Evaluating Global Environmental Changes from 1979 to 2019, to Identify Priority Conservation Areas for Birds

Geographic Information Science, Intl Dv, Community & Environ, Qihui Wang

1. Introduction

Nowadays, global warming is unignorable. In response, changes in climate have caused impacts on natural and human systems on all continents and across the oceans, which means that global species' distributions, populations, and other activities are highly affected by climate changing (AR5 Synthesis Report, n.d.). Therefore, studying environm-ental changes to identify priority protected areas is of significance to species protection.

In this study, global 19 bioclimatic variables from 1979 to 2019 were calculated and used to do the time series analysis to find temporal trends of climate change that are related to species physiology. The species distribution data from the IUCN Red List of Threatened Species™ (IUCN 2020) was used to calculate birds' diversity. Finally, the global Priority Conservation Areas for birds were identified by combining the temporal change in 19 bioclimatic variables with birds' diversity

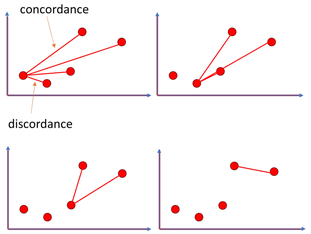
2. Data used

- **Climate data:** ERA5 monthly minimum air temperature at 2m height, maximum air temperature at 2m height and total precipitation data with 0.25 degrees resolution from 1979 to 2019(Copernicus climate change service (C3S(2017)).
- **The species distributions data:** Birds dataset from IUCN Red List of Threatened Species™ (IUCN 2020).

3. Methods

Bioclimate variables and Time series analysis: "RGEE" package and "dismo" package (Robert J. Hijmans et al.) in R was used to calculate 19 global bioclimate variables as shown in table 1 from 1979 to 2019. Then TerrSet was used to create time series of bioclimate variables raster images and to explore those correlations with a linear trend. In this study, I mainly focused on the monotonic trend (Mann-Kendall), a trend indicator that measures the degree to which a trend is consistently increasing or decreasing, having a range from -1 to +1.

Identifying Priority Conservation Areas: I used bird distribution range dataset to calculate the bird diversity on each pixel in 2019, then reclassified it into 3 using Natural Breaks. I calculated the mean values and standard deviation values of monotonic trends for each 19 bioclimate variables and used them to reclassify each of 19 monotonic trends into 3 classes. Combing the reclassified temporal change for every 19 bioclimatic variables with reclassified birds' diversity, I got the 19 kinds of global Priority Conservation Areas for birds based on 19 bioclimatic variables.



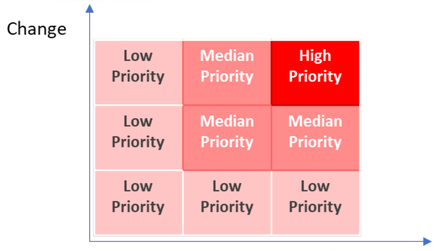
The X-axis represents time, and the Y-axis represents pixel value.

- monotonic trend = p(concordance) – p(discordance) = (8/10) – (2/10) = 0.6

Fig 1. An example how's the monotonic trend calculated

Tab 2 & Fig 2. Criterions for reclassification

Classes	Diversity Value Range	Classes	Monotonic Trend Value Range
Low Diversity	[0,5)	Low Change	between 1 std from mean
Median Diversity	[5,16)	Median Change	between 2 std to 1 std from mean
High Diversity	[16,68]	High Change	above 2 std from mean



Tab 1. 19 Bioclimate variables with descriptions

Variable	Description	Variable	Description
BIO1	Annual Mean Temperature (◦C)	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 (◦C)	BIO6	Min Temperature of Coldest Month (◦C)
BIO7	Temperature Annual Range (BIO5-BIO6)	BIO8	Mean Temperature of Wettest Quarter (◦C)
BIO9	Mean Temperature of Driest Quarter (◦C)	BIO10	Mean Temperature of Warmest Quarter (◦C)
BIO11	Mean Temperature of Coldest Quarter (◦C)	BIO12	Annual Precipitation (mm)
BIO13	Precipitation of Wettest Month (mm)	BIO14	Precipitation of Driest Month (mm)
BIO15	Precipitation Seasonality (Coefficient of Variation)	BIO16	Precipitation of Wettest Quarter (mm)
BIO17	Precipitation of Driest Quarter (mm)	BIO18	Precipitation of Warmest Quarter (mm)
BIO19	Precipitation of Coldest Quarter (mm)		

4. Results

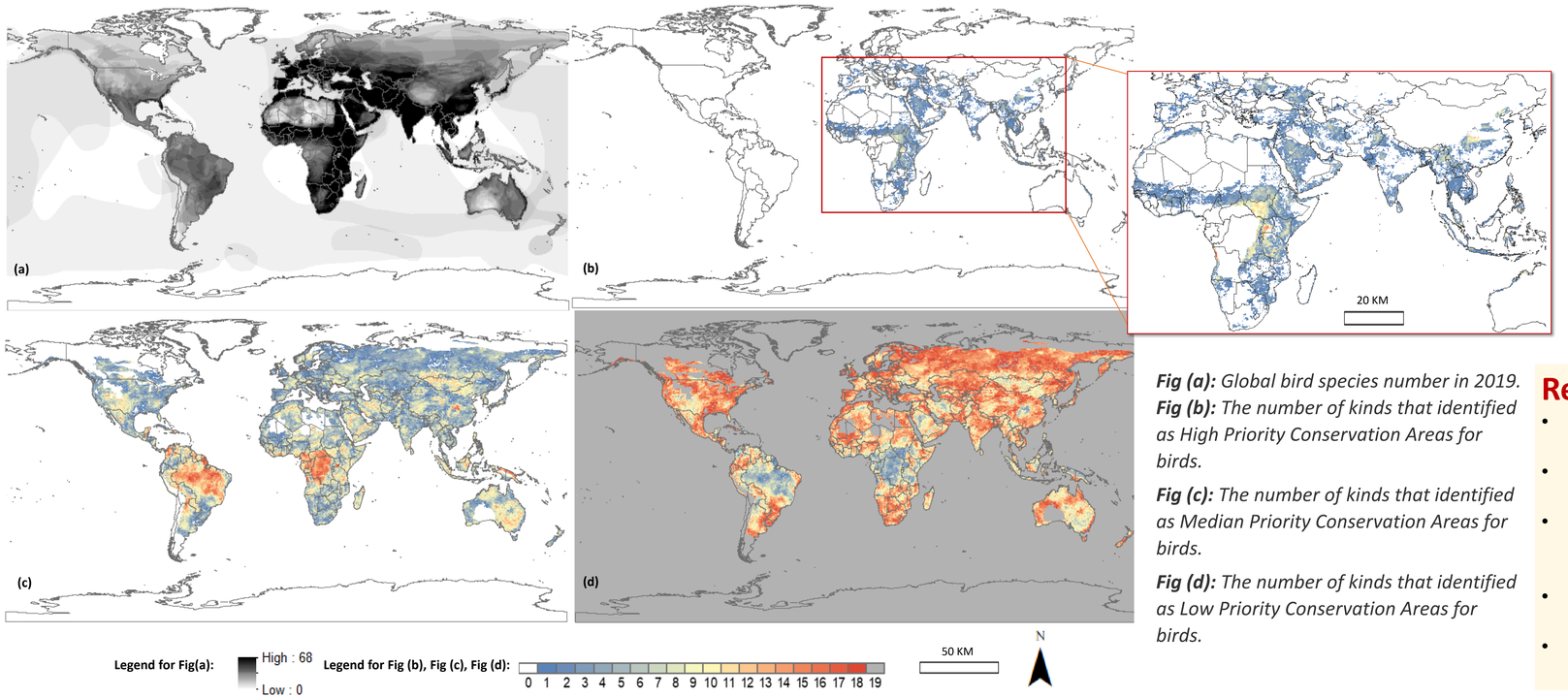


Fig (a): *Global bird species number in 2019.*
Fig (b): *The number of kinds that identified as High Priority Conservation Areas for birds.*

Fig (c): *The number of kinds that identified as Median Priority Conservation Areas for birds.*

Fig (d): *The number of kinds that identified as Low Priority Conservation Areas for birds.*

5. Discussion and Conclusion

- Fig (a) showed, except for Greenland and Antarctica, generally, the total number of different bird species on lands is higher than that on oceans.
- Fig (b) showed in the central part of Africa(e.g., South Sudan, Uganda, the Democratic Republic of the Congo, Angola) and center of China(near Sichuan and Chongqing), more than 9 of 19 kinds of Priority Conservation Areas maps identified those areas as High Priority Conservation Areas.
- Fig (c) showed a similar spatial pattern to the spatial pattern in Fig (b) that Median Priority Conservation Areas were identified in more than 13 kinds of maps. Besides those areas mentioned above, the middle of South America, as well as the northern coastal part of Indonesia and Papua New Guinea, are also included.

References:

- AR5 Synthesis Report: Climate Change 2014 — IPCC. (n.d.). Retrieved November 30, 2020, from https://www.ipcc.ch/report/ar5/syr/
- C Aybar, Q Wu, L Bautista, R Yali and A Barja (2020) rgee: An R package for interacting with Google Earth Engine Journal of Open-Source Software URL https://github.com/r-spatial/rgee/.
- Copernicus Climate Change Service (C3S) (2017): ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate. Copernicus Climate Change Service Climate Data Store (CDS), (date of access: 2020.08.28), https://cds.climate.copernicus.eu/cdsapp#!/home
- Hijmans, R. J., Phillips, S., & Elith, J. L. and J. (2020). dismo: Species Distribution Modeling (1.3-3) [Computer software]. https://CRAN.R-project.org/package=dismo
- IUCN 2020. The IUCN Red List of Threatened Species. Version 2020-2. https://www.iucnredlist.org. Downloaded on 09 July 2020.