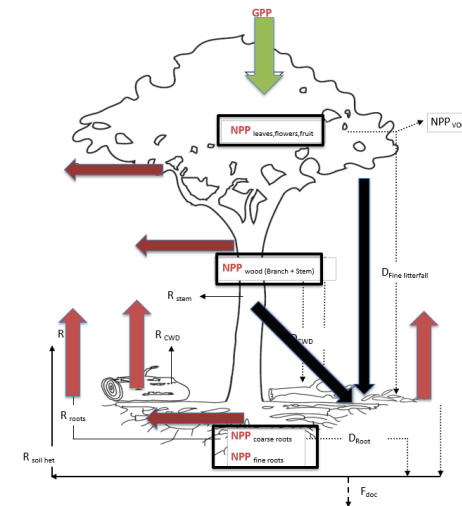- Where can these be improved and by how much?
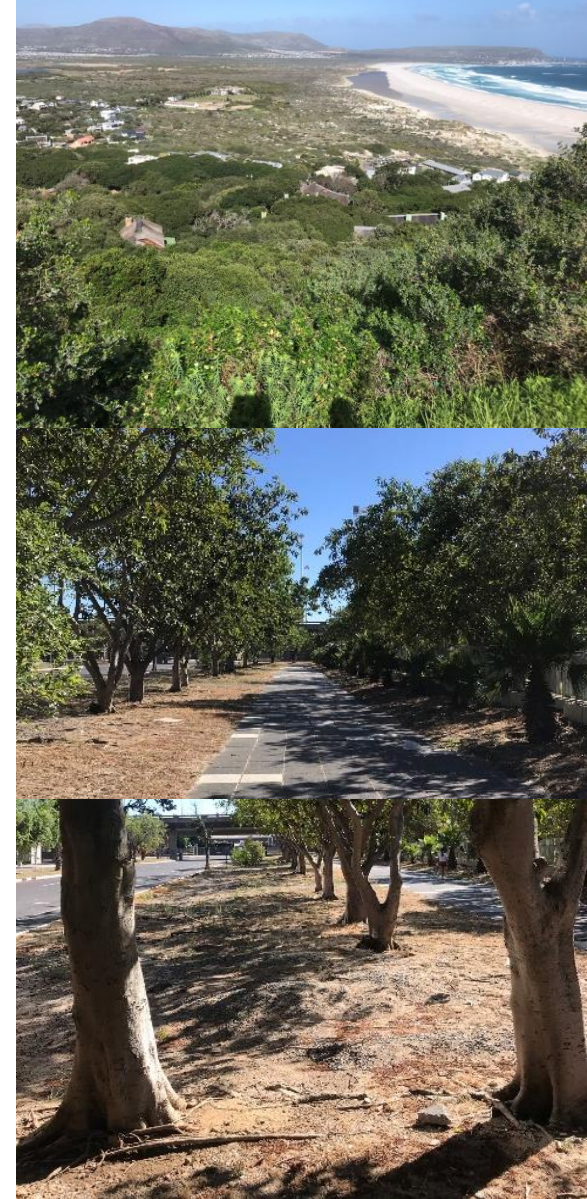
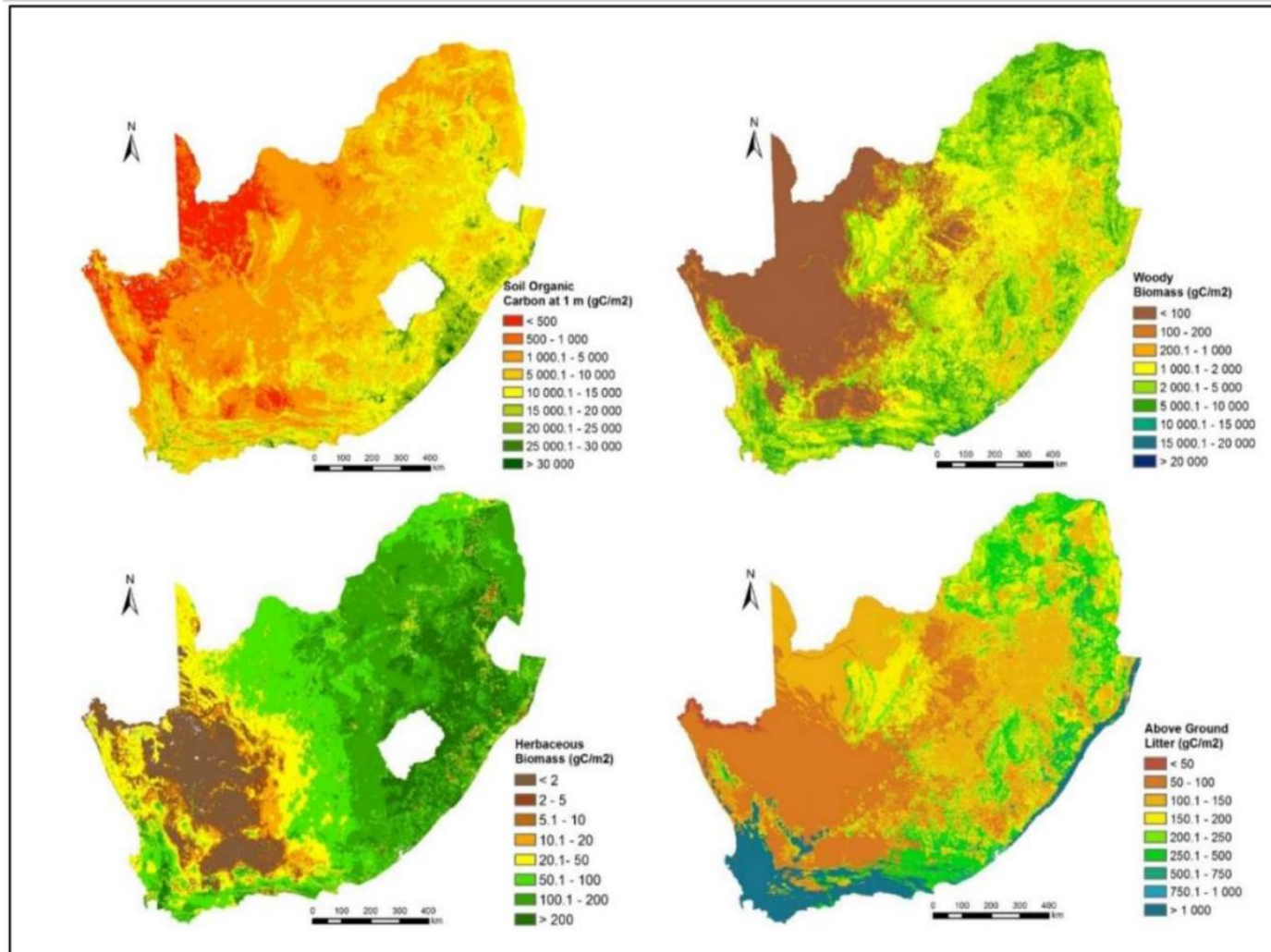# Carbon cycle and important variables to consider

- Key Carbon variables
  - Gross Primary Production
  - Respiration
  - Net Primary Production
  - Heterotrophic respiration
  - Fire
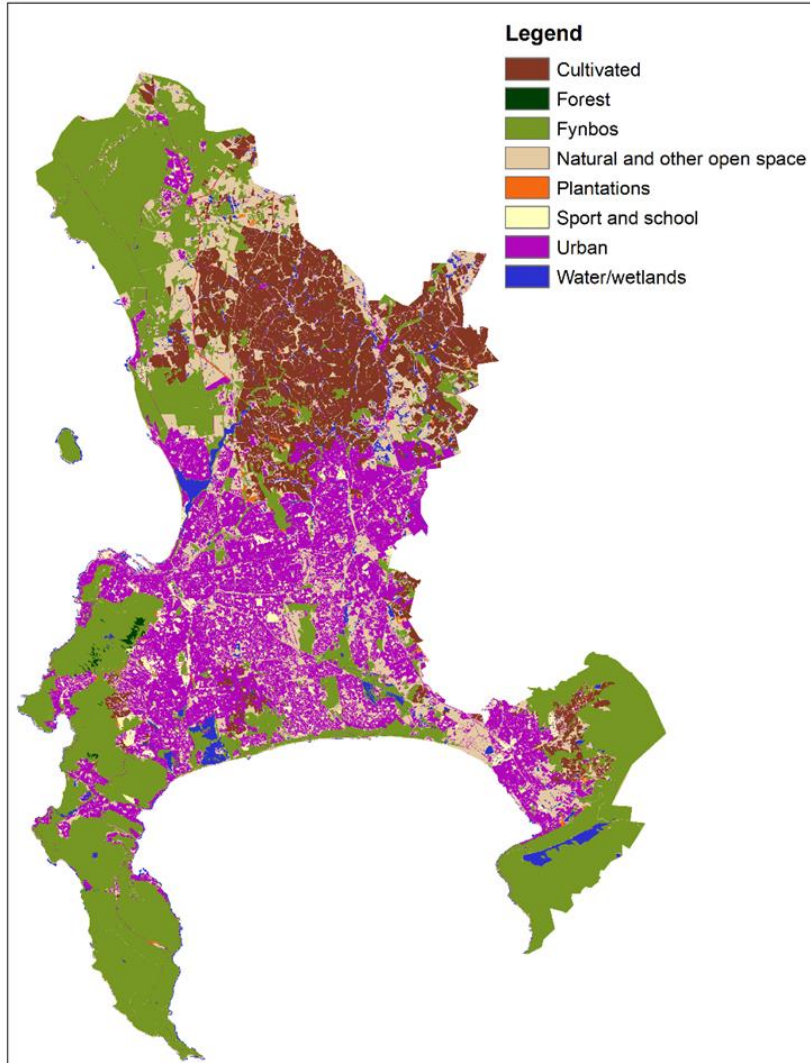

http://www.yadvindermalhi.org/blog

Data sets: Carbon sinks atlas

- National product
  - total carbon,
    - above ground biomass
    - soil carbon.
- Units can be converted to tons per hectare (t/ha)
- Available for three time periods 1990, 2014, 2018

https://ccis.environment.gov.za/carbon-sinks/#/

Where is the carbon in the city?

- Eight land cover classes

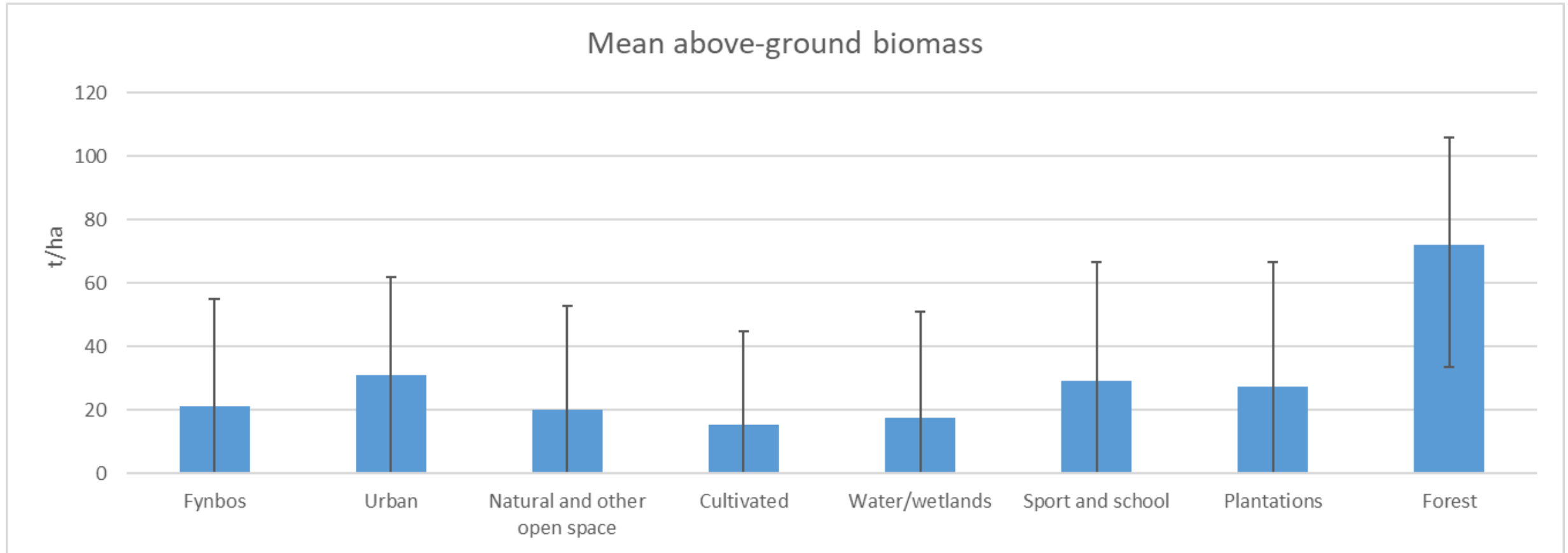| Class	Percentage
BioNet	37
Urban	24
Natural and other open space	18
Cultivated	16
Water/ wetlands	3
Sport and school	2
Forest	0.2
Plantations	0

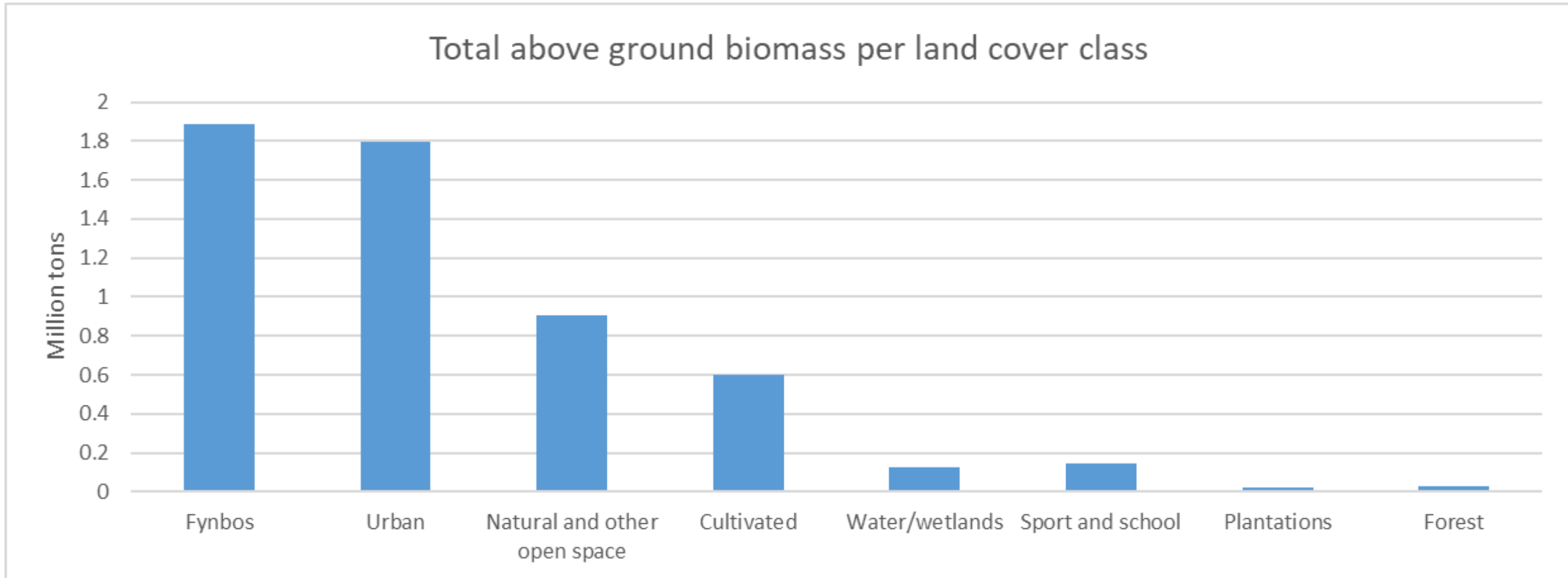# Total carbon (soil carbon and above ground biomass)
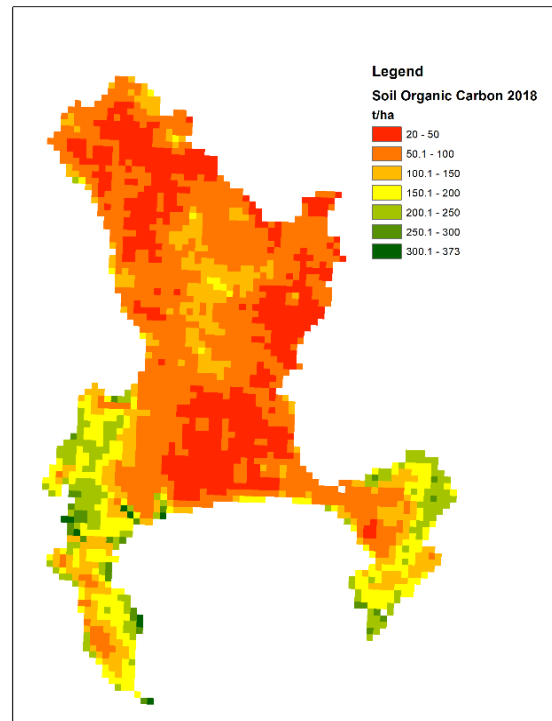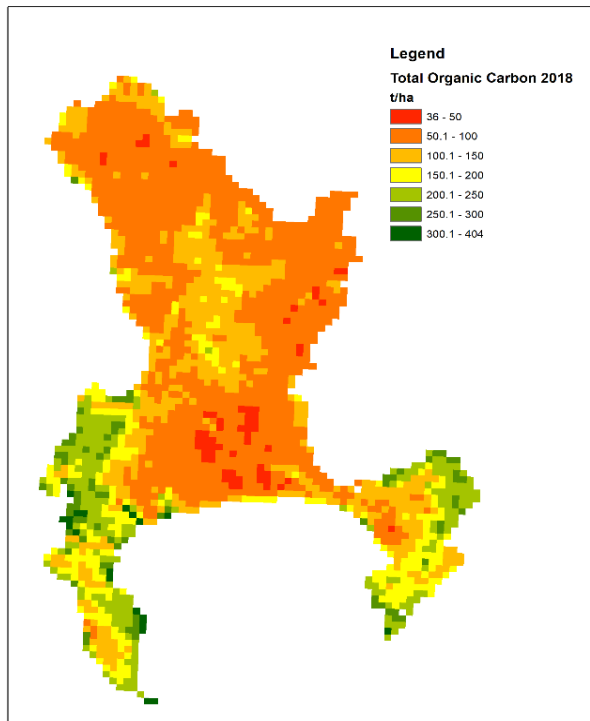
- ~29 million tons of carbon
- Soil carbon accounting for ~80% of the Total Carbon

Above-ground biomass – carbon density

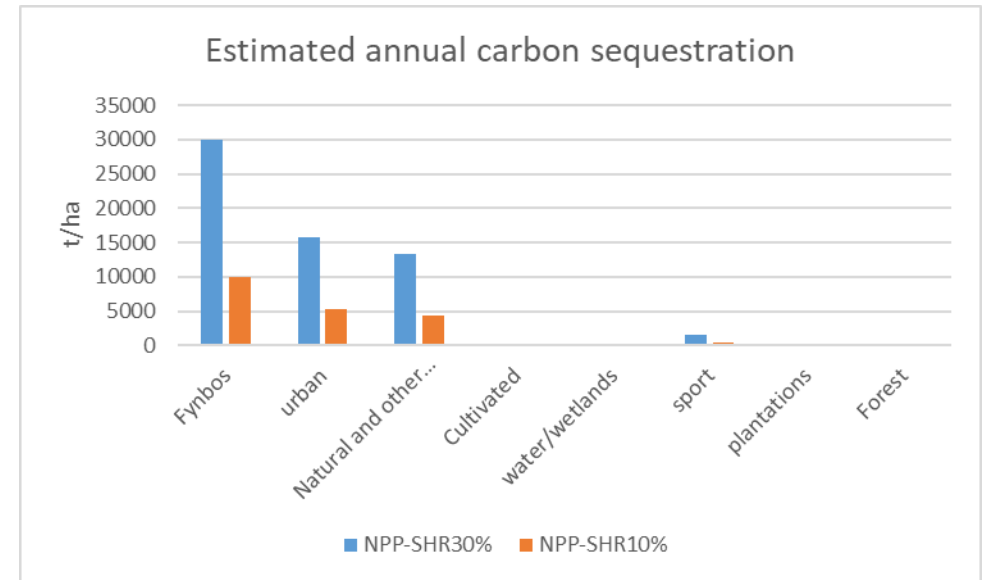Mean above-ground biomass

Above-ground biomass – cumulative carbon storage

Total above ground biomass per land cover class

Carbon sequestration

Net Primary productivity

Estimated annual carbon sequestration
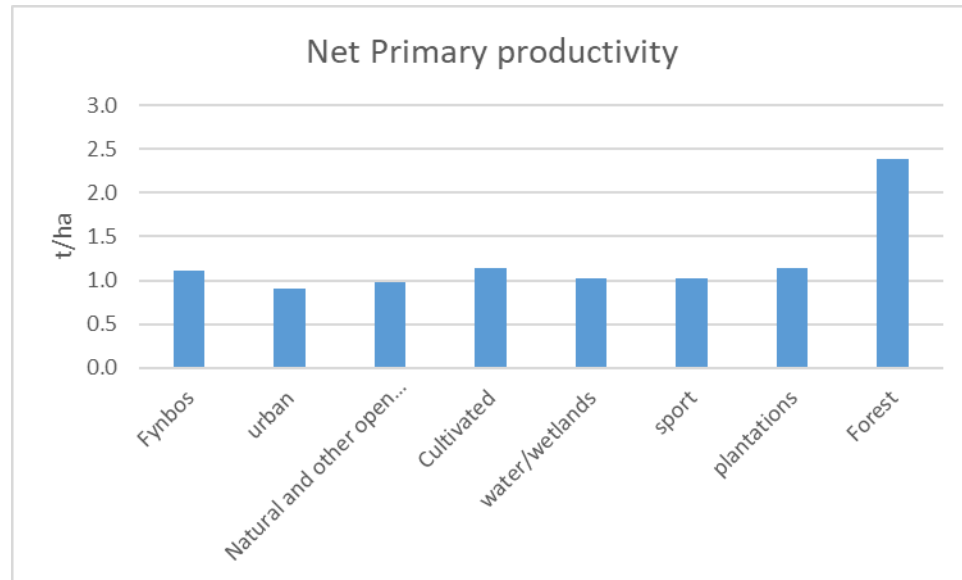
- Average Net Primary Productivity per land cover class
- Soil heterotrophic respiration rates between 70-90%
- **All vegetation sequestration: ~61 000 t/C or ~1% of emissions**

Habitat restoration

- 166 km^2 considered as habitat in poor condition
- Noticeable difference in primary productivity

NPP

+ ~900 tons of carbon per year (restoration time estimated 10-30 years)

Tree planting

- Between 2012 and 2020 – 20,368 trees planted
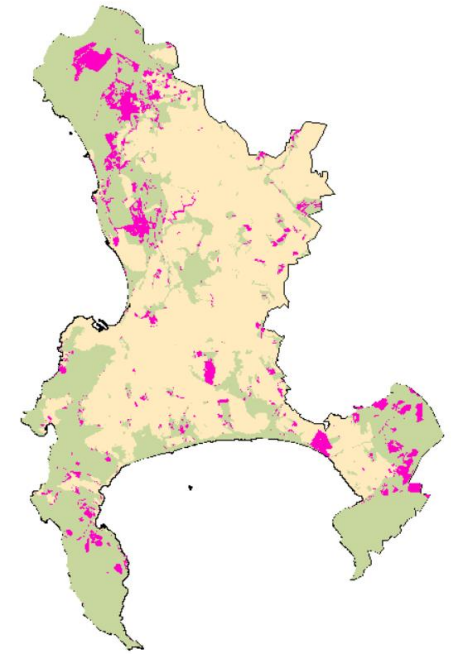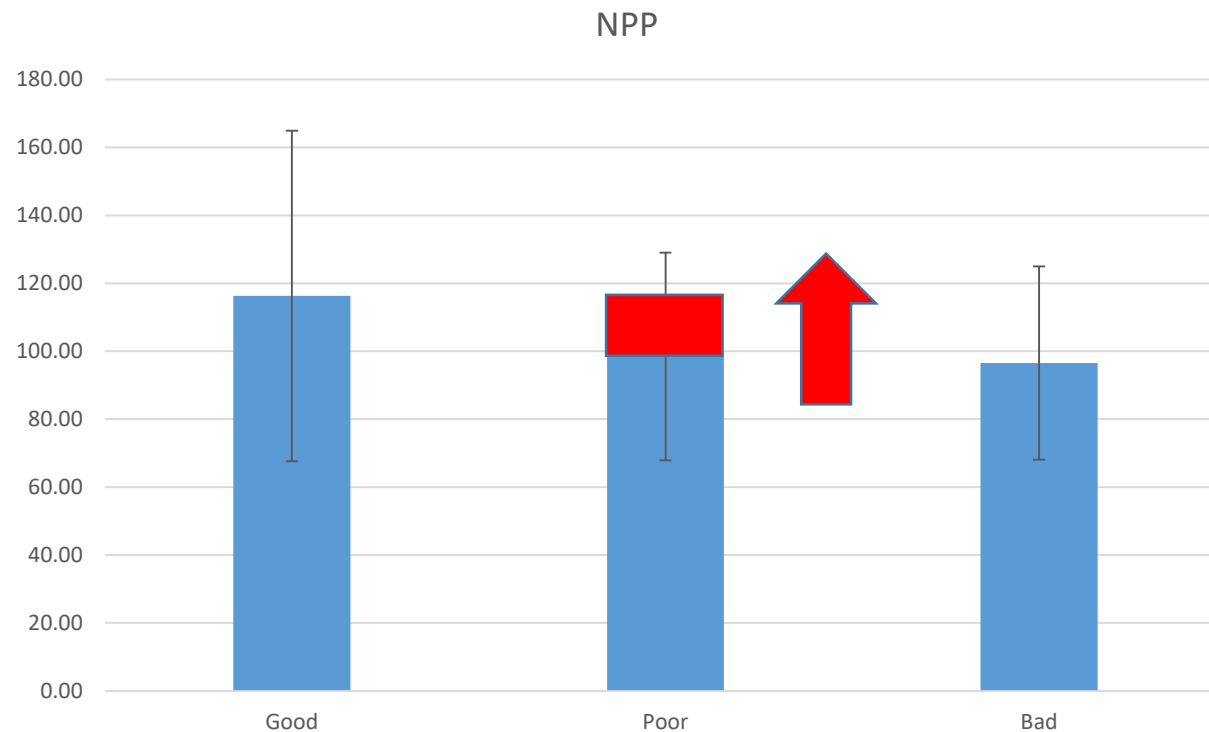 - Data supplied by Jan Botes and the Nursery
- Tree cover inventory indicates 7% of the City covered in trees

- Two methods were used to estimate carbon sequestration
  - 1) carbon sequestration over a decade of growth
    - Weighted average for hardwood vs softwood tree planted (EPA.gov.us)
    - 16.6kg of Carbon sequestered over 10 years

  - 2) average sequestration within urban areas
    - Based on US data (Nowak et al 2013)
    - Climate matching of cities to obtain best estimates

Tree planting – individual trees

Tree planting – individual trees

- ~300-400 t/C accumulated by 2030
- Ensuring tree survival is important
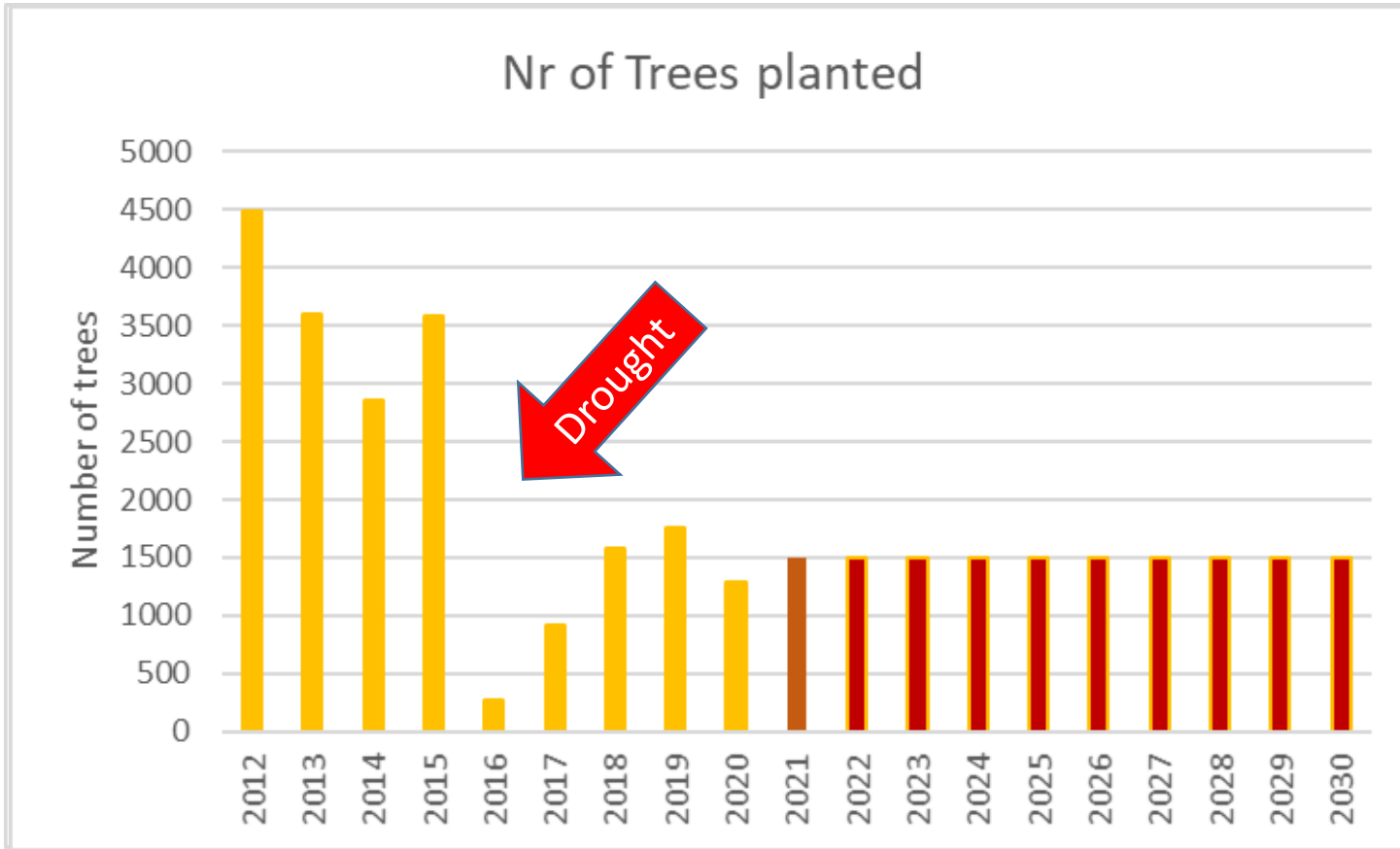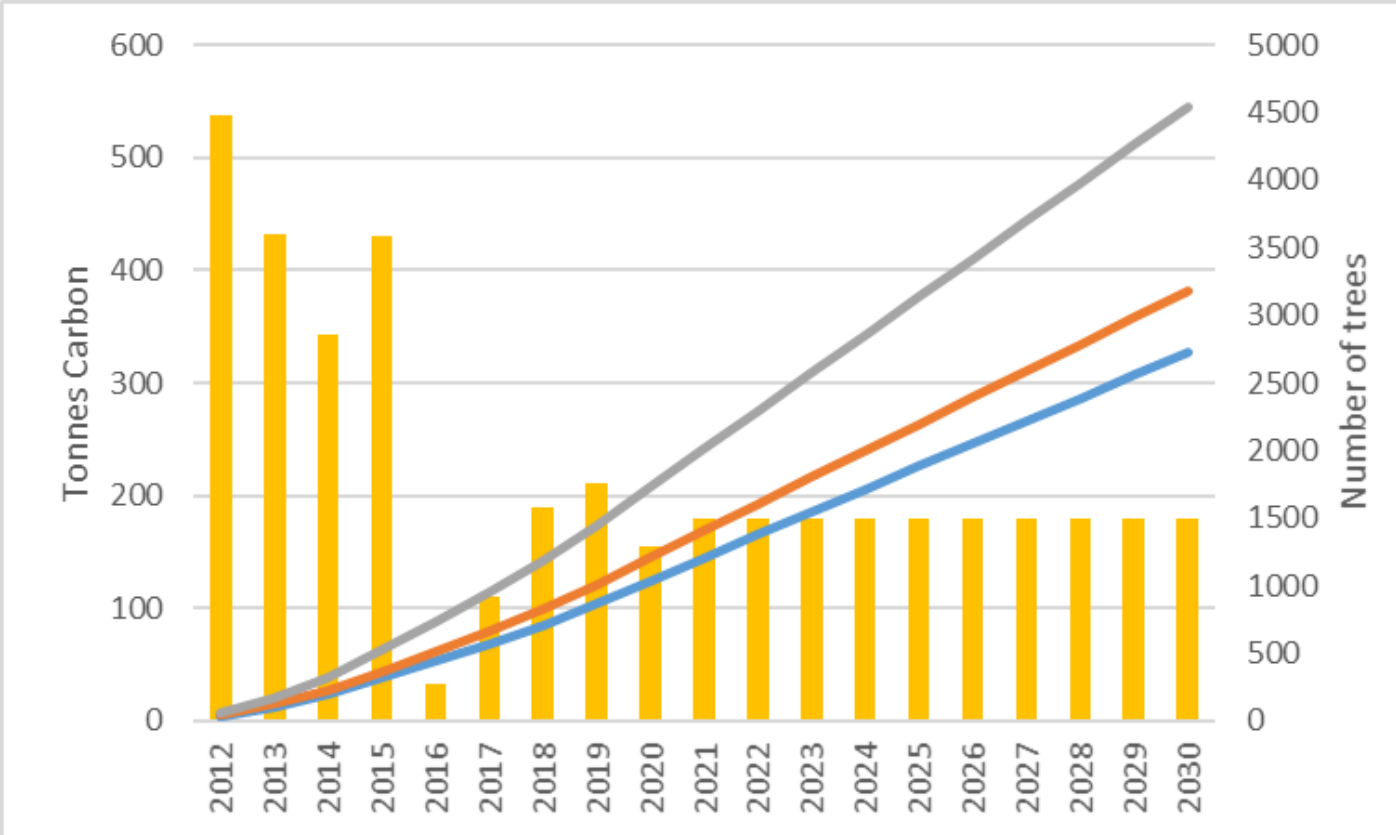
Legend:
- Number of trees
- 60% survival rate
- 70% survival rate
- 100%

Tree planting – canopy cover

- 7% of Cape Town covered by trees >2.75m in height

Tree Canopy Cover (A)	Area (km²) (A)	Average Net sequestration (SE) (kg C m⁻² year⁻¹) (B)	tC year⁻¹ (C=A*B)	% of annual emissions	Number of trees*
7% of Cape Town Area occupied by trees >2.75m)	172	0.164 (0.34)	28 140 (±11 505)	0.49%	1.7-14 million trees
Expanding tree cover by 3%	73.5	0.164 (0.34)	12 059 (±4 931)	0.21%	735k to 6 million trees

CSIR
Touching lives through innovation

Factors affecting carbon sequestration

- Fire
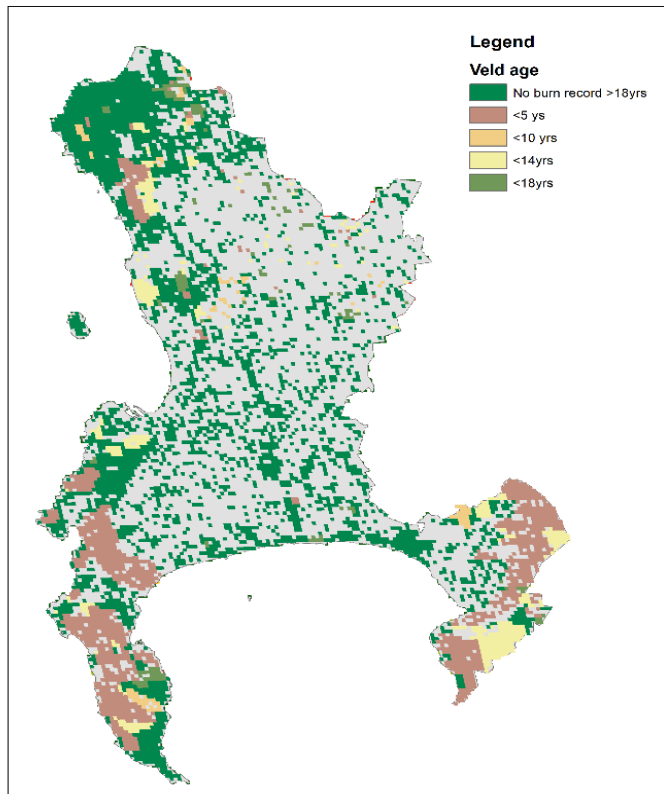
- Land use change
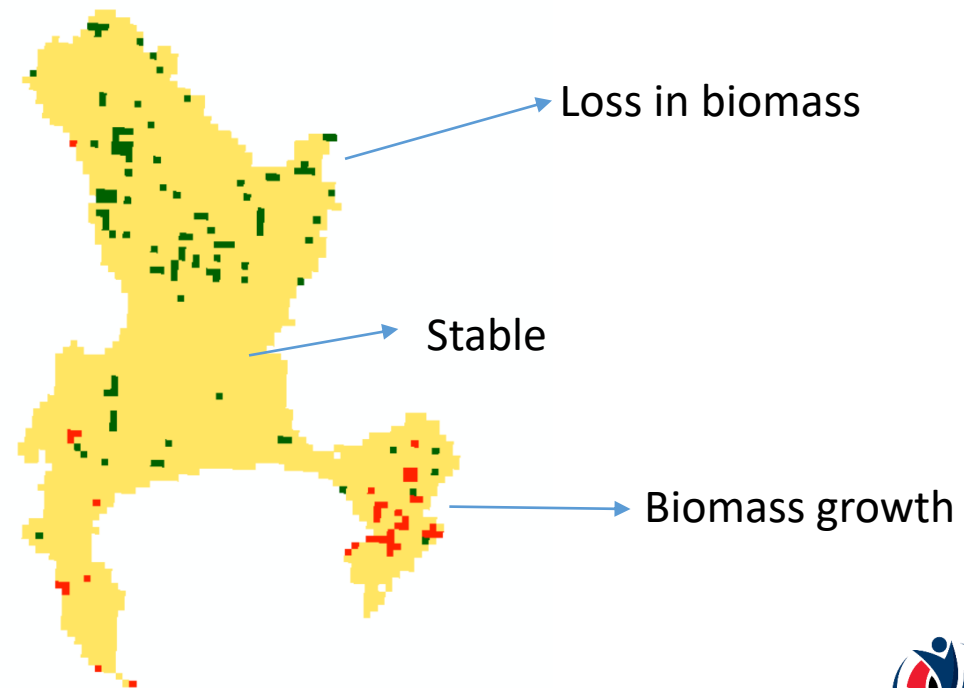
Species selection

- Considerations:
  - Fire spread
  - Facilitating the spread of Polyphagous shot hole borer
  - Location
  - Water use
  - Long-term maintenance
- Missing data regarding species specific sequestration rates

Comparison of cumulative sequestration rates

A Note on Spekboom

- Native to Eastern Cape thickets
- Native range sequestration estimated at 1-4 tC/ha
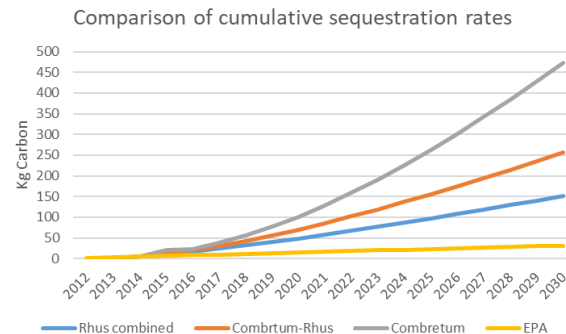- Usual planting density in restoration projects 2500 plants per ha.
- Calculations show that in ten years till 2030, between 11 and 46tC could potentially be sequestered by the 5000 the Spekboom trees handed out by the nursery in 2020.
- Realistic figures is probably less than 11tC if we account for mortality rates, likely kept in pots, maintenance limiting the growth potential of the plant.
- Not recommended for planting in biodiversity corridors.

CSIR
Touching lives through innovation

Limitations of the study

- Only focused on GHG benefits (not urban heat islands or ecosystem services)

- Did not consider cost vs benefits

- Did not include mapped alien vegetation or account for clearing plans

- No multi-criteria analysis to assist with prioritization

- No water impact assessments (surface or ground water)

- Excluded agricultural areas – large benefits associated with land use practices here

Conclusion

- Better understanding of Carbon sequestration rates in natural vegetation
- Active tree planting and habitat restoration in green spaces can increase sequestration rates, but overall GHG benefits will likely remain relatively low
  - Minimal GHG benefits (with additions sequestration rates likely to remain <2% of emissions)
  - Large areas to rehabilitate and long-term multi-decadal plan
- Responsible tree planting and not afforestation
  - Opportunities for increased tree cover across the city and suburbs
  - Tree planting benefits estimates based on single to few trees planted – not per hectare
- Species selection is important
  - Ensure longevity
  - Minimise fire risk

Recommendations

- **Continued investment in the protection and management** of the BioNet and restoration of degraded areas makes sense for long term climate benefits.

- The focus should on **responsible tree planting**, rather than afforestation programs, within urban areas while adhering to biodiversity and water limitations.

- The Natural and other open space areas outside of the BioNet present a unique opportunity to **protect undisturbed carbon stocks** and improve multi-functional land use planning.

- **Tree planting in suburbs, sports fields, and along roadsides** should rather seek to meet the needs of the community by improving greening and aesthetics while ensuring safe and open spaces than to focus solely on the greenhouse gas benefits.

- In light of the recent fires in Cape Town, **tree species selection within the urban edge** should ensure that greenbelts do not create fire corridors.

- The removal of alien vegetation should be followed up by **active restoration to ensure that ecological functions** are restored to rebuild soil carbon stocks .

Thank you

Ryan Blanchard

rblanchard@csir.co.za