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CLIMATE CHANGE IMPLICATIONS AND SOLUTIONS FOR WATER SUPPLIES IN INLAND AUSTRALIA

From the results of this project there are 3 major findings that can be noted which will aid in adapting and protecting Australia's settlements and infrastructure.

MAJOR FINDINGS AND OUTCOMES:

First is the surprising reliability of current Global Climate Models (GCMs) and their ability to replicate the climate of the past. The CSIRO MK 3.5 model was used to benchmark the GCM results and assess trends in climate conditions. GCMs are potentially very useful for water resource modelling within Australia.

The data which supports this result was in 2 parts; first a mean comparison was run. The results are shown below with 1 being a perfect mean match. The results in the table below were obtained by using monthly means from both the historical and GCM data. The results are calculated by summing the means of the GCM data over the length of the site records, then dividing by the summation of the historical data over the period.

Site	Precipitation (GCM/Historical)	Evaporation (GCM/Historical)
Mildura	0.99	1.05
Wagga Wagga	0.97	0.91
Menindee	1.10	1.05
Canberra	1.01	0.99

Table 1 Mean Based Comparison of GCM and Historical Data

From this the GCM data looks like a good match to the sites, thus giving confidence of the model's ability to project climate change trends into the future. However, just because the GCM works well on a mean based analysis this doesn't mean that it will translate into giving similar results for a behavioural analysis. This next comparison was a better test of the model's accuracy. A comparison of analysis of groundwater dam performance in the past has been used for this purpose..

		Farm			Groundwater		
		Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
Monthly Historical	Mildura	0	0	92	0	30	96
	Wagga	0	0	25	0	0	0
	Menindee	0	0	0	0	0	0
	Canberra	0	0	0	0	0	0
Monthly 20th Century GCM	Mildura	0	0	121	0	35	267
	Wagga	0	0	0	0	0	0
	Menindee	0	0	0	0	0	0
	Canberra	0	0	0	0	0	0

Table 2 Historical vs 20th Century GCM Predicted Number of Dam Days at Zero Capacity

From the table above the GCM has not performed as well at it did in the mean analysis with most values increasing. This shows how GCMs are very good at mean accuracy but when it comes to perfectly matching data sets they are still not as accurate as they should be.

The second major finding was the evidence that when climate change occurs it will have a negative effect on farm dams. The evidence of this is in the extreme failure of Mildura's case three dam. Even though this is just one case it highlights cause for concern.

With evidence that a farm dam's reliability will be significantly decreased under a changing climate, a solution to this was put forward in the form of a groundwater dam. Results show that groundwater dams are more beneficial in arid zones, with a 50% decrease in days at zero capacity, under a changing climate. These groundwater dams are also affected by the change in climate conditions as in the case of the farm dams but because of the minimised evaporation levels that are gained with the construction of these dams they were found to be more reliable than a farm dam.

		Farm			Groundwater		
		Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
Monthly Historical	Mildura	0	0	92	0	30	96
	Wagga	0	0	25	0	0	0
	Menindee	0	0	0	0	0	0
	Canberra	0	0	0	0	0	0
Monthly future GCM	Mildura	0	134	3450	0	79	1695
	Wagga	0	0	0	0	0	42
	Menindee	0	0	0	0	0	0
	Canberra	0	0	0	0	0	0

Table 3 Historical vs Future GCM Number of Days at Zero Capacity

From the table above Mildura is the site that will be focused on because it displays the relevant results. Mildura displays vulnerability of medium to large farm dams in the future with a changing climate. The groundwater dam for these same two cases shows a vast reduction in days at zero capacity.

This threat to farm dams increases when the smoothing effect due to the change in time step from daily to monthly is considered. This compromise in data is potentially very important and shouldn't be under estimated. The reduction in natural variability caused by this change also had an effect on the results. This demonstrates the importance of using daily data when it is available. Thus this crucial compromise also reduced the negative effects that the results displayed on farm dams.

		Farm			Groundwater		
		Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
Daily Historical	Mildura	0	0	134	11	58	95
	Wagga	0	0	47	0	0	0
	Menindee	0	0	0	0	1	0
	Canberra	0	0	0	0	0	0
Monthly Historical	Mildura	0	0	92	0	30	96
	Wagga	0	0	25	0	0	0
	Menindee	0	0	0	0	0	0
	Canberra	0	0	0	0	0	0

Table 4 Daily vs Monthly Historical Analysis Number of Days at Zero Capacity

At present only arid zones currently show a benefit for the construction of groundwater dams, however, this could change with the accuracy of the analysis performed. This is a consequence of the monthly time step, if a daily time step could have been used, it might have proved that groundwater dams can be beneficial in more than just arid zones under future GCM conditions.

Overall the effects of climate change on farm dams in Australia will be negative, causing a reduction in reliability and water security that these dams once provided. But the adaptation in the form of groundwater dams to these conditions is feasible and could provide the extra reliability that is required to ensure security of water resources in Australia's changing climate.

PROJECT SIGNIFICANCE TO ADAPTING AND PROTECTING AUSTRALIA'S SETTLEMENTS AND INFRASTRUCTURE:

The results found in this report will aid in helping Australia's settlements and infrastructure adapt to climate change, by highlighting the risks that many small inland water sources are not stable in a changing climate, and as a result many communities need to start looking at alternative water sources into the future .

This report has looked at groundwater dams, as an alternative for farm dams, and how well they perform at some sites which are affected by a changing climate. This however, may not be the only solution, but one which could be seen as a practical way to adapt for a changing climate.

FURTHER RESEARCH SUGGESTIONS:

With these new findings what new direction can be taken to further advance this field of research?

The key evidence for the use of groundwater dams in Australia came from the study of Mildura. A more focused analysis around this region would be seen as useful. The main focus would be on using multiple climate models and comparing their results. Also the confidence in variables could improve the results because more detail could be placed on approximating run-off coefficients and catchment areas.

The need for a daily time step analysis is crucial; this was the biggest compromise that was made in this analysis. This change would restore the natural variability that comes with all climates and definably give more accurate results. This advancement would be the one which would prove most useful in furthering research in this field.

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