Monitoring invasions: *looking into the disco ball*

Jasper Slingsby (*SAEON Fynbos*)
Glenn Moncrieff (*SAEON Fynbos*)
Laure Gallien (*CNRS, Grenoble, France*)
Adam Wilson (*University at Buffalo, NY, USA*)

National Symposium on Biological Invasions

Monitoring of Invasions

16 May 2019, Waterval (Tulbagh, Western Cape)

Who is this guy?

Disclaimer 1

I am not an invasion biologist!

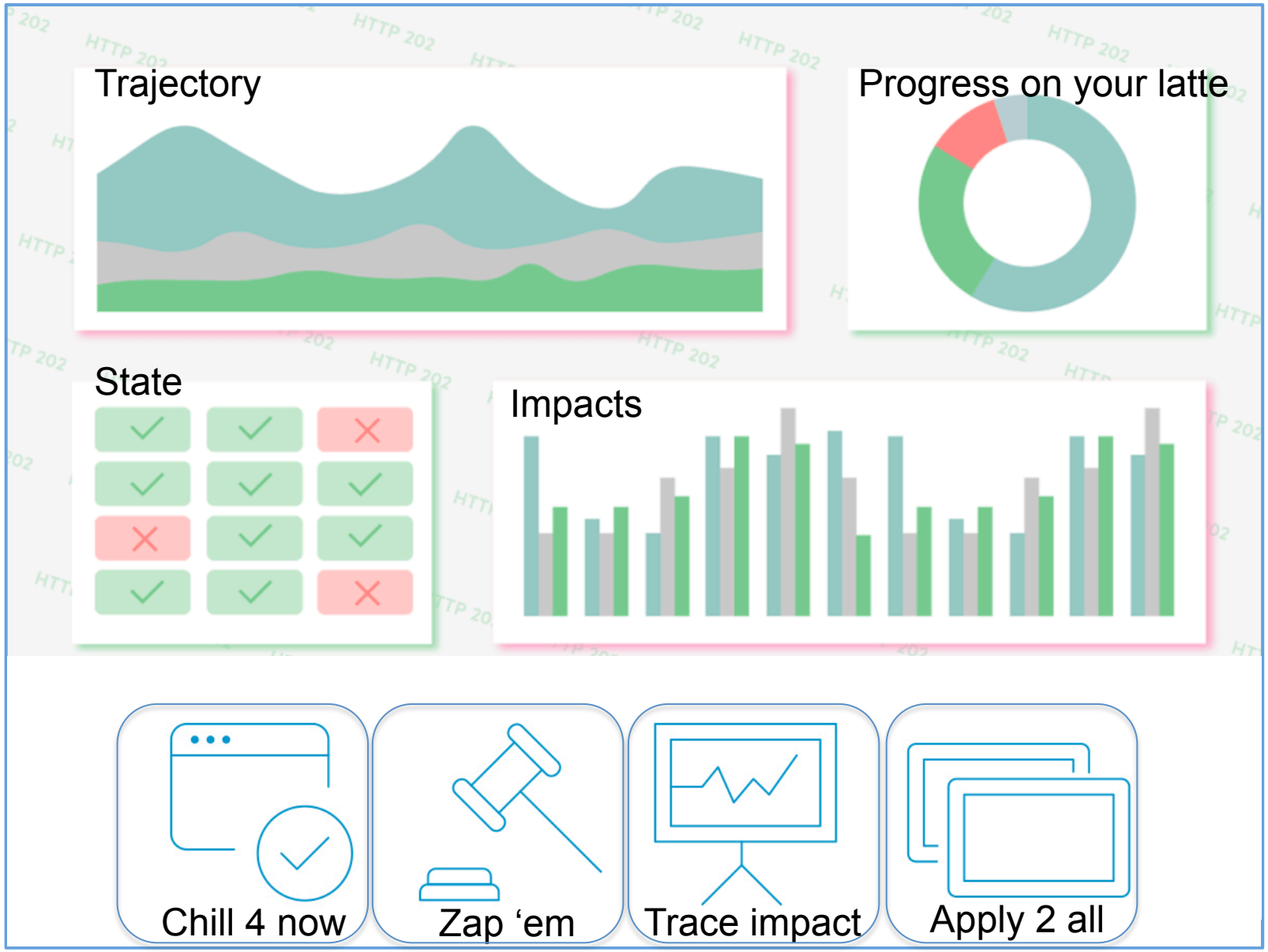
Please forgive me if I massacre your language!

I'm think I'm probably here because people associate SAEON with monitoring?

…and I'm at the SAEON Fynbos Node…

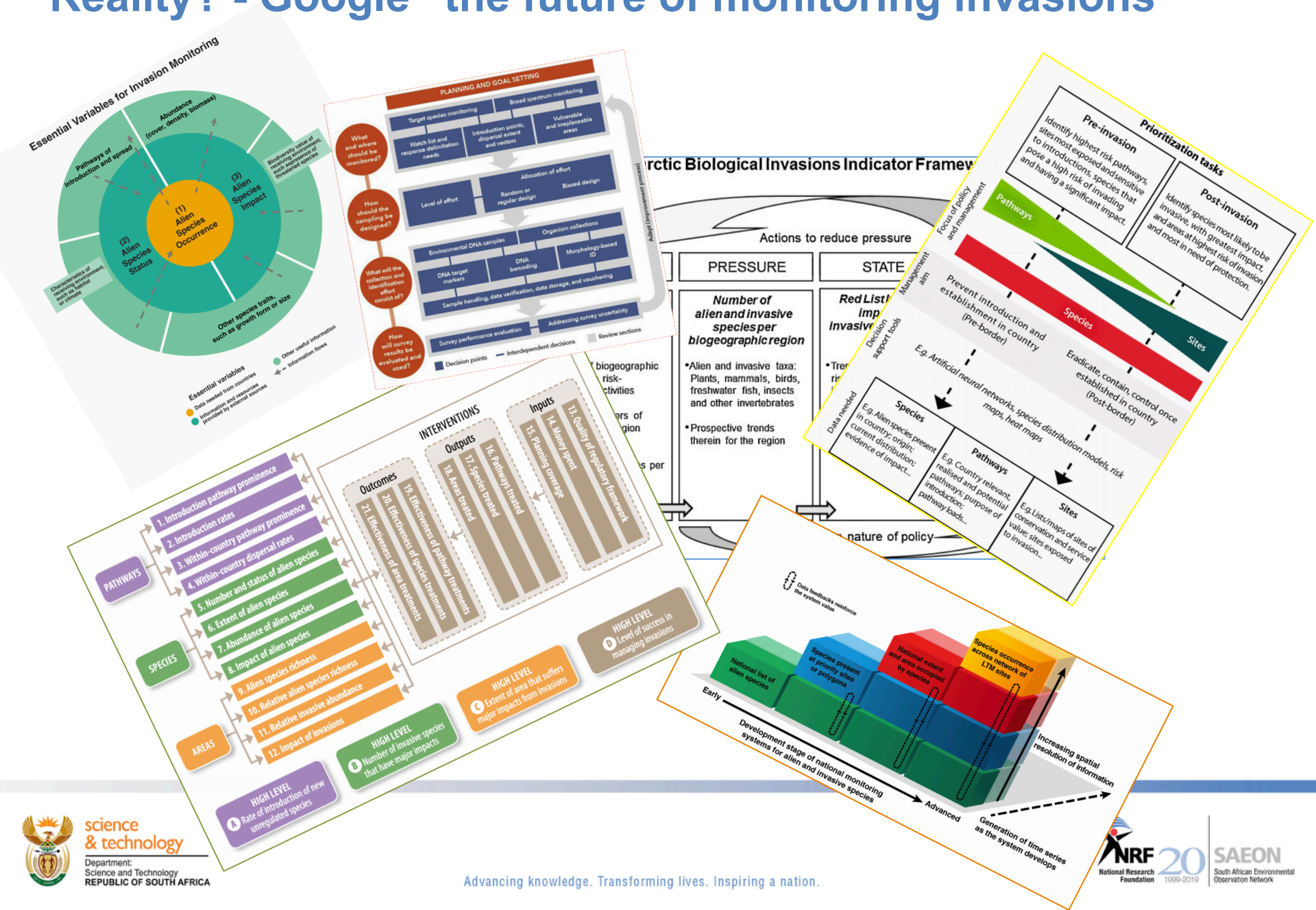
What's a disco ball got to do with anything?

What does the future of monitoring invasions hold?



i.e. the millennial expectation…

Reality? - Google “the future of monitoring invasions”



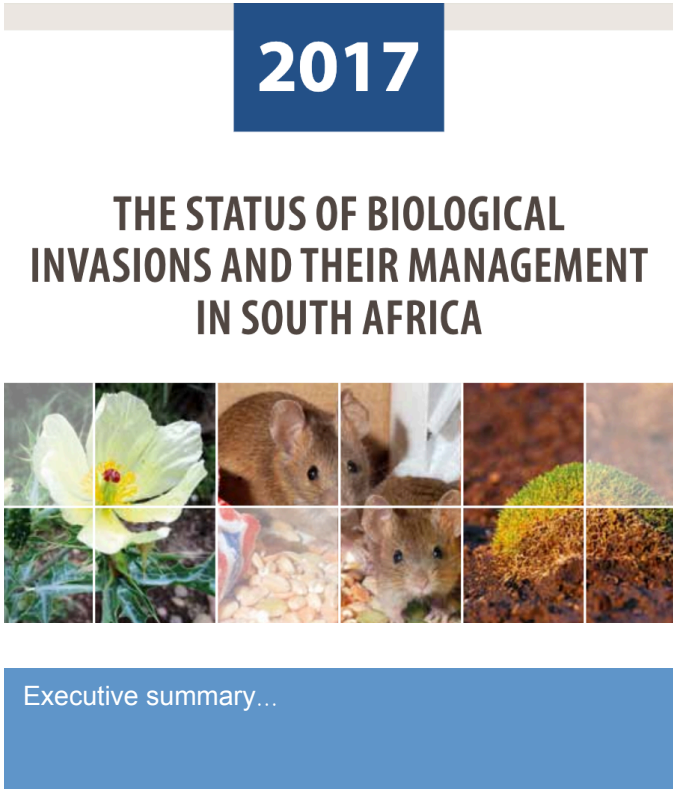
WHERE DOES MY WORK FIT IN?

"Three key areas of focus are identified:

(1) the need for more research to determine and assess the impacts of alien species;

(2) better monitoring of the effectiveness of current control measures; and

(3) the development of methods to look at the impact of biological invasions and their management on society as a whole."



WHERE DOES MY WORK FIT IN?

"Three key areas of focus are identified:

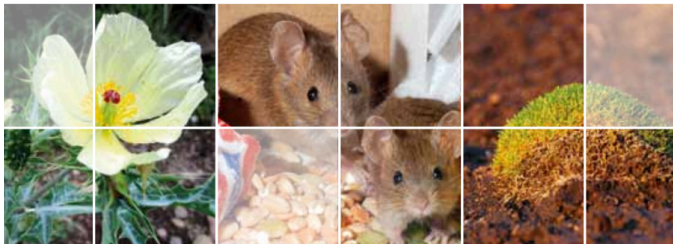
(1) the need for more research to determine and assess the impacts of alien species;
- Impacts on plant diversity (veg survey)

(2) better monitoring of the effectiveness of current control measures; and
- Remote sensing tools for monitoring

(3) the development of methods to look at the impact of biological invasions and their management on society as a whole."
- Estimating impacts of aliens on runoff

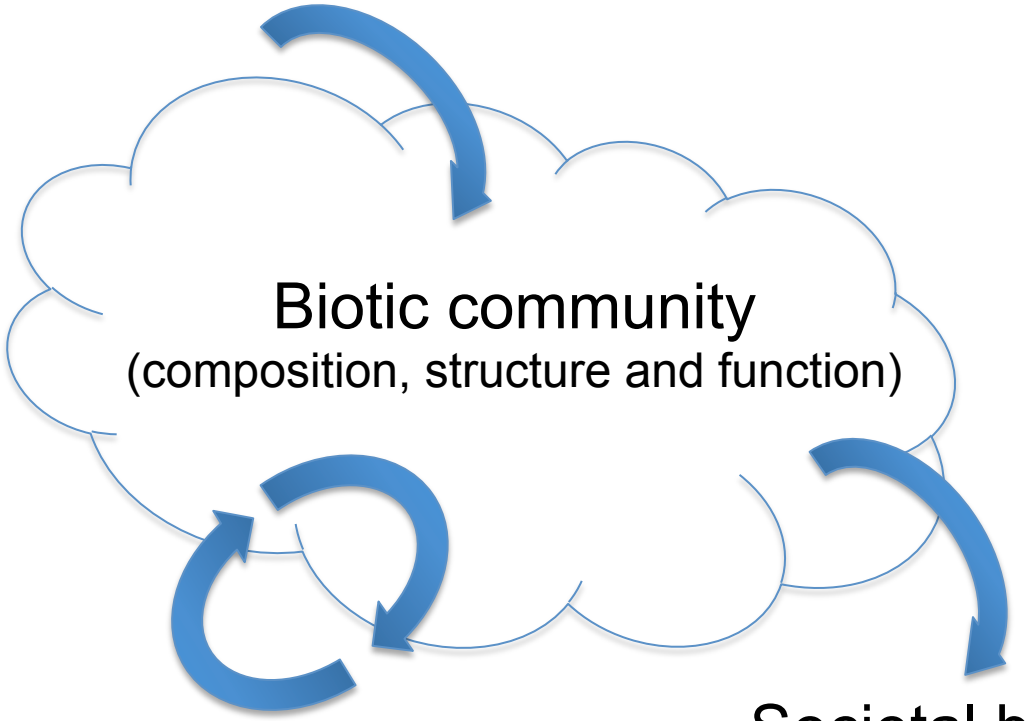
2017

THE STATUS OF BIOLOGICAL INVASIONS AND THEIR MANAGEMENT IN SOUTH AFRICA



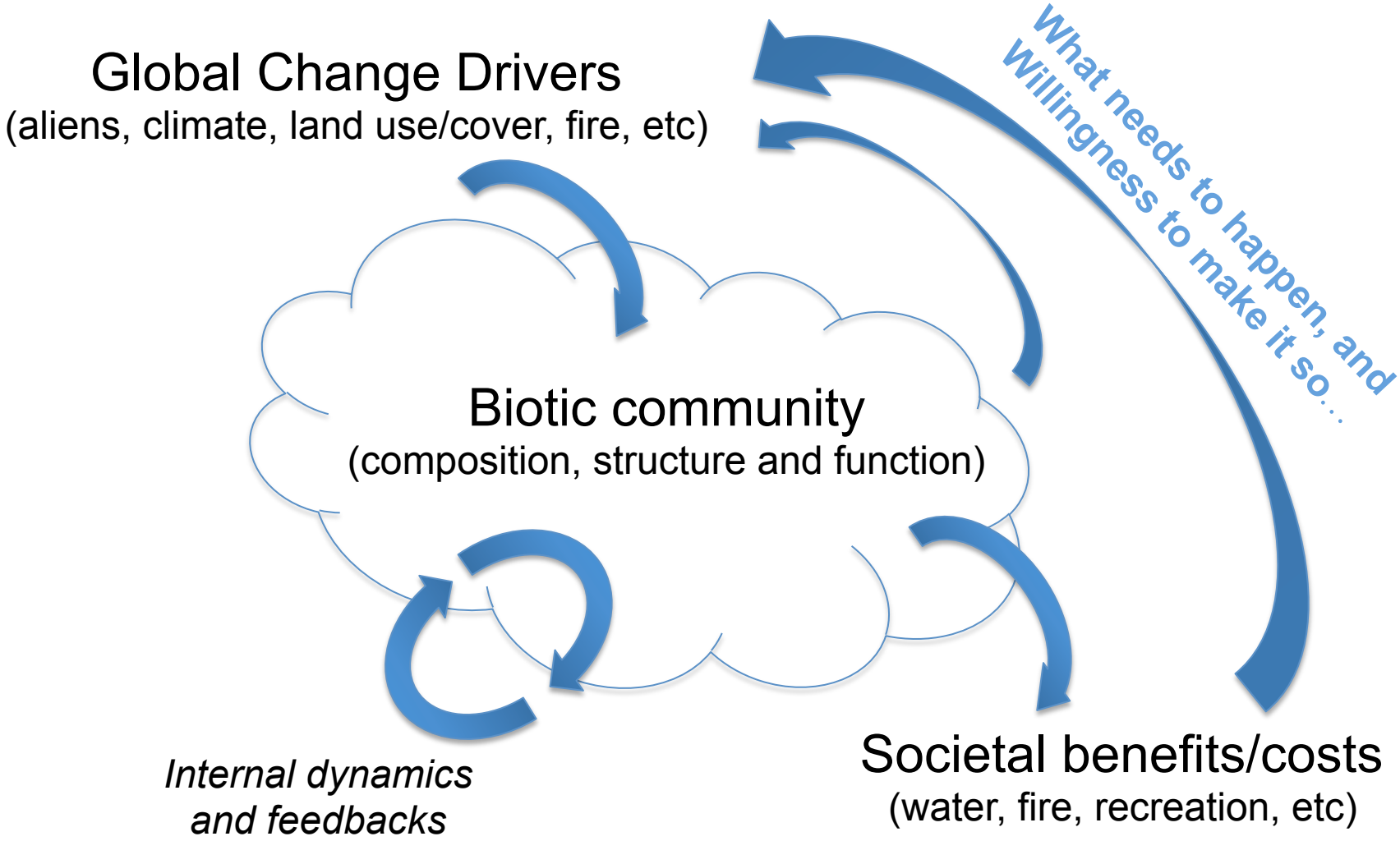
Executive summary...

Global Change Drivers
(aliens, climate, land use/cover, fire, etc)



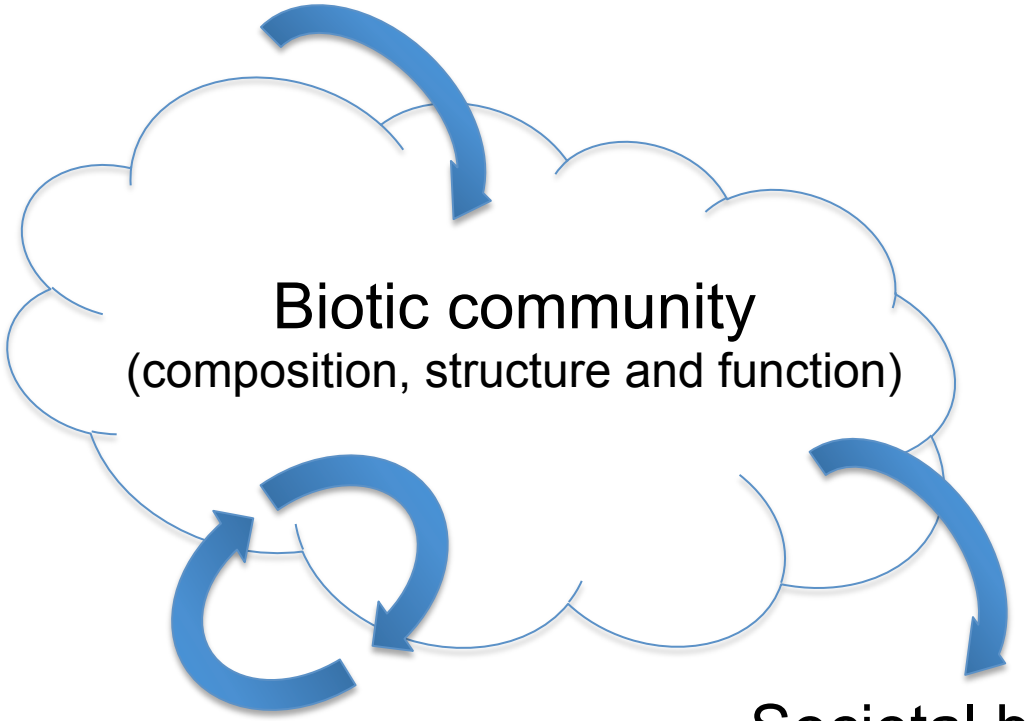
Internal dynamics and feedbacks

Societal benefits/costs
(water, fire, recreation, etc)


Global Change Drivers
(aliens, climate, land use/cover, fire, etc)
What needs to happen, and
Willingness to make it so…
Biotic community
(composition, structure and function)
Internal dynamics
and feedbacks
Societal benefits/costs
(water, fire, recreation, etc)

Mapping invasives

Global Change Drivers
(aliens, climate, land use/cover, fire, etc)



Water

Internal dynamics and feedbacks

Societal benefits/costs
(water, fire, recreation, etc)

Biodiversity impacts

Refining estimates of the impact of invasions on runoff (in the Cape Floristic Region)

Glenn Moncrieff *(SAEON)*

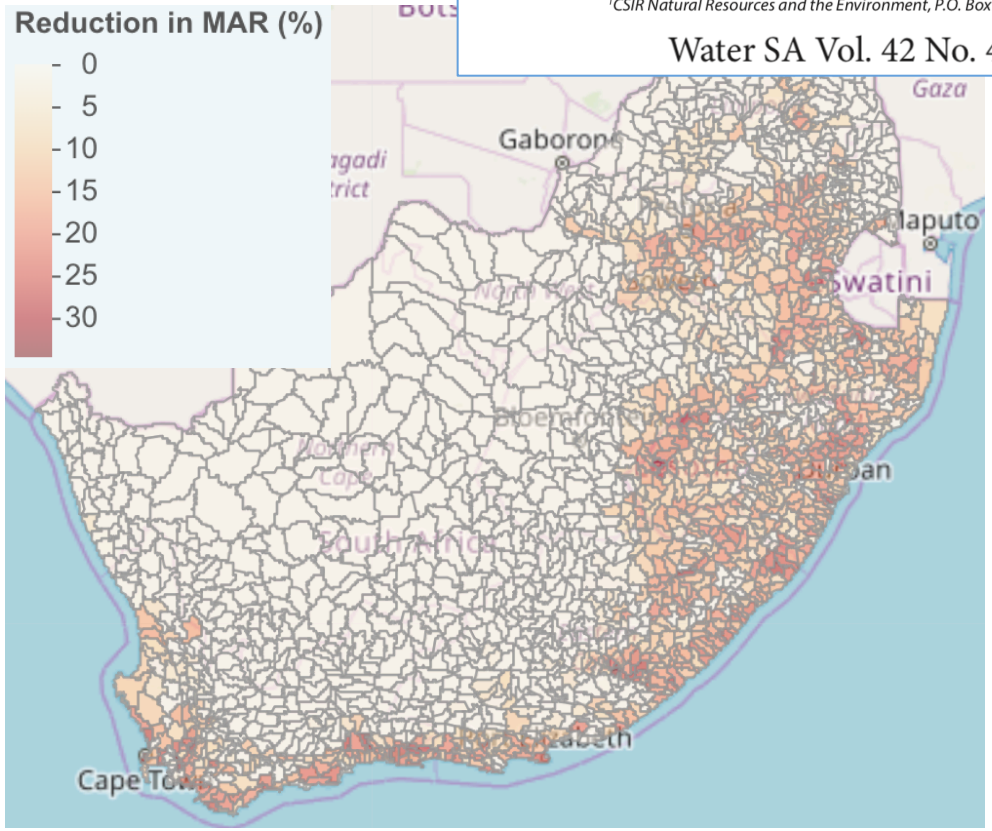
David Le Maitre *(CSIR)*

Estimates of the impacts of invasive alien plants on water flows in South Africa

David C Le Maitre[1]*, Greg G Forsyth[1], Sebinasi Dzikiti[1] and Mark B Gush[1]

[1]CSIR Natural Resources and the Environment, P.O. Box 320, Stellenbosch 7599, South Africa

Water SA Vol. 42 No. 4 October 2016



https://www.ecologi.st/post/aliens

How does it work?

Le Maitre et al. 2016 *Water SA*

Estimates of the impacts of invasive alien plants on water flows in South Africa

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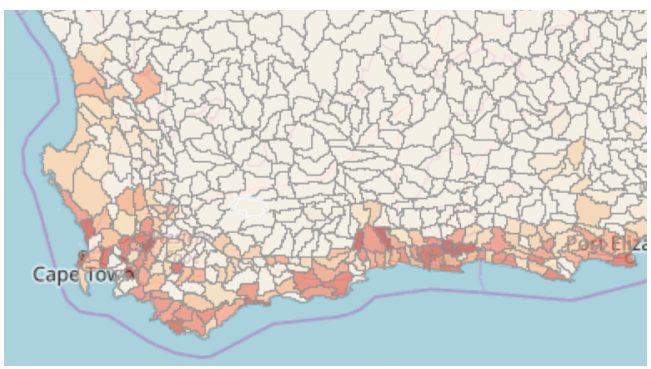
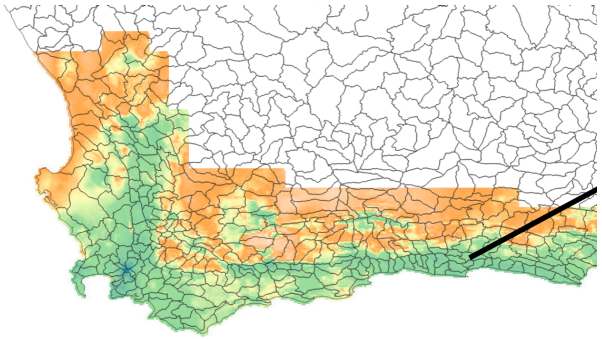
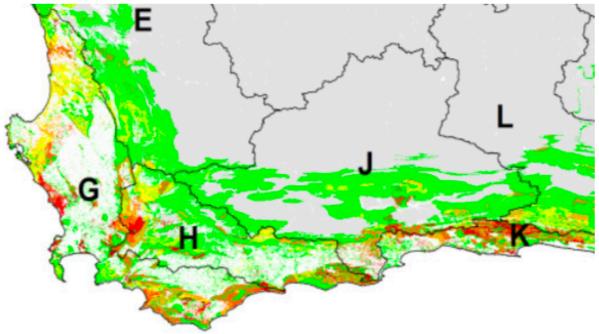






*Run-off lost ~ "Naturalised" run-off * Alien coverage[1]*

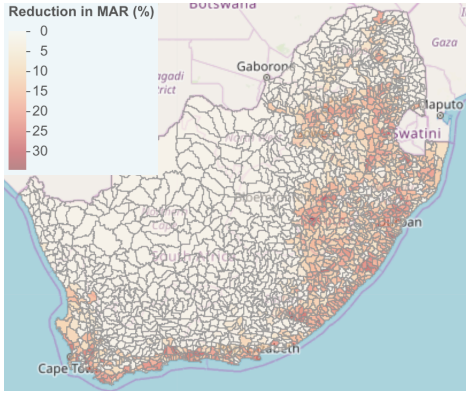
[1] The impact of alien coverage is modified by:
- Species (and species-specific growth conditions)
- Age of stand
- Proximity to rivers or groundwater

Refining estimates of the impact of invasions on runoff

Glenn Moncrieff (*SAEON*), David le Maitre (CSIR)

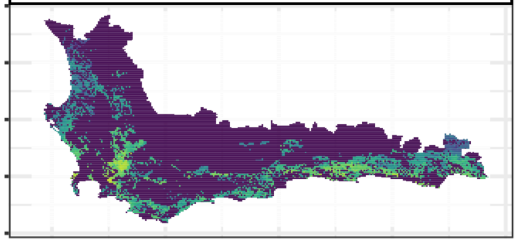
Our goal is to reconstruct the model in a Bayesian framework, allowing us to:

- Provide a repeatable workflow that allows regular updates with new data
- Include and/or quantify uncertainty in the input data/model parameters
- Quantify uncertainty in current estimates (improving credibility)
- Identify methods/data needs to improve estimates



Our model

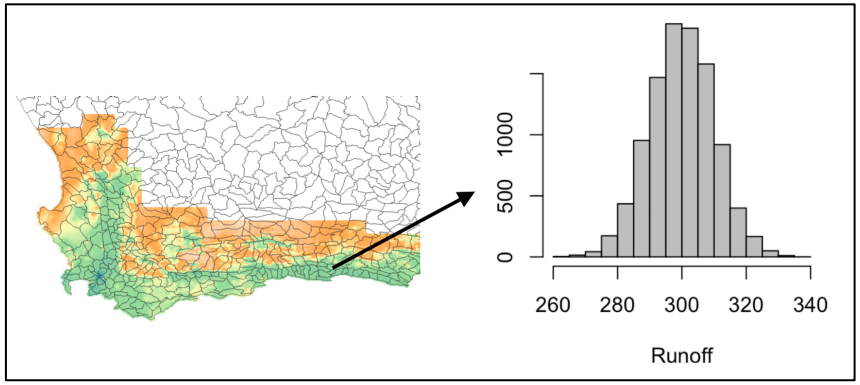
Lost runoff



~

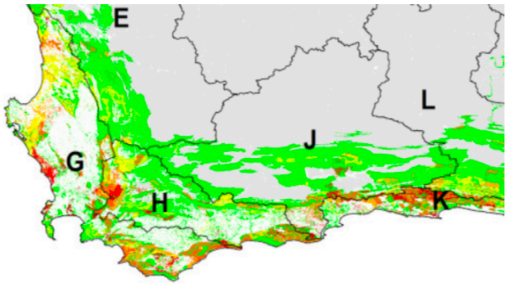
Naturalized run-off

Includes uncertainty in weather data

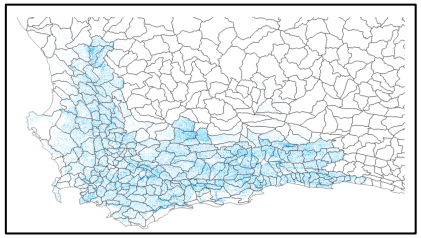


Alien density

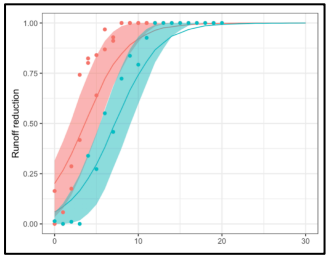
Includes low and high NIAPS data



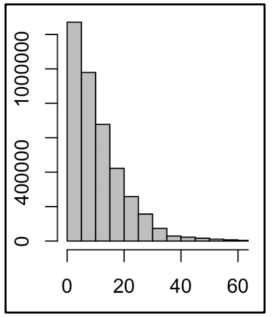
Uses 1:50k rivers



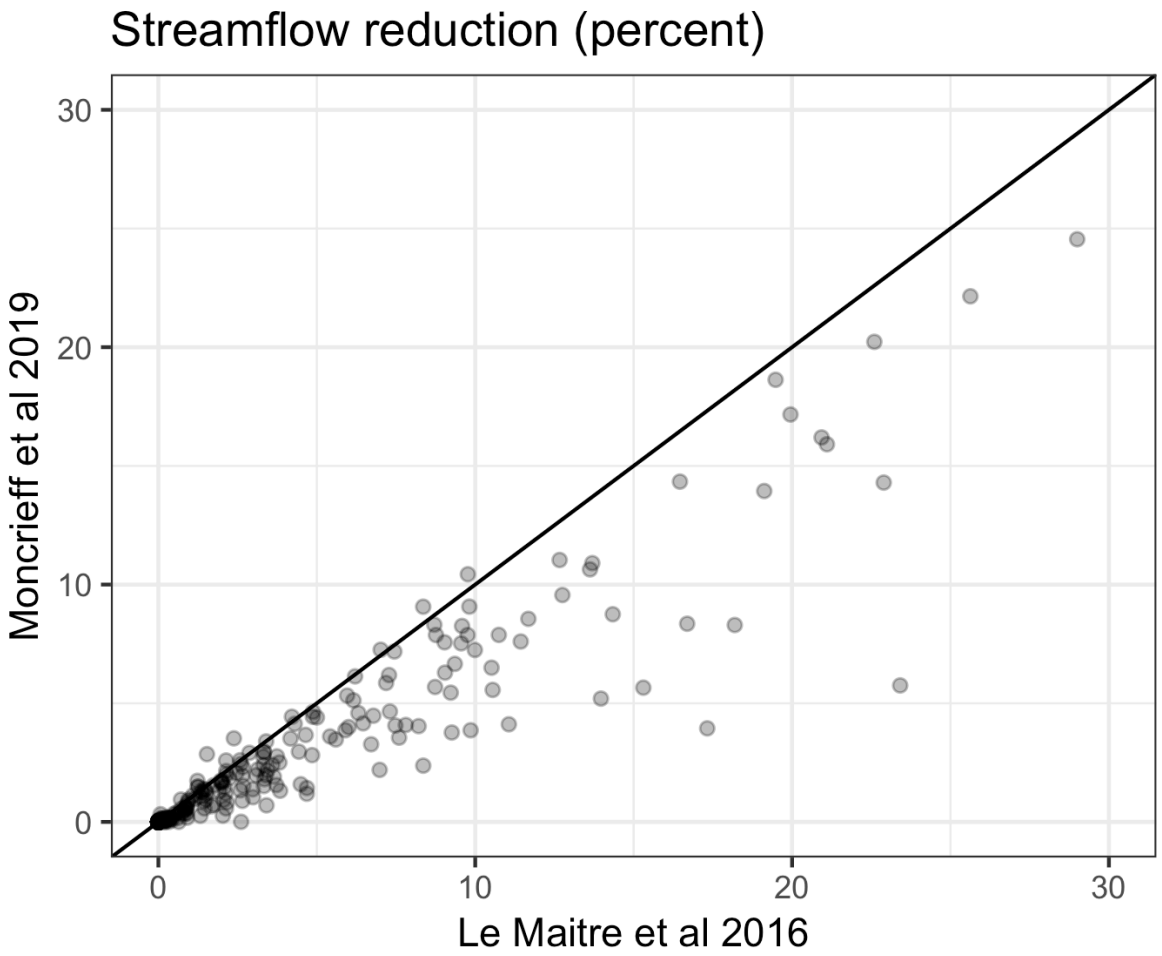
Includes uncertainty in species-specific streamflow reduction curves



Samples realistic ages



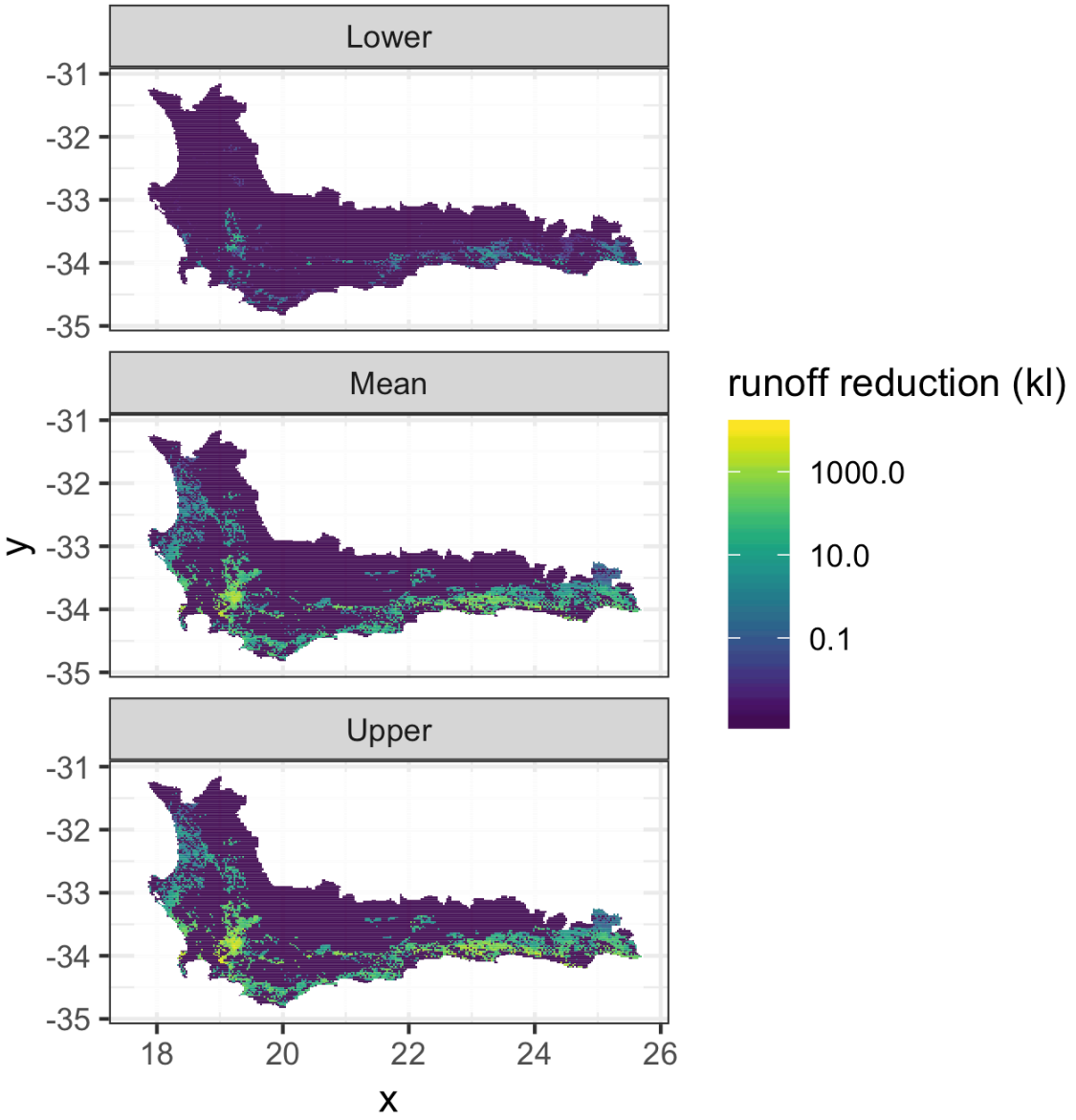
Preliminary results (Comparison of means)



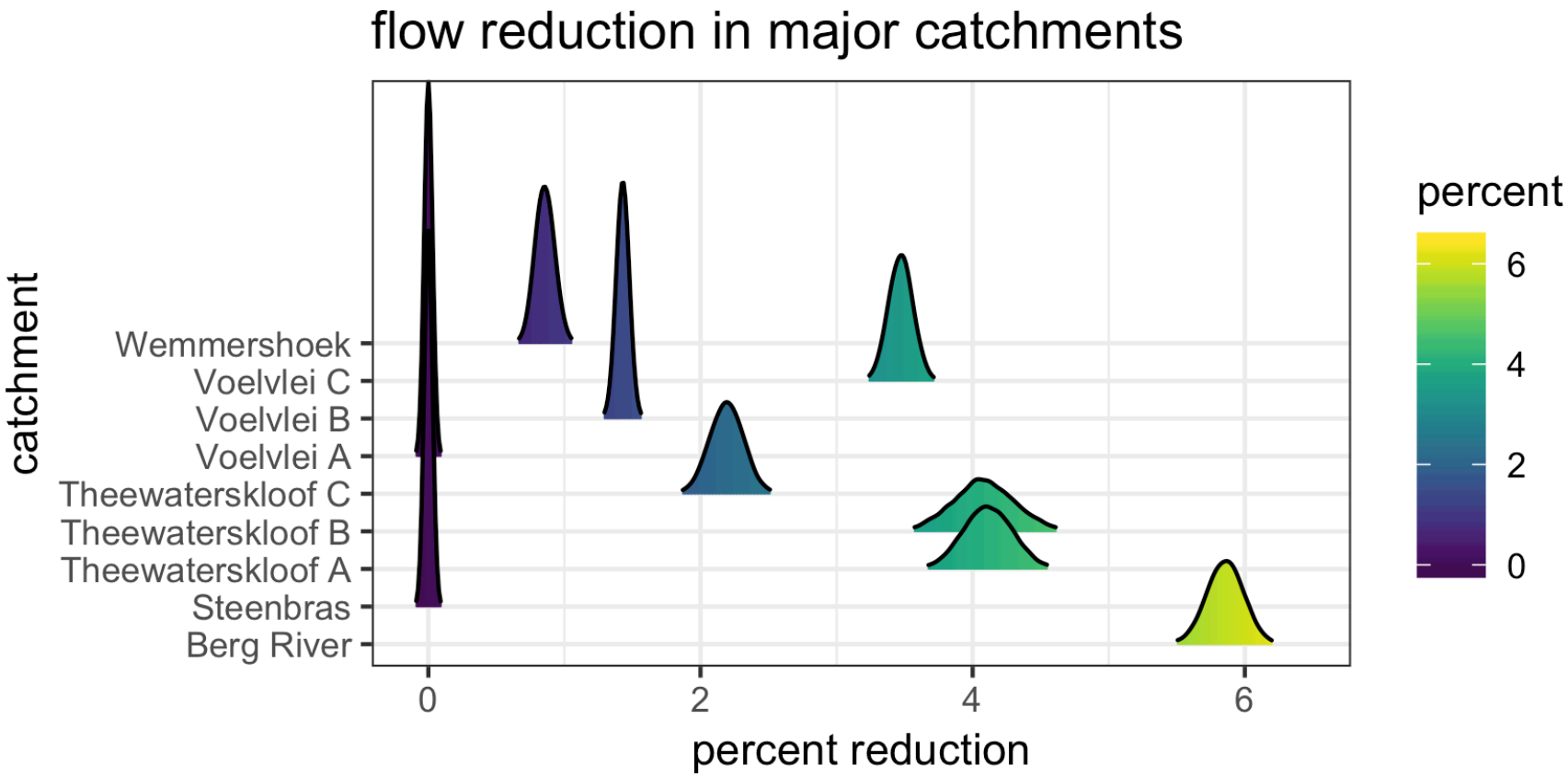
Preliminary! Still working on issues with our model, and some of our data are different.

Preliminary results

You get upper and lower estimates for each pixel (250x250m).



Preliminary results



You get a distribution, rather than a point estimate!

Refining estimates of the impact of invasions on runoff (in the Cape Floristic Region)

From here:

- Validation
  - Run time-series (annual estimates) over 20-30 years and compare with real data

- Sensitivity analyses
  - Which input variables are most important and need most attention re data collection?

- Inverse modelling
  - E.g. If we know the weather and the streamflow, we should be able to estimate the impact of aliens

Refining estimates of the impact of invasions on runoff (in the Cape Floristic Region)

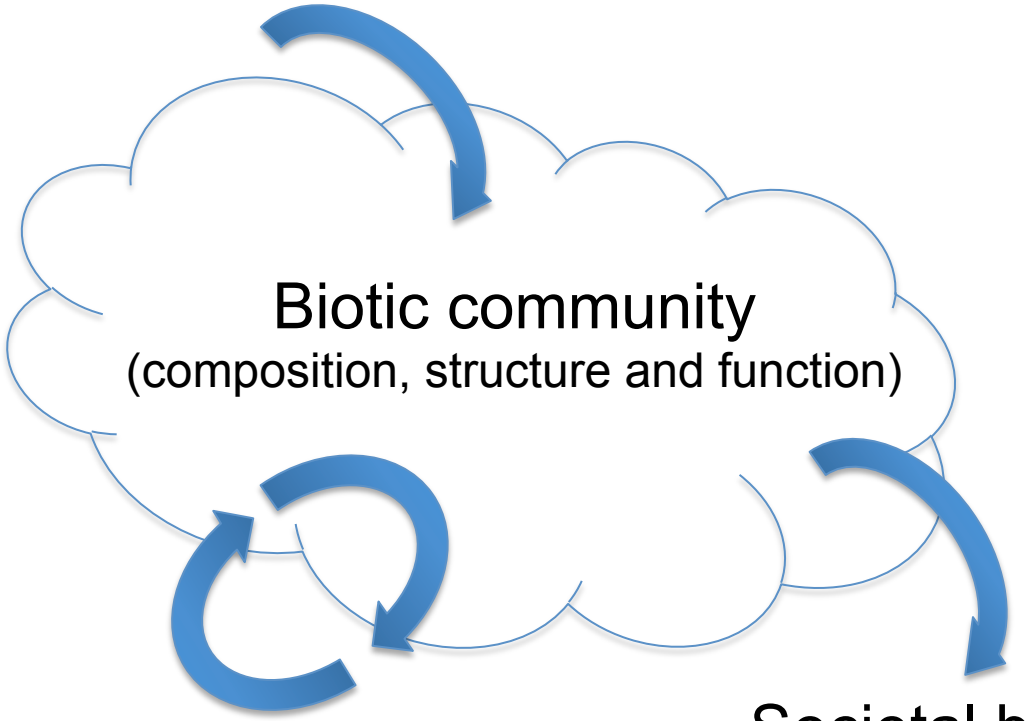
From here:

- Update input data to be more practical
  - E.g. use variables readily measurable with modern tools, like leaf area index (LAI) from satellite instead of coverage and age of plants, etc

- Include indigenous vegetation and natural processes like post-fire recovery cycles, and/or global change trajectories etc.
  - Hence need to focus on variables that are readily comparable with fynbos without having to do detailed measurements on 9000+ spp!

Mapping invasives

Global Change Drivers
(aliens, climate, land use/cover, fire, etc)



Water

Societal benefits/costs
(water, fire, recreation, etc)

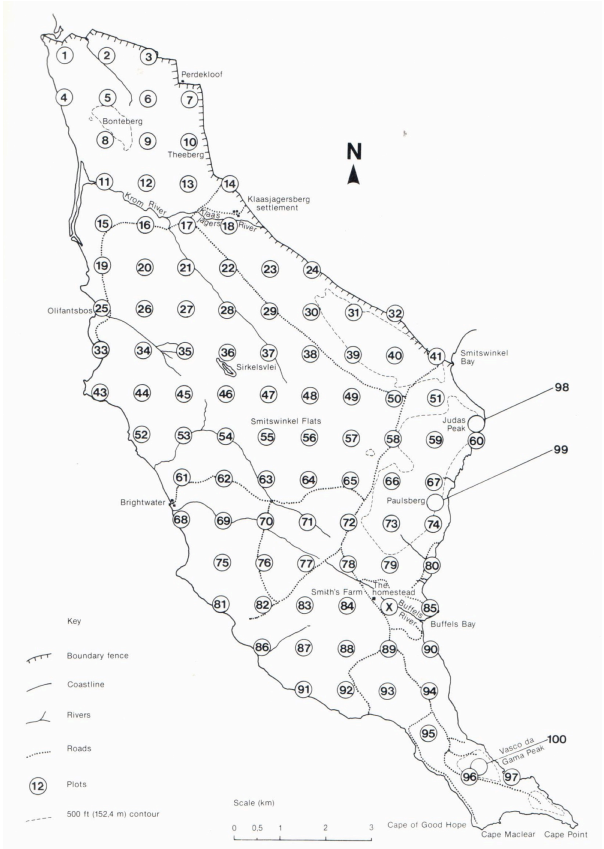
Internal dynamics and feedbacks

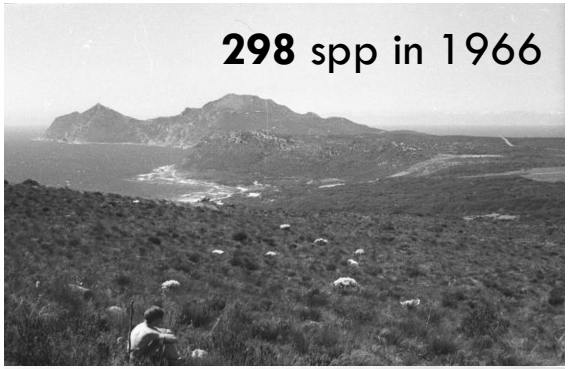
Biodiversity impacts

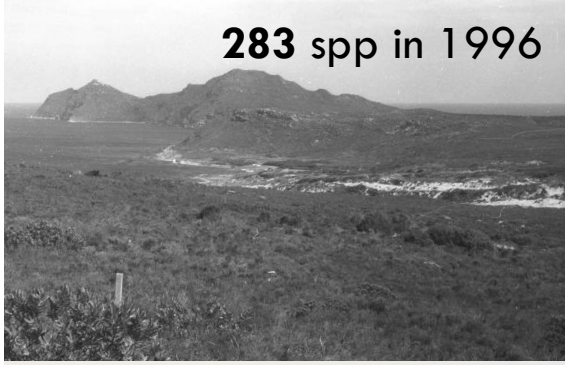
Impacts of global change on fynbos plant communities

Intensifying postfire weather and biological invasion drive species loss in a Mediterranean-type biodiversity hotspot

Jasper A. Slingsby[a,b,1], Cory Merow[c,d], Matthew Aiello-Lammens[d,e], Nicky Allsopp[a], Stuart Hall[f], Hayley Kilroy Mollmann[d], Ross Turner[g], Adam M. Wilson[h], and John A. Silander Jr.[d]







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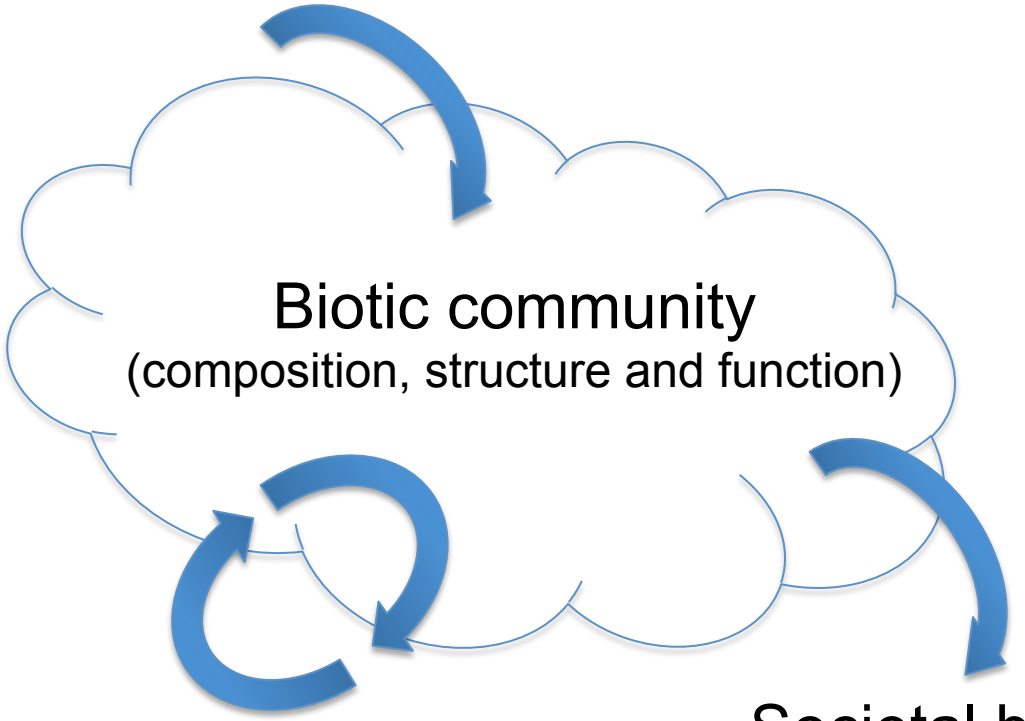

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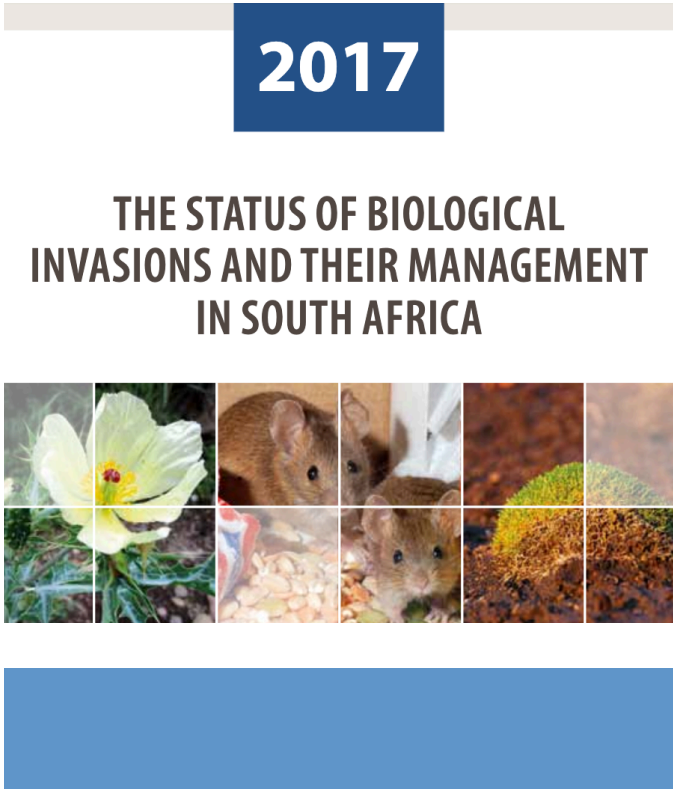
MAPPING INVASIVES

There is much hope that remote sensing tools will help

- Track rates of spread
- Estimate impacts
- Help prioritize and monitor control efforts
- Inform threat assessments
- etc



"remote sensing tools should be used"
"the use of remote sensing techniques should be explored"
"use of other approaches (for example remote sensing)"
"using remote sensing and gis"
"require physical sampling or remote sensing"

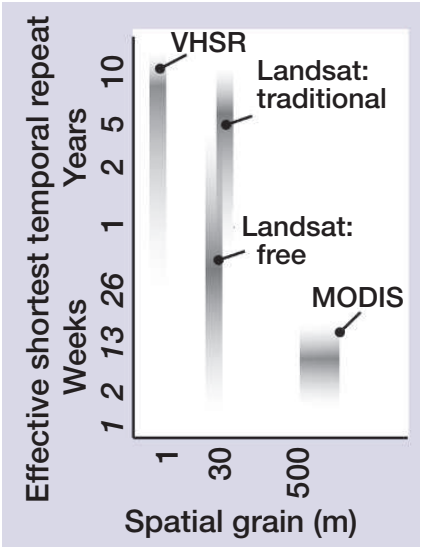
MAPPING INVASIVES - Where to start?

A plethora of:

- Datasets
  - Repeat time?
  - Spatial grain?
  - Sensor type?
  - Cost?

- Techniques
  - Classification
    - Unsupervised
    - Supervised
    - Object-based/oriented
  - Segmentation
  - Change detection
  - Trend analysis

- Analytical methods
  - Any stat you can think of!
  - Artificial Intelligence (Machine & Deep Learning)



MAPPING INVASIVES - Where to start?

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- Analytical methods
  - Any stat you can think of!
  - Artificial Intelligence (Machine & Deep Learning)

- What are the user requirements?
- How big is your wallet?
- How big is your computer?
- Access to expertise?

MAPPING INVASIVES

What are the user requirements?

"We need to know the number and size of all individuals of all species, nationally… every week…"

We need to temper

(and manage) expectations!!!

MAPPING INVASIVES

"We need to know the number and size of all individuals of all species, nationally… every week…"

You probably wouldn't know how to deal with these data even if remote sensing could provide them…

It would be a massive dataset, no matter how it were summarized…

MAPPING INVASIVES

"We need to know the number and size of all individuals of all species, nationally… every week…"

This is not completely impossible, but it is very VERY difficult!!!

- Requires small spatial grain = low temporal frequency (and/or high cost)
- Only large and emergent (i.e. not sub-canopy) species readily identifiable
- Massively computationally intensive!!!
  - (and no, Google Earth Engine won't solve the problem)
- Need lots of ground truth data for calibration/validation

MAPPING INVASIVES - Strategic pragmatism

A hierarchy of tools!

- Here be aliens! - National/Provincial
  - Here be high/low density - Mountain range or similar
    - Here be pines and black wattles - Catchment
      - Here be 7 adult, 14 sub-adult, etc - NBal

Use different data, techniques and algorithms at each level

Apply to different spatial extent at different temporal frequency

MAPPING INVASIVES - Strategic pragmatism

RReTool: Rapid and repeatable tools for monitoring global change impacts on natural resources

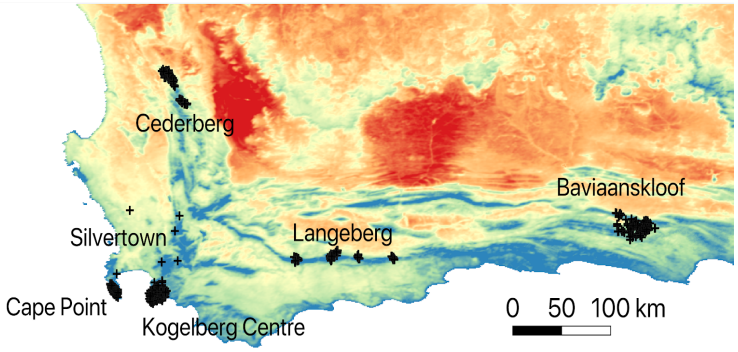
(SAEON, SEEC UCT, Rhodes Uni, others)

- Goal
  - Develop a hierarchy of tools for mapping ecosystem change at different spatial and temporal scales using different ***freely available*** data and software at each level

- Ultimate aspiration:
  - A website with instructions/walk-throughs for running each analysis on your own with nothing but a laptop and an internet connection
    - i.e. teach you to fish
    - I accept it's probably more than we'll achieve on one grant…

CFR

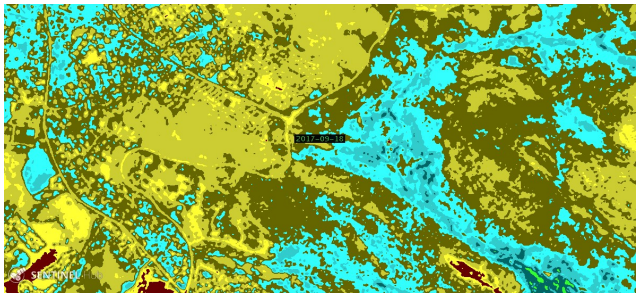
(change detection based on MODIS time series ~250m)



- Every 16 days for the CFR
- Detect “abnormalities” including aliens
- *~Working for Fynbos – needs validation*
- *PhD developing approach for Thicket*

Catchment/Reserve

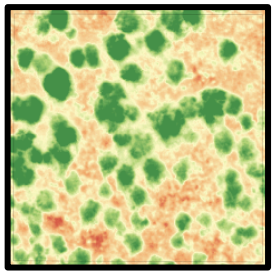
(classification of densities based on Sentinel/Landsat 10-30m)



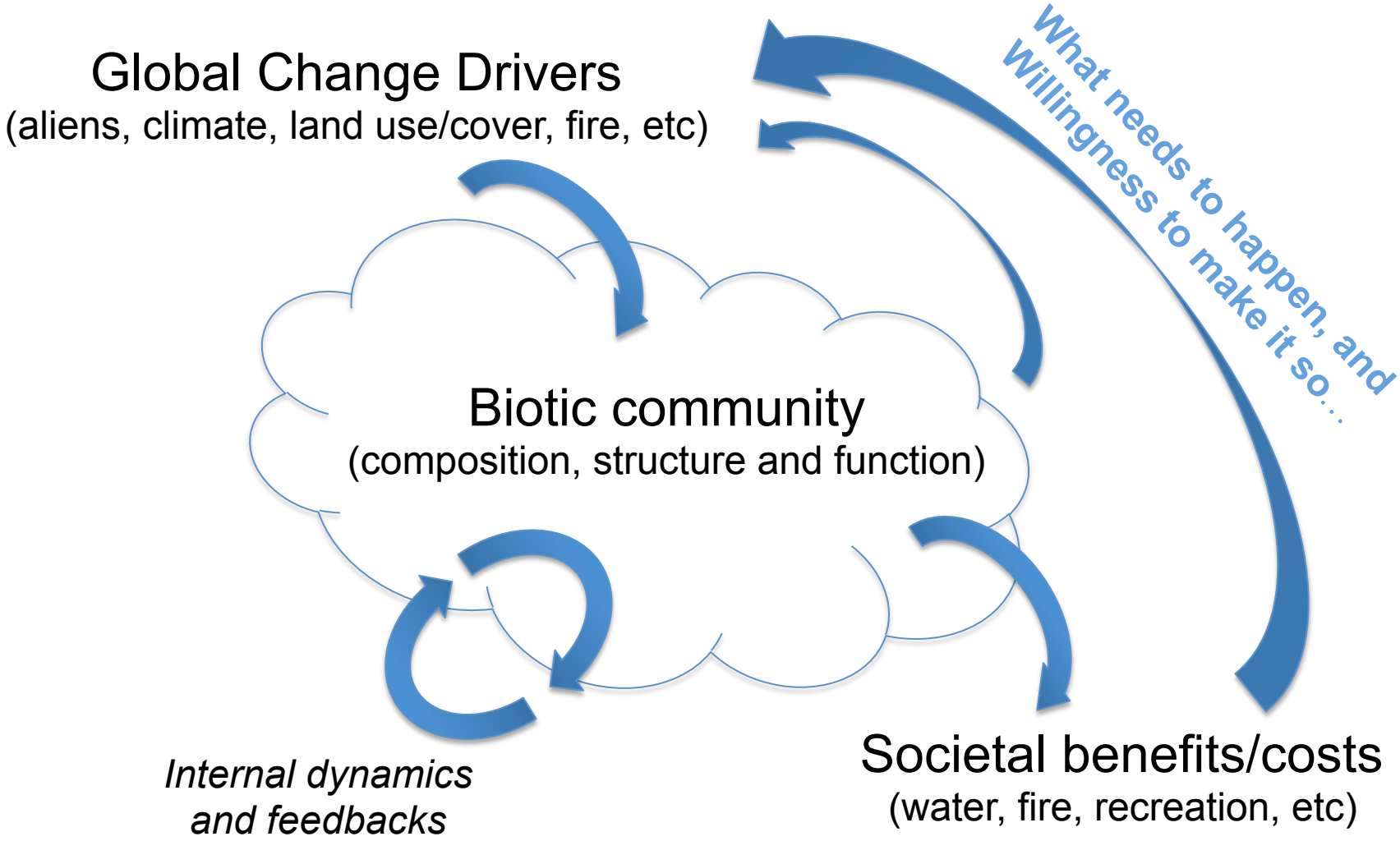
- Every 10-16 days for targeted areas
- Monitor control operations etc
- *2 MScs in progress (Fynbos, Grasslands)*

NBal

(identify individuals based on aerial or drone imagery 10-50cm)



- Every 2-3 years for targeted areas
- Monitor/prioritize control operations etc
- Calibration/validation data
- *1 MSc in progress*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THANK YOU!!!