Modelling distribution impact in relation to agricultural biodiversity

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Contents

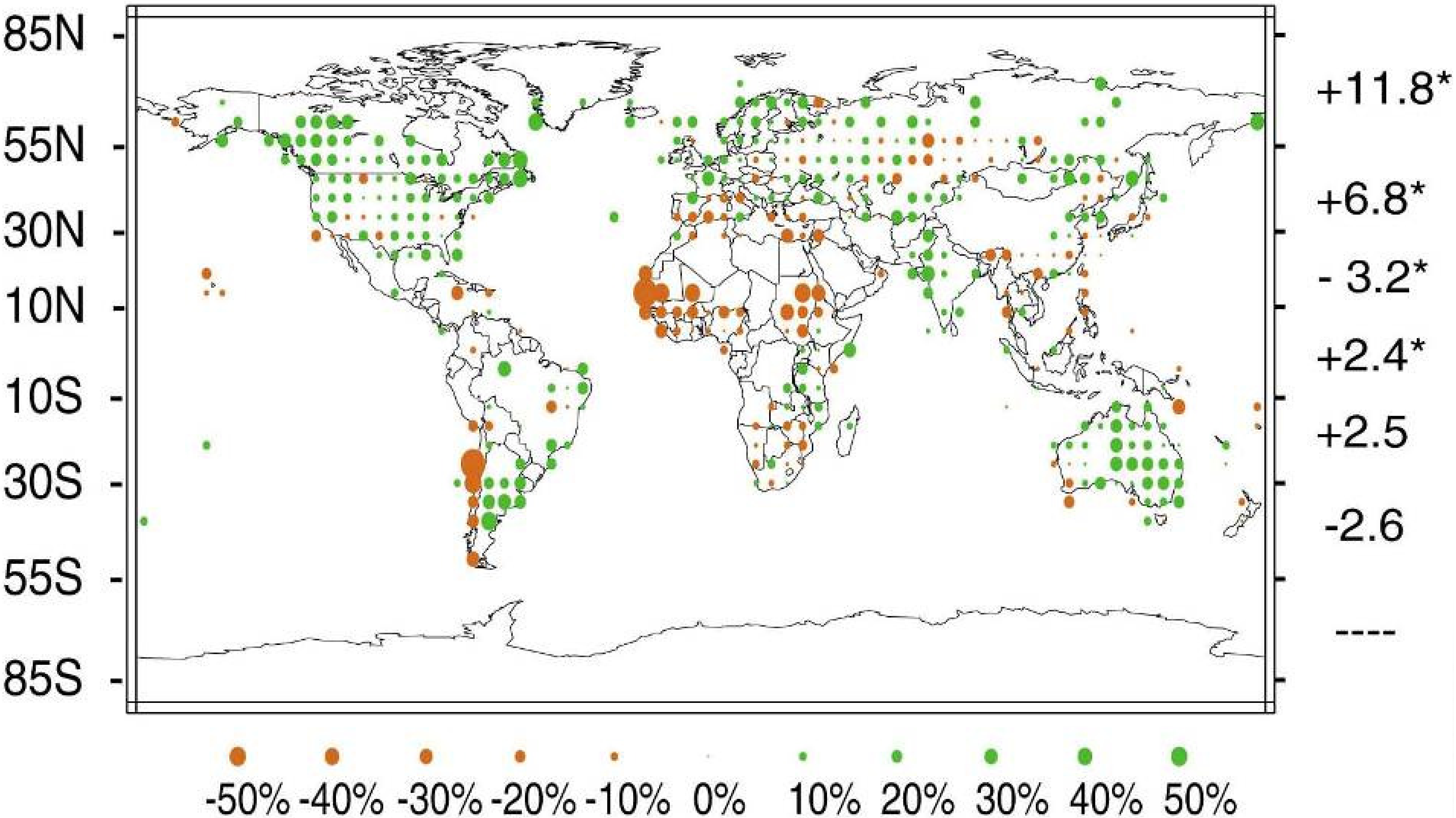
- What exactly is the issue of climate change for agriculture?
- Changes in distribution of wild relatives
- Impacts of forestry
- Changes in distribution of crops
- Opportunities from climate change

RECAP – JUST WHAT IS CLIMATE CHANGE IN THIS CONTEXT

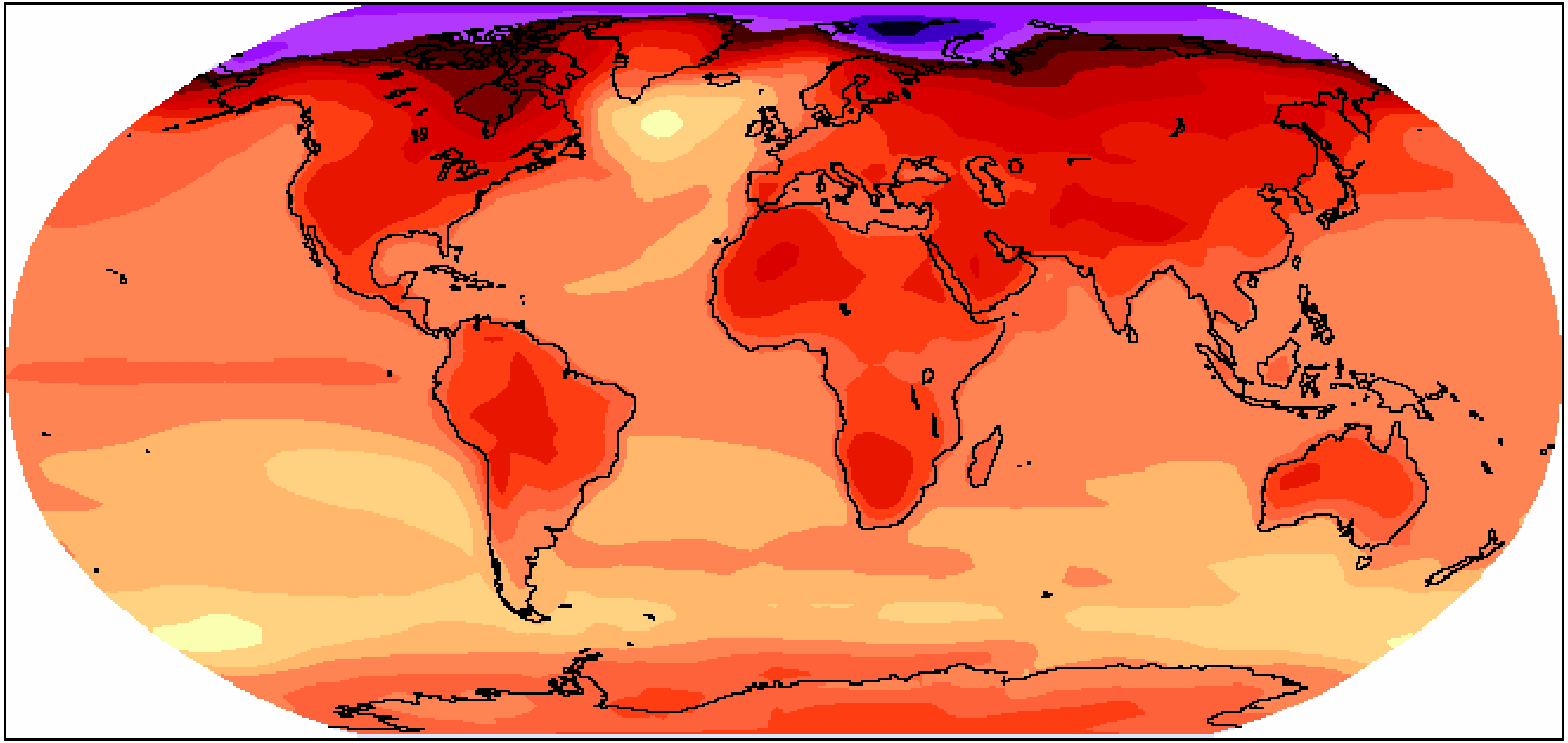
Drought Resistant Beans

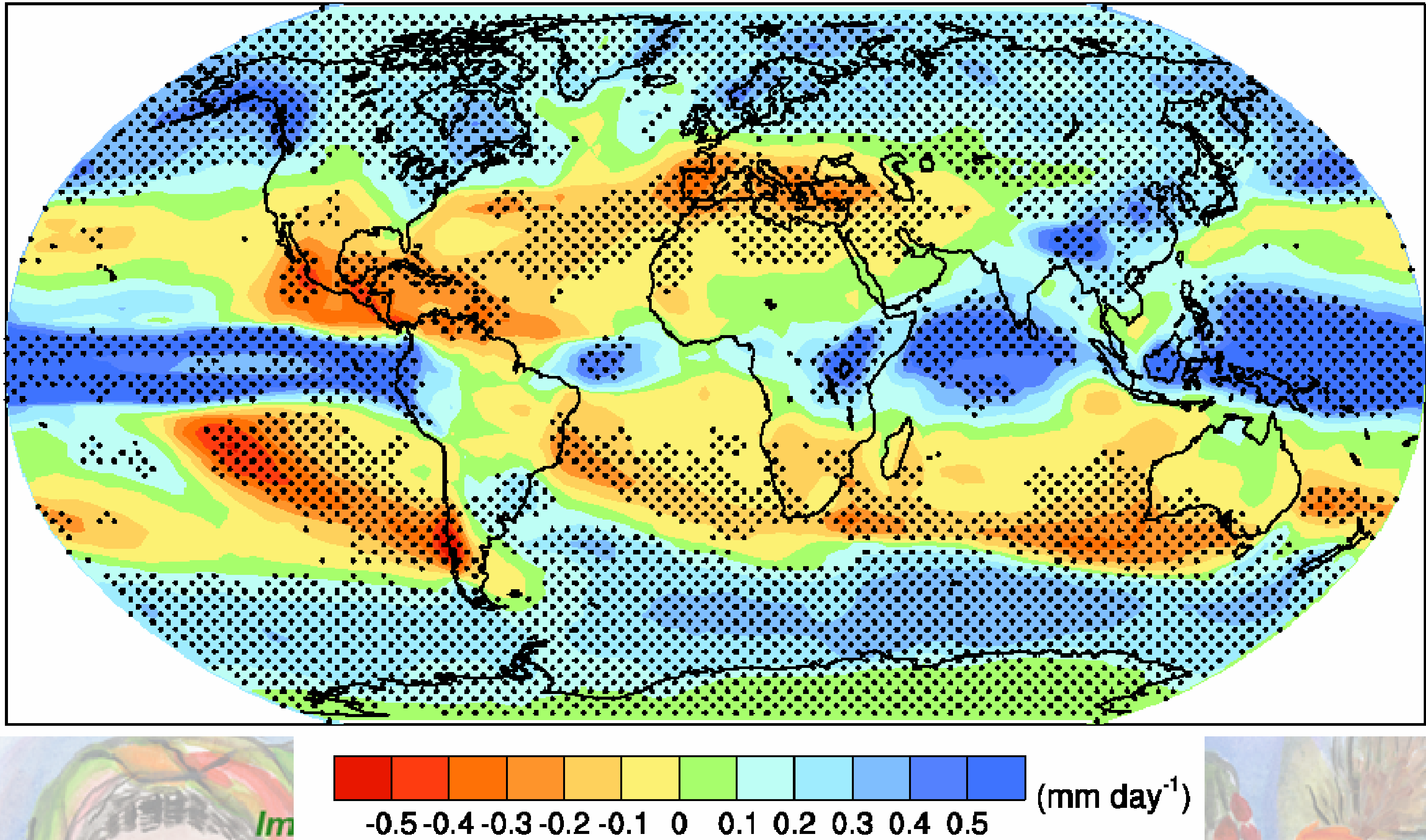
Trend (%/century) in Annual Precipitation

1900 - 1999

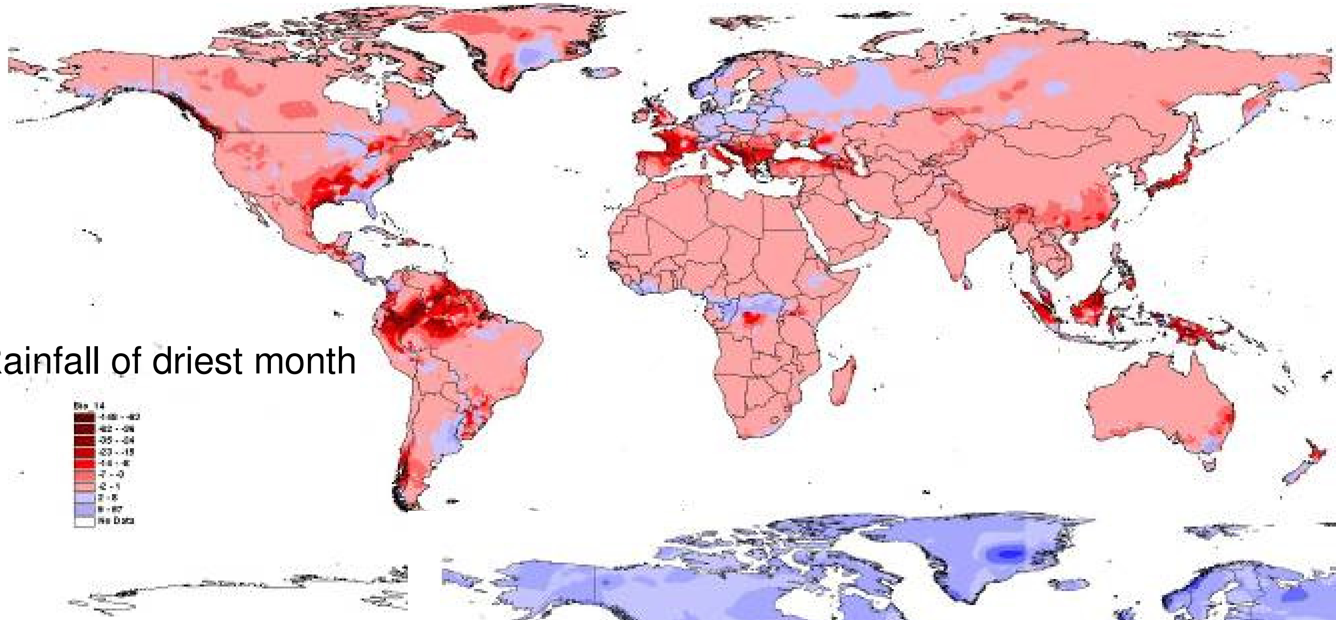


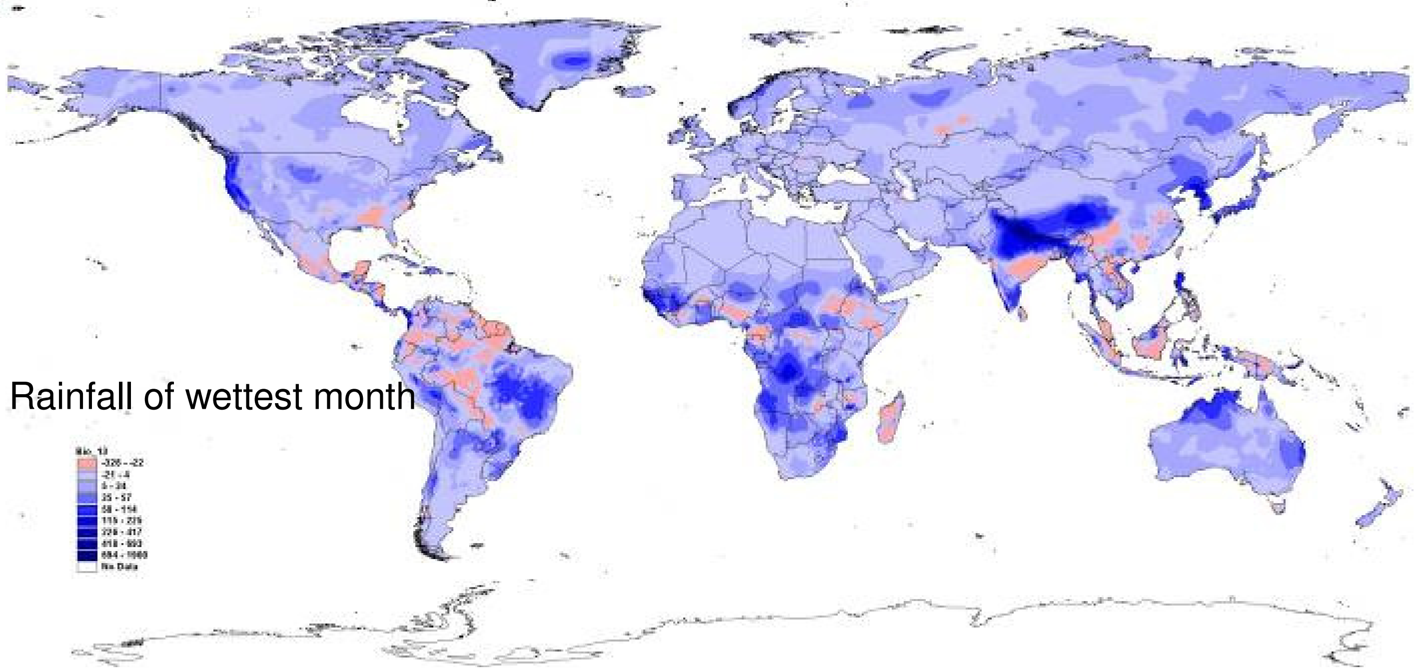
What do the 21 models say?




-0.5 -0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4 0.5
(mm day^{-1})

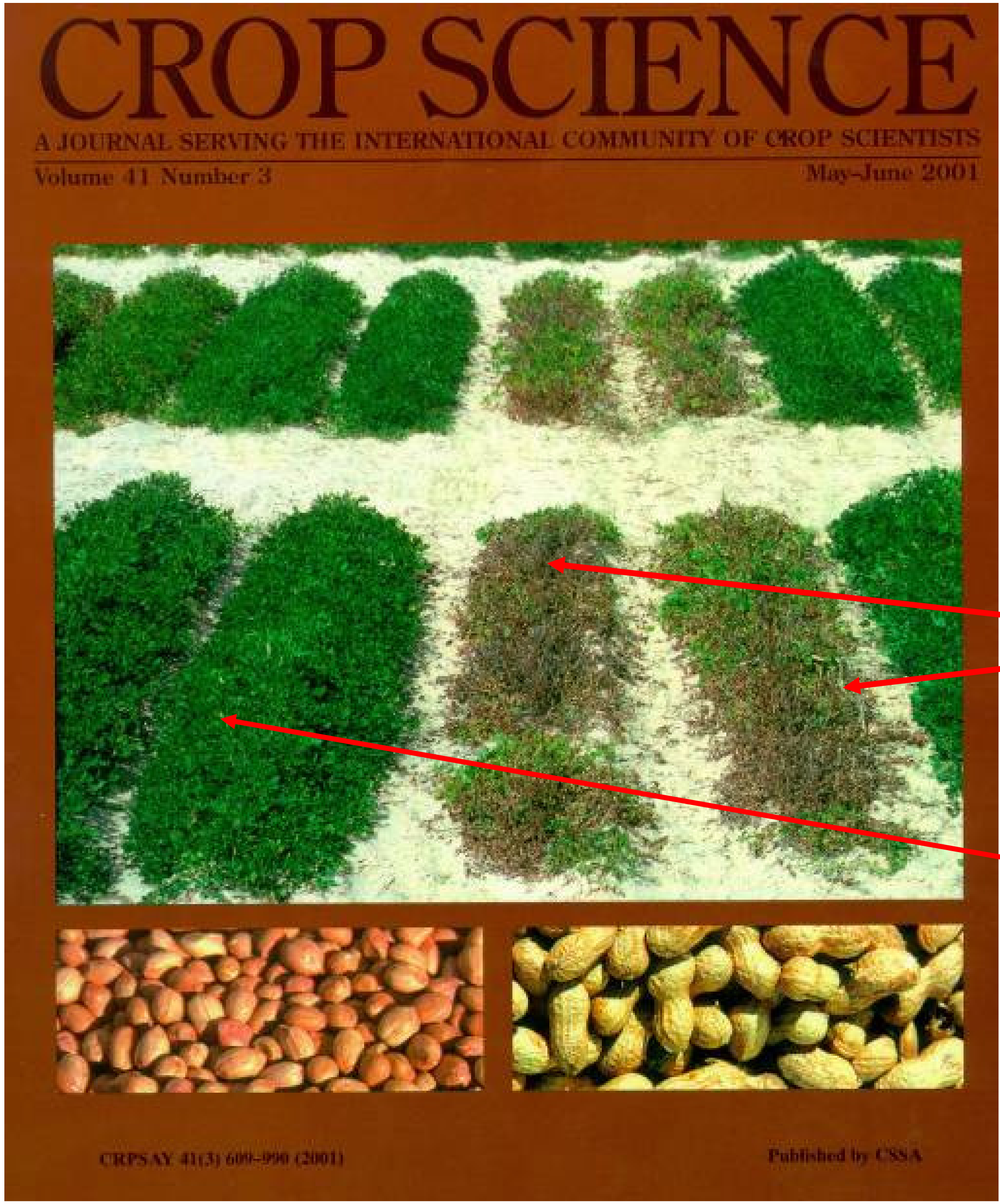
Wet season wetter, dry season drier





IMPACTS ON WILD RELATIVES

Impact of Climate Change – Biodiversity and Food Security



Wild relative species

A. batizocoi - 12 germplasm accessions

A. cardenasii - 17 germplasm accessions

A. diogoi - 5 germplasm accessions

Florunner, with no root-knot nematode resistance

COAN, with population density of root-knot nematodes >90% less than in Florunner

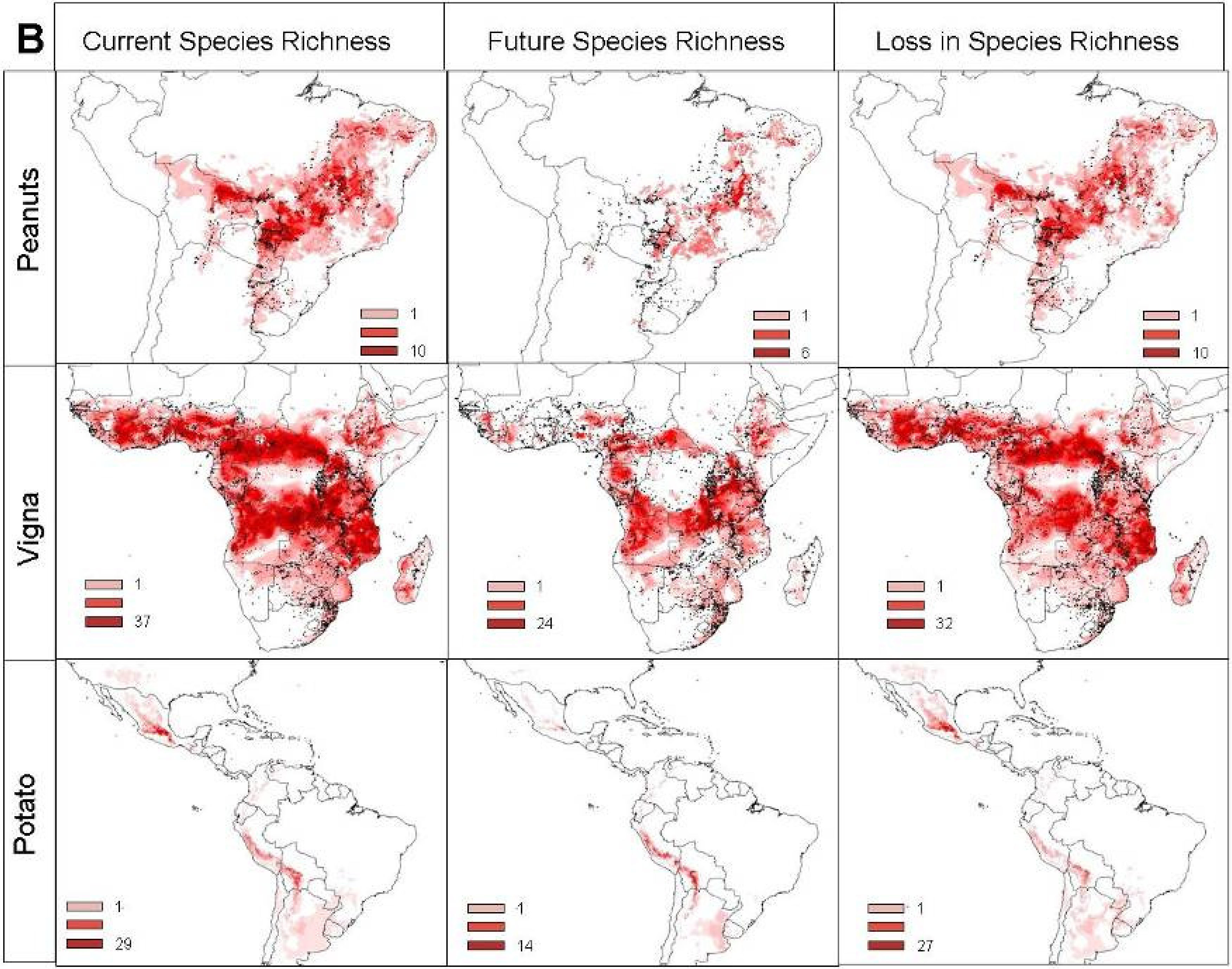
Impact of Climate Change – Wild Peanuts

Species	Change in area of distribution (%)	Predicted state in 2055
batizocoi	-100	Extinct
cardenasii	-100	Extinct
correntina	-100	Extinct
decora	-100	Extinct
diogoi	-100	Extinct
duranensis	-91	Threatened
glandulifera	-17	Stable
helodes	-100	Extinct
hoehnii	-100	Extinct
kempff-mercadoi	-69	Near-Threatened
kuhlmannii	-100	Extinct
magna	-100	Extinct
microsperma	-100	Extinct
palustris	-100	Extinct
praecox	-100	Extinct
stenosperma	-86	Threatened
villosa	-51	Near-Threatened

Impact on PGR

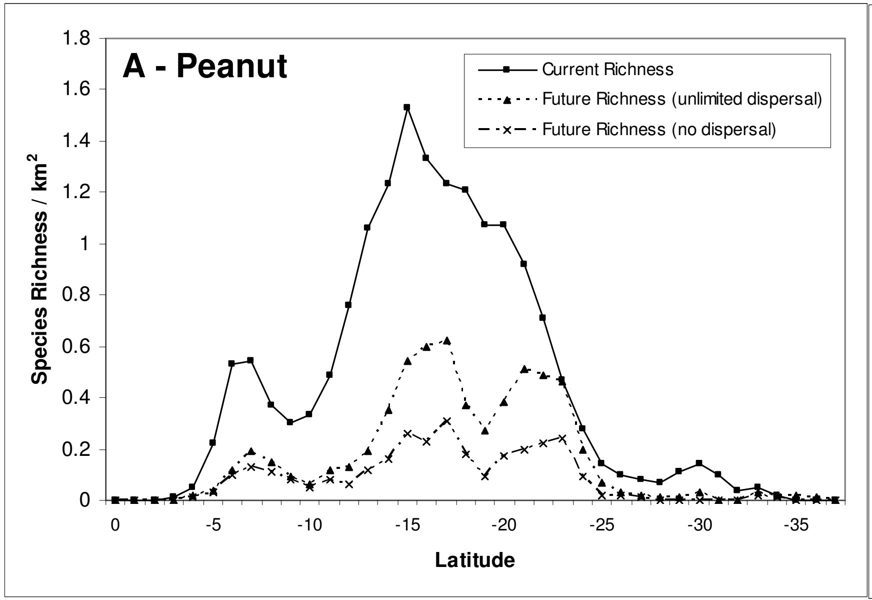
- Assessment of shifts in distribution range under climate change
- Wild potatoes
- Wild African *Vigna*
- Wild peanuts

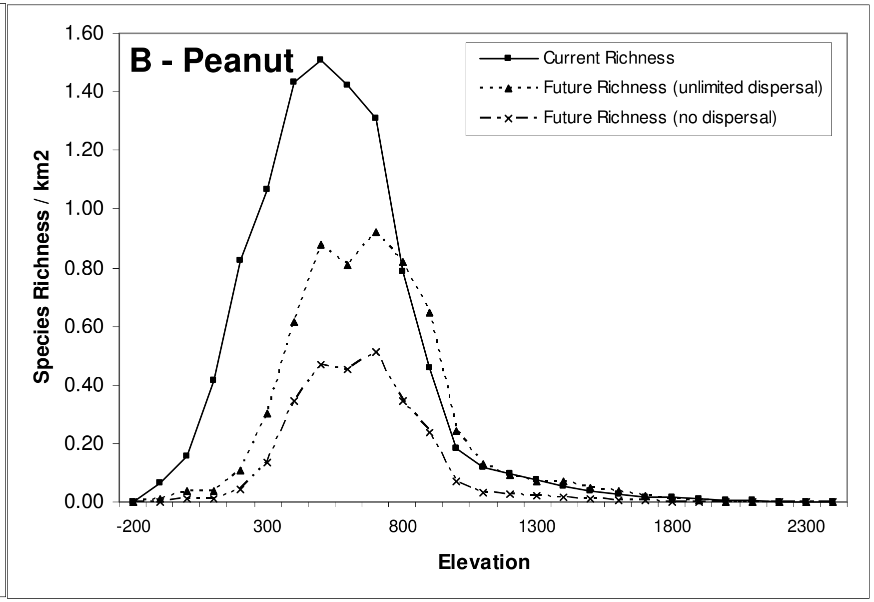
- Why?
  - Mountain species, lowland savannah species, broadly adapted species, Latin America, Africa, available datasets



B
Current Species Richness
Future Species Richness
Loss in Species Richness
Peanuts
1
10
1
6
1
10
Vigna
1
37
1
24
1
32
Potato
1
29
1
14
1
27

Latitudinal and Elevational Shifts

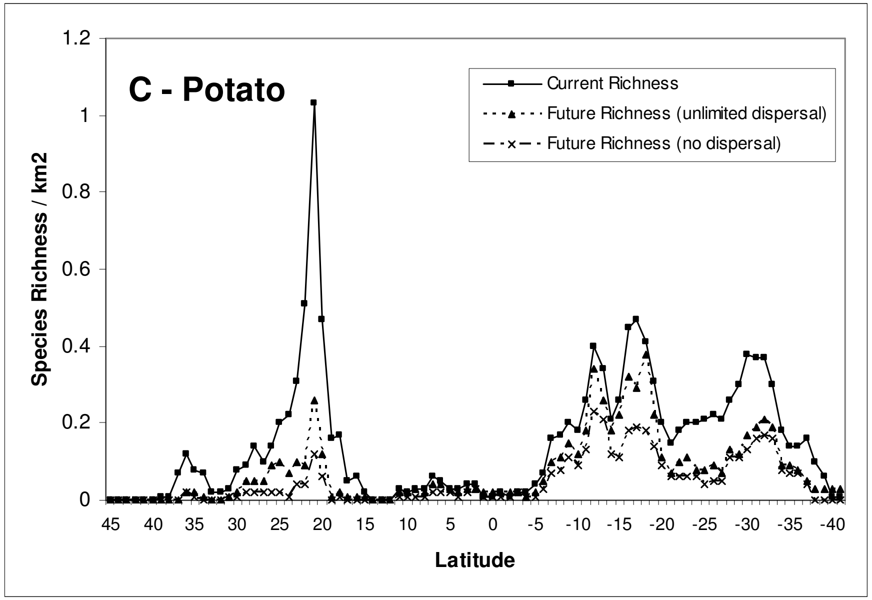


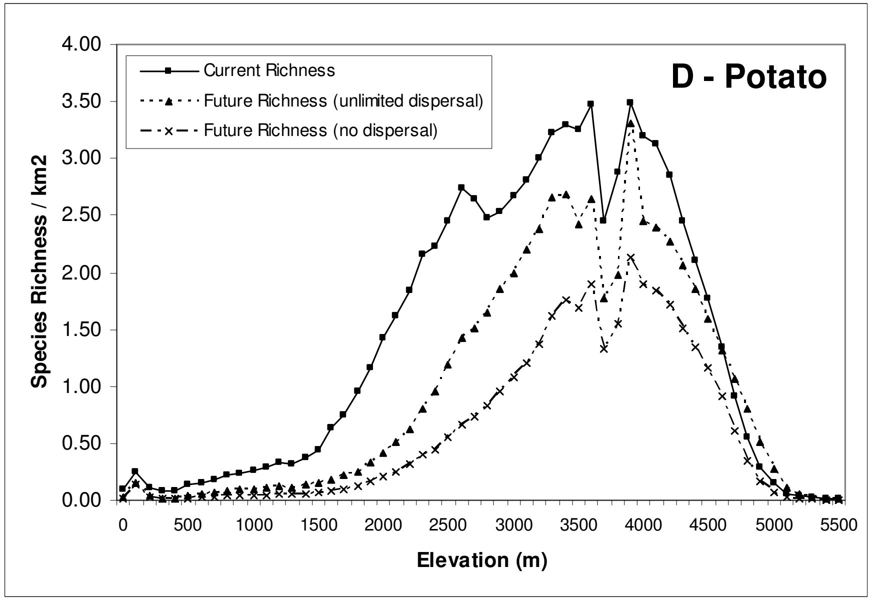


Peanuts

- Shift south and upwards

Latitudinal and Elevational Shifts

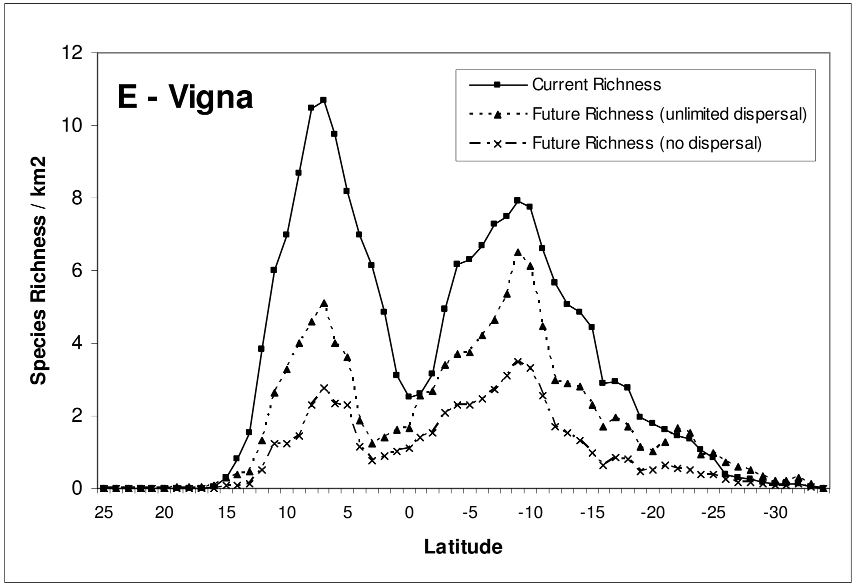


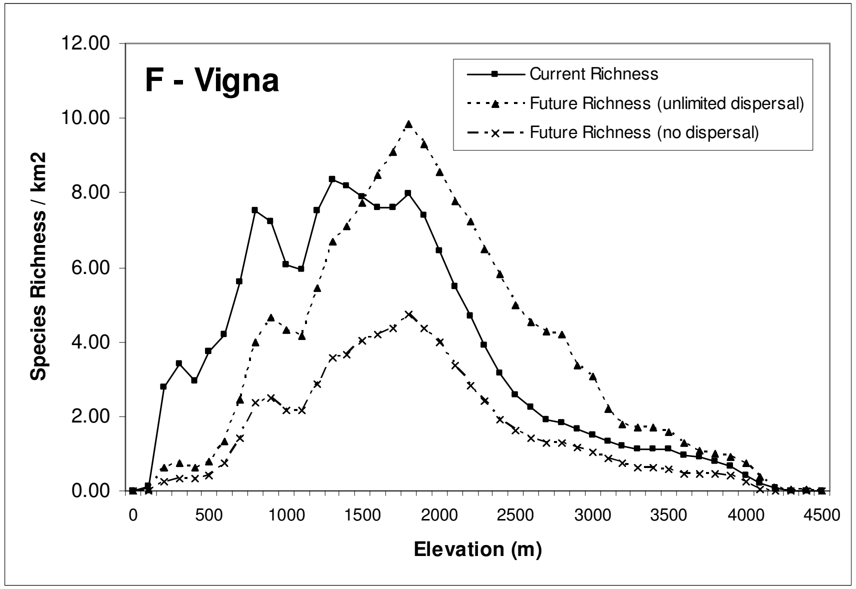


Potatoes

- Shift upwards

Latitudinal and Elevational Shifts





Vigna

- Shift south/north and especially upwards

Summary Impacts

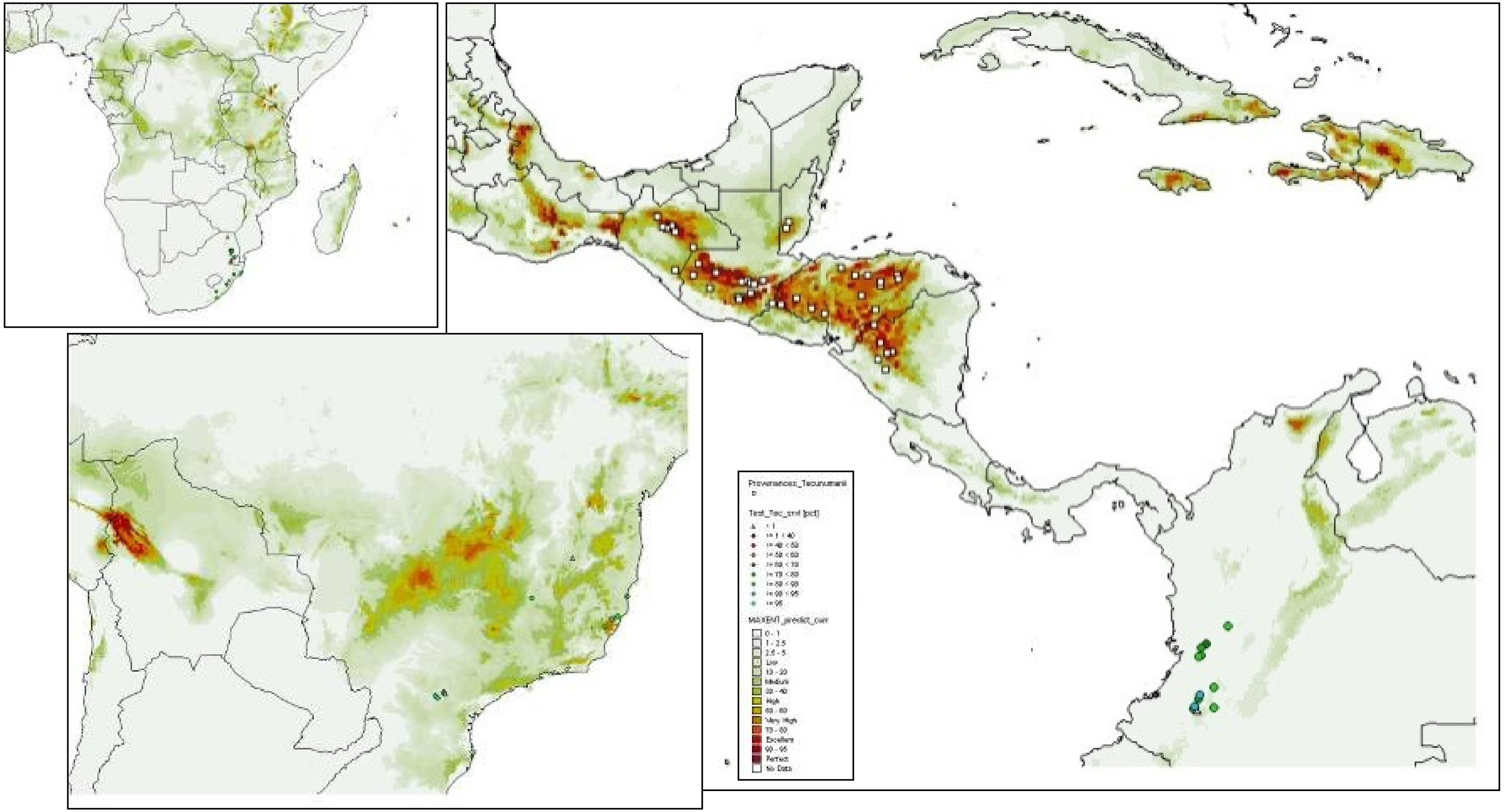
- 16-22% (depending on migration scenario) of these species predicted to go extinct
- Most species losing over 50% of their range size
- Wild peanuts were the most affected group, with 24 to 31 of 51 species projected to go extinct
- For wild potato, 7 to 13 of 108 species were predicted to go extinct
- Range sizes were reduced by approximately 38 to 69%.
- *Vigna* was the least affected of the three groups, losing 0 to 2 of the 48 species in the genus
- Range size was predicted to decrease by 65% (no migration) or increase 8% (unlimited migration)

Priority Species

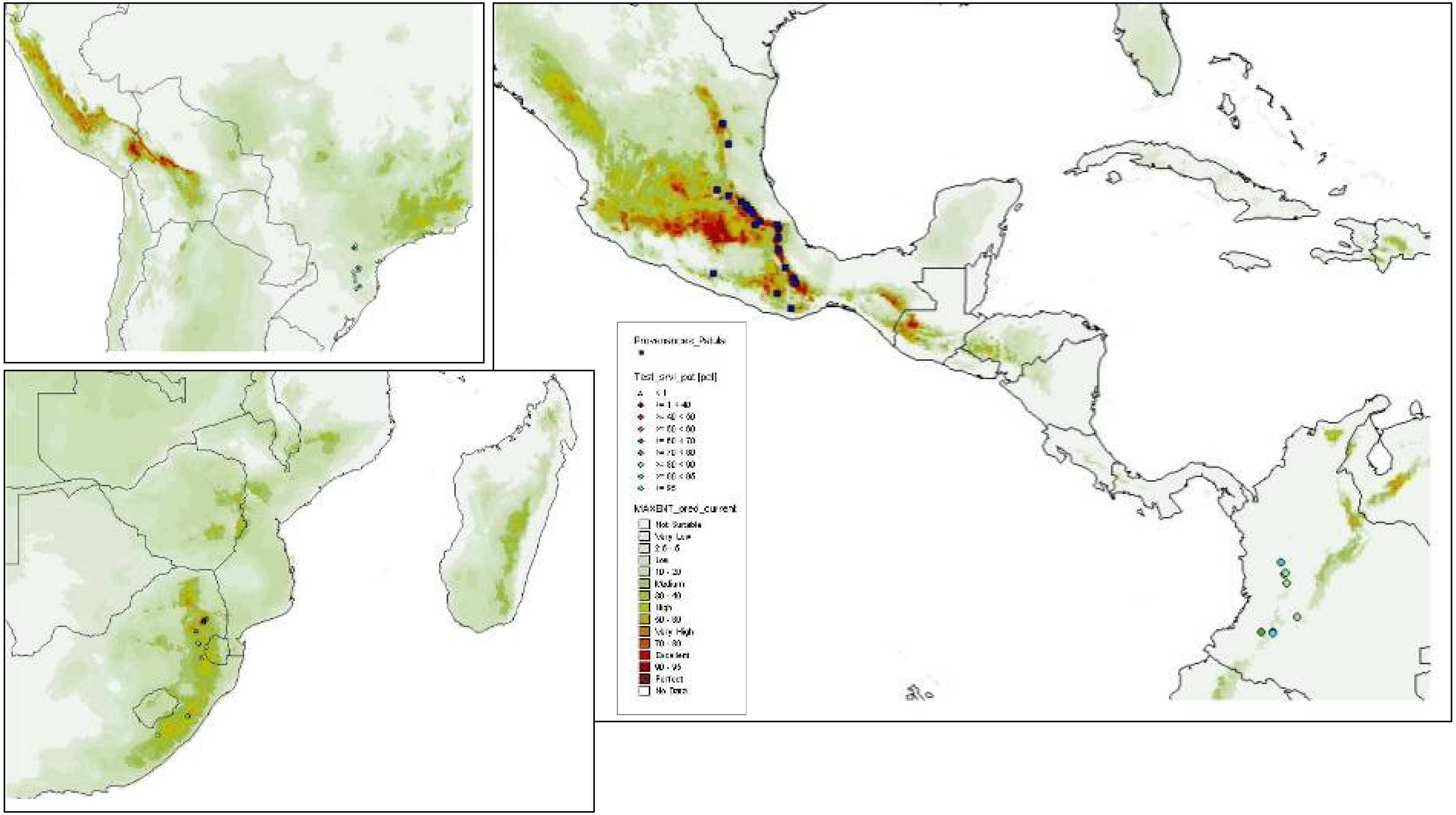
	Predicted extinction (no future range area)	10 species with <10,000 km2 future range area (km²)	10 species with greatest % loss of range area (% loss)
Peanut	*A. appressipila, A. archeri, A. benensis, A. cryptopotamica, A. douradensis, A. guaranitica, A. hatschbachii, A. helodes, A. hermannii, A. lignosa, A. marginata, A. palustris, A. setinervosa, A. simpsonii, A. stenophylla, A. magna, A. tuberosa, A. hoehneii, A. burkartii, A. retusa, A. glandulifera, A. paraguariensis, A. pseudovillosa, A. decora*	*A. benthamii (9465), A. cardenasii (5163), A. correntina (3264), A. triseminata (1308), A. matiensis (802), A. batizocoi (717), A. oteroi (609), A. subcoriacea (301), A. gracilis (232)*	*A. gracilis (99%), A. kretschmeri (99%), A. oteroi (99%), A. matiensis (99%), A. subcoriaceae (98%), A. triseminata (97%), A. kempff-mercadoi (96%), A. major (96%), A. batizocoi (96%), A. correntina (95%)*
Potato	*S. velardei, S. tarnii, S. xmichoacanum, S. xrechei, S. ugentii, S. chancayense, S. incamayoense*	*S. irosinum (5), S. paucissectum (5), S. hoopesii (41), S. piurae (87), S. raquialatum (146), S. longiconicum (179), S. arnezii (193), S. lignicaule (250), S. acroscopicum (422), S. xsambucinum (475)*	*S. irosinum (99%), S. hoopesii (97%), S. piurae (96%), S. xsambucinum (96%), S. paucissectum (95%), S. acroscopicum (95%), S. raquialatum (93%), S. jamesii (91%), S. arnezii (88%), S. trifidum (85%)*
Vigna	*No species*	*V. monantha (16), V. virescens (38), V. keraudrenii (110), V. phoenix (363), V. mungo (1066), V. richardsiae (2866), V. bosseri (3686), V. hosei (4387), V. mudenia (9590)*	*V. keraudrenii (98%), V. decipiens (85%), V. phoenix (78%), V. procera (64%), V. mungo (63%), V. angivensis (59%), V. antunesii (56%), V. gazensis (55%), V. platyloba (51%), V. juncea (50%)*

IMPACTS ON FORESTRY

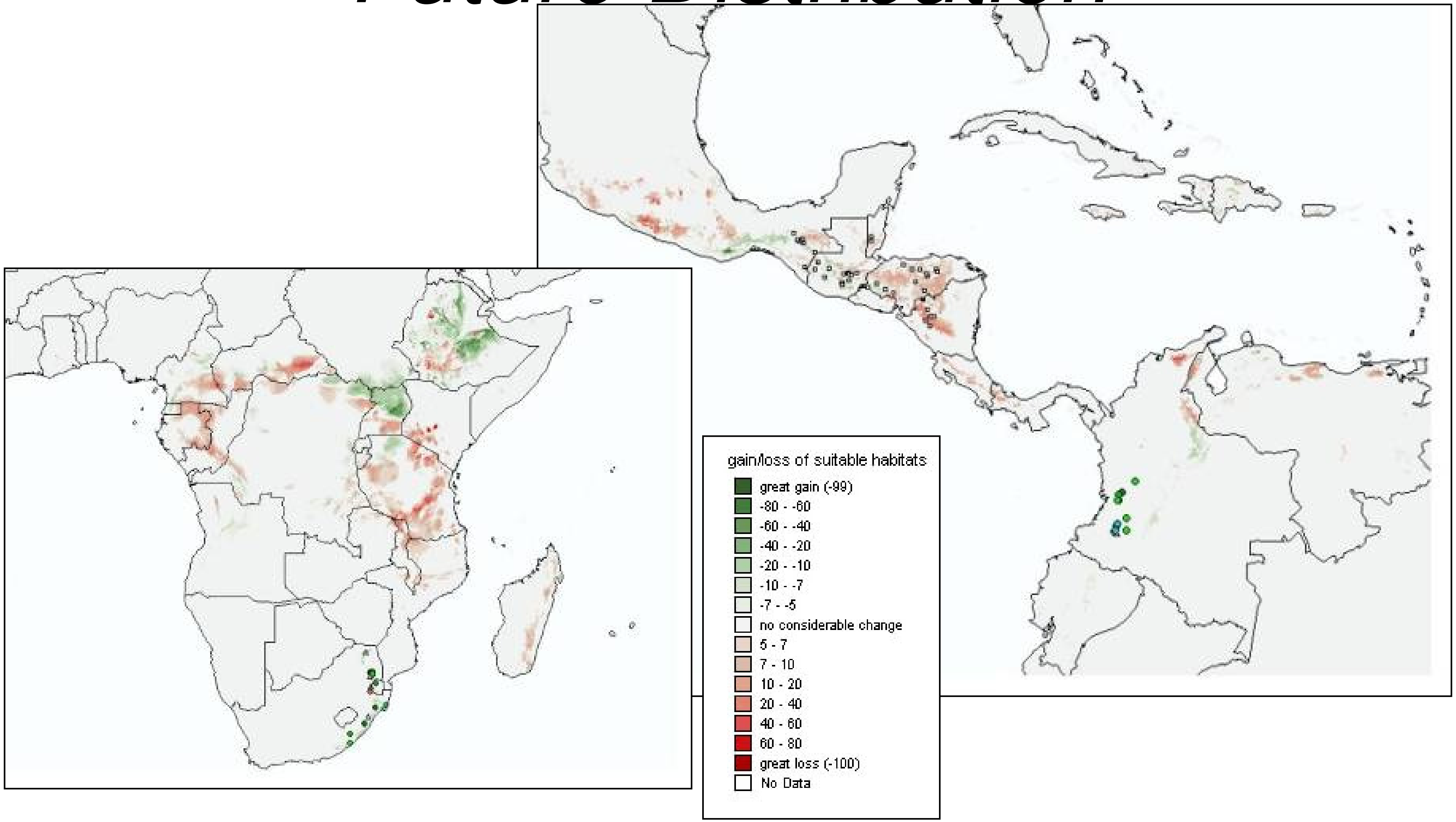
Provenances *P. Tecunumanii*
Current Distribution



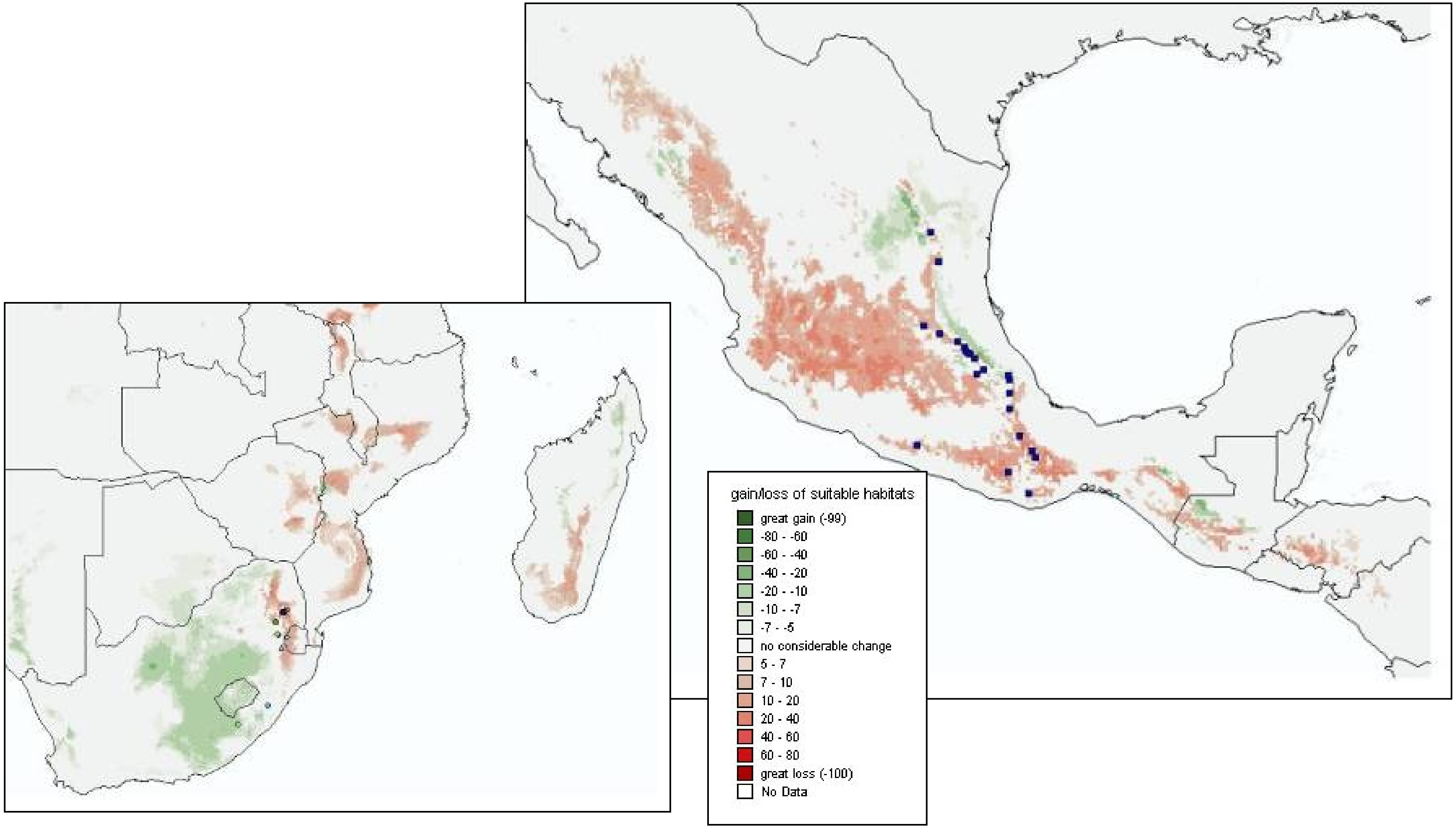
Provenances *P. Patula*
Current Distribution



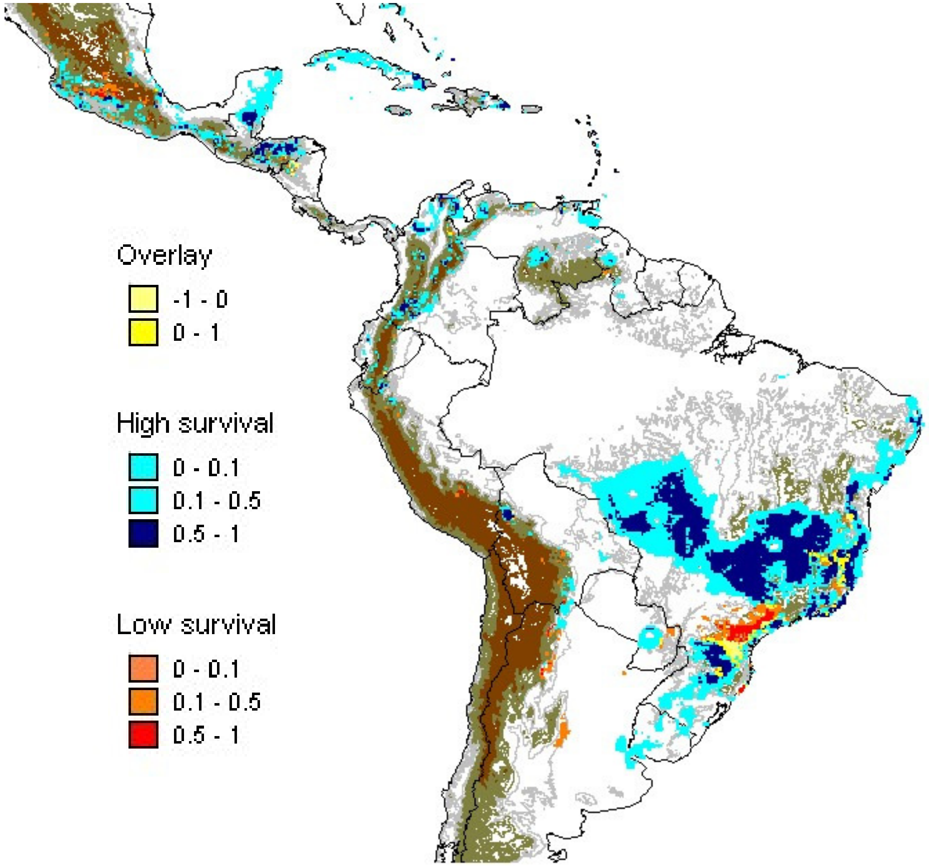
Provenances *P. Tecunumanii* *Future Distribution*



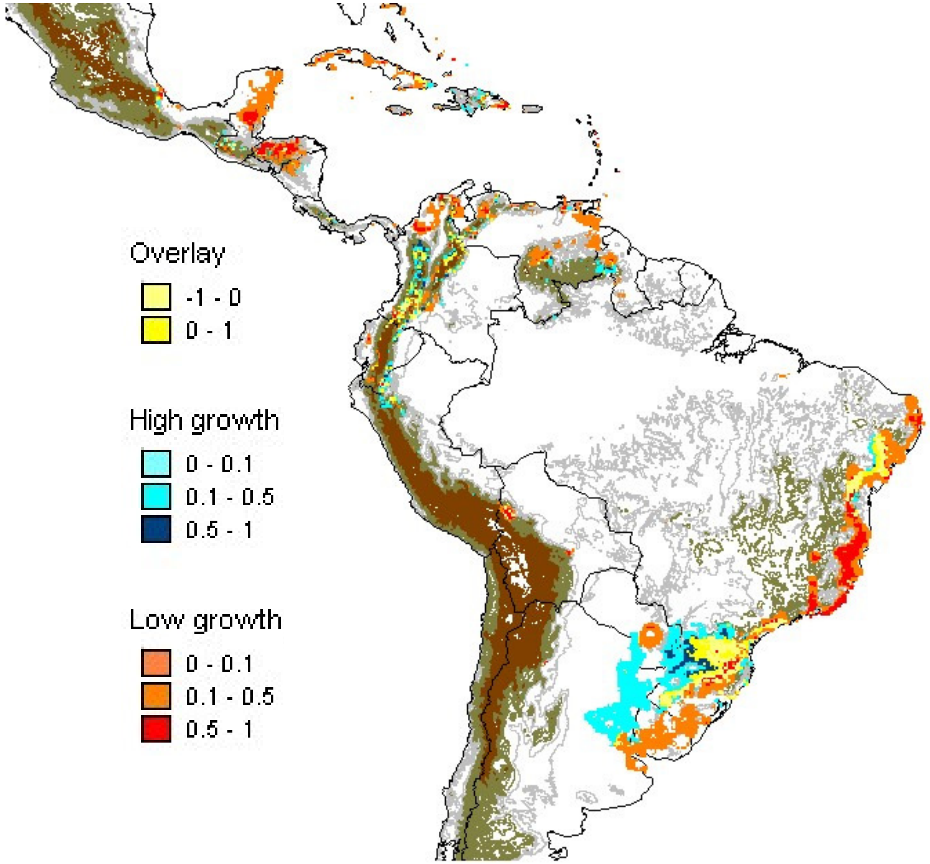
Provenances *P. Patula* *Future Distribution*



P. tecunumanii (Latin America)

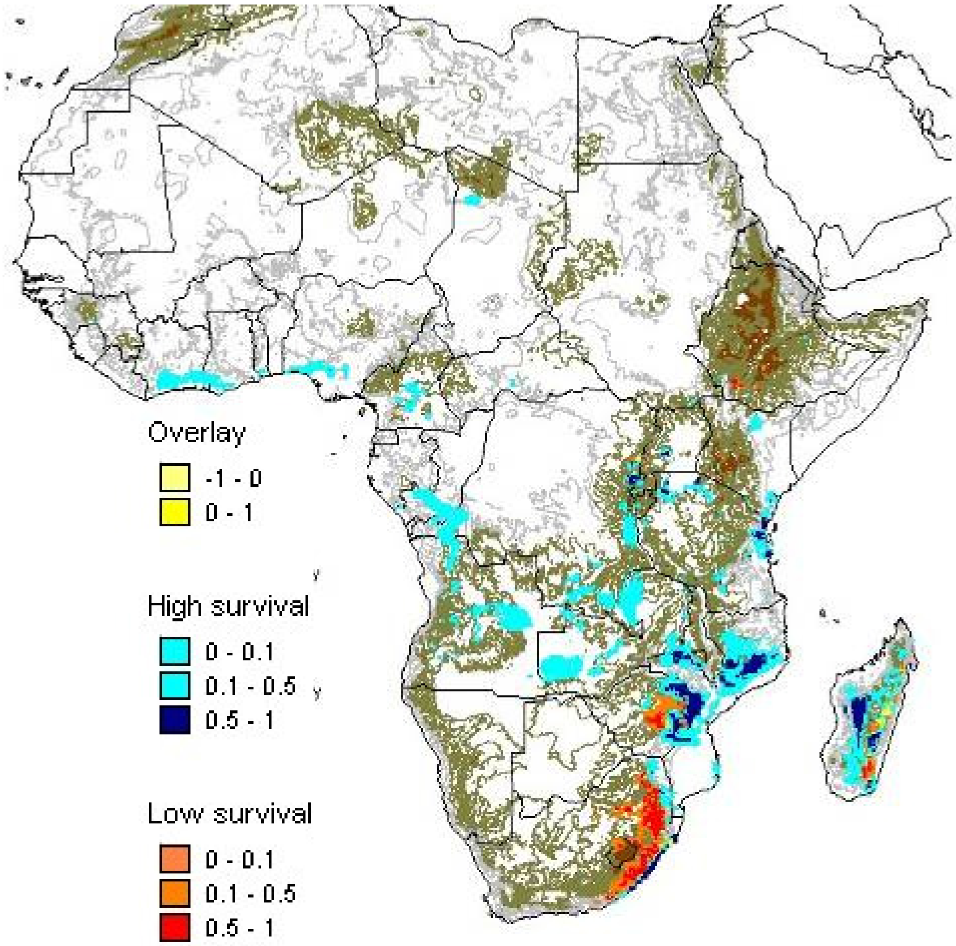


Survival probability

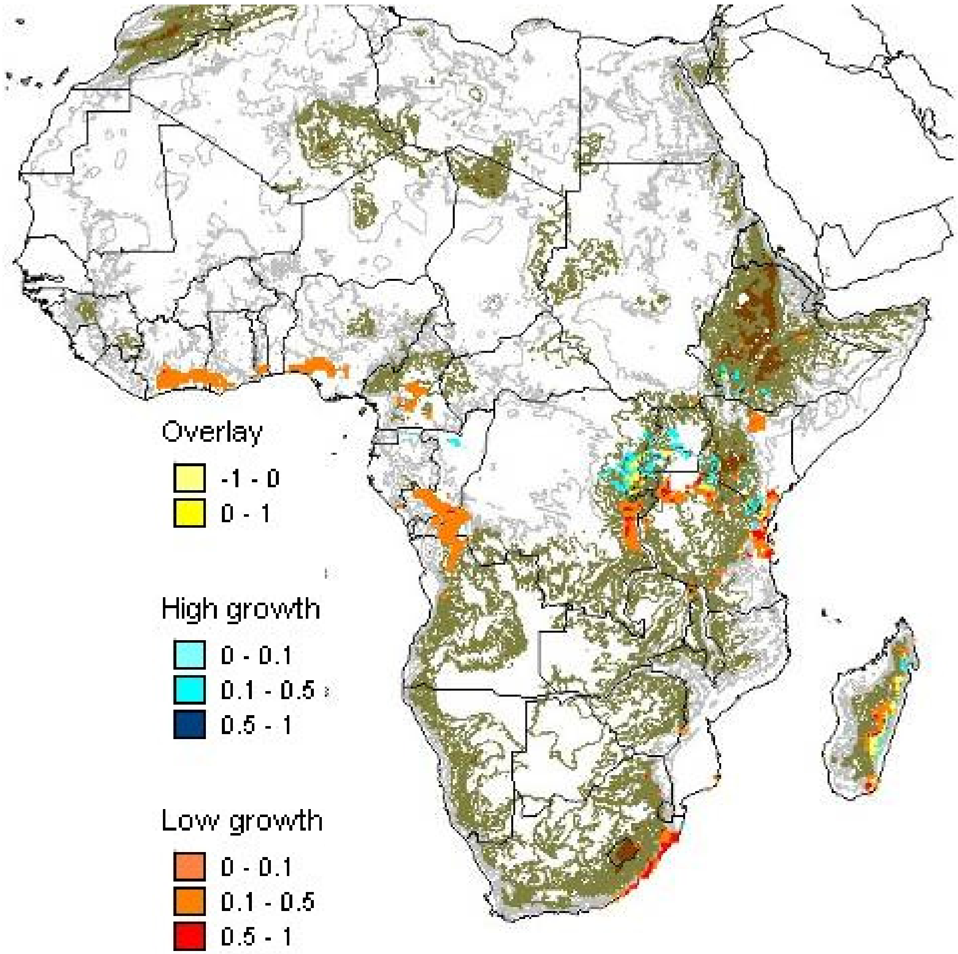


Growth probability

P. tecunumanii (Africa)



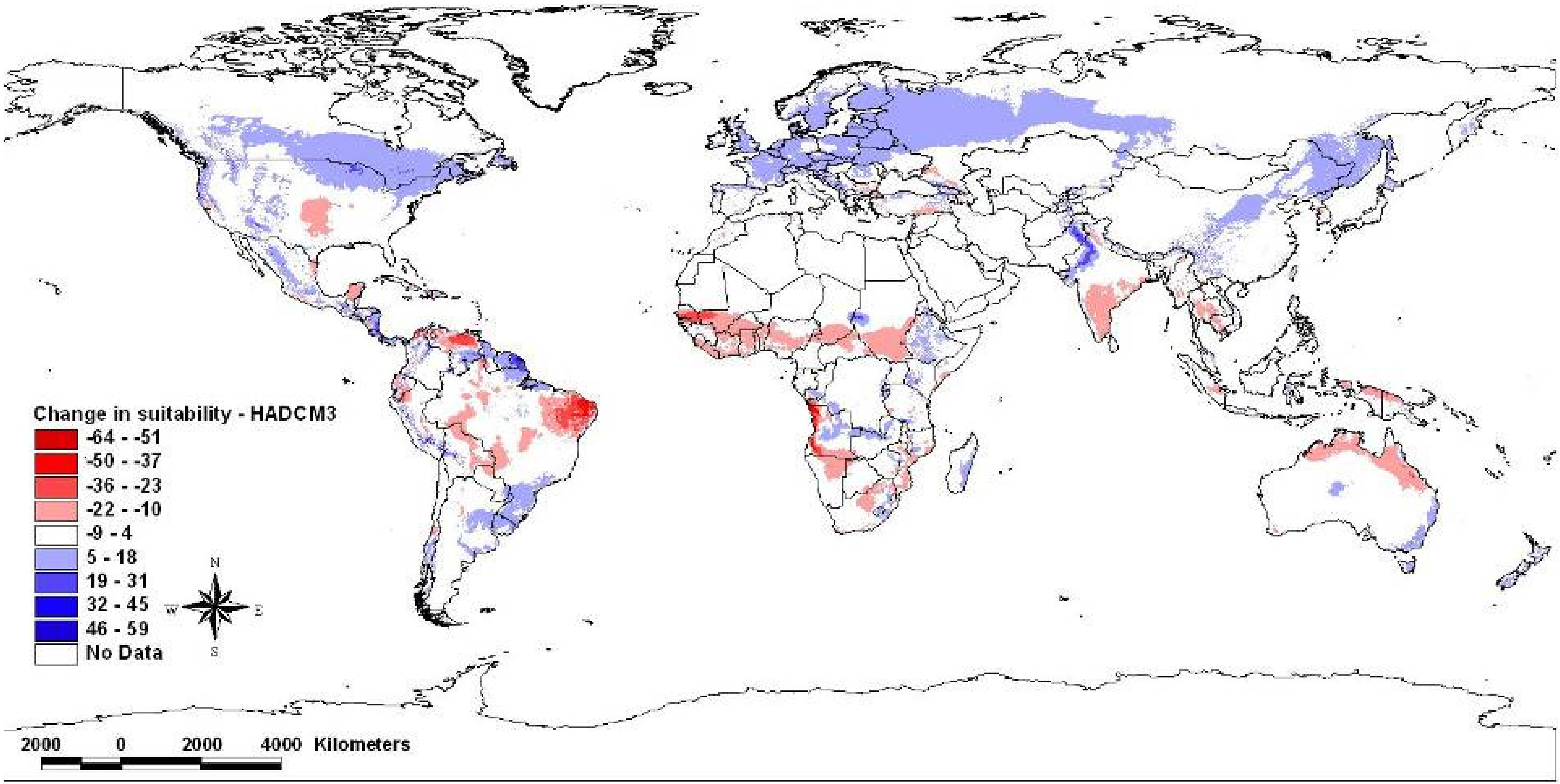
Survival probability



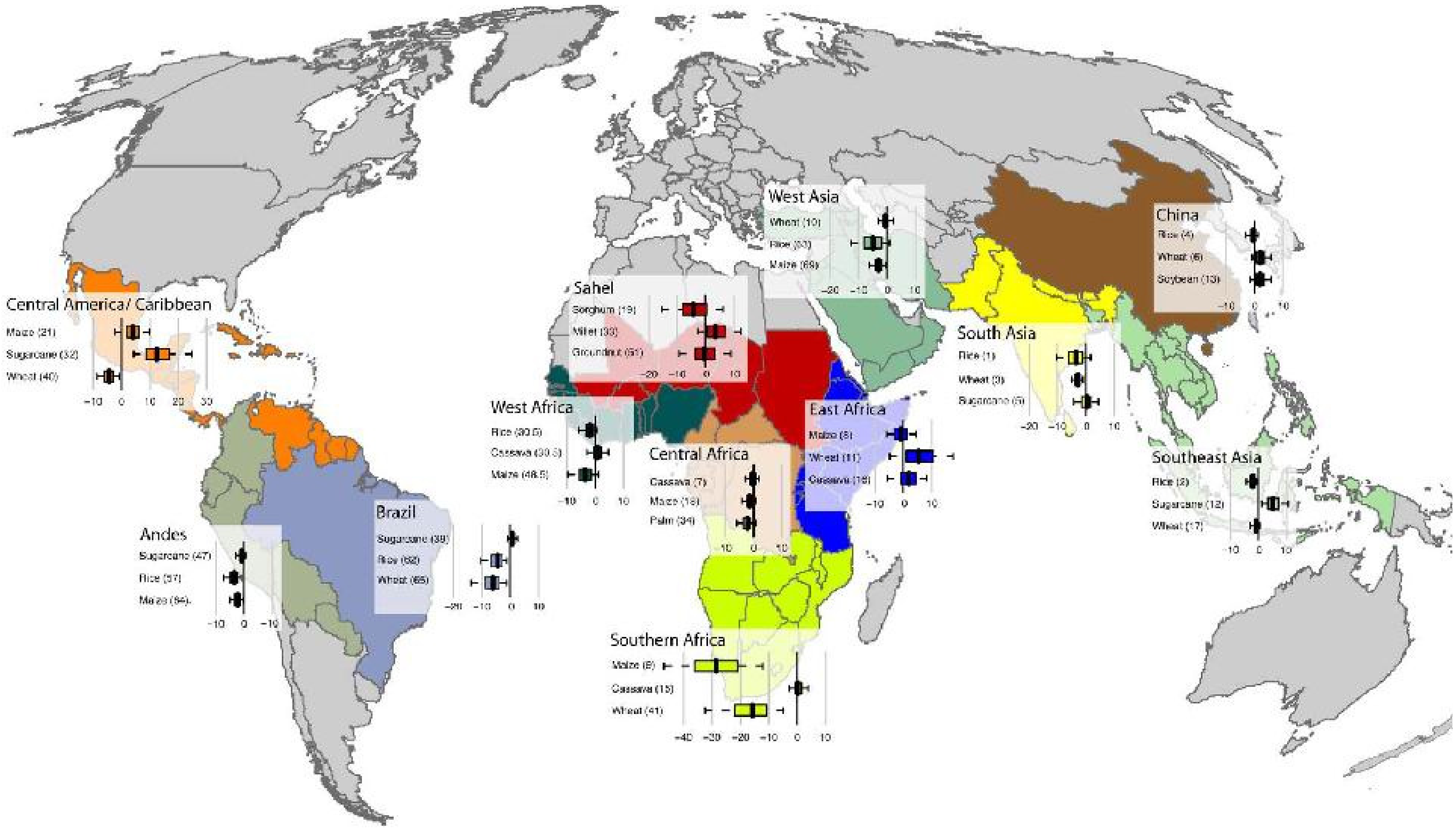
Growth probability

IMPACTS ON CROP PRODUCTION

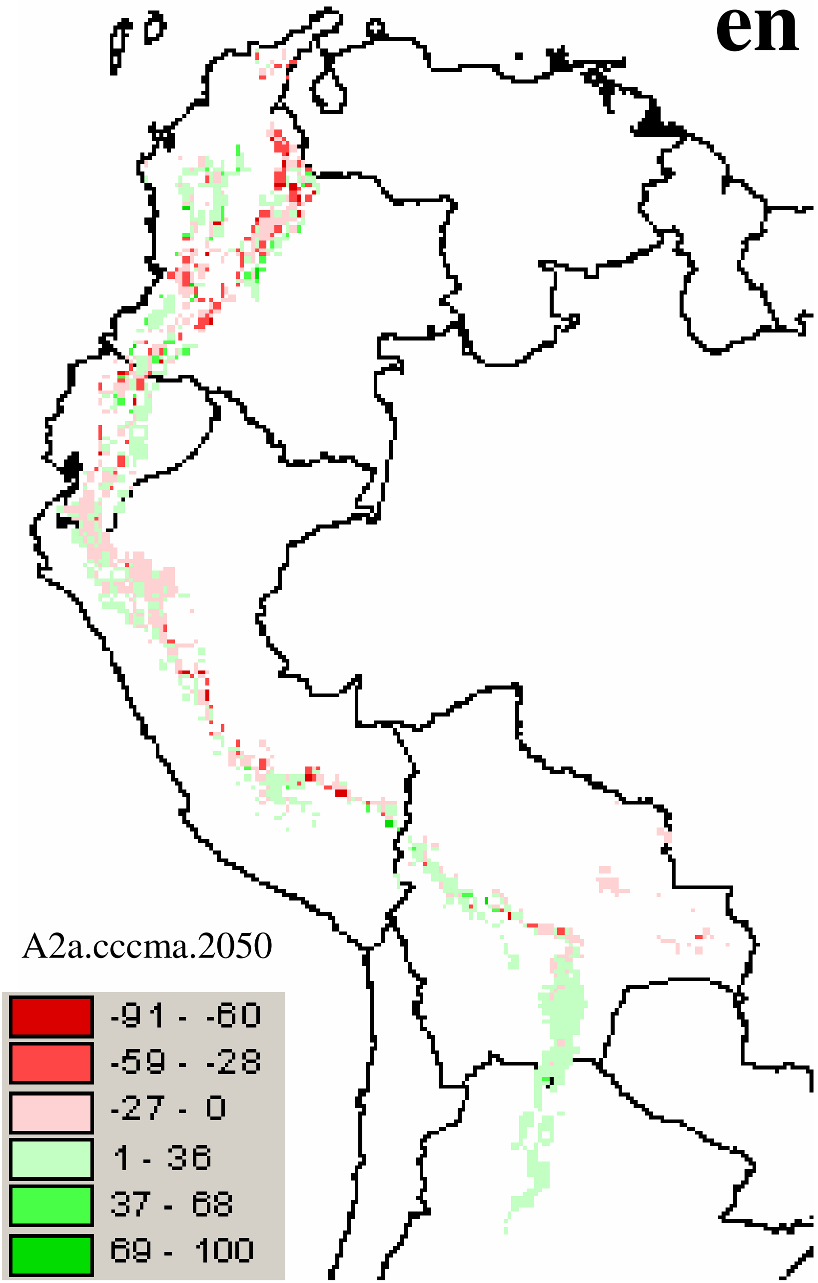
Crop suitability

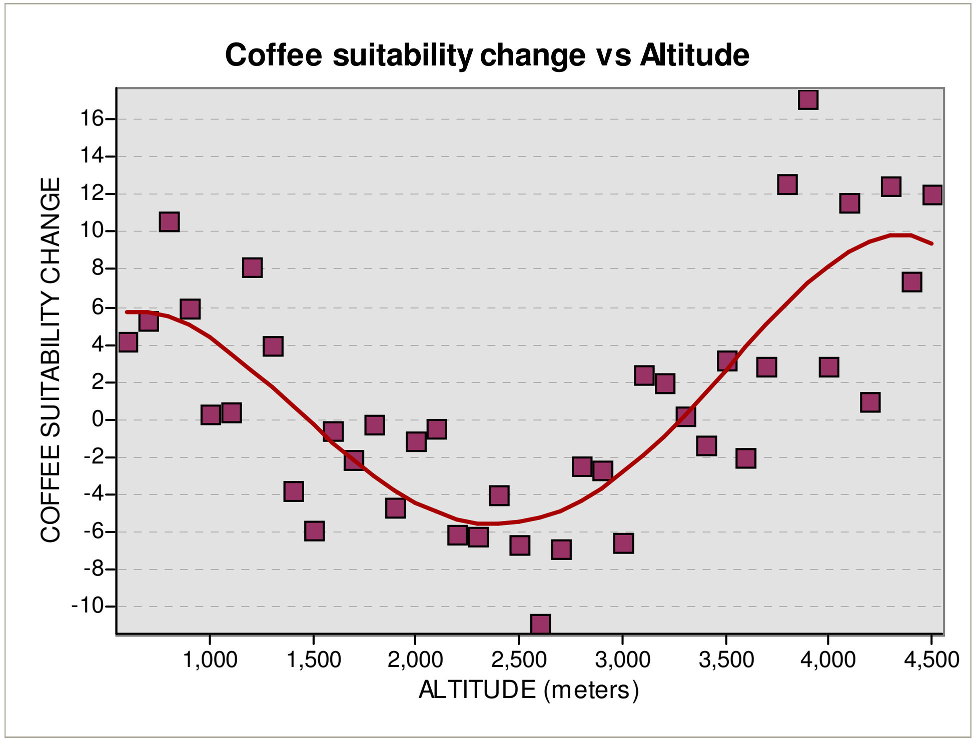


Lobell – Food Security



Cambio en la adaptabilidad de los cultivos de café en los Andes.





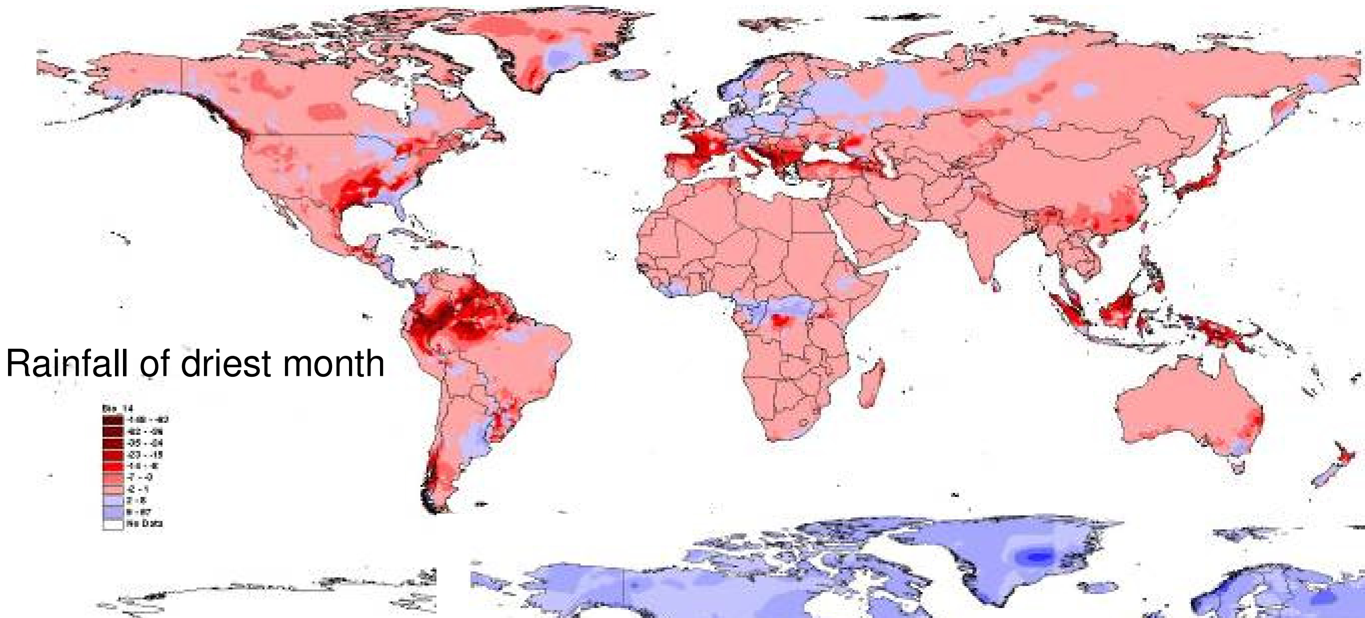
El cambio va desde latitudes medias (trópico) hasta la zona que pertenece al norte de Argentina.

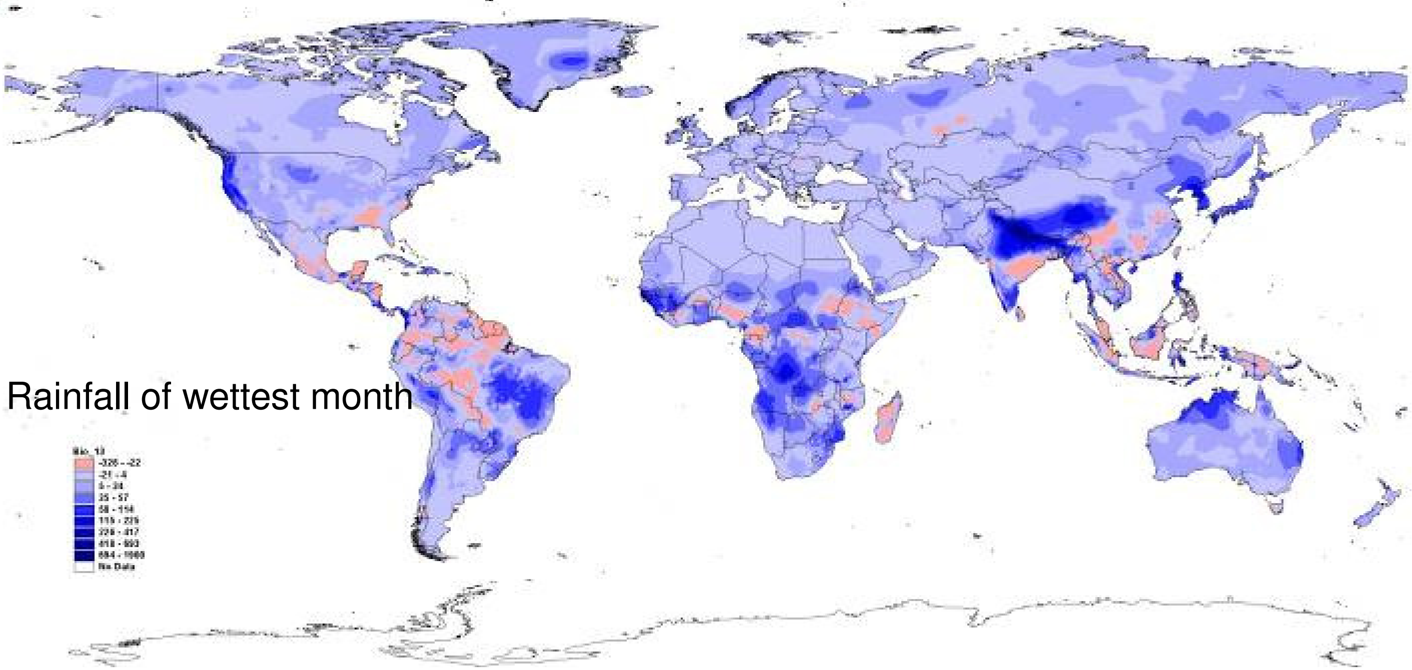
El 89% del área que cambia la adaptabilidad se mueve en el rango de (-27 – 36).

Cordillera central y occidental de Colombia, zonas cafeteras por excelencia, decrecimientos drásticos en la adaptabilidad.

Impacto negativo de 500-2000 m.

Wet season wetter, dry season drier





IMPLICATIONS

- Crop suitability CHANGES in both positive and negative ways
- Crop distributions shift, opportunities out there
- Key is managing transitions
- New abiotic stresses for crops -> continued demand for genetic resources
- Enabling agricultural diversification key to adapting

Improving lives through biodiversity research

Conclusions

- Wild species at risk
- Crop suitability shifts
- Need for systems for managing transitions
- Capitalising on opportunities