GIS-Driven Method for Site Feasibility Assessment of Large-Scale Solar Thermal Seawater Desalination: An Australian Case Study

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SolarPACES
Solar Power & Chemical Energy Systems
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Sydney, Australia
29th SolarPACES Conference

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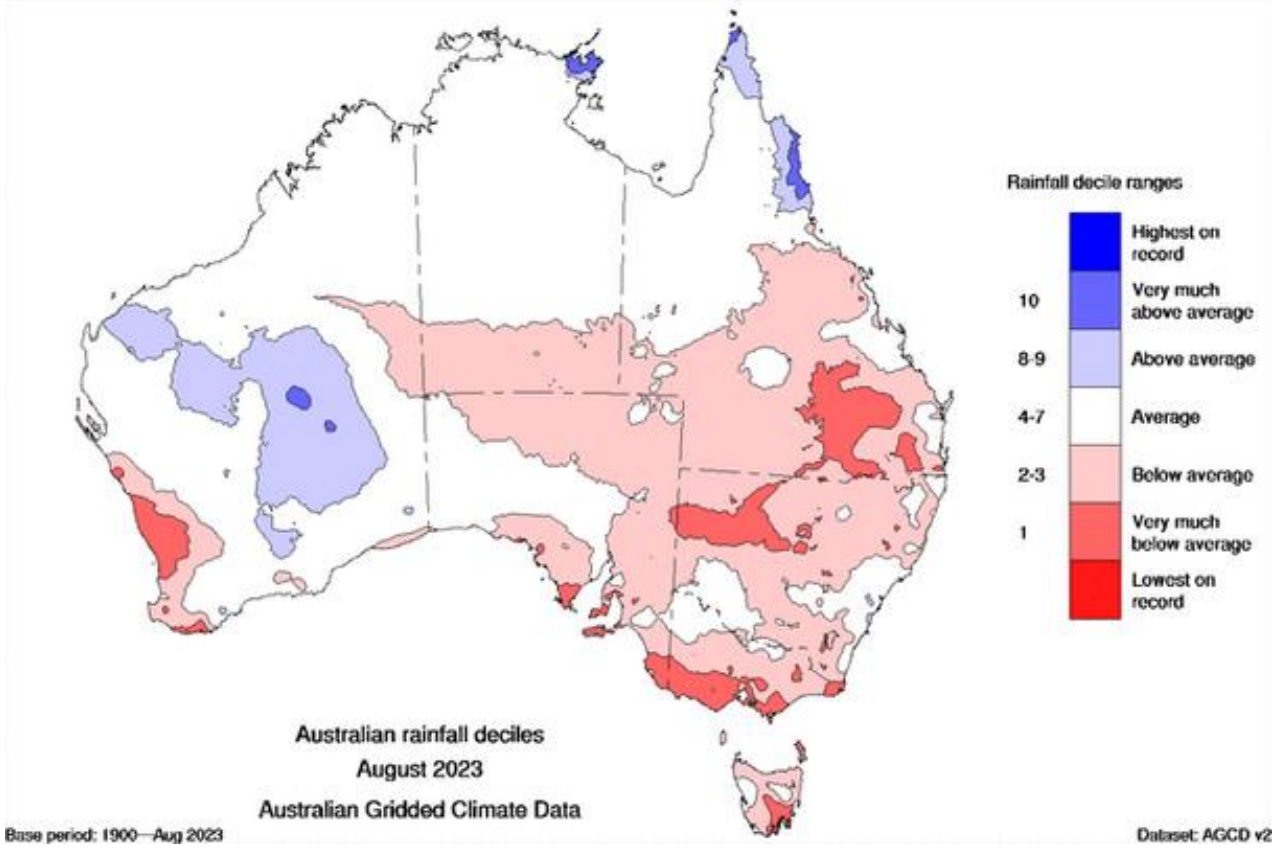
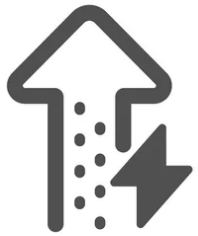
SYDNEY

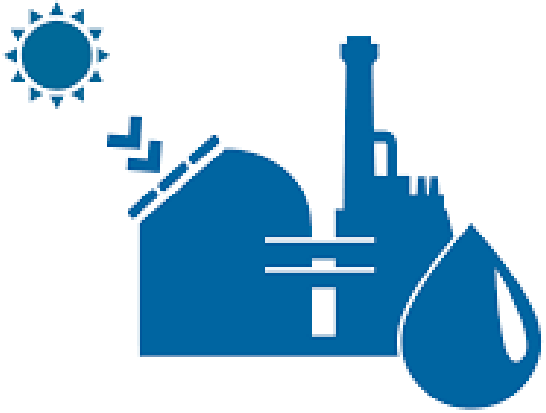
Background

Freshwater demand





Energy-intensive



Solar-driven desalination

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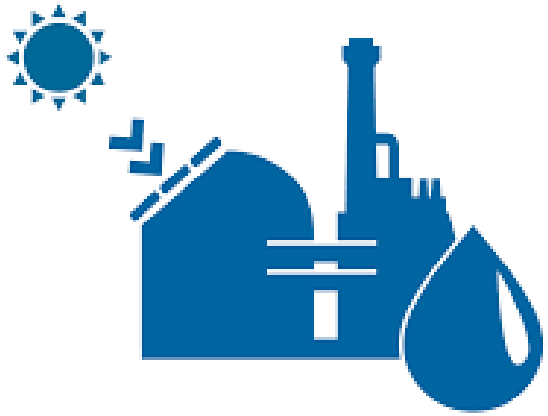
Objectives

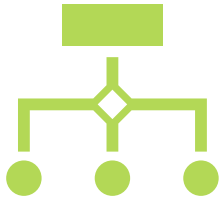


Solar-driven desalination

A promising solution is to utilize waste heat from **concentrated solar power** (CSP) plants to operate thermal desalination units (Multi-effect distillation)

Assess the viability of a site for hybrid CSP-MED desalination plants in Australia

GIS screening (QGIS)



Multi-criteria decision-making method (Analytic Hierarchy Process)

Techno-economic analysis (System Advisor Model and in-house MATLAB code)

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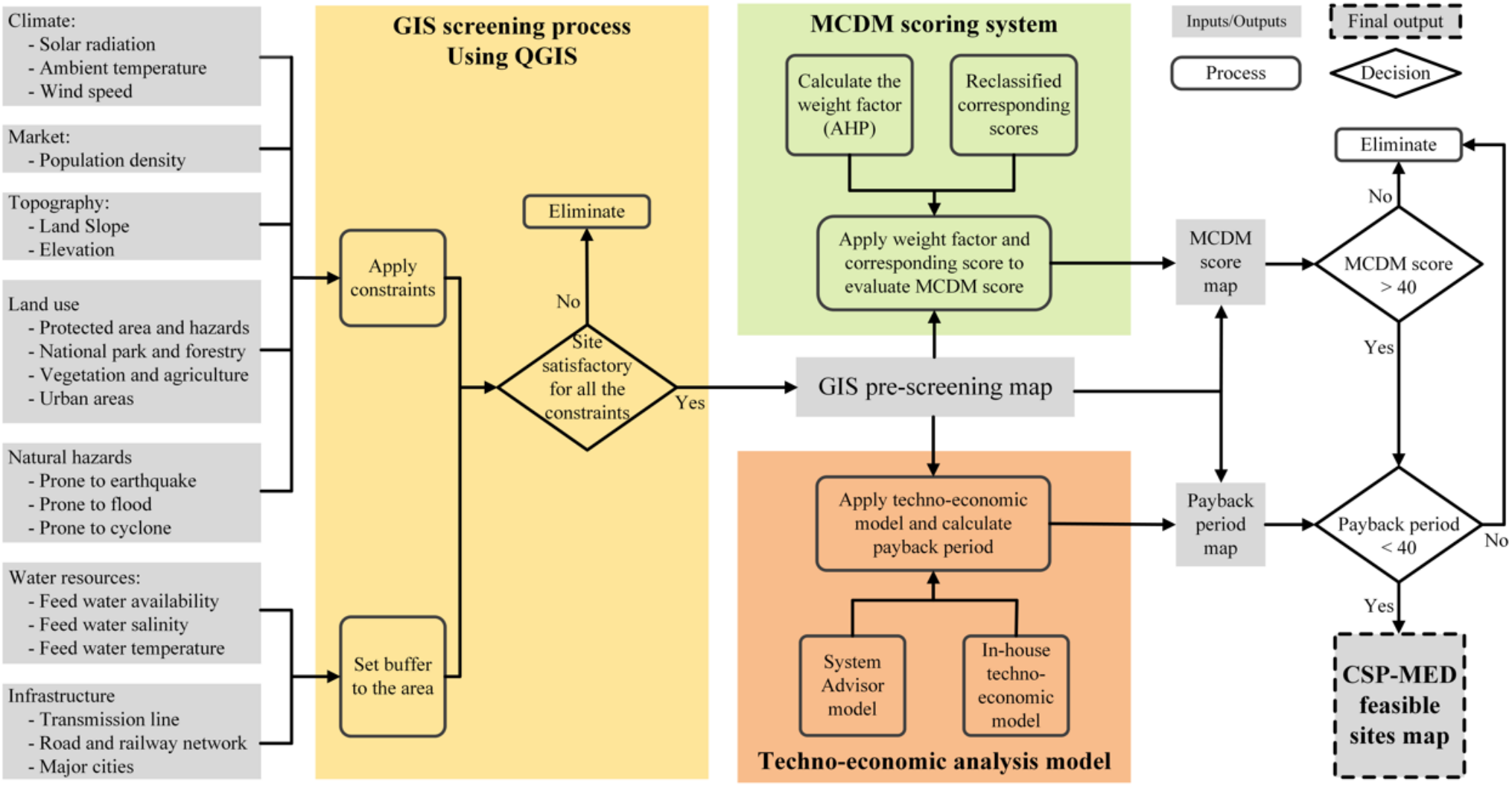
Method – Flow diagram



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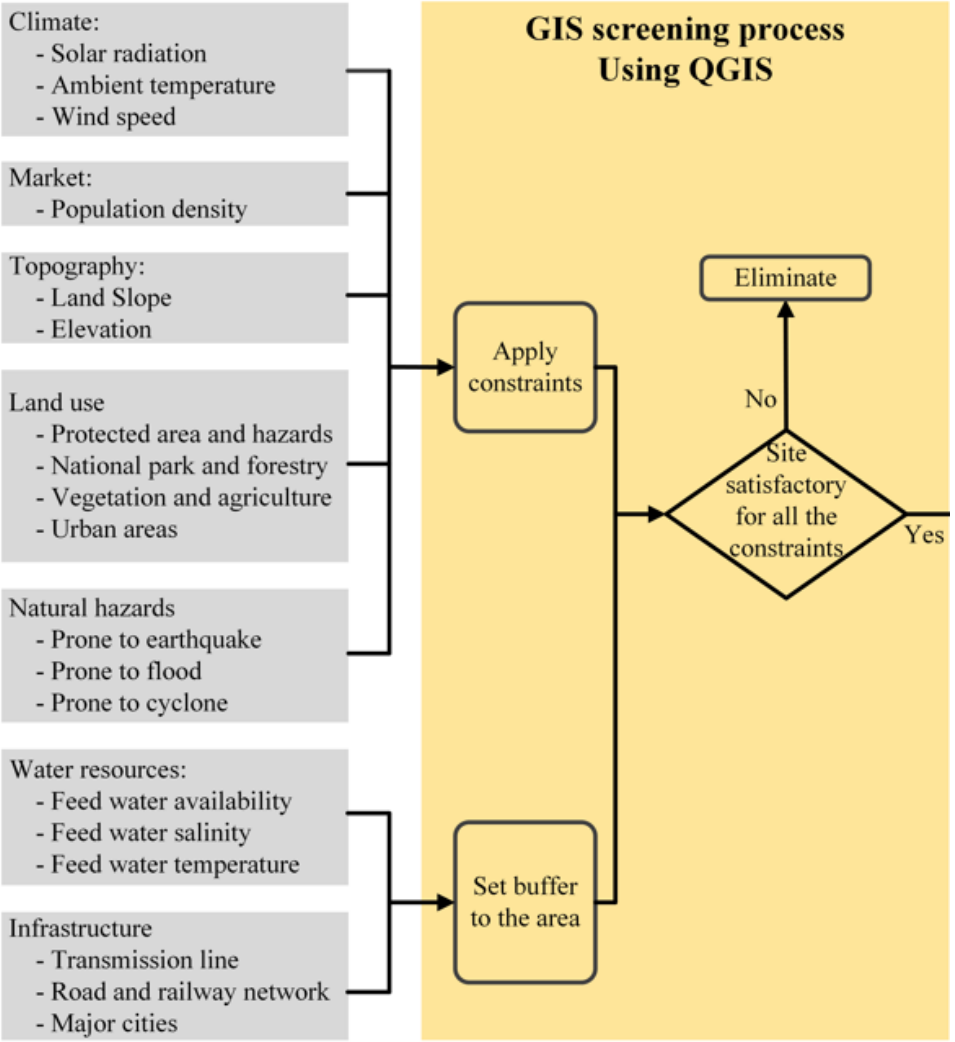
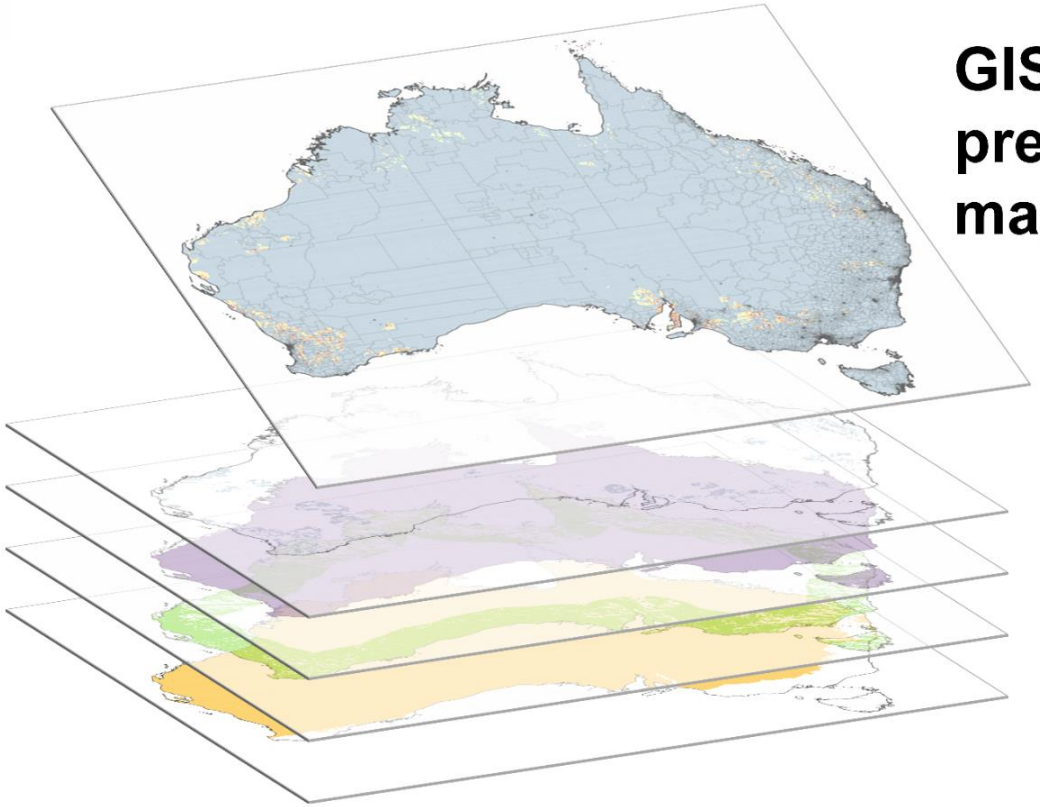
Method – GIS screening process





GIS pre-screening map

Land use

Natural hazard

Topography

Climate

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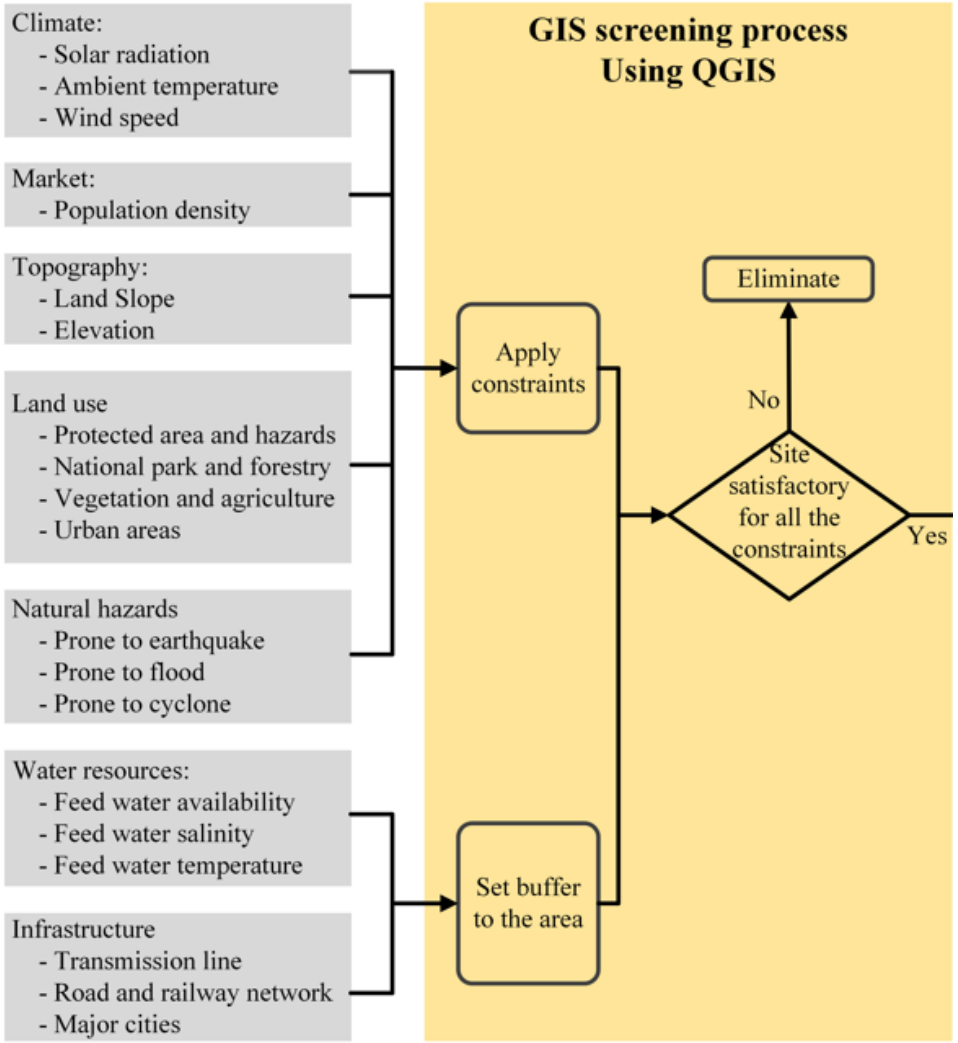
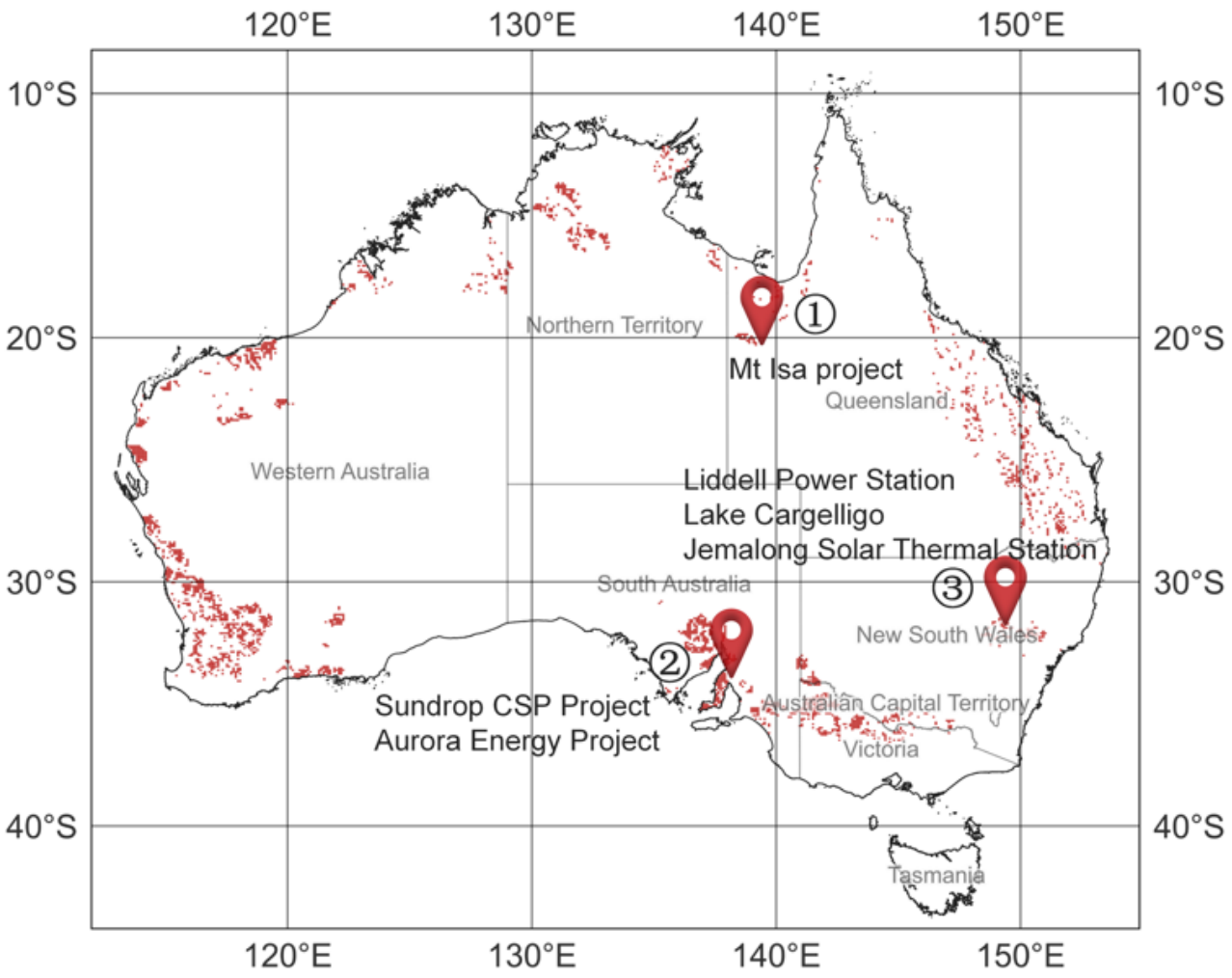
Method – GIS screening process





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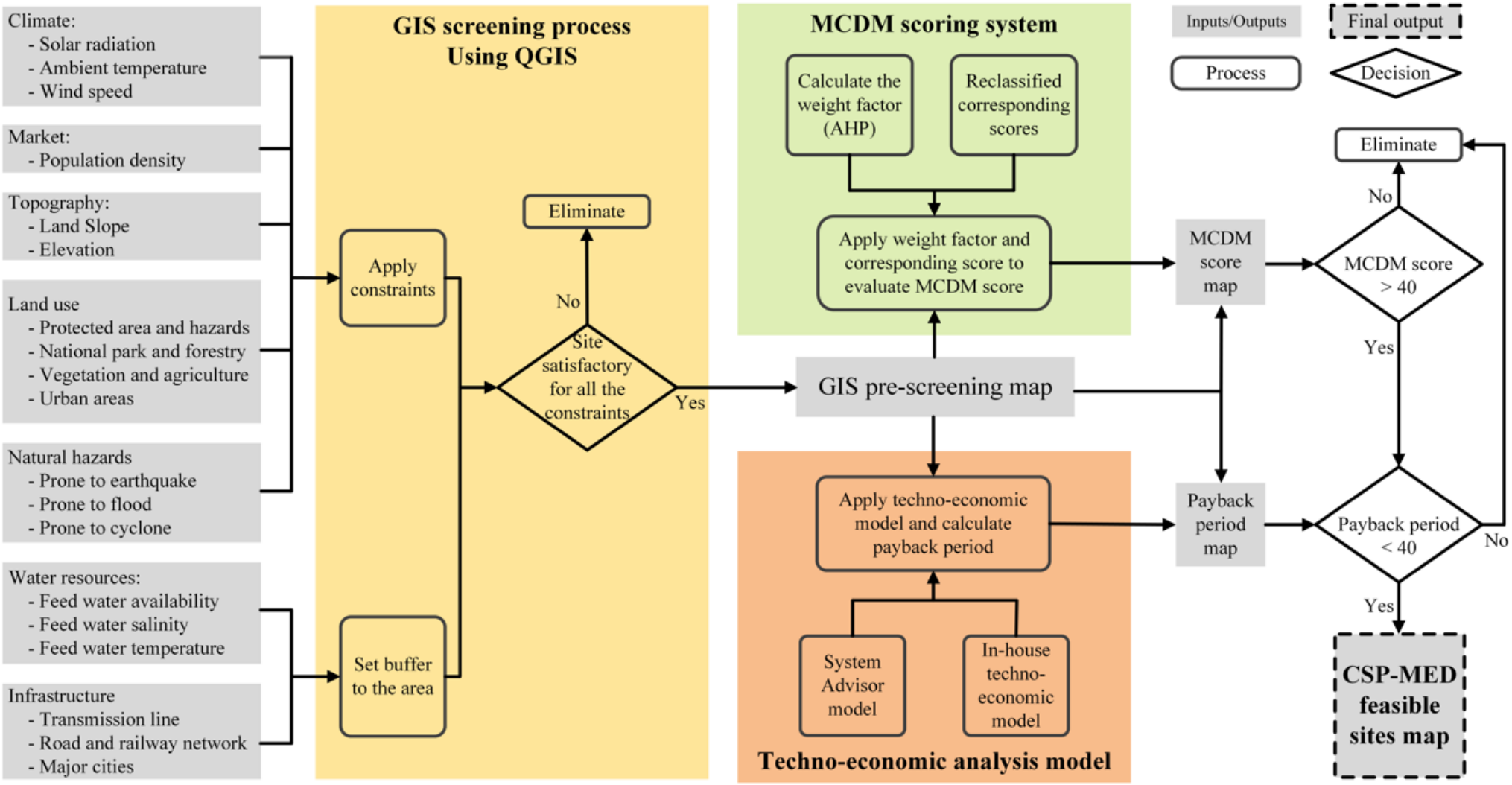

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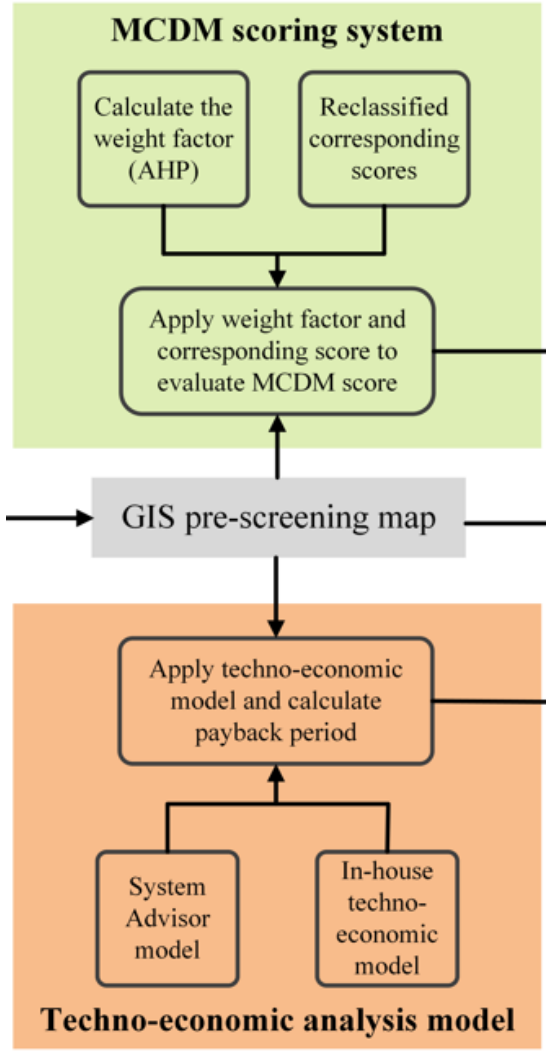
Method – Feasibility determination



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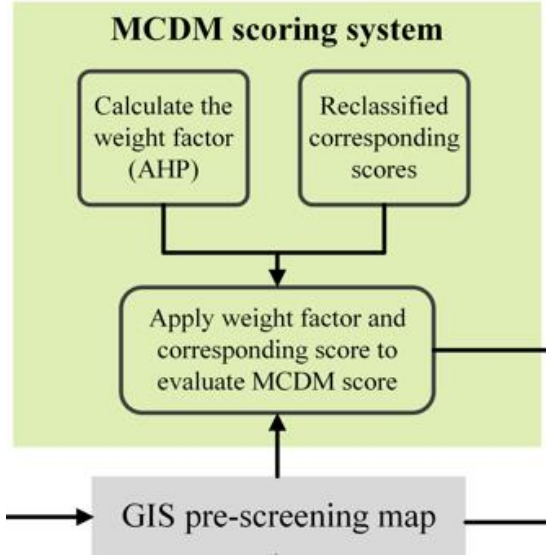
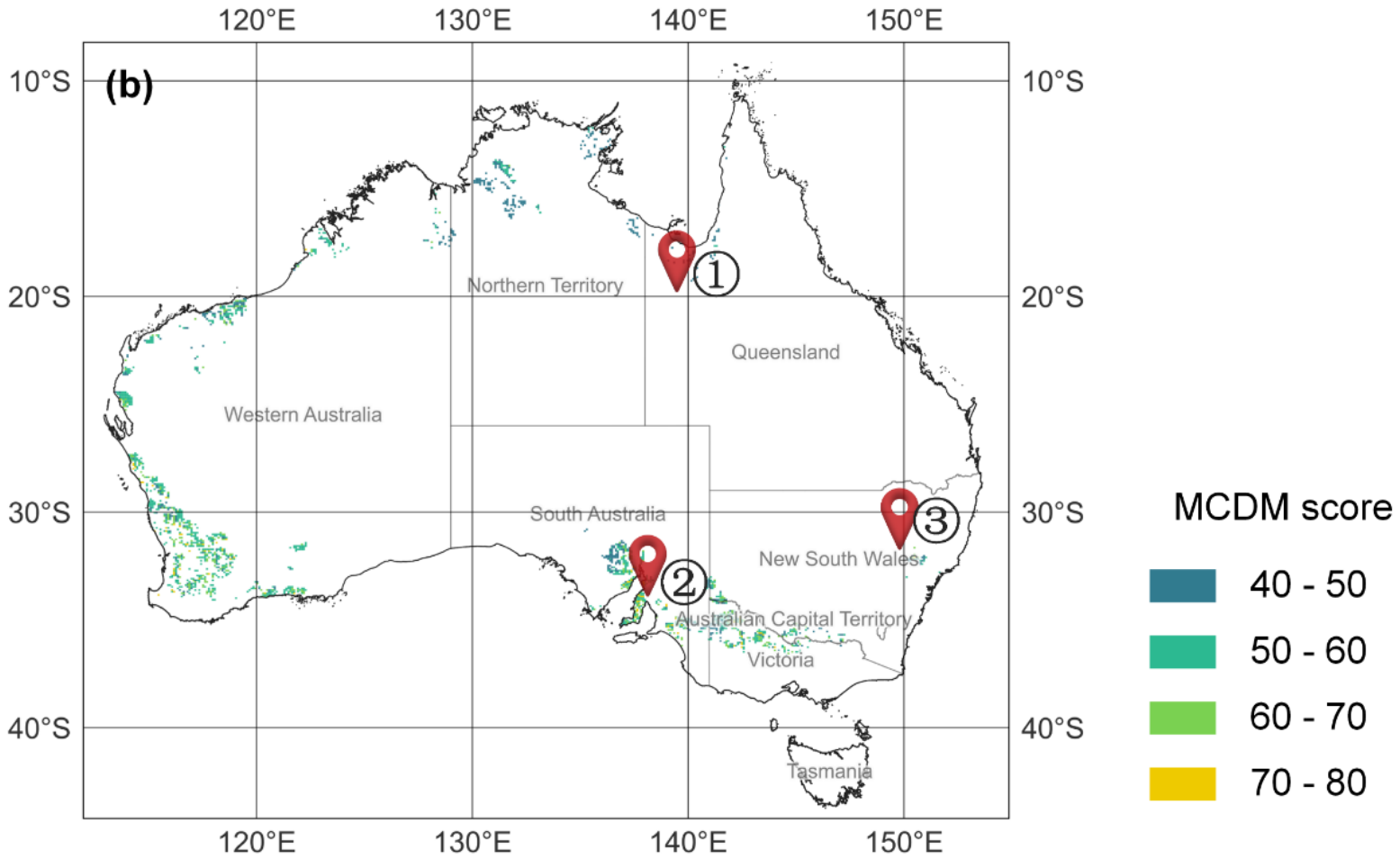
Method – MCDM scoring system



① Mt Isa project

② Sundrop CSP Project
Aurora Energy Project

③ Liddell Power Station
Lake Cargelligo
Jemalong Solar Thermal Station



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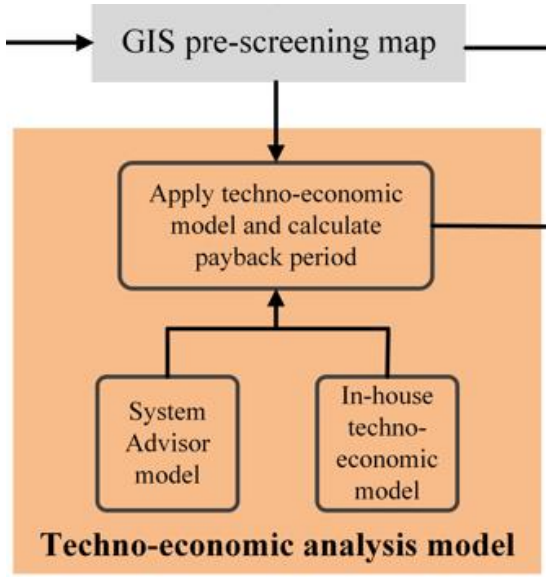

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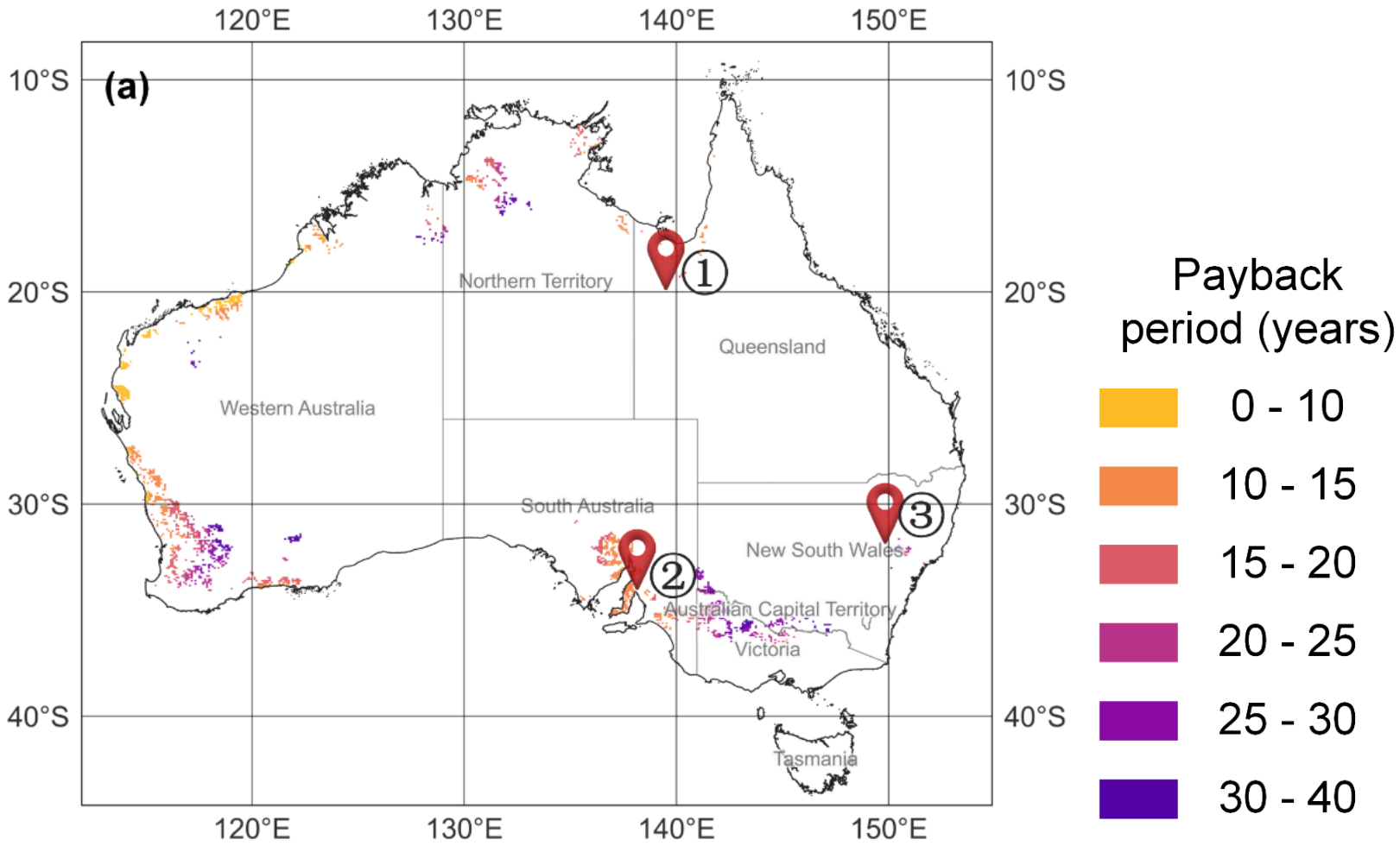

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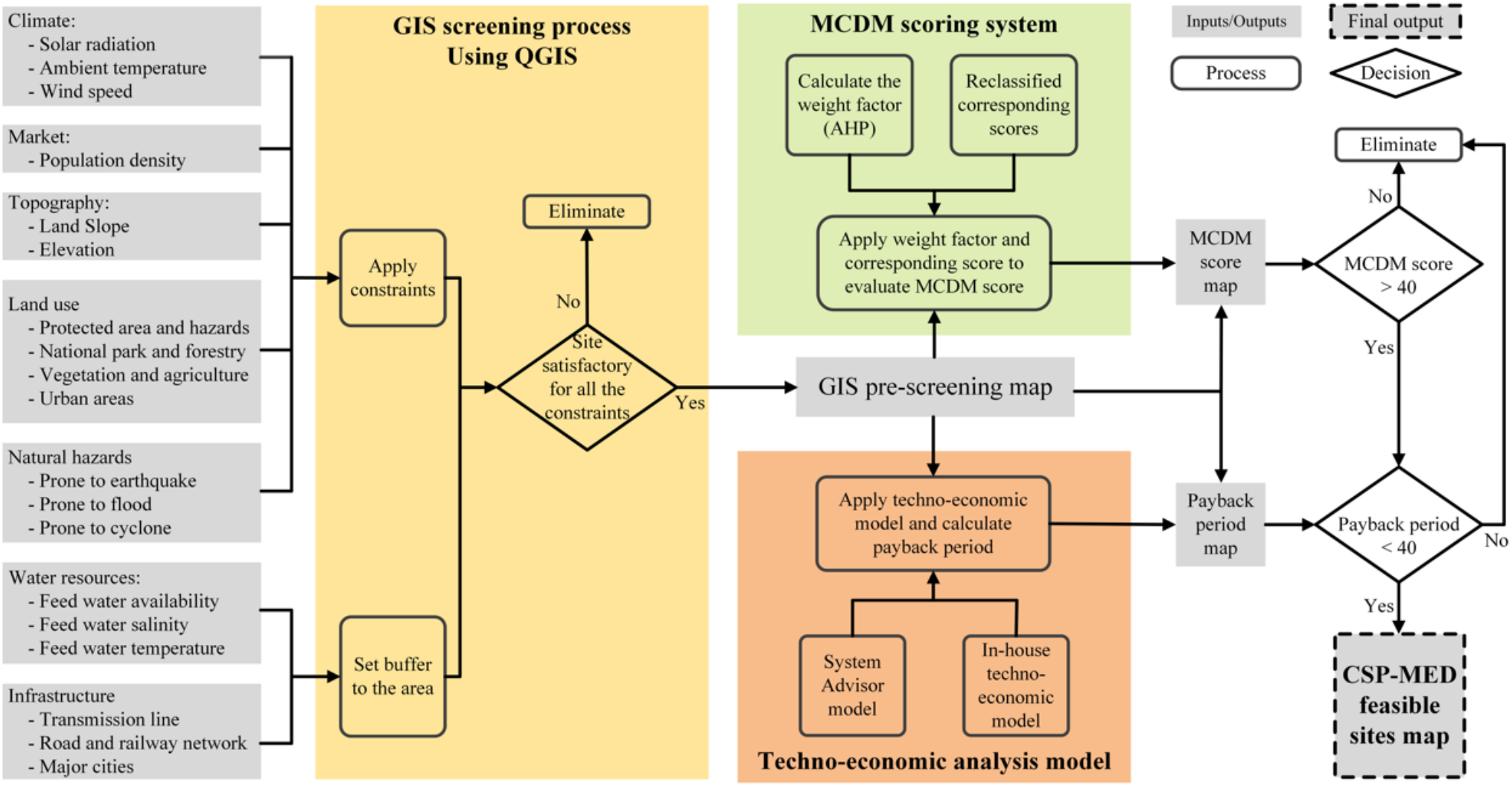

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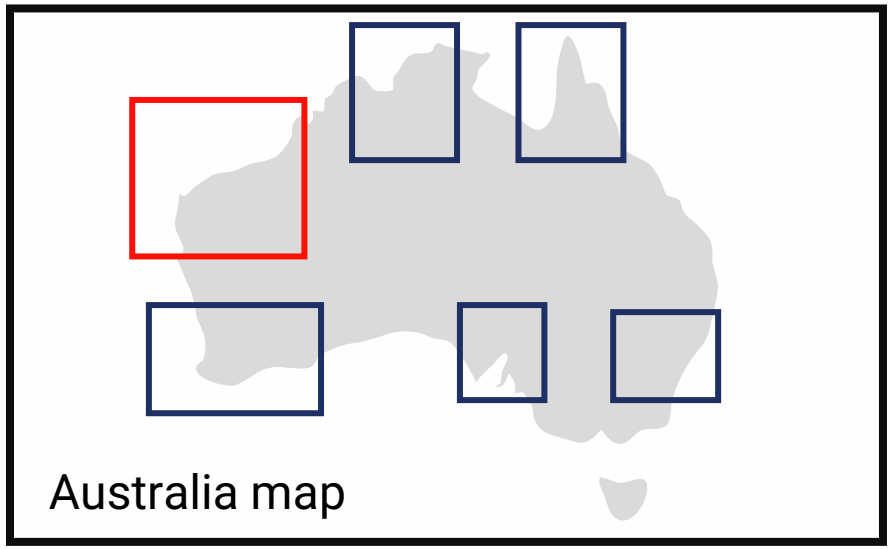
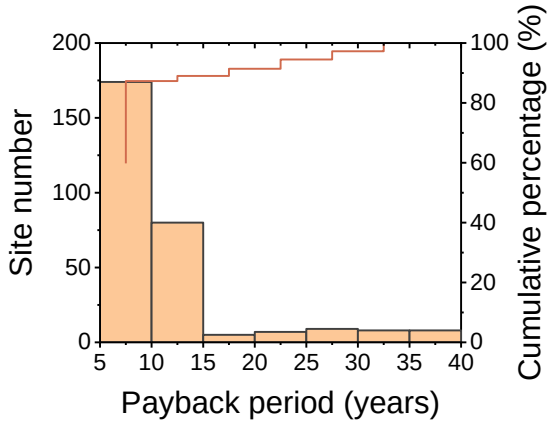
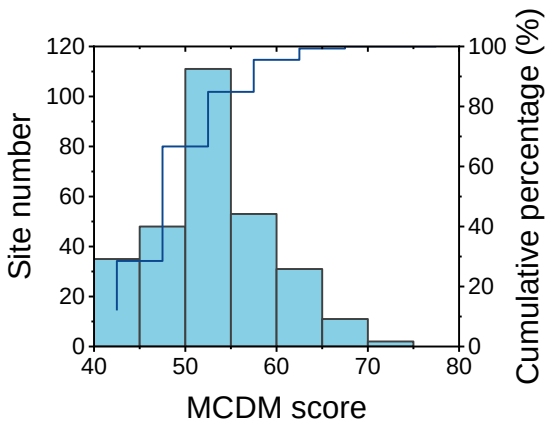
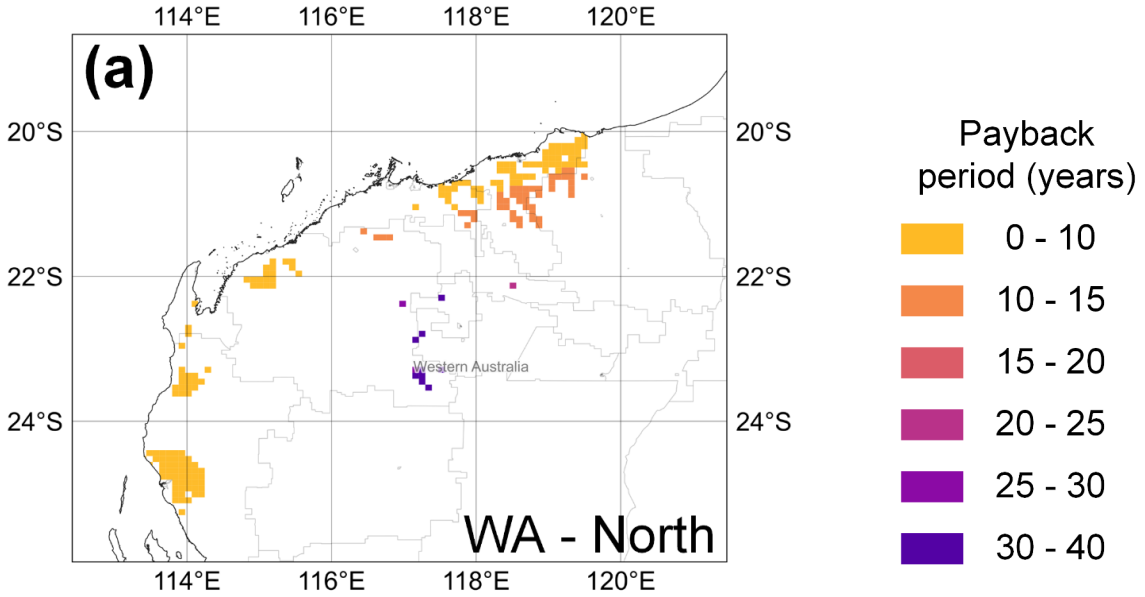
Regional Analysis

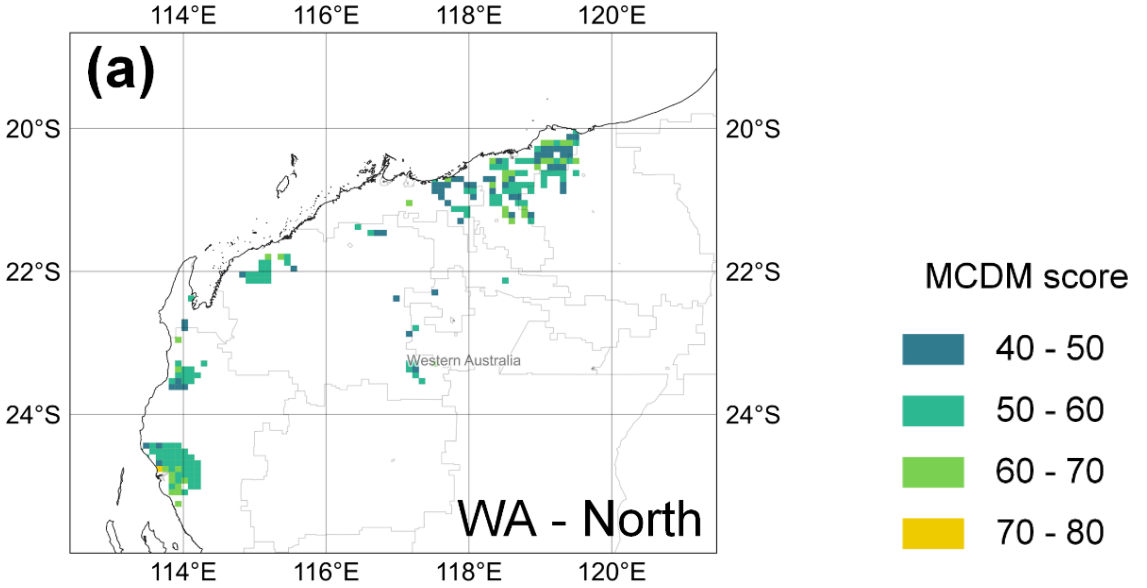
WA North











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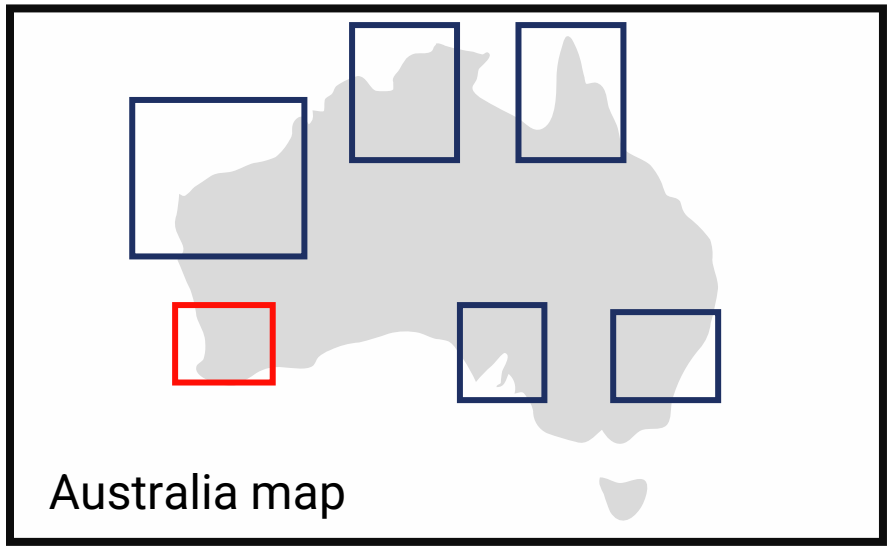
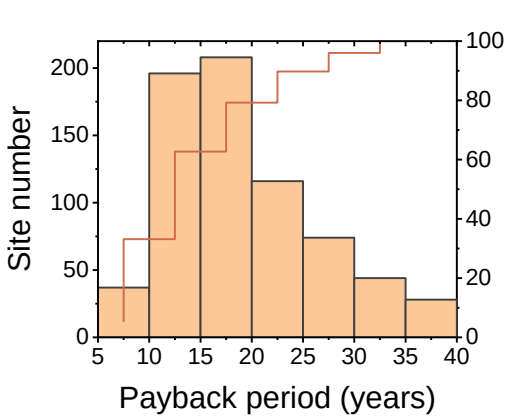
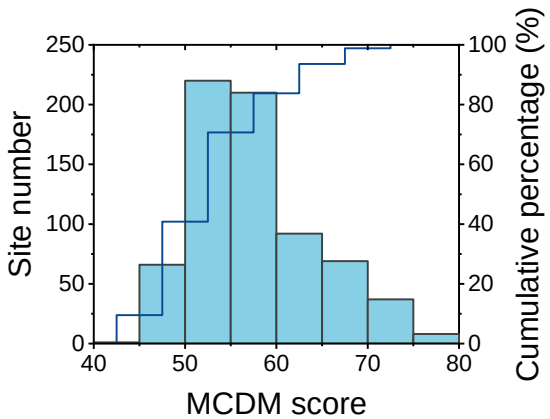
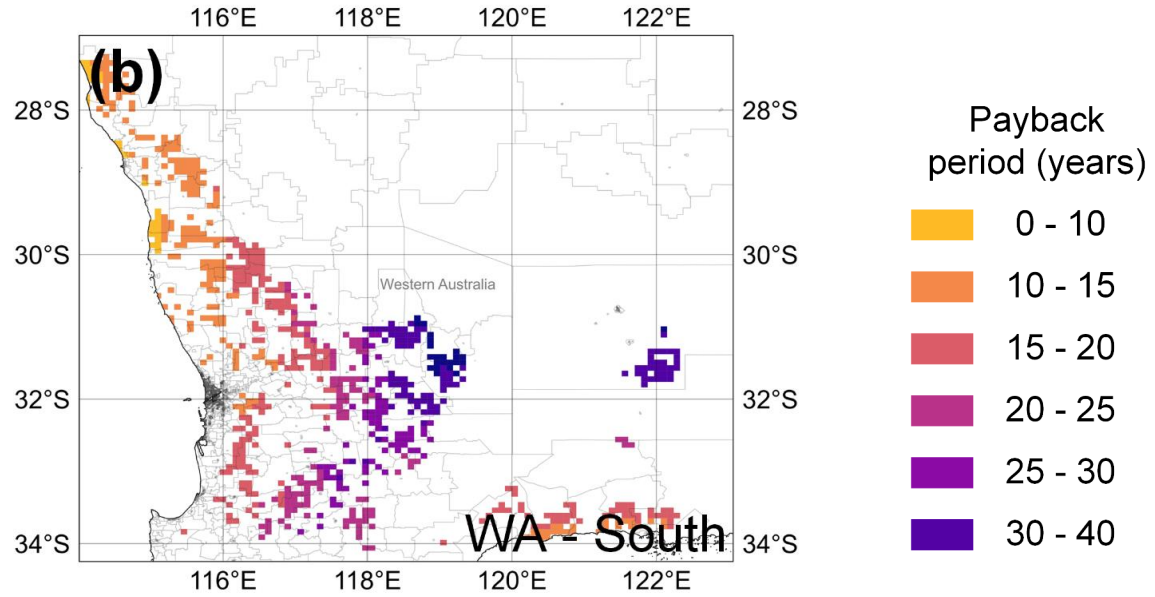
Regional Analysis

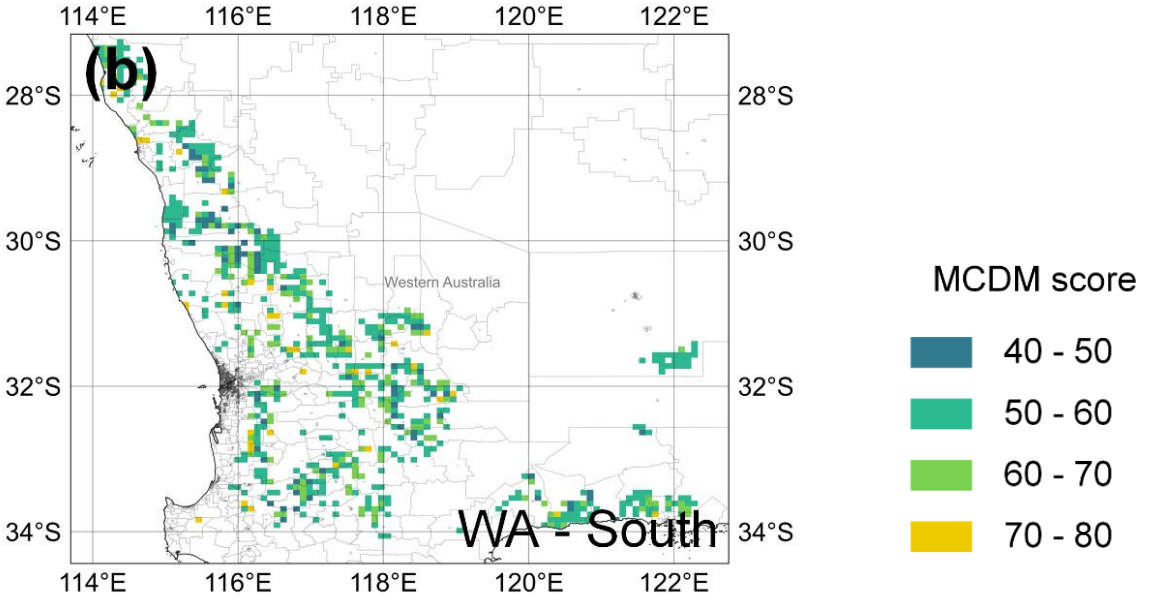
WA South











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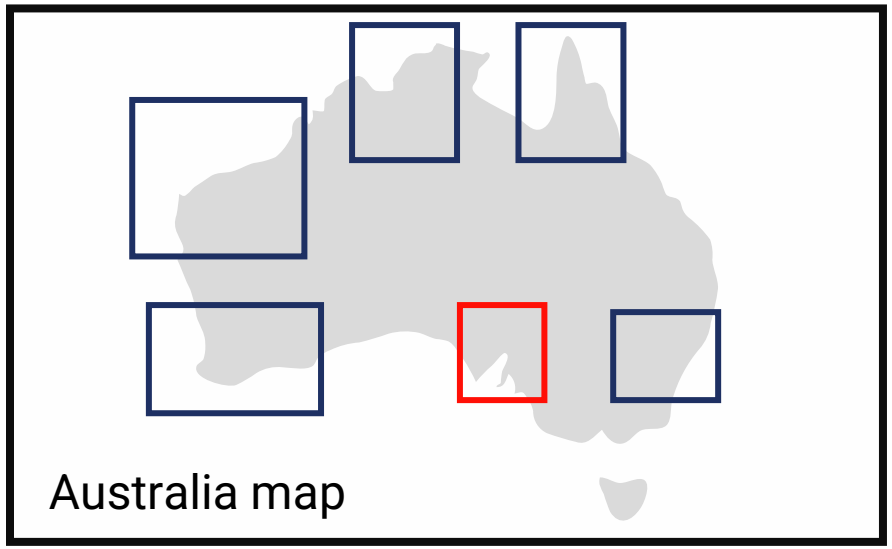
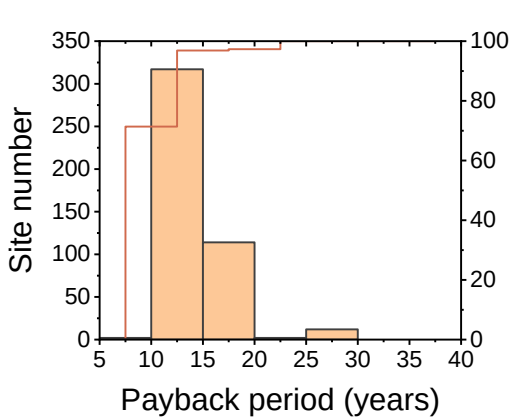
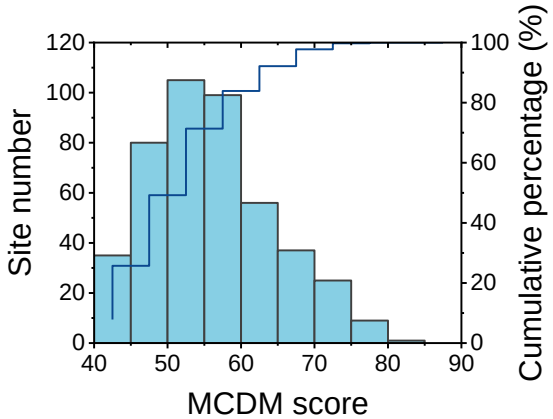
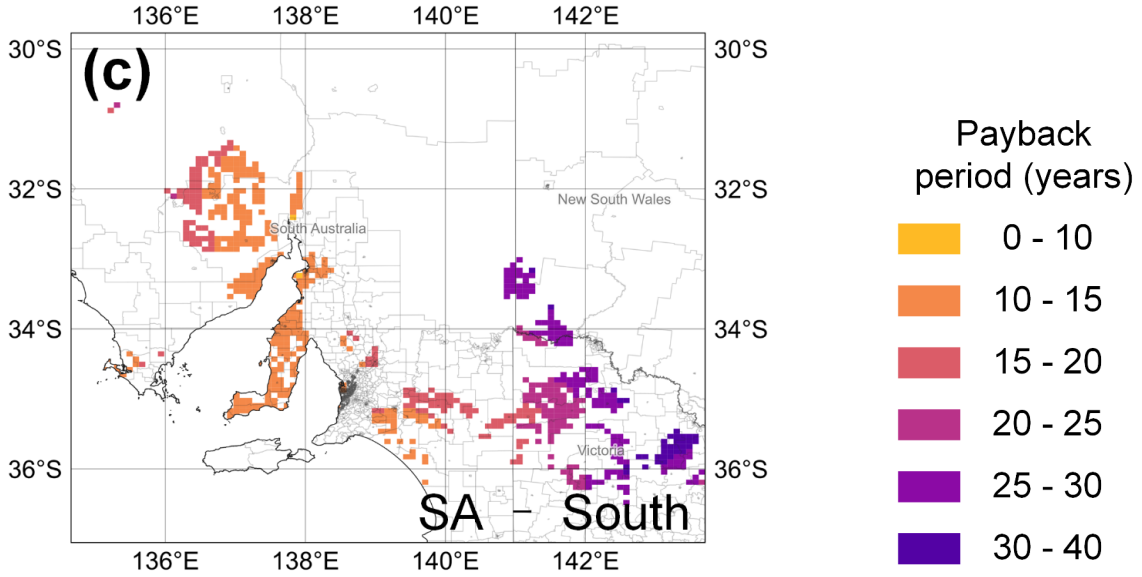
Regional Analysis

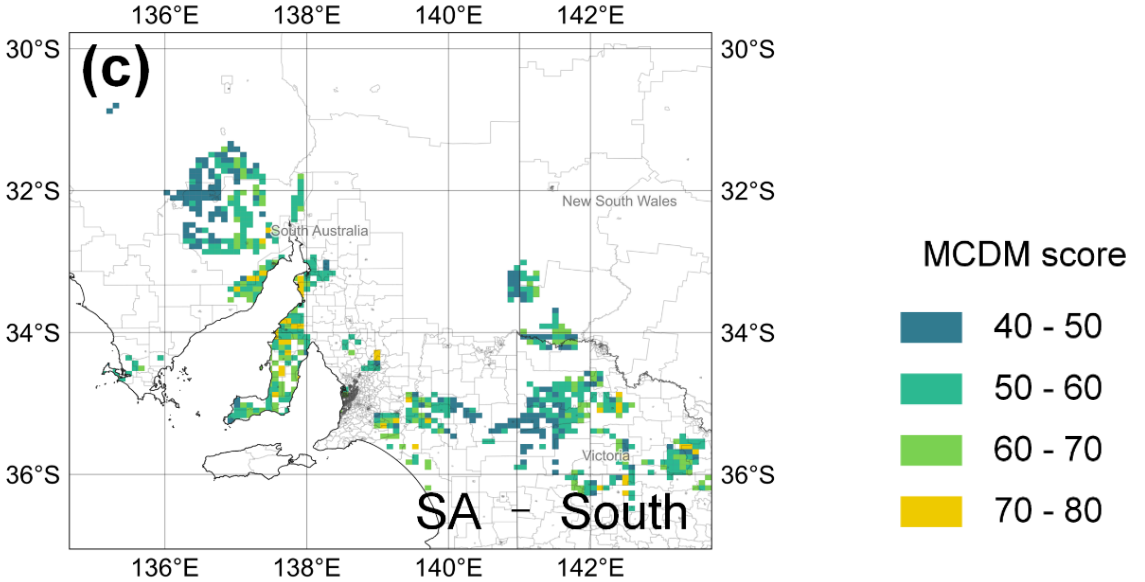
SA South











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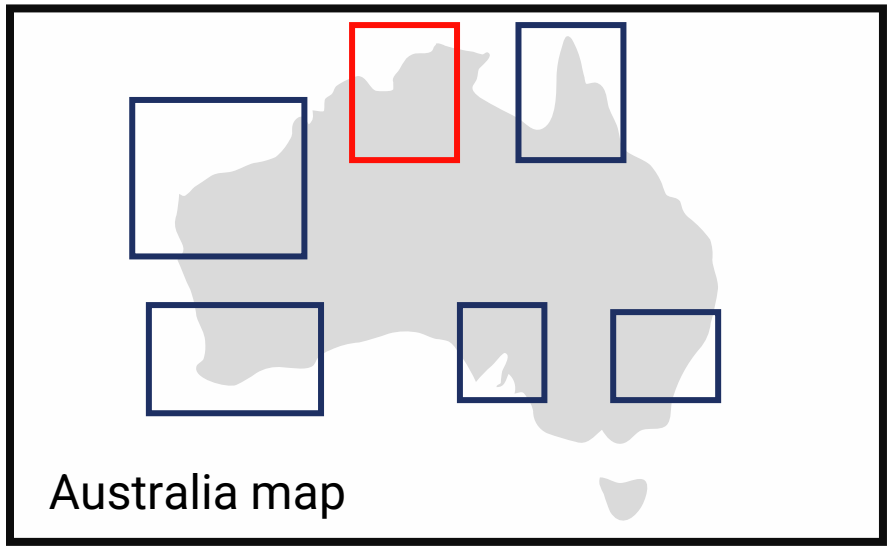
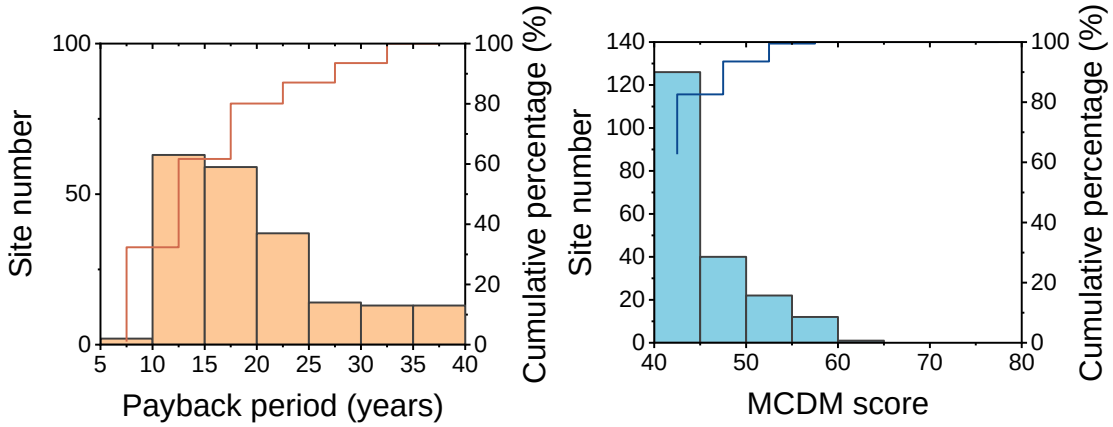
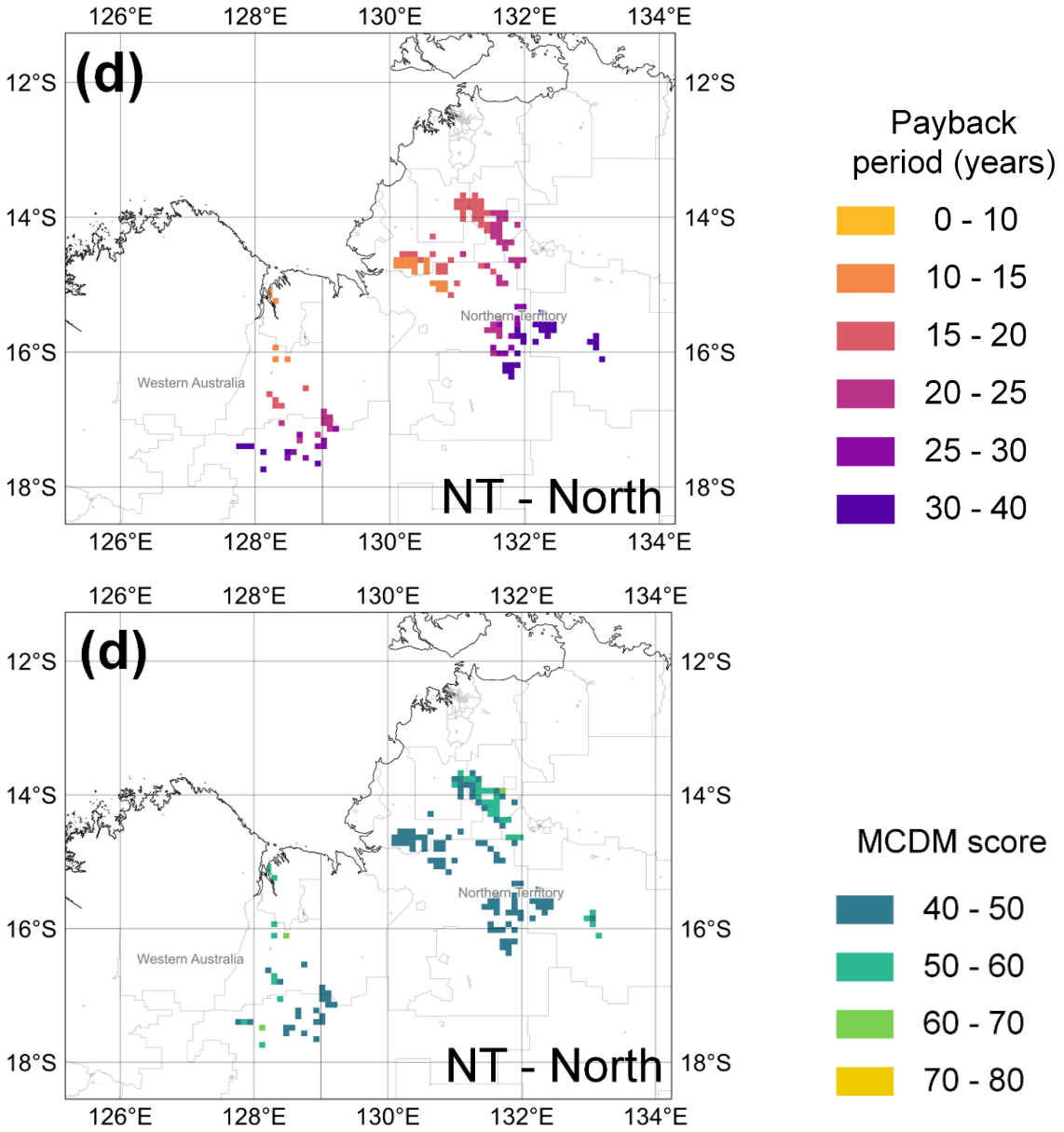
Regional Analysis

NT North







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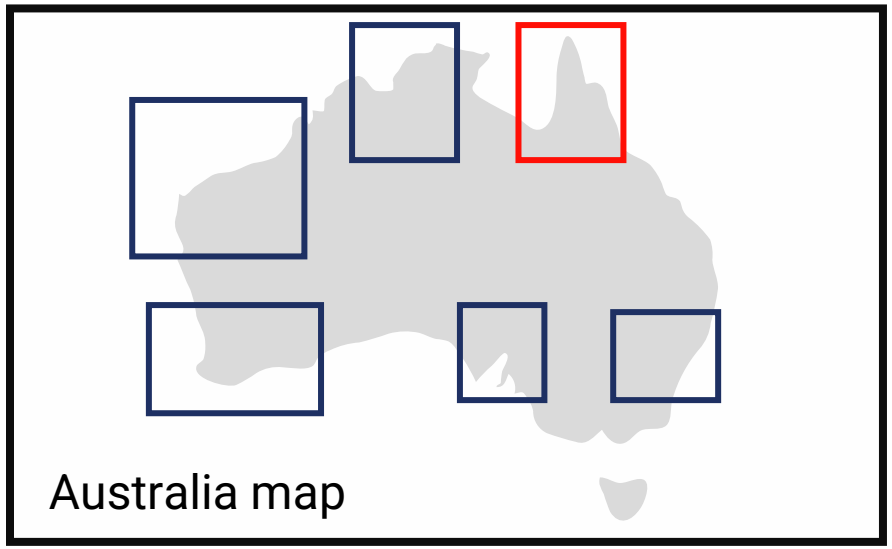
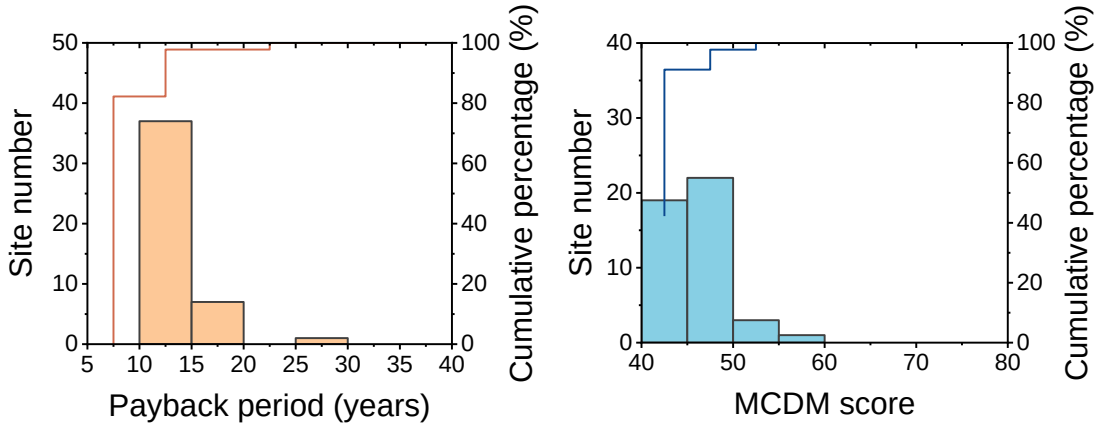
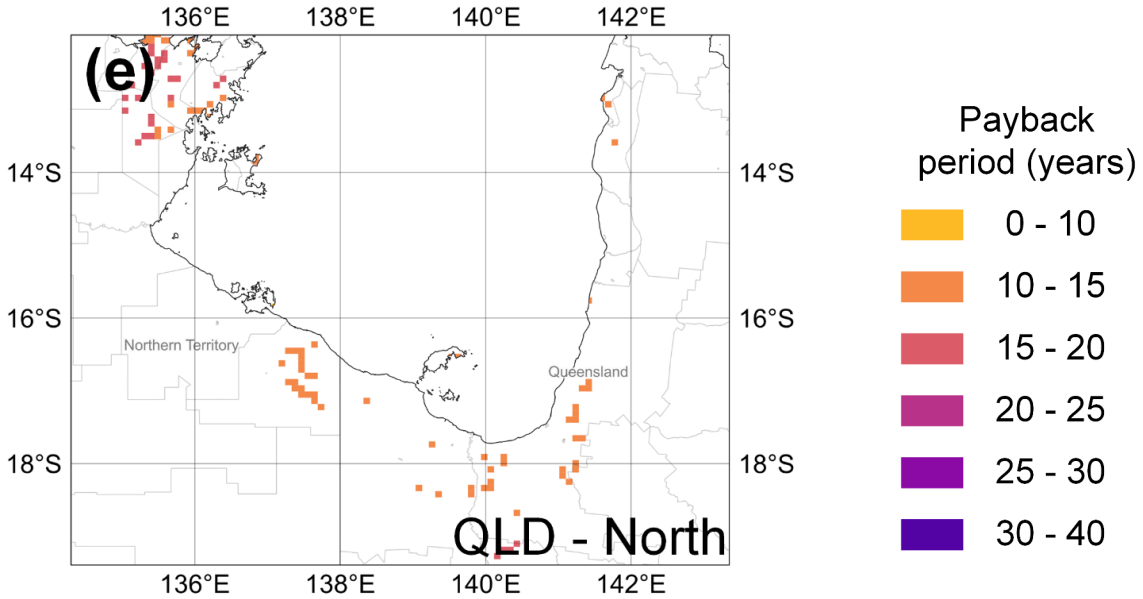
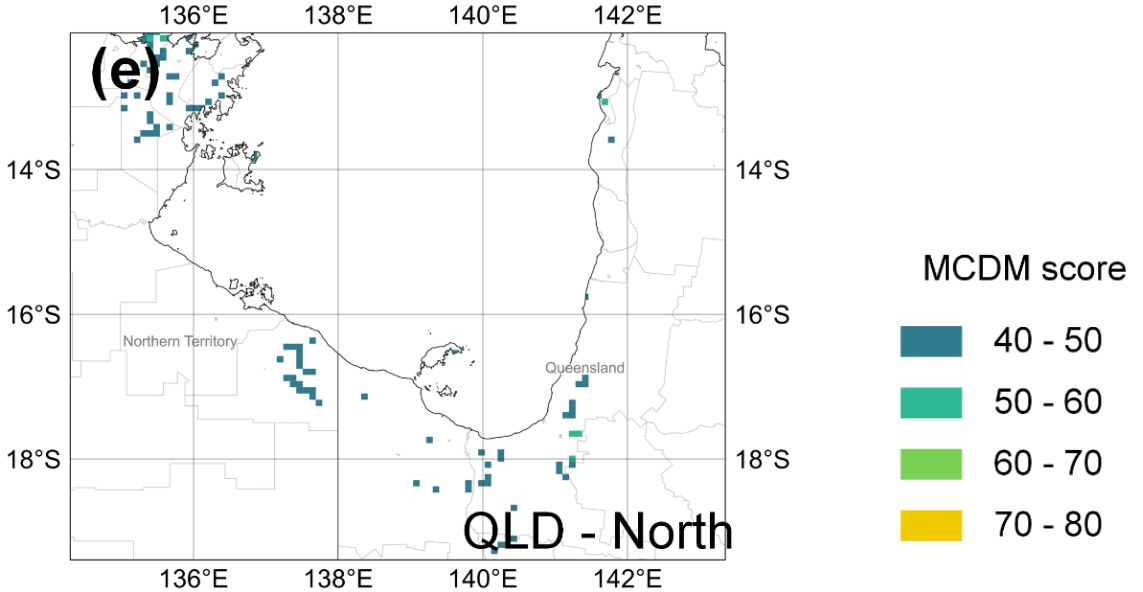
Regional Analysis

QLD North









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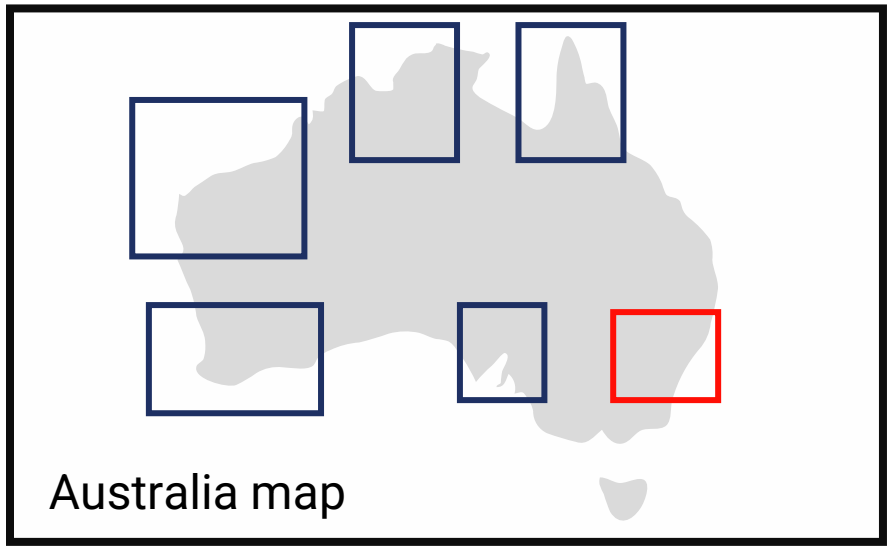
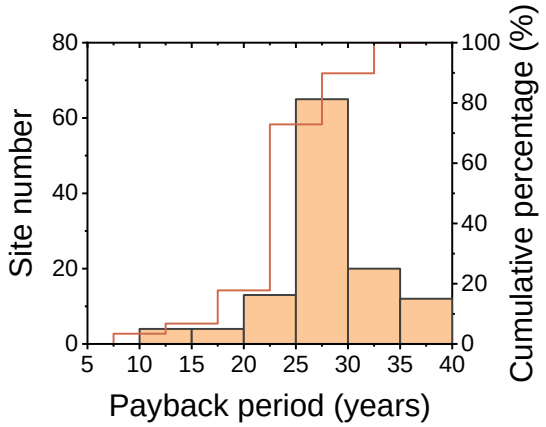
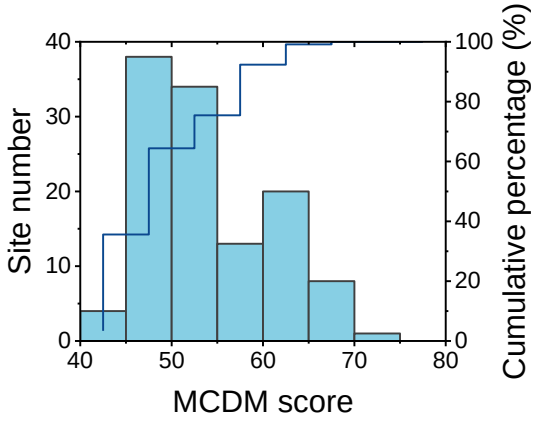
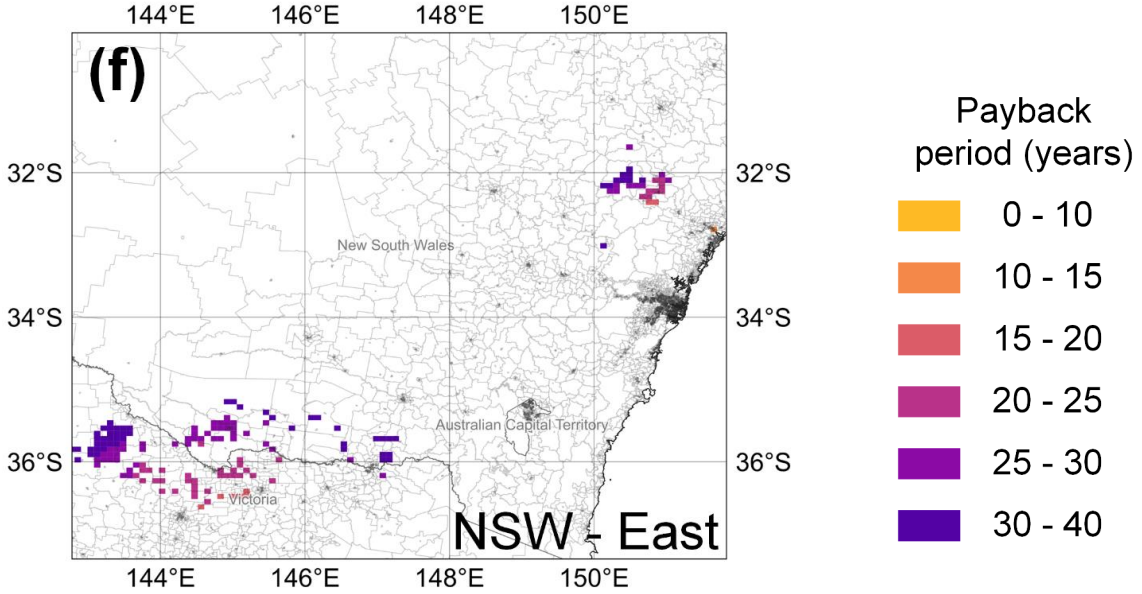
Regional Analysis

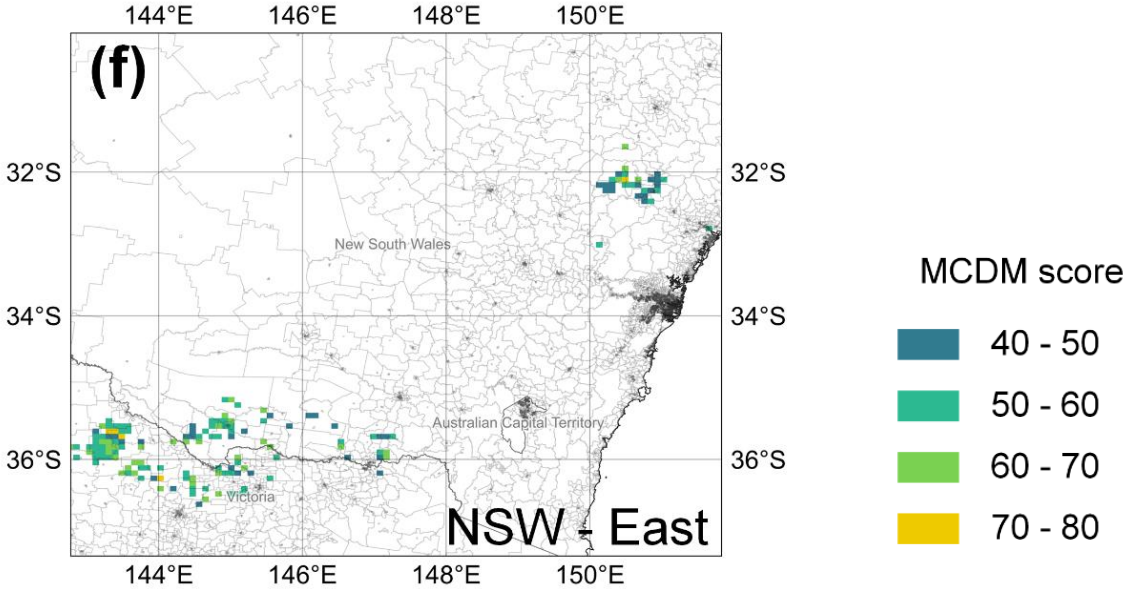
NSW East











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Conclusion

Region	Site number	Area (km2)	DNI (kWh/m2 /day)	Payback period (years)			MCDM score		
				P10	P50	P90	P10	P50	P90
South WA	291	60300	6.41	10.9	17.4	30.1	50.1	56.6	67.6
North WA	703	29900	7.58	8.7	9.7	23.5	44.4	52.6	61.3
SA South	447	3440	6.04	10.9	13.5	17.2	45.5	55.1	68.1
NT North	201	2140	6.14	12.5	17.2	32.4	41.1	43.3	53.4
QLD North	45	4400	6.24	10.7	12.6	17.4	42.2	45.2	49.6
NSW East	118	9800	5.97	21.3	28.2	34.9	47.6	52.1	63.4

- Demonstrated mean MCDM score of approximately **54.7 points** and average payback period of roughly **19.1 years** for selected suitable regions, indicating high overall feasibility.
- Highlighted the potential for decreasing payback periods for the CSP plant when combining a MED desalination plant with it, as demonstrated by the case of Sundrop CSP, offering a reduction from 16 to 10 years.

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Q&A

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Main Category	Decision variables	Preliminary constrains	MCDM method	Factor weight
Climate	DNI	> 5 kwh/m^2/day	-	
	Ambient temperature	-	-	
	Wind Speed	< 10 m/s	-	
Topography	Slope	< 10 %	√	10%
	Elevation	< 1000 m	-	
Market	Population density	> 10 people per km^2	√	18%
	Distance to urban area	< 50km	√	6%
Water resources	Proximity to feed water	< 300 km	-	
	Feed water salinity	-	-	
	Feed water temperature	< 28°C	-	
Infrastructure	Proximity to groundwater	< 9 km	√	11%
	Proximity to road and railway	< 20 km	√	11%
	Proximity to transmission line	< 50 km	√	23%
Land use	Vegetation and agriculture area	Eliminate	-	
	Urban area	Eliminate	-	
	Heritage area	Eliminate	√	9%
Natural Hazard	Prone to cyclone	< 400 estimate average annual loss	√	4%
	Prone to Earthquake	< 5 earthquakes in the past 1000 years	√	4%
	Prone to Flood	< 3 m Inundation depth for coastal and riverine floods	√	4%

Methodology - Constraints

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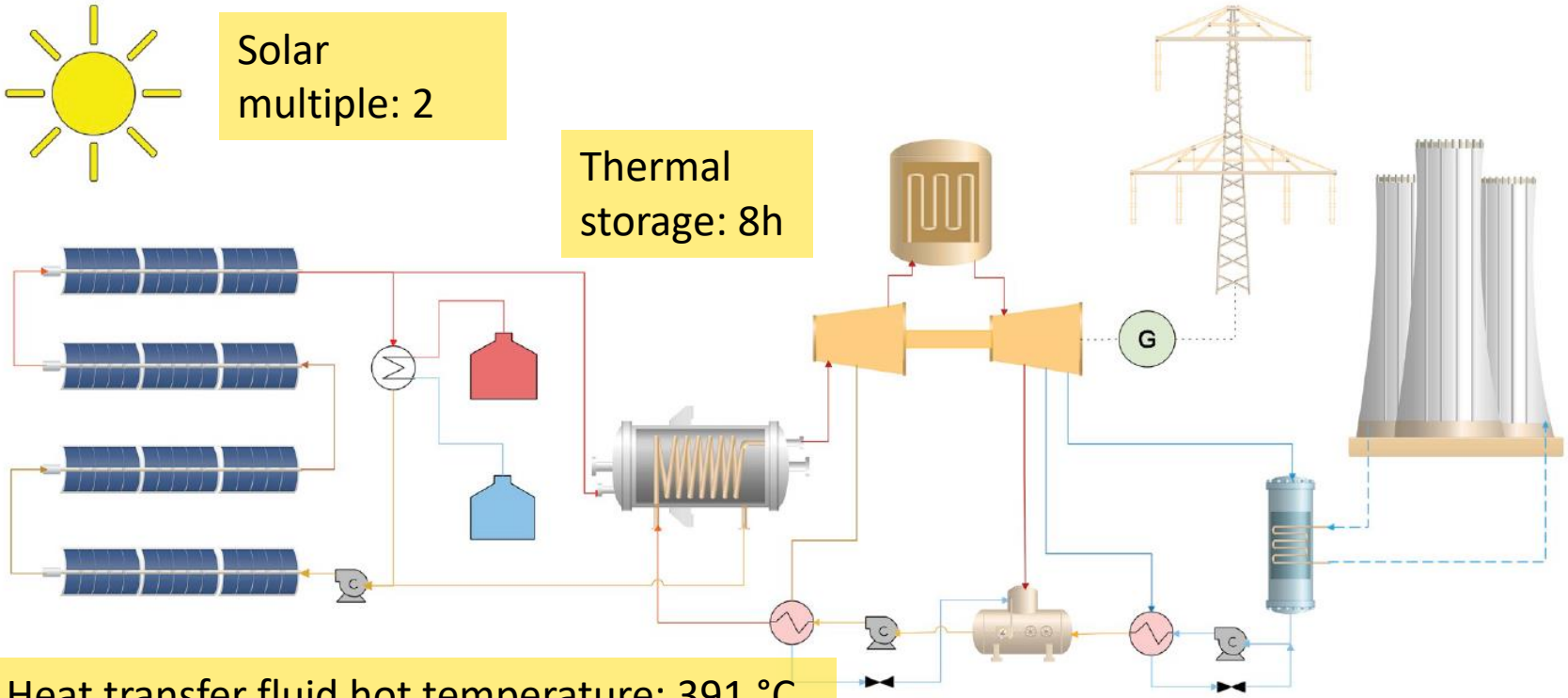
Methodology – Input data

Net power output:

50 MWe

Solar multiple: 2

Thermal storage: 8h



Heat transfer fluid hot temperature: 391 °C

Heat transfer fluid cold temperature: 293 °C

Condenser for CSP-MED	
Multi-effect distillation (MED)	Steam temperature: 70°C Gain output ratio：10.36
Condenser types for CSP-RO	
Once through cooling condenser (OTC)	87.08 m3/MWeh of the net power generated (specific seawater flow rate)
Air cooling condenser(ACC)	5% of the net power generated (specific power consumption)
Wet cooling condenser (WCC)	0.0329 Mwe/MWth of the thermal heat dissipated by the condenser (specific power consumption)

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