

Climate change and the changing fates of Asia's native honeybees


James C Makinson



WESTERN SYDNEY
UNIVERSITY



Hawkesbury Institute
for the Environment



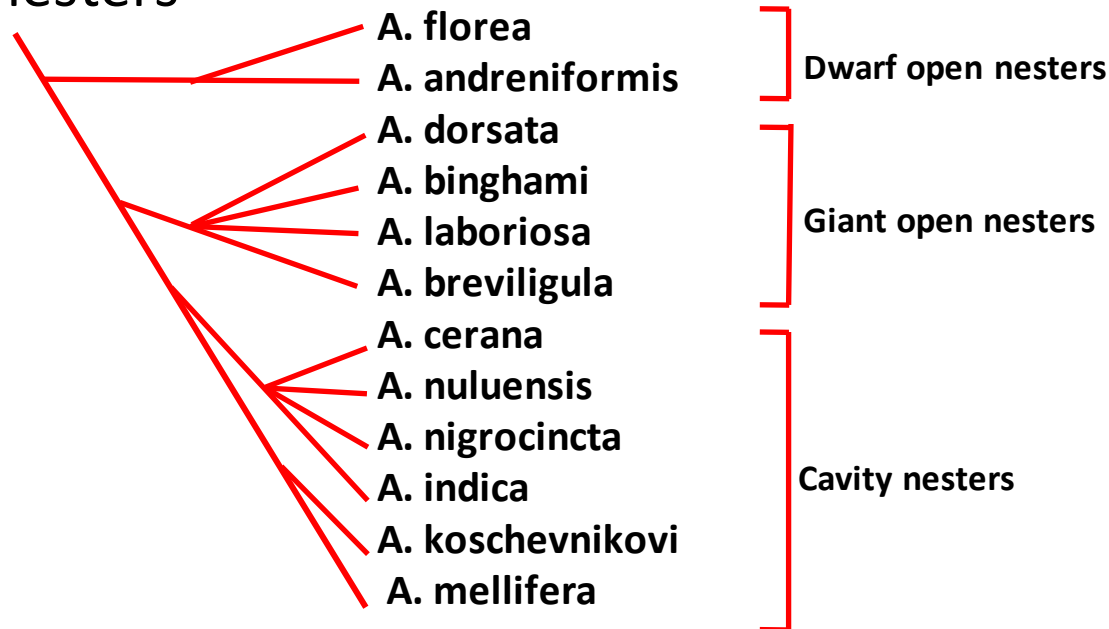
Climate change and the changing fates of Asia's native honeybees

- The effects of climate change will not be uniformly felt across all species.
- Many species are anticipated to be driven towards extinction.
- Some species may be set to thrive under changing climatic conditions
- Asian *Apis* provide an interesting model system to study how closely related species respond to climate change.

Who are the Asian honeybees?

12 currently recognised species separated into 3 broad categories based on nesting biology:

- Dwarf open nesters
- Giant open nesters
- Cavity nesters



Dwarf open nesters



- 2 different species



Giant open nesters



Cavity nesters



- 6 different species

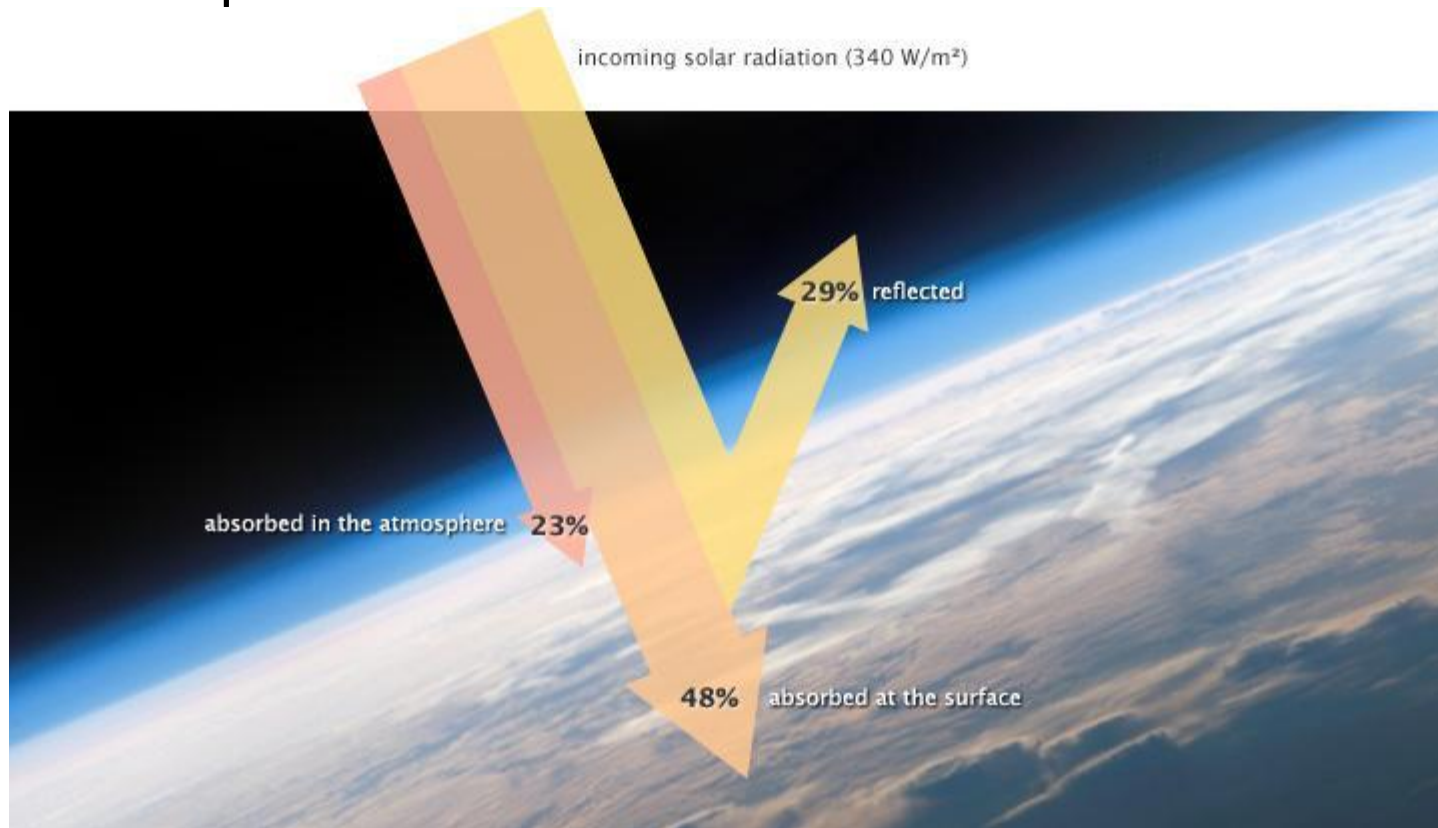
Focal species for today

- Black dwarf honeybee (*Apis andreniformis*)
- Red dwarf honeybee (*Apis florea*)
- Asian hive bee (*Apis cerana*)



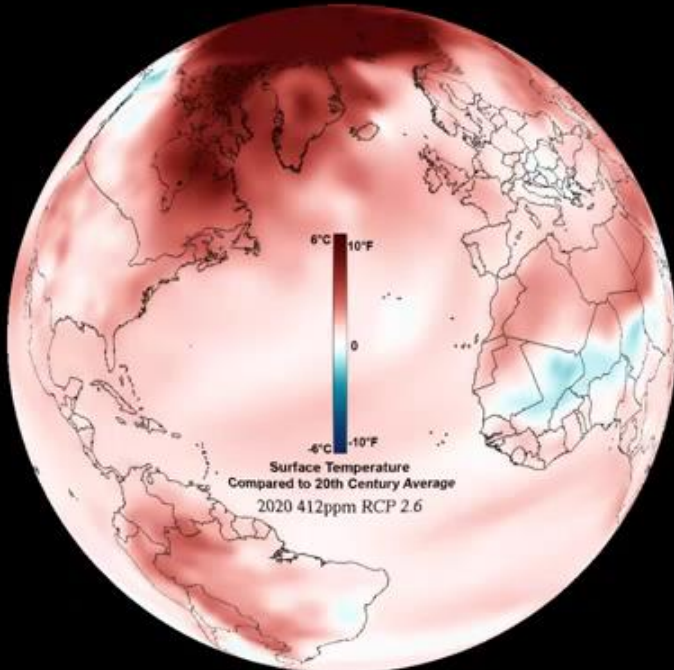
Which climate change scenarios to model?

- Representative Concentration Pathways (RCPs)
- Four separate climate models:



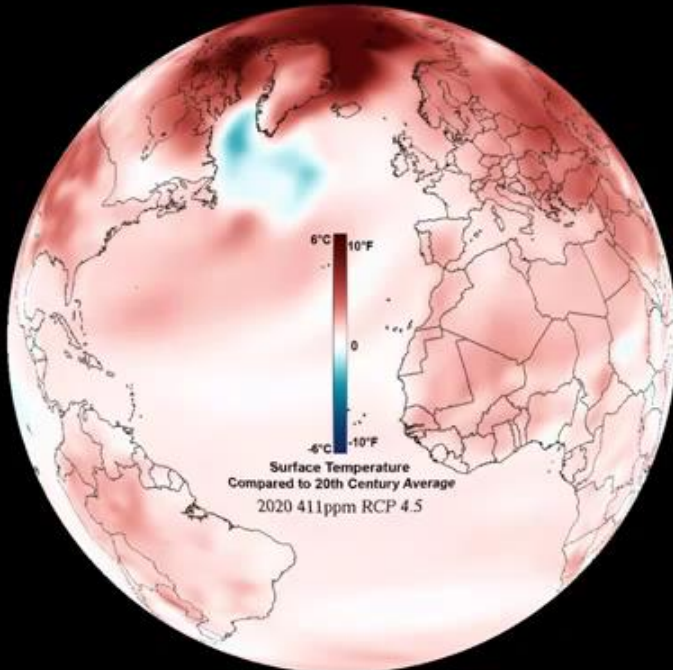
RMP 2.6

- 3.1 W/m² by mid-century
- returns to 2.6 W/m² by 2100.
- Large-scale global intervention starts immediately



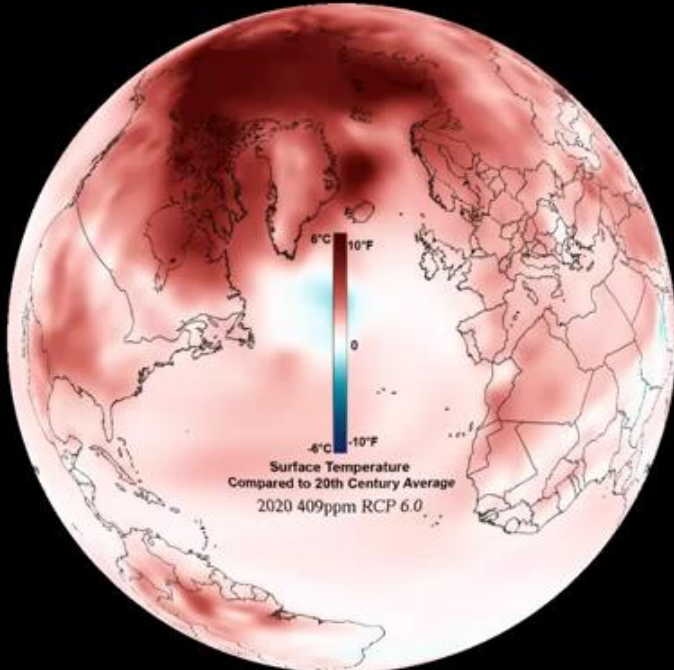
RMP 4.5

- radiative forcing level stabilizes at 4.5 W/m² before 2100
- Assumes we enact a range of climate change mitigation measures



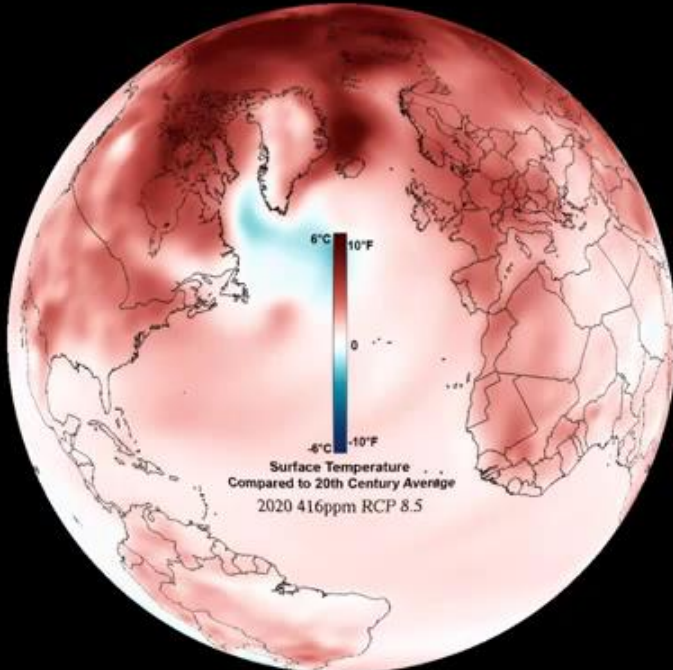
RMP 6.0

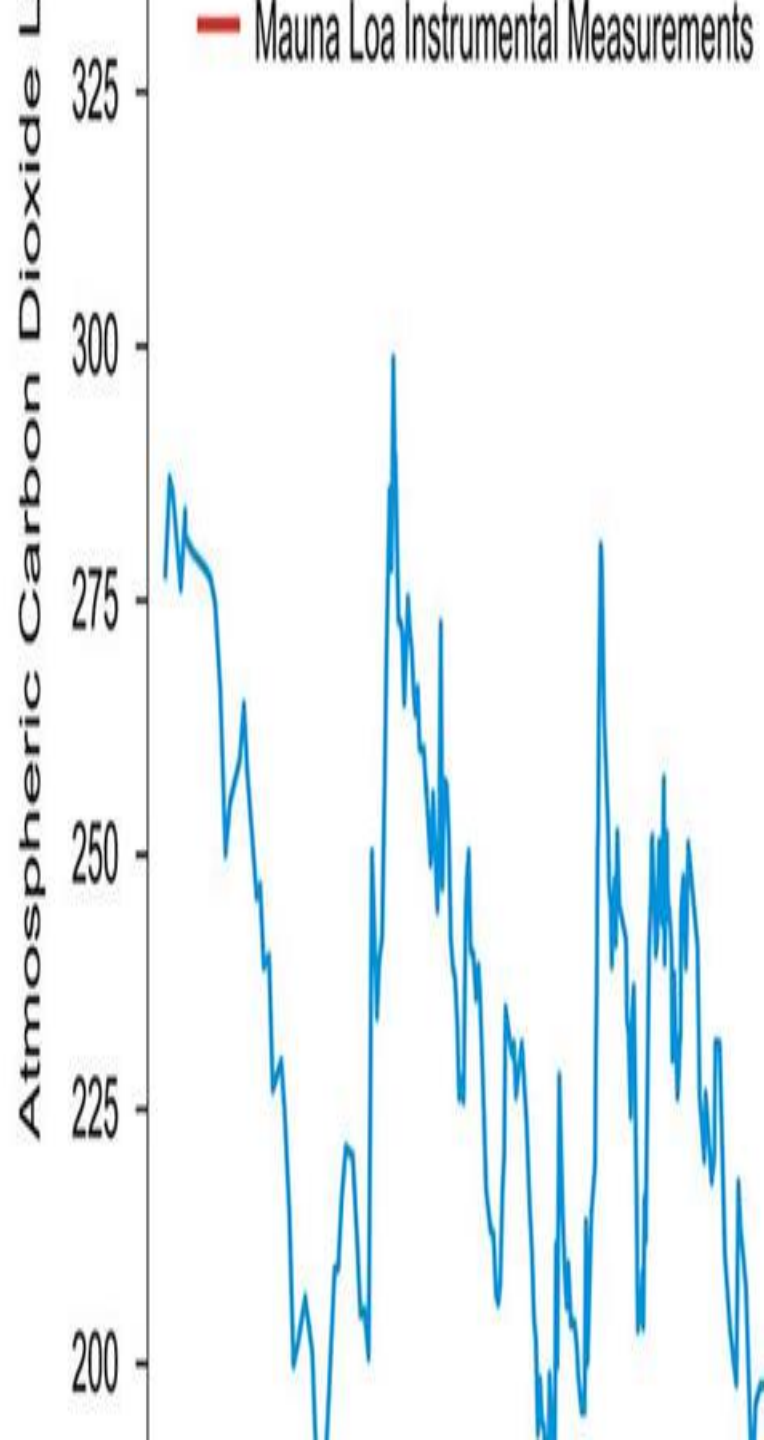
- radiative forcing level stabilizes at 4.5 W/m² before 2100
- continuous global warming to 2100
- CO₂ levels rise to 670ppm
- Temp by 3-4°C



RMP 8.5

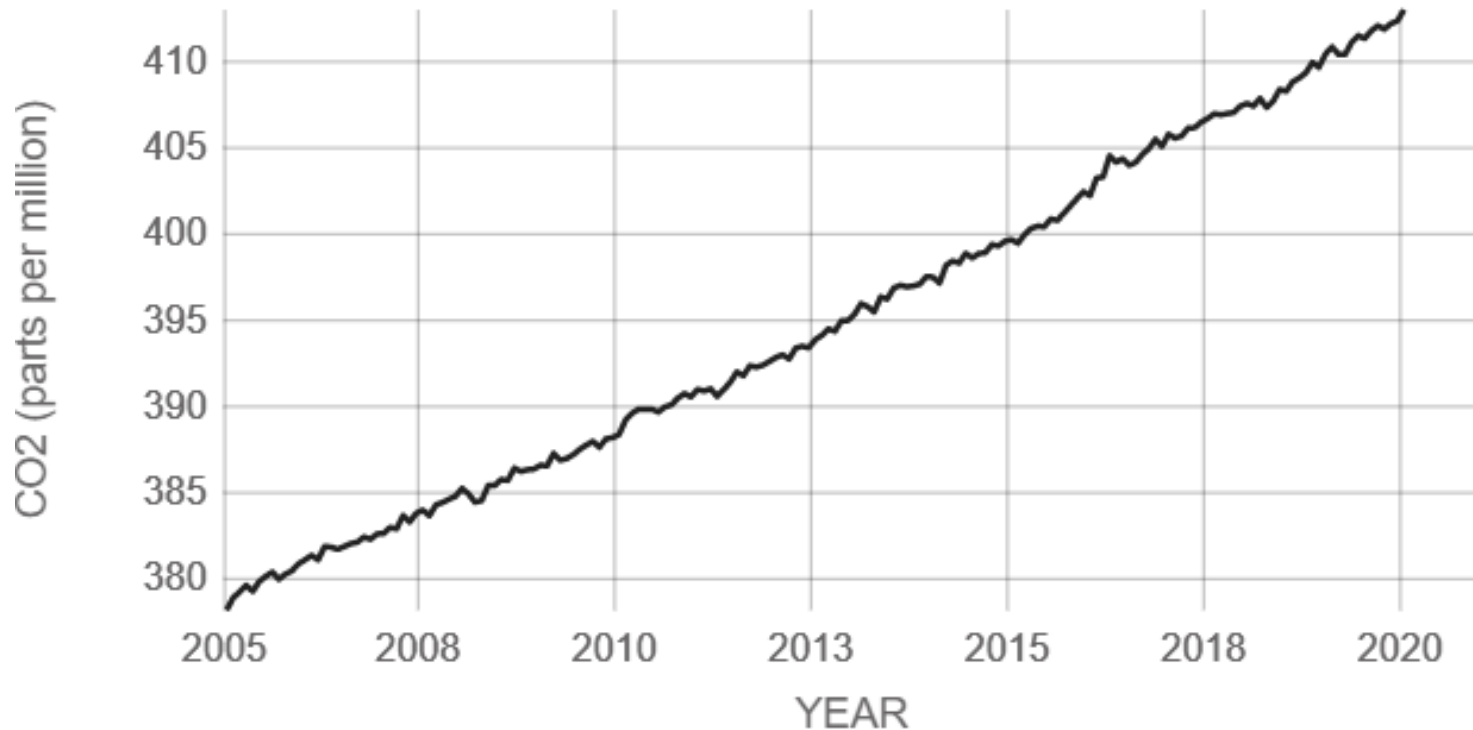
- CO₂ level rises to 936ppm by 2100
- global temp rise by 5-6°C





Which climate change scenarios to model?

- We feel RM 6.0 is a realistic starting point



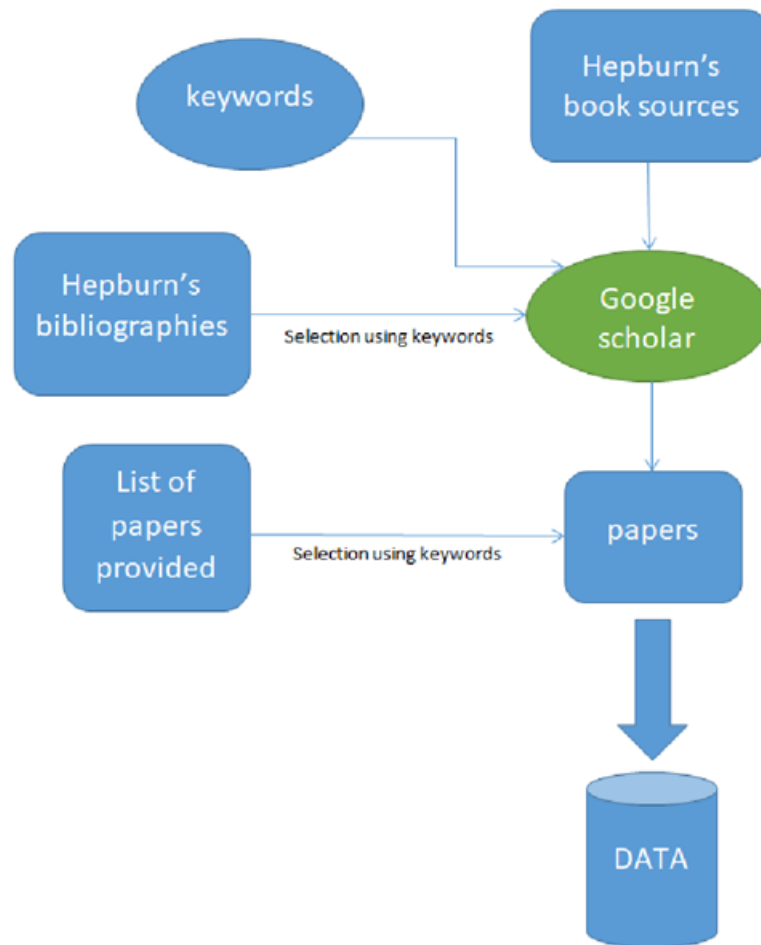
Source: climate.nasa.gov



Creating range maps

- Initial data collection and modelling was undertaken by Patrick Joanblanq during a 11 week undergraduate work experience program.

Choosing reliable species occurrence records

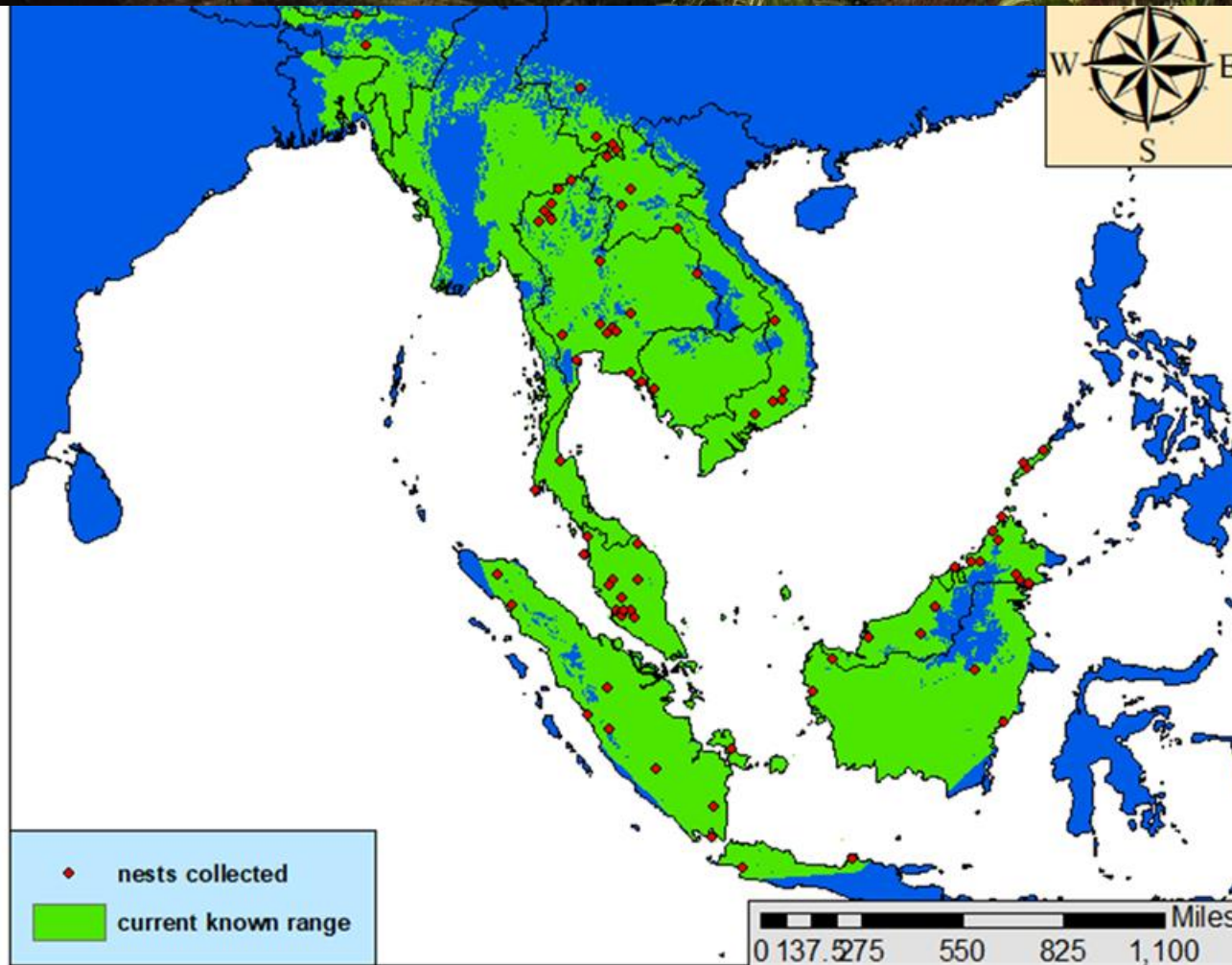




Creating range maps

- Initial data collection and modelling was undertaken by Patrick Joanblanq during a 11 week undergraduate work experience program.
- Current range was estimated using Model Builder in ArcGIS
 - Analogous to 'Over predicting correction Tools' of the SDM Toolbox
 - a 0.5 degree convex hull was used to avoid over prediction of current range

Current predicted range for *Apis andreniformis*





Creating habitat suitability maps

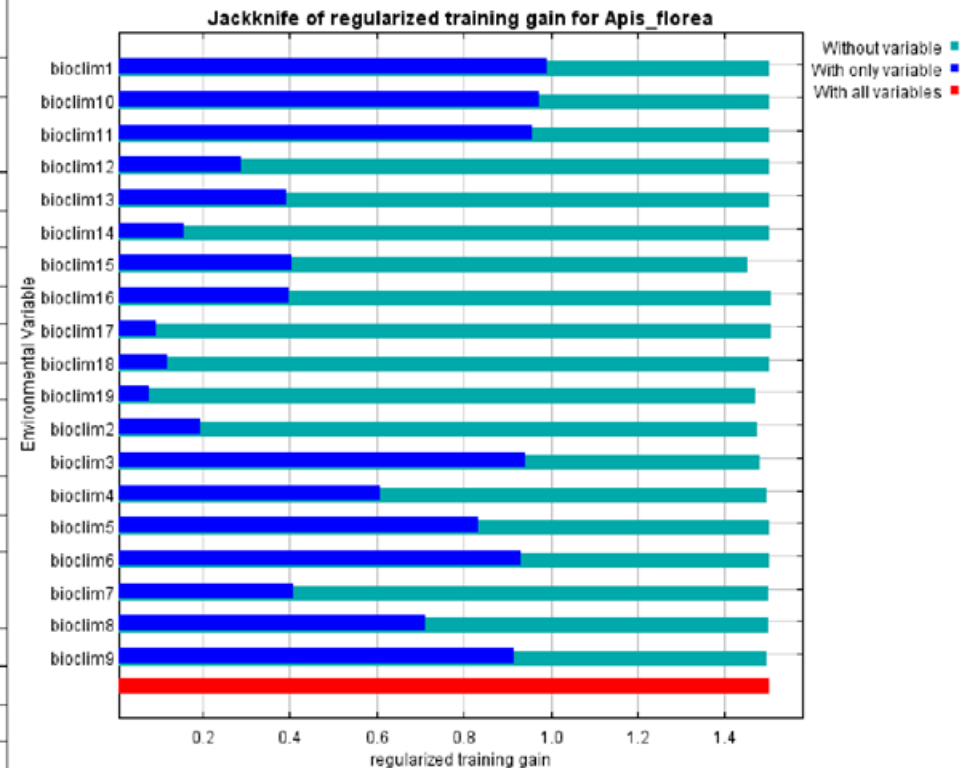
- We used the Maxent software package and the SDS Toolbox for ArcGIS to plot maps of the current ranges, and global suitable habitat for each species.
- We then created maps of the current and potential future ranges of the species in 2070 under the moderate RCP 6 global warming scenario, which predicts a mean 1.3°C global temperature rise.

Calculation species ranges

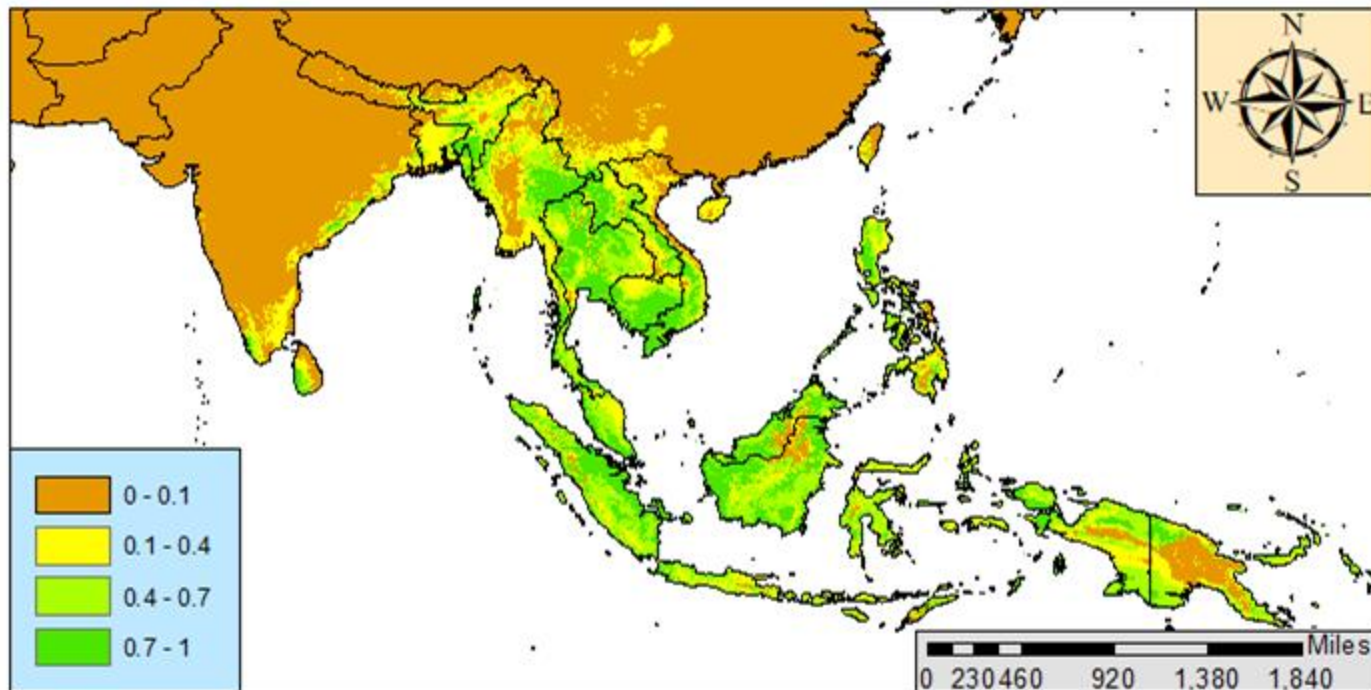
Code	Signification
Bio1	Annual Mean Temperature
Bio2	Mean Diurnal Range (Mean of monthly (max temp - min temp))
Bio3	Isothermality (BIO2/BIO7) (* 100)
Bio4	Temperature Seasonality (standard deviation *100)
Bio5	Max Temperature of Warmest Month
Bio6	Min Temperature of Coldest Month
Bio7	Temperature Annual Range (BIO5-BIO6)
Bio8	Mean Temperature of Wettest Quarter
Bio9	Mean Temperature of Warmest Quarter
Bio10	Mean Temperature of Warmest Quarter
Bio11	Mean Temperature of Coldest Quarter
Bio12	Annual Precipitation
Bio13	Precipitation of Wettest Month
Bio14	Precipitation of Driest Month
Bio15	Precipitation Seasonality (Coefficient of Variation)
Bio16	Precipitation of Wettest Quarter
Bio17	Precipitation of Driest Quarter
Bio18	Precipitation of Warmest Quarter
Bio19	Precipitation of Coldest Quarter

Table 1: bioclimatic variables from Worldclim

Source: information from the website <http://www.worldclim.org/>

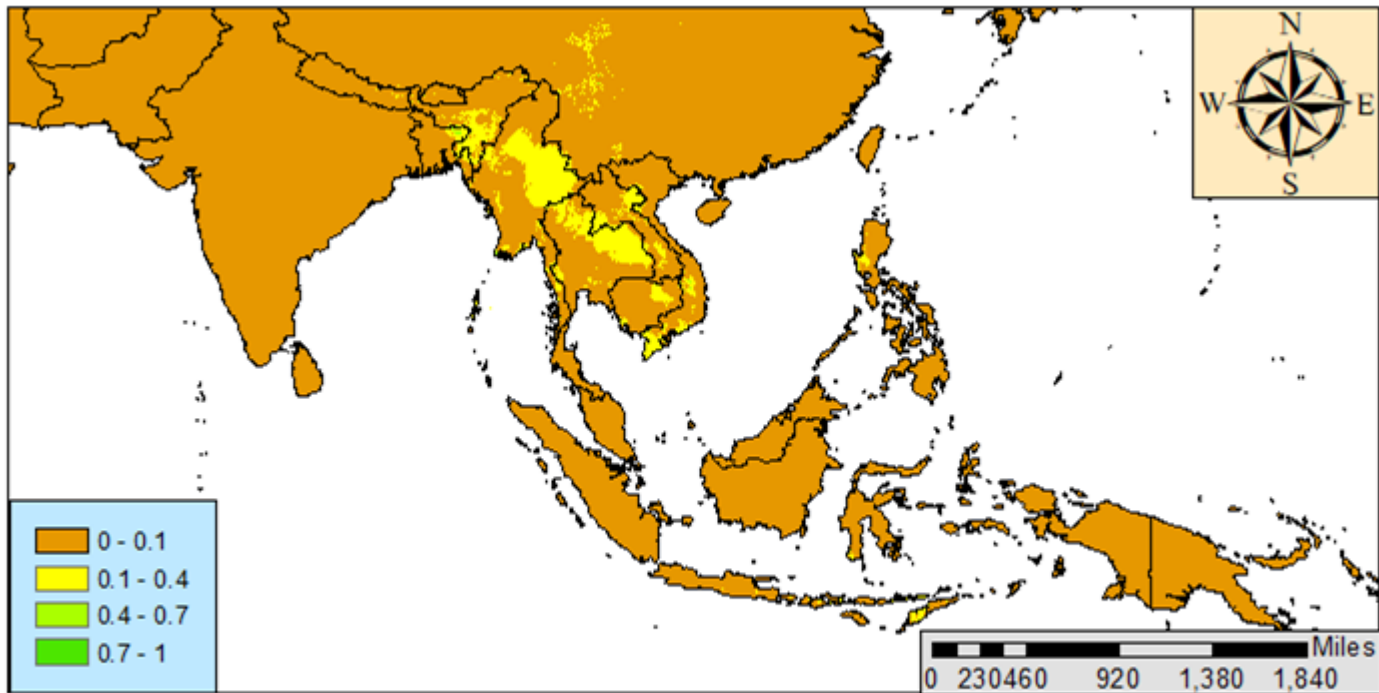


Current suitable area for *Apis andreniformis*



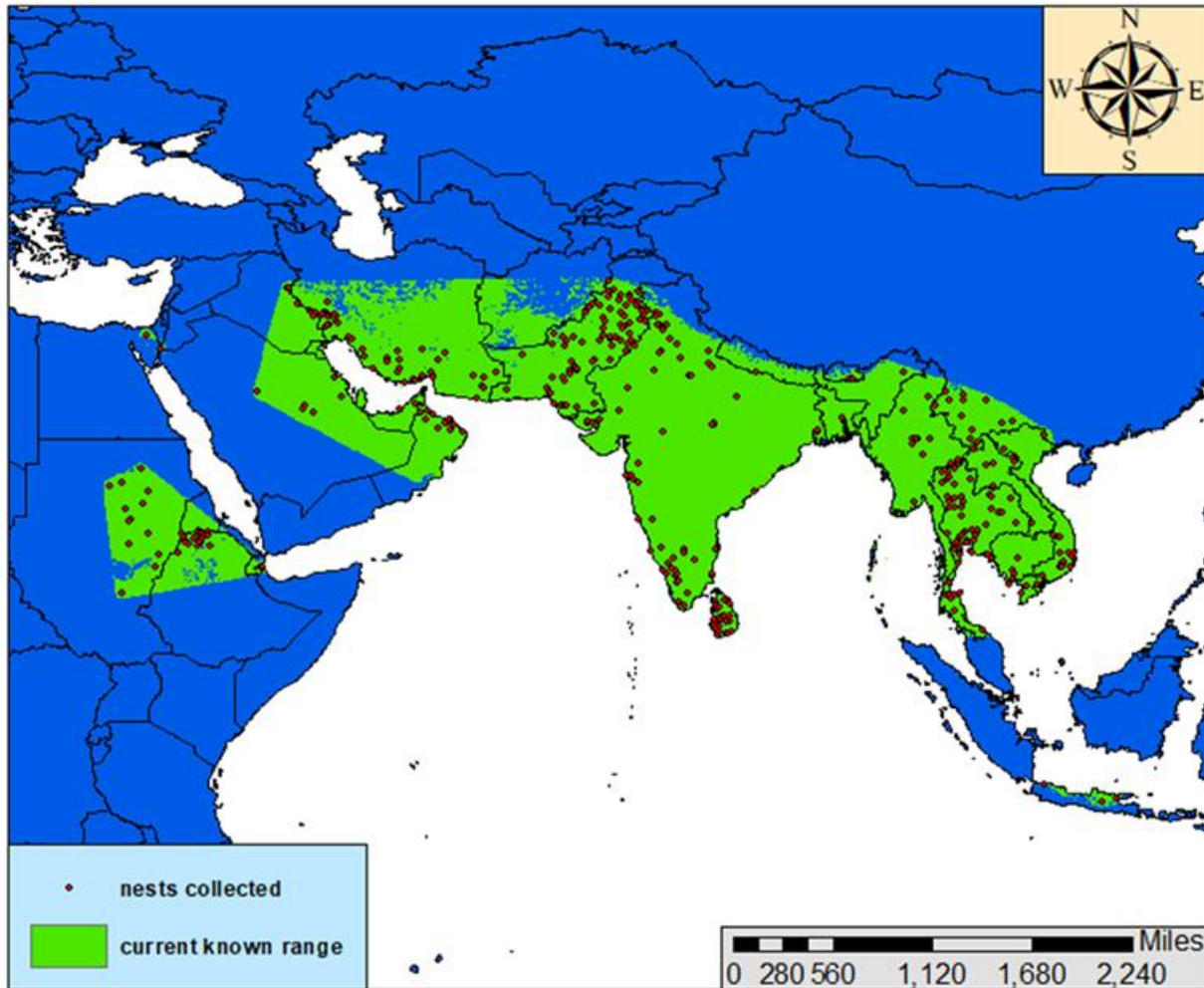
Map 1: scores of suitability under climate conditions

Future suitable area for *Apis andreniformis*

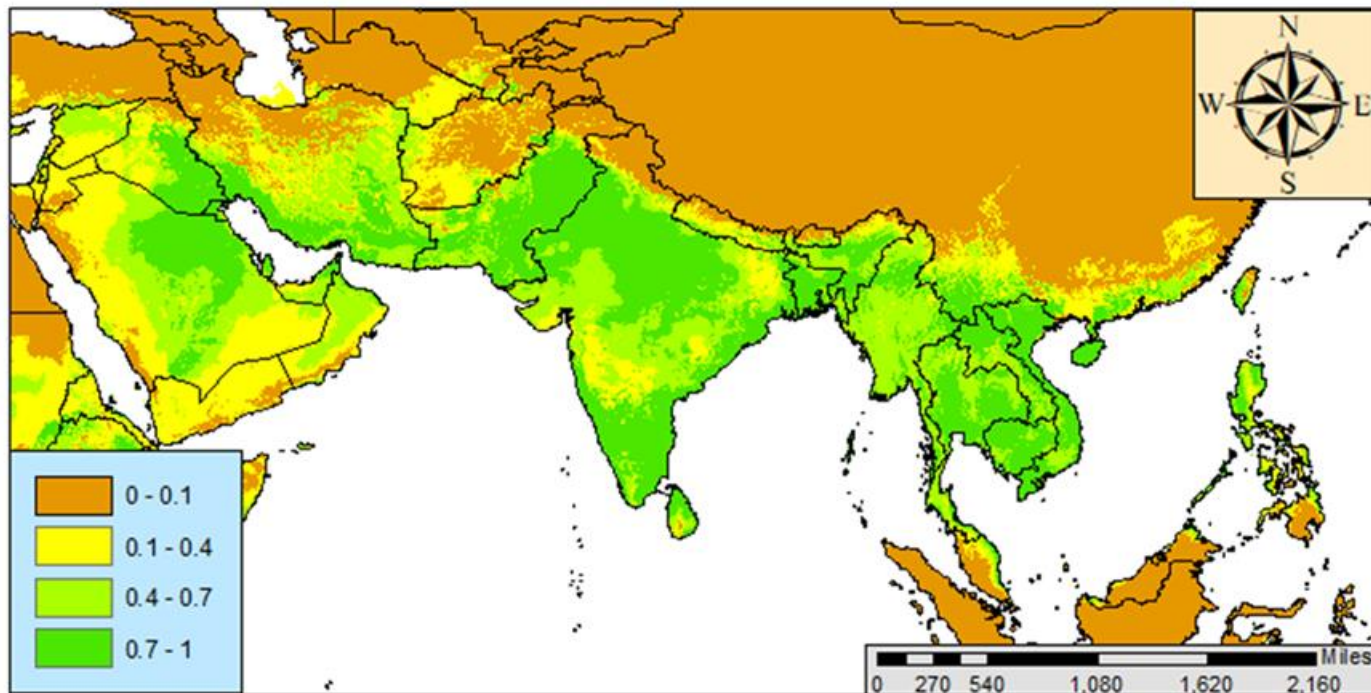


Map 2: scores of suitability predicted for 2070s climate conditions

Current predicted range for *Apis florea*

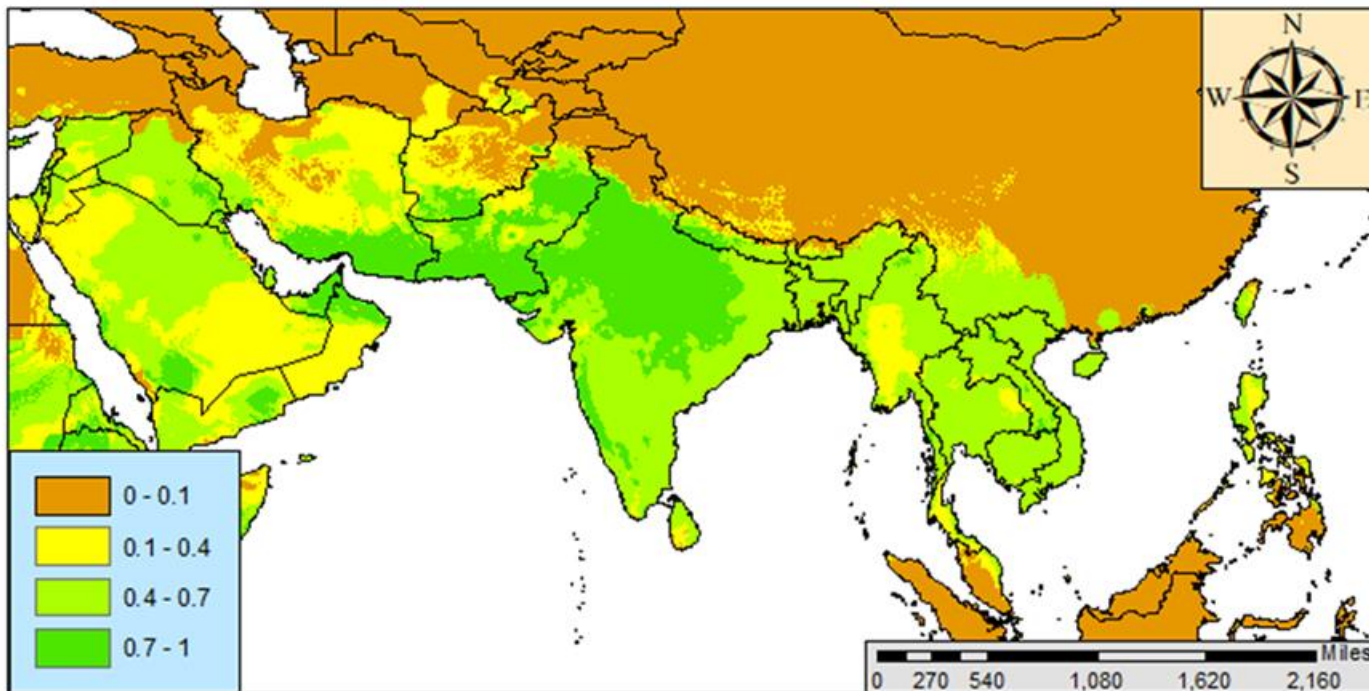


Current suitable area for *Apis florea*



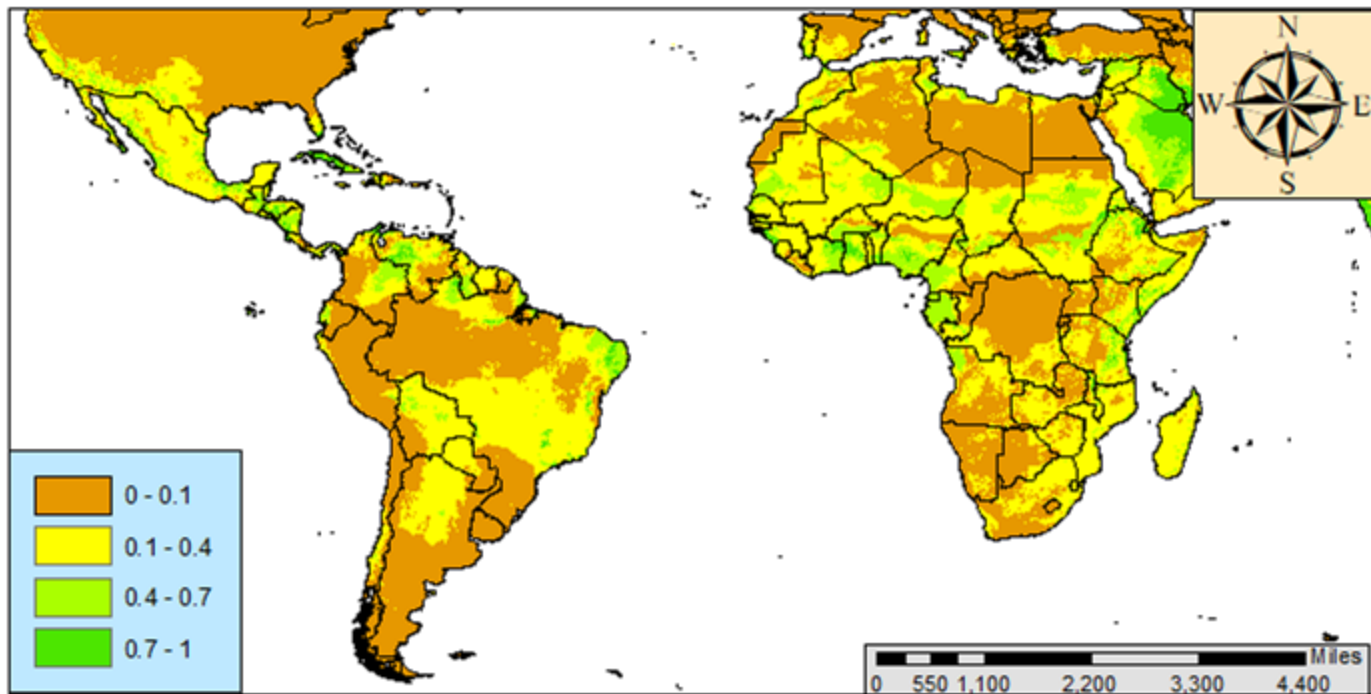
Map 1: scores of suitability under current climate conditions

Future suitable area for *Apis florea*



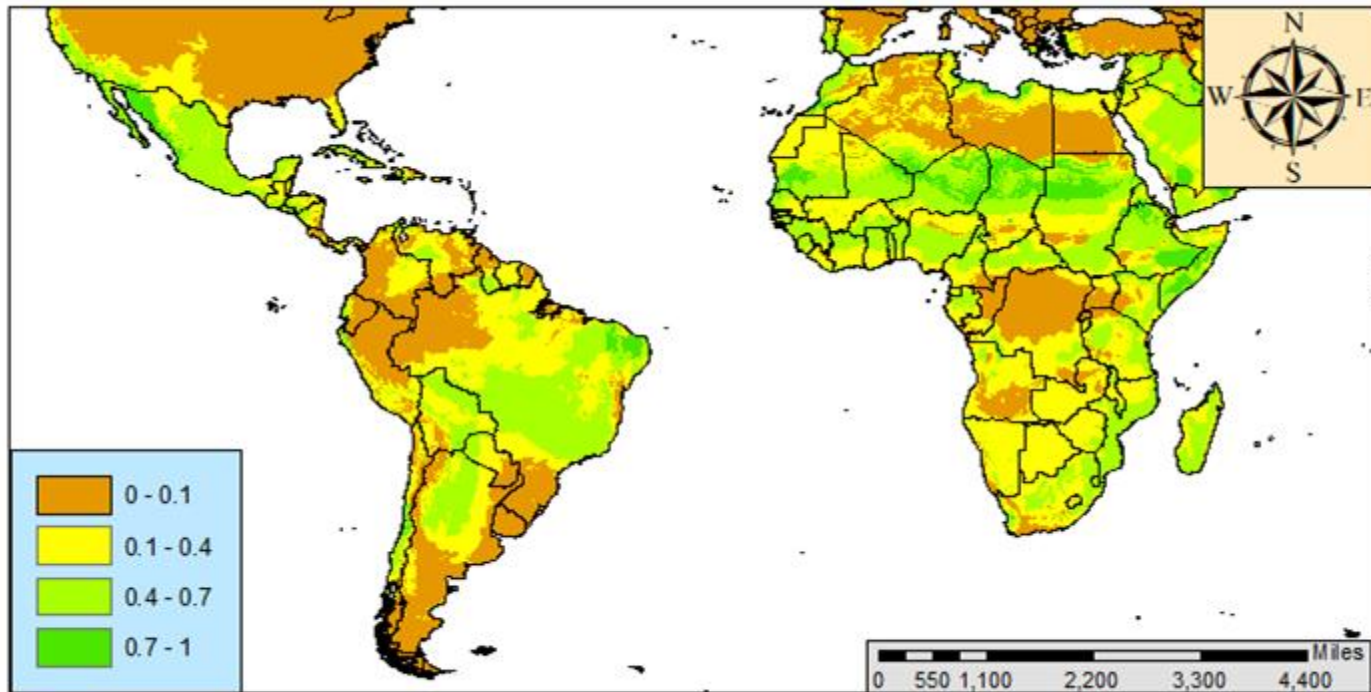
Map 2: suitability scores predicted for 2070s climate conditions

Current suitable range for *Apis florea* in Africa and the Americas



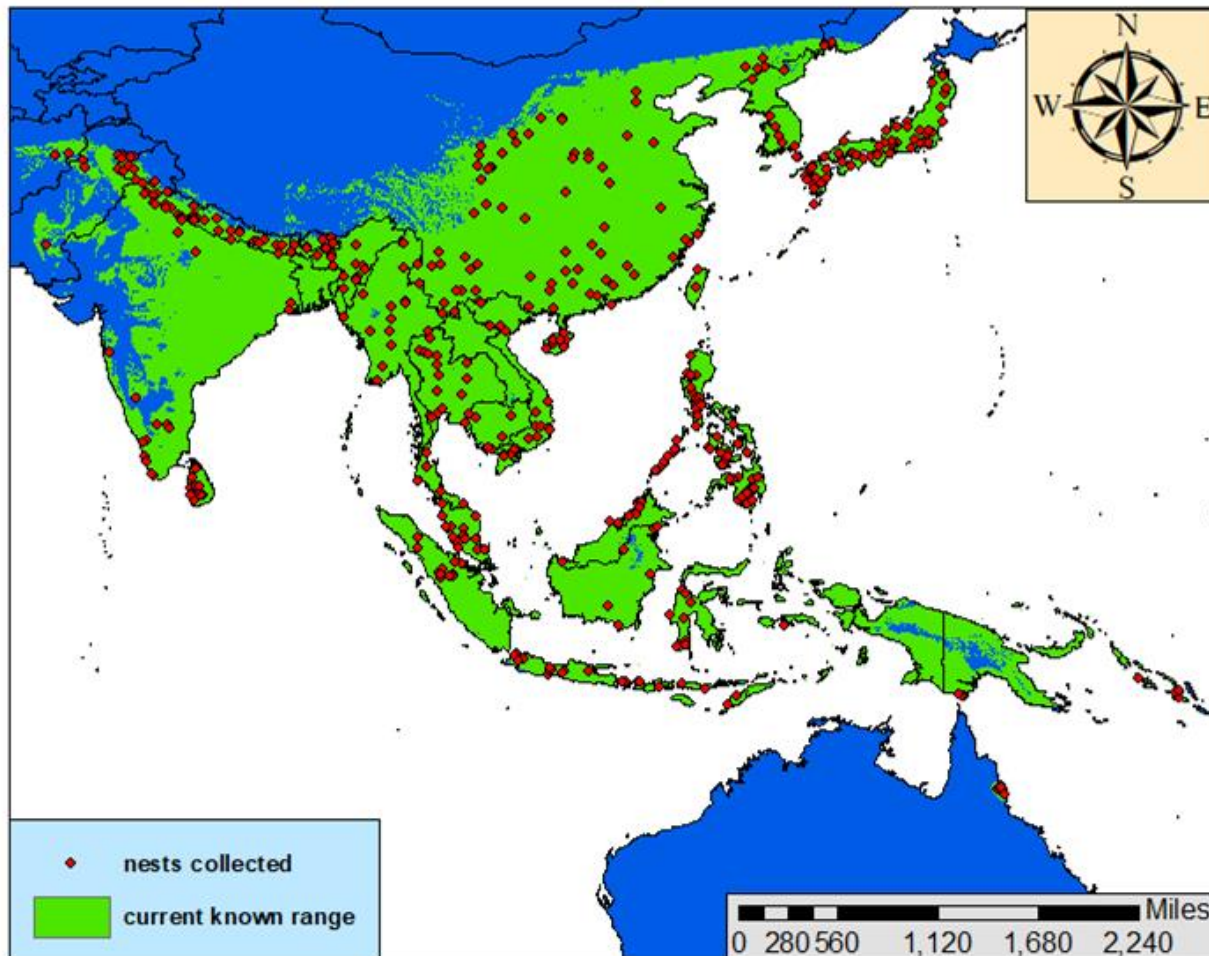
Map 1: scores of suitability under current climate conditions

Future suitable range for *Apis florea* in Africa and the Americas

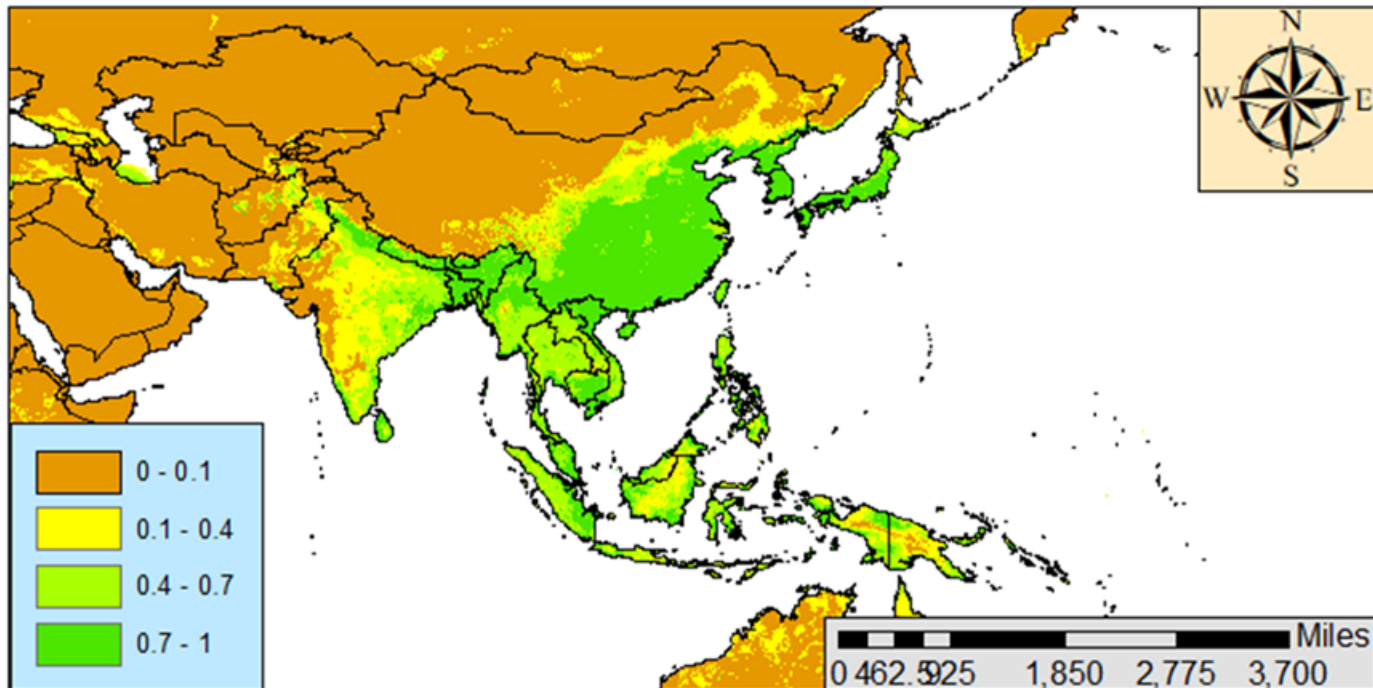


Map 2: suitability scores predicted for 2070s climate conditions

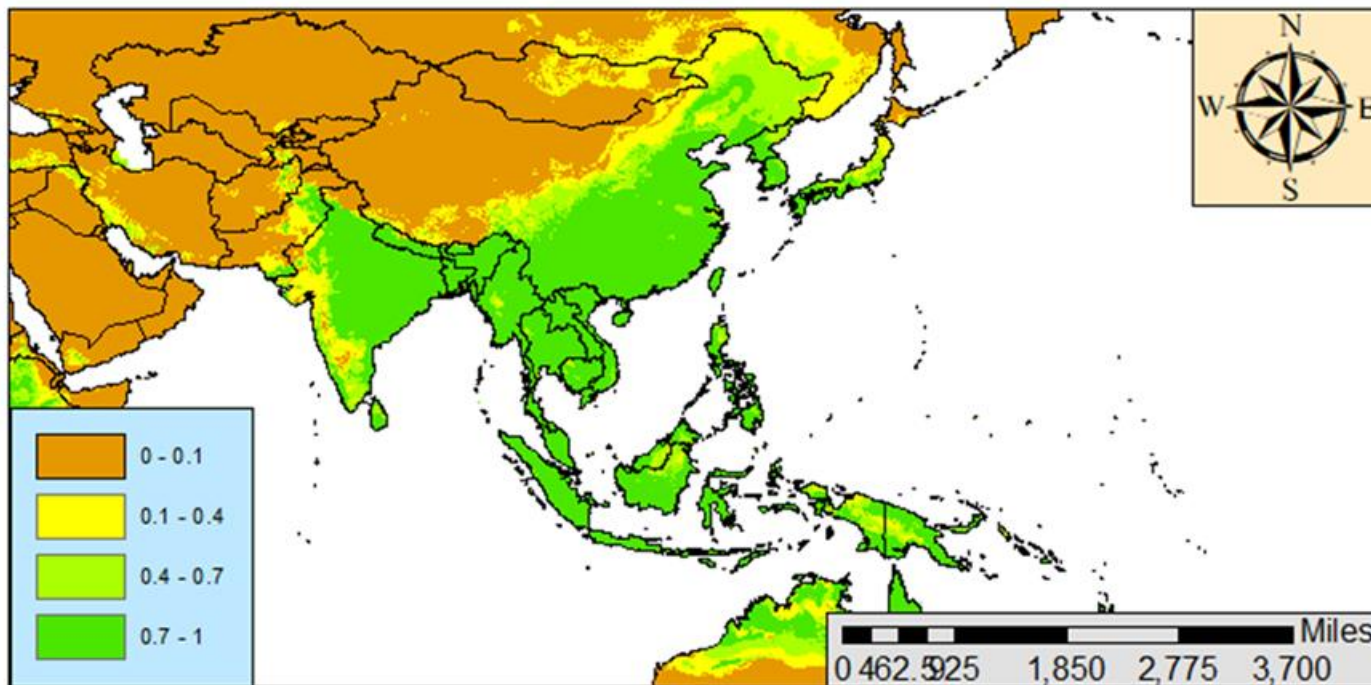
Current predicted range for *Apis cerana*



Current suitable area for *Apis cerana*

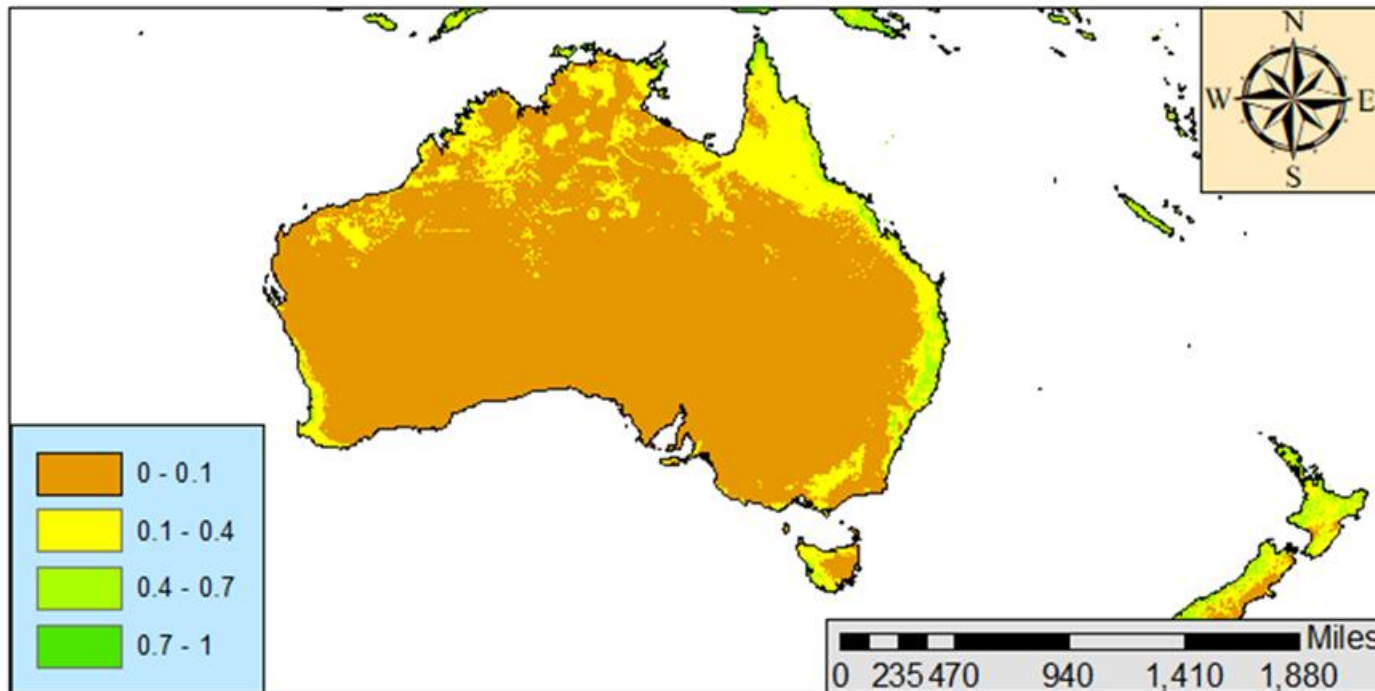


Future suitable area for *Apis cerana*



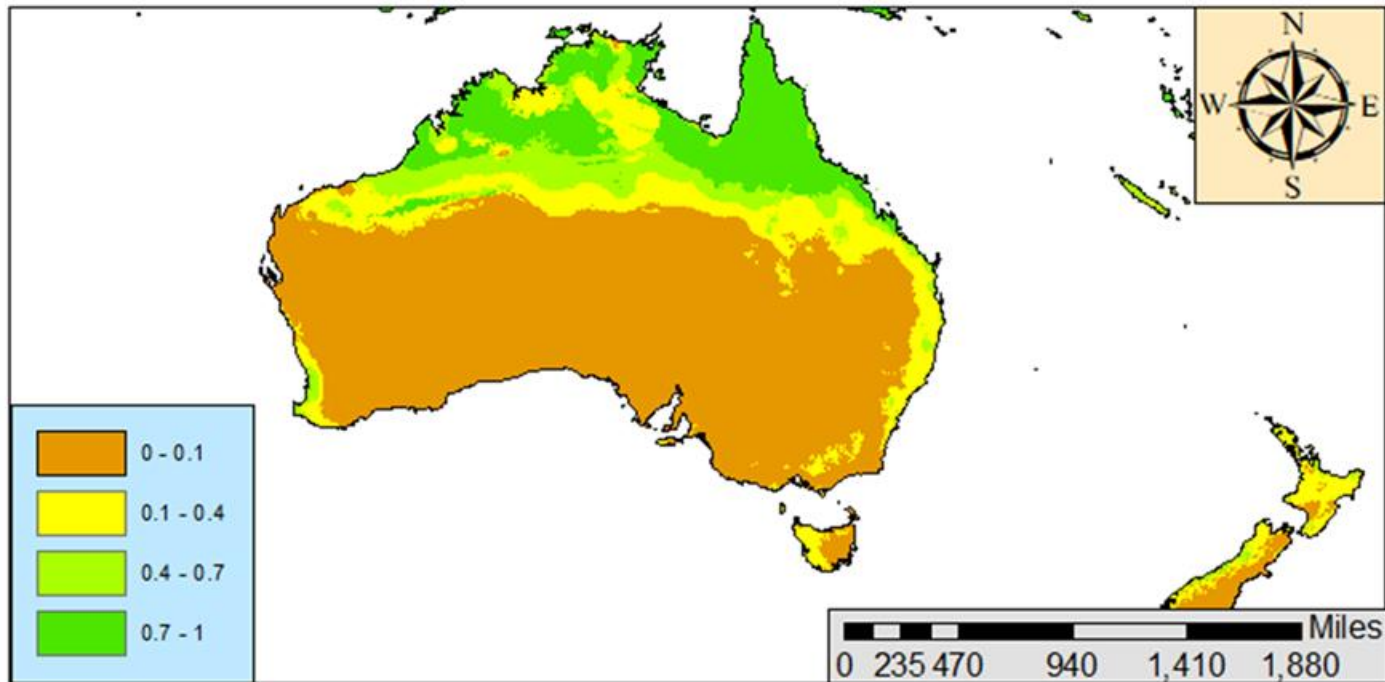
Map 2: scores of suitability predicted for the 2070s climate conditions

Current suitable range for *Apis cerana* in Australia



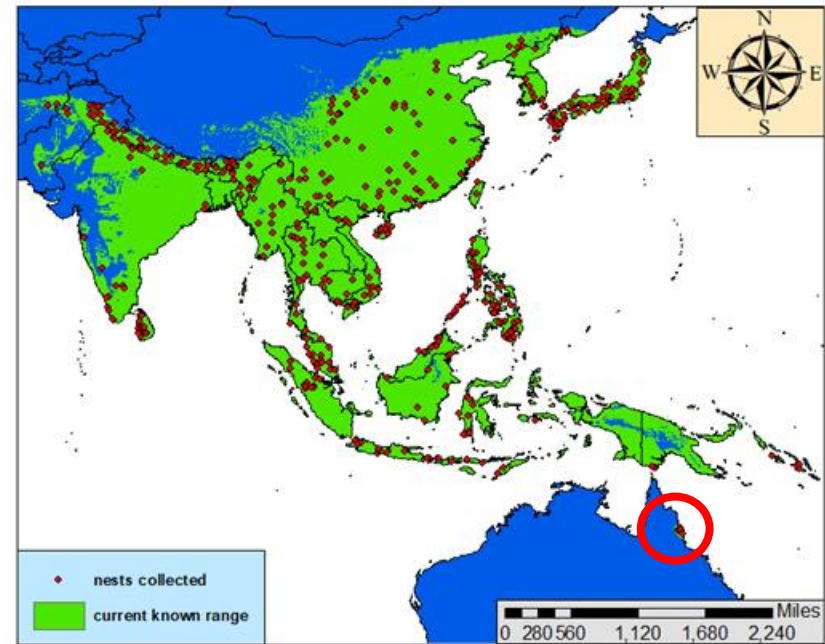
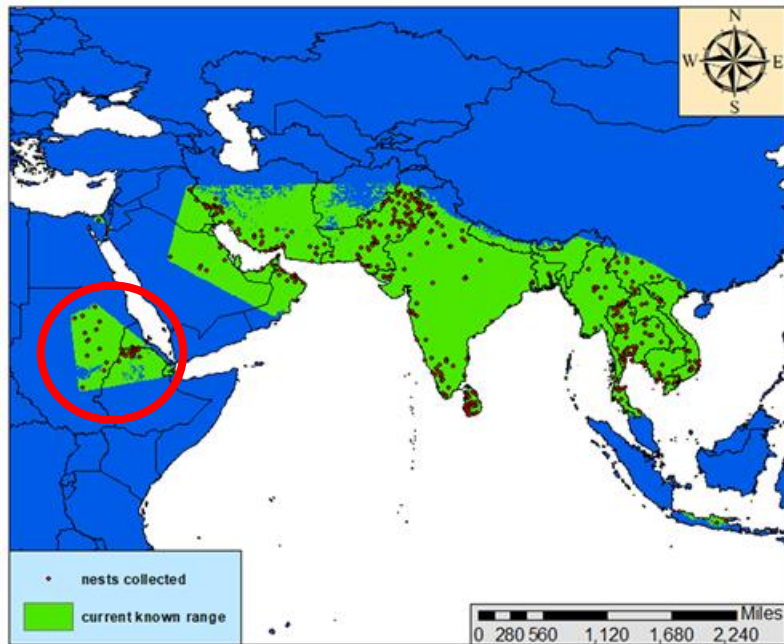
Map 1: scores of suitability under current climate conditions

Future suitable range for *Apis cerana* in Australia

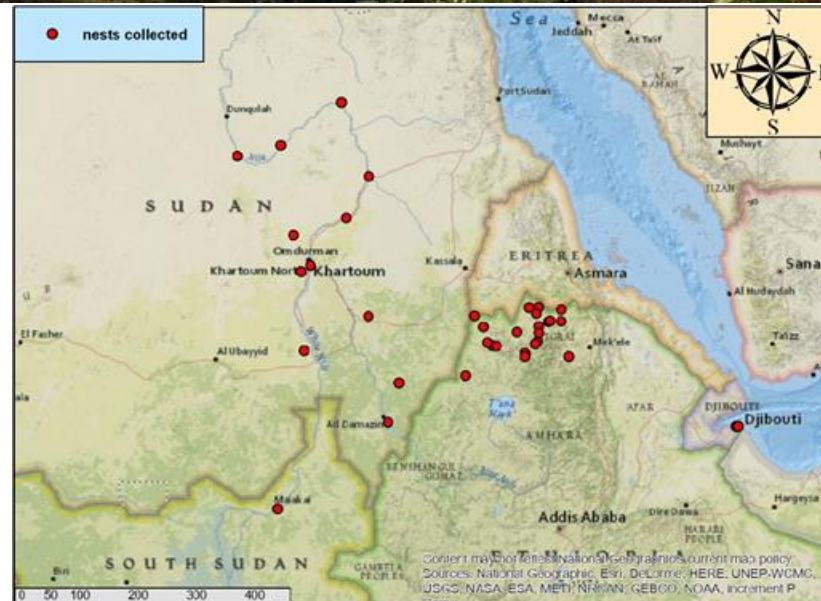


Map 2: scores of suitability predicted for the 2070s climate conditions

How fast are *Apis florea* and *Apis cerana* spreading?



Apis florea range expansion

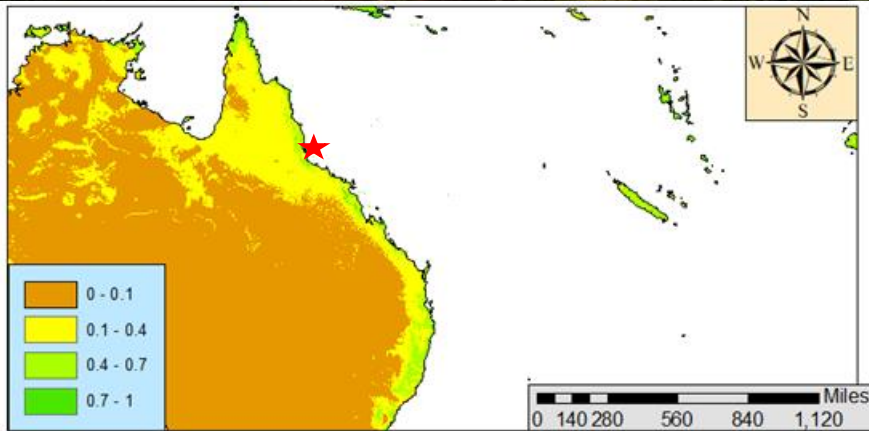


1985 – Khartoum

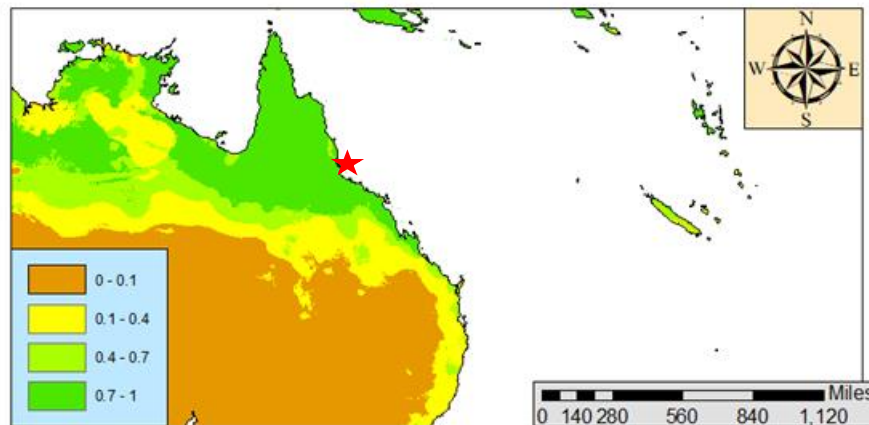
Direction of propagation	Estimated speed of expansion
Khartoum -> North Sudan (along the Nile river)	40.4 km/year
Khartoum -> South Sudan	31.9 km/year
Khartoum -> Djibouti	42.4 km/year

Table 4: speed of expansion estimated for *Apis florea*

Apis cerana range expansion



Map 1: scores of suitability under current climate conditions



Map 2: scores of suitability predicted for the 2070s climate conditions

- The first nest was recorded in 2007.
- The distance between that record and the most distant record (dated of 2012) was measured.
- The speed of expansion towards south of Cairns city calculated was around 13.9 km/year.
- Future climate conditions may release *Apis cerana* from it's Cairn's prison



Climate change and the changing fates of Asia's native honeybees

- Both the red dwarf honeybee (*A. florea*) and the Asian hive bee (*A. cerana*) can be expected to see large range expansions.
- The greatest increase in suitable range will be in the areas of their current range expansions.

In contrast...

- *A. andreniformis* is facing a complete disappearance of suitable climate conditions.
- We propose that this species may be of conservation concern.
- As we model more species under more scenarios, we anticipate more will also fall into this category.

Acknowledgements



Patrick Joanblanq



Jason Lim



myself!

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