Ms Margie Morrison
The Secretary
Standing Committee on Climate Change, Environment and Water
Via email: committees@parliament.act.gov.au

Hello. My name is David Gould. I have recently made an examination of local trends in temperature, rainfall and inflows and the connections between them. I wish to share the results of this examination with the committee. It is quite likely that members are already aware of the conclusion that I have drawn, as both ACTEW and the CSIRO have done work in this area—I basically just want to make sure. I am available if the committee wishes to meet with me at the proposed hearing next week (provided I have a little notice) or at some other date.

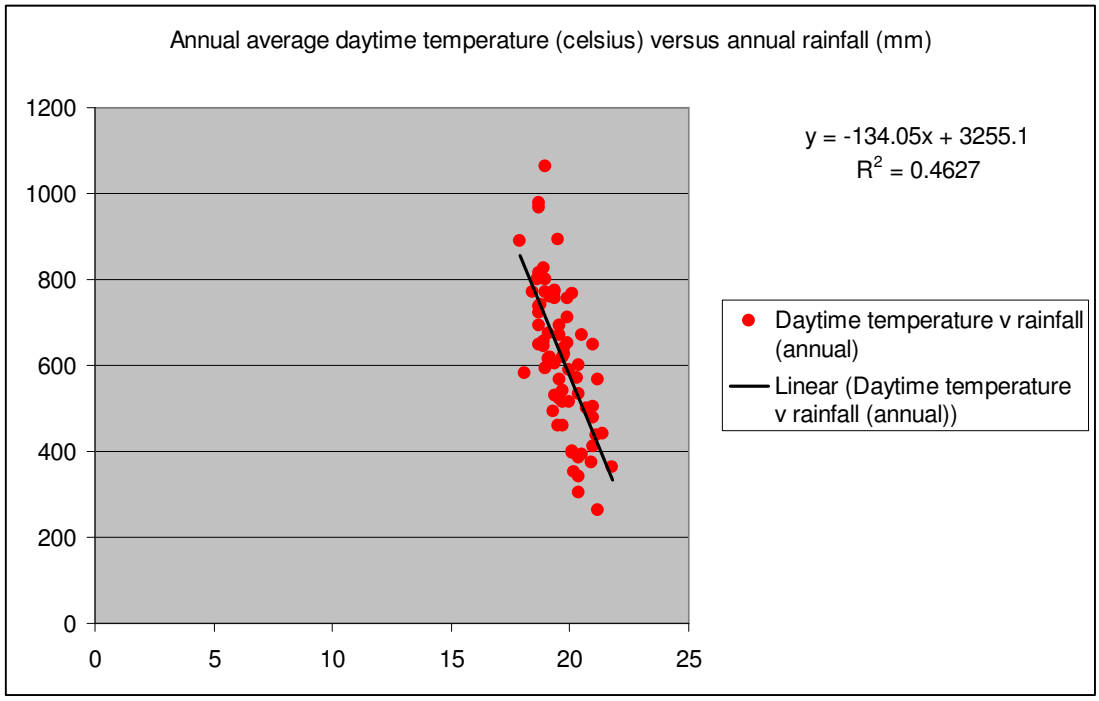
This submission addresses term of reference (c)(i) and makes recommendations regarding things to be included in the ACT Climate Change Strategy: Weathering the Change.

Summary

1.) In Canberra, increases in annual average maximum temperature are correlated with declines in rainfall.
2.) Declines in rainfall have been observed to cause dramatic declines in inflows.
3.) It is highly likely that global warming will continue to increase annual average maximum temperature in Canberra.
4.) If annual average maximum temperature in Canberra continues to increase at the observed rate, by 2020 rainfall will have declined to the point at which inflows effectively drop to zero.
5.) I recommend that the ACT government begin examining and indeed implementing further water security initiatives, along with undertaking more education of the populace on this issue.

The observed inverse correlation of annual average maximum temperature with rainfall in Canberra

Historically, there has been a clear inverse correlation between Canberra's annual average maximum daytime temperature and annual rainfall.



The above is a graph of average Canberra annual maximum daytime temperatures versus Canberra annual rainfall. The data is taken from the Bureau of Meteorology (Rainfall, Temperature) It extends from 1940 to 2009.

What this graph means is that for every one degree rise in temperature, rainfall declines by 134.05 mm. The 95 per cent confidence interval here is 94 mm to 174 mm, which means that—based on the data—we can be 95 per cent confident that the slope falls somewhere in that range, with the mean being 134 mm.

The result, incidentally, is statistically significant to the one per cent level, which means that this relationship between temperature and rainfall would occur by chance less than one per cent of the time. (For the statistically minded, this takes the potential autocorrelation of yearly temperatures into account).

Note that there are other factors than temperature involved in determining changes in Canberra rainfall. However, temperature is a very strong causal factor—indeed, based on the graph it is highly likely that it is the strongest causal factor.

Observed recent inflow declines in Canberra

There is a clear correlation between rainfall and inflows. This is intuitive, of course: the less rain that falls, the less water there is to flow into the dams and rivers.

In the Murray-Darling Basin, there have been three periods of serious drought for which we have records, including the current one. The observed relationship between rainfall decline and inflow decline is that for every one per cent decline in rainfall there is a between 1.5 per cent and three per cent decline in inflows.

However, Canberra inflows during recent years have suffered a much greater decline than the Murray-Darling Basin average. By 2004, inflows were more than 50 per cent below average:

In 2007, 2008 and 2009 inflows were, respectively, 20 per cent, 31 per cent and 23 per cent below average.

Rainfall over the past eight years was 18 per cent below the long-term average. Over the same period, inflows were 64 per cent below the long-term average. Thus, for each percentage decline in rainfall, inflows have declined by more than 3.5 per cent.

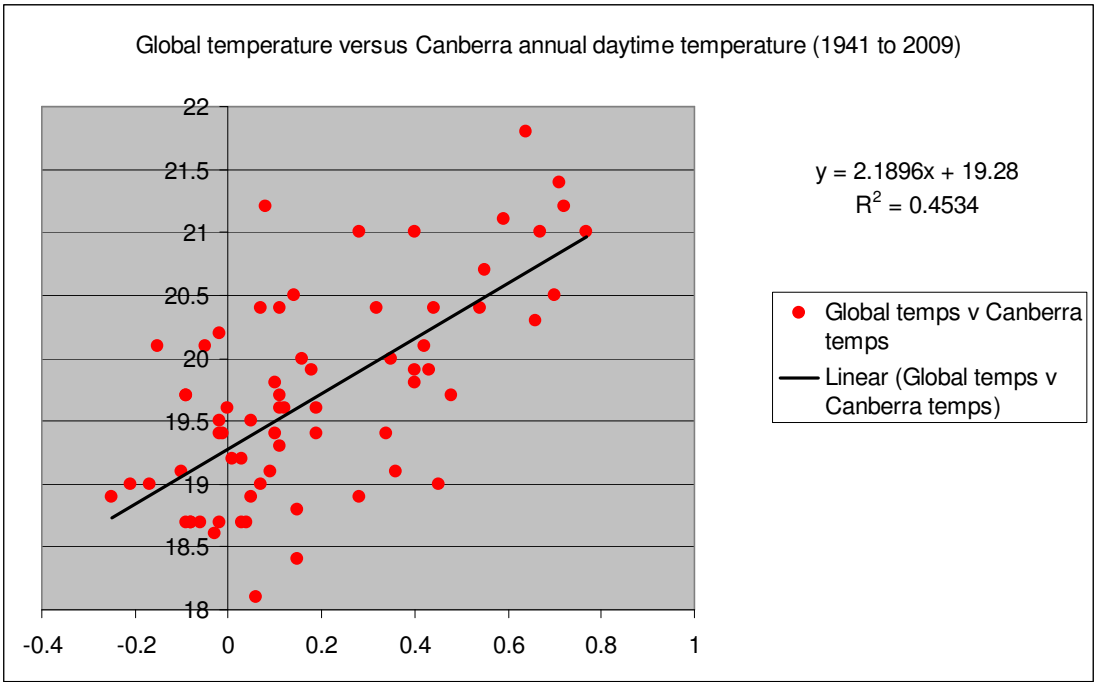
What this means is that a further 10 per cent decline in average rainfall will—if this relationship holds—see an end to runoff in Canberra.

In other words, at that point there will be no water flowing into Canberra dams from catchment runoff. None.

Average annual rainfall for Canberra is 620 mm. Thus, 10 per cent is 62 mm.

Global warming and Canberra's annual average maximum temperature

Historically, there has been a clear relationship between global temperature and Canberra's annual average maximum temperature.



The above is a graph of global temperature versus average Canberra annual maximum temperatures. The data is taken from the Bureau of Meteorology (Canberra temperature) and NASA. (Global temperature) It extends from 1941 to 2009.

What this graph means is that for every one degree rise in global temperature, average Canberra annual maximum temperature rises by 2.1896 degrees. The 95 per cent confidence interval here is 1.3 to 3.1, which means that—based on the data—we can be 95 per cent confident that the slope falls somewhere in that range, with the mean being 2.2 degrees.

The result is statistically significant to the five per cent level, which means that this relationship between temperature and rainfall would occur by chance less than one per cent of the time. (Again for the statistically minded, this takes the potential autocorrelation of global yearly temperatures into account).

We can be very confident, therefore, that as the globe warms, Canberra maximum temperatures will increase—and more rapidly than the globe. It is expected that the globe will warm by about .02 degrees per year over the next decade. That would translate to an increase in Canberra of .044 degrees per year.

Predicted inflows

In this section, I am going to take the three numbers calculated in each of the previous sections and make some predictions about future inflows.

The first number is the rate of observed decline in rainfall per degree increase in annual average maximum temperature. It was found to be 134 mm.

The second number is the decline in rainfall required to reduce inflows to zero. This was a further decline of 10 per cent of annual average, 62 mm.

The third number is the predicted annual increase in Canberra's maximum temperature, which .044 degrees per year.

To get the degree increase required to reduce rainfall by 62mm, we divide 62 mm by the rate, which is 134 mm per degree. We find that a rise of .463 degrees is required. We then divide that by the predicted annual increase in temperature, which .044 degrees per year. This gives us the result that in 10.5 years after the end of 2009, runoff in Canberra will drop to zero.

So, by 2020—assuming these relationships hold—there will be no runoff into Canberra dams.

Caveats and a prediction

Obviously, there are large uncertainties involved in this prediction. Indeed, simply taking the extremes of the 95 per cent confidence intervals discussed above, we get a prediction ranging from 5.7 years to 25.4 years, which would mean that Canberra's inflows may drop to zero anytime between 2015 and 2035. (Note that this would in fact be the 99.5 per cent confidence interval).

Further, this does not include uncertainties to do with the rate of global temperature increase or uncertainties in the precise relationship between rainfall and runoff.

It is also the case that the prediction of zero inflow by 2020 is based on the assumptions that the observed historical relationships between temperature, rainfall and runoff hold into the future, at least in the short term.

It should be noted, however, that these uncertainties apply in both directions. In other words, while Canberra runoff may not drop to zero until sometime after 2020, it is just as likely that Canberra runoff will drop to effectively zero prior to 2020.

Indeed, based partly on this fact, I am going to make the prediction that the precise year in which runoff will drop to effectively zero (defined by me as less than one per cent of the long-term average) will be 2017. There are two other reasons why I suggest this particular year.

The first reason is that in recent years local temperatures have been increasing faster than the long-term rate. This means that we will likely reach that point sooner. If we analyse the most recent data, 2017 is the year that emerges. However, the recent higher trends have not been running for long enough from which to derive statistically significant results, which is why this was not presented in the main discussion.

The second reason is that runoff decline tends to accelerate if there are no intermittent years of heavy rainfall in a dry period. There has been no such year in the last decade and rainfall variability has decreased dramatically, leading me to believe that there are no such heavy rainfall years in our immediate future.

However, the important thing to take away from this is not my precise prediction of 2017. Rather, it is that the evidence shows that Canberra runoff will continue to decline until it reaches zero, and that this point will very likely be reached well before 2035, with at least a 50 per cent chance of it being reached by 2020.

Water security

Examining ACTEW's plans for securing Canberra's water for the future, there are some very important—and very wise—initiatives being undertaken. However, given the urgency of the situation, I think that there is much more that needs to be done.

As an example, there have to date been purchases made of 12.5 gigalitres of water. At average usage in Canberra, this is less than four months supply.

The Murrumbidgee pumping station is able to provide up to 100 megalitres per day. Last year, Canberra used over 130 megalitres per day. While Canberrans have made good strides in reducing water usage, the easiest things have already been done. It will be more difficult to cut usage in the future, especially as population rises.

The enlarged Cotter dam will increase capacity. But this will only be of assistance in capturing the inflows during high rainfall years. With zero inflow, the new capacity will not be able to be used. Rainfall and inflows in Cotter dam catchment have dropped dramatically in recent years.

Designing the demonstration water purification plant was a good step also. However, it is probable that more than a demonstration plant will need to be deployed at relatively short notice.

I draw the committee's attention to this statement, which was made to this committee by the Managing Director of ACTEW Corporation, Mark Sullivan:

'It would be prudent in a risk management framework for Government to identify policies and implement programs based on the assumption that 2030 climate change may have already occurred in the Canberra region.'[1]

It is a statement that I wholeheartedly support. I therefore make the following recommendations:

- Canberra needs to begin the process of moving to stage 4 water restrictions, beginning with an education campaign as to why this is necessary and on what the restrictions entail. The restrictions should enter into effect by at latest the start of 2013. They should at least continue until sufficient water supplies have been secured.
- The public needs to be educated about water purification and why it will likely be necessary within the decade. The government needs to start setting money aside not only to build the demonstration plant but to design and build a commercial one.
- Laws should be introduced to ensure that all new homes in the Canberra region have water tanks of a reasonable size. Similar laws should apply to established homes (with a longer lead-in time), with further government assistance for those on low incomes.
- Government and commercial buildings need to be installed with large water tanks if this is possible, and water tanks should also be employed on public land (school grounds, for example).

[1] ACTEW Corporation, Submission no 26, Inquiry into Greenhouse Gas Reduction Targets, April 2009, p 4

Note that two of the recommendations include significant education components. Education is something I think has been lacking in the current water strategy.

Conclusion

It is clear that climate change is causing temperatures in Canberra to increase. Clear historical relationships between temperature, rainfall and runoff point to a future with zero runoff, and that future is imminent. By 2020, rainfall into Canberra dams will drop to zero.

I do not believe that many of the people of Canberra truly understand the threat to our water security. People see climate change as a distant threat. However, both the CSIRO and ACTEW agree that it is possible that significant climate change impacts have already occurred in the Canberra region. It is more than possible, and the people of Canberra need to be educated on this point and the implications that this has for our shared future.

While the Canberra people and the government have made and are making important progress in dealing with the water security crisis—and it is indeed a crisis—much more needs to be done.

Additional references

Recent inflow figures:
http://www.actew.com.au/publications/annualReport/2009/AnnualReport_2009.pdf

More information on the decline in Canberra inflows can be found here:
http://www.actew.com.au/publications/WaterPlanning2009Review_WaterSupplyandDemandAssessment.pdf

and here:
http://www.abare.gov.au/interactive/08_ResearchReports/Urbanwater/htm/chapter_2.htm

Water security measures:
http://www.actew.com.au/WaterSecurity/MajorProjects/default.aspx

More in factormation on the observed relationship of rainfall to inflows in the Murray-Darling Basin in general:
http://www2.mdbc.gov.au/subs/seaci/docs/ASM2009/ASM2009_1_05_Chiew_T2_overview.pdf

statistical methods:
http://www.chem.utoronto.ca/coursenotes/analsci/StatsTutorial/ErrRegr.html