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Assessment of climate change impacts on future streamflow in a catchment of the Australian Hydrologic Reference Stations (HRS)

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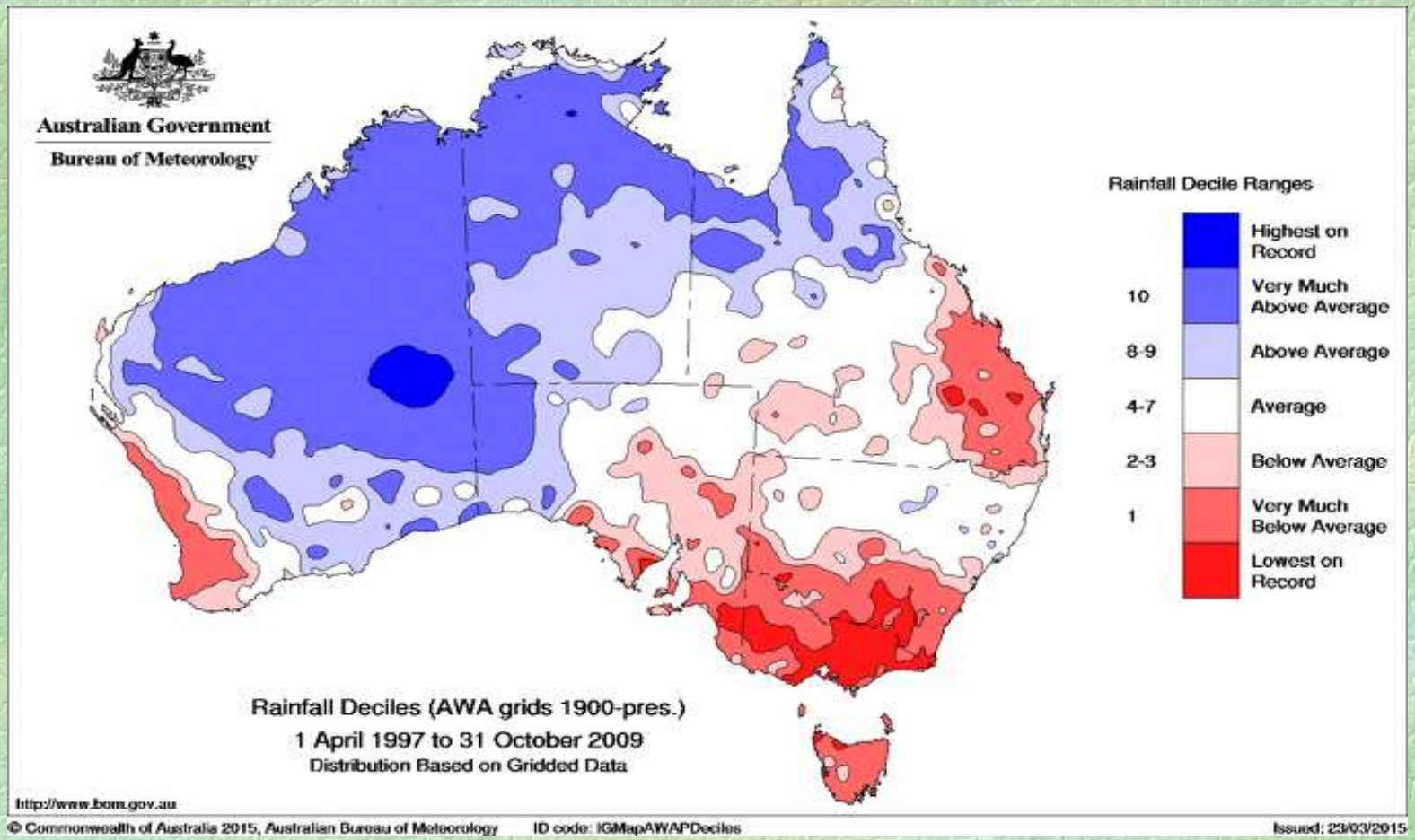
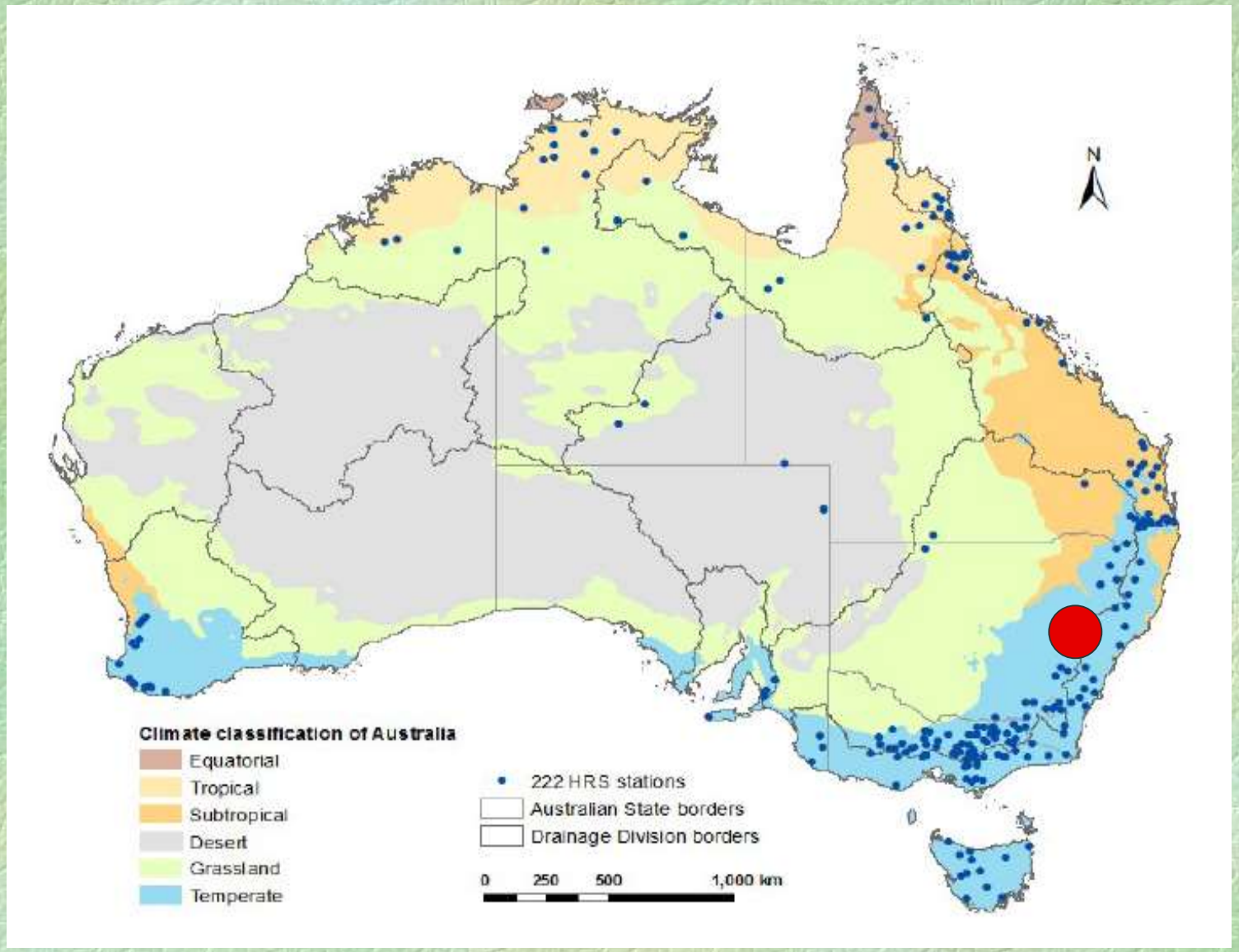
- In Australia, the average temperature has increased and Rainfall has decreased over the last 50 years specially the south-eastern Australia.
- Climate change impacts on long-term water availability and food security and the environment.



Australian Hydrological Reference Stations (HRS)

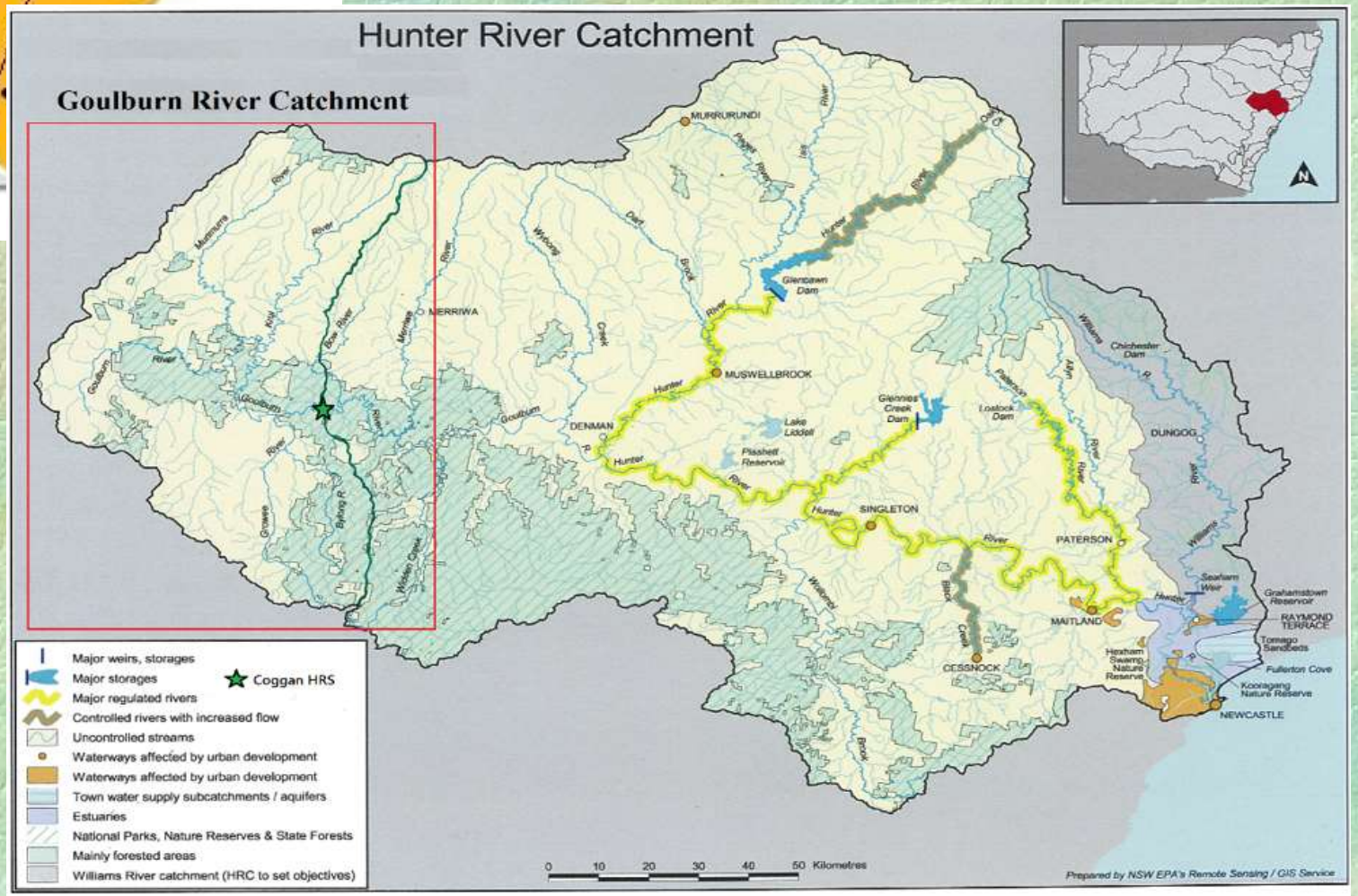
- The Australian Bureau of Meteorology (BoM) has created a network of 222 Hydrologic Reference Stations (HRS) across Australia, to explore the long-term streamflow trends in unregulated catchments
- All sites of the HRS-network were carefully chosen and prioritized according to three specific criteria
  - The contributing catchments of the selected sites are unaffected by the land-use change and local water resources regulations.
  - They hold long-term, high-quality discharge records
  - The selected stations signify all hydro-climatic areas within Australia.

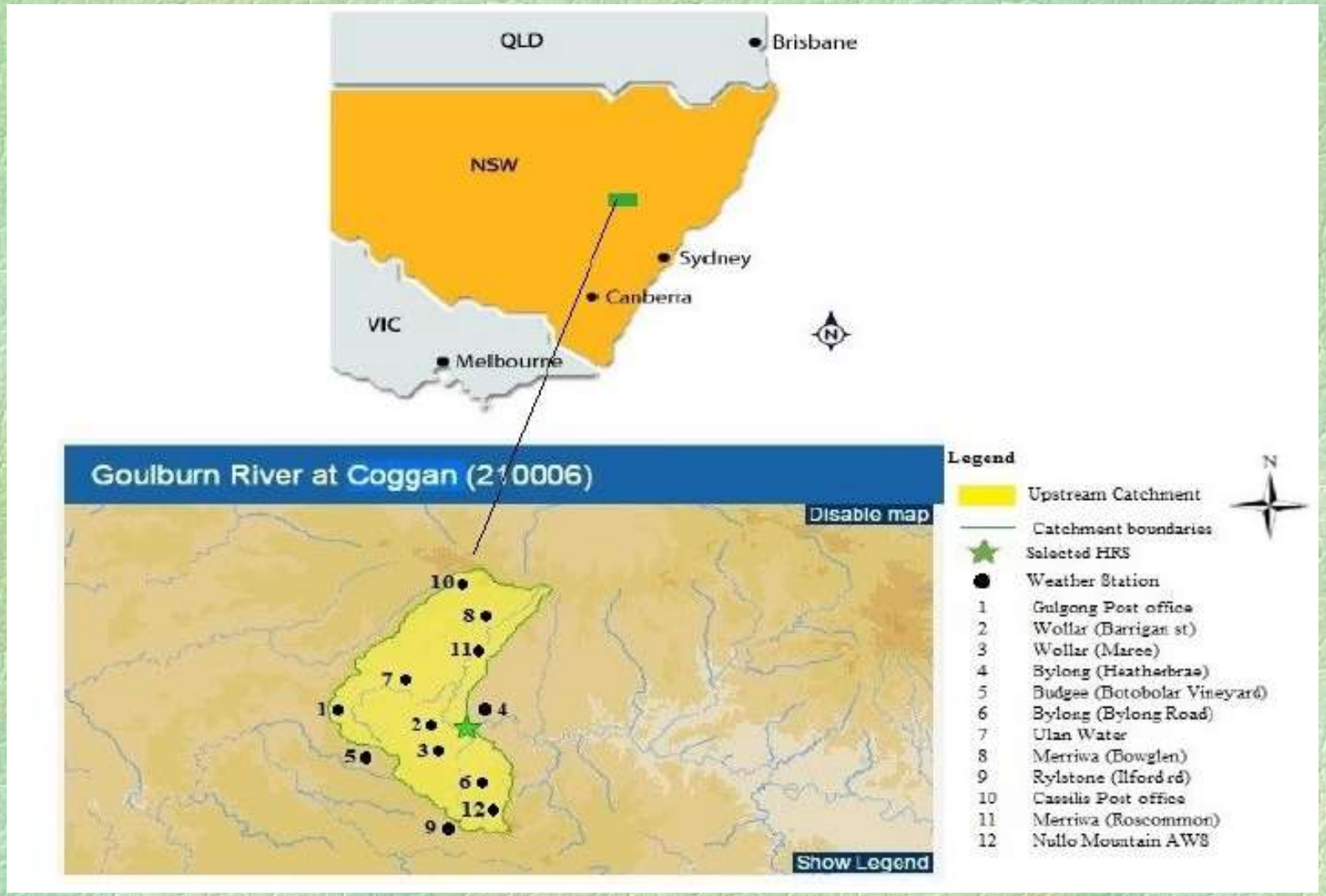
Australian Hydrological Reference Stations (HRS)



Study Area - Goulburn River catchment

- Area = 3402 km^2
- Mean Precipitation = 620 mm/year





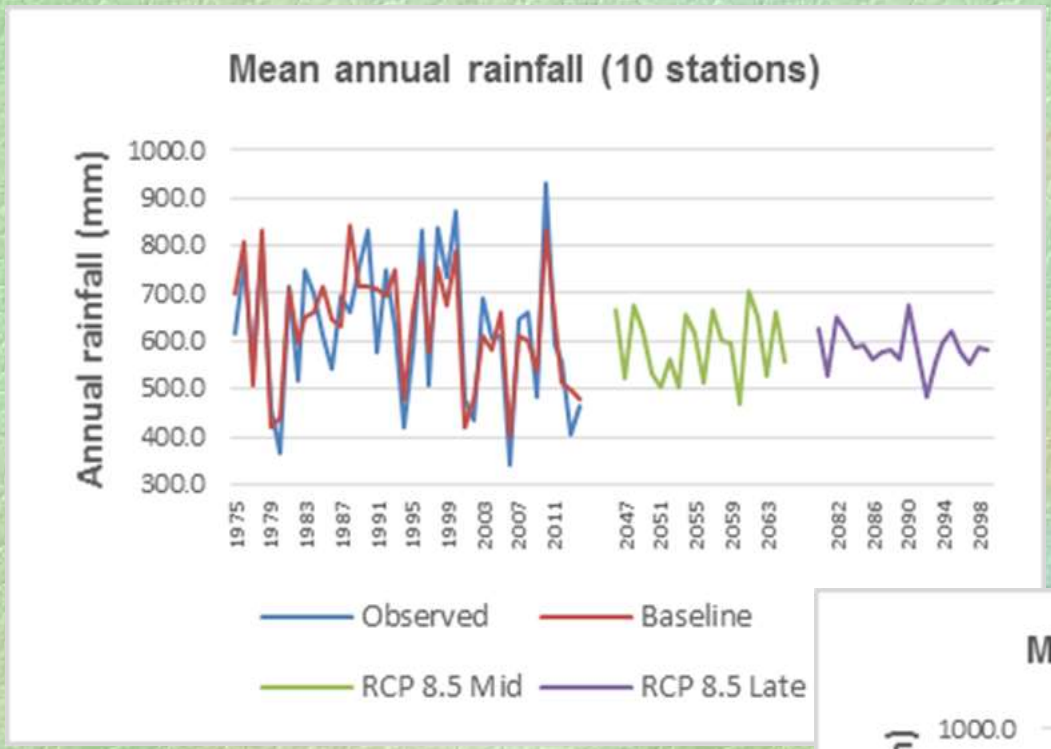
1- **Rainfall** (point data from 10 weather stations)
2- **Temperature** (point data from 3 weather stations)
3- **Potential Evapotranspiration** (point data from 3 weather stations)
4- **Stream flow** at the outlet point (gauged data at Coggan HRS)

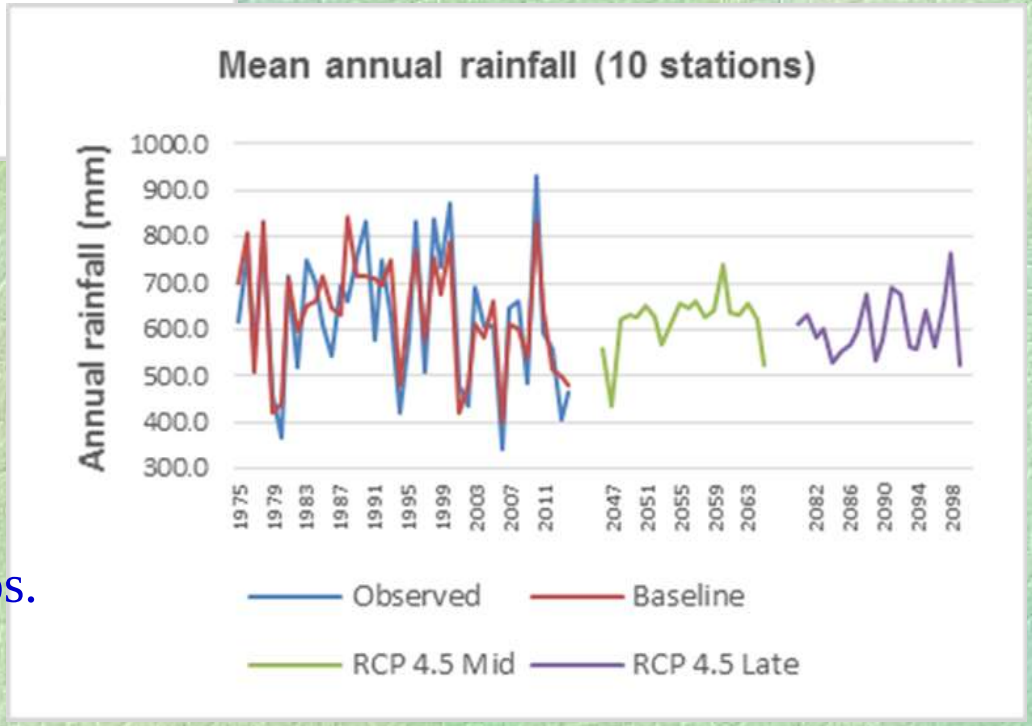
Future Climate Data

- Future climate series of **rainfall and temperature**
- Multi-model ensemble of **8-GCMs** - (CMIP5) Coupled Model Intercomparison Project phase 5
- Two RCPs (Representative Concentration Pathways) **RCP4.5 and RCP8.5**
- Two future periods **mid (2046-2065)** and **late (2080-2099)** of the 21st century
- **Reference/control run** period (1975-2014).

CMIP5 model ID	Institute	Atmosphere resolution (km)
ACCESS1.0	CSIRO-BOM, Australia	210×130
CanESM2	CCCMA, Canada	310×310
CNRM-CM5	CNRM-CERFACS, France	155×155
GFDL-ESM2M	NOAA, GFDL, USA	275×220
CESM1-CAM5	NSF-DOE-NCAR, USA	130×100
HadGEM2-CC	MOHC, UK	210×130
MIROC5	JAMSTEC, Japan	155×155
NorESM1-M	NCC, Norway	275×210

A Statistical Downscaling Model developed by BoM (BoM-SDM) (Timbal et al., 2008) was used to extract the local-scale daily rainfall and temperature (point climate projections) from the global-scale monthly outputs of the baseline and future periods.





Observed and CMIP5 (model)

Mean Annual rainfall

-RCP4.5 and RCP8.5 climate scenarios.

* The future simulated rainfall is the ensemble mean of 8-GCMs.

Future Climate Projection

Overview of mean annual sums of

Rainfall, Temperature and Potential Evapotranspiration

For the observed, baseline and the future periods.

Variable	Observed Climate (1975-2014)	(Baseline period) (1975-2014)	2046-2065		2080-2099	
			RCP4.5	RCP8.5	RCP4.5	RCP8.5
P (mm/year)	625	635	610	590	605	585
T (C°)	16.1	16.7	17.1	17.5	17.3	17.9
PE (mm/year)	1477	1542	1670	1690	1710	1750
Changes in mean annual values compared to the baseline period (+)increase, (-)decrease		P% (mm/year)	**-3.9**	**-7.0**	**-4.7**	**-7.8**
		T (C°)	**+0.4**	**+0.8**	**+0.6**	**+1.2**
		PE% (mm/year)	**+8.3**	**+9.6**	**+11.0**	**+13.5**

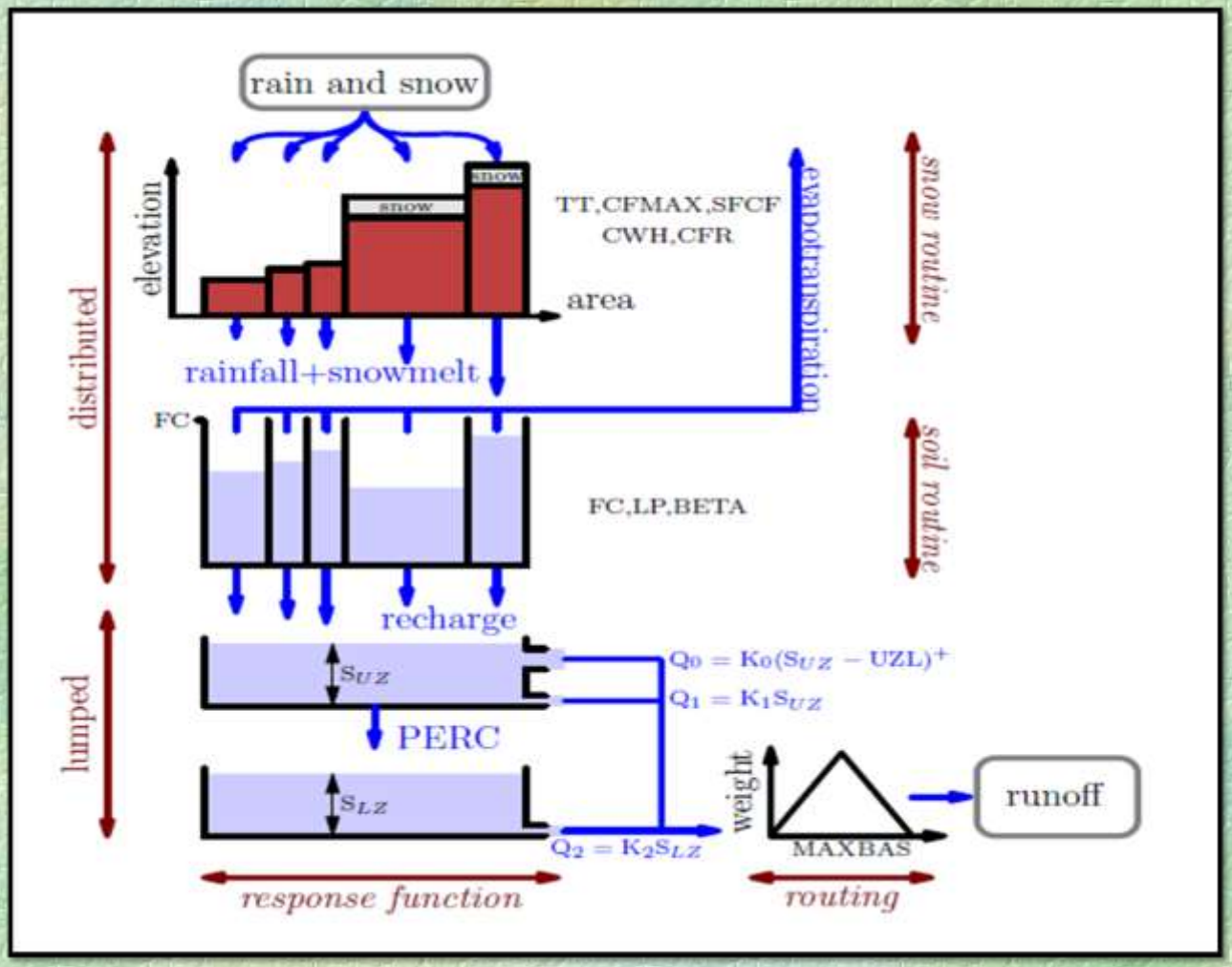
* All RCPs values represent the ensemble mean of 8-GCMs

Hydrological Modelling

The hydrological model - HBV model developed by SMHI

(Swedish Meteorological and Hydrological Institute)

A simple schematic structure of the HBV model

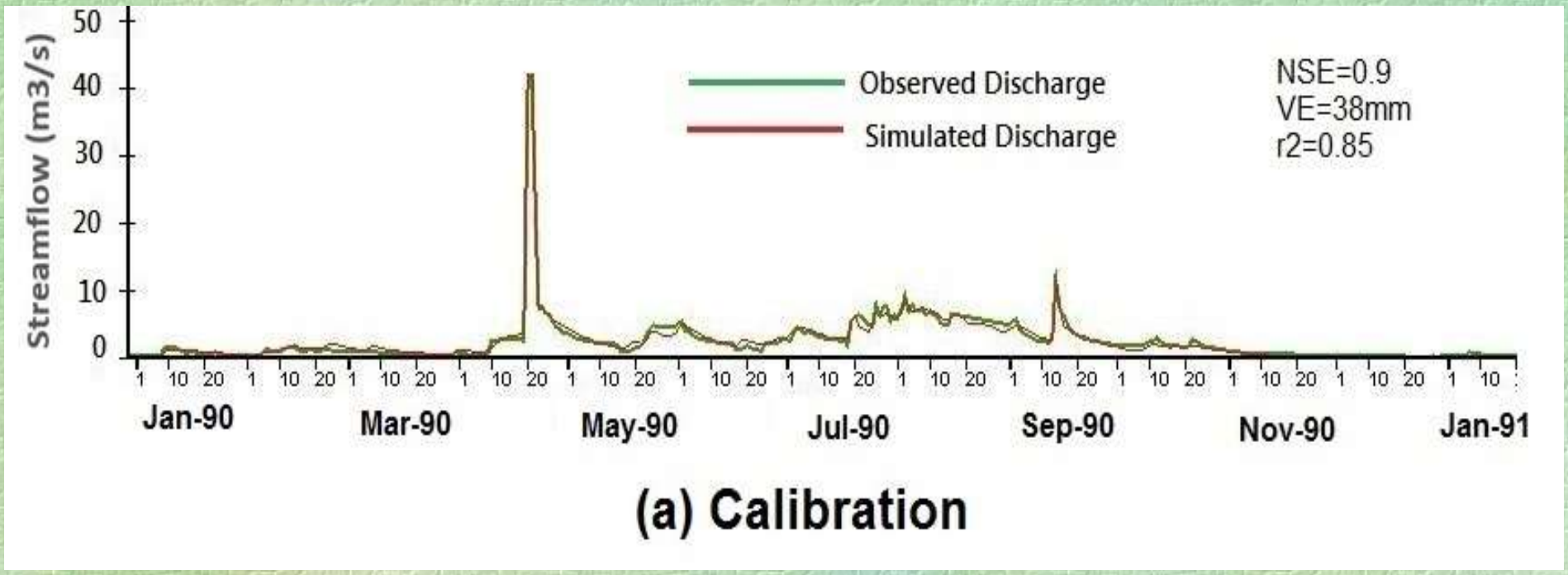


HBV-Model Calibration & Validation

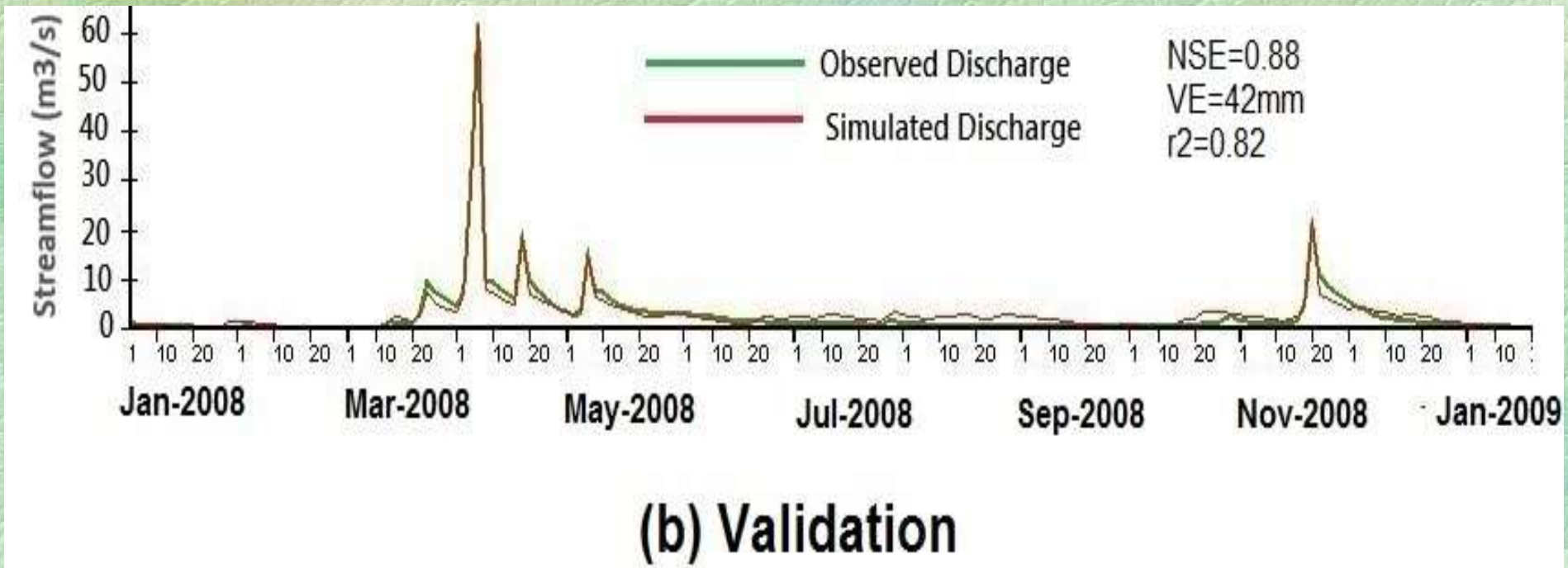
- Daily observed streamflow data at Coggan HRS on Goulburn River was available for 33 years (1975-2014).
- Model was calibrated and validated manually against the daily observed streamflow data for the periods (1976-2004) and (2005-2014) respectively.

HBV model parameters and their optimal values resulting from the calibration process

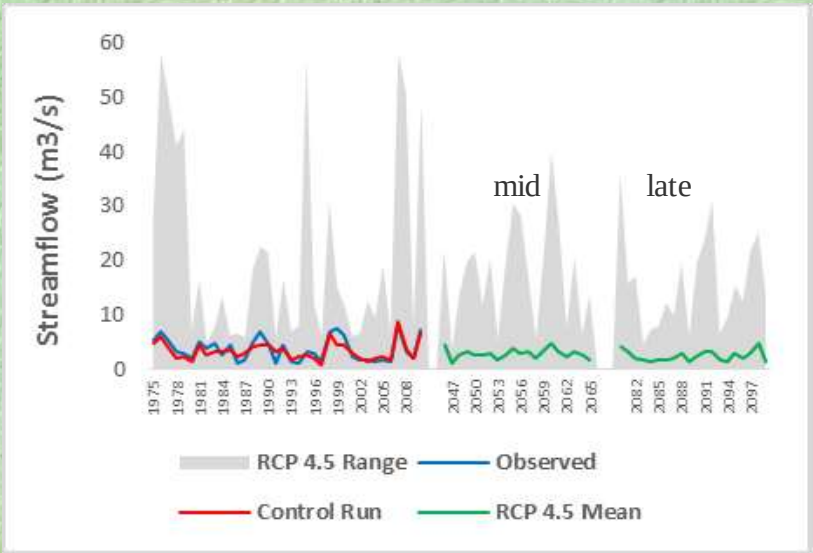
Parameter	Symbol	Unit	Optimal value
Rainfall correction factor	rfcf	-	0.8
Maximum soil moisture storage	FC	mm	250
Limit for potential evaporation	Lp	-	0.8
Shape coefficient	Beta	-	3
General correction factor for potential evaporation	ecorr	-	0.85
Recession coefficient for upper response box	Khq	1/day	0.9
Recession coefficient for lower response box	K4	1/day	0.07
Maximum percolation capacity	Perc	mm/day	0.9
Routing parameter	Maxbaz	day	0.5

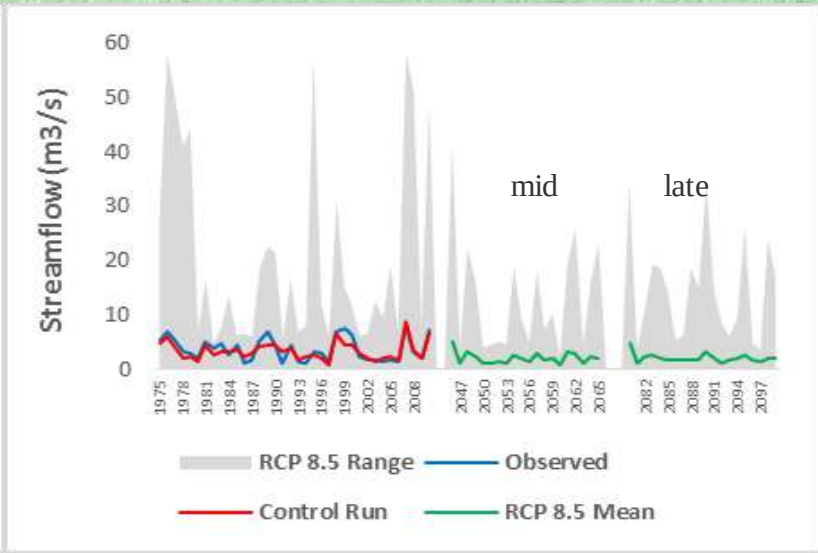


(a) Calibration

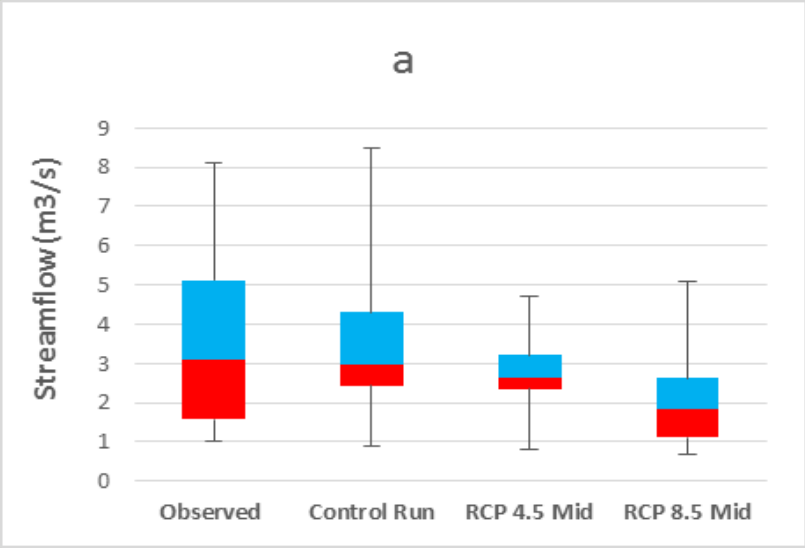


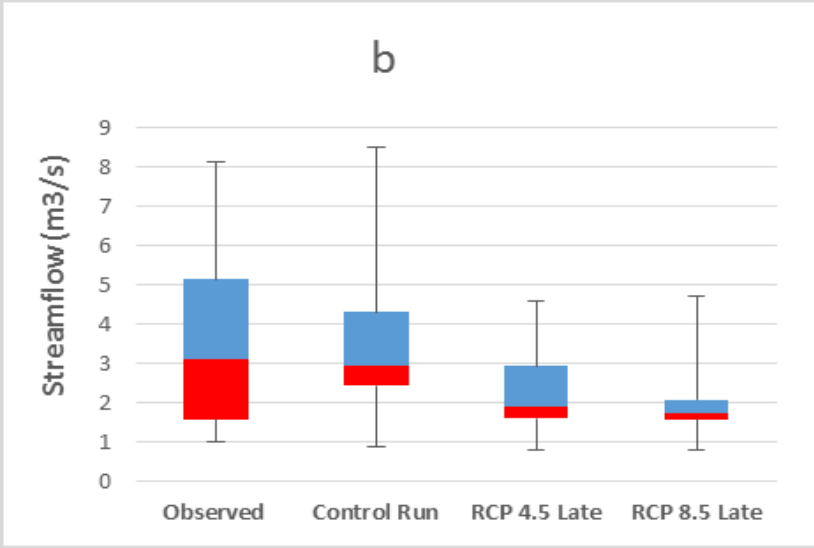
(b) Validation





Mean annual observed and simulated streamflow at Coggan-HRS. The average simulated runoff is the ensemble mean of 8-GCMs, while RCP4.5 and RCP8.5 range are the maximum and minimum of all GCMs.





The 25th and 75th streamflow percentile statistics under the RCP4.5 and RCP8.5 climate scenarios: (a) mid-century and (b) late-century.

B- Future River Discharge Simulation

Mean annual streamflow at Coggan-HRS for the observed, control-run and future periods (m3/s). The values of all RCPs represent the ensemble mean of 8-GCMs

Variable	Observed (1975-2014)	Control-run (1975-2014)	2046-2065		2080-2099	
			RCP4.5	RCP8.5	RCP4.5	RCP8.5
Q Min.	1	0.9	0.8	0.7	0.8	0.8
Q25	1.6	2.4	2.3	1.1	1.6	1.6
Q75	5.1	4.3	3.2	2.6	3.0	2.0
Q Max.	8.1	8.5	4.7	5.1	4.6	4.7
Q Mean	3.7	3.3	2.7	2.0	2.3	1.9
Changes in mean annual runoff compared to the control-run (%) (+) increase, (-) decrease		**Q Min.**	**-11**	**-22**	**-11**	**-11**
		Q25	**-4**	**-54**	**-33**	**-33**
		Q75	**-26**	**-40**	**-30**	**-53**
		Q Max.	**-45**	**-40**	**-49**	**-45**
		Q Mean	**-18**	**-39**	**-30**	**-42**

Summary & Conclusions

- The hydrological modelling results show **decreasing tendencies in the future streamflow** measured at Coggan-HRS under the RCP4.5 and RCP8.5 climate scenarios (compared to the reference/control run - **1975-2014)**.
- Findings of the this study well matches with similar outcomes of other previous studies which have been carried out in other Australian basins and revealed a noticeable decrease in the future rainfall & runoff.
- As the Goulburn-River flow is projected to decrease due to future climate change, this would effectively impose further limitations on the surface water supply systems in the Hunter-River basin.
- The findings may also be significant to manage the usage of future water resources in the catchment such as irrigation, water supply and even ecological/environmental use considering the low flows condition.

THANK YOU..!!

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