Using Earth Observations and Ecosystem Modeling to Improve the Sustainability of Agribusiness and Extractive Industries in Working Landscapes

Becky Chaplin-Kramer
Natural Capital Project
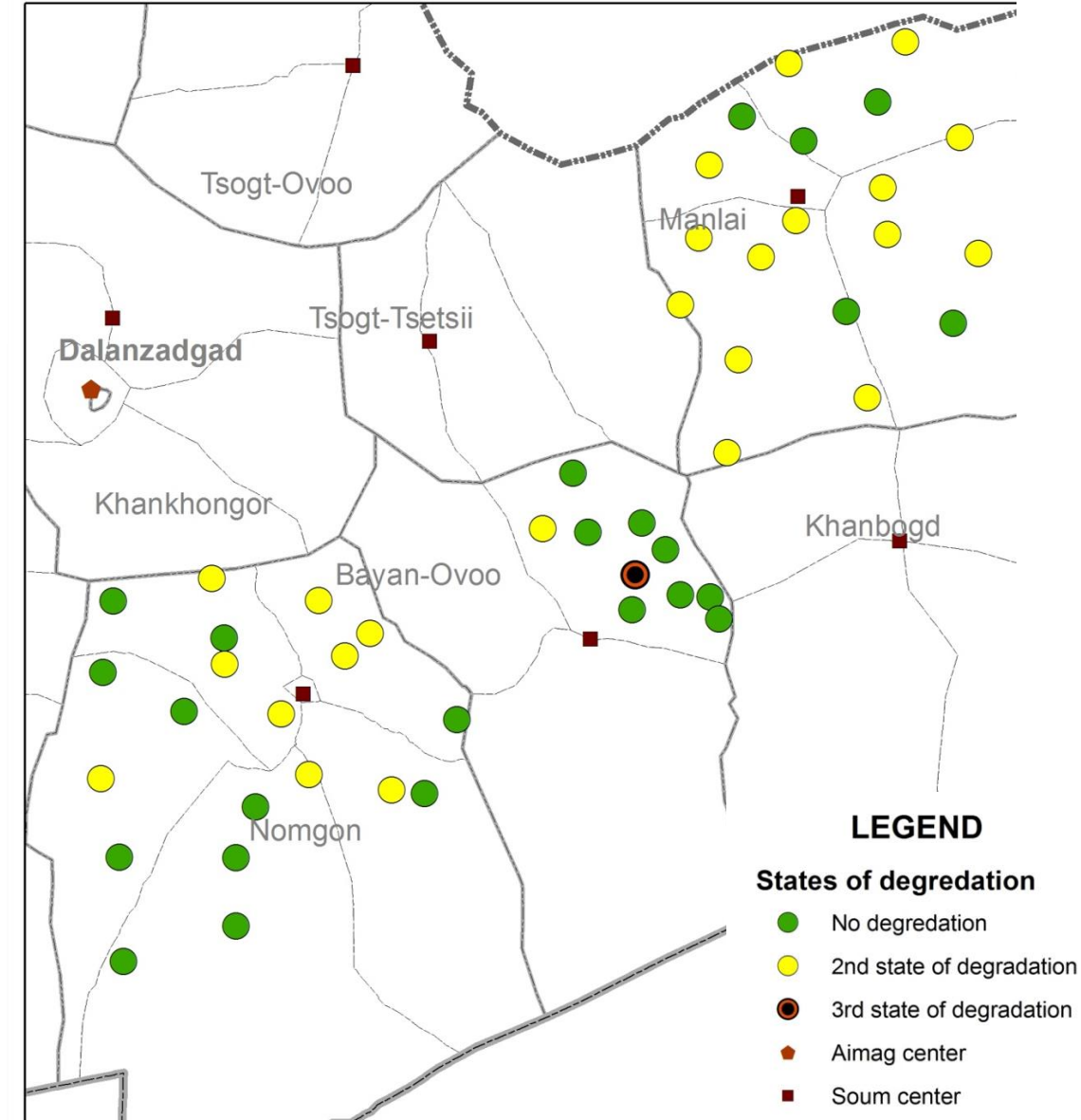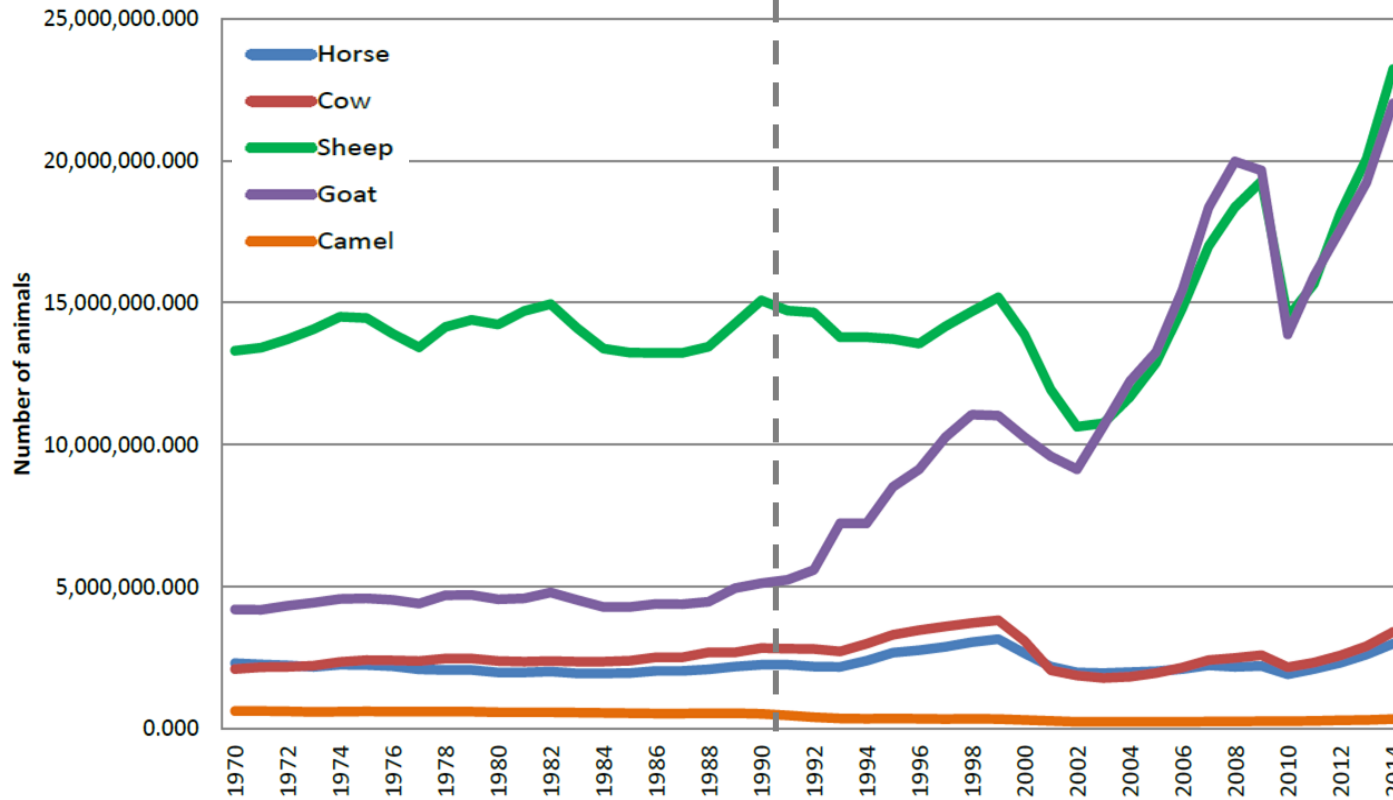Stanford University & University of Minnesota

@beckyck
@natcapproject

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Livestock trends and rangeland degradation

Legend

States of degredation
- No degredation
- 2nd state of degredation
- 3rd state of degredation
- Aimag center
- Soum center

The Sustainable Cashmere Project is a new initiative that aims to use market mechanisms to foster sustainable practices and deliver measurable improvements on rangelands, wildlife and livelihoods through the cashmere supply chain in Mongolia.

Sustainable Cashmere Project

Sustainable Cashmere Project
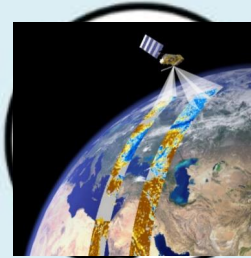
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WCS

natural capital PROJECT

NASA

Measurements

Wildlife monitoring

Rangeland monitoring

Earth observations & rangeland modeling to complement on-the-ground monitoring

Goals

Improvements in wildlife habitat and population

Improvements in rangeland condition

Improvements in ES

Improvements in value addition from cashmere and livestock products

Actions

No poaching

Pasture management

Incentives for action

Awareness

Guardian dog

Certification

Capacity building

Breeding

Health

Alternative income

Sorting, cleaning

Where should field resources be deployed?
How should herd size be adapted to changing conditions?
What are the risks of management strategies and how can they be managed?

The Good Growth Company

Are changes in grazing management able to offset mining impacts enough to have a net positive impact?

How much can management contribute to rangeland health and ecosystem services?

And will this be adequate to support wildlife and maintain herder livelihoods, amidst climate change?
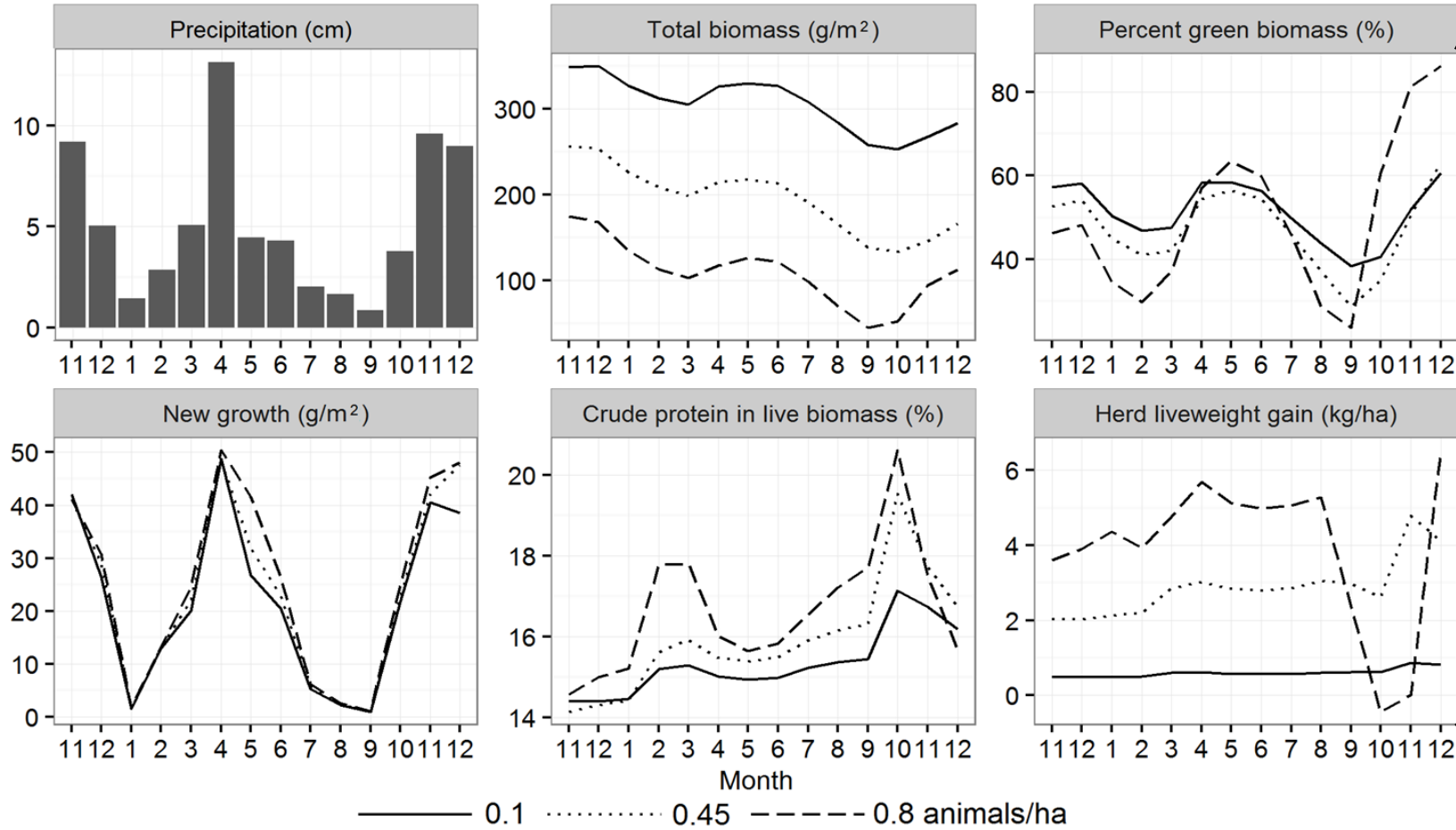
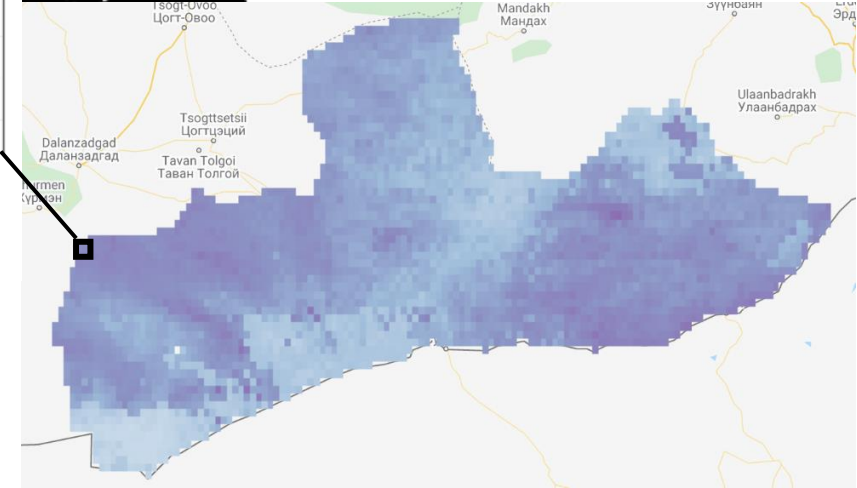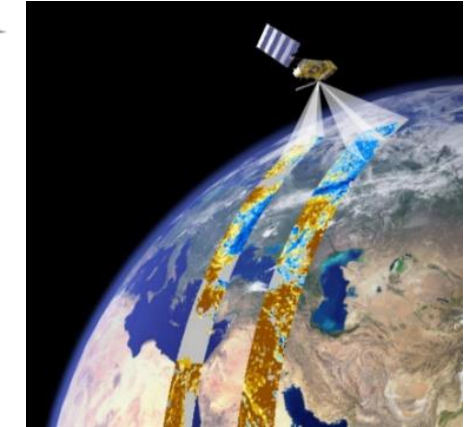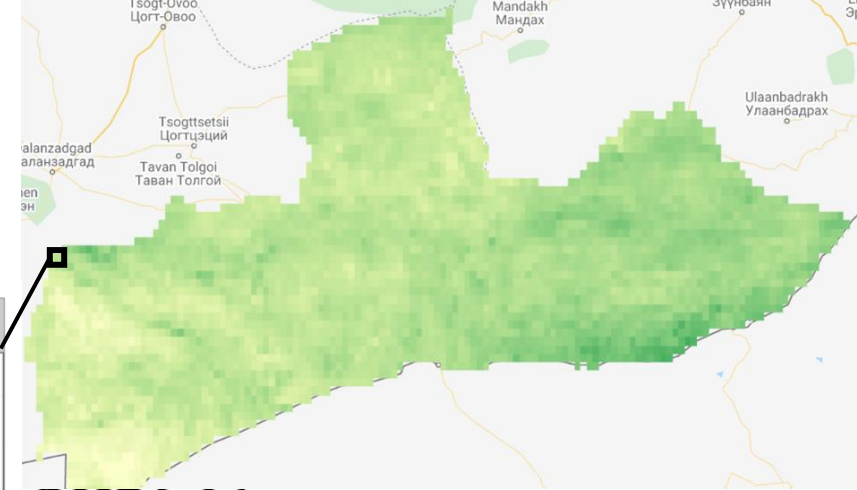What role can management play amidst climate change?

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Rangeland Production Model (RRM)

Validation across a precipitation gradient

Model accuracy improved using satellite climate data (CHIRPS precipitation, MODIS LST) and calibrated with vegetation indices (MODIS NDVI)

15 transects, 5 replicates each = 75 sites across Mongolia
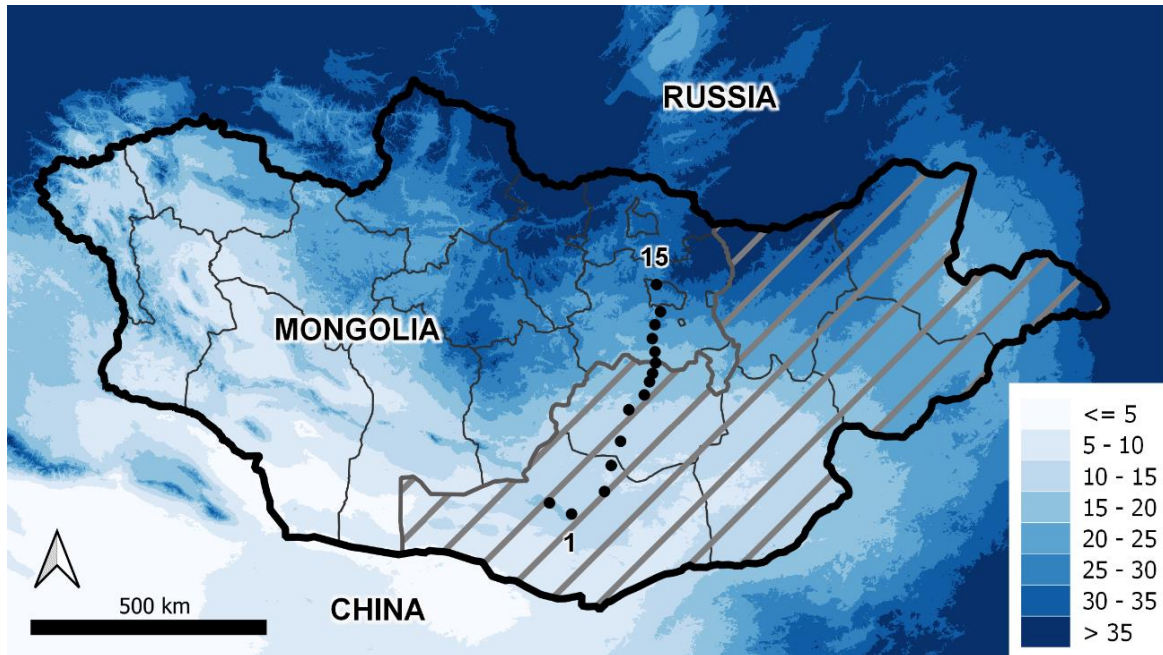
Standing biomass (kg/ha)

(2014: ρ = 0.82, p < 0.001; 2015: ρ = 0.78, p = 0.001)
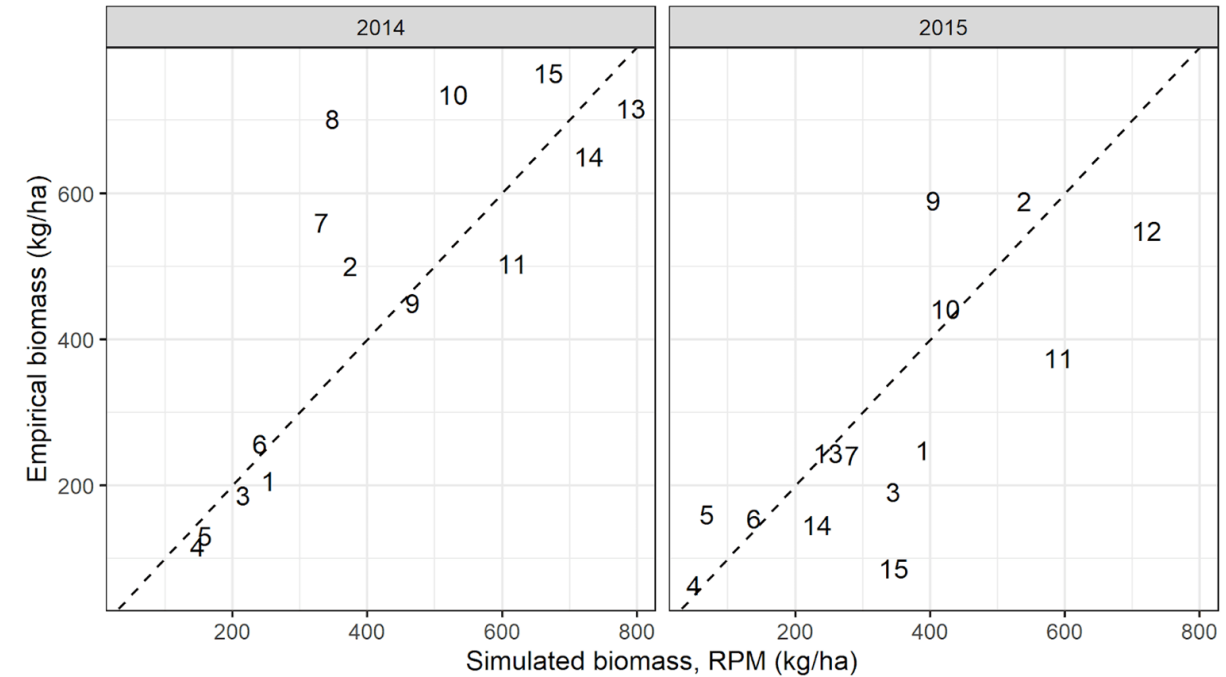
Change under future climate conditions

Current

Future (2070)

8000+ kg/ha

Cumulative biomass (April – Sept)

100 kg/ha

>1

<1

Average diet sufficiency (April – Sept)

What role can management play amidst climate change?

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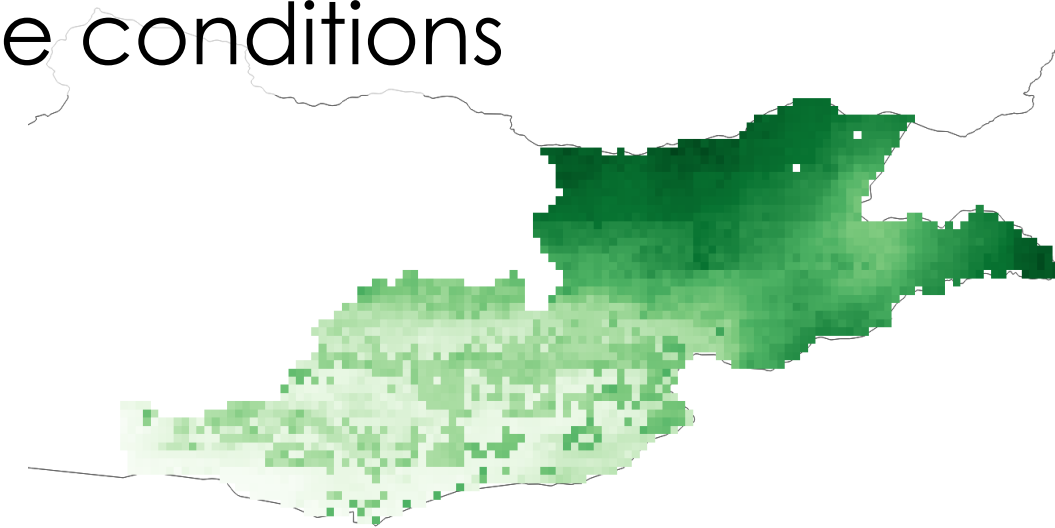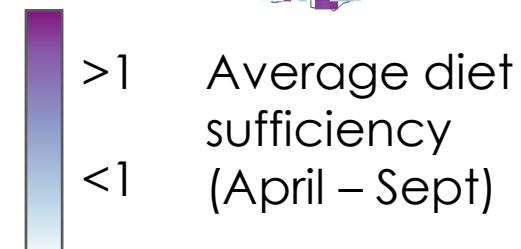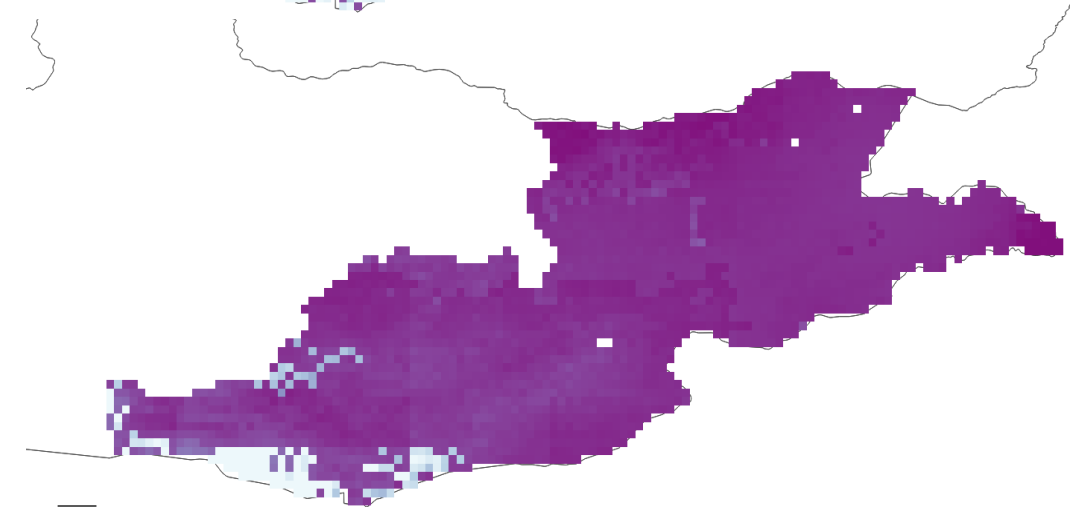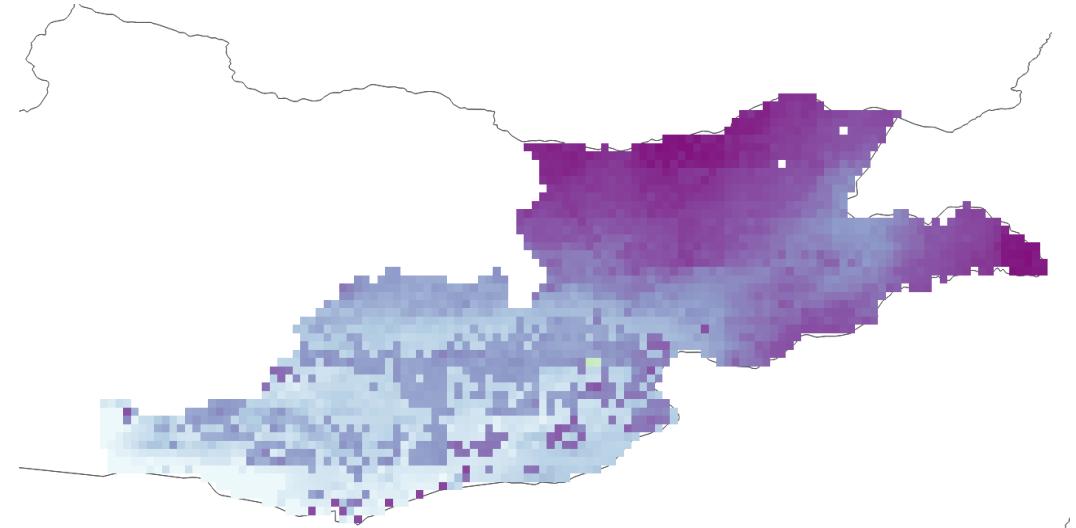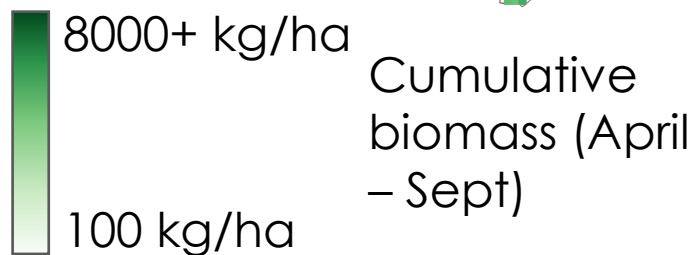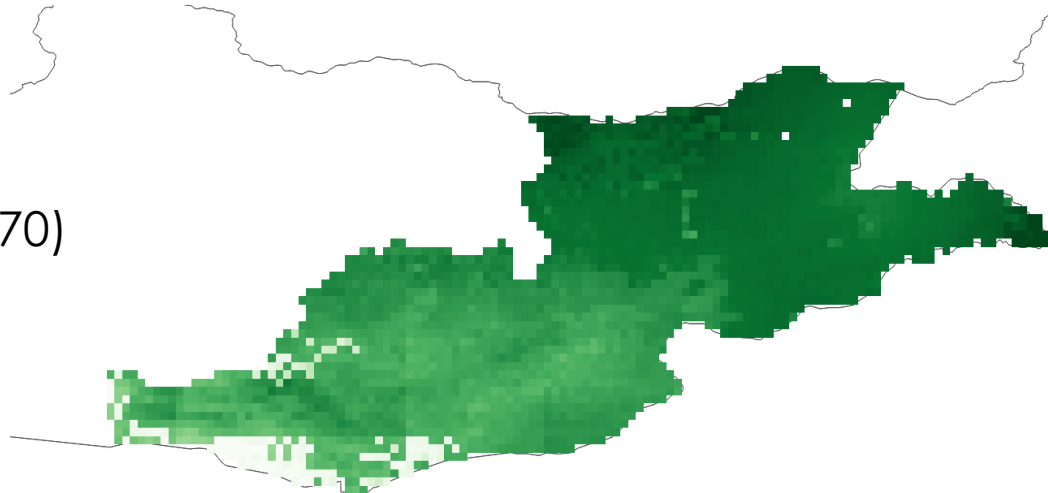
Grazing impacts matter more in more productive climates; will matter more under future climate
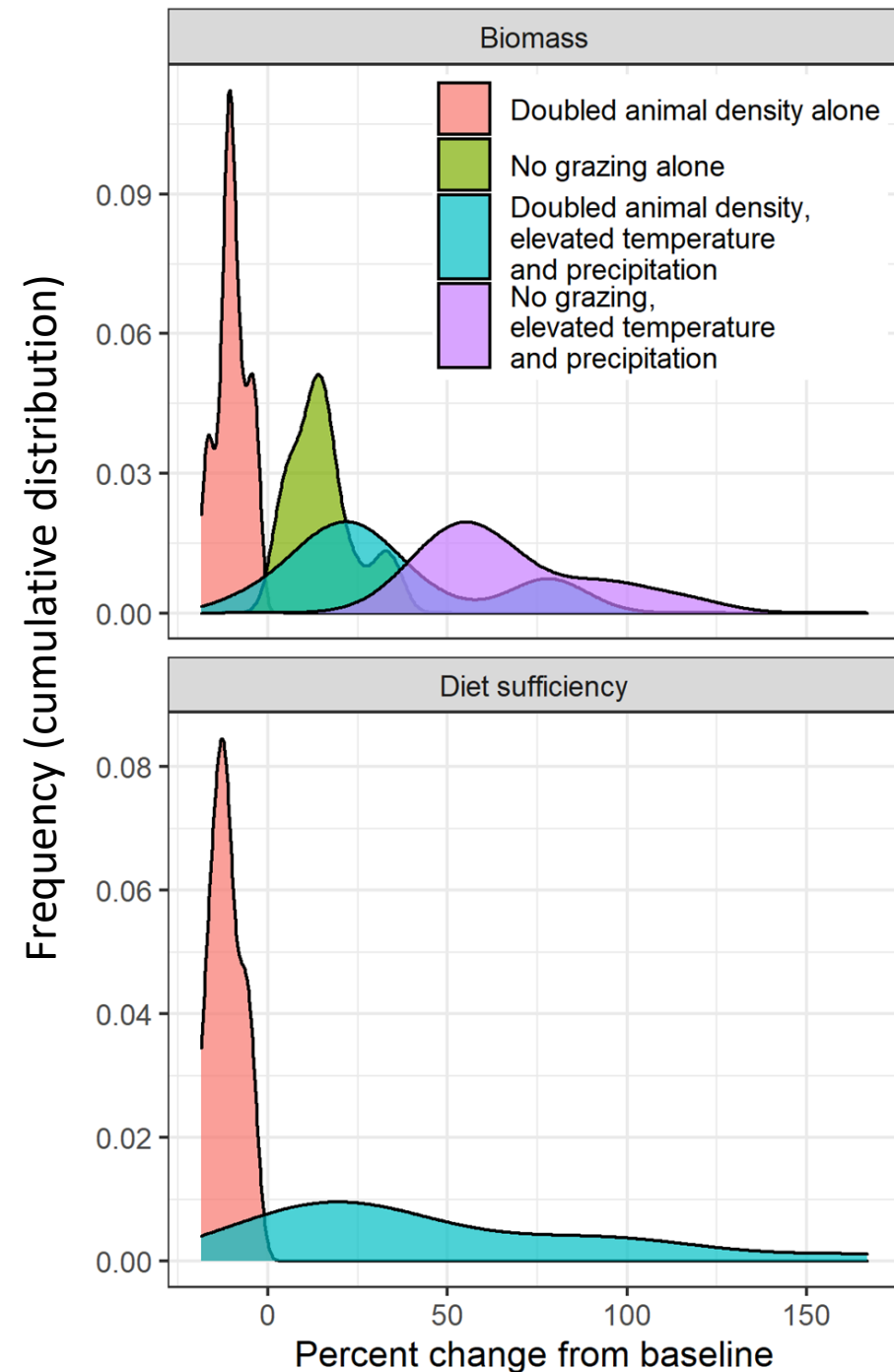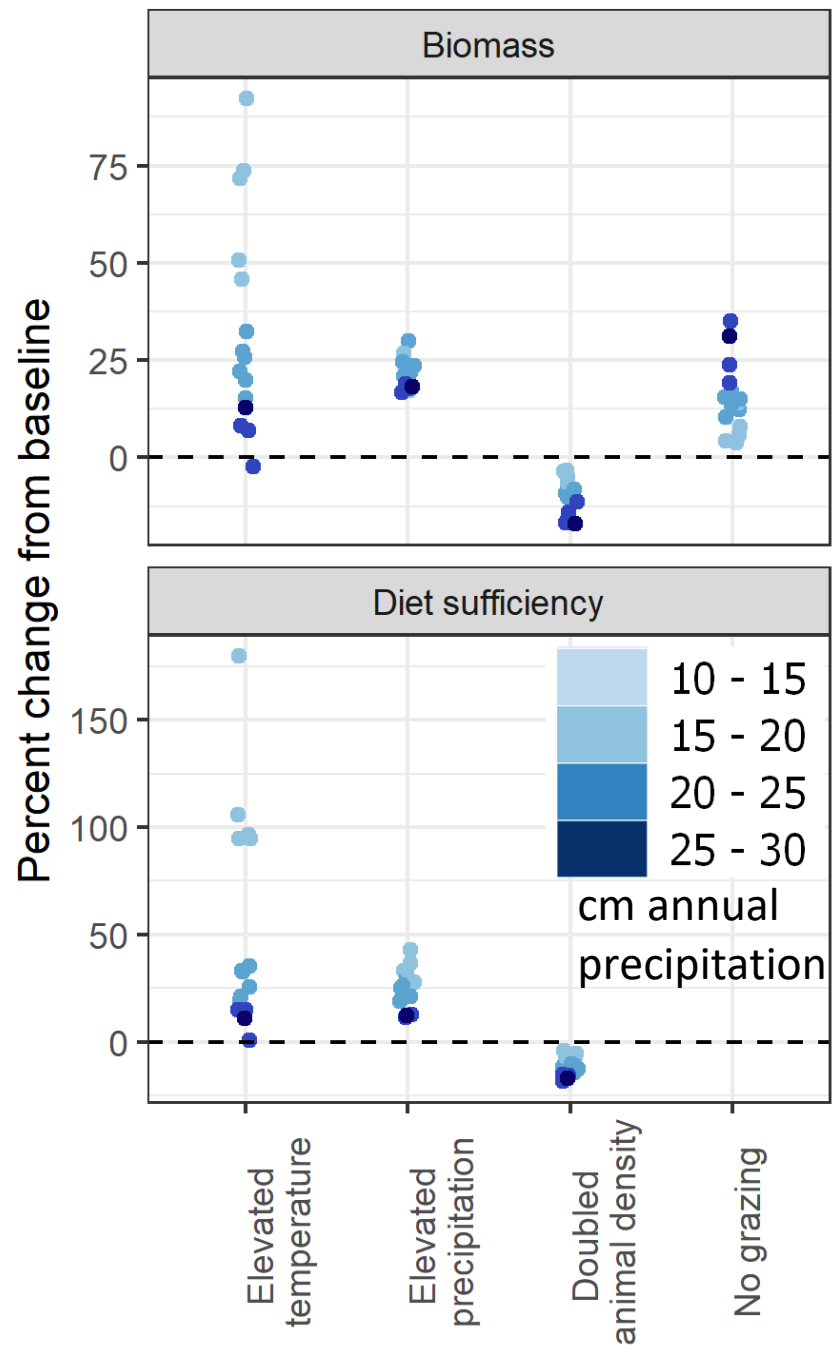
Wind erosion and sandstorm prevention are more impacted by change in vegetation than climate

Soil loss

0.007 kg/m²

(A)

61 * 10^10 kg

0

FVC
fraction vegetation coverage, the annual average is displayed

50%

(B)

10%

0%

100%

-100%

Change in soil loss (%)

with uniform FVC=0%

(C)

with uniform FVC=50%

(D)

with uniform FVC=100%

(E)

with FVC increased 10%
(110% of original vegetation)

(F)

with FVC increased 20%
(120% of original vegetation)

(G)

with FVC increased 50%
(150% of original vegetation)

(H)
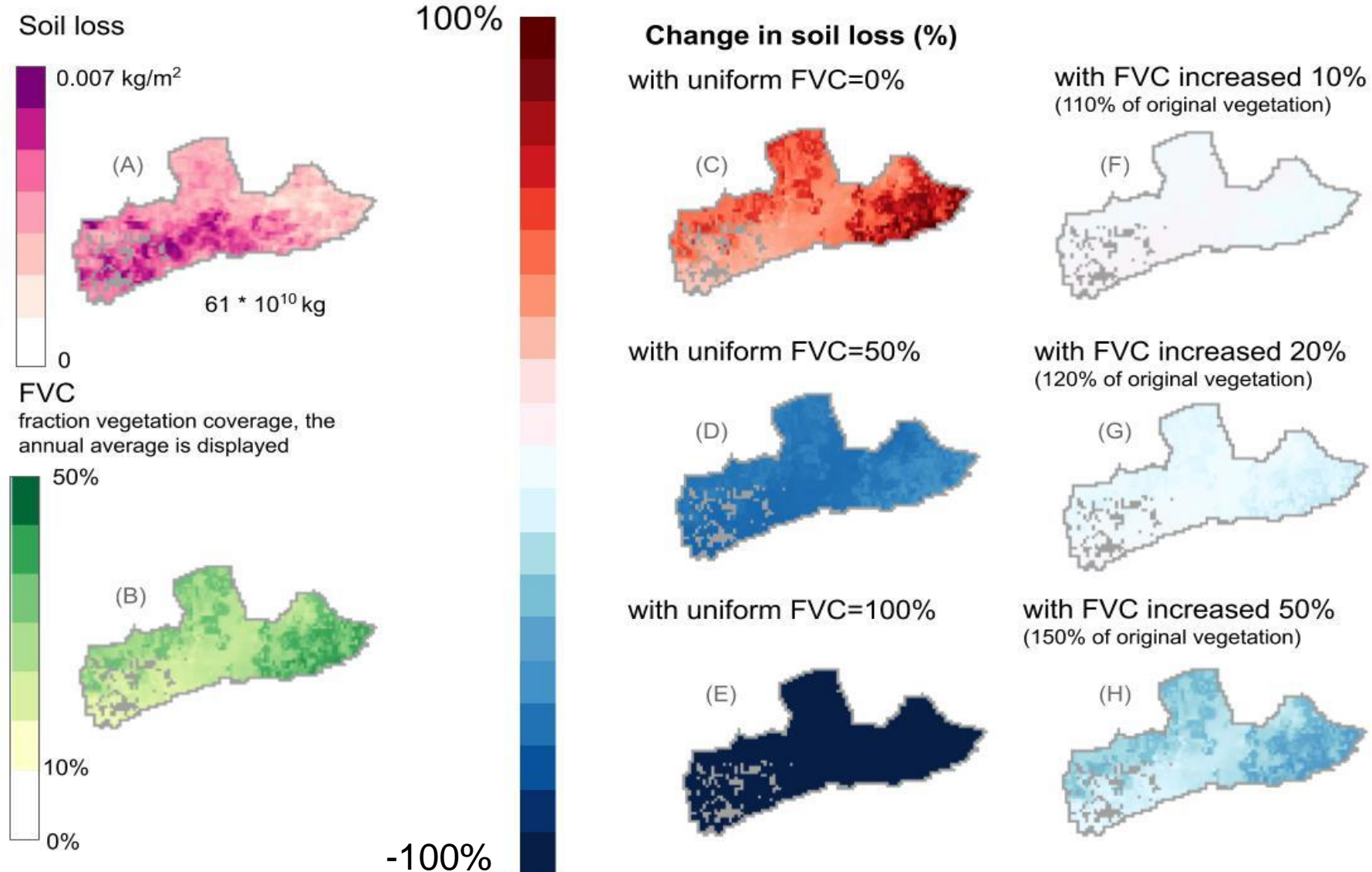
Under future climate (7 °C increase in temperature; 18% increase in precip; according to RCP7.0)

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WHAT IS AN EP&L?

An Environmental Profit & Loss Account facilitates a better way of thinking

and is an innovative tool imagined by Kering

in our own operations and across our entire supply chain

it measures the environmental footprint

and then calculates its monetary value
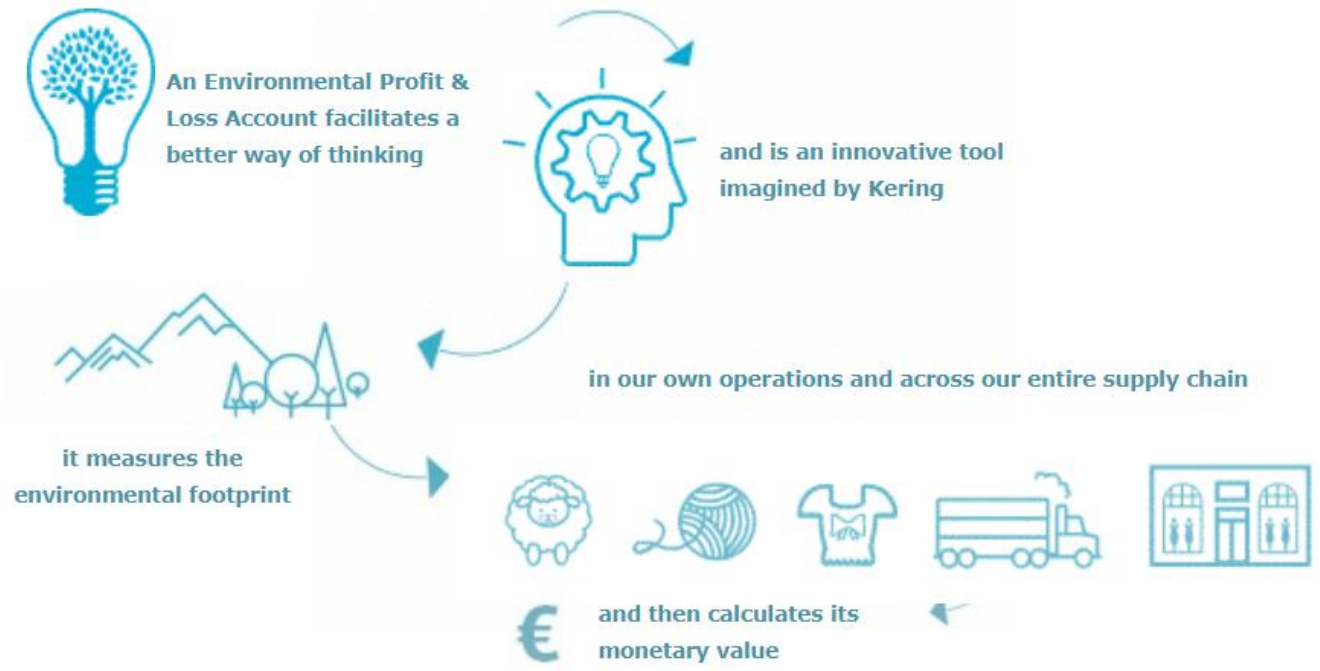
WHY AN EP&L?

UNDERSTAND WHERE IMPACTS ARE

DEVELOP A KNOWLEDGEABLE DECISION-MAKING PROCESS

STEER OUR BUSINESS STRATEGY RESPONSIBLY

STRENGTHEN OUR BUSINESS AND MANAGE RISKS FOR THE FUTURE

BE TRANSPARENT WITH STAKEHOLDERS

EP&L: Environmental Profit & Loss

UNDERSTANDING OUR FOOTPRINT

TO MEASURE OUR TRUE ENVIRONMENTAL FOOTPRINT WE EXAMINE:

Carbon emissions · Water use · Water pollution · Land use · Air pollution · Waste

AND TO REALLY UNDERSTAND OUR IMPACT
WE ANALYSE THESE FACTORS THROUGH OUR VALUE CHAIN:

Raw materials › Processing › Manufacturing › Assembly › Operations & Retail

	TIER 0: STORES WAREHOUSE OFFICES	TIER 1: ASSEMBLY	TIER 2: MANUFACTURING	TIER 3: RAW MATERIAL PROCESSING	TIER 4: RAW MATERIAL PRODUCTION
AIR EMISSIONS					
GHGS					
LAND USE					
WASTE					
WATER CONSUMPTION					
WATER POLLUTION					

EP&L: Environmental Profit & Loss

Impact drivers → **Impacts to ecosystem services** → **Impacts to societal value**

Raw materials

Manufacturing (Footprint)

Occupation of converted land

New conversion of ecosystems

Provisioning	Local	Food
		Fibre, other raw materials
	Regional	Domestic and industrial water
		Ornamental products
	Global	Bio-prospecting & medicinal plants
		Air
Cultural	Regional	Recreation
		Spiritual and aesthetic
		Cognitive
Regulating	Regional	Pollution control
		Erosion control
		Disease and pest control
		Flood control
	Global	Equable climate

1,400 individual estimate of ecosystem service values

TEEB database + additional recent studies

Area of land occupied or converted (aspatial)

Or increase!

- Reduction in biomass (IPCC 2006)
- Reduction in species richness (Ellis 2012)
- Or, full loss (e.g., for provisioning ES)

- Economic value for based on per-hectare estimates from benefits-transfer
- Beneficiaries weighting by percent of national population in rural areas

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Improvements to EP&L through spatially-explicit ecosystem service modeling

Remote sensing

InVEST
integrated valuation of ecosystem services and tradeoffs
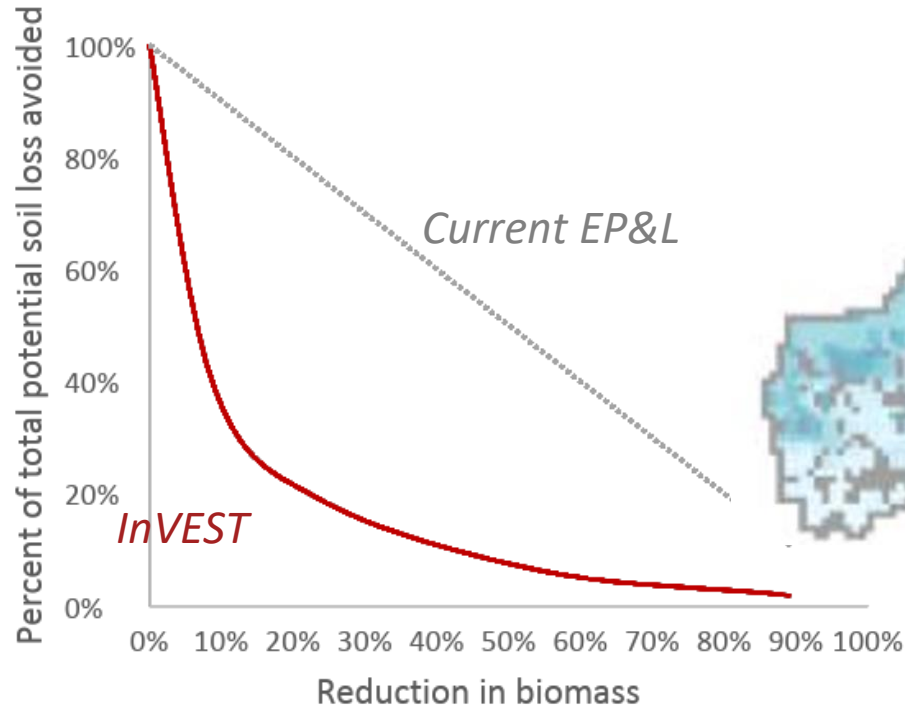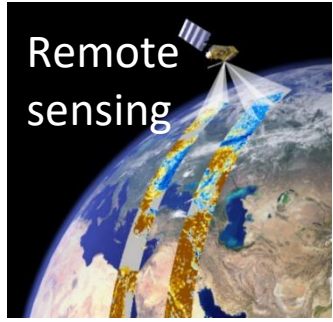
Difference in erosion
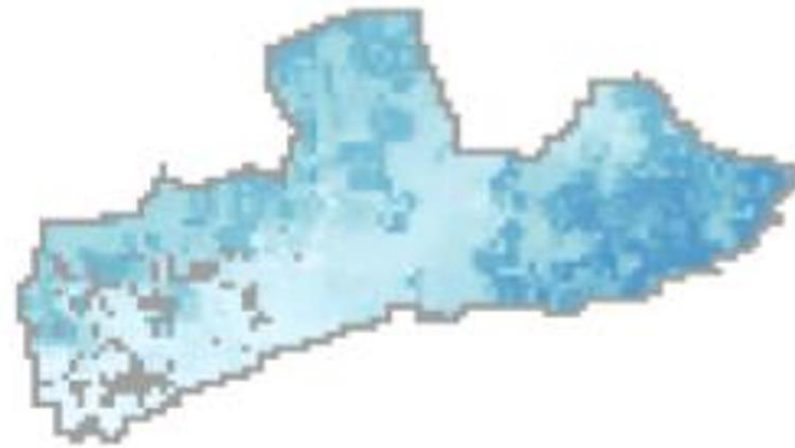
Well-managed rangeland
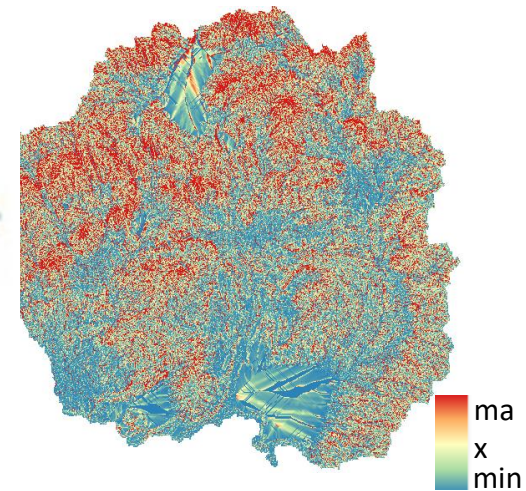
Poorly-managed rangeland

Assuming linear relationship between biomass and ecosystem services underestimates service loss by 2-5 times

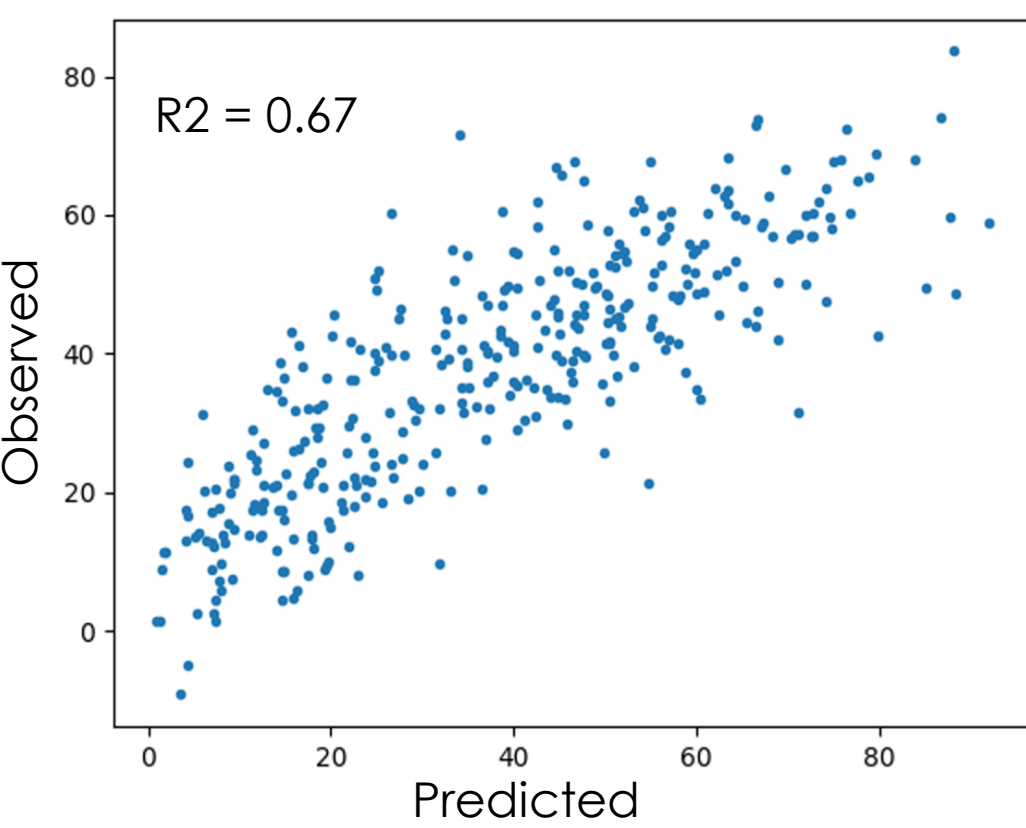How much has management contributed to rangeland health?

Are changes in grazing management able to offset mining impacts enough to have a net positive impact?

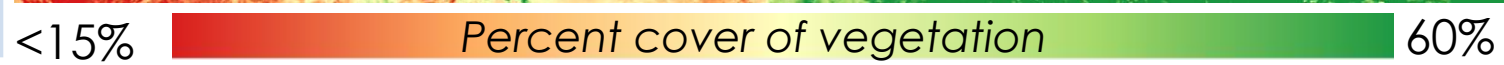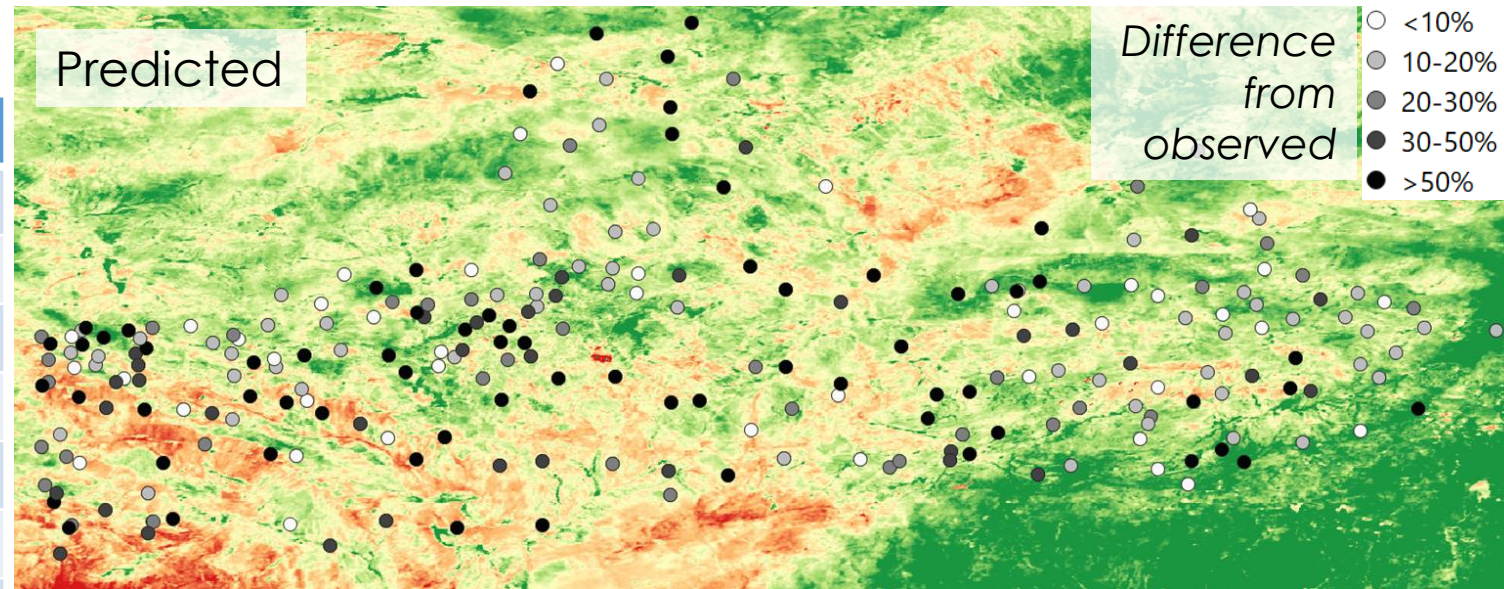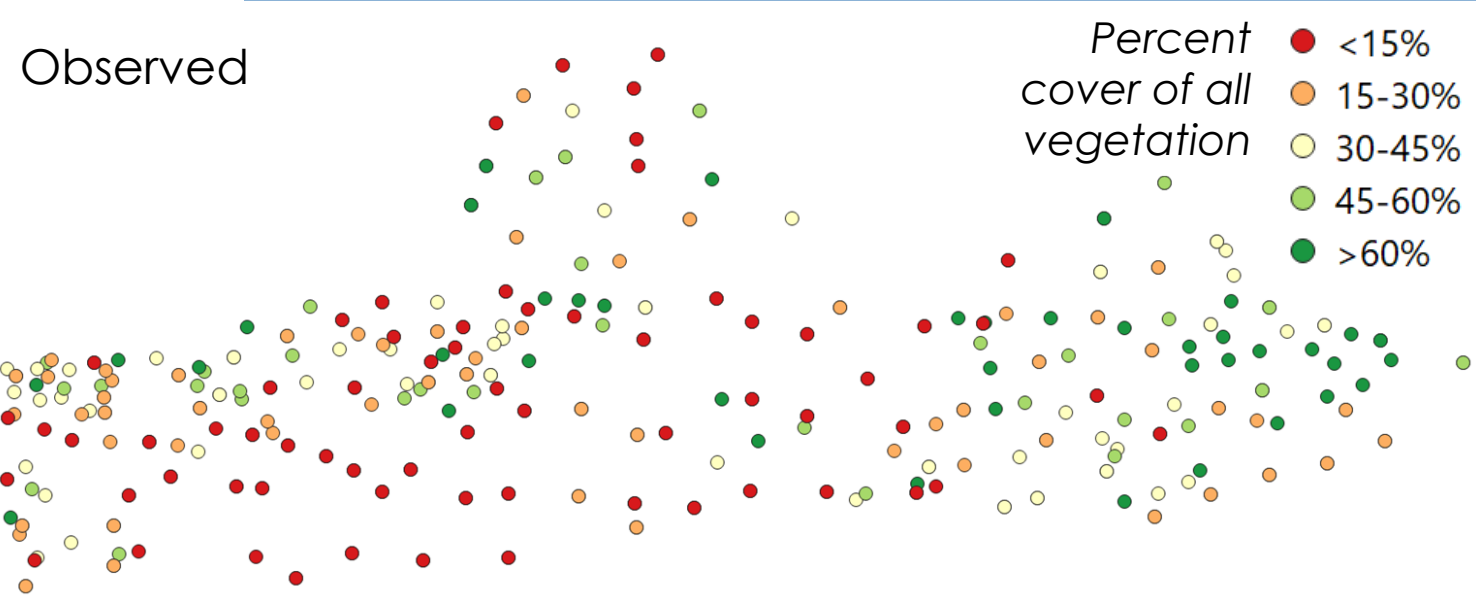How accurately (and cost-effectively) can we detect changes in rangeland condition?

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Satellite monitoring

R2 = 0.67

Observed (y-axis) vs Predicted (x-axis)

Observed

Percent cover of all vegetation
- <15%
- 15-30%
- 30-45%
- 45-60%
- >60%

Predicted

Difference from observed
- <10%
- 10-20%
- 20-30%
- 30-50%
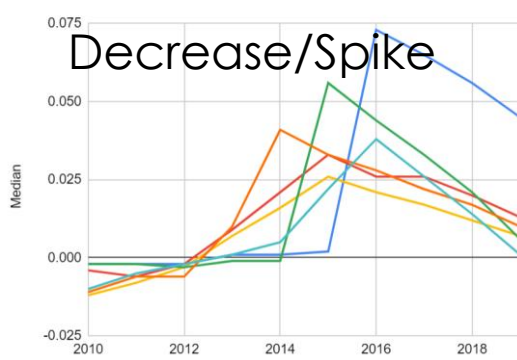- >50%

<15%   Percent cover of vegetation   60%

| Significant predictors (LASSO model) |
| --- |
| Early fall precipitation x Range in NDVI |
| Early spring minimum temperature |
| Mid-fall minimum temperature |
| Summer minimum temperature |
| Spring precipitation x NDVI near sampling date |
| Fall max temperature x NDVI near sampling date |
| NDVI near sampling date |

Decrease/Spike

Steep Increase
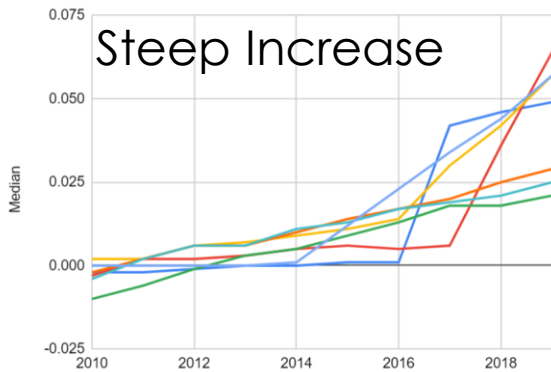
LandTrendr
(Landsat past 10 years)
Different trajectories of the
relationship between
precipitation & greenness
*Positive residuals =
better than average*

LandTrendr Clusters
■ Decrease/Spike   Degradation?
■ Increase
■ Stasis/Gradual Increase
■ Steep Increase
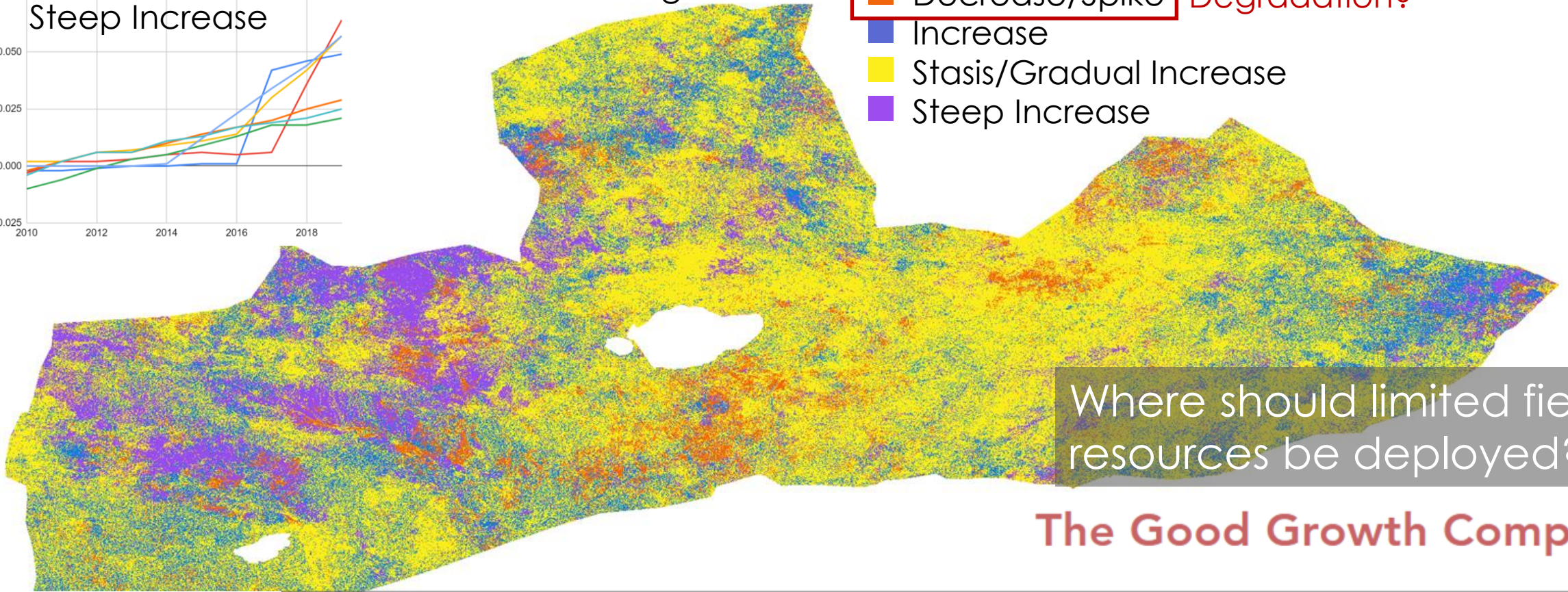
Where should limited field
resources be deployed?

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How can we improve monitoring design?

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Wet year (2018)

Rangeland production modeling

Grazing difference
(Cumulative live biomass)

Maximum difference

Minimum difference

Wet year (2018)

Grazing difference **on degraded pixels**
(Cumulative live biomass)

Maximum difference
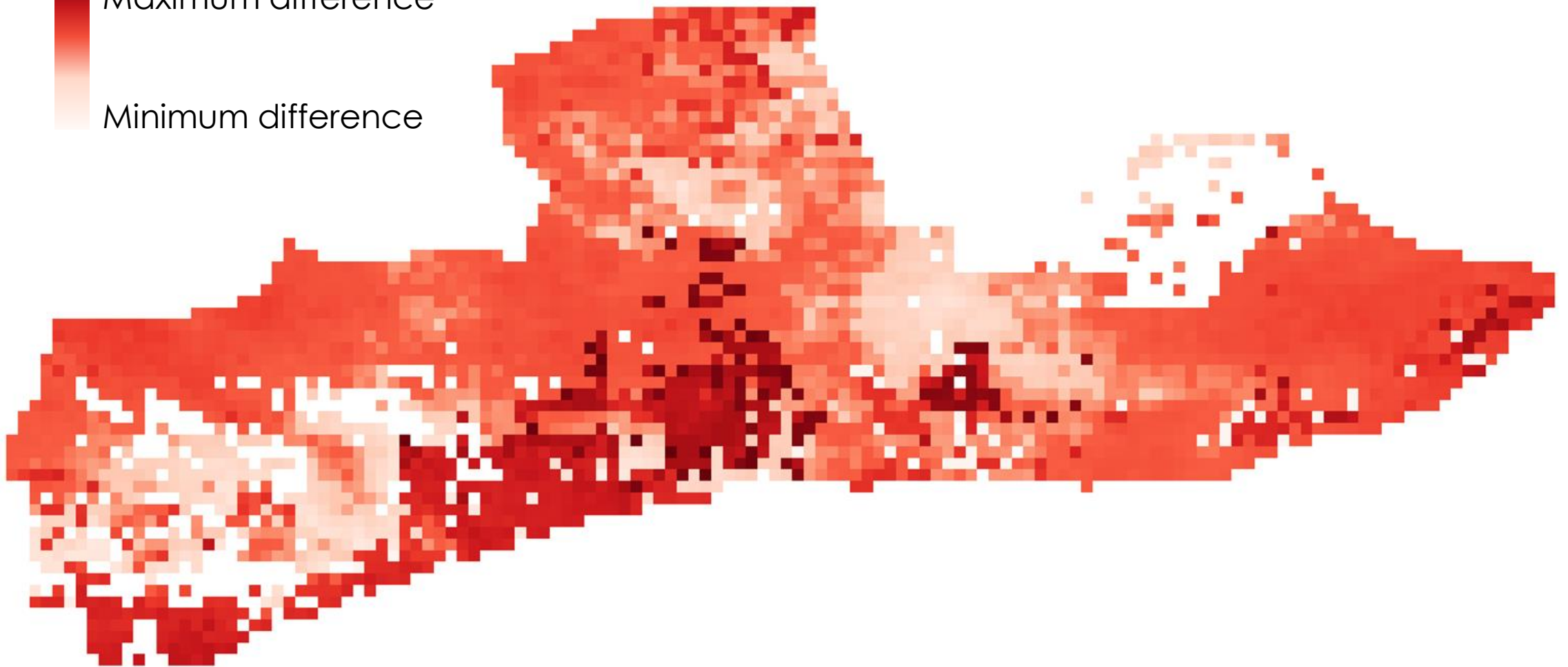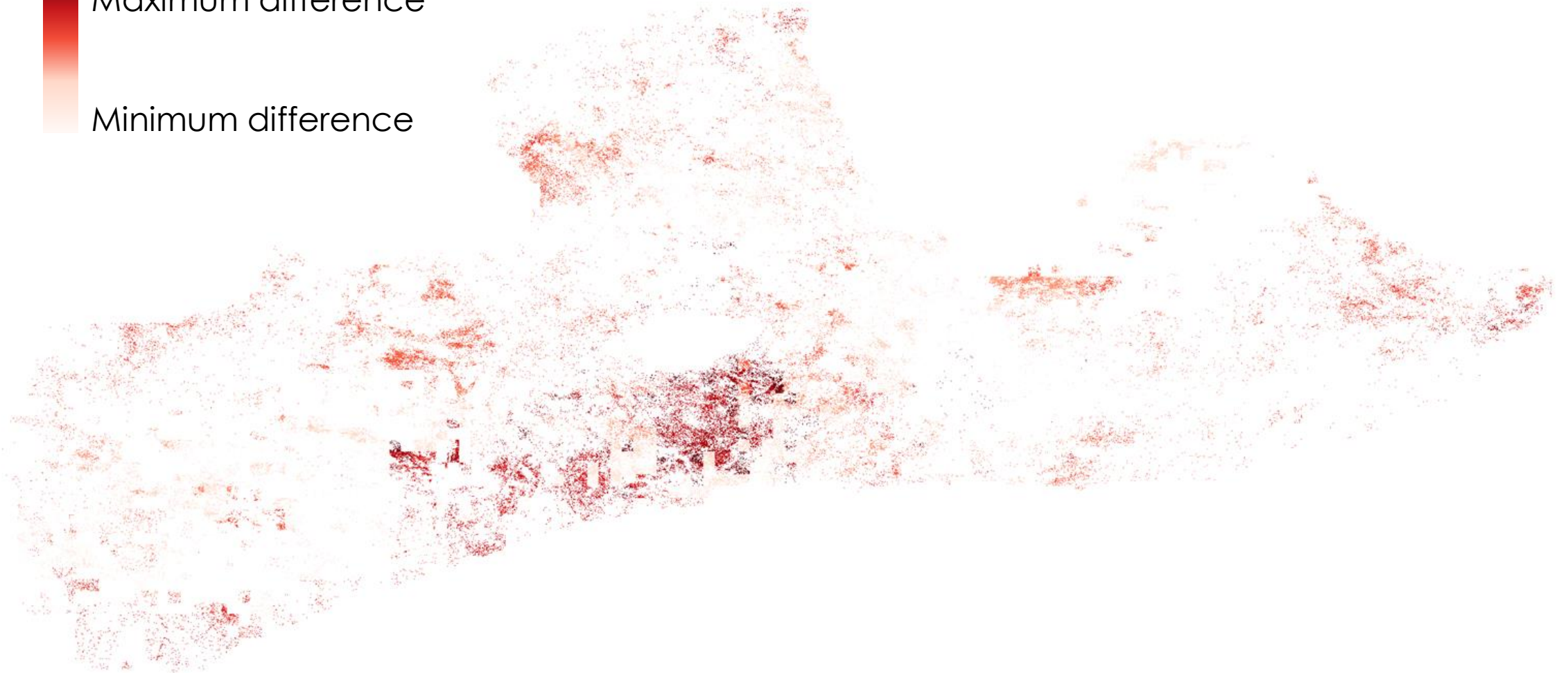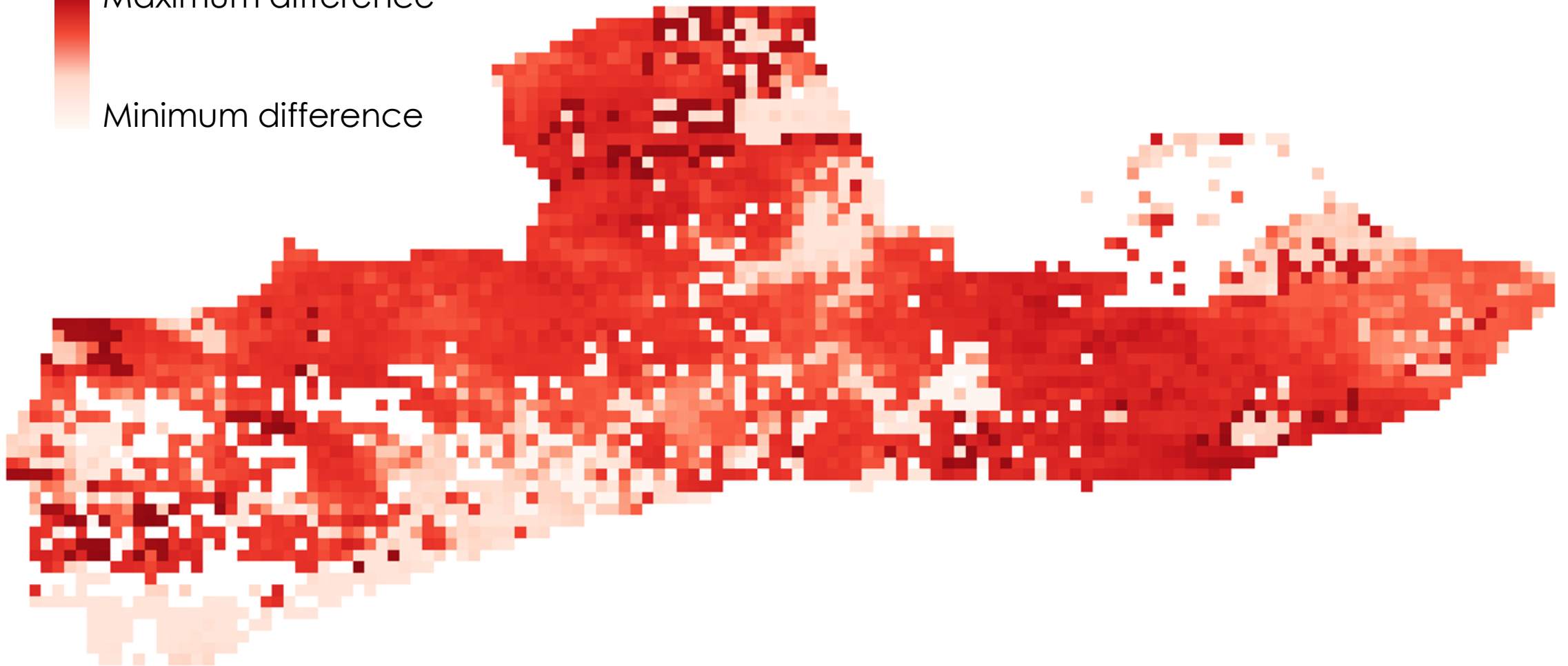
Minimum difference

Dry year (2019)

Rangeland production modeling

Grazing difference
(Cumulative live biomass)

Maximum difference
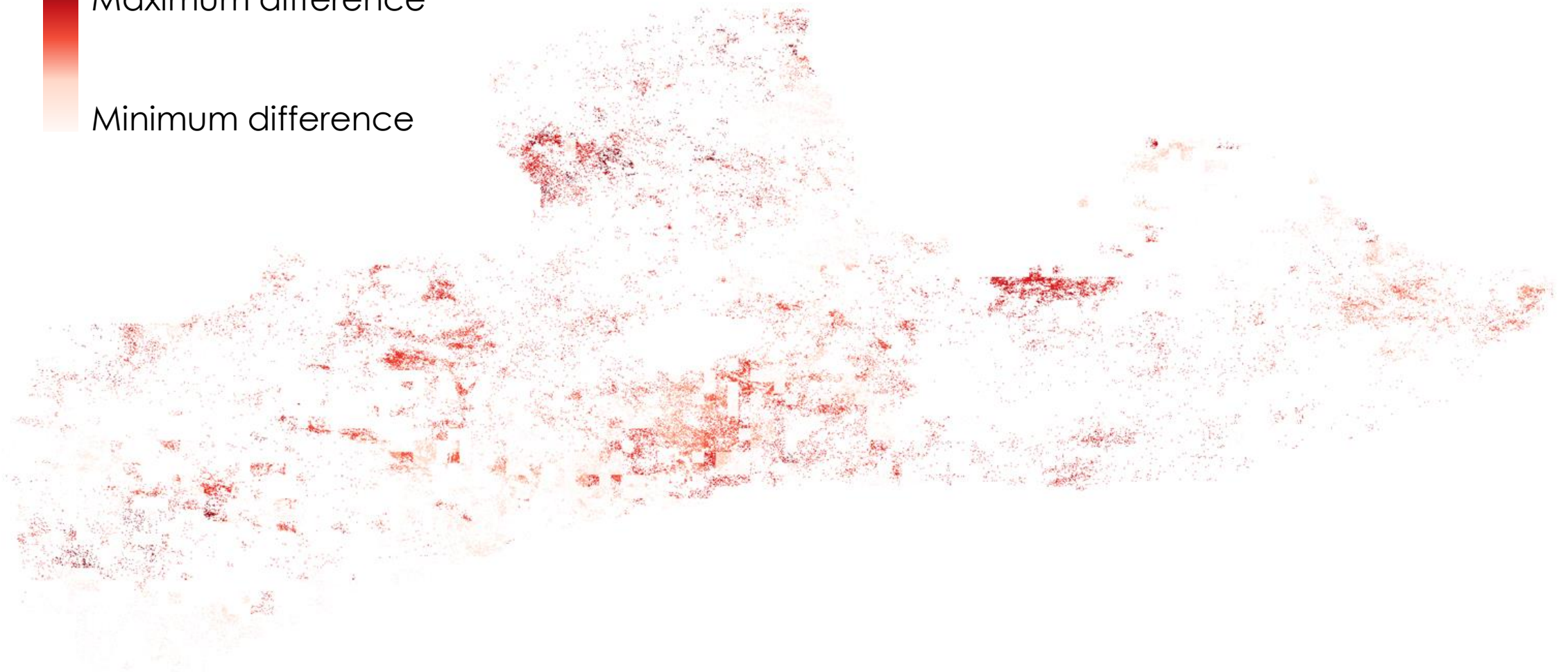
Minimum difference

Dry year (2019)

Combined modeling & monitoring

Grazing difference **on degraded pixels**
(Cumulative live biomass)

Maximum difference

Minimum difference

How can we improve monitoring design?

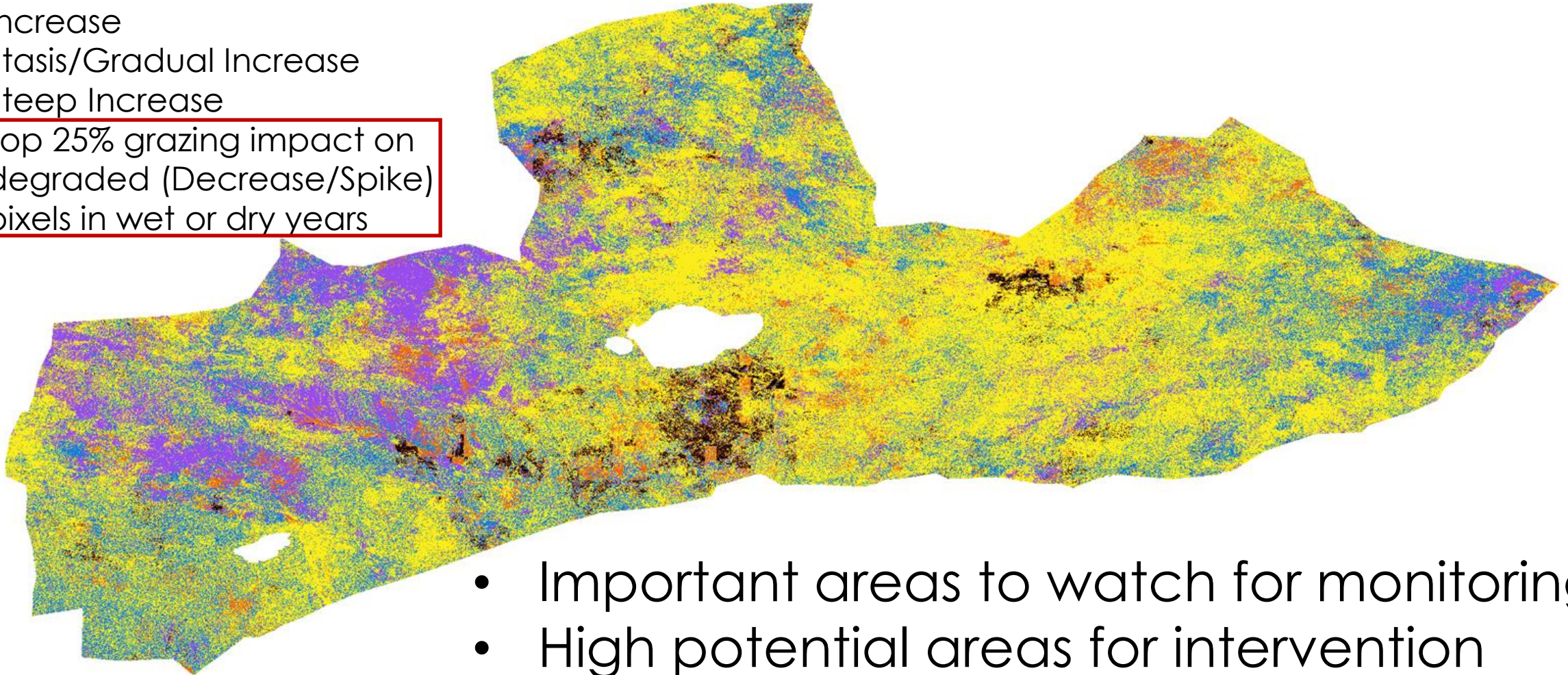**LandTrendr Clusters**
(Landsat past 10 years)

- Decrease/Spike
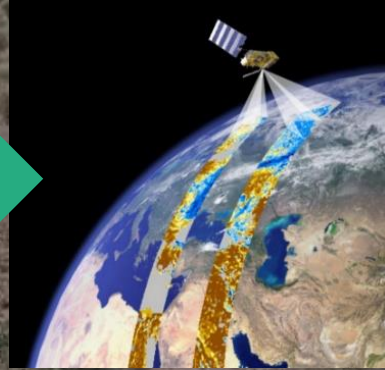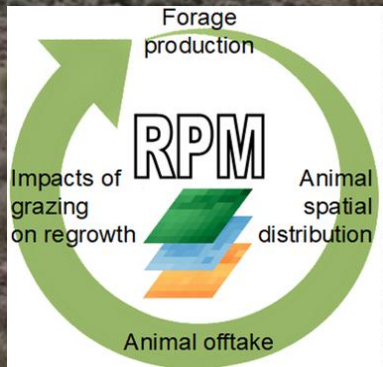- Increase
- Stasis/Gradual Increase
- Steep Increase
- Top 25% grazing impact on degraded (Decrease/Spike) pixels in wet or dry years

- Important areas to watch for monitoring
- High potential areas for intervention

Scaling up regenerative grazing through combined modeling & monitoring

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@beckyck @natcapproject

Where should field resources be deployed?

How should herd size be adapted to changing conditions?

What are the risks of different management strategies and how can they be managed?

The Good Growth Company

"Putting regeneration at the center of business, using the best available science to define regeneration"