Impact of climate change on Hydro Tasmania's Dams

Chris Harries

Water inflows into Tasmania's western river systems has been inexorably declining in recent decades. Furthermore, runoff is predicted to continue to decline in these catchments to the end of this century. This climate change trend has quite profound negative implications for Hydro Tasmania's future business performance.

A summary of these findings is attached – as extracted from *Climate Futures for Tasmania* CRC research document.

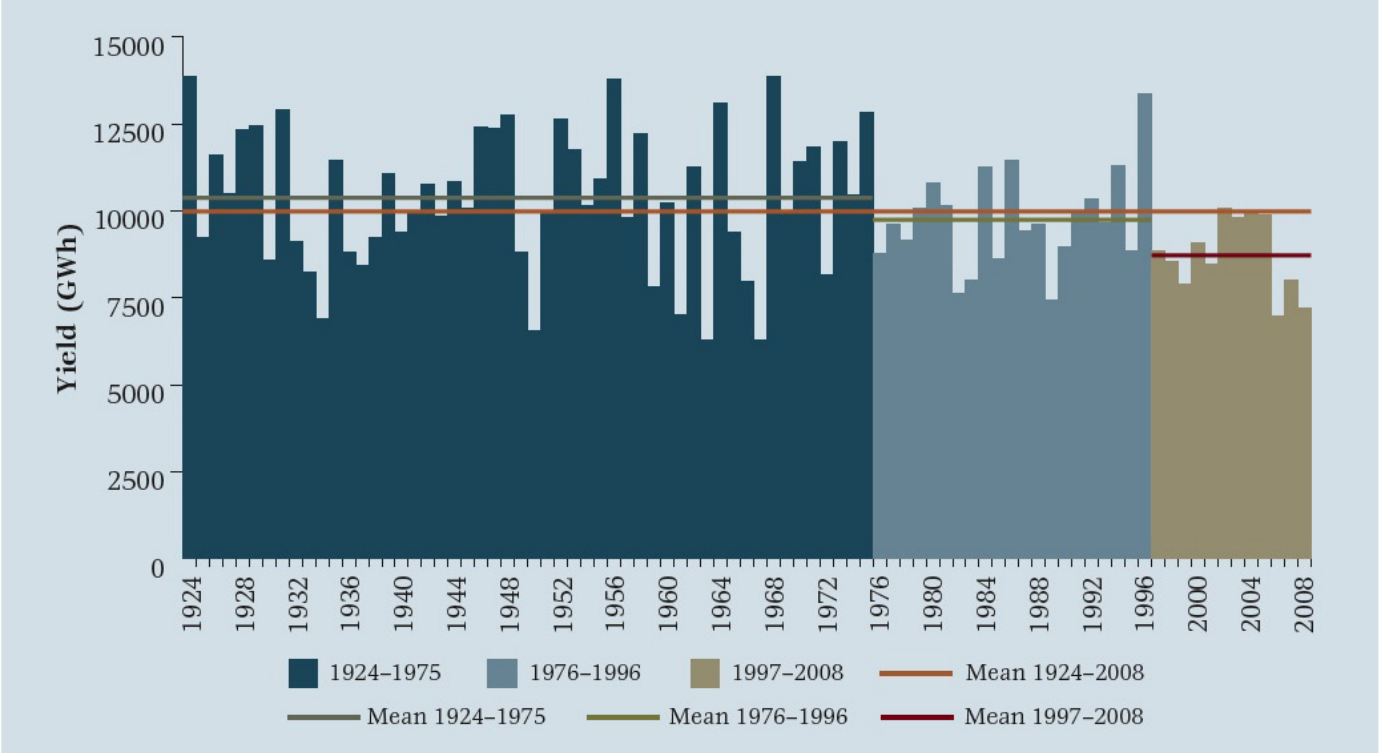
It should be noted that the lowered water inflows are only partly caused by reduced rainfall. A bigger factor is soil dryness, caused by increased ambient temperatures. This factor reduces run-off more markedly, especially in the shoulder seasons (Autumn and Spring)

Reduced runoff into the hydro-electric system can be notionally apportioned thus: 30% resulting from reduced rainfall as compared to 70% as a result of the soil dryness factor.

As a consequence of declining water runoff Hydro Tasmania officially downgraded the *Long Term Average Energy Yield* of its hydro system by over 10 percent in 2008. To graphically appreciate the scale of this, this equates to an equivalent loss of 130 MW of power generation capacity. To replace that loss with new dam infrastructure would cost the business upward of $500 million.

This downgrade was based on retrospective evidence from the previous 20 years performance data, showing that the performance of its whole system had been in decline, as shown in the chart below. That time period was long enough for the business to accept the reality that this was an impact of climate change, not a temporal weather fluctuation issue.

Hydro Tasmania is fully aware that this trend, in gradually lowered water inflows, is predicted to continue for the rest of this century.

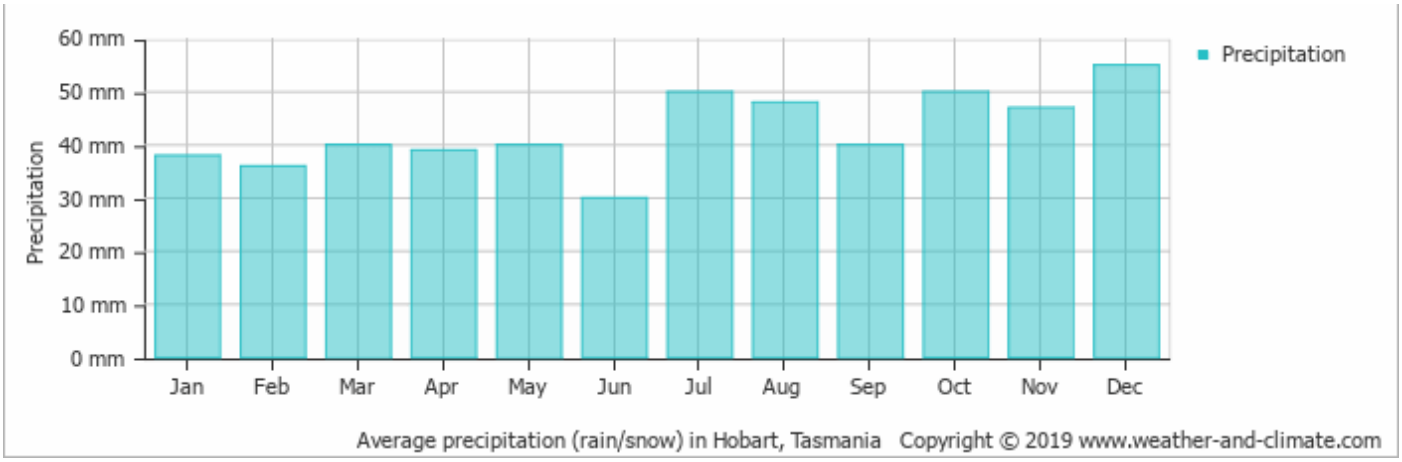


This chart, showing electricity yield of the Tasmanian system, clearly shows the trend described above. Look at the horizontal bars. This information resulted in a downgrade of the system's rated output by a factor of 10 percent.

Why soil dryness matters

Just as increasing soil dryness is causing dramatic changes to wildfire incidences in Tasmania, the very same condition is having dramatic impact on the state's hydro-electric system.

To understand this it is informative to compare Tasmania's monthly rainfall with its river flows. From this chart we can see that Tasmania receives fairly even distribution of rainfall throughout the year.



By contrast the runoff into our river systems markedly peaks in winter months. The chart below shows a fairly typical pattern in this regard. Why is this so?

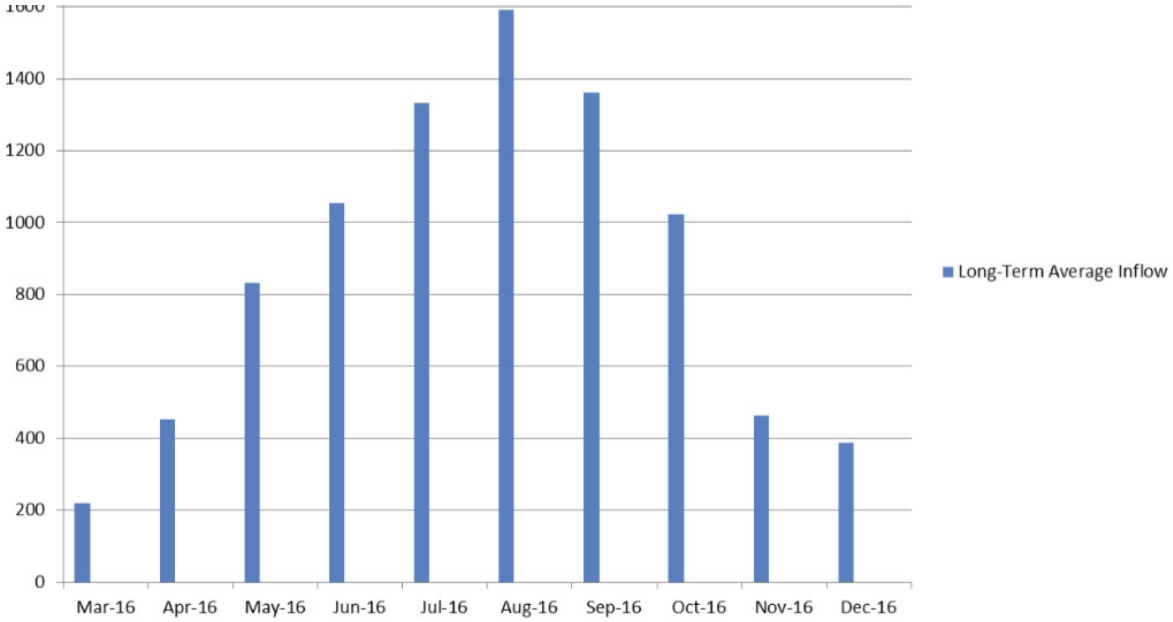


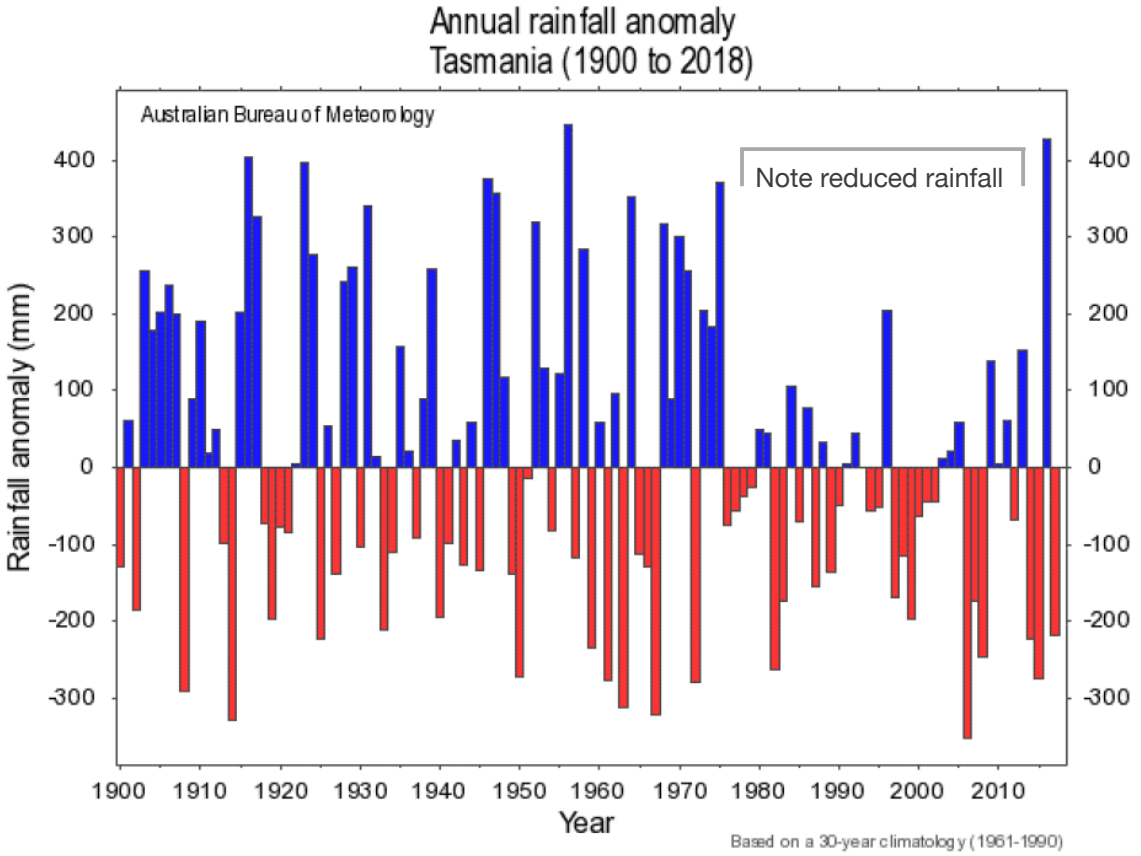
Figure 2: Long-term average inflows (GWh) for the remainder of 2016

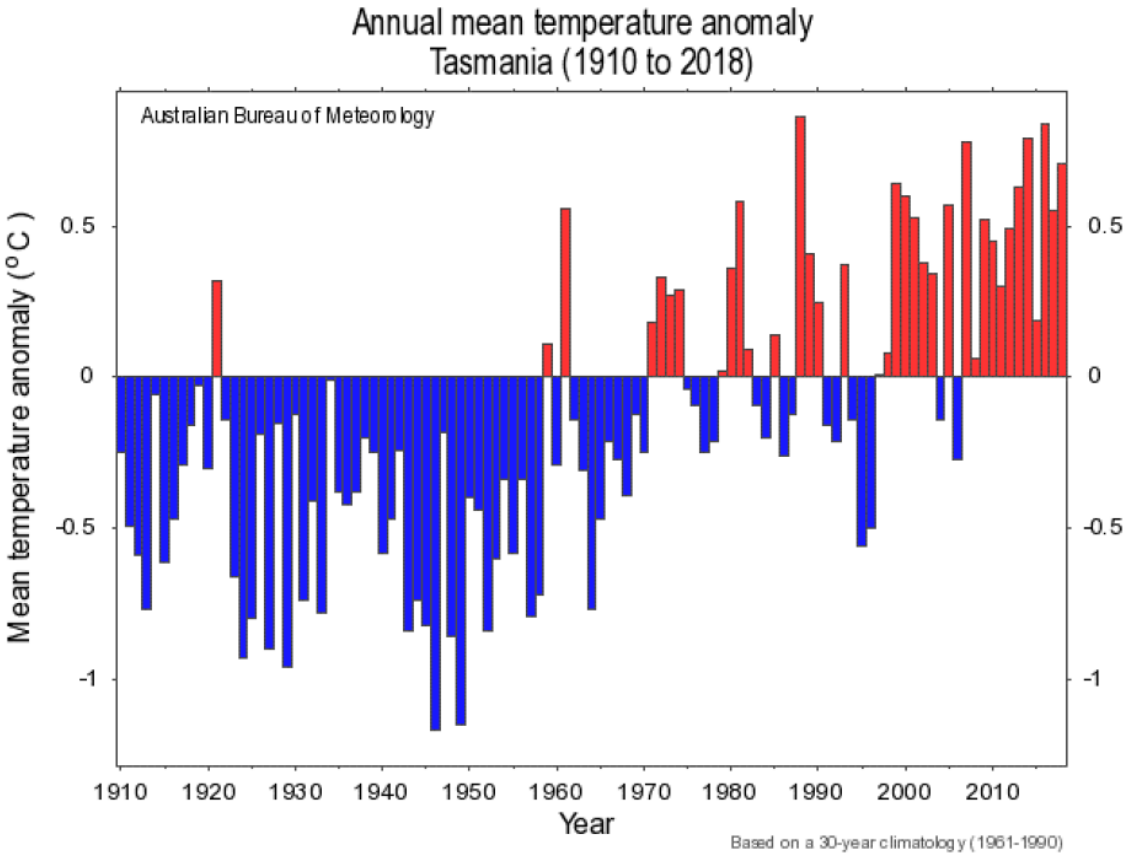
This phenomenon is almost entirely explained by the effect of soil dryness (temperature related). When soils become saturated, as they do in Winter, any rains that fall will instantly run off into streams and rivers. However, in warmer months when soils are dry a frontal shower may wet the soil surface temporarily and then evaporate without running off at all.

This hyper sensitivity – between soil dryness and water runoff – is resulting in rather dramatic consequences as climate change increases ambient temperatures, shrinking the mid-year band, above, where water flows are relied upon to replenish storages.

This drying trend is continuing

This year the Bureau of Meteorology published further clear data showing that these trends are continuing right to the present. The two charts below record a high level of deviation from historic conditions from the early 1970s to the present.





This data applies to the whole of Tasmania. The negative trend would be magnified further in the state's western river catchments. It is perhaps a sobering thought that had the Franklin Dam being built it would have served no purpose at all other than to shore up declining system output.

Looking into the future

As we look to the future now, this double whammy (less precipitation + higher temperatures) has serious consequences for the bottom line of hydro-electric production and profitability.

Hydro Tasmania's currently estimates that Tasmania is 90% self sufficient in electricity supply (from hydro + wind energy capacity). This estimate may indeed be a generous, top end figure since longer term climate trends become statistically valid only over considerable time. A few drought years can be seen as an aberration, accepting that weather fluctuates from year to year anyway. Longer term trends tend to be accepted only after following a good many years of data collection.

Continued modeling is being undertaken to further refine analysis of these climate change trends for Tasmania.

Why this may be the main driver behind the *Battery of Nation* project.

It is worth putting these regressive energy losses into a practical context. The hard reality for Tasmania is that climate change induced energy losses from the Hydro system mean that 9,154 new 5kw rooftop solar systems would need to be added each year, just to compensate for climate change losses alone. This is three times the current installation rate of solar in Tasmania.

Alternatively, this would be equivalent to adding 6 new wind turbines (of typical capacity) each year to compensate for loss of hydro-electric output. That is, a major new wind farm, comprising sixty wind turbines, would have to be built each ten years just to stop us slipping backwards.

It should be noted here that the predicted decline in Long Term Average Yield of our power system affects base load supply. Hydro Tasmania can only supply energy to meet base load demand according to how much water goes into its dams.

From this we can see why the corporation is so keen to pursue its much vaunted *Battery of the Nation* project. Pumped-hydro technology is much less rainfall dependent because it stores energy by cycling the same water (generating electricity then pumping the same water back up).

Hydro Tasmania's ultimate expressed aim is to switch its entire hydro-electric system from base load energy production to peak load supply for the national market, seeing this in the interest of optimising its business bottom line.

References

Cooperative Research Centre: Water and catchments summary *(relevant extract is attached)*

'Climate Futures' reports for Tasmania

State government website

Hydro Tasmania Annual Report 2009 *(extract is attached)*

Entura website reference (mainly focuses on managing drought)

water and catchments

Tasmania's hydro-electric system

Tasmania's hydro-electric system covers a large proportion of the western and central areas of Tasmania. The system stores significant quantities of water in reservoirs and diverts the courses of several rivers, including transferring water between watersheds. The system includes Australia's largest and sixth largest lakes: Lake Gordon/Pedder (11,000 GL) and Great Lake (3,000 GL). Outflows from Tasmania's hydro-electric system into Tasmanian rivers depends not only on inflows, but also on energy demand and prices, maintenance schedules, environmental regulations and the national electricity market operating rules. All of these functions contribute to the operation of the system and need to be considered when projecting power station operation and river flows.

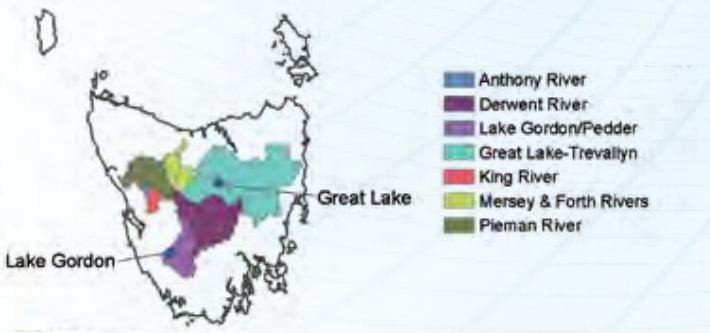
There has been an ongoing decline in observed inflows to hydro-electric catchments through the 20th century. Projections indicate that inflows will continue to decline through the 21st century.

Decreased inflows could lead to an overall reduction in power generation capacity by 2100. Declines to inflows in the central plateau catchments could have a marked impact on power generation, because these catchments feed a large capacity, highly efficient power station.

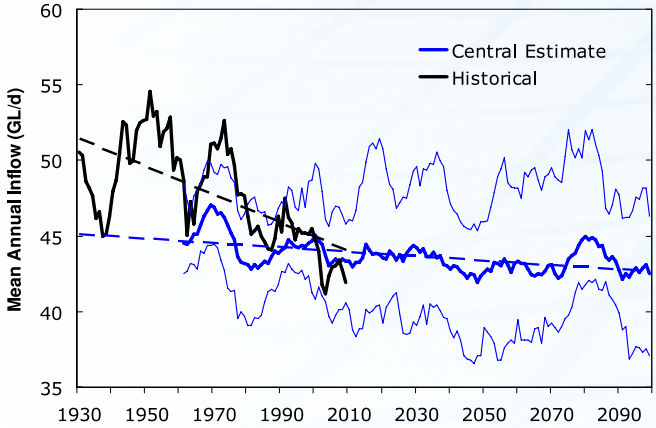
Impacts to hydro power generation

- Tasmania's hydro-electric systems covers a large area of the state and includes two of Australia's largest reservoirs: Lake Gordon/ Pedder and Great Lake.
- By 2100, climate change is likely to reduce inflows to catchments used for hydro-electric power generation and this could reduce the power generation capacity of the Hydro Tasmania hydro-electric system.

Hydro-electric catchments



Inflows



Inflows to hydro-electric catchments
Historical inflows to hydro-electric catchments (black line) have declined during the 20th century. Inflows are projected to continue to decline through the 21st century.

local climate information for local communities

of this type in the world when it was constructed in 1962.

We also undertook predictive modelling of Aboriginal heritage values on Hydro Tasmania's land to help us protect Aboriginal heritage on our sites.

Climate change

Climate change, and the need to mitigate the global impact of this change in the future, has significant implications for Hydro Tasmania's business.

The *Climate Futures* modelling indicates that long-term climate impacts on water resources in Tasmania are likely to reduce inflows and increase variability. This poses a significant risk for Hydro Tasmania. We have already de-rated our system's long-term capacity to generate electricity due to recent climatic conditions of a reduction of average water inflows of over 10 per cent compared to the historical long-term average.

On the other hand, if a market for carbon is established, Hydro Tasmania is likely to see increased value of its current renewable energy generation portfolio and will have opportunities to assist efforts to reduce our national carbon emissions. There are likely to be further business opportunities as customers are increasingly interested in a broader range of products and services, as well as increased incentives for developing more renewable generation capacity.

Our climate change response strategy contributes to global and national efforts to reduce carbon emissions. We will review the strategy in 2009/10 due to the changing reporting requirements and regulatory environment.

Climate Change Response Strategy

Our aim is to be Australia's first carbon neutral generator by 2012. The strategy has several elements:

- advocating for a favourable climate change legislative and regulatory framework
- developing additional renewable energy
- developing products and services to help customers meet their climate change mitigation obligations
- reducing our own carbon footprint.

Advocating for a favourable climate change framework

Hydro Tasmania strongly supports the federal government's proposed Carbon Pollution Reduction Scheme (CPRS) and the Renewable Energy Target (RET). In particular, we strongly believe that the following steps are critical for the development of Australian's renewable energy market:

- the immediate introduction of a carbon emissions trading scheme to ensure the full cost of carbon is built into all investment decisions
- a stringent emissions cap on carbon emissions that reflects the views of the international scientific community on what is required to avoid dangerous climate change, and ensures that the costs of reducing emissions is spread across the whole economy