Multivariate Spatio-Temporal Delineation of Ecoclimatic Regions for Evaluating Sampling Network Sites in Turkey

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Rationale/Motivation

- Turkey hosts a wide variety of ecosystem types and is projected to be one of the regions most vulnerable to climate change in the Mediterranean basin.
- Thus, it is urgent to design a framework of ecoclimatic regions to support an 'ecological observatory network' and initiate long-term ecological monitoring studies in Turkey.
- Our study marks the first ‘ecoregionalization’ study for Turkey based on past conditions and future climate scenarios by integrating several environmental factors.
- Furthermore this is the first endeavor to provide optimal sampling sites for ‘ecological observatory network design’ for Turkey.

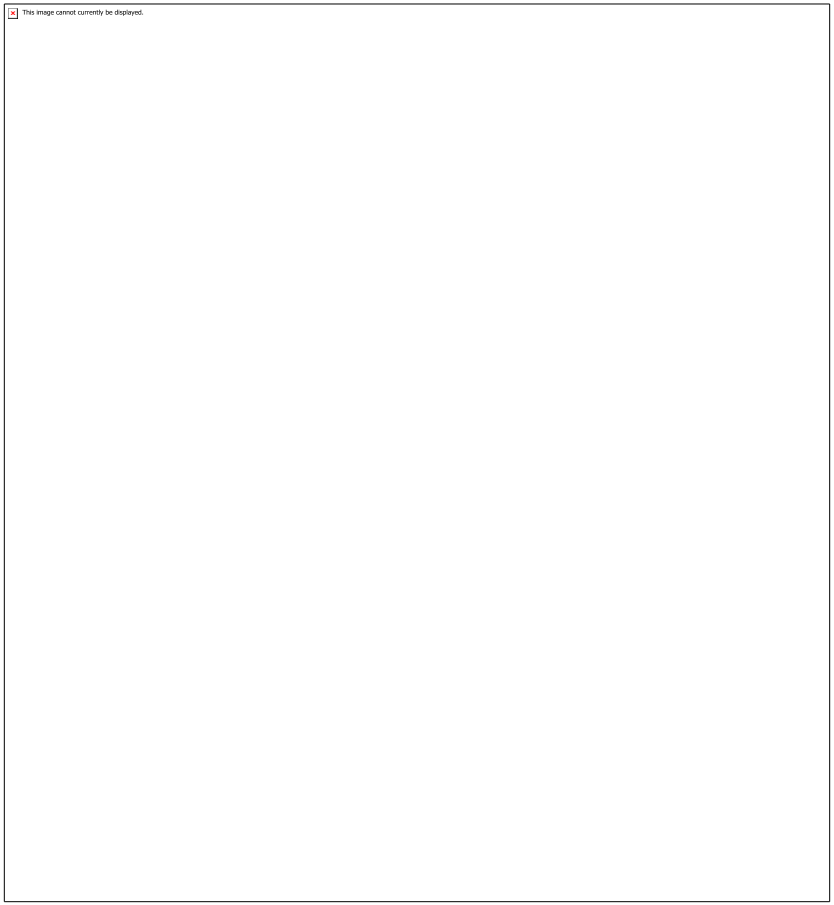
Aim of the study

- We present a multivariate representation of ecoclimatic regions for Turkey at several levels of division and map their contemporary and projected future distributions under the A2 emissions scenario from the ECHAM5 model.

- Using ten ecoclimatic variables (integrating topographic and soil attributes with climatic attributes) we applied multivariate spatio-temporal clustering to quantitatively delineate ecoclimatic regions and to provide optimal sampling sites for a design of a prospective ‘ecological observatory network’ for Turkey.

Generation of *Unique* Input Layers

- Using NCL, NCO, CDO and by developing codes in R following 10 variables were generated which are unique to NEON input layers.
- They are based on ‘growing season’(gs) – definition of ECA



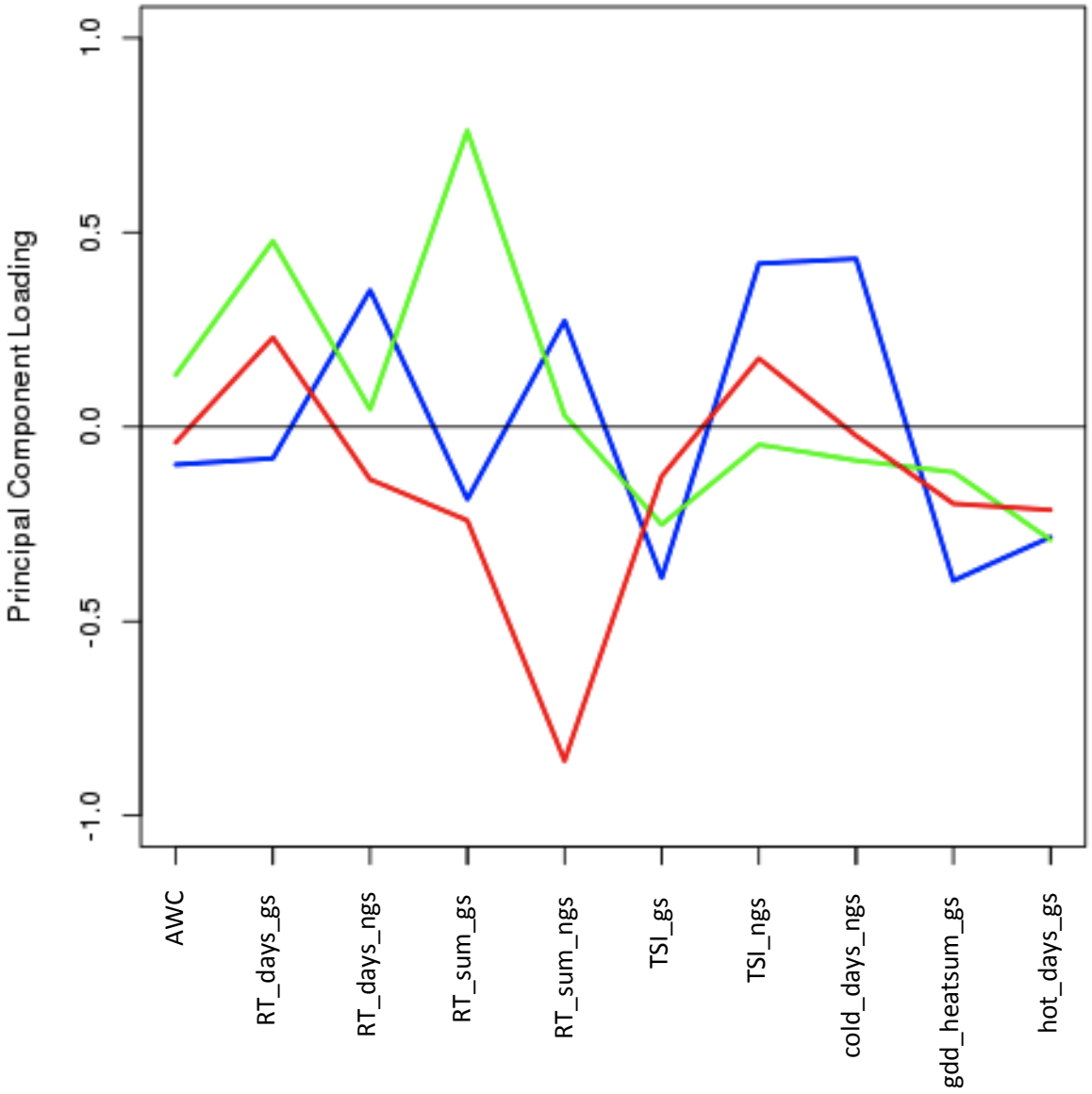
Multivariate Spatio-Temporal Clustering—MSTC
(Hargrove and Hoffman, 2004)*

- We applied the MSTC approach to derive ecoregions based on climatic, edaphic and topographic factors for present and future at multiple levels of division.
- This quantitative delineation of ecoregions across space and through time facilitates assessment of the *magnitude of change* between present and future environmental conditions and enables the evaluation of the ecological implications of climate change scenarios.
- Kumar et al. (2011) extended this approach to a fully distributed, k-means parallel clustering algorithm, which was applied in this study.

* Hargrove, W. W. and Hoffman, F. Potential of multivariate quantitative methods for delineation and visualization of ecoregions. Environ. Manage., 34:S39-60, April 2004.

** Kumar, J. Mills, R.T., Hoffman, F., Hargrove, W. W. Parallel k-Means Clustering for Quantitative Ecoregion Delineation Using Large Data Sets. Proceedings of the International Conference on Computational Science (ICCS 2011), volume 4, Procedia Comput. Sci., pg.1602-1611. Elsevier.

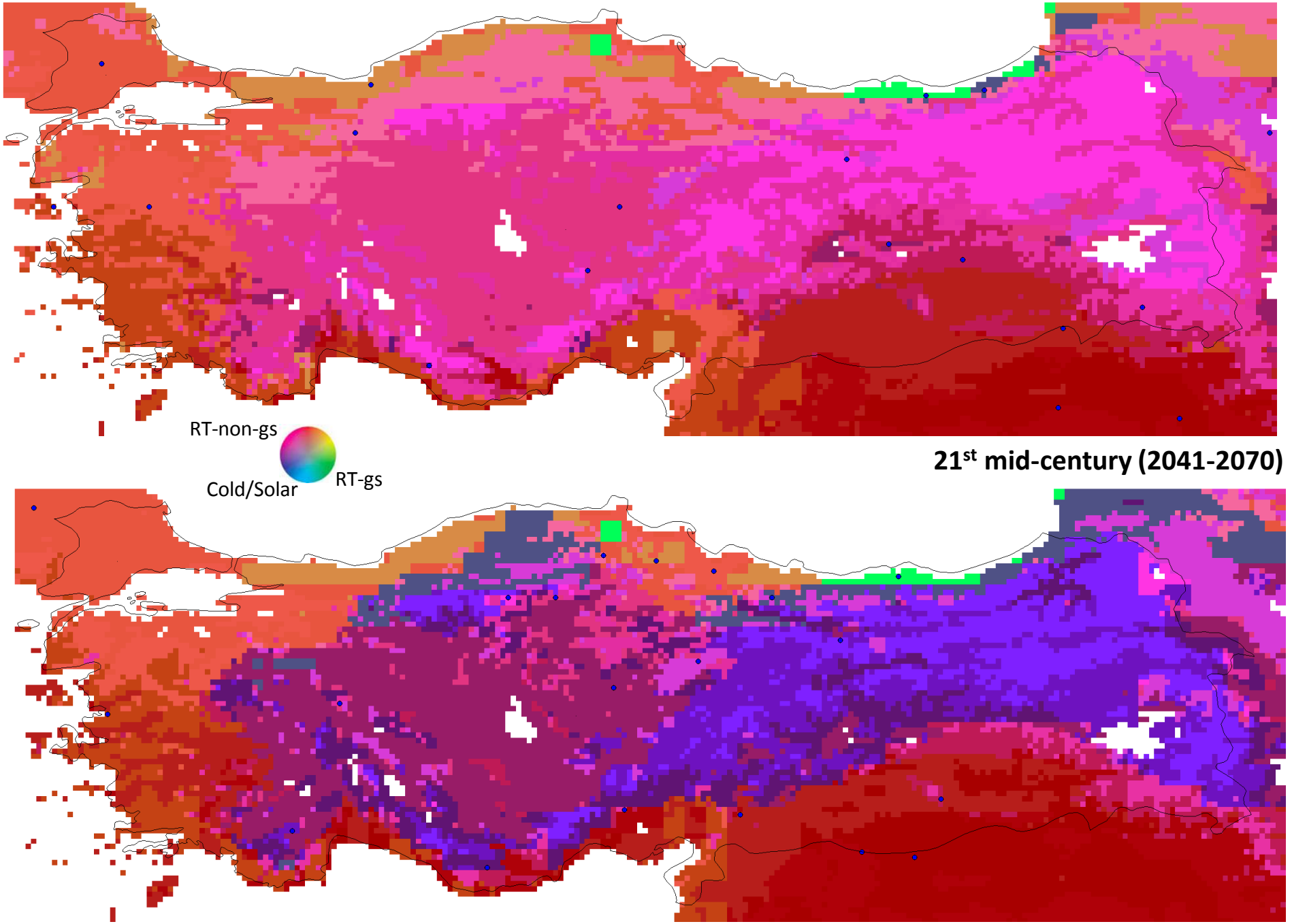
Similarity Color Assignments



RGB Color Code assignment

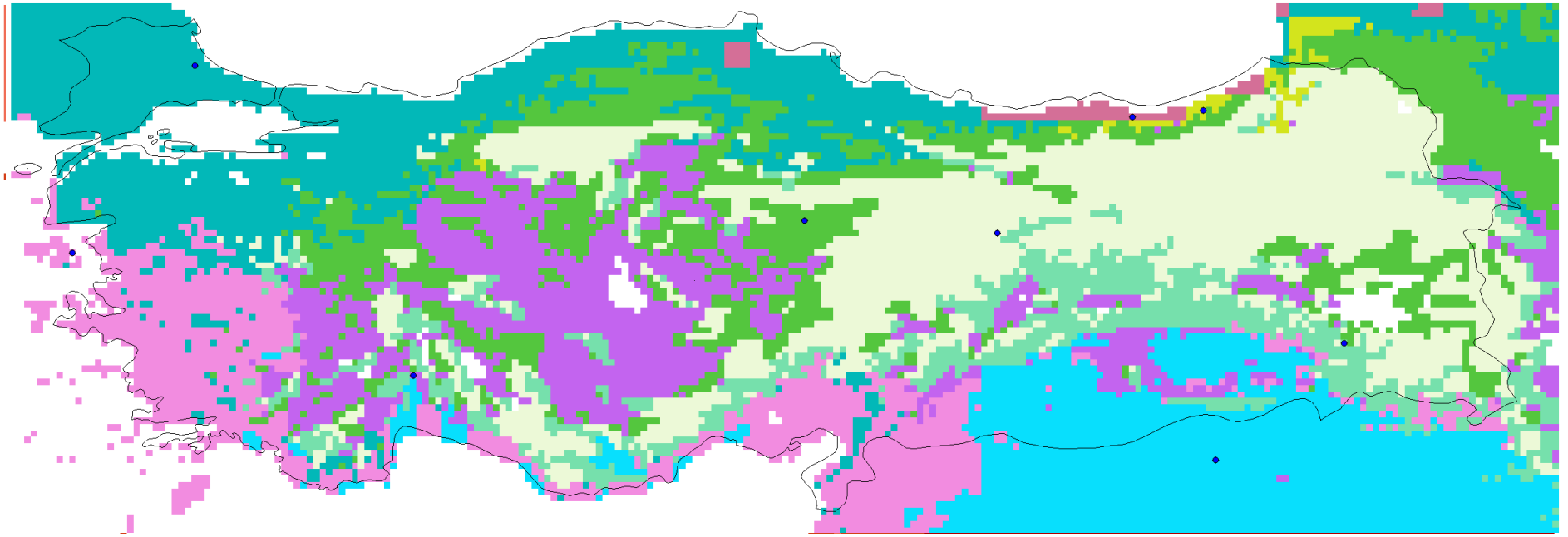
Factor 1: Cold/Solar
Factor 2: Precipitation in the gs
Factor 3: Precipitation in the non-gs

Similarity Color Map of Ecoclimatic Regions-20 Clusters

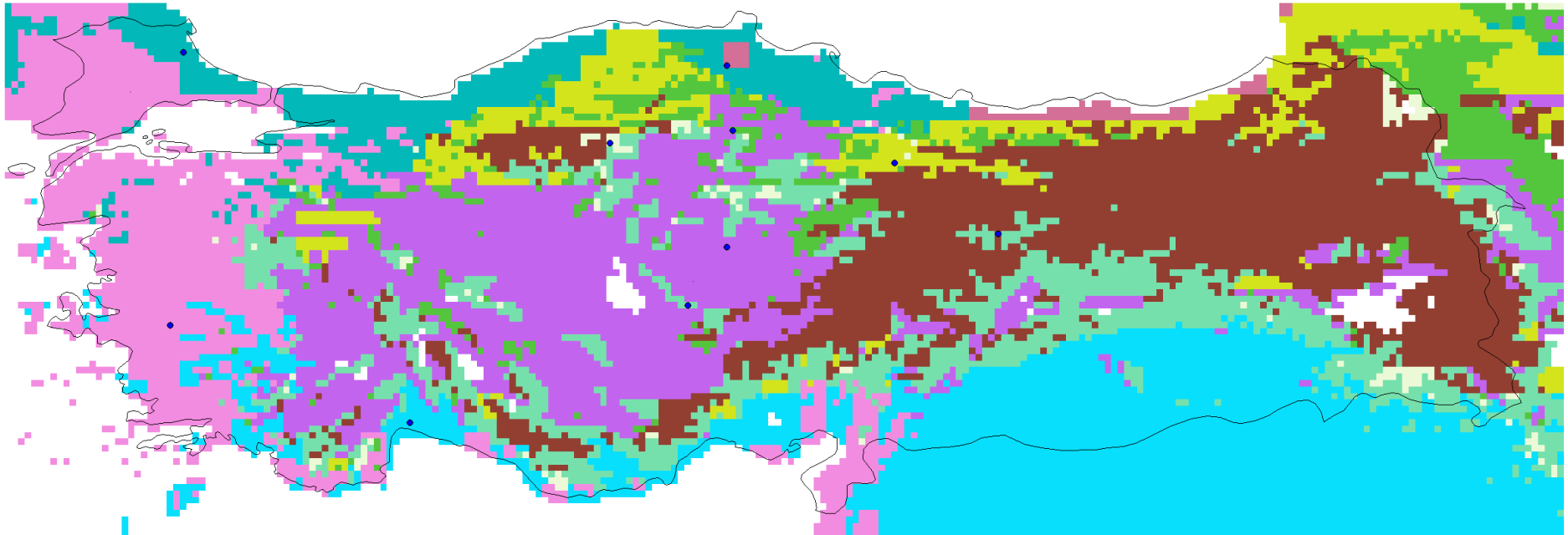


Random Color Map of Ecoclimatic Regions-10 Clusters

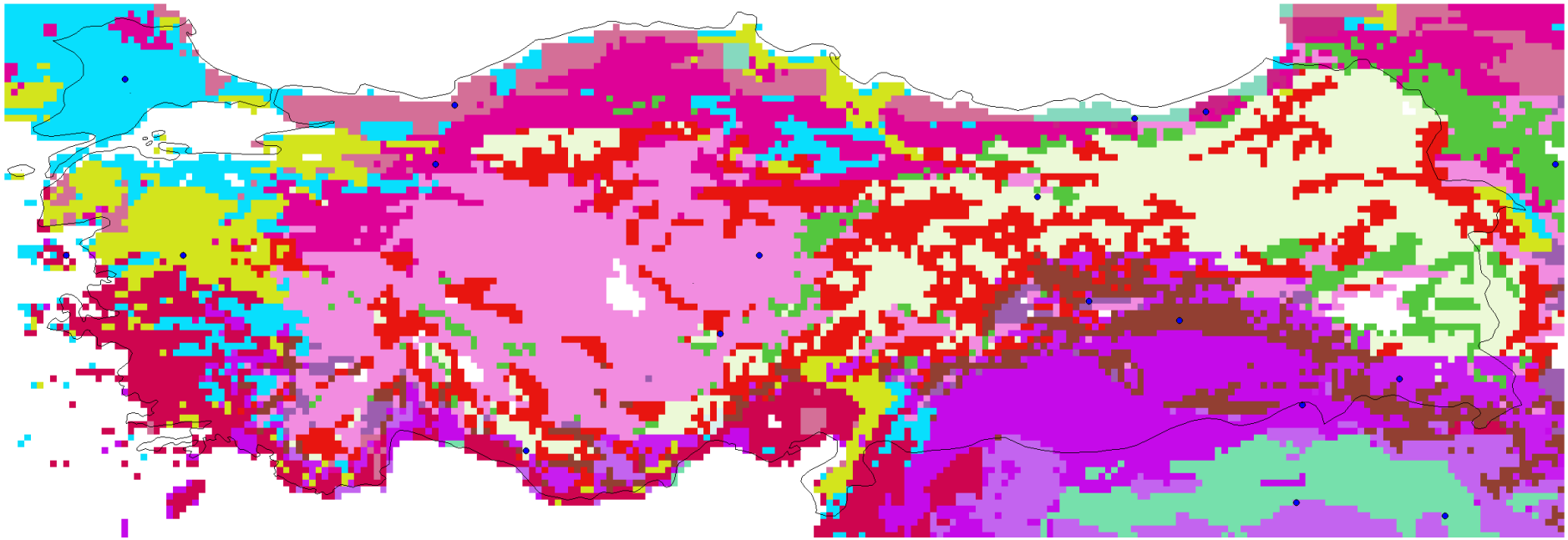
Present

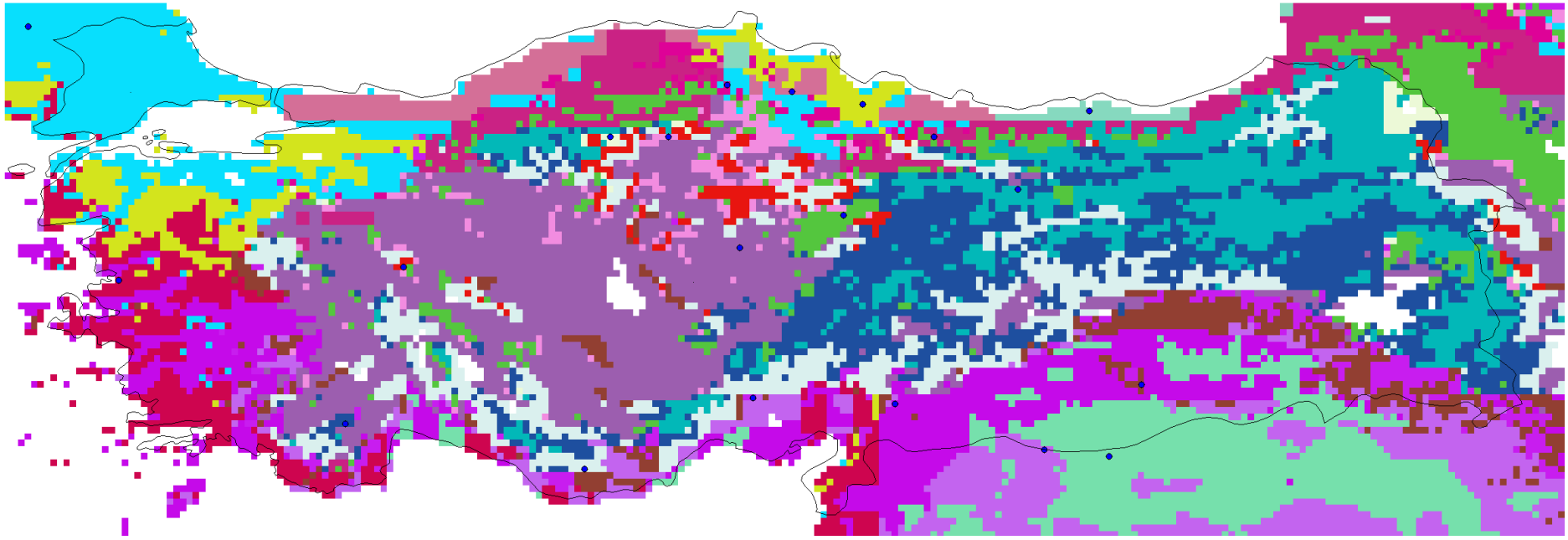


21st mid-century (2041-2070)



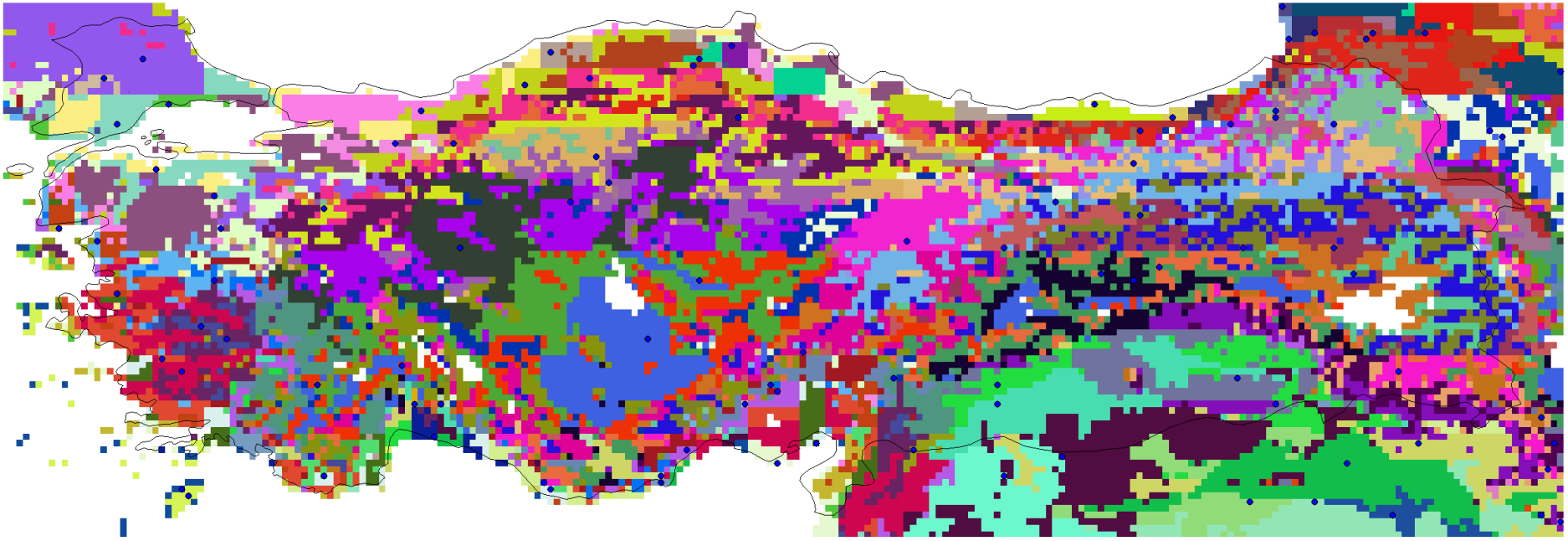
Random Color Map of Ecoclimatic Regions-20 Clusters



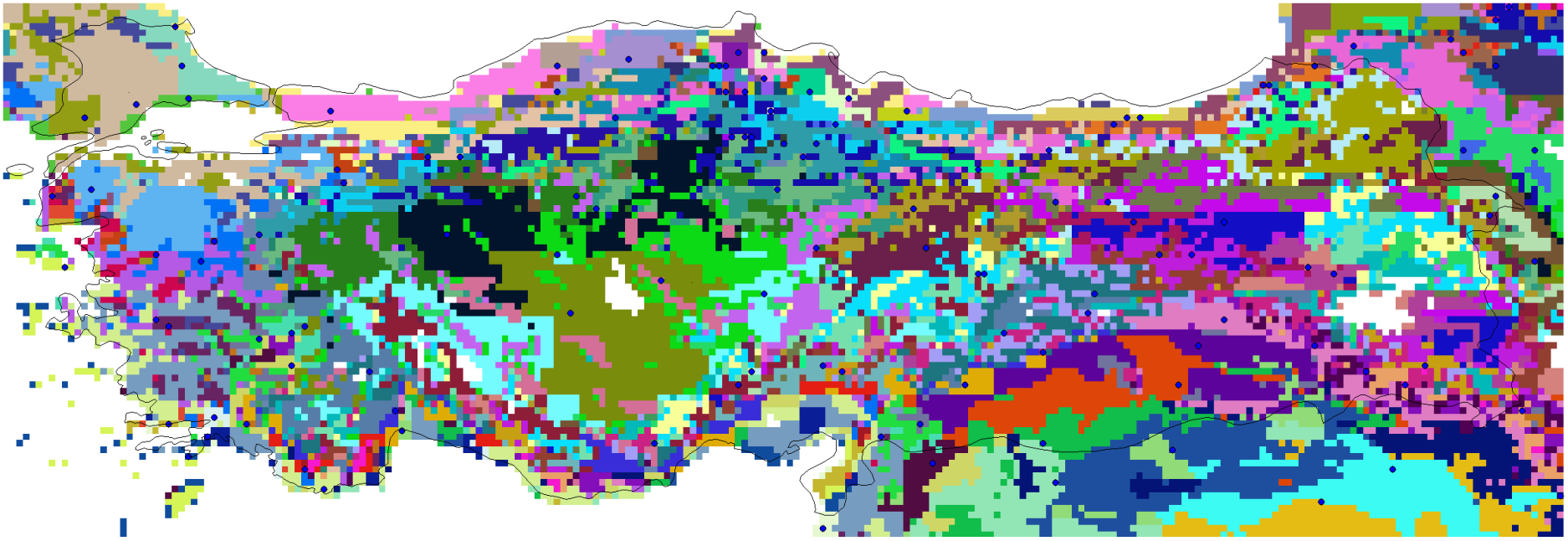


Random Color Map of Ecoclimatic Regions-150 Clusters

Present

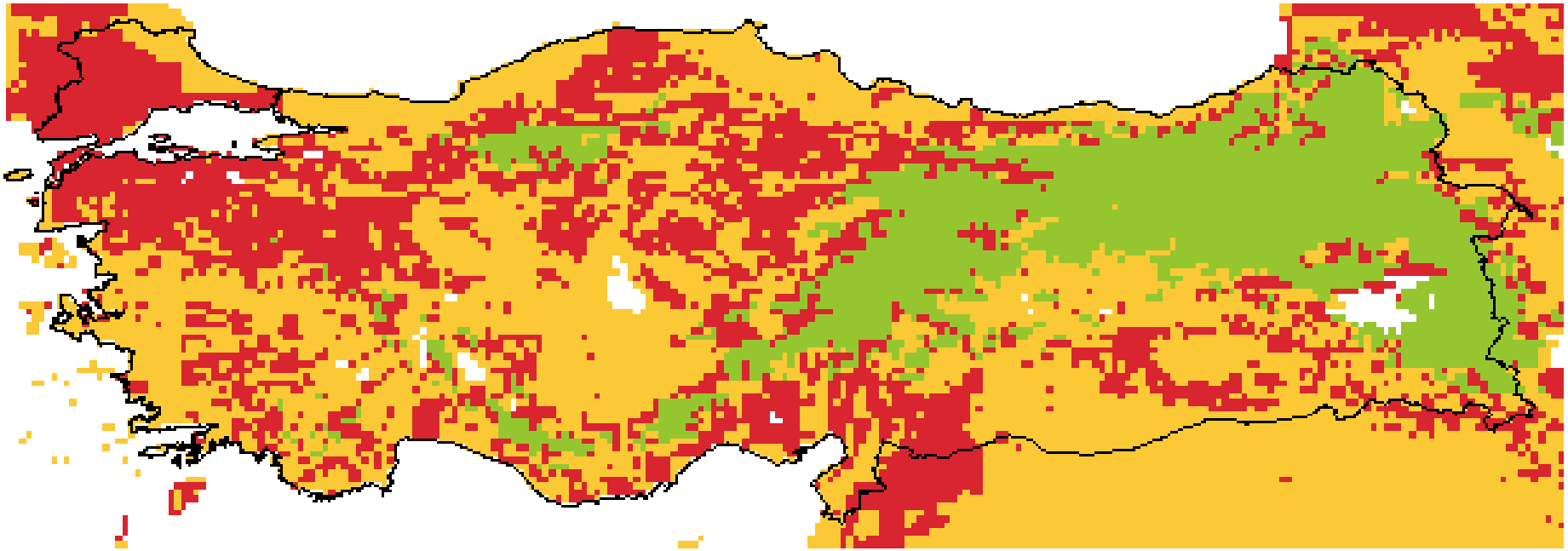


21st mid-century (2041-2070)



Maps of Sensitive and Novel Regions

10 clusters

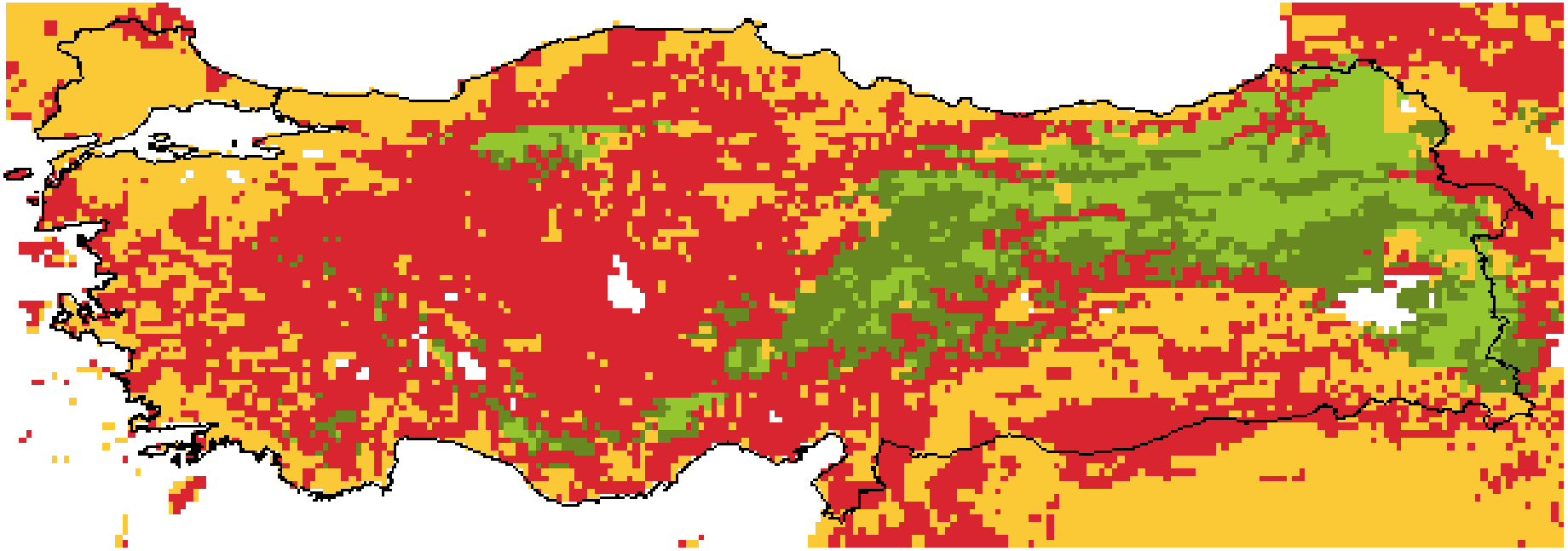


We compared maps of the 20th century and 21st mid-century regionalizations and prepared maps to demonstrate shifts in their spatial location and newly emerging ecoclimatic regions.

Our results revealed that changes in ecoclimatic regions occurred ~40% of the land area of Turkey, 18% of which has no analog in the present.

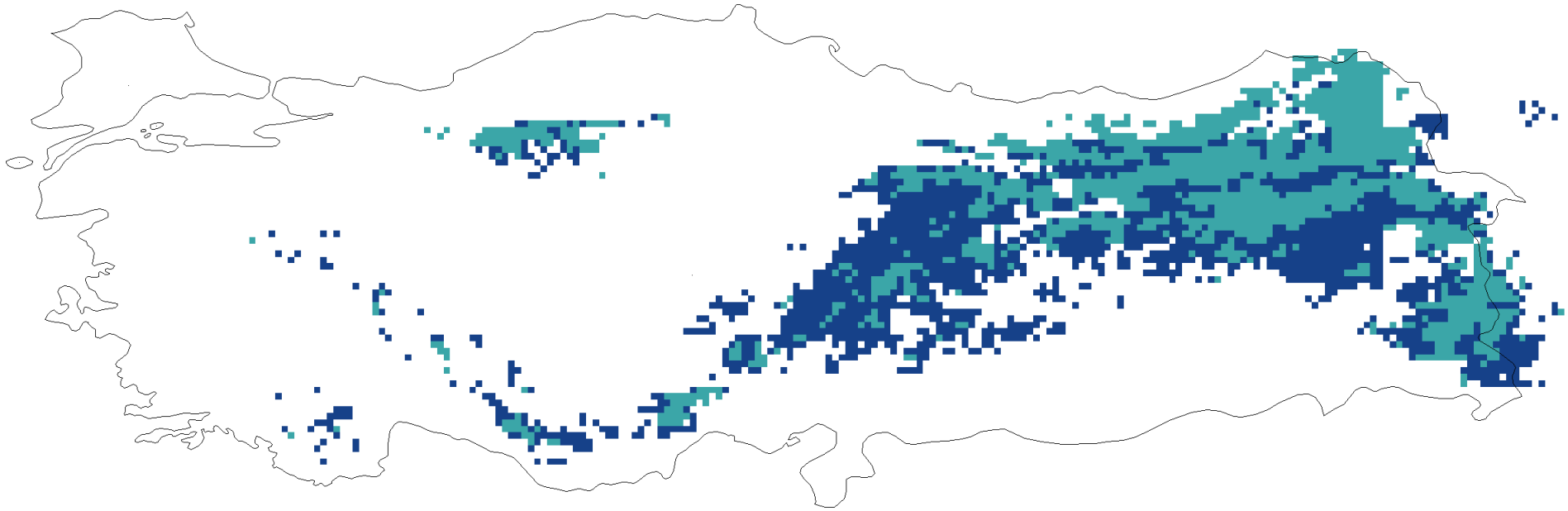
Maps of Sensitive and Novel Regions

20 clusters

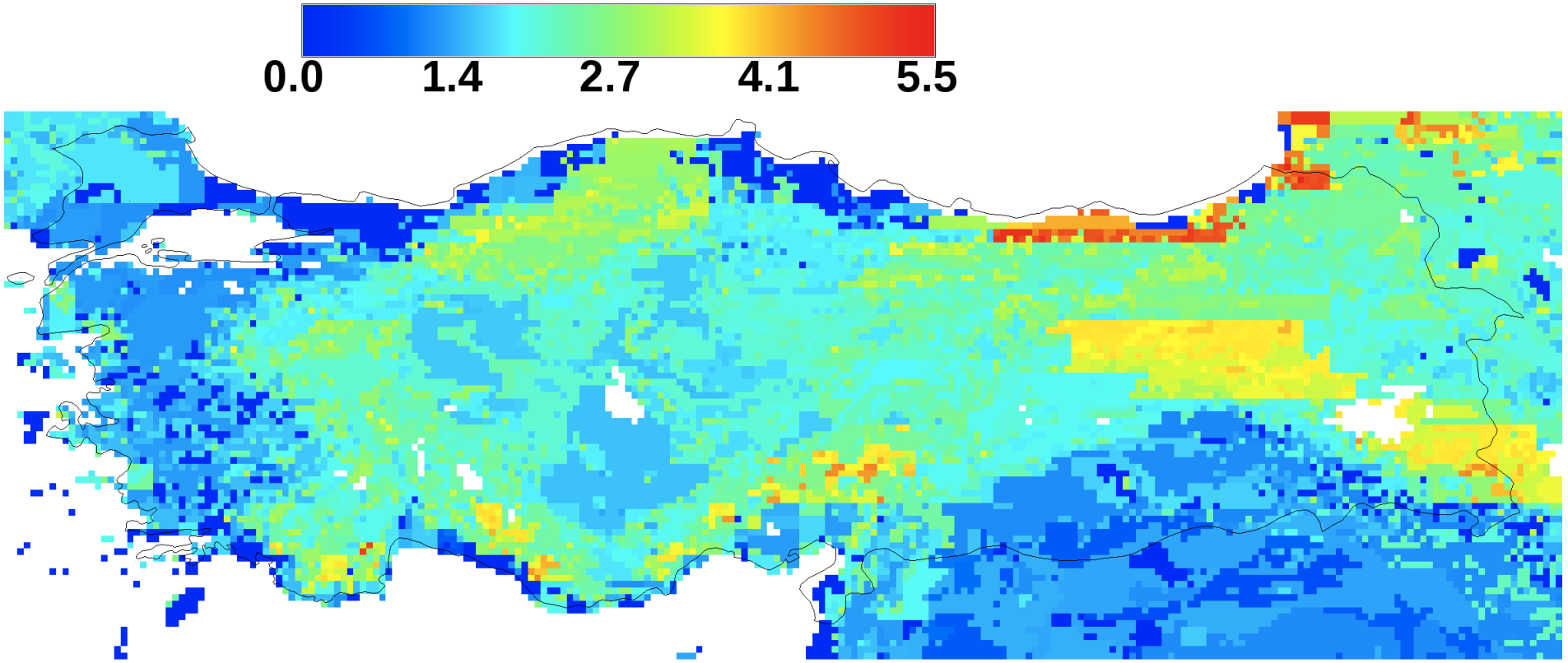


Our results showed that ~50% of the land area of Turkey is changed and, 17% of which were assigned to 2 emerged ecoclimatic regions.

Sensitive and Novel Ecoregions

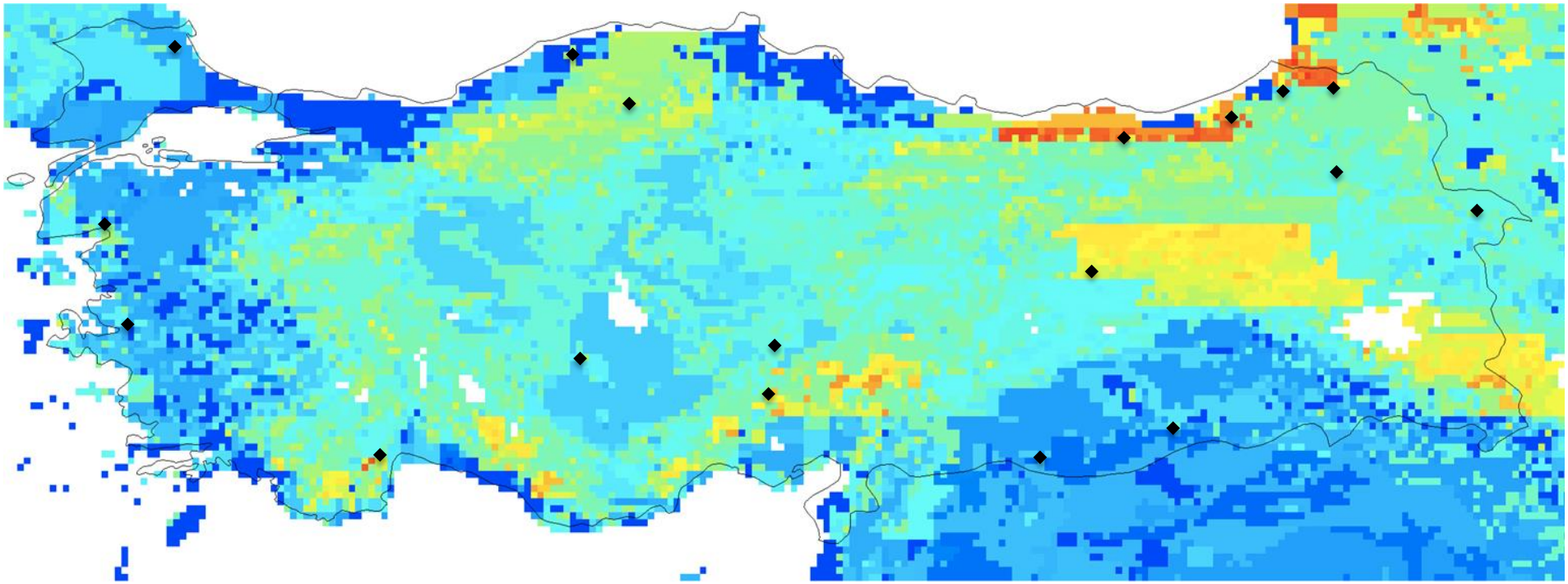


Magnitude of Change Map



Candidate Sites for the Network Design for Turkey

To propose **optimal sampling sites** for long-term ecological monitoring in a prospective ‘ecological observatory network’ for Turkey,



We are now developing these optimal sites using the “Network Representativeness Analysis” (Hoffman et al., submitted)*.

* Hoffman, F., Kumar, J., Hargrove, W.W. and Mills, R.T. Representativeness-based sampling network design for the Arctic. Landscape Ecol., submitted.

Conclusion

- In this study we present the application of MSTC to define optimal ecoclimatic regions both across space and through time to support identification of sampling network sites and provide a framework for a prospective ‘ecological observatory network’ for Turkey.

- In areas/countries (that lack long-term ecological monitoring) where the national ecological networks have not been established yet like Turkey, using this well-approved explicit multivariate statistical methodology for delineation of optimal ecoclimatic regions and sampling network sites can be the most efficient strategy to provide a framework for ‘ecological observatory network design’.

THANKS !

QUESTIONS ?
COMMENTS…