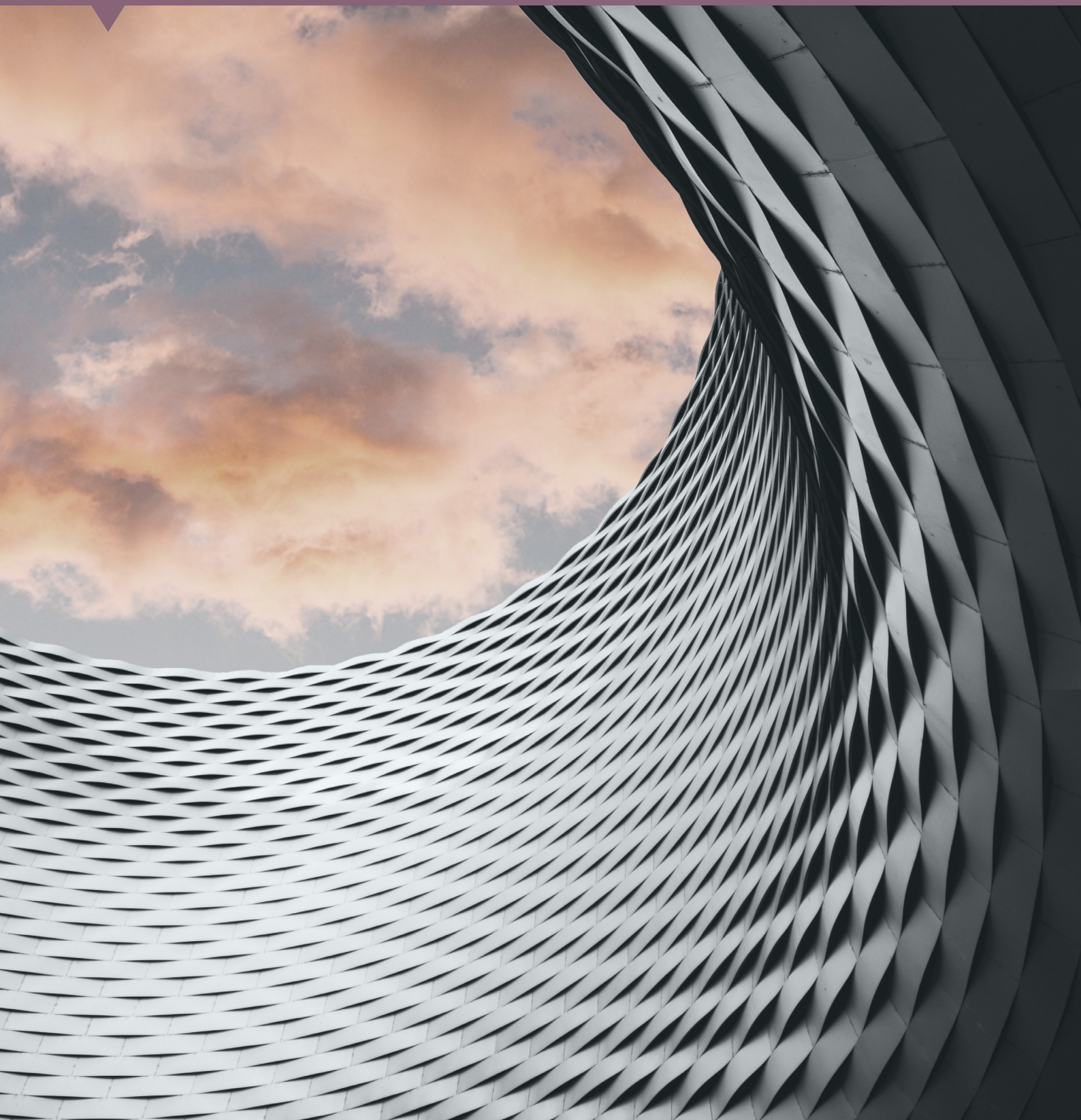
Earth Systems and Climate Change Hub

National Environmental Science Programme

What are climate change science and services worth?



Earth Systems and Climate Change Hub researchers have developed a conceptual cost-benefit framework to measure the economic value of the Hub's research outputs to the Australian economy and society more generally. While it is difficult to obtain quantitative estimates of the benefits of 'public good' climate change services, in part due to their underpinning and cross-cutting nature, the Hub's analysis suggests that investment in climate change science and services shows a net benefit of between US$34 billion and US$52 billion per year to the Australian economy by 2100 under a high emissions scenario.

Climate change science and services

Meteorological services are generally characterised as 'weather services' (dealing with timescales of minutes to weeks), 'climate services' (months) and 'climate change services' (decades to centuries). The science and services of the Earth Systems and Climate Change Hub, for the most part, sit in the climate change services category.

These services include the use of simple information like historical observed climate data sets as well as more complex products such as model-based predictions and projections of weather and climate variables for both mean condition and extreme events. Additional outreach resources (e.g. guidance materials, management tools, training and technical support) are often included as well to develop user capacity. These resources assist users in choosing the right product for the decisions they need to make, and explain the utility and associated limitations and/or uncertainty that may be associated with applying the available information.

A knowledge value chain

The science and services delivered by the Earth Systems and Climate Change Hub are not generally end products in themselves, rather inputs as part of a knowledge value chain. This chain typically involves many stages of knowledge creation, decision-making and associated stakeholder engagement; each stage adding value as evidence informing related policy-development and/or planning processes. When applied effectively, science-based services have the potential to enhance the productivity, efficiency, value and resilience of the Australian economy in a tangible way across multiple sectors. However, measuring the return on investment in the Hub's science by quantifying socio-economic impacts of service delivery at a sectoral level is technically challenging – but necessary, to demonstrate the impact of government investment in this research.

Understanding costs and benefits

Hub researchers combined climate and economic modelling to develop a framework that can be used to analyse and assess GDP growth under different climate and investment scenarios. By comparing these scenarios with a (counter-factual) reference case – where climate and climate services are not available/applied or otherwise have no impact on the economy – they could explore the costs and benefits of these services.

Two climate scenarios were considered:

- a high, 'business as usual' emissions scenario, where the climate evolves according to the RCP8.5 scenario with a change in radiative forcing for 8.5 Wm^{-2} in 2100
- a low, 'best case' emissions scenario, where the climate evolves according to RCP3PD scenario with radiative forcing peaking at 3 Wm^{-2} by mid-century and declining to 2.6 Wm^{-2} by 2100.

Four climate services investment scenarios were considered, where the government invests and implements policies to varying degrees to improve climate services and in doing so, mitigates some climate impacts at national economy scale.

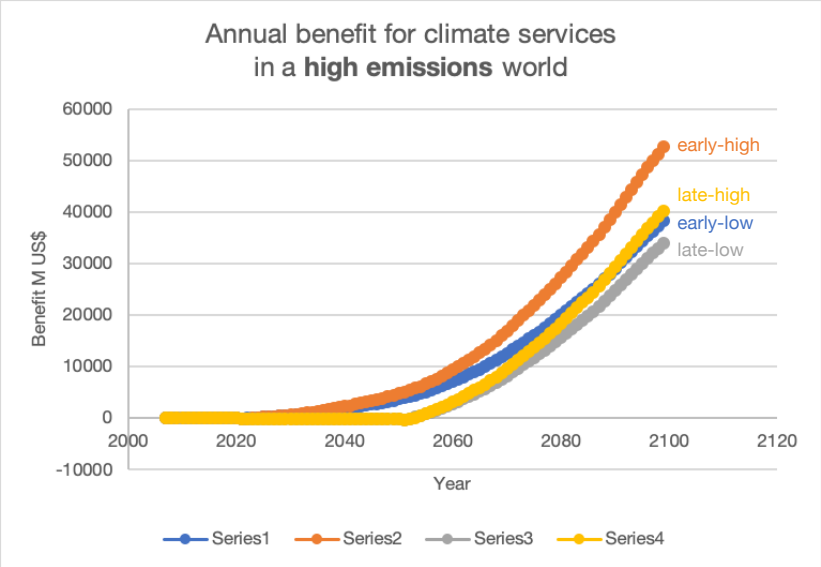
These scenarios are:

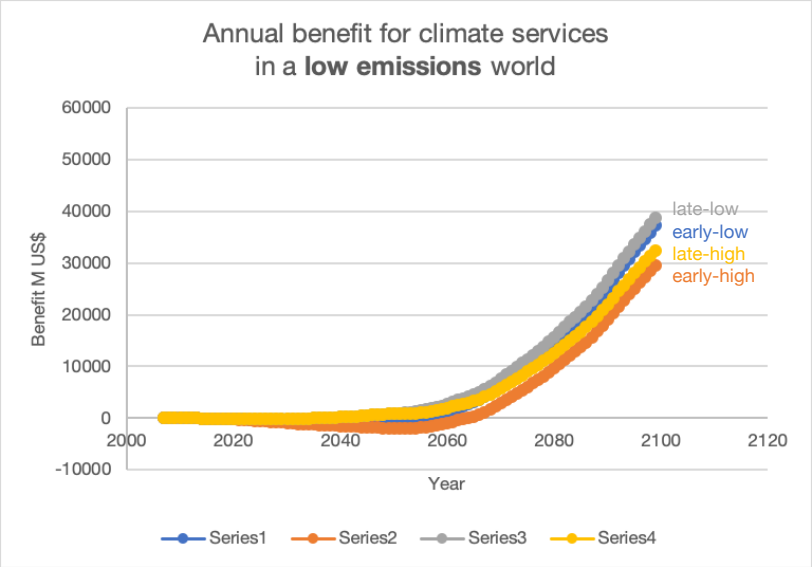
- Early-low scenario (series 1): starting in 2020, investing 0.05% of GDP per year in climate services that reduces economic impacts of climate change by 10%, after 2030
- Early-high (series 2): starting in 2020, investing 0.1% of GDP per year in climate services that reduces economic impacts of climate change by 25% after 2030
- Late-low (series 3): starting in 2050, investing 0.05% of GDP per year in climate services that reduces economic impacts of climate change by 10%, after 2060
- Late-high (series 4): starting in 2050, investing 0.1% of GDP per year in climate services that reduces economic impacts of climate change by 10%, after 2060.

What's it worth?

Researchers calculated that the high emissions pathway results in a reduction in GDP of around 2% per year in 2100 from climate-related economic impacts, compared to the reference case. For the low emissions scenario, the reduction is 0.75% per year. To estimate the benefits of climate services, researchers compared these GDP reductions with the reduction in GDP under each of the climate services investment scenarios.

Researchers found that in the high emissions world, investment in climate services returns a net benefit to the national economy in 2100, with the high investment scenarios outperforming the low investment scenarios. The early-high investment scenario results in just over US$52 billion per year of benefits to the economy in 2100, after all costs and benefits are taken into account. The late-low investment scenario is the poorest, providing benefits to the economy of only US$34 billion per year in 2100. In the low emissions world, investment in climate services returns a net benefit in 2100 of between approximately US$30 and 40 billion per year. This is somewhat less for each climate services investment scenario than under the high emissions world, with the low investment scenarios marginally outperforming the high investment scenarios.





Annual benefit of four climate services investment scenarios (in $US millions) in a high (top) and low (bottom) emissions world. Investment scenarios are early-low (series 1; blue), early-high (series 2; orange), late-low (series 3; grey) and late-high (series 4; yellow).

Implications

With governments and private businesses making climate-sensitive policy, planning and investment decisions to mitigate climate risk over multiple decades across all sectors of the economy, there is potential for these decisions (and socio-economic outcomes) to be improved by investment in and application of climate services.

The Hub's analysis suggests that such improvements are enhanced under both high and low emissions scenarios, but more so where investment is made early under the high emissions scenario compared with the same investment strategy under the low emissions scenario. It also follows that further gains are possible if the quality and quantity of services are enhanced through investment in requisite scientific infrastructure, observational capability, knowledge-based interpretative and decision support tools, guidance materials, user training and other capacity development, and the basic underlying research and development to inform and facilitate the application of climate services.

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Next steps

To assist in economy-wide, national and international decision-making on the provision for and development of science-based climate services it will be necessary to continue to work on better understanding sector-specific climate impacts and development of tailored climate services that offset these impacts. This will allow for better estimates of the full range of economic benefits of climate services.

One activity will be to embed a supply chain of climate change services as a specified component (sector) in the economic modelling methodology. This would allow the exploration and analysis of specified investments in climate services along the supply chain to enhance the utility and functionality of these climate services, as well as the overall economic effect on target sectors.

The scenarios used in this case study were simplistic configurations based on specified assumptions to illustrate the cost-benefit analysis framework. Development of formal scenarios based on actual data needs to be undertaken in order to validate the conceptual framework. A more rigorous approach to understanding the relationship between government expenditure, investment in various parts of the climate services supply chain, and the practical delivery of climate services at a sectoral level would yield more accurate and useable estimates of the socio-economic benefits of climate services.

The four main ways the climate and economy interact are: (1) reductions in human health and labour capacity; (2) sector-specific climate impacts; (3) impacts on infrastructure and capital investments; and (4) rare events and catastrophes. Better understanding the points and mechanisms of interaction between the climate and the economy under different emissions scenarios would lead to better understanding of where the most beneficial interactions could occur with the climate services supply chain.

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