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## **How to outsmart climate change: reducing risk in planning for coastal ecosystem services under sea level rise**

**Key words:** Climate Adaptation, Coastal Spatial Planning, Uncertainty

### **Abstract:**

The world's ecosystem services will be significantly affected by climate change, but the precise spatial and temporal impacts are inherently uncertain. Consequently, the outcomes of planning long term conservation actions, such as the designation of protected areas, are subject to substantial risks.

In order to explicitly incorporate these risks, we adapt an approach for risk-sensitive resource allocation in economics, Modern Portfolio Theory, to conservation planning. The key advantage of this approach is that it accounts for correlations in future outcomes among sites in order to identify which combinations of sites are likely to provide multiple ecosystem services across a wide range of climate scenarios.

We exemplify the approach using a case study of conservation planning for coastal wetlands and associated ecosystem services under uncertain rates of sea level rise in Moreton Bay, Australia. This case study is pertinent as sea level rise projections are highly variable and can alter the distribution of coastal wetlands through loss due to inundation and landward migration. We compared our risk-sensitive approach to climate adaptation plans that ignored uncertainty.

We found that ignoring uncertainty was a high-risk strategy, even when planning for the worst-case scenario. In contrast, explicitly accounting for uncertainty resulted in solutions that ensured the supply of ecosystem services with relatively low risk of failure across all climate scenarios. This method is likely to be of use in other conservation contexts where the impacts of climate change on species, ecosystems, and their services vary spatially over different climate change scenarios.