Challenges and Adaptation Needs for Water Quality in the Murray-Darling Basin in response to Climate Change

Abstract

1. Introduction

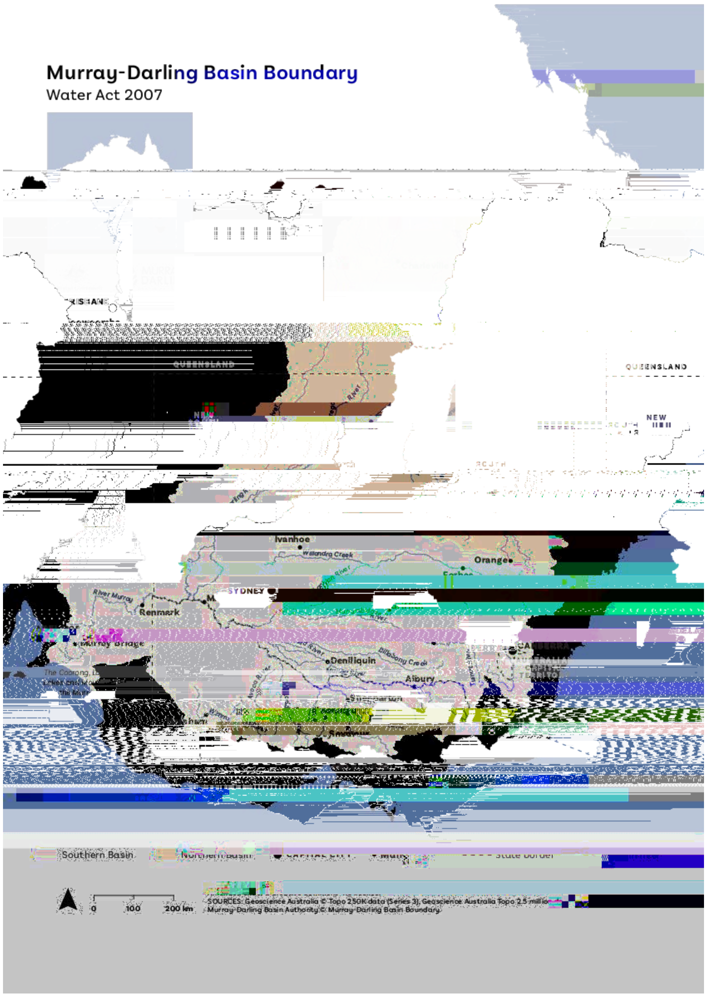

Figure 1. The Murray-Darling Basin and its Northern and Southern Basins

Figure 2: Framework for SW-GW interaction impacts for the MDB, with a focus on water quality (adapted from Conant, Robinson et al. 2019)

2.2 Water quality policy framework

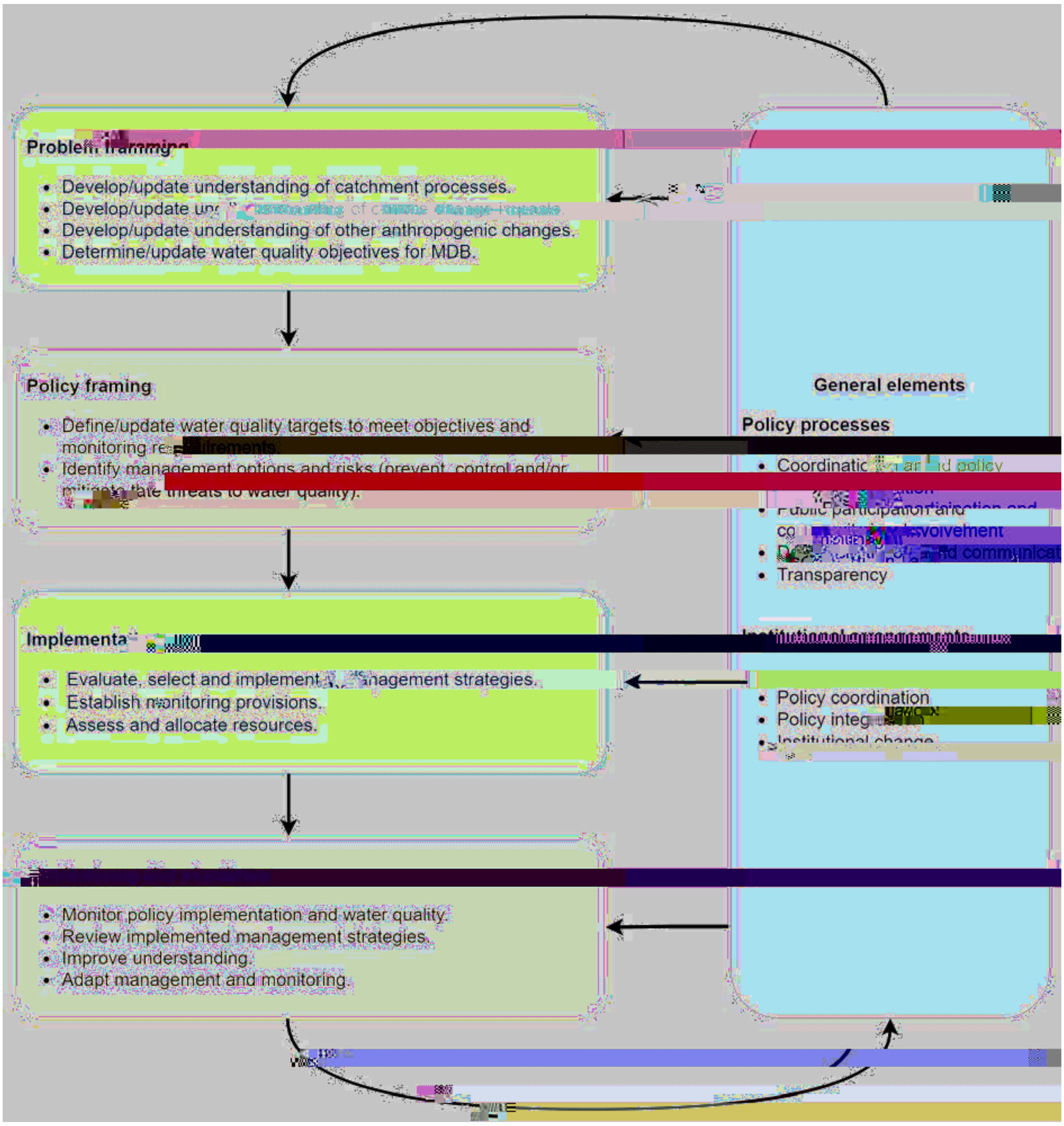

Figure 3: Simplified water quality policy framework for the MDB (adapted from Bennett 2008, Dovers and Hussey 2013)

Table 1: Summary of MDB key water quality targets (adapted from RM Consulting Group Pty Ltd (2020))

Type of target	Description of target
Flow management target	• Flow management salinity targets 95% of the time at five locations in the Murray River, including < 800 EC (µS/cm) at Morgan in South Australia (SA). • DO >50% saturation.
Water Resource Plans (States)	• Irrigation infrastructure salinity targets 95% of the time over a 10-year period. • Sodium adsorption ratio < that which would cause soil degradation. • Water dependent ecosystem targets for 21 Target Application Zones for turbidity, Total Phosphorus, Total Nitrogen, DO, pH, temperature, pesticides, heavy metals, other contaminants. • Cyanobacteria cell counts (<10 µg/L total microcystins; or <50,000 cells/mL toxic Microcystis aeruginot173 ( )-369 (<)7a1 ()-4 (t173 ( )-36eo) ((

2.3 Current water quality condition

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Table 2: Occurrence of major cyanobacterial blooms in the Murray-Darling Basin

Year	Cyanobacterial bloom event	Details	Reference
1983	Murray River	No details.	Clune and Eburn (2017)
1991/92	1,000 km Darling-Barwon		

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Year	Cyanobacterial bloom event	Details	Reference
		Creek-Edward River-Wakool River-Niemur River distributary system. Species: Chrysosporumovalisporum occurred for the first time in these rivers. Toxins: No measurable toxins.	
2017/18		“Widespread blooms, especially in the Lower Darling”. No further details.	

3. Climate change challenges for future (50-year) MDB water quality

3.1 Climate change threats to water quality

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Table 3: MDB-scale hydroclimate scenario storyline from Zhang et al. (2020)

Hydroclimatic metrics	A warmer and drier climate with rainfall decreased by 10% and with more severe multi-year droughts	Category
Mean annual flow - determines water availability and inflows for reservoirs	With a 10% reduction in rainfall and higher PET, mean annual flow will decrease by 20-30%. Dry catchments will show a greater percentage reduction than wet catchments. Mean annual flow will decrease by up to 60% during the extended drought period because of the 10% rainfall reduction and more severe multi-year drought.	Large decrease
Overbank flows - inundate floodplains to recover wetland functions and re-establish in-channel habitats	Overbank flows will decrease by up to 30%, decreasing to 60% during the extended drought period because of the 10% rainfall reduction and more severe multi-year drought.	Large decrease
Freshes - small-to-medium short duration flows in channels to maintain ecosystem productivity and diversity	Freshes will reduce by up to 30%, decreasing to 50% during the extended drought period because of the 10% rainfall reduction and more severe multi-year drought.	Large decrease
Replenishment flows - maintain downstream storages and refill pools and water holes in rivers	Replenishment flows will decrease by up to 30% during the extended drought period because of the 10% rainfall reduction and more severe multi-year drought.	Moderate decrease
Baseflows - commonly maintained by groundwater storage, not directly affected by rainfall. Important for aquatic habitat	Baseflows will decrease by up to 15% during the extended drought period because of the 10% rainfall reduction and more severe multi-year drought.	Slight decrease
Cease-to-flow days - occur when the river stops flowing at a specific location. Can lead to loss of connection and habitat	Cease-to-flow days in ephemeral streams will increase. Perennial streams may become ephemeral.	Moderate increase
Dry spells - follow cease-to-flow events and can result in declining water quality and drying out of pools leading to death of plants and animals	Dry spells will increase in length.	Moderate increase
Flow sequencing - the same mean annual flow with different sequences of wet and dry spells can lead to different ecological health outcomes	Flow sequencing will be altered.	Slight change

3.2 Threats and implications for MDB water quality vulnerabilities

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Water quality issue	Predicted threat to MDB water quality and implications
Sediments Sediments flushed into waterways from farms, mining, riverbank erosion, following bushfires or stirred up by carp affect river fauna and flora. Sediments make waterways turbid, reduce sunlight in waterways, reduce the rate of photosynthesis, smother organisms and degrade habitats (MDBA 2022). Sediment budgets modelled by Prosser, Rustomji et al. (2001) were upgraded to improve modelling of sediment inputs, transport and export for the MDB (DeRose, Prosser et al. 2003). Modelling showed relatively high suspended sediment loads in most upland MDB areas, and that sediments are being redistributed in the MDB rather than being exported. Reservoir deposition degrades water quality. Sediment monitoring is inadequate to assess if annual loads are increasing or decreasing (Walker and Prosser 2021).	Climate change induced high-intensity rainfall events may result in greater volumes of sediment being washed into waterways during larger flooding events, particularly in the northern Basin, contributing to turbidity increases. As described above for nutrients, more research is required to evaluate the effectiveness of regional scale catchment works to reduce sediment accessions to waterways, and when setting ecologically meaningful targets. Improved sediment monitoring and modelling are required to better manage MDB water quality.
Metals and other toxic compounds These contaminants are generated by exposure of acid sulfate soils to oxygen as water levels fall in waterways and on floodplains, by historic and current mining and by inappropriate use of chemicals. Acidification in the middle and lower reaches of the southern Basin has been linked to acid sulfate soils (Baldwin 2021). These contaminants kill fish and other aquatic life (MDBA 2022) and are a threat to water quality for domestic, agricultural and other uses.	Climate change induced high-intensity rainfall events may result in episodes of waterways contaminated with metals, other toxic compounds, and low pH. Reduced overland flows and extended droughts resulting from climate change are predicted increase the potential for drying out of southern Basin wetlands and floodplains, leading to increased occurrences of exposure and oxidation of acid sulfate soils. Baldwin (2021) describes management

Water quality issue	Predicted threat to MDB water quality and implications
Low DO levels Low DO levels can occur as a result of drought or flood conditions. During drought, sudden changes in weather condition can result in oxygen levels throughout a water column quickly reducing when thermally stratified water bodies with deeper, low oxygen layers mix rapidly with oxygenated surface layers. During floods, large inputs of organic matter creating a blackwater event can rapidly consume the oxygen in a water body for it to become hypoxic (see below). Low DO levels kill aquatic life (MDBA 2022).	Higher temperatures, extended droughts and high-intensity rainfall events resulting from climate change are predicted to

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4.3 Visions of water quality for the MDB in 50 years

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References

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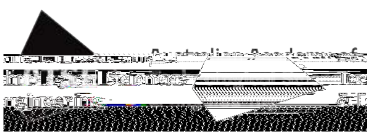

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