

Water in south-west Western Australia

Water for a Healthy Country Flagship

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The CSIRO South-West Western Australia Sustainable Yields Project provides science to underpin the sustainable planning and management of the water resources of south-west Western Australia

Project overview

Led by CSIRO's Water for a Healthy Country Flagship, the South-West Western Australia Sustainable Yields Project is the most comprehensive assessment of current water yields and the possible impacts of climate change and development on the water resources of south-west Western Australia. This region has already been impacted by climate change, experiencing a 10 to 15 percent decrease in annual rainfall since about 1975 which resulted in runoff decreasing by over half. However it is less well known how such a reduction

in rainfall influences recharge and groundwater levels and impacts on water dependent ecosystems and yields.

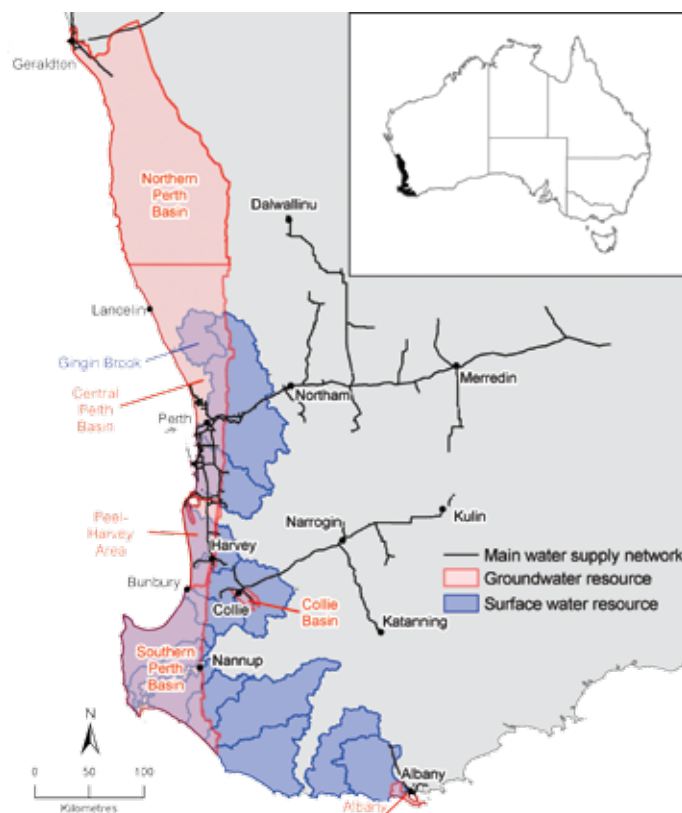
The project area occupies about 62,500 km² and contains over 1.9 million people or 89 percent of the population of Western Australia. It is concentrated over the highest rainfall part of the south-west of the state. The project provides a nationally consistent assessment of regional water availability that is useful for water managers, environmental managers and water users when considering the possible future impacts of climate change and development on water resources and the environment.

The project estimated the likely water yield of all major fresh, marginal and brackish surface water and groundwater resources under the same climate and development scenarios as used in equivalent studies in the Murray-Darling Basin, northern Australia and Tasmania. The project has also estimated future water demands and compared these with likely future yields from all water resources under several scenarios. Finally the possible impact of climate on water dependent ecosystems was assessed.

Water in the region

Fresh runoff occurs in the short streams that drain west from the Darling Range that lies east of the Perth Basin (Figure 1). Larger streams that extend into the Wheatbelt are too saline for use. Reservoirs for metropolitan use are located in the northern part of the surface water region while scheme irrigation dams occur in the Harvey and Collie areas and self-supply farm dams are common in the south-west and south.

Extensive groundwater resources are found in the Perth and Collie sedimentary basins, with less extensive resources in the western Bremer Basin near Albany. Groundwater is the main water source in these sedimentary basins, although surface water from Darling Range dams is used to irrigate coastal land west of Harvey and Collie. Wellfields provide Perth with more than half of its drinking water and groundwater supplies more than 85 percent of all metropolitan water use. On the coastal plains, self-supply groundwater is used for irrigating high value horticultural crops around Perth, west of Harvey and south of Bunbury.



> Figure 1. Groundwater resources and surface water resources in the project area

Key finding 1

South-west Western Australia has experienced significant climate change since the mid-1970s which has impacted on surface water and groundwater yields, and water dependent ecosystems

Previous work has shown that annual rainfall in south-west Western Australia has declined by 10 to 15 percent since about 1975 when compared with earlier records. The decline in autumn and early winter is most marked, as has been a reduction in rainfall intensities, runoff into dams and recharge into aquifers. Wetlands and perennial streams that were relatively abundant in the mid-twentieth century have either decreased or dried out as a result of this change. Climate modelling has indicated that there is a high probability that a proportion of the change is due to the presence of greenhouse gases. Some studies have indicated that wet and dry decades may be a feature of the region's historical climate.

Key finding 2

Over central and northern parts of the project area the mean annual rainfall has been lower during the recent past than during the historical past

The period in the late 1970s was dry in the south-west region but there have been even drier periods recorded in the northern and central parts of the project area since the mid-1990s. Long-term rises in groundwater levels under

> Irrigation at a dairy farm near Harvey, WA (Robert Garvey)

dryland agriculture in the northern Perth Basin are not as marked as they were in previous decades. The almost complete absence of very wet seasons and the occasional wet year has been particularly influential as it is often these periods that result in the greatest runoff and recharge.

In the southern part of the project area the recent past (1997 to 2007) has not been any drier than in the previous two decades.

Key finding 3

Almost all daily global climate models used by the Intergovernmental Panel on Climate Change Fourth Assessment Report predict that the climate in the region will get hotter and drier by 2030 relative to the 1990 base period

Fourteen of the 15 daily global climate models (GCMs) used in the Intergovernmental Panel of Climate Change Fourth Assessment Report predict that the 2030 climate will be drier than during the historical period of 1975 to 2007. The 15th model does not estimate any significant change. The average reduction in rainfall projected to occur is 7 percent with a 10th and 90th percentile range of 1 to 14 percent reduction.

It is unusual to find such high agreement between so many climate models. The 7 percent reduction is in addition to the 10 to 15 percent reduction already acknowledged to have occurred since the mid-1970s.

Key finding 4

Surface water modelling has indicated that the future yields in the region are likely to be on average 24 percent lower by 2030, with a possible range of 4 to 49 percent lower

A number of rainfall-runoff models were used to assess future water yields should the climate dry as indicated by the GCMs. Under the median future climate surface water yields (i.e. water

that can be safely diverted from streams) are projected to decline by an average of 24 percent. Under the wet extreme climate the yield decline is only 4 percent but under the dry extreme climate the decline is 49 percent.

The highest yielding areas of Harvey and Collie are less affected by climate change, with estimated reductions of 15 and 22 percent respectively. In comparison, the Donnelly and Warren management areas are projected to experience reductions of 39 and 36 percent respectively. All four of these regions are important for irrigated agriculture. Under the dry extreme climate more than a third of all surface water areas would experience a decline in yields in excess of 60 percent.

Key finding 5

A median future climate is expected to decrease summer and winter runoff by 20 to 30 percent and especially affect water dependent ecosystems that depend on high flows

Stream biota and riparian zones rely on river flows for their functioning. The modelling has indicated that both winter and summer flows may reduce by between 20 and 30 percent under the median future climate. The impact may be most severe on functions that require high flows which influence channel scouring, channel morphology and the inundation of floodplains. The relative lack of high intensity rainfall events has been a feature of the climate shift that has been experienced since the mid-1970s.

Key finding 6

Significant gaps between water yields and demands are expected to occur by about 2020 in areas where surface water resources are used for irrigation

Surface water irrigation catchments are expected to experience both reduced water yields and increased demands as the economy and population grow which will result in a deficit of water. This is already apparent in some areas but will



be larger by 2020. Increased water use efficiencies and water trading may help address some water shortages.

Key finding 7

Groundwater demonstrates greater resilience to climate change where watertables are within a few metres of the surface. The falling watertable results in less evaporative and drainage losses which increase net recharge. Levels are projected to continue to rise in areas under dryland agriculture

Key finding 8

Groundwater modelling has indicated that future yields in the region are likely to be on average 2 percent lower by 2030, with a range of +2 to -7 percent

Groundwater levels in parts of the region have been projected to rise even under the dry extreme future climate. This is because the predominant land use on the Perth Basin is dryland agriculture which enables recharge to occur, especially if the soils are sandy and the aquifer is not full. This mechanism results in dryland salinisation in inland parts of Western Australia. However there is little salt stored under the coastal plain and groundwaters are often fresh to brackish.

The watertable is within 3 metres of the soil surface in over a fifth of the southern Perth Basin. In these areas a decrease in rainfall may result in reductions of evaporative losses and groundwater discharge to drains which will result in the fall in groundwater levels being less than would otherwise be the case. Where there is perennial vegetative cover and soils are clayey, groundwater levels are expected to fall significantly as a result of climate change.

As a result of all these feedback processes, groundwater yields may decline by only about 2 percent under the median future climate but by up to 7 percent under the dry extreme future climate. However some important and vegetated areas such as Gngangara,



> Mundaring Dam east of Perth, WA (Robert Garvey)

Blackwood and Albany may experience reductions in groundwater yields of more than a third.

Key finding 9

The decreased evaporative losses associated with falling groundwater levels are likely to result in groundwater dependent ecosystems such as wetlands being impacted. Abstractions may need to be adjusted accordingly

The reduction in evaporative losses may benefit groundwater yields because a higher percentage of rainfall could become recharge. However the fall in evaporative losses reflects that many wetlands that have developed in the wetter parts of the mid-twentieth century may be lost because of climate change. Because environmental impacts are the main constraint to groundwater development, a drier climate may require even more care when abstracting groundwater.

Key finding 10

Consumptive water demand in the region is expected to increase by 35 percent by 2030, with a range of between +10 and +57 percent depending on population and economic growth factors

South-west Western Australia has a rapidly growing population and economy that is resulting in increases in

the demand for water. Unconstrained demand may double by 2030 but is more likely to grow by about a third. Unlike other states, only about a third of all water use is for irrigated agriculture, most is self-supplied through on-farm bores and dams, and most is used to grow high value produce. About three-quarters of the water used is groundwater which is also unusual. Trading between groundwater users could affect environmental values in areas of greatest concentration and an assessment and approval of trades will be complex. This makes the possibility of transferring water from low to high value uses more challenging than in inter-connected riverine irrigation systems such as the Murray-Darling Basin.

Key finding 11

Significant gaps between groundwater yields and demands are expected to occur by about 2020 for areas around Perth

Pressures on groundwater are already high in the Perth areas where it currently meets about 85 percent of all water demands. With groundwater levels estimated to continue to fall on the Gngangara Mound and with demand for water growing rapidly, the competition between public and private users of groundwater in this area is projected to increase.

Key finding 12

If water quality and transportation costs are ignored, the region has enough water overall to meet all except high demands until 2030 under the median future climate scenario

When the future yields of water resources under the median future climate are estimated, there is potentially enough water in south-west Western Australia to meet all unrestricted demands under the medium demand scenario until at least 2030. This assumes that the water can be transported to where it is needed and water quality constraints are not a barrier to use. This also assumes that water use efficiencies remain unchanged and current environmental constraints remain in place. These assumptions, plus others, are conservative and more work would need to be done to assess the finding.

Key finding 13

Under the dry extreme climate and high demand, the region is expected to have an overall deficit of over 250 gigalitres per year (GL/year)

High demand and a much drier climate may result in all available water being required to meet future demands. Desalination is being used to meet potable water demands in south-west

Western Australia so this scenario is not without foundation. Higher cost sources such as desalination may be required to meet local needs because of the impact and cost of moving water from where it is available to where it is needed.

Key finding 14

Groundwater is expected to progressively substitute for surface water resources where both sources are available in the region

The decrease in surface water yields that has been experienced since the mid-1970s is projected to continue under all future climate scenarios. Already in the Perth area, surface water sources have been progressively replaced by superficial aquifer sources in the 1980s and 1990s and then deep aquifer sources since about 1998. Where surface water and groundwater resources can meet a water need it is expected that the greater resilience of groundwater will result in it becoming even more important in the future in a relative sense. An exception to this may be the Albany Area where groundwater resources are limited and surface water resources are more available.



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