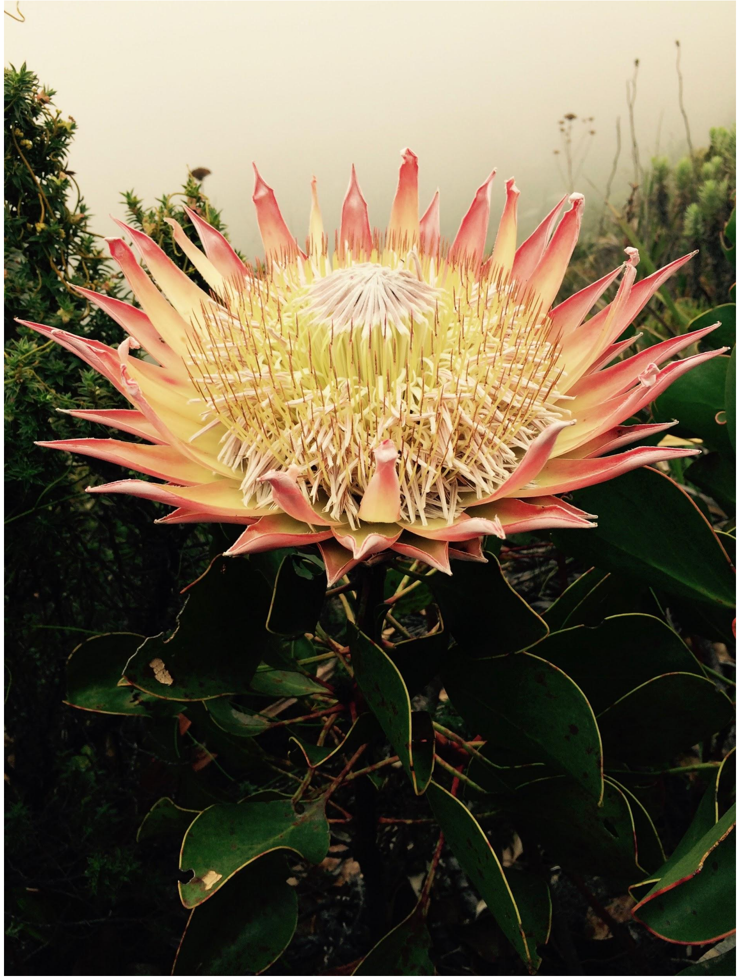


A core model for forecasting the dynamics of a fire-prone ecosystem

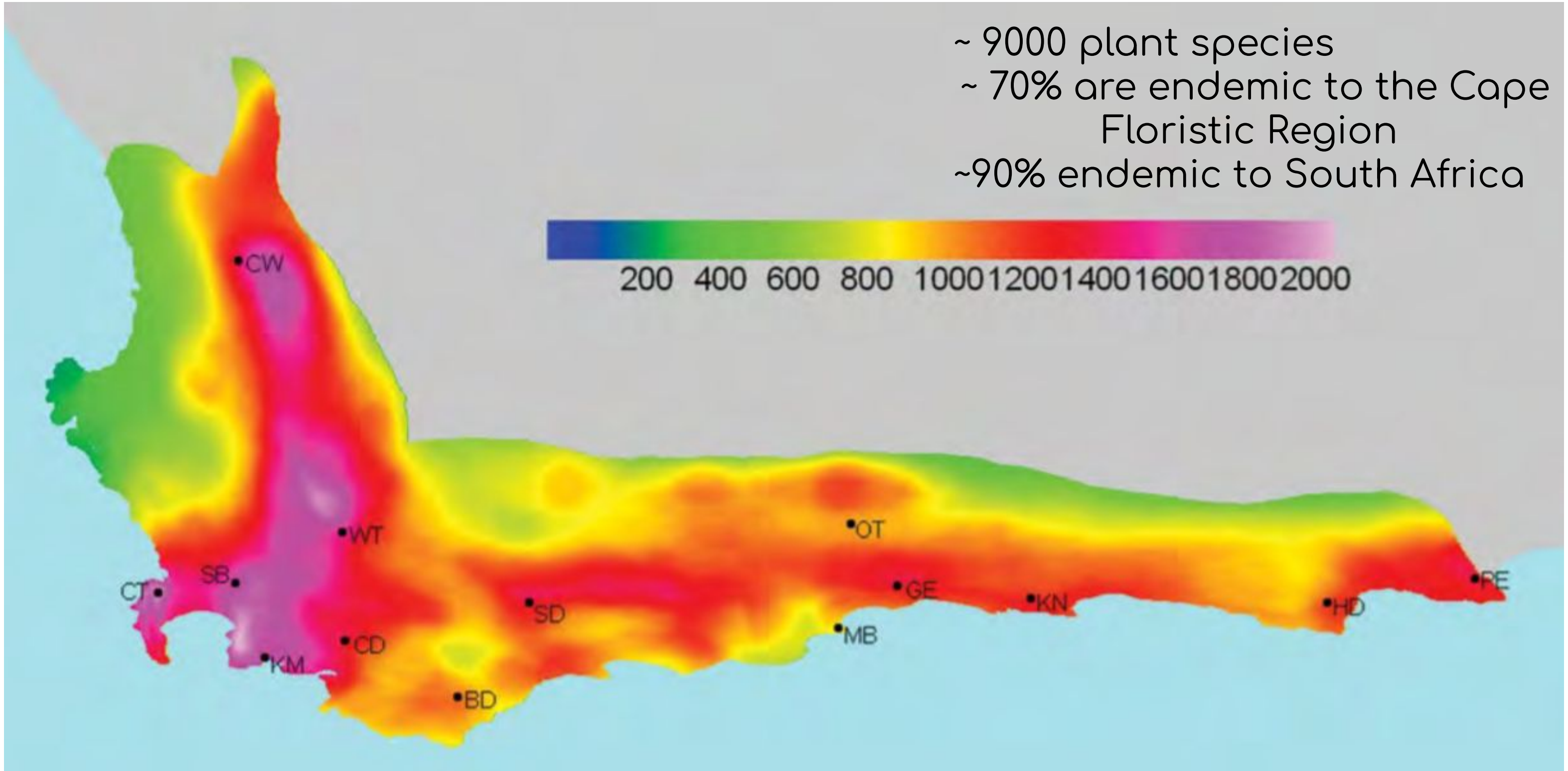
Jasper A. Slingsby [1,2], Glenn R. Moncrieff [1,3], Adam M. Wilson [4]

[1] SAEON Fynbos Node
[2] SEEC, Biological Sciences, University of Cape Town
[3] SEEC, Statistical Sciences, University of Cape Town
[4] University at Buffalo, NY

Fynbos

Species Diversity (Freiberg and Manning 2013)

~ 9000 plant species
~ 70% are endemic to the Cape Floristic Region
~90% endemic to South Africa

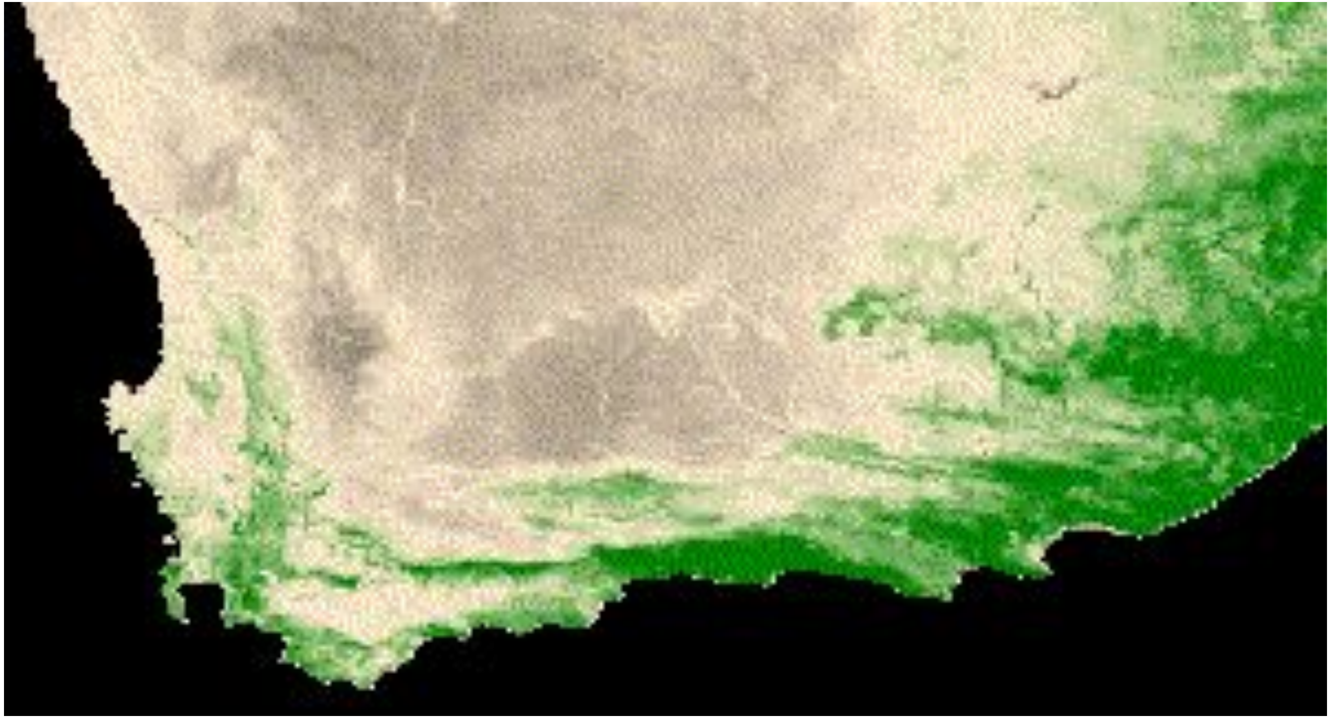


Fynbos

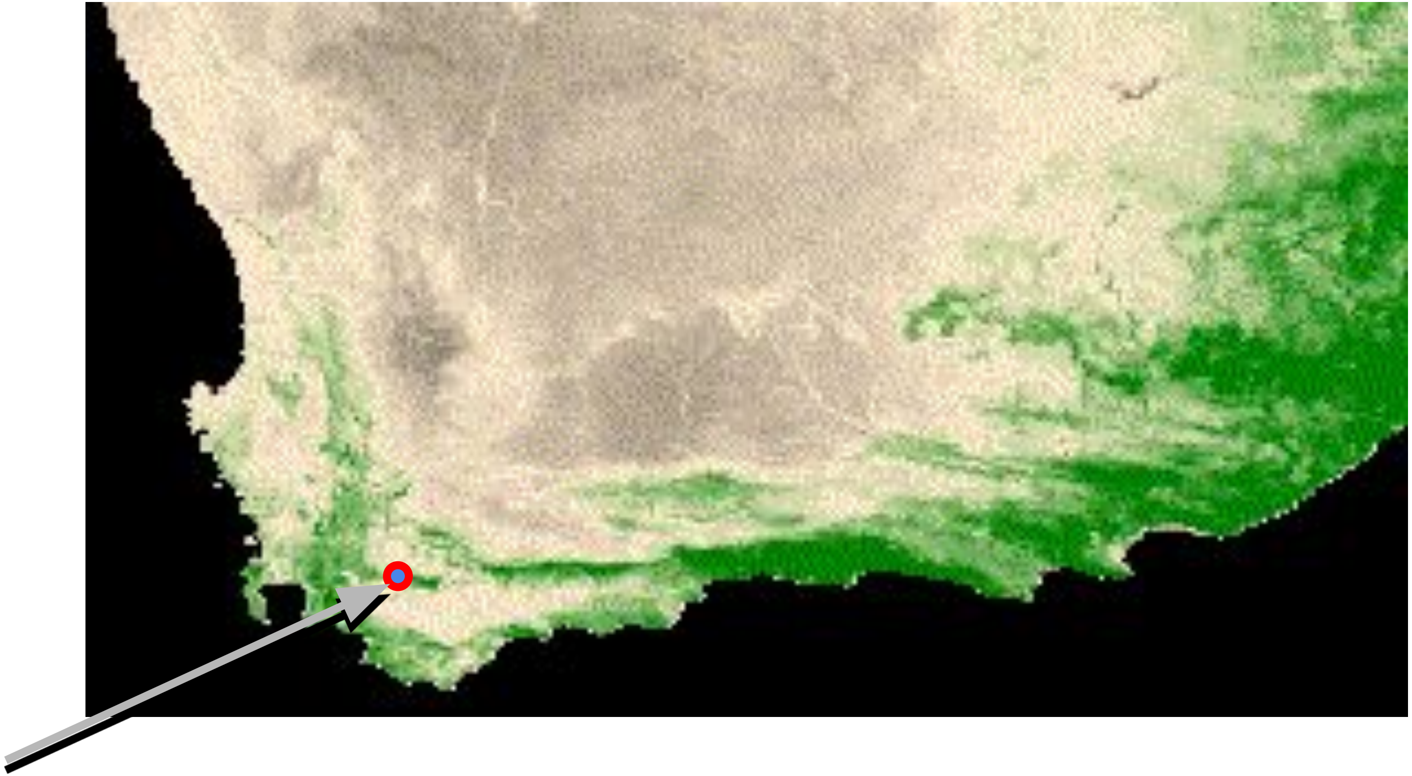
Fynbos

fire

post-fire growth



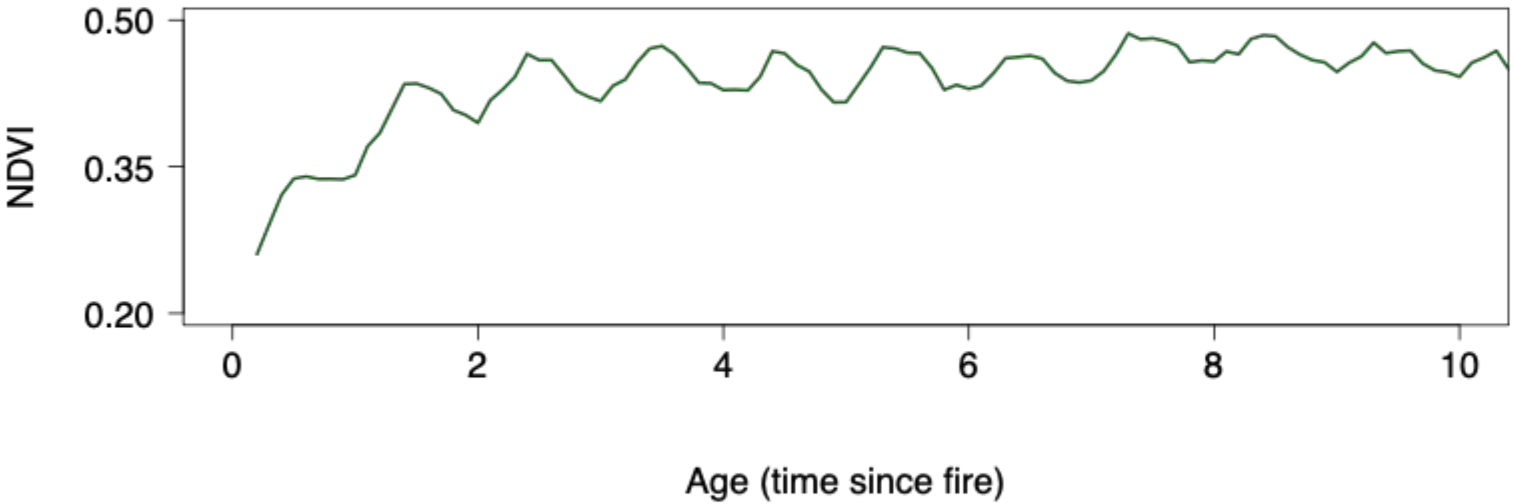
seasonality



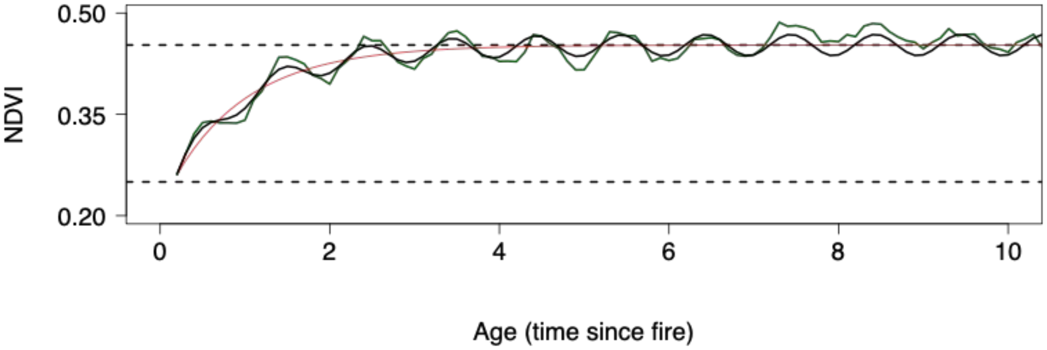
seasonality

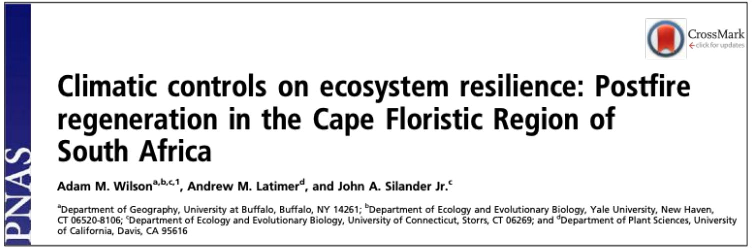
Fynbos “vegetation greenness” (NDVI) through time

Fynbos “vegetation greenness” (NDVI) through time



Fynbos “vegetation greenness” (NDVI) through time




PNAS

CrossMark

Climatic controls on ecosystem resilience: Postfire regeneration in the Cape Floristic Region of South Africa

Adam M. Wilson[a,b,c,1], Andrew M. Latimer[d], and John A. Silander Jr.[c]

[a]Department of Geography, University at Buffalo, Buffalo, NY 14261; [b]Department of Ecology and Evolutionary Biology, Yale University, New Haven, CT 06520-8106; [c]Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, CT 06269; and [d]Department of Plant Sciences, University of California, Davis, CA 95616

Wilson et al. 2015. *PNAS*

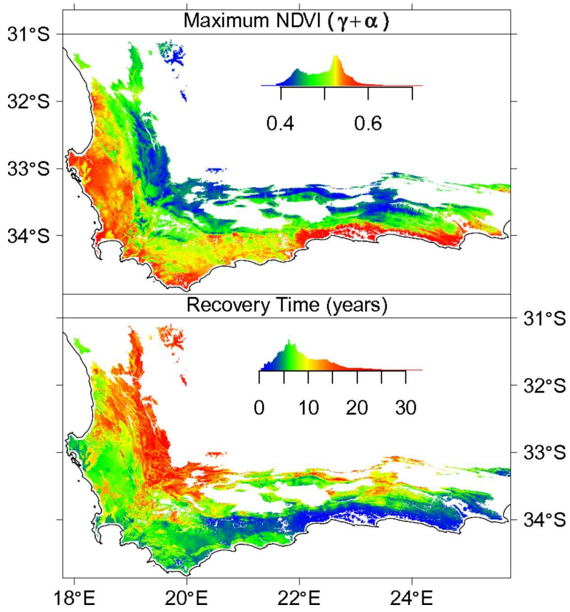
$$\boxed{\begin{array}{c} NDVI_{s,t} = \alpha_s + \gamma_s * (1 - e^{-(\frac{age_{s,t}}{\lambda_s})^{k_s}}) \\ + sin(2\pi * age_{s,t} + \phi) * A_s \end{array}}$$

negative exponential (growth trajectory) + sine term (seasonality)

Modelling fynbos NDVI

1) estimate parameters

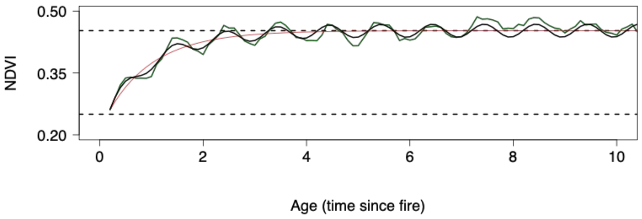
parameters



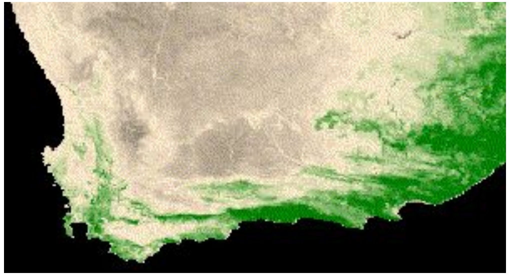
Wilson et al. 2015. *PNAS*

core equation

$$NDVI_{s,t} = \alpha_s + \gamma_s * (1 - e^{-(\frac{age_{s,t}}{\lambda_s})^{k_s}}) + sin(2\pi * age_{s,t} + \phi) * A_s$$



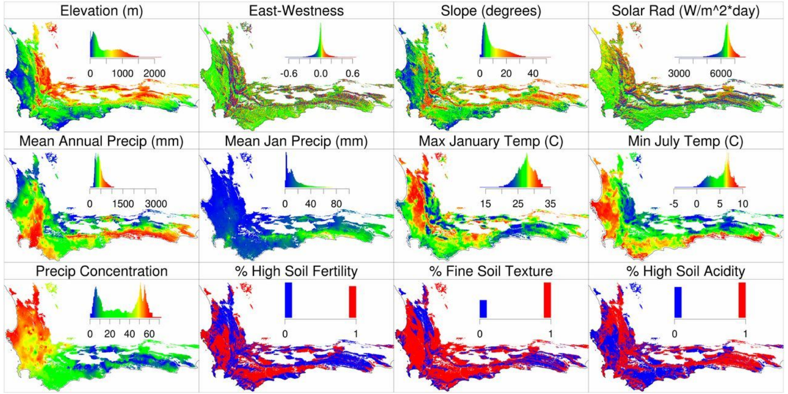
NDVI record



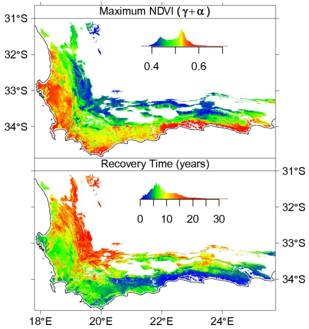
Modelling fynbos NDVI

1) estimate parameters
2) model parameters with covariates

covariates



parameters



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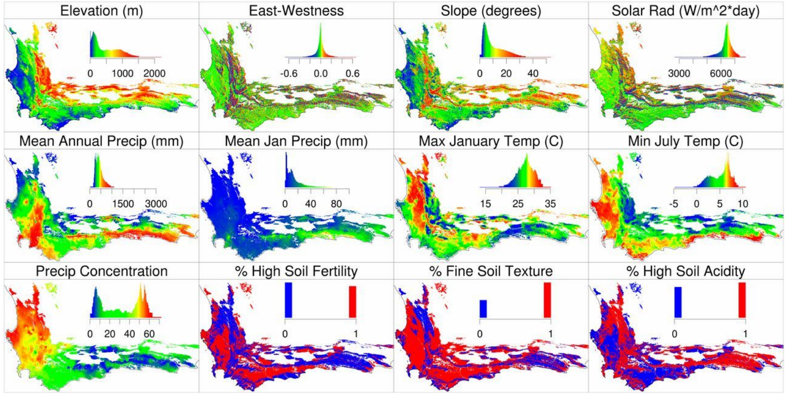
$$NDVI_{s,t} = \alpha_s + \gamma_s * (1 - e^{-(\frac{age_{s,t}}{\lambda_s})^{k_s}}) + sin(2\pi * age_{s,t} + \phi) * A_s$$

Wilson et al. 2015. *PNAS*

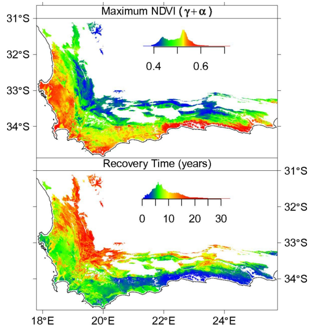
Modelling fynbos NDVI

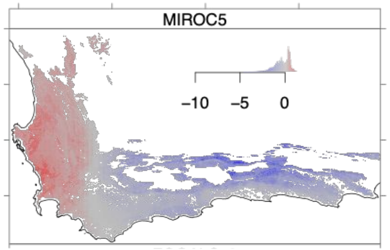
1) estimate parameters
2) model parameters with covariates
3) predict NDVI

covariates



parameters





core equation

$$NDVI_{s,t} = \alpha_s + \gamma_s * (1 - e^{-(\frac{age_{s,t}}{\lambda_s})^{k_s}}) + sin(2\pi * age_{s,t} + \phi) * A_s$$

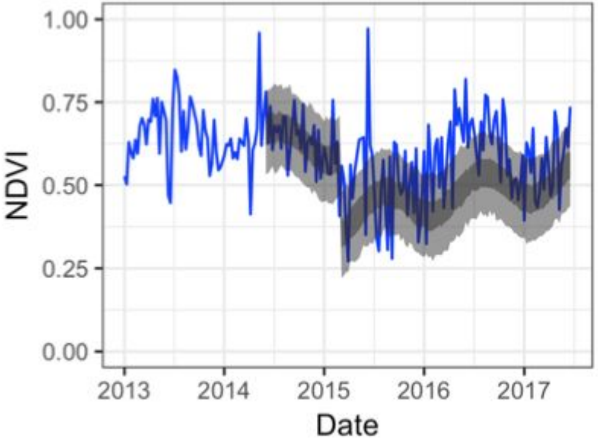
This allows…

1. Near-real time change detection
2. Model/predict ecosystem properties like growth, biomass, water, fire
3. Linking ecosystem function to plant traits
4. …?
5. …?

1. Change detection!

Too green:

- invasion by alien trees



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Near-real time forecasting and change detection for an open ecosystem with complex natural dynamics

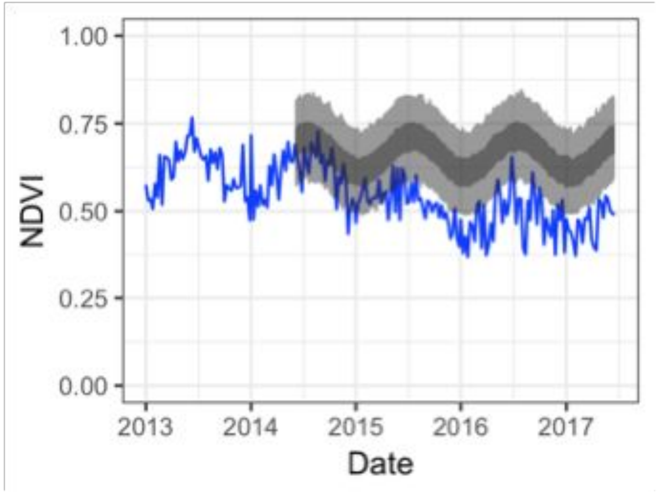
Jasper A. Slingsby[a,b,*], Glenn R. Moncrieff[a,c], Adam M. Wilson[d]

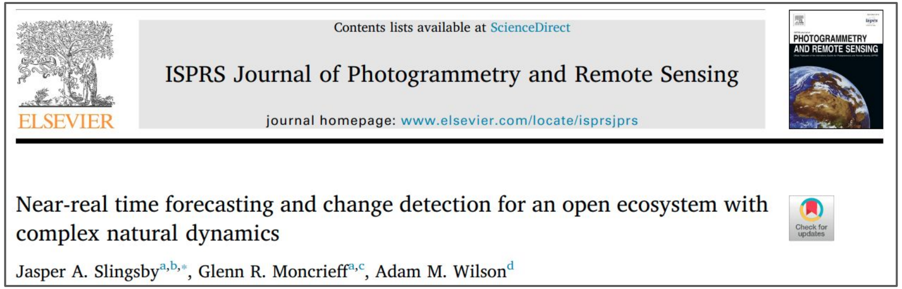
https://doi.org/10.1016/j.isprsjprs.2020.05.017

1. Change detection!

Not green enough:

- vegetation clearing or mortality





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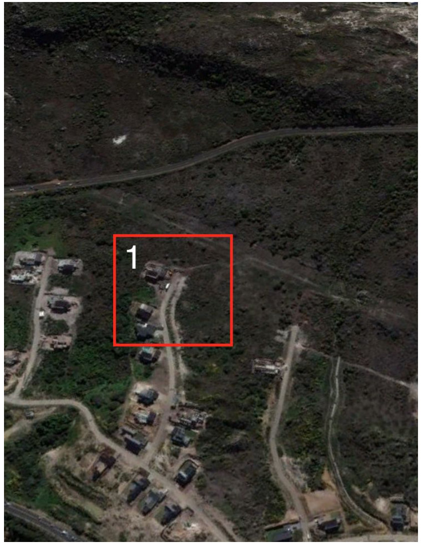
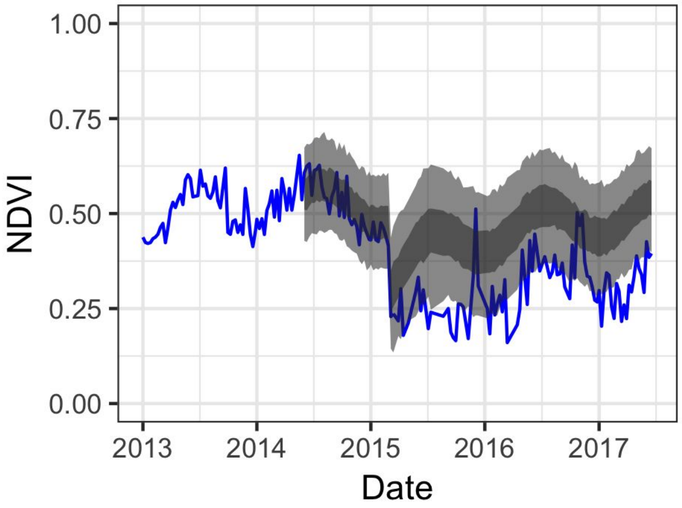


1. Change detection!

Not green enough:

- retarded postfire growth



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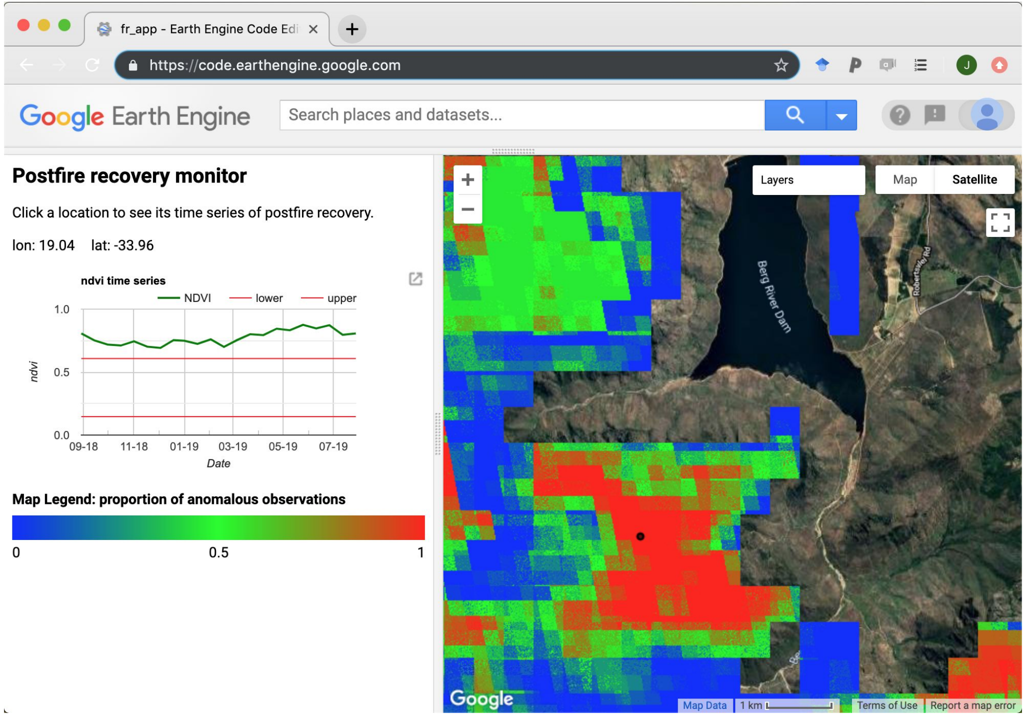
1. Change detection!

Global Fynbos Watch!😉

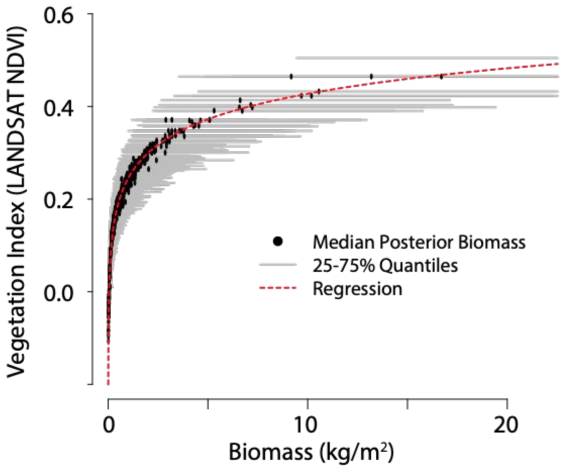
ToDo:

- more validation
- improve covariates
- user needs
- whole biome

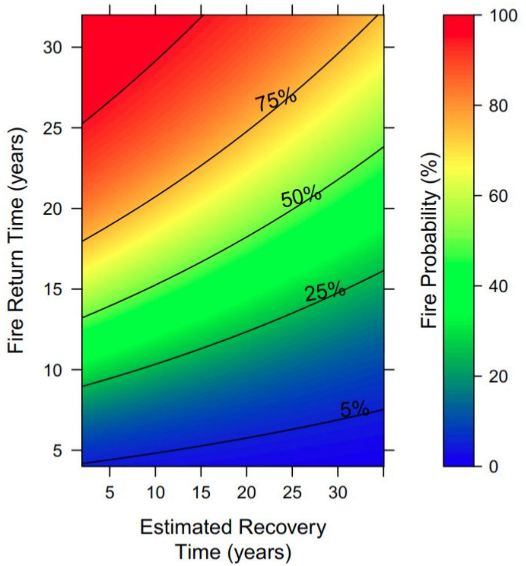


2. Projecting ecosystem properties:

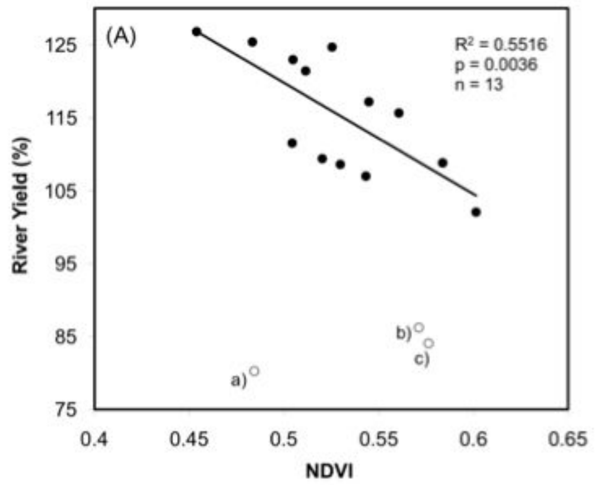
biomass/carbon



fire



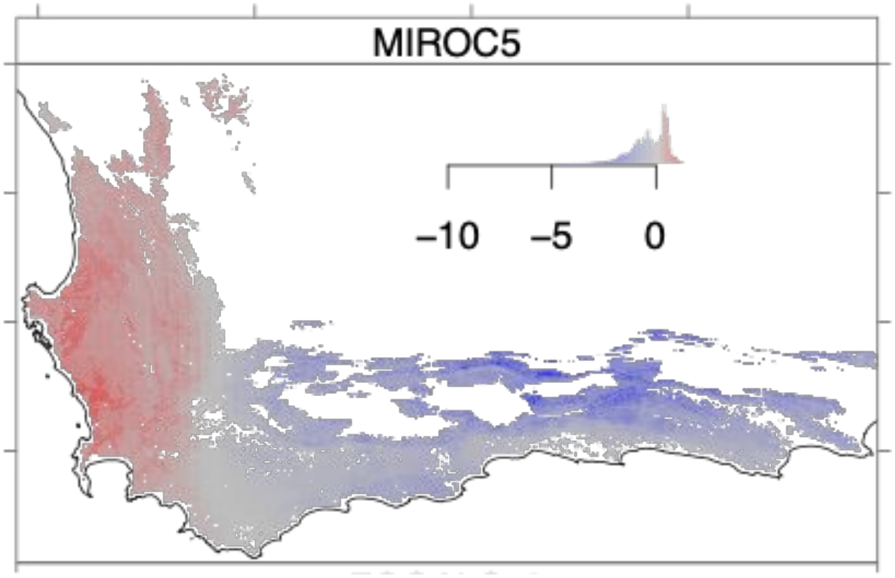
stream flow



2. Projecting ecosystem properties:
post-fire vegetation recovery under future climate

Implications for:

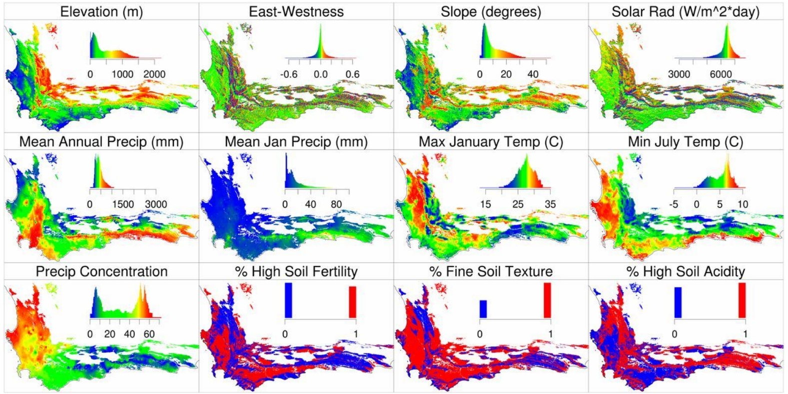
- Fire
- Water
- Carbon
- Habitat
- etc



Model suggests vegetation growth will mostly be faster under climate change, because Fynbos growth is mostly cold limited!!!

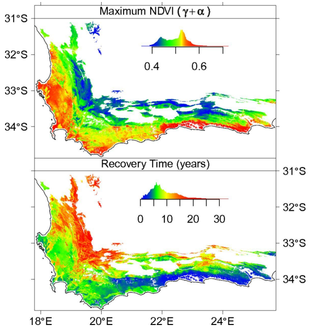
3. Linking function to plant traits

predictors



^^[plug in plant traits as predictors]^^

parameters



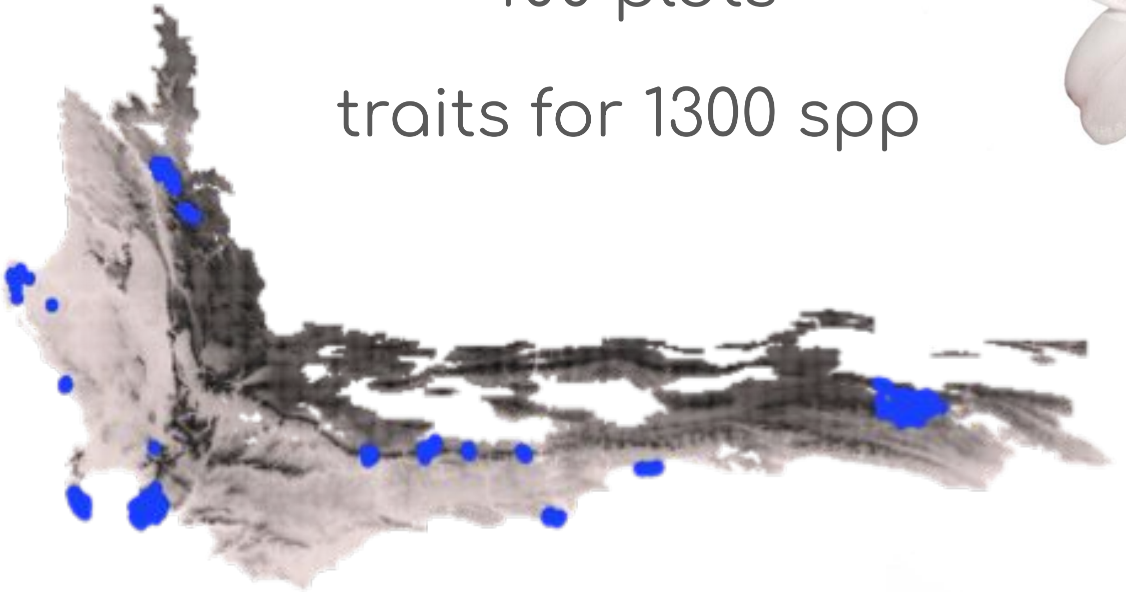
core equation

$$NDVI_{s,t} = \alpha_s + \gamma_s * (1 - e^{-(\frac{age_{s,t}}{\lambda_s})^{k_s}})$$
$$+ sin(2\pi * age_{s,t} + \phi) * A_s$$

3. Linking function to plant traits

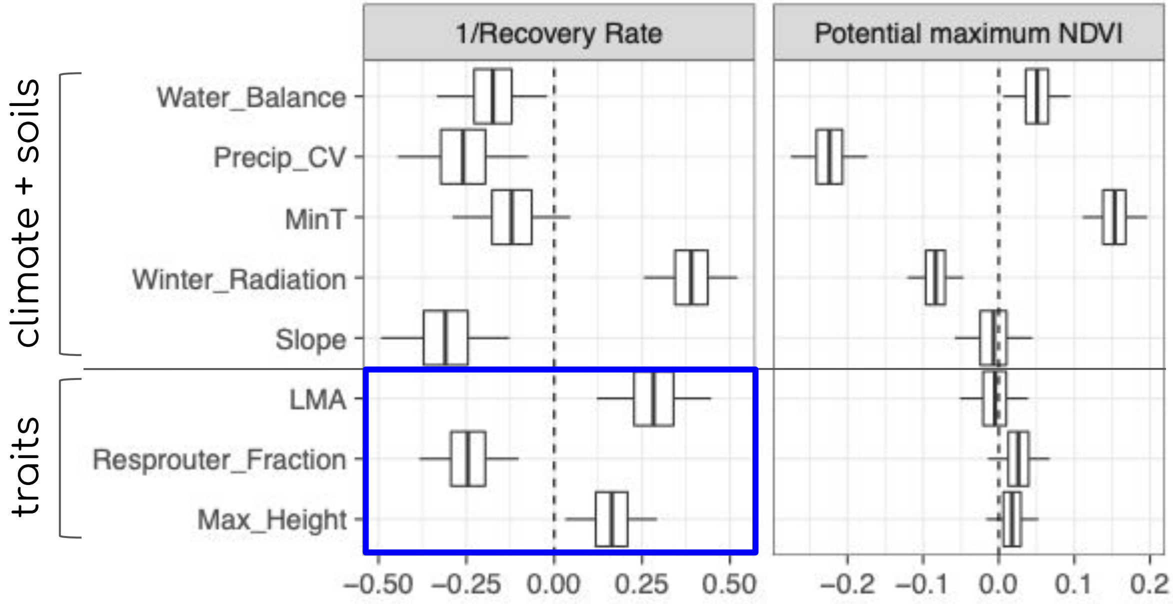
400 plots

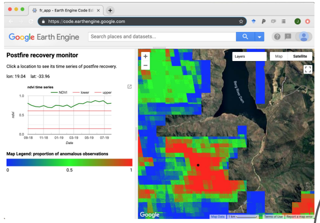
traits for 1300 spp

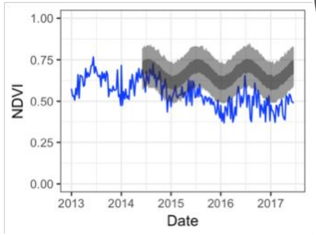


3. Linking function to plant traits

Traits predict postfire regeneration parameters!!!





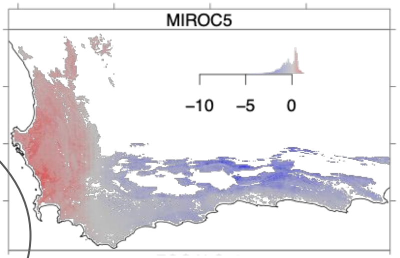


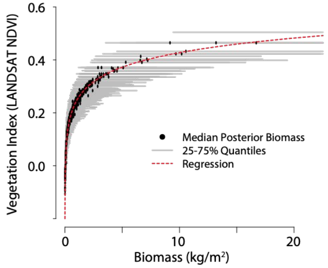
near-real time change detection

core model

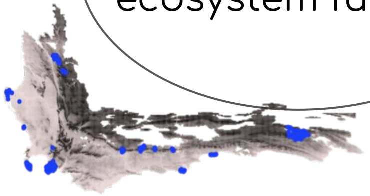
$$NDVI_{s,t} = \alpha_s + \gamma_s * (1 - e^{-(\frac{age_{s,t}}{\lambda_s})^{k_s}})$$
$$+ sin(2\pi * age_{s,t} + \phi) * A_s$$

predict ecosystem properties





link traits to ecosystem function



Acknowledgements

Nicky Allsopp, John Silander, Vernon Visser and others at SEEC

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