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Mapping groundwater-dependent ecosystems using a high-resolution global groundwater model

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Supplementary Figures and Tables

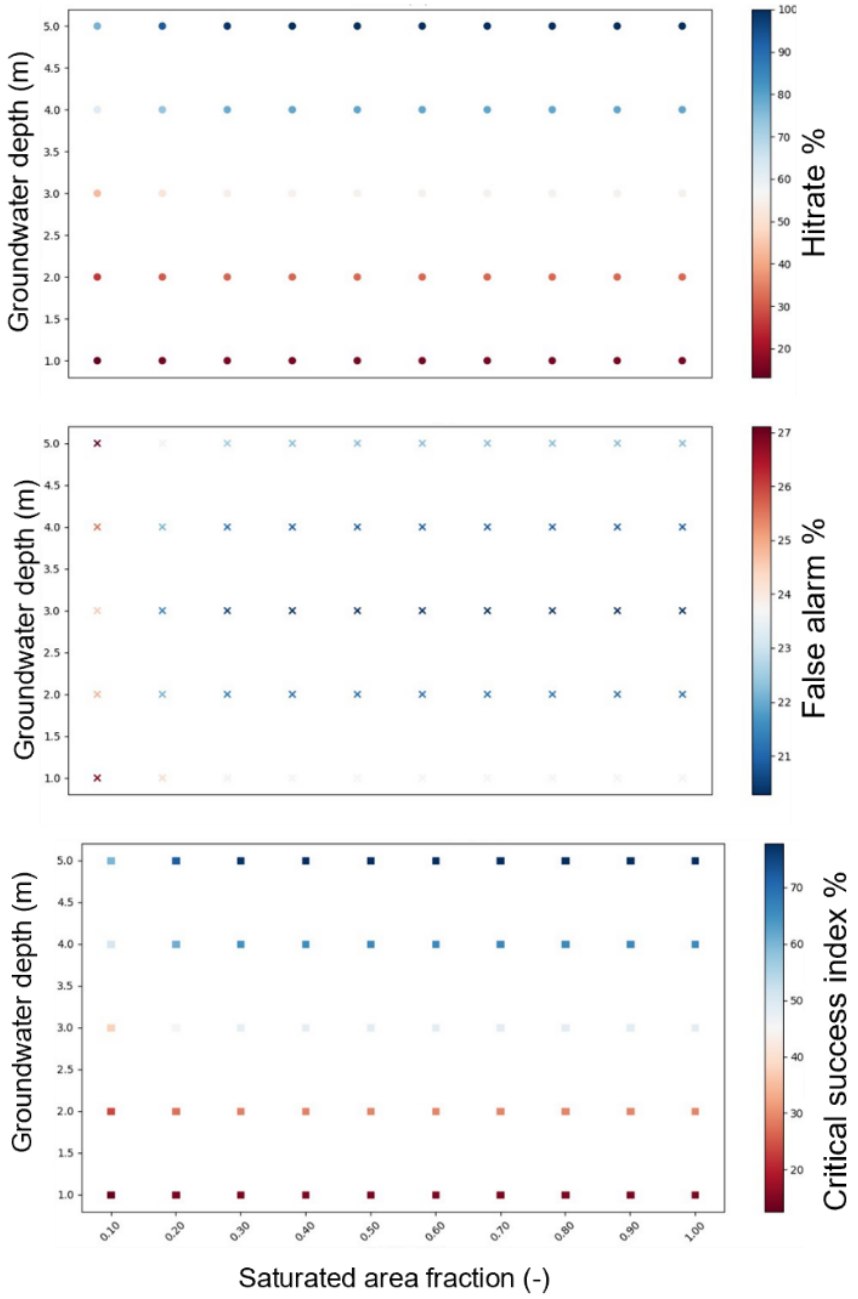
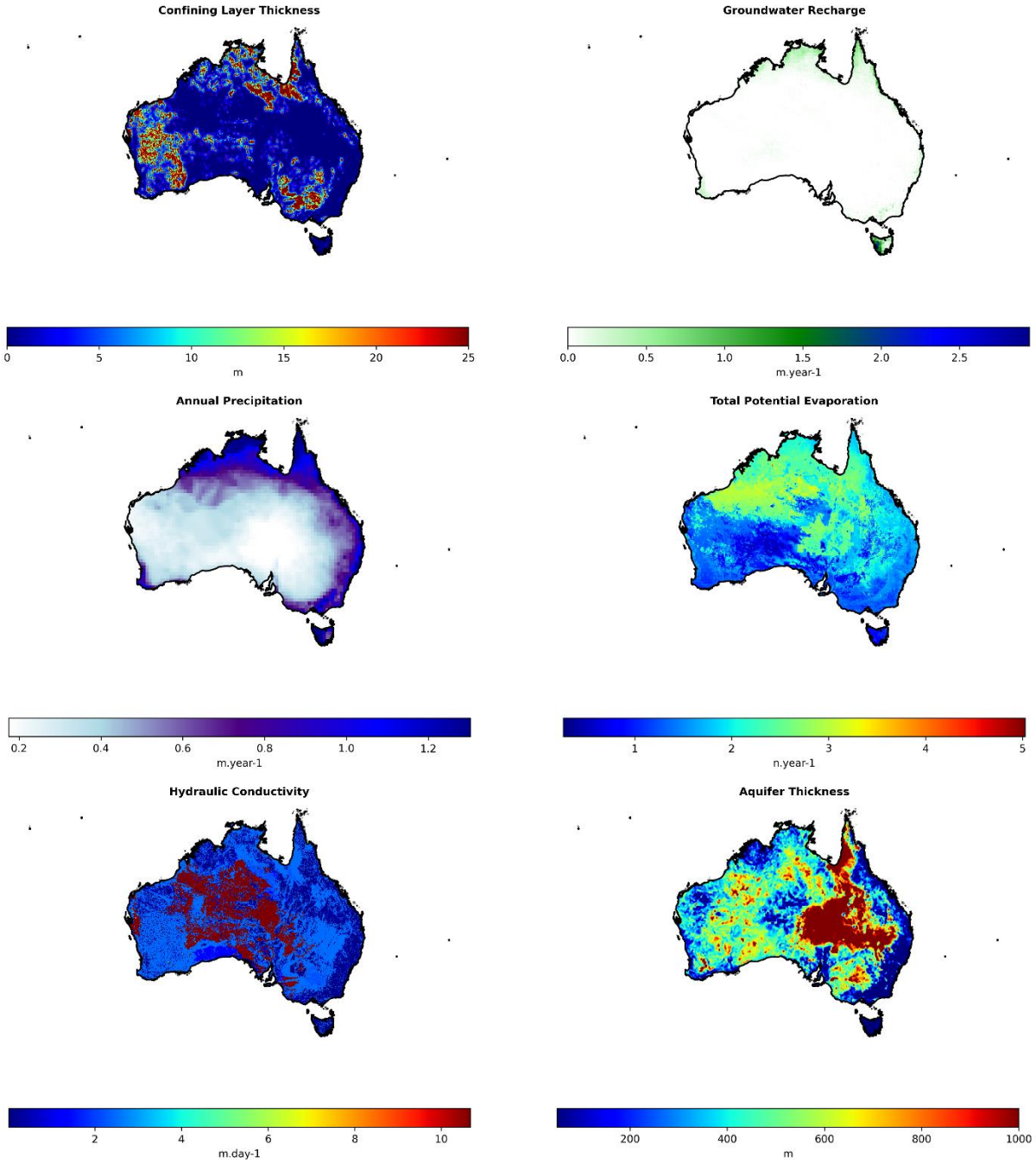


Figure S1. Sensitivity analysis of threshold selection for wetlands against hit-rate, false alarm rate and critical success index with the Australian GDE atlas

Table S1: Model input and parameters as well as data sources

Description	Symbol	Unit	References/Sources
Upper and lower soil store parameters			FAO (2007) soil map; van Beek and Bierkens (2009)
• Soil thickness	Z1 and Z2	m	
• Residual soil moisture content	θr1 and θr2	m^3/m^3	
• Soil moisture at saturation	θs1 and θs2	m^3/m^3	
• Soil water storage capacity per soil layer: SC = Z/(θs − θr)	SC1 and SC2	m	
• Soil matric suctions at saturation	ψs1 and ψs2	m	
• Exponent in the soil water retention curve	β1 and β2	dimensionless	
• Saturated hydraulic conductivities of upper and lower soil stores	K1 and K2	m/day	
• Total soil water storage capacities = SCupp + SClow	W_{max}	m	
Land cover fraction: land cover areas (including extent of irrigated areas) over cell areas	fl_{cov}	m^2/m^2	GLCC v2.0 map (USGS, 1997); Olson (1994a, b); MIRCA2000 dataset (Portmann et al., 2010); FAOSTAT (2012)
Topographical parameters			HydroSHEDS (Lehner et al., 2008); Hydro1k (Verdin and Greenlee, 1996); GTOPO30 (Gesch et al., 1999)
• Cell-average DEM	DEM_{avg}	m	
• Floodplain elevation	DEM_{fpl}	m	
Root fractions per soil layer	Rf_{upp} and Rfl_{ow}	dimensionless	Canadell et al. (1996); van Beek and Bierkens (2009)
Arno scheme (Todini, 1999; Hagemann and Gates, 2003): exponents defining soil water capacity distribution	β_{arno}	dimensionless	Canadell et al. (1996); Hagemann et al. (1999); Hagemann et al. (2002); van Beek (2008); van Beek and Bierkens (2009)
Ratio of cell-minimum soil storage to Wmax	fw_{min}	m/m	van Beek (2008); van Beek and Bierkens (2009)
Ratio of cell-maximum soil storage to Wmax	fw_{max}	m/m	van Beek (2008); van Beek and Bierkens (2009)
Parameters related to phenology			Hagemann et al. (1999); Hagemann (2002); van Beek (2008); van Beek and Bierkens (2009)
• Crop coefficient	K_c	dimensionless	
• Interception capacity	$S_{int-max}$	m	
• Vegetation cover fraction	C_v	m^2/m^2	
Groundwater parameters			GLHYMPS map (Gleeson et al., 2014); van Beek (2008); van Beek and Bierkens (2009)
Aquifer transmissivity	KD	m^2/day	
Aquifer specific yield	Sy	m^3/m^3	
Groundwater recession coefficient	J^{-1}	day^{-1}	
Meteorological forcing			van Beek (2008); CRU (Harris et al., 2014); W5E5 (Cucchi et al, 2020; Stefan et al, 2021)
• Total precipitation	P	m/day	
• Atmospheric air temperature	T_{air}	°C or K	
• Reference potential evaporation and transpiration	$E_{ref,pot}$	m/day	
Others			
• Non-irrigation sectoral water demand (i.e., livestock, domestic, and industrial)	-	m/day	Wada et al. (2014)
• Desalinated water	-	m/day	Wada et al. (2011a); FAO (2016)
• Lakes and reservoirs	-	-	GLWD1 (Lehner and Döll, 2004); GRanD (Lehner et al., 2011)



25 **Figure S3: Confining layer thickness, average recharge, average annual total precipitation, and average annual total potential evapotranspiration Hydraulic conductivity, aquifer thickness.**

Table S4: Summary statistics of similarity matrix of mapped GDEs against known GDEs in the Australian GDE atlas by Doody et al. 2017

GDE	*Known GDE Hitrate*	*Hitrate (All GDEs)*
Aquatic	79 %	87 %
Wetland	92 %	95 %
Terrestrial	89 %	92 %

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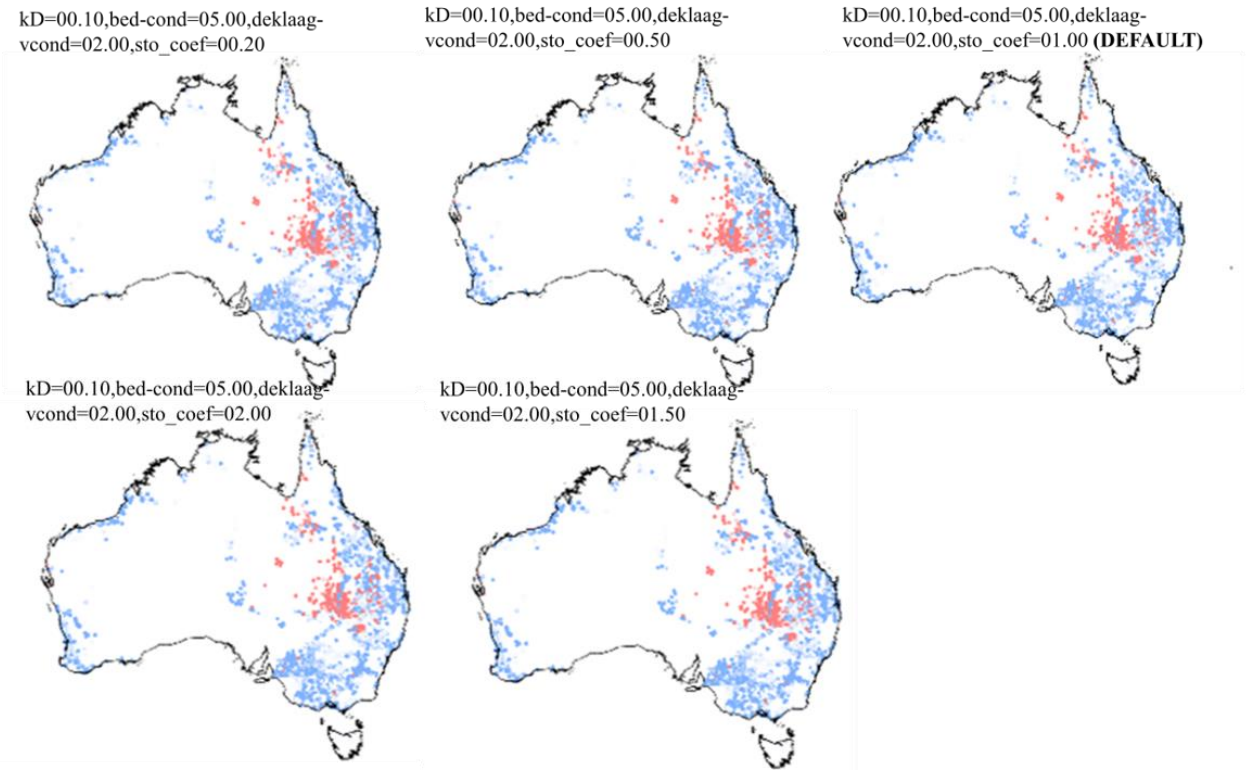

Figure S5. Bias of observed groundwater depths against simulated groundwater depth from pre factor global parameter sets . kD = transmissivity, bed-cond= river bed conductance, deklaag-vcond = thickness of the vertical confining layer and sto_coef = storage coefficient

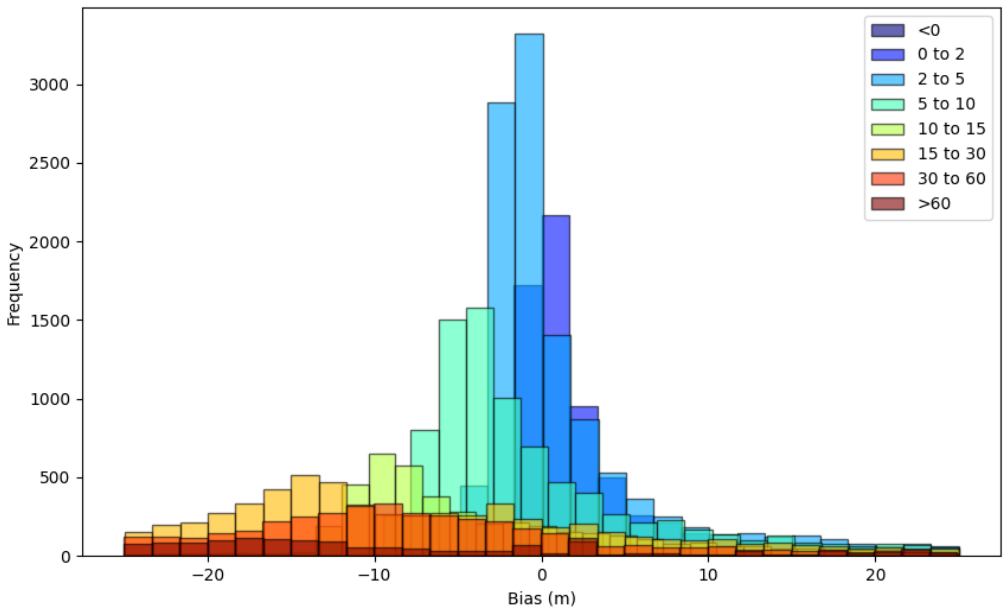

Figure S6. Histogram of mean bias of categorized observed groundwater depths (m).

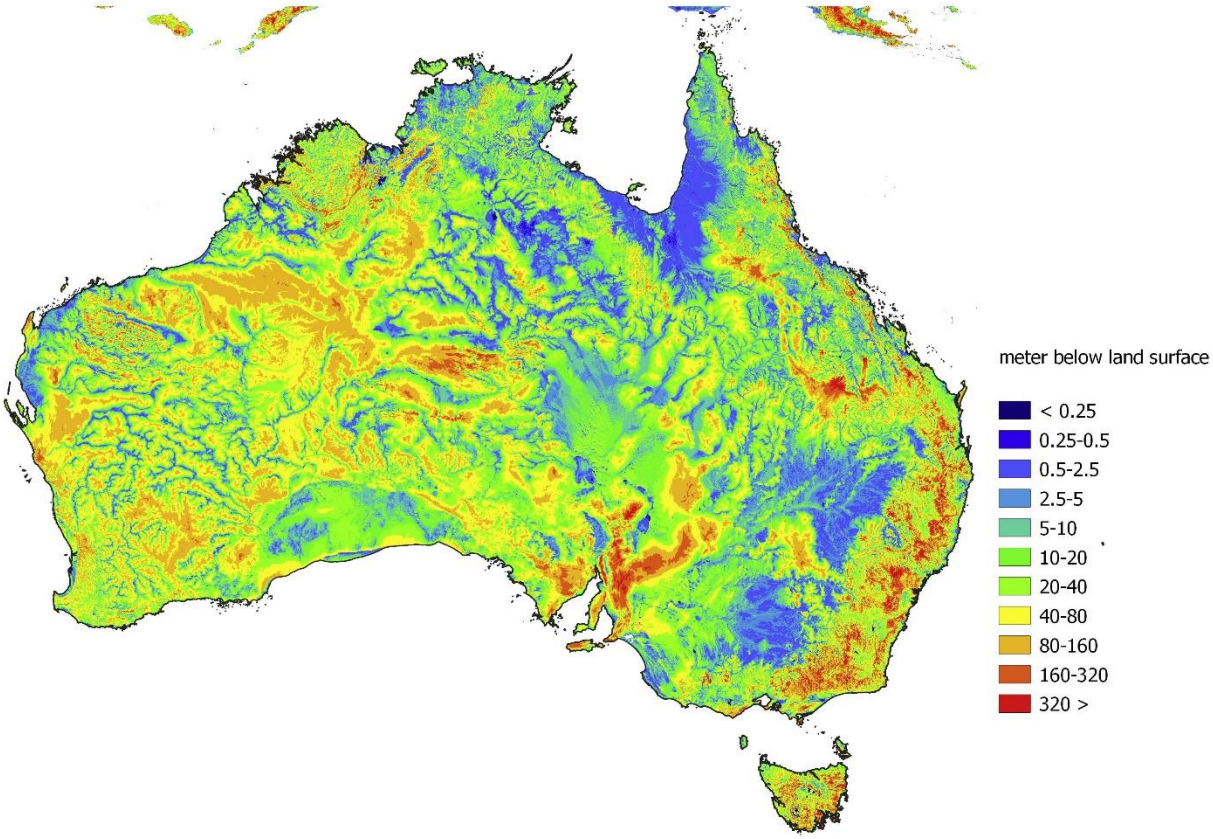

Figure S7. Average simulated groundwater levels for 1979 – 2019 with the steady-state model.

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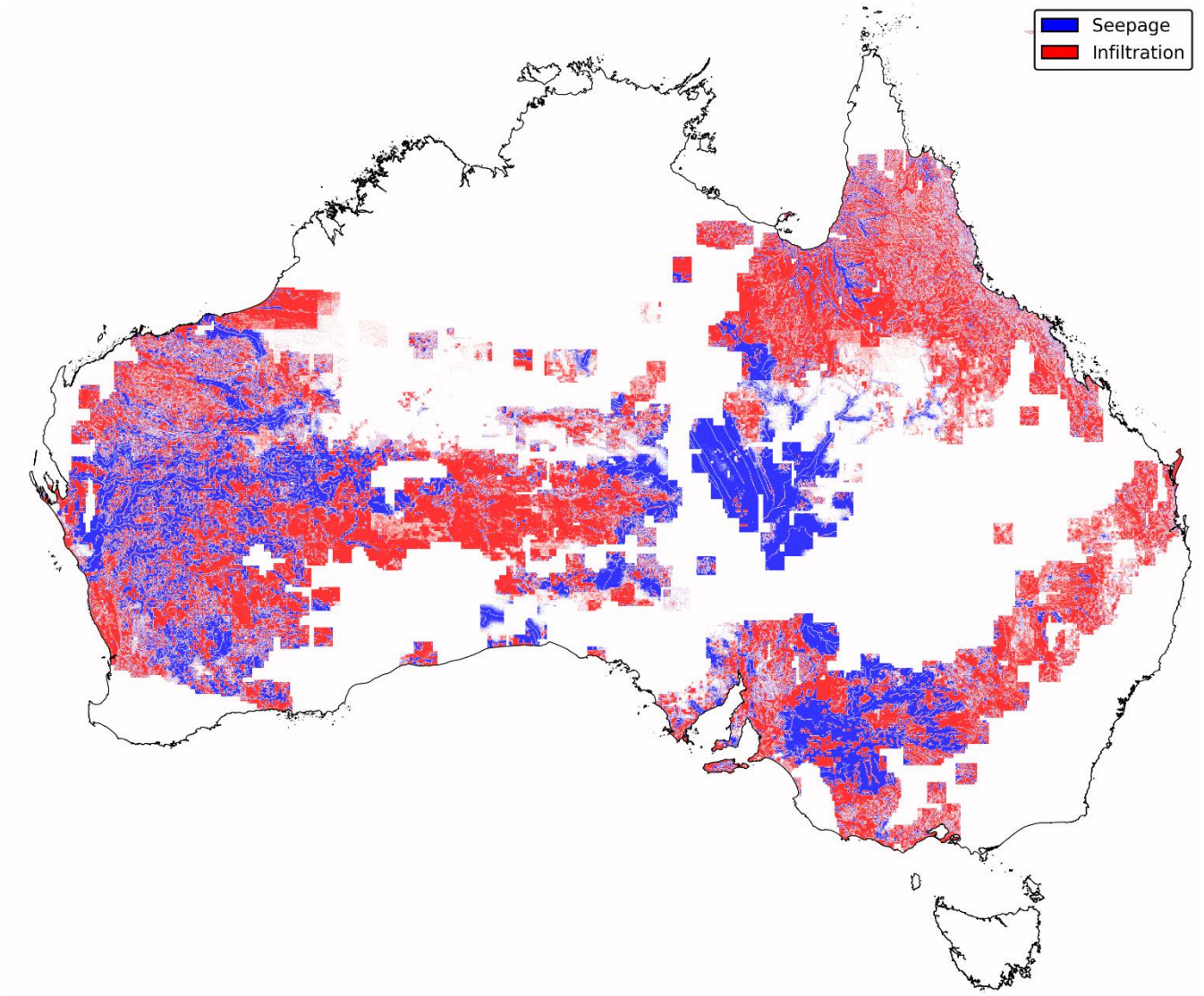


Figure S8. Locations (red) where groundwater seepage (in red) or infiltration (in blue) occurs from the lower model layer towards the upper layer of the groundwater model.

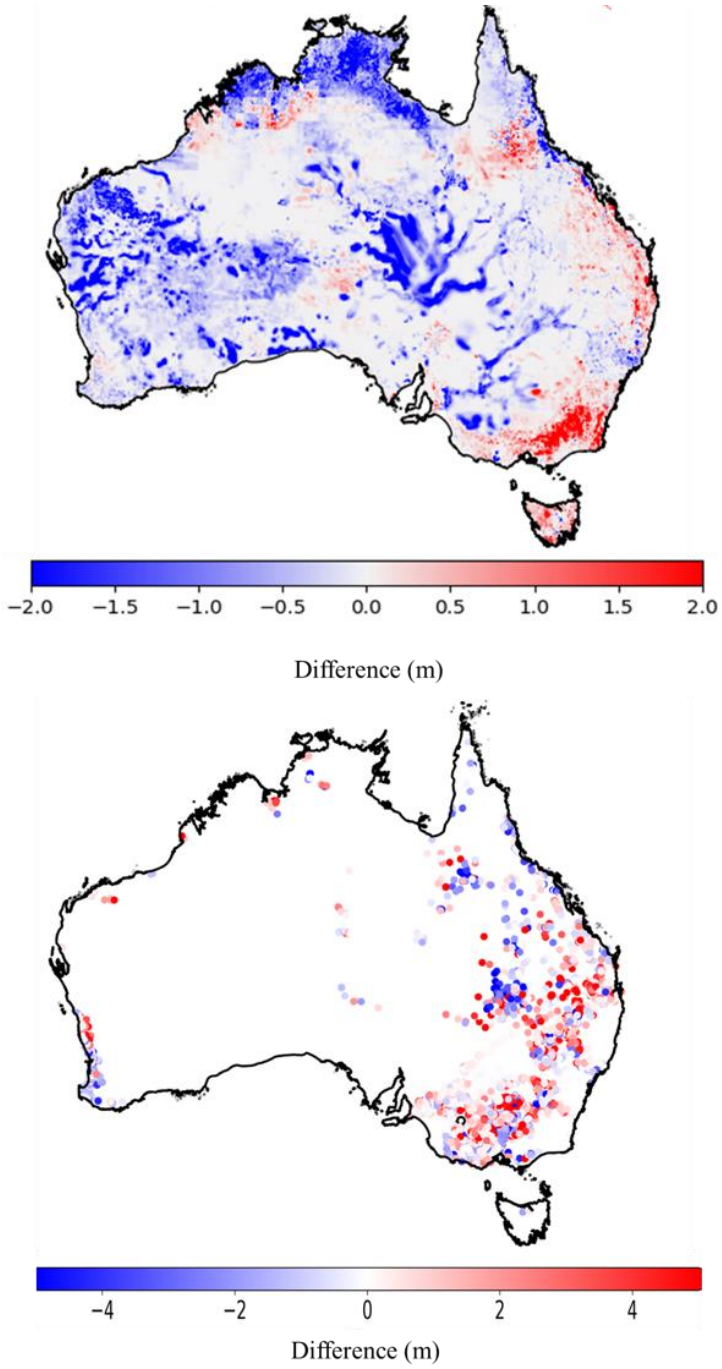
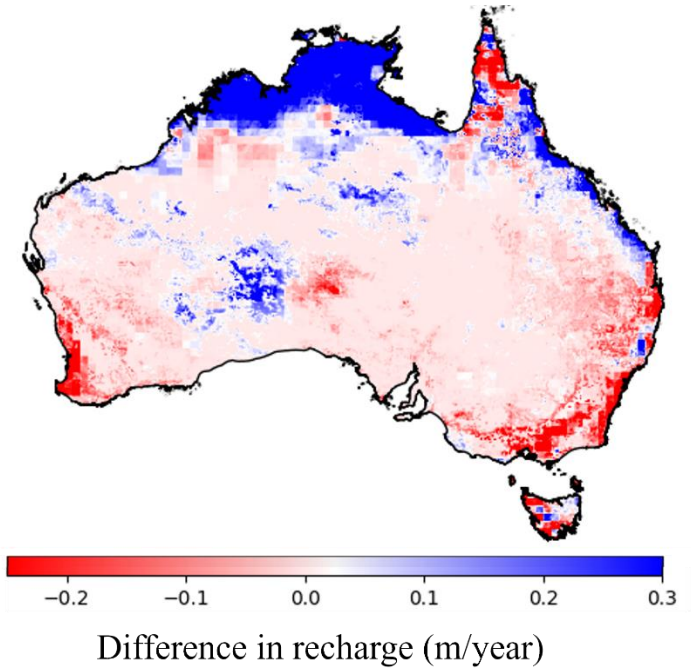


Figure S9. Differences below surface level (m) in average simulated (top) and observed (bottom) groundwater depths between 1979-2000 and 2001-2019. Red areas indicate a decline in groundwater levels and blue areas indicate areas with an increase in groundwater levels. White areas in bottom figure are locations with no well data.



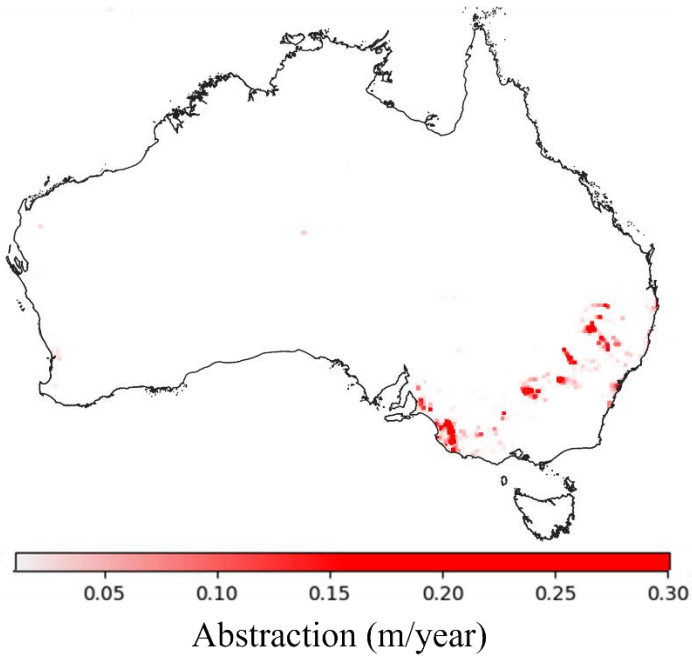


Figure S10: Changes between simulated groundwater recharge and between period 2001-2019 relative 1979-2000 and average abstraction rates over 2001-2019.

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