A Multi-State Evaluation of the Climate Change Preparedness of Terrestrial Protected Regions

Frances Marie Panday[1], Diyang Cui[1], Rachel Lamb[1,2], and George Hurtt[1]

[1]University of Maryland
[2]Maryland Department of the Environment

April 16, 2023

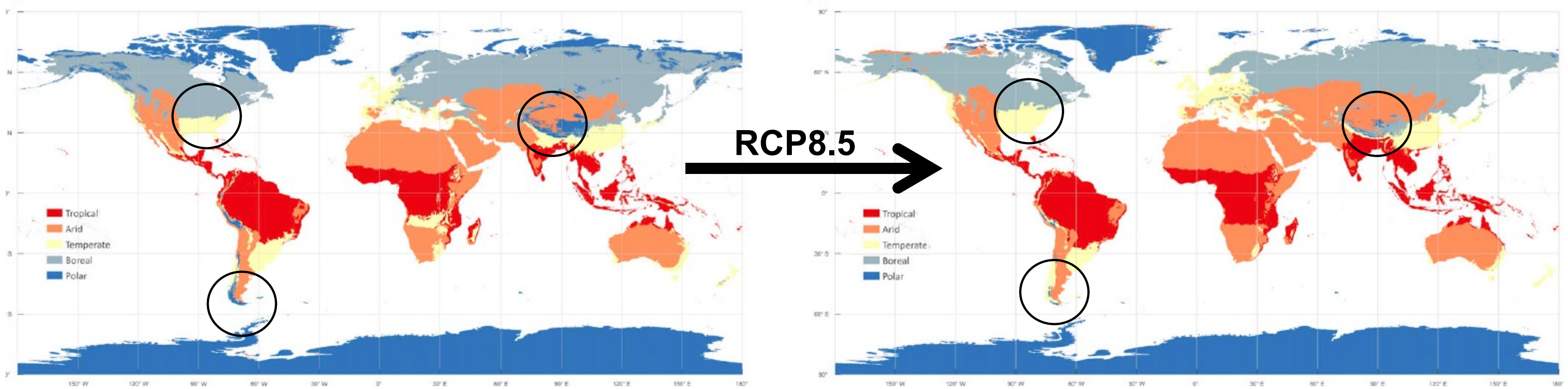
DEPARTMENT OF
GEOGRAPHICAL
SCIENCES

A Multi-State Evaluation of the Climate Change Preparedness of Terrestrial Protected Regions

Frances Marie Panday[1], Diyang Cui[1], Rachel Lamb[1,2], and George Hurtt[1]

[1]University of Maryland, College Park,
[2]Maryland Department of the Environment

Climate change (CC) will cause a **redistribution of climate zones** across the landscape[1]



1980-2016

2070-2100

Beck et al., 2018

The **climate velocity** (km/yr) measures the speed and direction at which the climate changes over time[1,3]

Protected areas (PAs) are the best tool for preserving ecosystems[2]

- Current PA management design is **outdated** in climate change **mitigation** and **adaptation**[4]
- Evaluating the climate change vulnerability of PAs is valuable for **species conservation, resource management**, and **climate action planning**

NAIC Cooperation for Wilderness and Protected Area Conservation (2012)

IUCN World Parks Congress (2014)

(1) Chen et al., 2011; Loarie et al., 2009; Cui et al., 2021 (2) Brito-Morales et al., 2018; Ackerly et al., 2010 (3) Carroll et al., 2017 (4) Araújo et al., 2004

Are terrestrial protected areas adequately prepared for incoming climate changes?

Estimate the magnitude of threat by calculating climate velocity of PAs

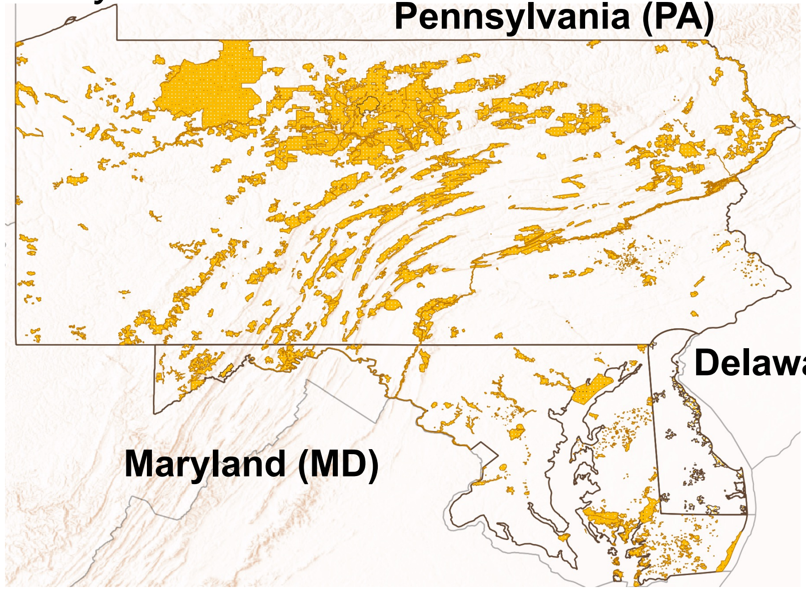
Assess their adaptive capacity to deal with incoming changes by scoring associated plans for CC preparedness

→ ←

Policy relevant research

Climate Change Risk Framework

Study area



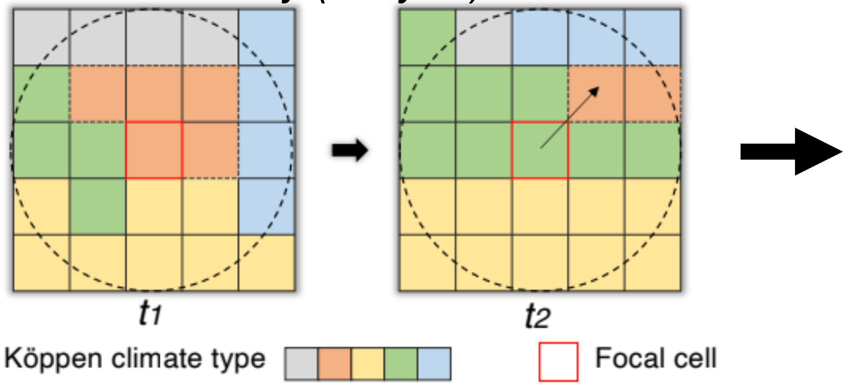
Data sources

- US Census Bureau + State agency's vector boundaries
- Koppen Climate Classifications (Cui et al., 2021)
- Climate zone velocity grids (Cui et al., 2022 in prep)
- World Database on Protected Areas (WDPA) - federal
- USGS-Protected Area Database (PAD) - local

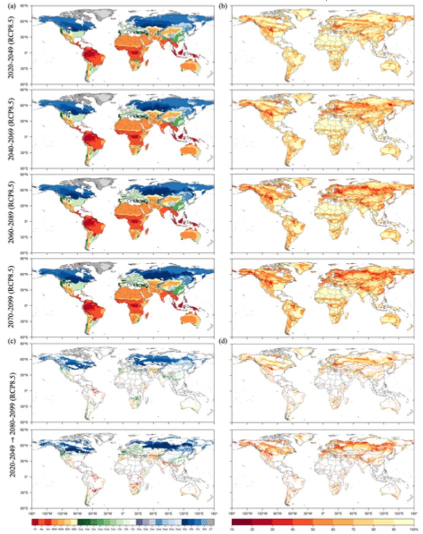
Methods

- Köppen-Geiger Classification Maps
  - Future (2020-2099)
- Climate zone velocity calculation
  - Bioclimatic variables
  - Various time stamps
  - Topography

Climate velocity (km yr $^{-1}$)



Cui et al., 2021



B22D-1473 - Potential shifts of climate zones in global terrestrial protected areas and implications for biodiversity conservation
Tues, Dec 13 9:00am-12:30pm| Poster Hall, Hall A (South, Level 3)

Climate Change Preparedness Framework

Plan Sources

- State agencies (ex. MDNR)
- Local government
- Federal agencies (ex. USFS)
- NGOs

Types of Plans

- Federal guidelines
- Program guidance
- Park-specific management plans
- Resource-specific management plans
- Local climate action plants

Classification categories

Baseline

1. Low
2. Medium
3. High

Planning

1. Low
2. Medium
3. High

Monitoring

1. Low
2. Medium
3. High

Capacity for Adaptive Management to Climate Change

1. High (8 <)
2. Medium (5 -7)
3. Low (< 4)

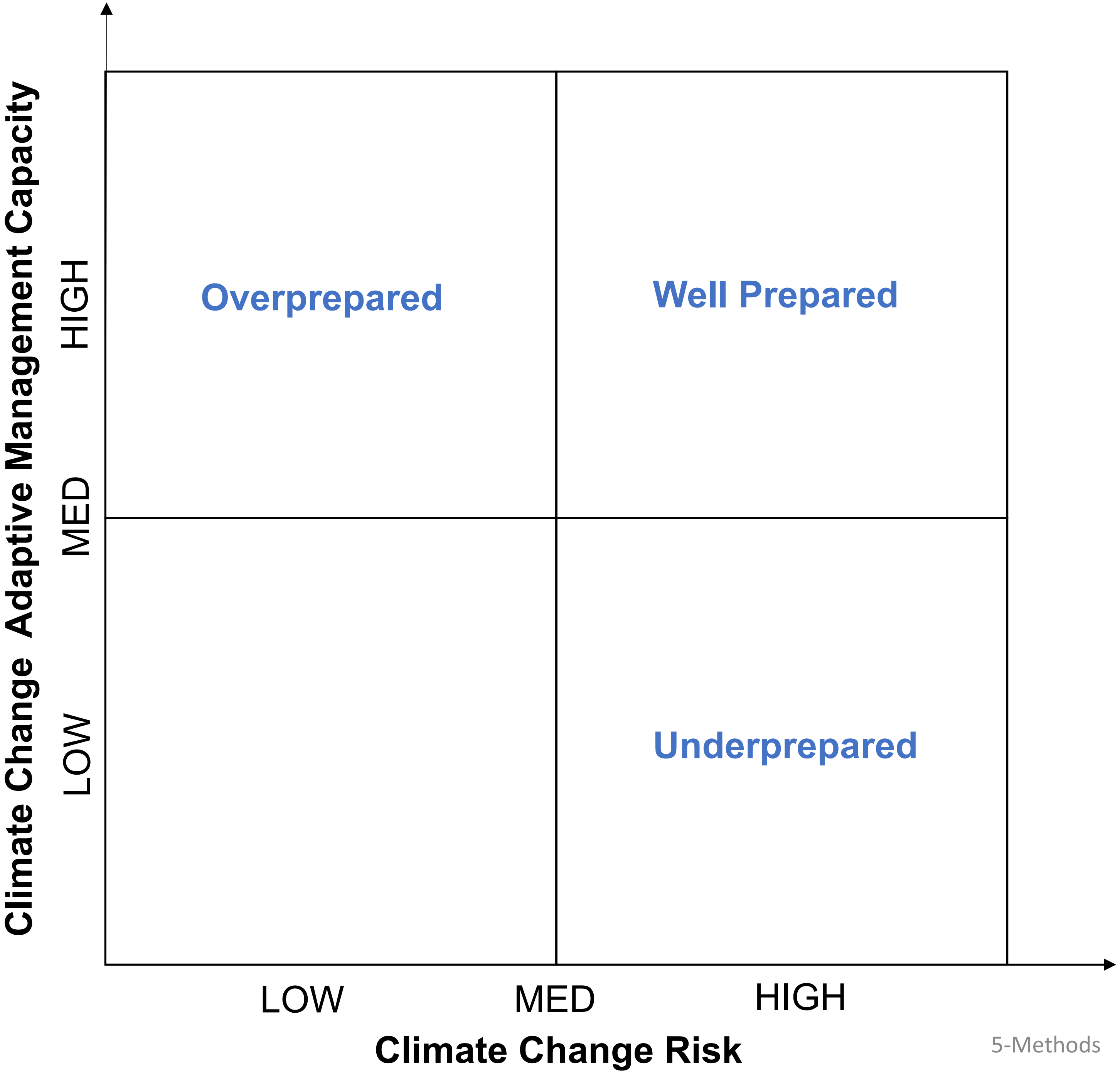
Baseline: Awareness of CC impacts to managed resources
Planning: Level of planned management response to known risk
Monitoring: Planned monitoring and assessment for ongoing planning

Climate Change Preparedness Matrix

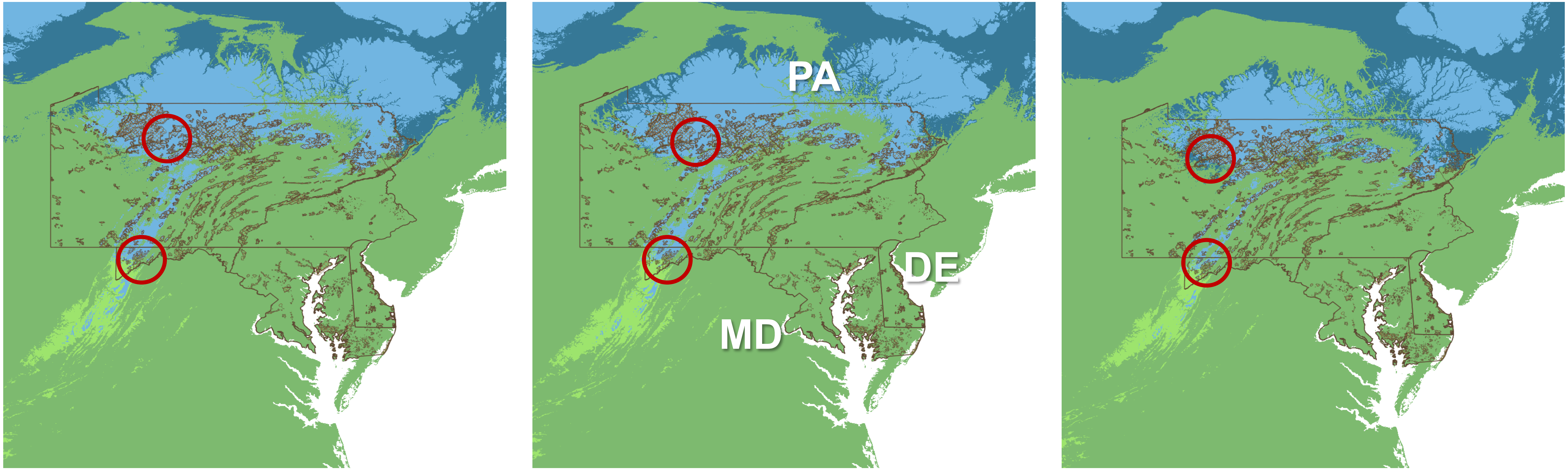
Protected areas and its associated management plans scored for **climate change preparedness** based on:

1. Climate change risk

2. Climate change adaptative management capacity



Shifts in Climate Zones 2020-2099



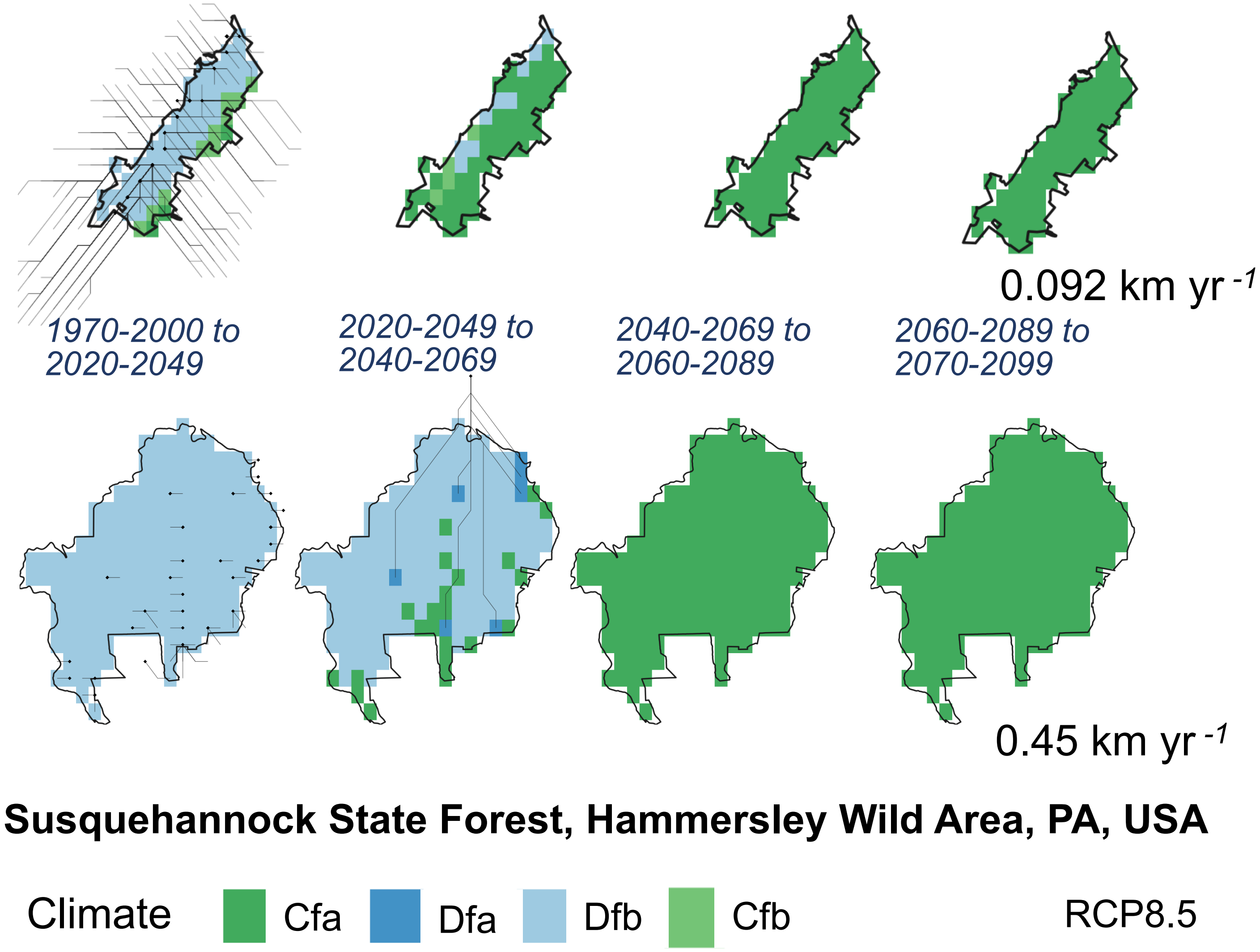
RCP2.6 | **RCP4.5** | **RCP8.5**

- cfa - Temperate, without dry season, hot summer
- cfb - Temperate, without dry season, warm summer
- dfa - Boreal, without dry season, hot summer
- dfb - Boreal, without dry season, warm summer

- Projected shifts **poleward** and **upward**
- Some PAs undergo up to **3 climate zone changes**

Preliminary Results: MD vs PA Case Study

Dans Mountain Wildlife Management Area (WMA), MD, USA



<u>WMA 15-Year Vision Plan, 2016</u>

- IUCN V – Protected Landscape
- Capacity for Adaptive Mgmt: **Medium**
  - **Baseline** - 0
  - **Planning** - 2
  - **Monitoring** – 4
- Preparedness Rank: **Moderately Underprepared**

<u>Resource Management Plan, 2016 + Management Activity Plan, 2022</u>

- IUCN VI – PA with sustainable use of natural resources
- Capacity for Adaptive Mgmt: **Low**
  - **Baseline** - 1
  - **Planning** - 0
  - **Monitoring** – 1
- Preparedness Rank: **Highly Underprepared**

Conclusions

- In **~50 years**, most PAs will have **new climates**
- **Minimal adaptive capacity** and overall **little preparation** for CC related impacts

Next steps → Scale this approach to other states (ex. DE) and quantify impacts towards biodiversity

Recommendations

- Incorporate **updated climate science** and **data** into planning
- **Interagency** and **multilateral** coordination
- **Collaborative** and **adaptive** scales of management

Thank you!
Any questions?

Frances Marie Panday
BS/MS Student
Department of Geographical Sciences
fpanday@umd.edu

Learn more about calculating climate velocity in PAs

Diyang Cui - Tuesday, Dec 13 9:00-12:30
Poster Hall, Hall A (South, Level 3)
B22D-1473 - Potential shifts of climate zones in global terrestrial protected areas and implications for biodiversity conservation

References

Ackerly, D. D., Loarie, S. R., Cornwell, W. K., Weiss, S. B., Hamilton, H., Branciforte, R., & Kraft, N. J. B. (2010). The geography of climate change: implications for conservation biogeography. *Diversity and distributions*, *16*(3), 476-487.

Araújo, M. B., Cabeza, M., Thuiller, W., Hannah, L., & Williams, P. H. (2004). Would climate change drive species out of reserves? An assessment of existing reserve-selection methods. *Global change biology*, *10*(9), 1618-1626.

Beck, H. E., Zimmermann, N. E., McVicar, T. R., Vergopolan, N., Berg, A., & Wood, E. F. (2018). Present and future Köppen–Geiger climate classification maps at 1-km resolution. Scientific Data, 5, 180214. https://doi.org/10.1038/sdata.2018.214

Brito-Morales, I., Molinos, J. G., Schoeman, D. S., Burrows, M. T., Poloczanska, E. S., Brown, C. J., ... & Richardson, A. J. (2018). Climate velocity can inform conservation in a warming world. *Trends in ecology & evolution*, *33*(6), 441-457.

Carroll, C., Roberts, D. R., Michalak, J. L., Lawler, J. J., Nielsen, S. E., Stralberg, D., ... & Wang, T. (2017). Scale-dependent complementarity of climatic velocity and environmental diversity for identifying priority areas for conservation under climate change. *Global Change Biology*, *23*(11), 4508-4520

Chen, I. C., Hill, J. K., Ohlemüller, R., Roy, D. B., & Thomas, C. D. (2011). Rapid range shifts of species associated with high levels of climate warming. *Science*, *333*(6045), 1024-1026.

Cui, D., Liang, S., Wang, D., & Liu, Z. (2021). A 1 km global dataset of historical (1979–2013) and future (2020–2100) Köppen–Geiger climate classification and bioclimatic variables. *Earth System Science Data*, *13*(11), 5087-5114.

Cui, D., Liang, S., Hurtt, G., Liu, Z., Wang, D., & Panday, F.M. (2022, in-prep). Potential shifts of climate zones in global terrestrial protected areas and implications for biodiversity conservation

Hamann, A., Roberts, D. R., Barber, Q. E., Carroll, C., & Nielsen, S. E. (2015). Velocity of climate change algorithms for guiding conservation and management. *Global Change Biology*, *21*(2), 997-1004.

Loarie, S. R., Duffy, P. B., Hamilton, H., Asner, G. P., Field, C. B., & Ackerly, D. D. (2009). The velocity of climate change. *Nature*, *462*(7276), 1052-1055.

Pecl, G. T., Araújo, M. B., Bell, J. D., Blanchard, J., Bonebrake, T. C., Chen, I. C., ... & Williams, S. E. (2017). Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being. *Science*, *355*(6332), eaai9214.