# Designing climate-proof marine protected areas: a case study in South America

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Warming of the oceans is causing the redistribution of marine species, which could undermine the effectiveness of marine protected areas (MPAs) globally. However, climate change is usually ignored in prioritisation plans, and there are few practical approaches for making climate-proof MPAs. Climate velocity – the speed and direction of isotherm movement through time – can approximate shifts in species' ranges in response to warming. Here, we develop an approach for the design of climate-proof MPAs by using climate velocity in the identification of areas where biodiversity is likely to move slowly in response to climate change. We applied this approach to waters off South America. We first calculated climate velocity off the Pacific and Atlantic coasts under three climate projection scenarios. We found that MPAs had comparable exposure to climate change, with similar median climate velocities on both coasts, although a few MPAs off the Atlantic coast are likely to experience substantially faster velocities, especially in tropical regions. To design climate-proof MPAs, we then incorporated climate velocity into a marine prioritisation plan using the software Marxan and AquaMaps data on the distribution of 1,000 species. We found that the spatial configuration of a climate-proof network differs substantially from one that ignores climate change. Further, there were a few areas that were always selected when climate velocity was included, suggesting that these are a very high priority for conservation. Our approach shows that we can design climate-proof MPAs that retain more biodiversity as the climate warms. This could be critical as we expand the area of the ocean under protection from 8% currently to the Aichi Target of 10%, and the current push to extend this to 30% by 2030.

Keywords: Climate change; Climate velocity; Climate projection scenarios; Marine spatial prioritization; conservation