Using species distribution models for predicting climate change impacts on protected areas

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Objective

Protected areas (PA)

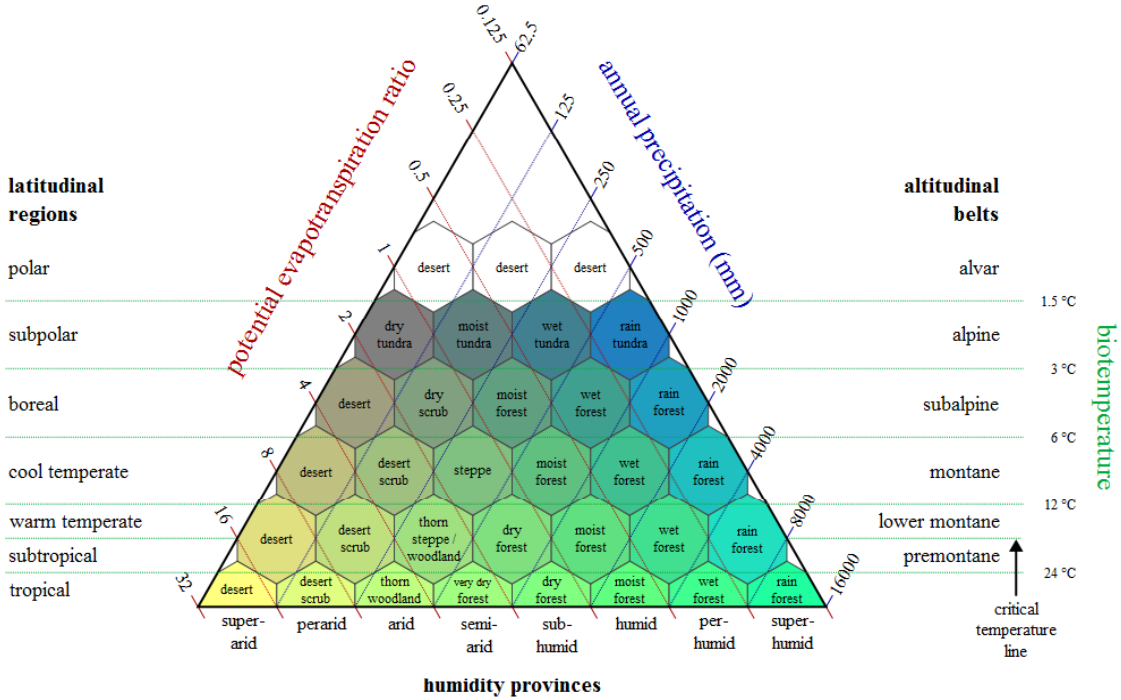
- Assessment of parks at global level
- 130,000 and increasing
- What are the consequences of climate change?
- Will there be other areas that can protect the same animals?
- Will PAs protect the animals or act as prisons?

Context: Web Services

- Results to be used in updated version of APAAT
- DOPA – Digital Observatory of Protected Areas

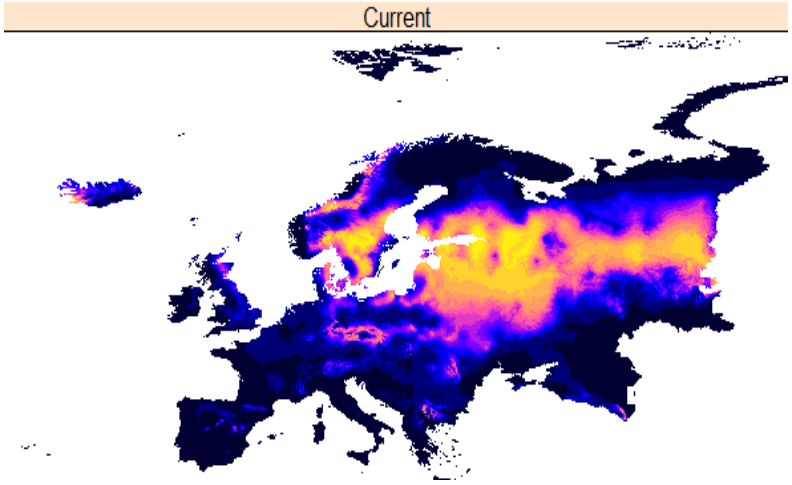
Climate data

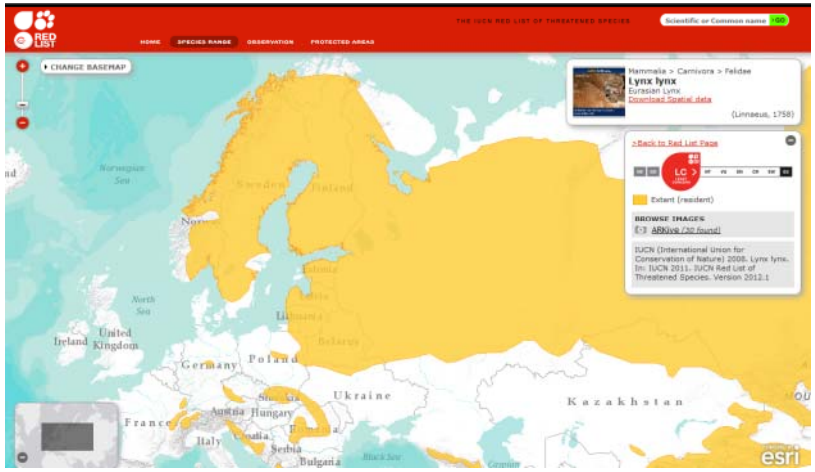
- Using Holdridge variables – current and forecast
- Climate data from WorldClim – 10min
- Examples with HADCM3 A2a scenario – relatively large changes



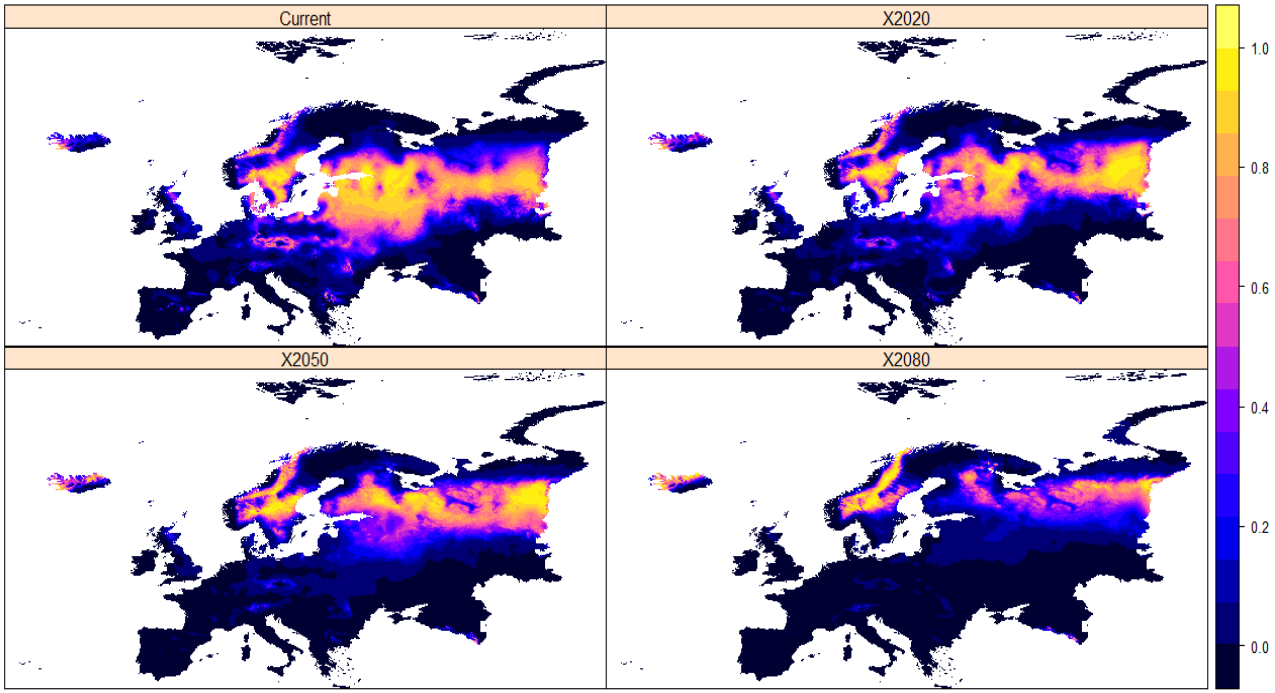
Species distribution models

- Predicts the similarity to a training data set of environmental indicators
- Several methods such as Maxent, Bioclim, Domain, Mahalanobis
- Frequently used for forecasting impacts of climate change on species habitats





Forecast



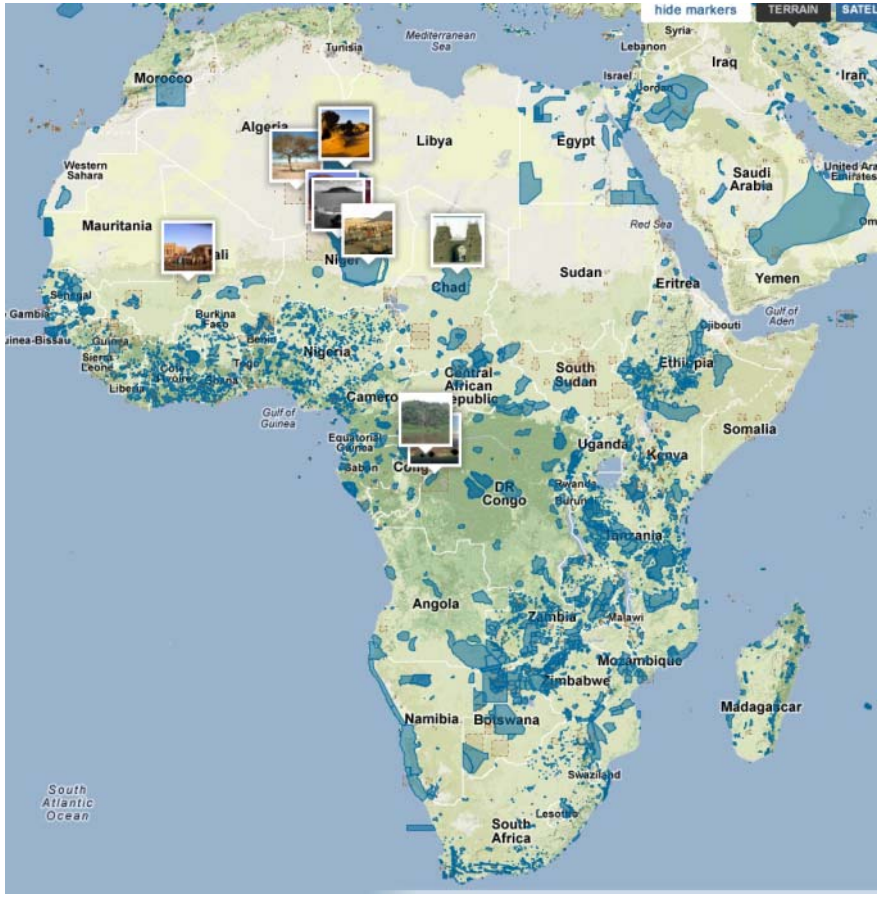
- Some limitations
  - Can be challenging to find the right combination of environmental indicators
  - Is current climate the limiting factor?
  - Will some species be well adapted for new climates?

Predicting impact of climate change for protected areas

We want

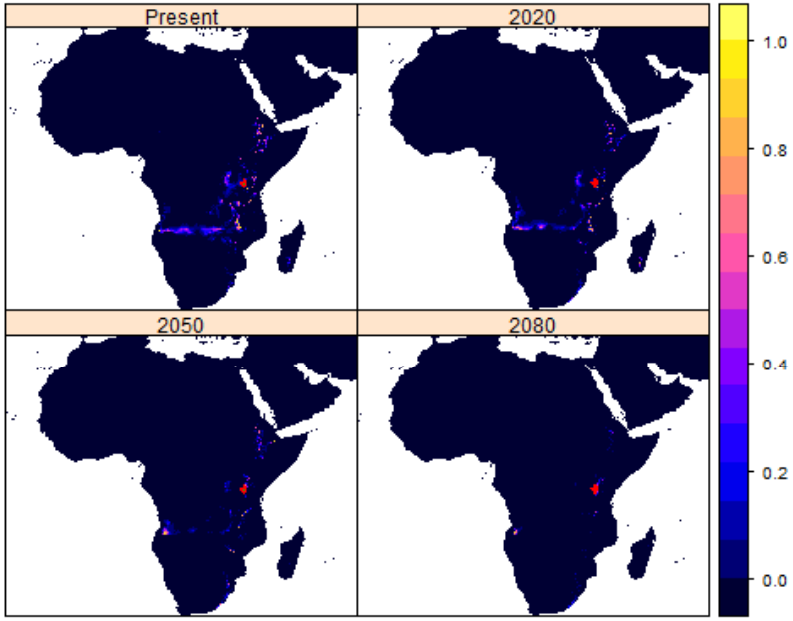
- Method giving PA tolerance for changes, not looking at individual species
- Consistent method easy to apply for large number of parks
- Method finding which parks are more threatened by climate change

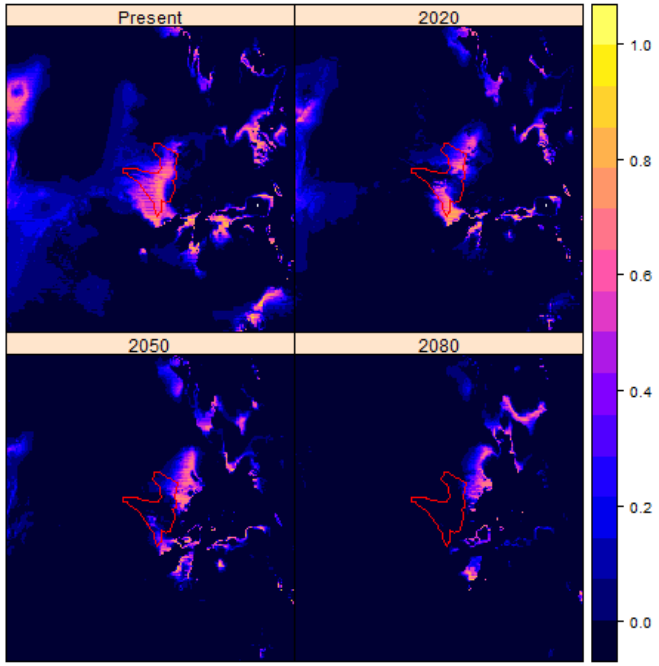
SDMs: Robustness to change depends on variability of training data



Naïve method: Use climate variables from PA

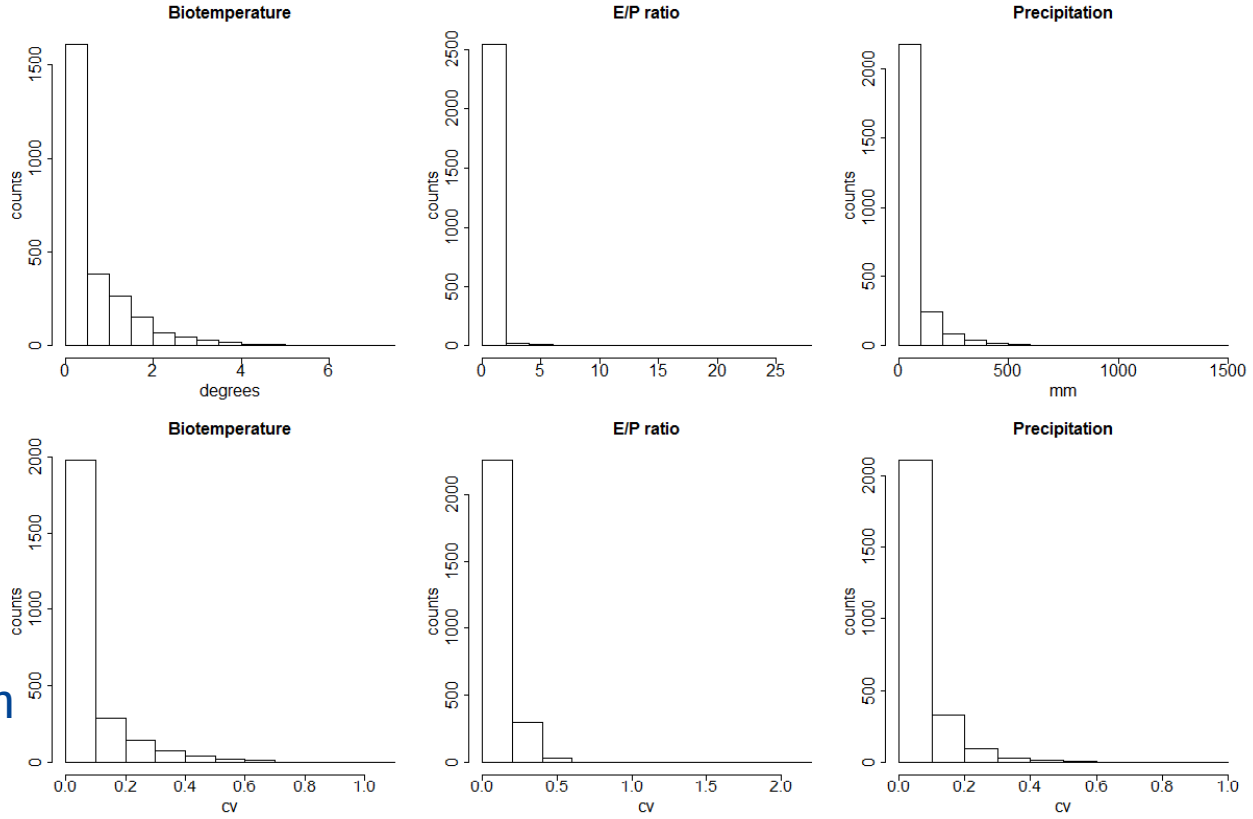
- Large PAs have larger tolerance to changes than small PAs
- Hilly PAs have larger tolerance to changes than homogeneous PAs





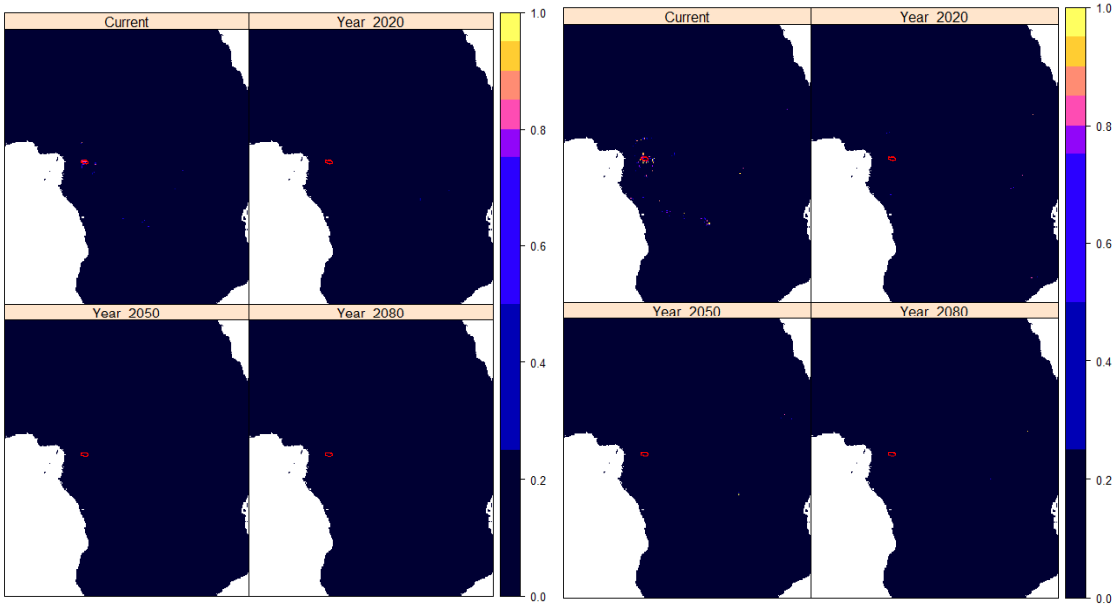
Observed variability within PAs

- Small variability within parks
- Variability based on interpolated maps (smoothing)
- Around 3,000 of the largest parks
- Smaller variability in smaller parks
- Serengeti: 1.2C, 0.14, 85mm



Simple improvement – use minimum variability

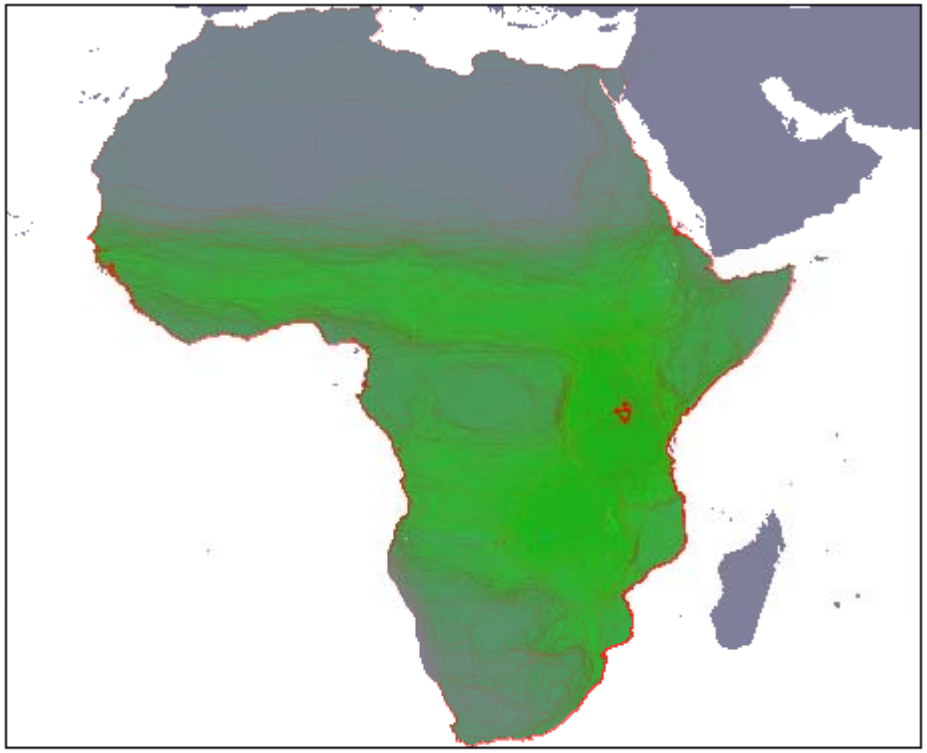
- Compare the estimated variability with a minimum variability
- Modify covariance function if necessary



- Based on guessing
- Computationally fast
- More consistent result
- Not always better result

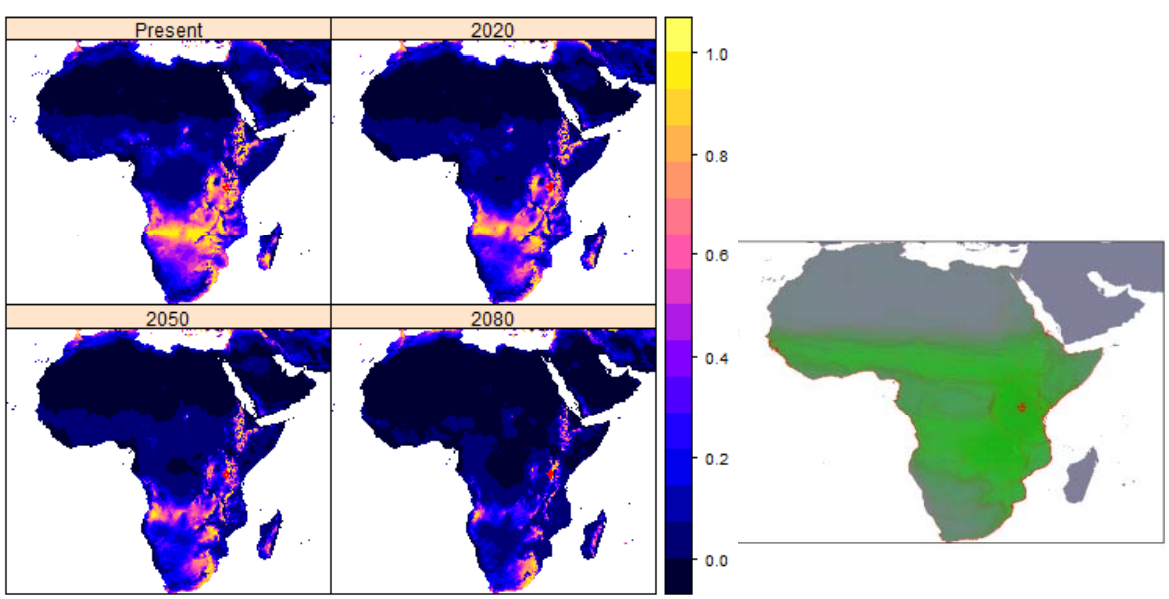
Where do the species in a park live?

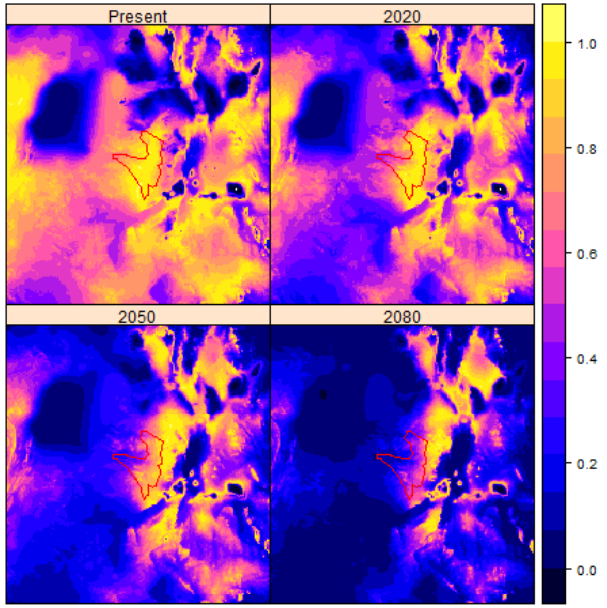
- Include estimated species ranges
- Mean and variance weighted with the presence in the park
- Data sets with high uncertainty
- Likely to overestimate similarity
- Possible to give higher weights to particular animals (red list, endemic species, etc.)



Weighted with species ranges

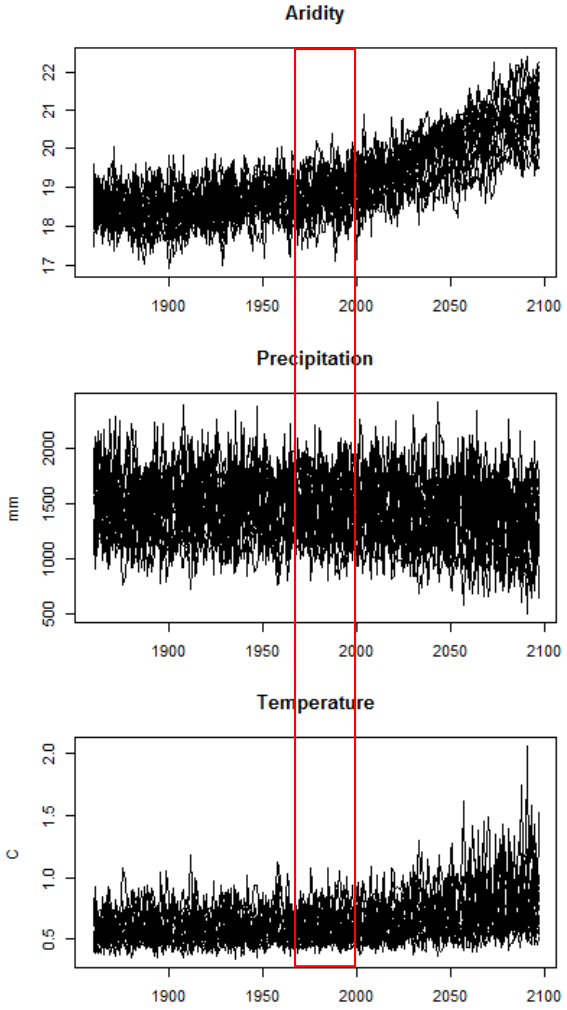
- Most likely overestimating similarity
- Still rather extreme decrease for this park





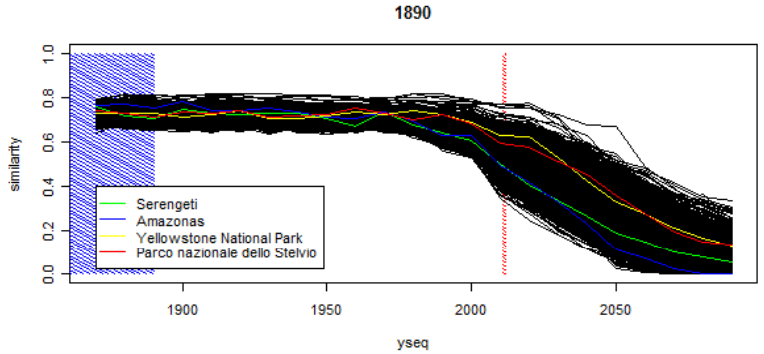
What is the variability today?

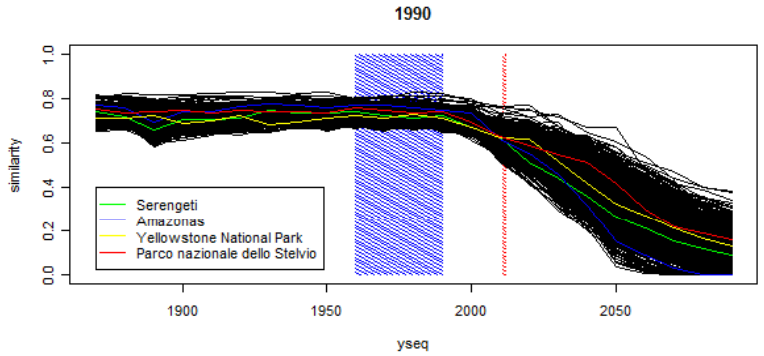
- Use temporal variability as substitute for tolerance
- Time series from HADCM3 model (1859-2098)
- QUMP runs with uncertainty
- Use 30-year period as reference
- Variance represents hindcast climatic variability for a location

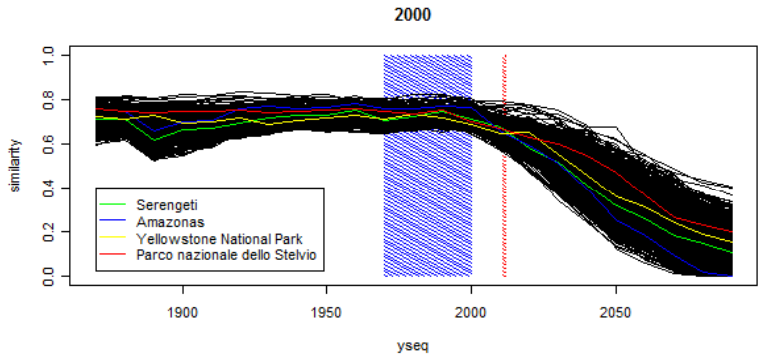


Similarity with the future

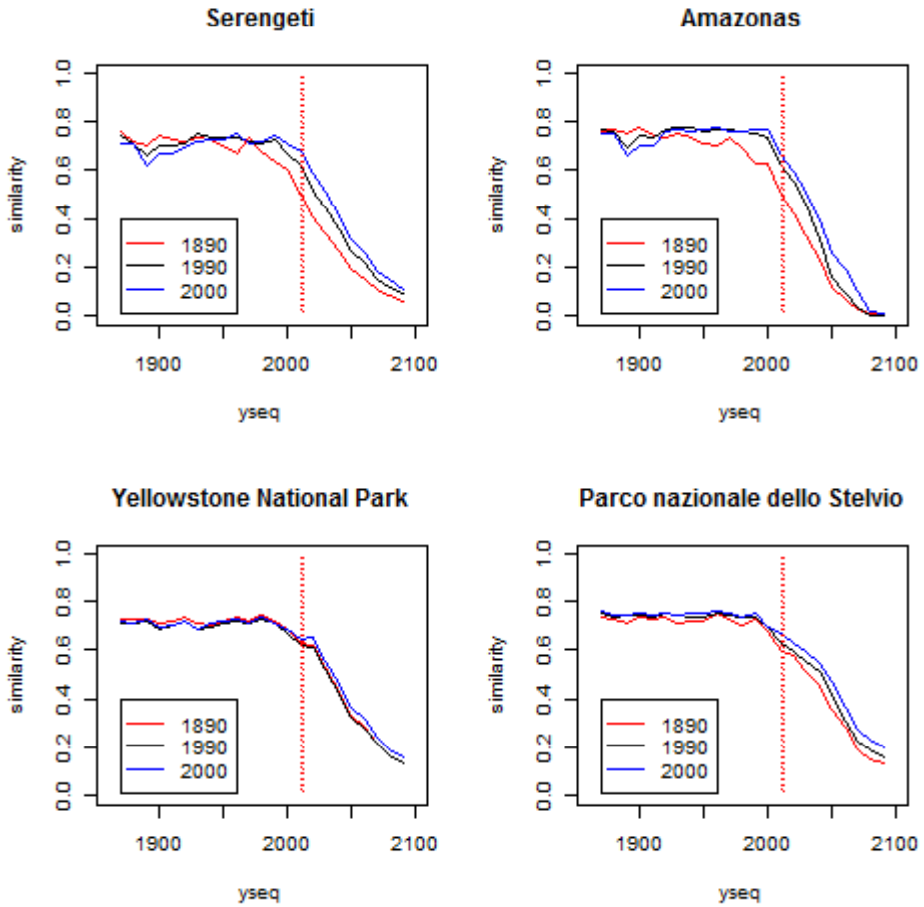
- Similarity between reference period and future climate
- Figure shows median of QUMP runs
- All scenarios show strong decrease, strongest for tropical areas
- Method not yet used for computing similarity maps







Effect of reference period



Conclusions

- Necessary to assess climate change impacts on PAs globally – available through web service
- SDMs are useful – variability of training data defines tolerance for changes
- Four methods – not ranked
- Validity of result for a park depends on reliability of GCMs and downscaling method (Hartley)
- Methods do not take possible thresholds into account - difficult to assess for all parks
- Who will live in new climates?

Thanks!

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