Australian Government

Department of Climate Change, Energy, the Environment and Water

Updated Guidance: The Climate Change Considerations of Australian Rainfall and Runoff

Australian Water School

Dr Conrad Wasko | The University of Sydney

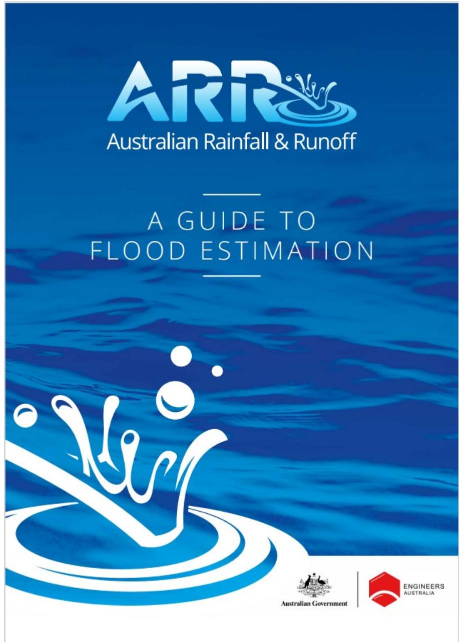
Project background

Why does this need updating?

- ARR widely used to estimate flood risk and inform flood resilient design and management in the built environment.
- The climate is changing - we **must** build climate change into future infrastructure design.
- We **need** to include the most recent climate science research, projections and observed data.

“As a result, practitioners feel 'hamstrung' by the guidance that is currently provided, and decision makers are concerned that the latest science is not always being appropriately applied in policy outcomes”

Australian Rainfall and Runoff - Australian Rainfall and Runoff (ga.gov.au)



Partnership between DCCEEW and Engineers Australia

Project Control Group

Oversight and Direction

(engineering practitioners, Government, Industry)

Technical Working Group

Drafting Update

(industry and academia, engineering and climate science)

User Needs and Input

(via open consultation)

Funded by National Emergency Management Agency, Disaster Risk Reduction Program

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Principles guiding the update

- reflect contemporary science
- practical and easy to use
- consistent and comprehensive
- reflect best practice communication around uncertainty and risk

Scientific review

Science review

"A systematic review is an authoritative account of existing evidence using reliable, objective, thorough and reproducible research practices"

"Meta-analysis is the formal, quantitative, statistical combination of results from two or more separate studies"

Includes information from 300 distinct peer reviewed scientific studies published largely from 2011 onwards

https://hess.copernicus.org/articles/28/1251/2024/

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Hydrology and Earth System Sciences
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EGU

A systematic review of climate change science relevant to Australian design flood estimation

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Abstract. In response to flood risk, design flood estimation is a cornerstone of planning, infrastructure design, setting of insurance premiums, and emergency response planning. Under stationary assumptions, flood guidance and the methods used in design flood estimation are firmly established in practice and mature in their theoretical foundations, but under climate change, guidance is still in its infancy. Human-caused climate change is influencing factors that contribute to flood risk such as rainfall extremes and soil moisture, and there is a need for updated flood guidance. However, a barrier to updating flood guidance is the translation of the science into practical application. For example, most science pertaining to historical changes to flood risk focuses on examining trends in annual maximum flood events or the application of non-stationary flood frequency analysis. Although this science is valuable, in practice, design flood estimation focuses on exceedance probabilities much rarer than annual maximum events, such as the 1 % annual exceedance probability event or even rarer, using rainfall-based procedures, at locations where there are few to no observations of streamflow. Here, we perform a systematic review to summarize the state-of-the-art understanding of the impact of climate change on design flood estimation in the Australian context, while also drawing on international literature. In addition, a meta-analysis, whereby results from multiple studies are combined, is conducted for extreme rainfall to provide quantitative estimates of possible future changes. This information is described in the context of contemporary design flood estimation practice to facilitate the inclusion of climate science into design flood estimation practice.

Guidance

Community response and feedback

"Following the [science] review … no defensible methods were identified for incorporating climate change into direct flood-based procedures such as flood frequency analysis."

vs

"Although frequency analysis will continue to be used for design flood estimation and the calibration of models to historic data, climate change influences a range of flood drivers which impact on flood magnitude in a highly non-linear fashion. It is thus difficult to directly adjust flood information without reference to the causal processes by which climate change influences flood magnitude."

Australian Government
Department of Climate Change, Energy, the Environment and Water

Draft update to the Climate Change Considerations chapter in Australian Rainfall and Runoff: A Guide to Flood Estimation

Book 1. Chapter 6. Climate Change Considerations

ENGINEERS AUSTRALIA

Frequently Asked Questions (FAQ)

Technical questions for guidance users

How can I choose a future climate scenario?

Australian Rainfall and Runoff does not prescribe the use of a particular climate scenario for a given application of the guidance. For further information, the user is directed to relevant jurisdictional documents, for example the NSW Flood Risk Management Manual and associate guidelines.

Climate change is very uncertain – how do I account for uncertainty?

Both climate change factors and non-climate change factors influence the design flood uncertainty.

A consequence of climate change is an increase in the uncertainty of a design flood estimate. Where possible, uncertainties in the estimates of change have been presented and can be used in conjunction with the uncertainty in non-climate change factors to derive uncertainties around the design flood estimation (See Section 6.4.6). As for all climate related investigations, decisions should consider the sensitivity of uncertainty upon the outcome of interest.

Why was global temperature used for standardisation rather than local temperature?

Global temperature is a good indicator of the available moisture in the atmosphere that drives extreme rainfalls. The adoption of global temperature enabled a diverse set of studies on the influence of climate change on rainfall and flooding to be considered on a comparable basis. Research has shown that local temperatures co-vary with many other factors making them a poor indicator of the available moisture.

What has changed

- Apply climate change factors to historical IFDs
- Rates of change vary with storm duration and apply up to the PMP
- Global temperatures are used for factoring rainfalls (not local temperatures)
- Guidance provided for other factors (e.g. temporal pattern, losses, sea level)

Rainfall intensity/depth

"For most Australian catchments, changes in extreme rainfall are likely to represent the primary mechanism for increases in flood risk."

Table 1. Recommended rates of change (α) and associated uncertainty derived in Wasko et al. (2024), presented per degree global temperature change (%/°C). The factors in this table are applicable for exceedance probabilities from 1EY up to and including the PMP and are designed for application across mainland Australia and Tasmania.

	≤ 1 hr	> 1 hr and < 24 hr	≥ 24 hr
Central (median) estimate (%/°C)	15	Interpolation zone (see Table A1)	8
'Likely' range	7-28		2-15

Other factors that influence flood estimation

- Temporal patterns
- Spatial patterns
- Losses
    - Rates of change that can be applied in a similar manner to rainfall intensity/depth changes
- Sea level rise

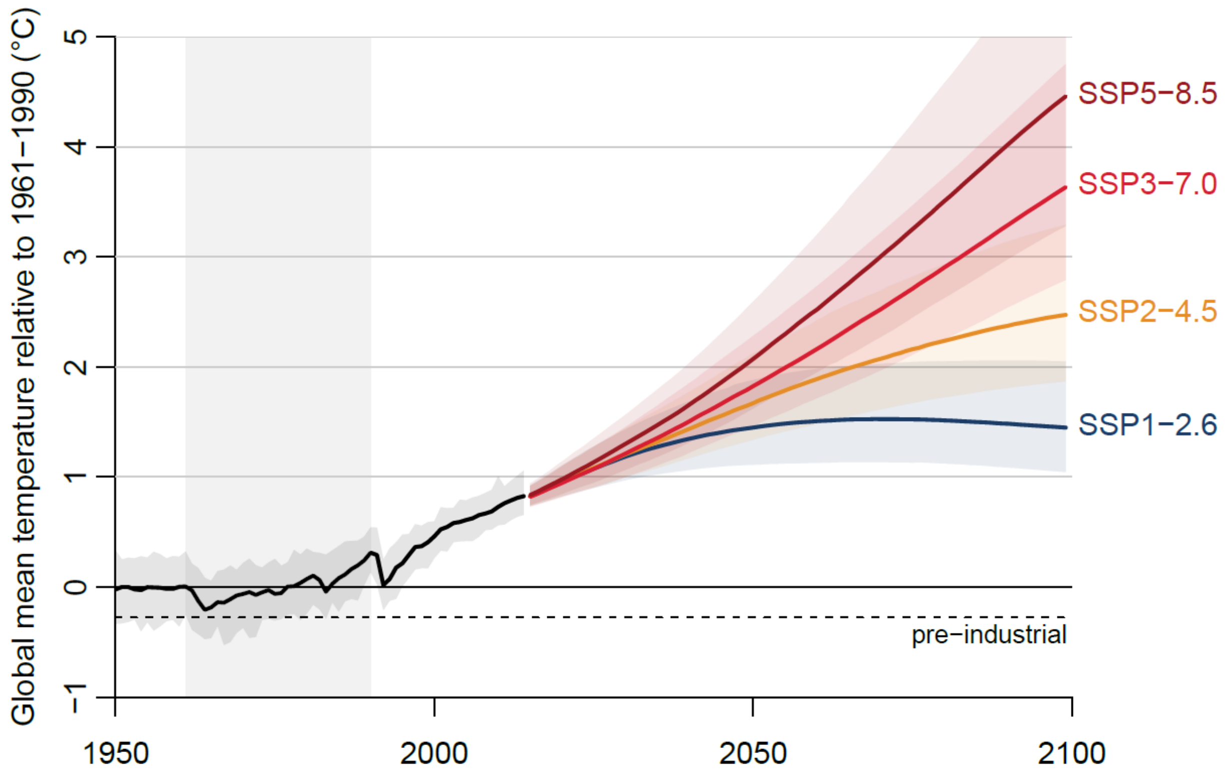
DRAFT

Temperature projections

"The data from individual gauges varies, but a good estimate for the midpoint of the data period used in estimating the 2016 IFDs is 1961-1990."

"A range of factors are likely to influence selection of SSP(s) that are specific to the design problem of interest."

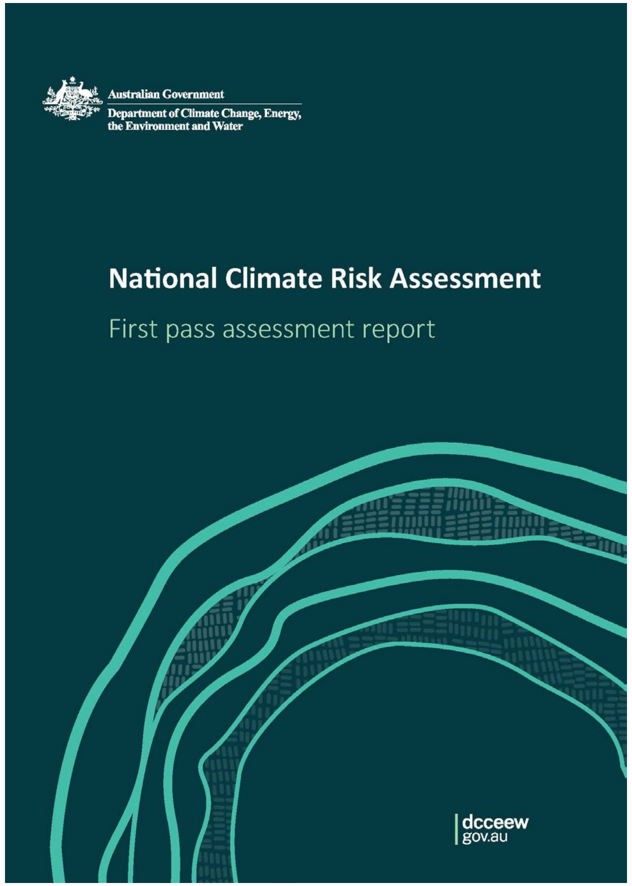
An example of adaptive management under uncertainty around the future climate is provided in Example 2 (Section 6.6)

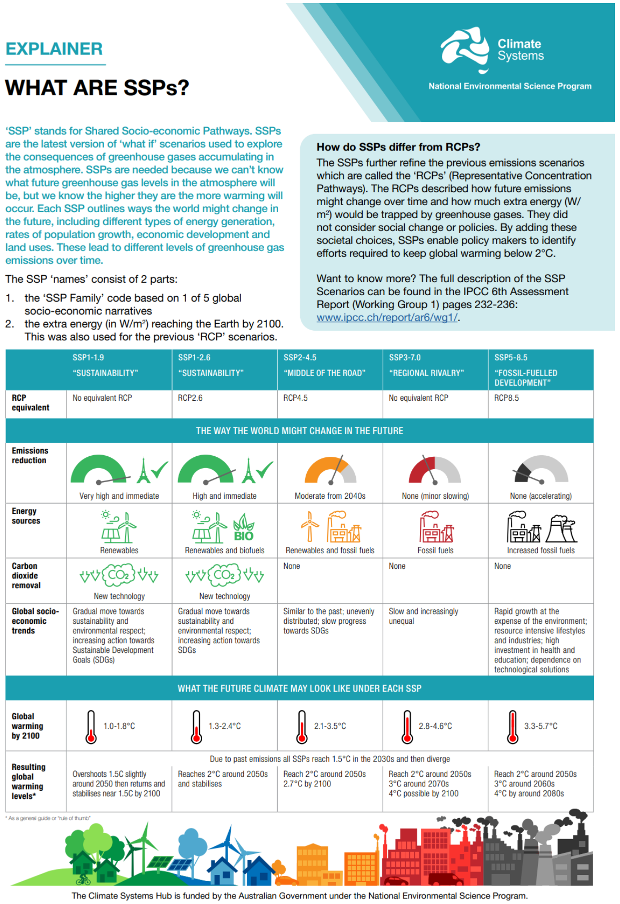


Temperature projections

https://www.dcceew.gov.au/climate-change/publications/ncra-first-pass-risk-assessment

https://nesp2climate.com.au/wp-content/uploads/2024/01/Understanding-SSPs-1.pdf





EXPLAINER

Climate Systems
National Environmental Science Program

WHAT ARE SSPs?

'SSP' stands for Shared Socio-economic Pathways. SSPs are the latest version of 'what if' scenarios used to explore the consequences of greenhouse gases accumulating in the atmosphere. SSPs are needed because we can't know what future greenhouse gas levels in the atmosphere will be, but we know the higher they are the more warming will occur. Each SSP outlines ways the world might change in the future, including different types of energy generation, rates of population growth, economic development and land uses. These lead to different levels of greenhouse gas emissions over time.

The SSP 'names' consist of 2 parts:

1. the 'SSP Family' code based on 1 of 5 global socio-economic narratives
2. the extra energy (in W/m^2) reaching the Earth by 2100. This was also used for the previous 'RCP' scenarios.

How do SSPs differ from RCPs?

The SSPs further refine the previous emissions scenarios which are called the 'RCPs' (Representative Concentration Pathways). The RCPs described how future emissions might change over time and how much extra energy (W/m^2) would be trapped by greenhouse gases. They did not consider social change or policies. By adding these societal choices, SSPs enable policy makers to identify efforts required to keep global warming below 2°C.

Want to know more? The full description of the SSP Scenarios can be found in the IPCC 6th Assessment Report (Working Group 1) pages 232-236: www.ipcc.ch/report/ar6/wg1/.

	SSP1-1.9 "SUSTAINABILITY"	SSP1-2.6 "SUSTAINABILITY"	SSP2-4.5 "MIDDLE OF THE ROAD"	SSP3-7.0 "REGIONAL RIVALRY"	SSP5-8.5 "FOSSIL-FUELLED DEVELOPMENT"
RCP equivalent	No equivalent RCP	RCP2.6	RCP4.5	No equivalent RCP	RCP8.5
THE WAY THE WORLD MIGHT CHANGE IN THE FUTURE					
Emissions reduction	Very high and immediate	High and immediate	Moderate from 2040s	None (minor slowing)	None (accelerating)
Energy sources	Renewables	Renewables and biofuels	Renewables and fossil fuels	Fossil fuels	Increased fossil fuels
Carbon dioxide removal	New technology	New technology	None	None	None
Global socio-economic trends	Gradual move towards sustainability and environmental respect; increasing action towards Sustainable Development Goals (SDGs)	Gradual move towards sustainability and environmental respect; increasing action towards SDGs	Similar to the past; unevenly distributed; slow progress towards SDGs	Slow and increasingly unequal	Rapid growth at the expense of the environment; resource intensive lifestyles and industries; high investment in health and education; dependence on technological solutions
WHAT THE FUTURE CLIMATE MAY LOOK LIKE UNDER EACH SSP					
Global warming by 2100	1.0-1.8°C	1.3-2.4°C	2.1-3.5°C	2.8-4.6°C	3.3-5.7°C
Resulting global warming levels*	Due to past emissions all SSPs reach 1.5°C in the 2030s and then diverge				
	Overshoots 1.5C slightly around 2050 then returns and stabilises near 1.5C by 2100	Reaches 2°C around 2050s and stabilises	Reach 2°C around 2050s 2.7°C by 2100	Reach 2°C around 2050s 3°C around 2070s 4°C possible by 2100	Reach 2°C around 2050s 3°C around 2060s 4°C by around 2080s

* As a general guide or "rule of thumb"

The Climate Systems Hub is funded by the Australian Government under the National Environmental Science Program.

Next steps

Next steps

- Workshops – Oct – Dec 2024
  - helping users understand how this national guidance relates to regulations and other guidance and can be used to support decisions.
  - Register your interest: climate.science@dcceew.gov.au

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