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## Mapping vulnerability and conservation adaptation strategies under climate change

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### Abstract

Identification of spatial gradients in ecosystem vulnerability to global stressors is an important step in the formulation and implementation of appropriate countermeasures<sup>1,2</sup>. Here we build on recent work to map ecoregional exposure to future climate, using an envelope-based gauge of future climate stability—defined as a measure of how similar the future climate of a region will be to the present climate<sup>3,4</sup>. We incorporate an assessment of each ecoregion's adaptive capacity, based on spatial analysis of its natural integrity—the proportion of intact natural vegetation—to present a measure of global ecosystem vulnerability. The relationship between intactness (adaptive capacity) and stability (exposure) varies widely across ecoregions, with some of the most vulnerable, according to this measure, located in southern and southeastern Asia, western and central Europe, eastern South America and southern Australia. To ensure the applicability of these findings to conservation, we provide a matrix that highlights the potential implications of this vulnerability assessment for adaptation planning and offers a spatially explicit management guide.

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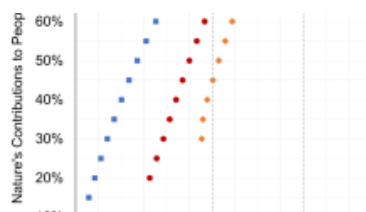
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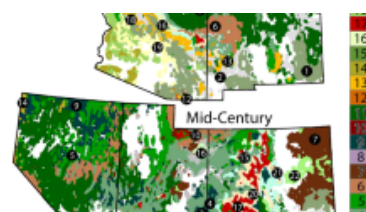
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## References

- 1 Dawson, T. P. et al. Beyond predictions: Biodiversity conservation in a changing climate. *Science* **332**, 53–58 (2011).
- 2 Crossman, N. D., Bryan, B. A. & Summers, D. M. Identifying priority areas for reducing species vulnerability to climate change. *Divers. Distrib.* **18**, 60–72 (2012).
- 3 Iwamura, T., Wilson, K. A., Venter, O. & Possingham, H. P. A climatic stability approach to prioritizing global conservation investments. *PLoS ONE* **5** (2010).

- 4 Iwamura, T., Guisan, A., Wilson, K. A. & Possingham, H. P. How robust are global conservation priorities to climate change? *Glob. Environ. Change* <http://dx.doi.org/10.1016/j.gloenvcha.2013.07.016> (2013).

---

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

---

- 6 Brook, B. W., Sodhi, N. S. & Bradshaw, C. J. A. Synergies among extinction drivers under global change. *Trends Ecol. Evol.* **23**, 453–460 (2008).

---

- 7 Butchart, S. H. M. et al. Global biodiversity: Indicators of recent declines. *Science* **328**, 1164–1168 (2010).

---

- 8 Williams, S. E., Shoo, L. P., Isaac, J. L., Hoffmann, A. A. & Langham, G. Towards an integrated framework for assessing the vulnerability of species to climate change. *PLoS Biol.* **6**, 2621–2626 (2008).

---

- 9 Bellard, C., Bertelsmeier, C., Leadley, P., Thuiller, W. & Courchamp, F. Impacts of climate change on the future of biodiversity. *Ecol. Lett.* **15**, 365–377 (2012).

---

- 10 Foden, W. et al. *Species Susceptibility to Climate Change Impacts* (IUCN, 2008).

---

- 11 Summers, D. M., Bryan, B. A., Crossman, N. D. & Meyer, A. S. Species vulnerability to climate change: Impacts on spatial conservation priorities and species representation. *Glob. Change Biol.* **18**, 2335–2348 (2012).

---

- 12 Heller, N. E. & Zavaleta, E. S. Biodiversity management in the face of climate change: A review of 27 years of recommendations. *Biol. Conserv.* **142**, 14–32 (2009).

---

- 13 Olson, D. M. & Dinerstein, E. The Global 200: Priority ecoregions for global conservation. *Ann. Mo. Bot. Gard.* **89**, 199–224 (2002).

- 14 Broennimann, O. et al. Measuring ecological niche overlap from occurrence and spatial environmental data. *Glob. Ecol. Biogeogr.* **21**, 481–497 (2012).

---

- 15 Williams, J. W., Jackson, S. T. & Kutzbach, J. E. Projected distributions of novel and disappearing climates by 2100 AD. *Proc. Natl Acad. Sci. USA* **104**, 5738–5742 (2007).

---

- 16 Loarie, S. R. et al. The velocity of climate change. *Nature* **462**, 1052–1055 (2009).

---

- 17 Mantyka-Pringle, C. S., Martin, T. G. & Rhodes, J. R. Interactions between climate and habitat loss effects on biodiversity: A systematic review and meta-analysis. *Glob. Change Biol.* **18**, 1239–1252 (2012).

---

- 18 Sekercioglu, C. H., Schneider, S. H., Fay, J. P. & Loarie, S. R. Climate change, elevational range shifts, and bird extinctions. *Conserv. Biol.* **22**, 140–150 (2008).

---

- 19 Mackey, B. G. & Watson, J. E. M. Climate change, biodiversity conservation, and the role of protected areas: An Australian perspective. *Biodiversity* **9**, 11–18 (2008).

---

- 20 McDonald-Madden, E., Runge, M. C., Possingham, H. P. & Martin, T. G. Optimal timing for managed relocation of species faced with climate change. *Nature Clim. Change* **1**, 261–265 (2011).

---

- 21 Bottrill, M. C. et al. Is conservation triage just smart decision making? *Trends Ecol. Evol.* **23**, 649–654 (2008).

---

- 22 *Millennium Ecosystem Assessment: Ecosystems and Human Well-Being* (Millennium Ecosystem Assessment, World Resources Institute, 2005).

---

- 23 Klausmeyer, K. R., Shaw, M. R., MacKenzie, J. B. & Cameron, D. R. Landscape-scale indicators of biodiversity's vulnerability to climate change. *Ecosphere* **2**, 88 (2011).

---

- 24 Jetz, W., Wilcove, D. S. & Dobson, A. P. Projected impacts of climate and land-use change on the global diversity of birds. *PLoS Biol.* **5**, 1211–1219 (2007).

---




- 25 Olson, D. M. et al. Terrestrial ecoregions of the worlds: A new map of life on Earth. *Bioscience* **51**, 933–938 (2001).
- 
- 26 Arino, O. et al. GLOBCOVER. The most detailed portrait of Earth. *ESA Bull. Eur. Space* **136**, 24–31 (2008).
- 
- 27 Bicheron, P. et al. *Globcover: Products Description and Validation Report* (MEDIAS-France, 2008).
- 
- 28 Hijmans, R. J. & Graham, C. H. The ability of climate envelope models to predict the effect of climate change on species distributions. *Glob. Change Biol.* **12**, 2272–2281 (2006).
- 
- 29 Ramirez, J. & Jarvis, A. *High Resolution Statistically Downscaled Future Climate Surfaces* (CIAT, 2008).
- 
- 30 IPCC *Climate Change 2007: The Physical Science Basis* (eds Solomon S. et al.) (Cambridge Univ. Press, 2007).
- 

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J.E.M.W. and T.I. designed the analysis; J.E.M.W. and T.I. performed the analysis; J.E.M.W., T.I. and N.B. analysed the results and wrote the paper.

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## Ethics declarations

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Competing interests

The authors declare no competing financial interests.

## Supplementary information

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