# Modeling Awareness & Decision Making: The Case of Climate Change and Water Resources

By: David Adamson[[1]](#footnote-1)

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**Abstract**

We can classify future problems and their contingencies into three levels of increasing unawareness: White Swans, Grey Swans and Black Swans ([Taleb, 2007](#_ENREF_44)). White Swans are problems with known sets of probable outcomes and contingencies (i.e. complete awareness). Grey Swans are problems that are known and we are aware that the complete set of outcomes and contingencies is unknown. Black Swan problems involve unforeseen problems (i.e. totally unaware) and can be derived from heuristics.

Climate change is a classic Grey Swan. Climate change is expected to alter the mean, variance, timing and intensity of rainfall. However, the future realized emission path is unknown and when combined with the complexities of climate modeling and downscaling issues associated with hydrological responses, an incomplete problem set exists. The realized spatial events of temporal changes in rainfall will determine the future volume of water to share between all users in a river basin. If the share of resources is inequitable economic welfare (return from resource uses, environmental, and social objectives) is reduced.

This paper illustrates the welfare outcomes from allocating water resources using a state contingent analysis versus an expected value approach in Australia’s Murray-Darling Basin. The comparison of these two approaches helps illustrate the need to be able to separate the environmental signal and the management response to that signal. By separating the management response inductive reasoning and differential learning about climate change can be represented. This representation then helps prevent a Grey Swan turn Black.

**JEL Codes:** D81, Q15, Q54

**Keywords**: Unawareness, Climate Change, Stochastic State Contingent Analysis, Expected Value, Water

1. RSMG, School of Economics, The University of Queensland, Australia. E-mail: [d.adamson@uq.edu.au](mailto:d.adamson@uq.edu.au) Phone +61 (0)7 3365 6782 [↑](#footnote-ref-1)