Asian Elephant Range Shifts and Connectivity Under Climate Change

Shermin de Silva
University of California San Diego | Trunks & Leaves Inc.

Migratory Species and Climate Change Expert Workshop
February 2025

NATURE AND ENVIRONMENT | CHINA

Chinese elephants' epic expedition ending?

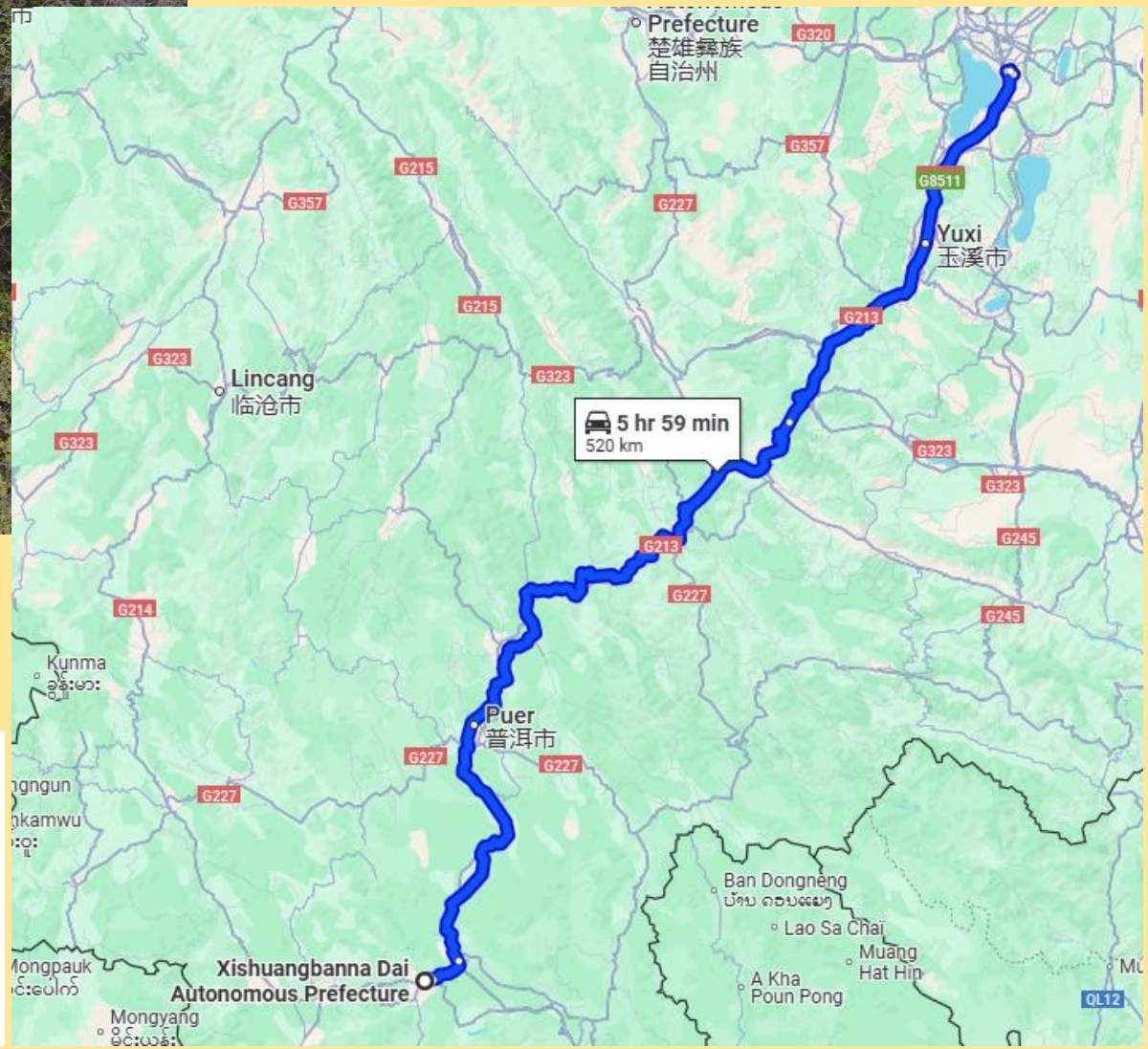
08/10/2021

A hefty headache for authorities

The more than year-long journey has presented a rather large challenge for authorities.

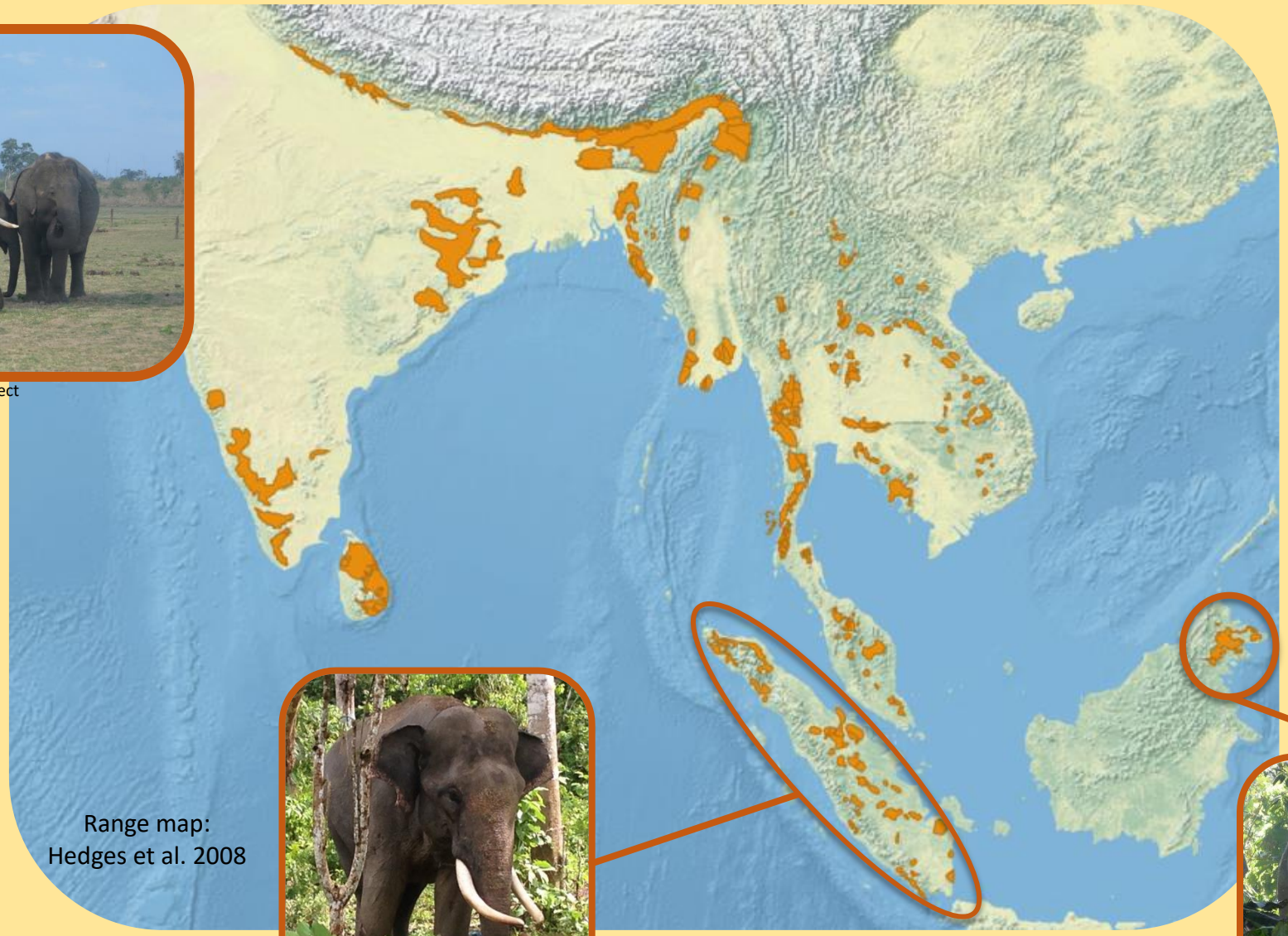
An emergency committee had to be established to ensure the elephants took the right route.

More than 25,000 police and other staff along with 1,500 emergency vehicles were deployed to ensure public safety. They tracked and made sure the animals were fed so as not to bring them into human settlements in search of food, which didn't always go according to plan.



Extant elephant range and populations.

Udawalawe Elephant Research Project



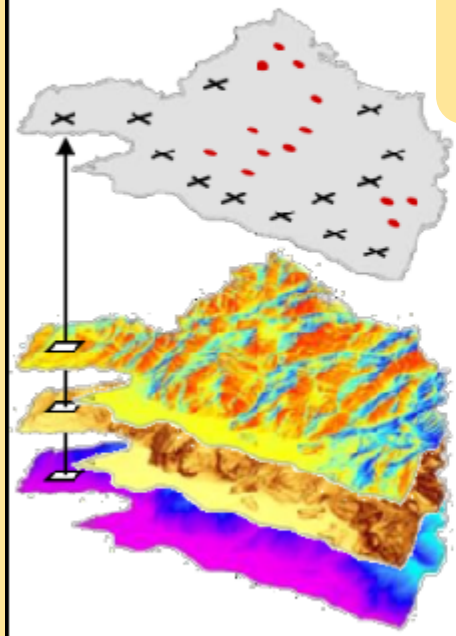
Range map:
Hedges et al. 2008

National Park Service / M. Flora

S. de Silva

Elephant Landscapes: Ecological Niche Modelling (aka Species Distribution Modelling)

Datasets



Presence (and absence) data

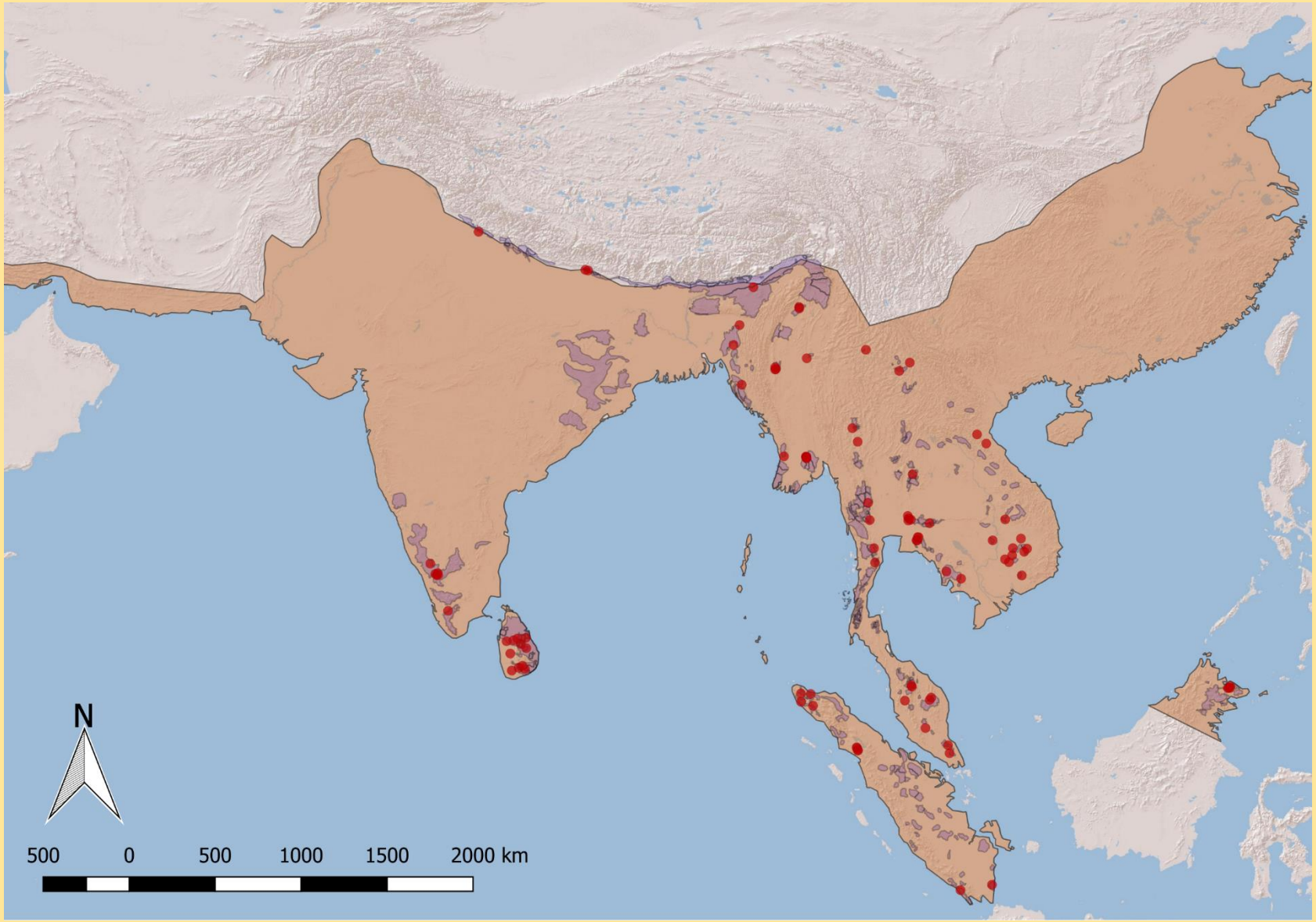
Spatial covariate layers (predictors)

Statistical / Machine learning model.

Maximum Entropy (MAXENT)

Figure modified from: Evans, M, 2016. “Species distribution modelling of the Glossy Black Cockatoo in Queensland’s Condamine region.”

Elephant Landscapes



Historic outline: Olivier 1978, *Oryx*; Rangemap: Hedges et al. 2008, USFWS

de Silva et. al, *in review*

Predictors: The Land-Use Harmonization dataset

Hurtt, Chini, Fockling, & Sahajpal,
University of Maryland

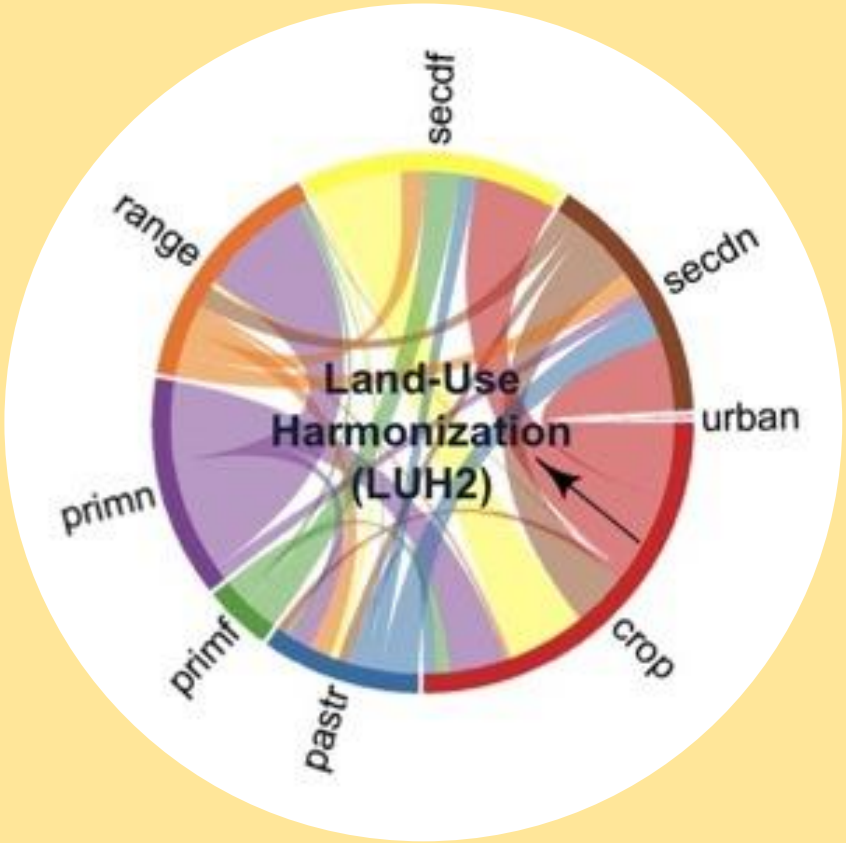


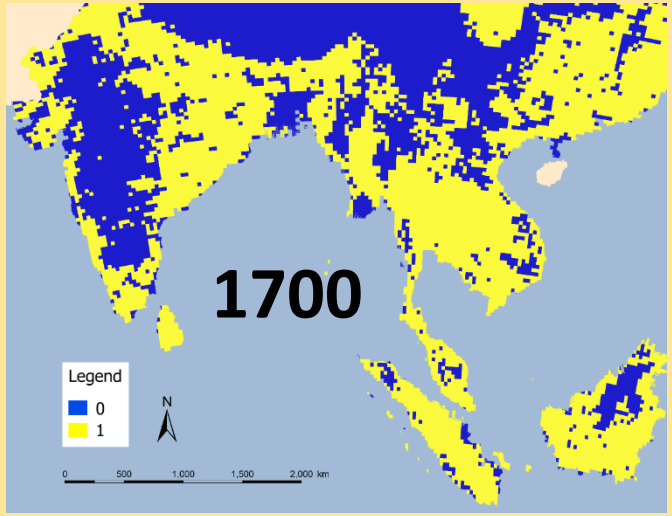
Figure: Hurtt et al., Land Use Harmonization (umd.edu)

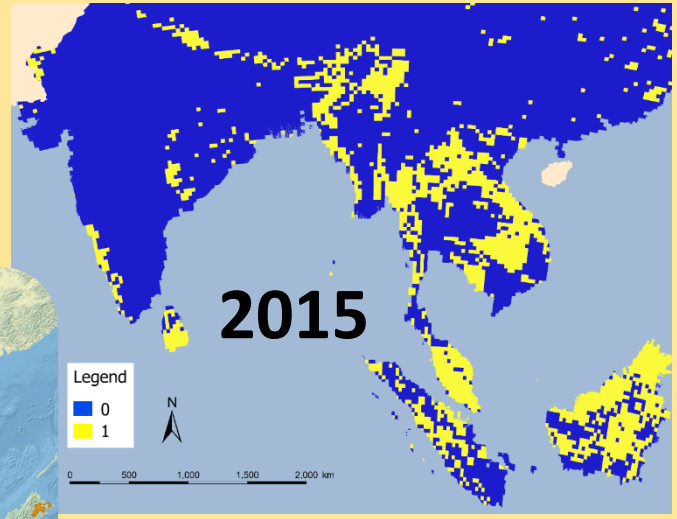
- Models historical land-use transitions GLOBALLY for the period **850-2015**.
- Models possible future land-use patterns from **2015-2100** under 6 scenarios (more on that later).
- 46 variables, including land-use types and management (e.g. irrigation). **We used 20 of these for years, plus elevation.**
- Allows us to link past and future with a consistent set of variables, long timescales.
- Relates impact of land-use & socioeconomic changes, rather just climatic variables.

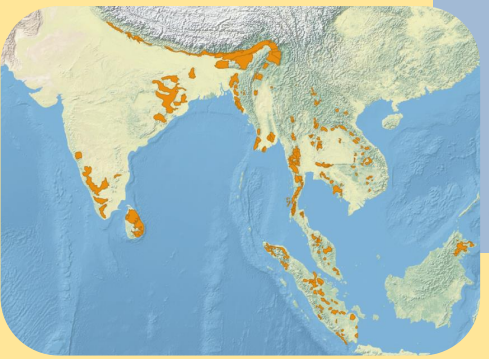
Elephant Landscapes: Historical change

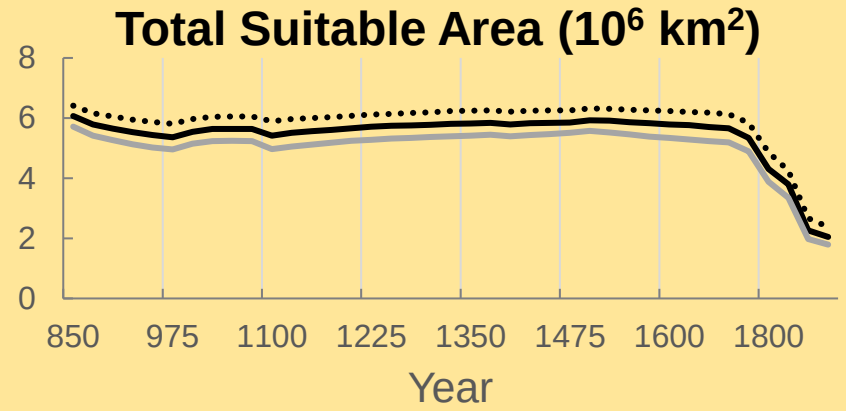
Change in suitable habitat, 850–2015

Yellow: Suitable
Blue: Unsuitable

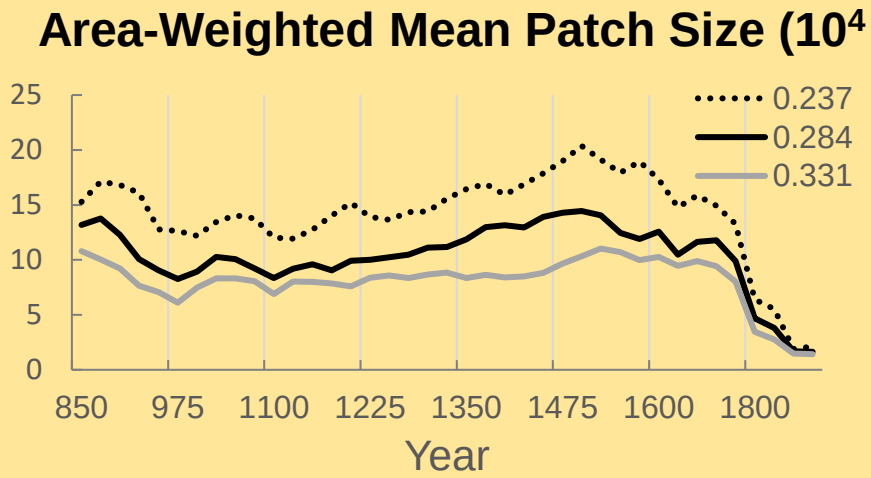




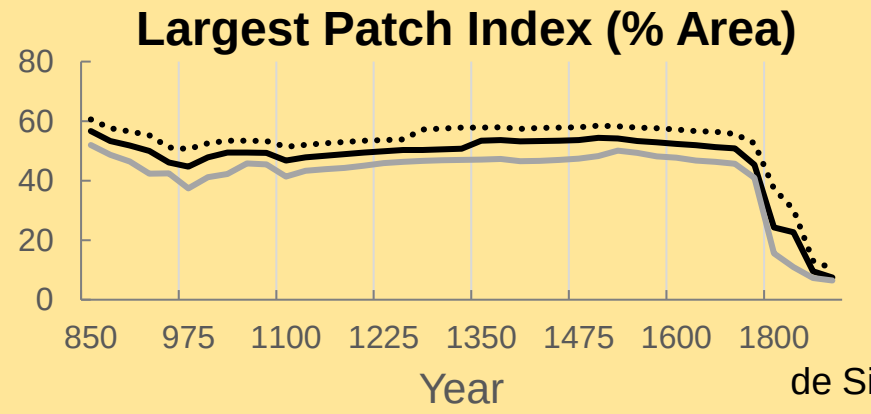




Area loss >60%



Average Patch size decreased 83%



Largest patch size decreased 83%

de Silva et. al, *2023 Scientific Reports*

Scenario Description
RCP 2.6 / SSP 1: Sustainable development; low inequality
RCP 3.4 / SSP 4: Deep inequalities; low-carbon tech in developed countries, traditional biofuels in others.
RCP 4.5 / SSP 2: Intermediate in terms of inequality, population growth, energy tech, institutional strength.
RCP 6 / SSP 4: A higher-emissions alternative to scenario 3.4/4.
RCP 7 / SSP 3: High inequality, population growth, slow energy tech, weak institutions.
RCP 8.5 / SSP 5: Fossil fuel-driven, but stronger institutions and more equitable.

de Silva et. al, *in prep*

Elephant Landscapes: Future predictions

RCP/SSP	Change in suitable area within current range (%)	Change suitable area outside current range (%)	Change in total suitable area (%)
2.6/1	-39.22	-21.84	-24.24
3.4/4	-89.54	-82.26	-83.26
4.5/2	-31.08	-9.3	-12.3
6.0/4	-36.03	-16.61	-19.29
7.0/3	-32.01	-9.75	-12.82
8.5/5	-46.03	-18.64	-22.41

Similar

de Silva et. al, *in prep*

Elephant Landscapes: Future predictions

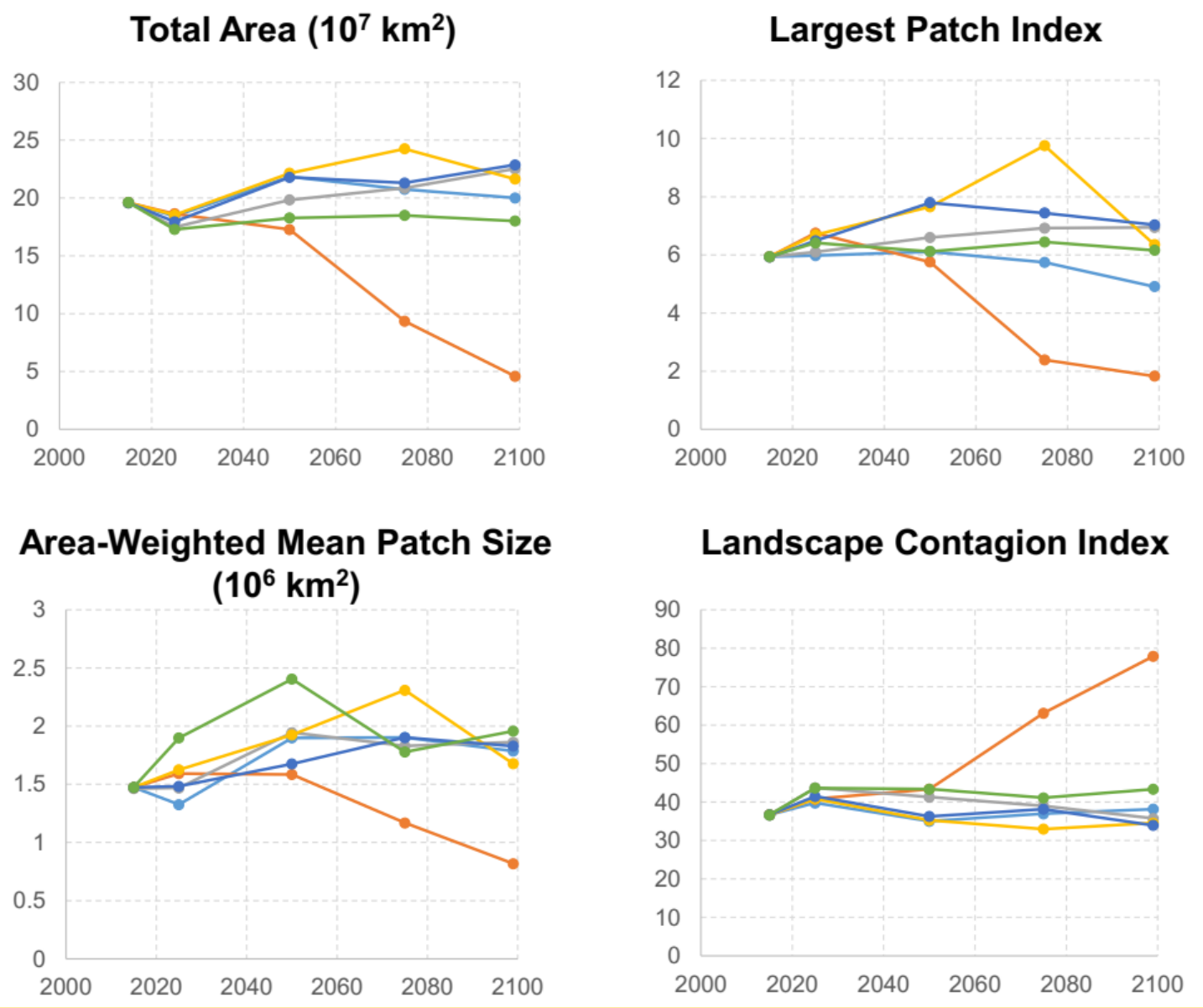
RCP/SSP	Change in suitable area within current range (%)	Change suitable area outside current range (%)	Change in total suitable area (%)
2.6/1	-39.22	-21.84	-24.24
3.4/4	-89.54	-82.26	-83.26
4.5/2	-31.08	-9.3	-12.3
6.0/4	-36.03	-16.61	-19.29
7.0/3	-32.01	-9.75	-12.82
8.5/5	-46.03	-18.64	-22.41

← Worst

← Better

de Silva et. al, *in prep*

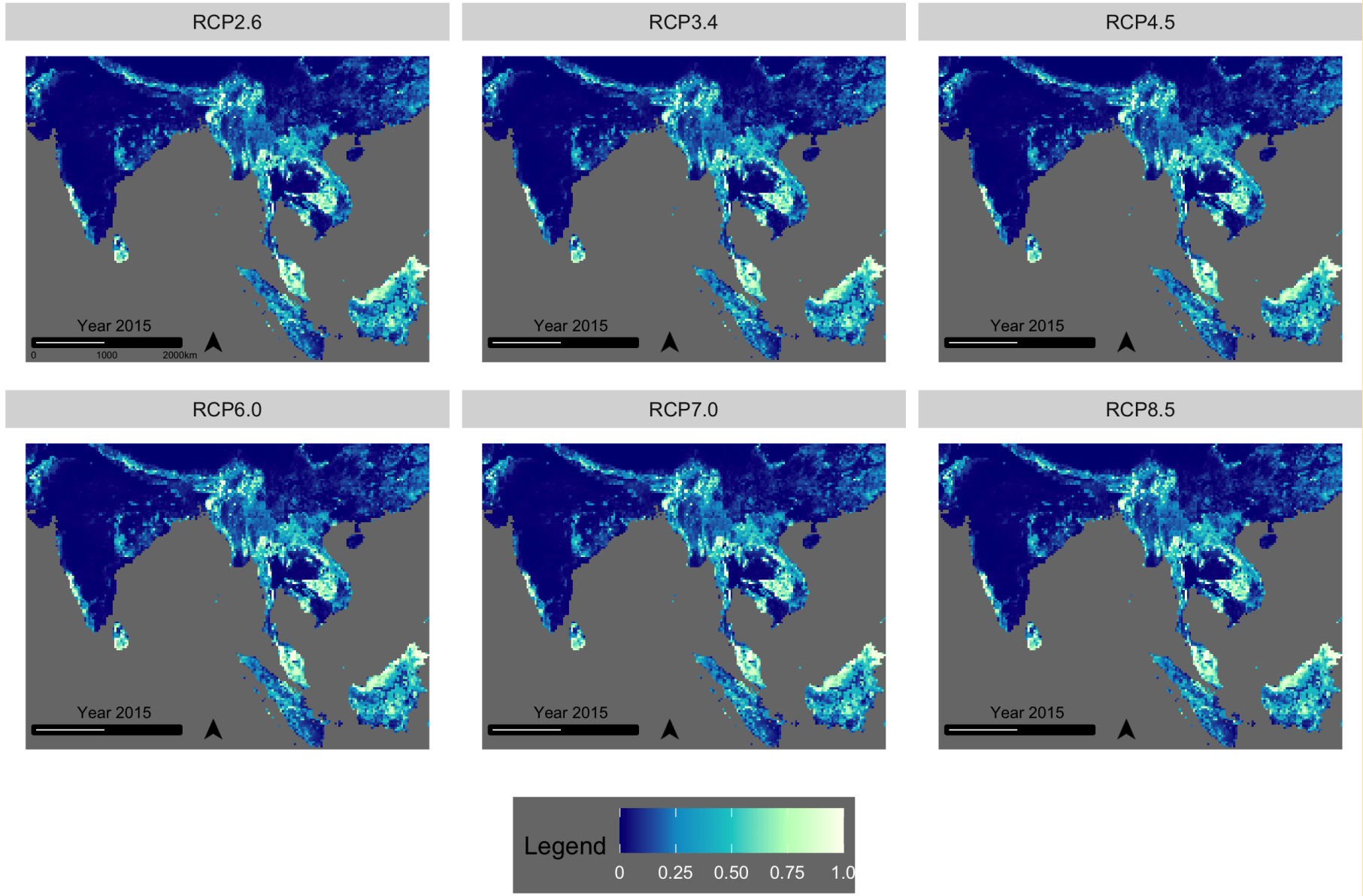
Elephant Landscapes: Future predictions



- Most are similar
- Lower emissions outcome not necessarily better for these habitats
- Socioeconomic pathway matters.

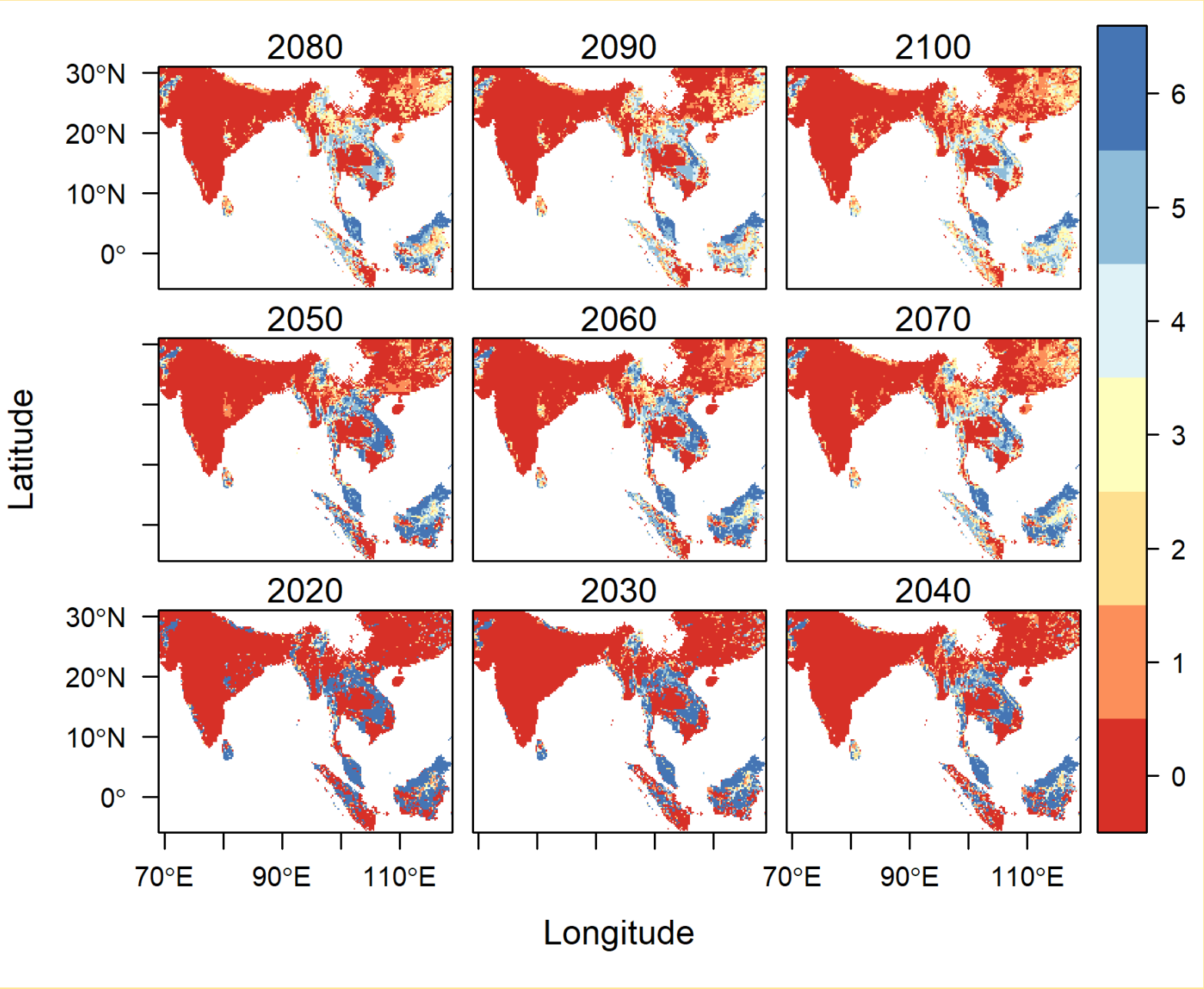
de Silva et. al, *in prep*

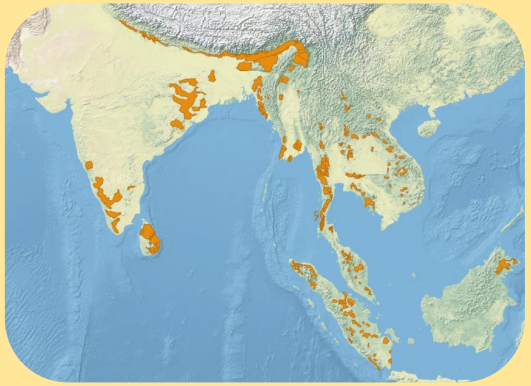
Elephant Landscapes: Future predictions



de Silva et. al, *in prep*

Elephant Landscapes: Future predictions





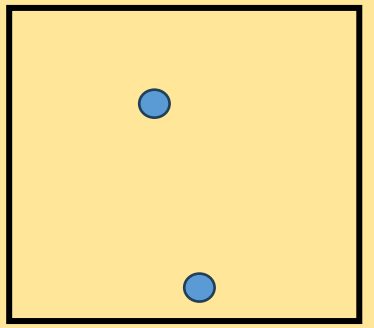
Overlap between different scenarios where 0 = not suitable in any scenario and 6 = suitable in all six.

What is the connectivity between CURRENT range and FUTURE suitable habitat?

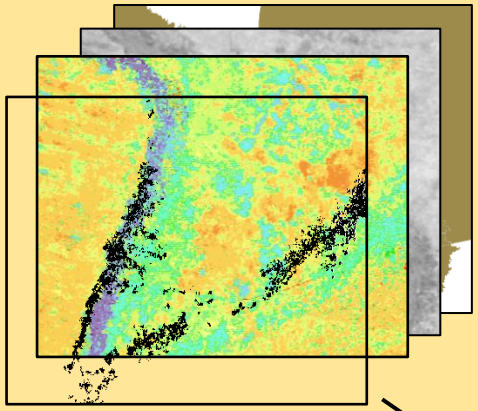
de Silva et. al, *in prep*

Common Connectivity Modeling Workflow

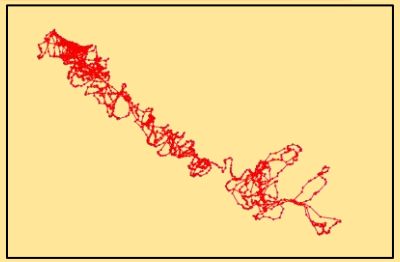
Source and destination nodes



Landscape attributes



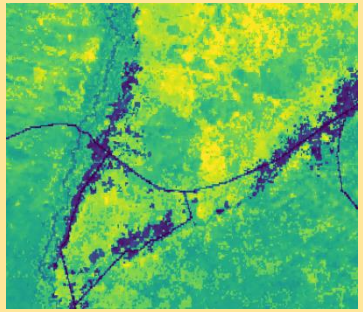
Animal Data



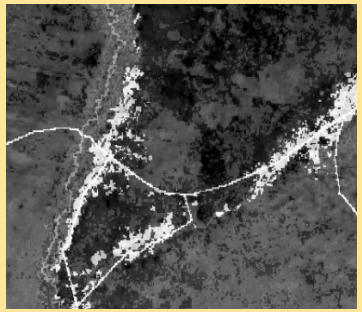
movement/ occurrence

Model

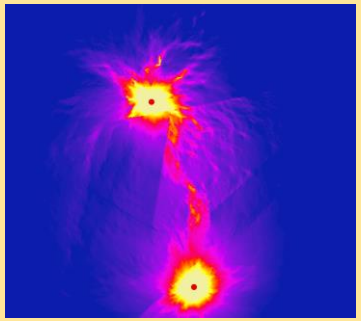
Habitat suitability



Resistance to movement



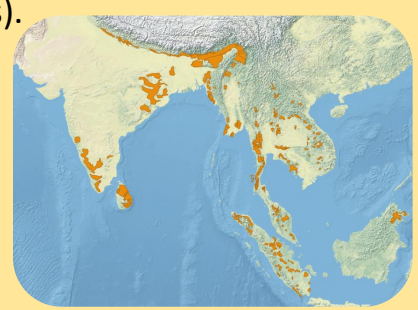
Connectivity model



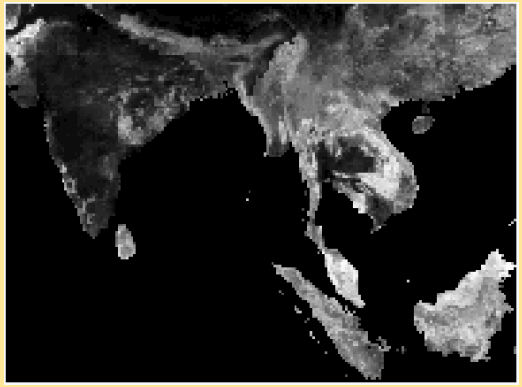
Common Connectivity Modeling Workflow

Angela Brennan
(Conservation Science Partners Inc.
/ Save The Elephants)

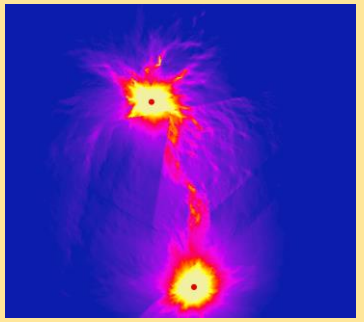
SOURCE/DESTINATION:
Current elephant range (all possible pairings).



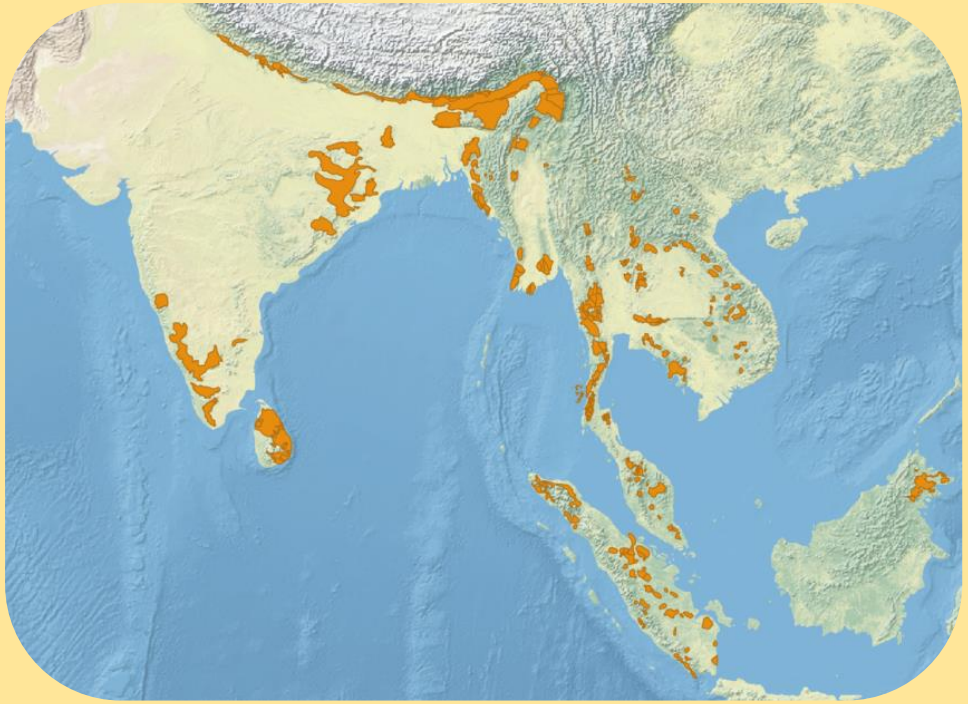
Resistance to movement every 5 years from 2020-2100 (average suitability across all 6 scenarios); Masked out elevations >1600m.



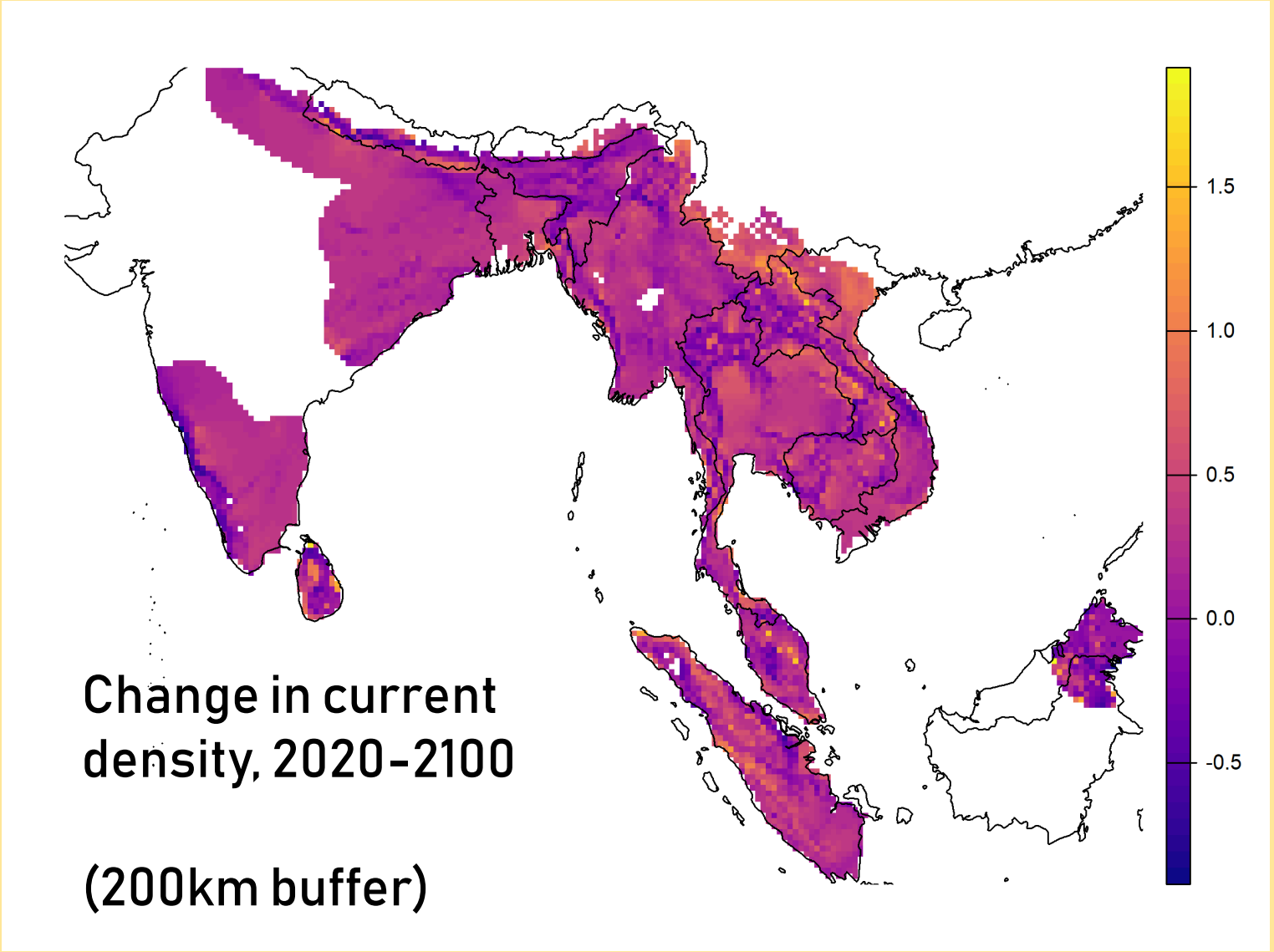
Connectivity model



Elephant Landscapes: Future predictions



What is the overlap with human populations?



Change in current density, 2020-2100

(200km buffer)

Elephant Landscapes: Future predictions

Human population projections:

Jones, B., O'Neill, B.C., 2016. Spatially explicit global population scenarios consistent with the Shared Socioeconomic Pathways. Environmental Research Letters 11, 84003. DOI:10.1088/1748-9326/11/8/084003.

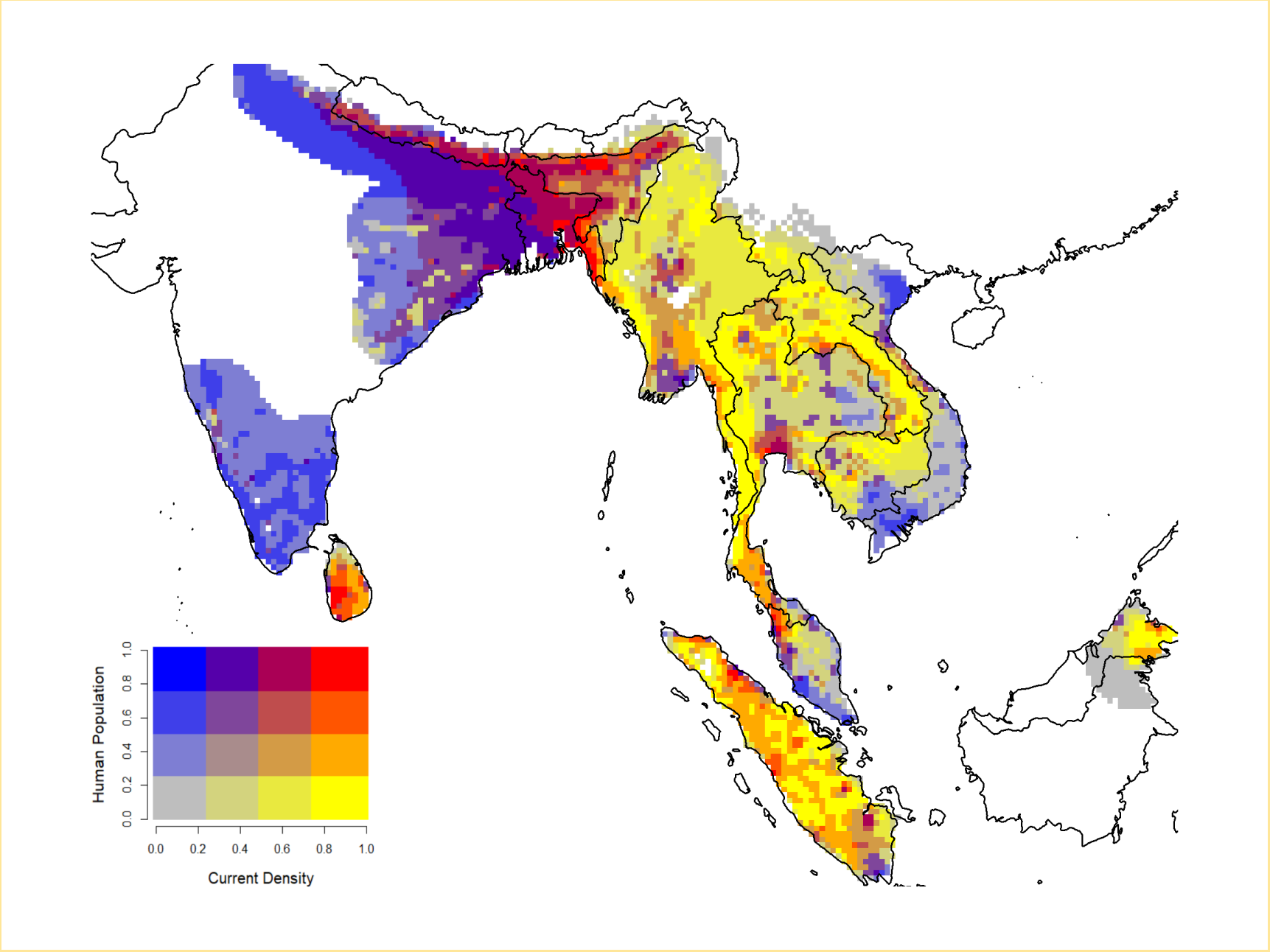
https://www.cgd.ucar.edu/sections/iam/modeling/spatial-population

Prediction for 2100

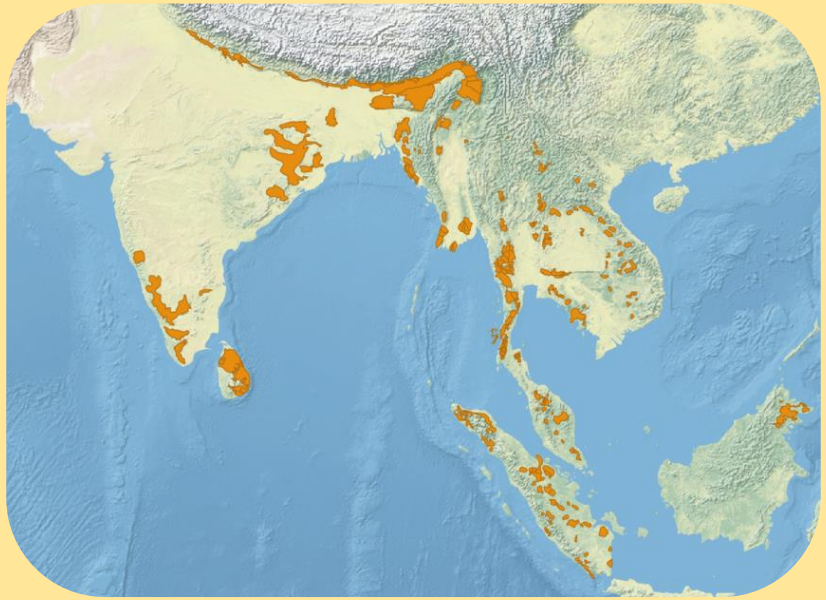
Connectivity predictions:

Current density in 2100

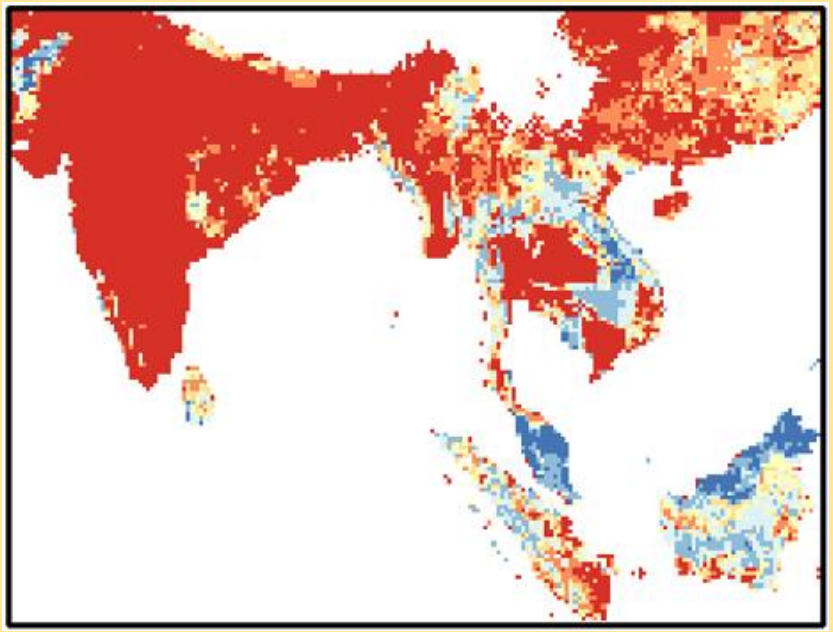
Elephant Landscapes: Future predictions



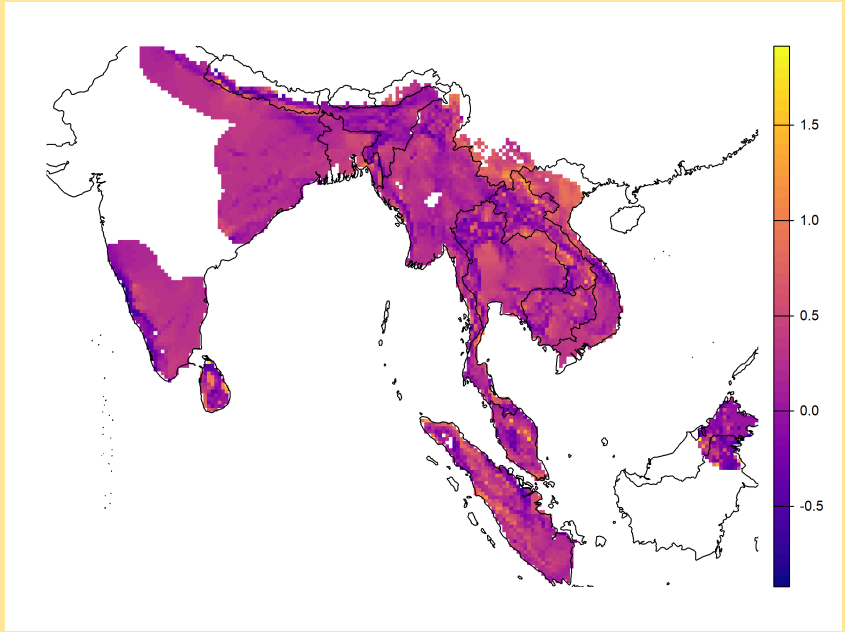
Elephant Landscapes: Future predictions



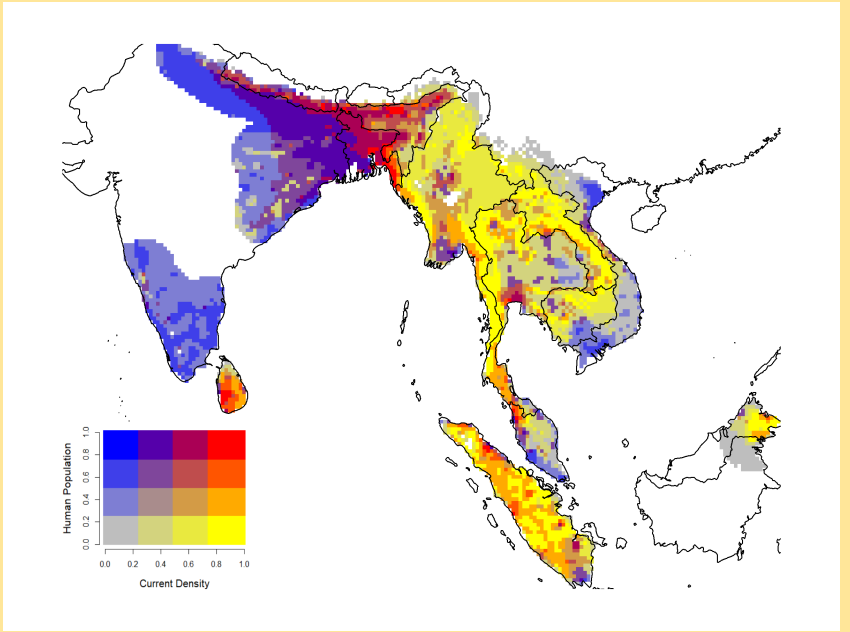
Where elephants are.



Where they need to be.



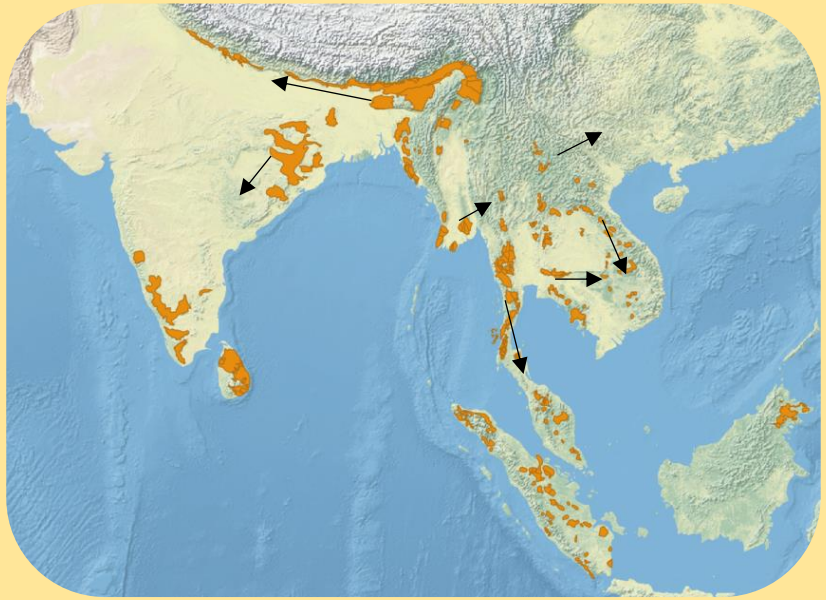
How can they get there?



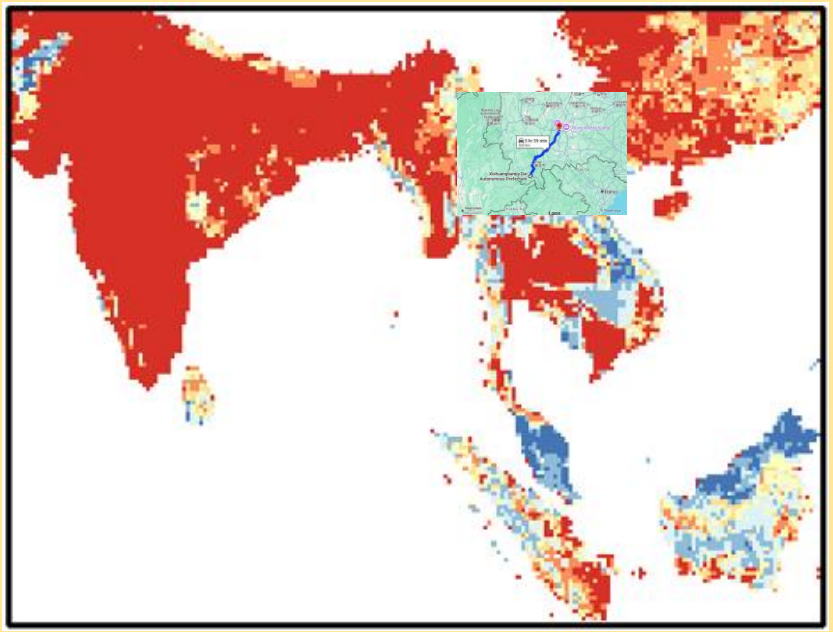
Where will they encounter people?

Elephant Landscapes: Future predictions

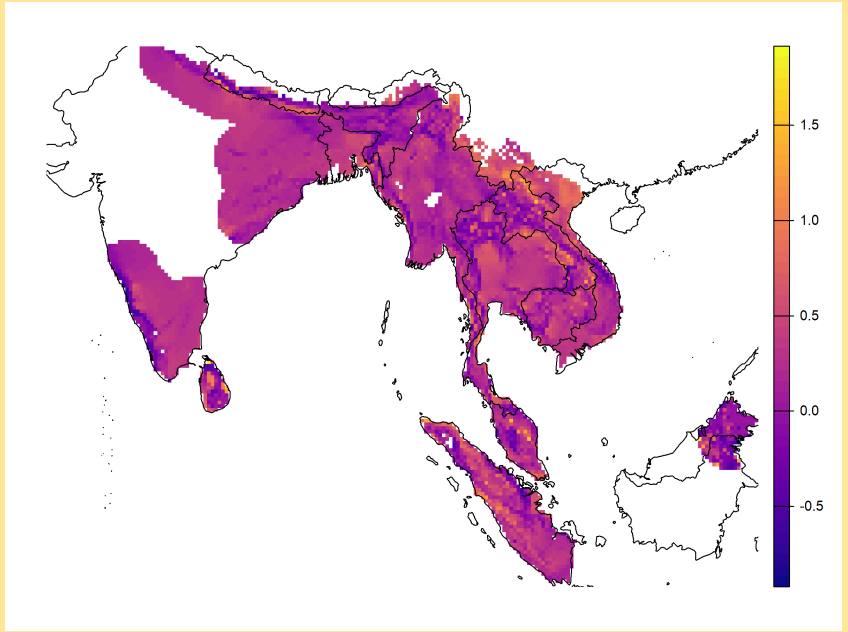
Technical challenge:
We still can't predict where populations might actually go – ESPECIALLY those that seem stuck.



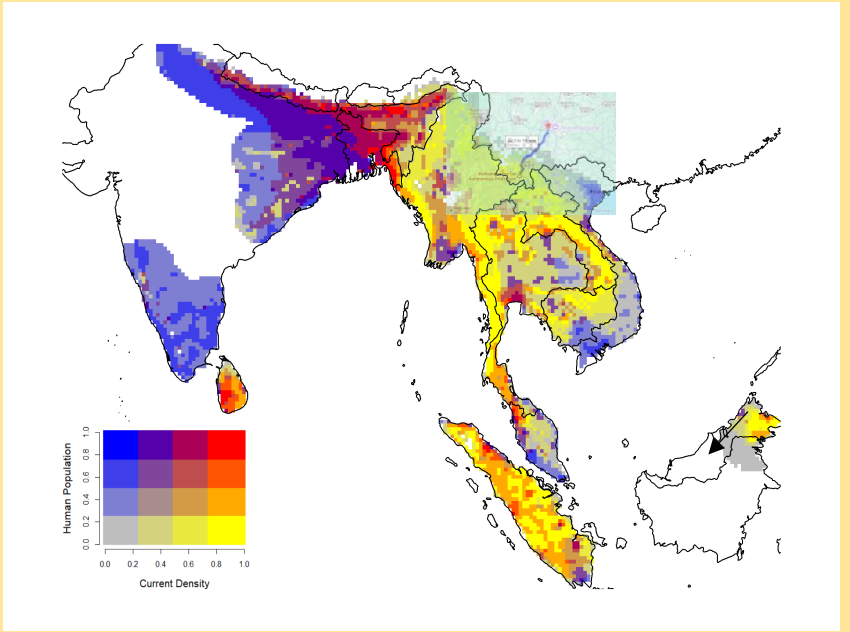
Where elephants are.



Where they need to be.



How can they get there?



Where will they encounter people?

Acknowledgements

Students

Tiffany Wu – Colby College (now at Montgomery Parks)
Josiah Johnson – Colby College (now at University of Georgia)
Alison Thieme – Former Smithsonian intern (now at Sustainable Agricultural Systems Lab)
Ashley Weaver – Colby College

Collaborators

Philip Nyhus – Colby College
Peter Leimgruber – Smithsonian Conservation Biology Institute
Angela Brennan – Conservation Science Partners