**Assessing effective deterrence of theft in transboundary water systems**

**Analysis of water theft remains challenging given poor data and limited cases, restricting assessments to higher levels where attempted. However, high level research within key transboundary contexts can offer evidence for improved theft deterrence and critical legislative change requirements, along with institutional insights for other jurisdictions. For example, Federal water regulators of Australia’s Murray–Darling Basin (MDB), which is a significant transboundary water system, have called for consistency in compliance and certainty across State jurisdictions to help protect water market confidence and resource reallocation outcomes that are critical in drought periods. This paper explores the complex legal processes for penalty setting in water theft cases that may drive ineffective compliance when the value of legal harm is procedurally downgraded under the legitimate consideration of mitigating factors. We aim to identify applied certainty and severity deterrence principles for reducing environmental and economic harm, as well as how to incorporate alternate water values in penalty setting to inform a future framework to analyse MDB legislative consistency and institutional transparency with lessons for other countries.**

***Keywords***: water theft, Murray–Darling Basin, legal review, detection, deterrence, penalties

# Introduction

Limited data and evidence of water theft make analysis difficult, but illegal activity is likely far higher than officially reported [1]. This illustrates a clear rationale for immediate and ongoing research into water crime [2]. Most water theft studies report outcomes that are not based on empirical analyses nor referenced to other empirical works [3], making research adoption and adaptation challenging. However, some countries, like Australia, do have data to allow analysis of water theft outcomes. For example, by June 2023 the New South Wales (NSW, an Australian State jurisdiction) Natural Resource Access Regulator (NRAR) received 265 suspicious activity reports, finalised 360 investigations, delivered 63 warnings, stop work orders and penalty notices, and had six active prosecutions [4]. The Australian Federal Labor government has also targeted water theft in the Murray–Darling Basin (MDB, see Figure 1 and *Methods* section for more context detail) by seeking to ensure that the recently created Inspector General of Water Compliance (IGWC) has the powers necessary to reduce water theft, uphold compliance with MDB rules, and restore confidence amongst those living and working in the Basin [5].

The Inspector General, Mr Troy Grant, also highlighted to the 2022-23 Federal Budget Estimates Committee that deterrence powers are ineffective and goals unachievable without urgent change in MDB water theft management. Since February 2023 the IGWC has been forced to drop 62 cases due to poor MDB State legislative support, inconsistent approaches to water theft, and allowances for some irrigators to balance accounts in arrears [6]. Water is one of Australia’s most valuable commodities worth an estimated AU$96.5 billion, with average water allocation (i.e., seasonal lease or spot) trade exceeding AU$2 billion per annum [7]. These rights and their economic value, supply reliability, and security are all compromised by theft. Yet effective change is unlikely under limitations to our understanding of the extent, harm caused by, and successful deterrents to, illegal activity. Ultimately, we have little understanding of how complex drivers affect water theft and even less understanding of how to achieve effective compliance via deterrence mechanisms [1, 8].

So, why do some users steal water, while others do not? What comprises effective deterrence? Strong theft deterrence is critical to future supply reliability and property right protections for private (e.g., irrigators), public (e.g., key national environmental sites), and social (urban, cultural, and recreational) water users. Yet some people enjoy rule-breaking or differ in personal moral development [9], decreasing deterrence. Others’ illegal activity may be conditioned by their environment [10] or personal divergent perceptions of the legitimacy and fairness of rules [11]. Some illegal activity may be more likely when the benefits outweigh the costs [12] or if the victim is from an ‘out-group’ (e.g. environmental user), and those of the ‘in-group’ (e.g. irrigators) consider theft from out-group users to be acceptable or worthy of more lenient sanctions [13]. Large user numbers [14] and any general perception/acceptability of non-compliance across user groups [15] will also reduce detection probabilities and increase theft activity. Finally, Bretreger et al. [16] note that as water demand grows, and reliable supply is impacted by climate change, water theft increases. In the MDB, limited seasonal allocations, corresponding water allocation price rises, and expressions of panic and worry for water users were all evident during the Millenium Drought between 2000 and 2010 [17] and more recent supply shortages [18], with identification and reporting of alleged theft cases growing in NSW.

By contrast, cultural values and norms may impose effective deterrence institutions against water theft, especially where regulatory controls deter resource exploitation [19]. Successful deterrence may also occur under shared social objectives and effective monitoring [20] or understanding the connectivity between ground and surface water resources [21]. Effective deterrence thus relies on a strong culture of compliance to reduce market impacts and assure effective water regulation [22], especially across multiple State borders; but the MDB still lacks comprehensive and transparent compliance regimes spanning State political boundaries [23]. Some research has examined questionable behaviour by MDB regulatory organisations and politicians, and how this may hinder compliance and encourage increased legal harm via water theft [24, 25]. But globally, harm visited on nature has remained largely invisible or legally irrelevant for decades [26]. In response, researchers have recommended systems operating on best practice science such as rivers with legal status [27], satellite surveillance and detection methods [16], making legality more economically attractive [28], double entry accounting methods to track use [29], and/or detecting and prosecuting persistent illegal water users with effective graduated sanctions [30].

According to the IGWC, MDB-State enforcement may also benefit from quantifying water theft via the inclusion of commercial (market) costs, environmental harm, and losses to First Nations peoples to create a consistent enforcement protocol across the MDB States/Territories. However, only New South Wales (NSW) and South Australia (SA) have increased water theft penalties, only Queensland (QLD) and NSW use joint satellite monitoring to detect water theft activity [4], Victoria (VIC) has relatively low penalties but is moving toward graduated sanctions (see Figure 2) similar to other States (e.g., NSW and QLD)[26], and the Australian Capital Territory (ACT) is mainly focused on urban water issues with minimal non-compliance [25].

A diagram of a pyramid

Description automatically generated

Figure 2: NRAR mitigating issues and penalty escalation framework [31, pg. 9]

This supports the view that water theft compliance across the MDB States currently remains unaligned and disconnected. It should also be noted that Section 100 of the Australian Constitution prohibits the Federal Government from making any laws in trade or commerce that abridge the right of the states or their residents to the reasonable use of river waters for conservation or irrigation. Other Constitutional provisions pertaining to water are narrow in scope and only permit, for example, legislating with respect to navigation and shipping (Section 98) and general trade and commerce among the states (Section 51(i)). The Federal Government’s authority over water resources is therefore limited, with most regulatory power vesting with the states. In 2017, the Howard government was forced to rely upon a combination of other constitutional heads of power to pass the Water Act 2007 (Cth) after it failed to reach agreement with one of the Basin states (Victoria). In 2008, however, all Basin states agreed to refer (under Section 51(xxxvii)) certain powers over water management pursuant to the 2008 Intergovernmental Agreement on Murray-Darling Basin Reform [32].

Thus, appropriate deterrence to water theft continues to be debated, often without satisfactory data or analysis [16]. Deterrence options have broadly settled into either bottom-up approaches based on altered social norms [33] which may increase the probability of local user-detection and reporting if strong penalties do not drive compliance [34], or top-down regulatory measures where social norms are ineffective and compliance is incentivised through punitive measures [35]. If the probability of detection through social norms is lacking, and the sanction relatively minor, strong deterrence will remain absent [36]. More recently, Earnhart and Friesen [37] econometrically tested mixed deterrence results in a wastewater pollution context. They found that low detection and prosecution *certainty* values and less *severe* penalties resulted in counterproductive outcomes, but that certainty of prosecution compelled stronger deterrence. For example, capital punishment should constitute the most severe form of penalty, yet evidence of strong deterrence effects remains equally mixed [38], where offenders facing capital punishment outcomes can commit more crime than those from countries without capital punishment. Thus, deep and wide study in this area is urgently needed to inform other water management jurisdictions [16] and regulatory changes suggested for the MDB States by Federal authorities.

Better research into water theft is especially needed in the MDB where, as elsewhere, water resource use is transboundary by nature. This means that annual water allocation trade rules and mechanisms allow water to be used anywhere [18], particularly in the south (e.g., NSW, VIC and SA). For example, water can originate in NSW but be traded and then used in SA with increased threat of theft along the broader delivery network. Theft detection, prosecution, and conviction will be less certain if there are inconsistent legislative and prosecution approaches for MDB State water regulators and managers. Further, applications of mitigation factors by the courts or water management authorities to downgrade an offence and apply lower-tier penalties (see Figure 2) may be used for valid legal reasons but result in less severe penalty outcomes. Penalty mitigation approaches may also undermine the value of the water right asset and efficiency innovations undertaken by other users to save and redistribute water resources (e.g., to environmental flows). This is because individuals that steal water incur lower input costs (e.g., as compared to market prices), have no incentive to be efficient in their use, and experience limited incentives to reduce their agricultural output or water input use in low supply (e.g., reduced annual allocation level) periods. These actions may result in an inefficiently high level of legal harm where critical attributes of water rights [i.e., excludability, rivalry, variability and mobility as per 39] are ignored for (contrite) water thieves, rather than being fully factored into the harm incurred by the individual or organisation from whom the water was stolen.

This assessment drives three research questions for us to explore: i) what does a review of water theft legislation across the MDB States tell us with regard to improved certainty and compliance, ii) could assessment of water allocations and weighted average prices (often deemed inappropriate to apply by a State authority and the courts[[1]](#footnote-1) due to location of offence, lack of sufficient evidence, mitigation of harm, etc.) increase the severity of penalties if used to calculate legal harm in *all* cases, and iii) what does an expectation of more frequent and severe climate change water supply impacts in the southern MDB (i.e., sMDB comprising NSW, VIC and SA where most trade occurs) indicate regarding necessary change to effective water theft deterrence and water right equity protections?

# Results

Geographically in the MDB from north to south, QLD uses around 11% of total MDB water resources and under the *Water Act 2000* (Qld) applies a risk-based proportionate approach to theft detection and an opportunity to award graduated sanctions. QLD has increased financial penalties for illegal take activity since 2010 to $257,742 per offence with no distinction between private individuals or corporations (see *Water Act* 2000 (QLD) Sections 808, 808A). Enforcement has also increased since 2020/21 under a joint satellite monitoring program involving NSW authorities but the penalty levels and sanctions remain below other States (e.g., NSW and SA). QLD thus suffers from both low (but possibly increasing) certainty of enforcement and low severity of financial penalty relative to other States.

NSW is the largest water user in the MDB extracting around 50% of total resources through more than 38,000 water rights. Some of those rights exist under the *Water Act 1912* (NSW), which has largely been repealed by other legislation, but the existence of those rights requires the Act to be kept in place. *Water Act 1912* (NSW) penalties are minor in relative terms and have not changed across the review period. The *Water Management Act 2000* (NSW) is the critical regulatory instrument favouring educative responses to financial penalties, but where penalties for individuals have decreased in real terms. However, NSW is championing the use of satellite technology to better monitor theft and illegal extractions. Finally, under s60G, the relevant Minister can impose unique penalties of either a charge not exceeding five times the market value of the water taken or, if they have a water account, it may be debited five times the volume of water taken. However, we could not identify any cases where either Ministerial fine had been applied. Overall, NSW has a higher certainty of detection and prosecution via satellite technology, making NSW the example for others to follow [40] and illustrating one potential rule/process standard for establishing consistent MDB approaches.

The ACT is a small jurisdiction embedded in NSW that is home to the capital city Canberra and operates similar in nature to Washington DC. It uses a very small portion of total MDB water resources at around 0.2%. The Territory has mostly urban water theft issues, but minimal compliance problems are noted. This may explain why, while water theft is an offence, in the most recent period individual penalties have dropped approximately 85% and corporations have had penalty provisions added—but again at relatively low levels. As a largely urban water user with limited water rights, it is arguable that consistency with other MDB States may be of lesser importance. However, in summary, the ACT is judged to have more certain probability of detection via meter use and inspections while penalty severity is relatively low compared to other States.

In VIC, the second-largest water user at 34% of total MDB via around 30,000 water rights, a “zero-tolerance approach” to water theft has been adopted. That said, VIC courts tend to award low-level penalties that represented 60% of prosecutions in the 2020-21 water year. Recent changes to the *Water Act* *1989* (Vic) have enabled water supply corporations (e.g., Goulburn-Murray Water) to issue their own penalty notices from 2022, which have increased in recent years, but remain low relative to other States. However, while VIC has strengthened links between low-level infringements and movement toward a full range of penalty options like those in NSW, implementation is progressing slowly. The role of water supply corporations is unique to VIC and SA (see below) and may advantage detection and certainty of compliance under extensive metering use by those corporations. However, for individuals the relatively low financial penalty rate given mostly high security (and higher value) rights in VIC versus high prison time sends mixed signals on severity and drives greater inconsistency.

For SA, the fourth largest water user at 5% of total via approximately 5,000 water rights, the State has recently repealed earlier water legislation (i.e., the *Natural Resources Management Act 2004* (SA)) to adopt a “zero-tolerance” and (mainly) educative and graduated approach (i.e., under the new *Landscape South Australia Act 2019* (SA)) applied alongside a mandatory penalty framework regardless of the volume extracted in the (mainly) pressurised and metered supply system. Flagged penalty increases in 2010 to $700,000 for individuals and $2.2 million for corporations did not appear in the legislative changeover—but are quite severe (see Table 1). Penalties are prosecuted by SA water supply corporations (e.g., Central Irrigation Trust) and if overuse is detected users are provided an opportunity to ‘balance’ their account before prosecution commences. The requirement to balance accounts has recently changed from annual to quarterly, catching some water users out and testing the certainty of successful penalty application under appeal challenges. So, while SA has some of the most severe penalties of any MDB State (e.g., if 500 megalitres, or million litres of water [ML], is stolen the fine could total $12.5 million) recent prosecution of water over-extraction has not progressed well, leading to potential lower certainty perceptions by users.

Finally, although the Federal Government (Cth) has no constitutional power over national water resources (outside of those that have been referred to it by affected states) there is the relevant *Water Act* 2012 (Cth). Recent changes with respect to theft of environmental water—a significant national asset estimated at $14 billion—have significantly increased Federal penalties associated with legally damaging activity. However, the Federal Government has limited means by which it can pursue pecuniary actions, relying on State powers and laws. Therefore, they have very severe penalties but low legal certainty, compromising deterrence effectiveness. In part this reality would likely be a factor behind the Inspector General’s frustration discussed at the start of this paper, where addressing consistent approaches by the MDB States would advance Federal Government water theft deterrence objectives. We summarise this information in Table 1. Our analysis suggests that consistency across all MDB States is low, with key differences between certainty and severity principles for effective theft deterrence continuing across the MDB States.

While there is considerable inconsistency across the MDB States with respect to certainty of detection and prosecution and penalty rates, we do find commonality in the legal processes for evaluating and setting State penalties in the case of water theft. For example, most penalty values are established, reviewed, and updated annually via units that can be revised each financial period through other Acts (e.g., *Penalties and Sentences Act 1992* (Qld.)). Further, as discussed above, State courts are required to apply mitigation criteria to determine penalties because different water theft offences must account for relevant objective seriousness and subjective circumstances of each offence and offender. Using NSW as an example, with similar provisions in other MDB States, the *objective seriousness* criteria are: the nature of the offence; the maximum penalty for the offence; impact on other water user’s rights; market value of any water lost, misused or unlawfully taken; harm caused or likely to be caused to the environment; reasonable foreseeability of harm and any practical measures taken to prevent, control, abate or mitigate that harm; any severe water shortage or extreme event at the time of the offence; the person’s intentions or state of mind and reasons for theft (i.e., financial gain); whether they were complying with orders from an employer/supervisor; and whether the water taken had been released for environmental purposes and, if so, whether the person was aware of that fact.[[2]](#footnote-2)

The *subjective circumstance* factors that may be considered include prior criminality; remorse through acceptance of responsibility, acknowledgement of harm caused, and reparation for such harm; a guilty plea entered at the earliest available opportunity; aiding authorities; being of good character; having no prior convictions of similar (i.e., environmental) offences; and any likelihood of reoffending (as per the Crimes (Sentencing Procedure) Act 1999 (NSW) Sections 21A(2)-(3)). Other common law principles may also apply in the sentencing process (e.g., even-handedness in fines and capacity to pay principles). In this regard there is some consistency offered through the legal process. However, despite these similarities, the probability of lower severity will feature in legal cases such that, where a market does not technically exist in an area, the Court may choose to ignore financial gains, weather-driven changes to allocation outcomes, and/or allocation water market price signals—potentially from an unfamiliarity by the courts of how water markets work, where data is available, and linking these signals to their assessment. This can easily be addressed, and based on this research will be discussed in greater depth in future analysis.

The Bureau of Meteorology (BoM) has compiled a publicly-accessible database of water market outcomes by Australia where the MDB features heavily [41]. This dataset also includes national water projections [7], while State departments historically record and publish regular allocation determinations for all MDB regions [e.g., 42]. We use this information to assemble Table 3 and 4 below. One clear finding is that, following the Millennium Drought experience (2001-2010), it no longer takes significant threats to water supply for irrigators to react through the market, sometimes quite irrationally [18]. For example, in the 2018/19 and 2019/20 water years a consecutive set of drier than normal periods, coupled to lower allocations for many MDB regulated river systems, worried irrigators about future supply and pushed weighted average market prices higher—approximately five times higher than the previous water year. It is exactly these conditions, which are prevalent in the MDB, that will drive water theft and higher harm for all other users in future and must be better factored into (potentially, where warranted) more severe penalty setting consistently across cases.

In a recent case, one factor in calculating the penalty was that no water market existed in the area, and so this impact could not be considered (see for example Natural Resources Access Regulator v Thompson [2022] NSWLEC 48 (Pepper J). Yet, NSW did have a signal for water values generally through weighted average prices that could have been applied as a measure of the opportunity costs of that illegal extraction. As the action took place between August 2017 and December 2018 relevant water allocation and pricing data (e.g., Lower Darling with similar conditions) for that period could have been used to assess and then calculate an appropriate value for the resource and any legal harm from being unavailable to other users; that is, average general security water allocation of 90% and an average market price of $100/ML. If we multiply what was stolen (i.e., tricky to estimate due to meter-tampering but judged to be between 734 and 893ML—say 800ML as a basis) using the market value above we can calculate an economic harm of at least $80,000; a conservative yet useful measure in this instance. Compared to the actual penalty awarded ($57,500 plus legal costs) we find a slightly more severe outcome that is still well below the maximum (i.e., $247,500 at that time).

Alternatively, in SA where water users are required to balance their account quarterly if they over-extract during that period, failure to do so can quickly accrue significant fines based on maximum penalties. Over-extraction of 100ML in a quarter would attract a significant maximum fine (i.e., $2.5 million based on $25 per kilolitre (1,000 litres of water)) if the irrigator is unable to purchase or secure balancing volumes in the market. SA also experiences some of the highest market prices in the MDB given almost wholly high security rights (i.e., full supply of water is available in 95% of years typically) and a lower portion of MDB supply (i.e., 5% of total). This is likely too severe and, while aimed at driving strong deterrence, has thus far resulted in arguments of being unfair and ignoring capacity to pay criteria. Therefore, a careful balance is needed going forward. At present, we are scouring court records to build a comprehensive case history of such outcomes to further test our recommended changes to water theft penalty setting via a novel framework based on the *objective seriousness* and *subjective circumstance* factors outlined above. But this simple example shows how easy it is for courts to find, analyse, and apply such data for penalty assessment. In cases of environmental harm the assessment may be more challenging given non-market values for ecological welfare gains. Further, economic studies for deriving such values either exist or can be conducted to provide similar costs to affected users, to again raise the severity of water theft penalties consistently across the MDB.

Finally, the need for changes to certainty and severity are urgent given expected climate change impacts to supply, demand drivers for perennial crops, and wide-spread water user uncertainty about future conditions and how best to adapt. Increased scarcity, or changes to geospatial or temporal water resource availability may quickly lead to extensive panic, theft, and structural losses as stated above. We see some predicted likelihood of such outcomes in an update to the Garnaut Climate Change Review [43] (Figure 3) using modelled climate impacts on sMDB runoff out to 2100. Assumptions include 450 ppm mitigation efforts, and two projections spanning extreme outcomes (GFDL-ESM2M, rcp45) and more benign expected changes (ACCESS-01, rcp45). The analysis shows that predicted pathways for climate impacts provided by Quiggin et al. [44], illustrated by the solid lines, suggest two main water supply outcomes based on business as usual (BAU), 450ppm and 550ppm average mitigation strategies, and the addition of future dry state of nature condition assumptions. The Quiggin et al. [44] pathways are predictably wide but the modelling shows that climate change runoff impacts are located approximately between the two, heading toward 5,000GL (gigalitres or 1,000 megalitres) by 2100. It is important to note that runoff is not inflows to storage—inflows would be even lower again. Thus, the motives for future water theft will only increase and the issues surrounding certainty of prosecution and severity of penalties as a driver of deterrence must not be delayed in the MDB.

# Discussion

From the analysis undertaken in this paper we agree with the Inspector General that little has changed since the Bricknell [1] review and State consistency in water theft laws and deterrence is lacking, driving poor regulatory outcomes and exacerbating both commercial and environmental harm. While some evidence of State attempts to become more consistent exists, progress in the MDB needs to be hastened and strengthened. This is especially true when we consider how local climate change impacts might encourage increased Basin-level theft where multiple jurisdictions manage the water resource and delivery to lawful right-holders. Water rights are a pathway to significant commercial and environmental benefits depending on whether their excludability and rivalrous nature are maintained [46]. Water theft extinguishes the excludable and rivalrous attributes of water and, as supply for all users may be diminished, the harm from that activity increases.

A graph of different colored lines

Description automatically generated

**Figure 3:** Actual and predicted future runoff, sMDB 2000 – 2100 using BoM rainfall and runoff data, CSIRO *Climate Futures Model* Projections and Garnaut Climate Change Review Projections [45]

As we have shown, where the rights of those that own the water are not properly accounted for and the full commercial/environmental loss is reduced and made less certain through the valid application of legal procedures, theft becomes lucrative in a basic benefit-cost analysis sense. This also undermines the efficiency and equity potential for water markets in Australia which have been of significant benefit in previous drought periods [47], and serve as a best-practice example globally. It is also very achievable for the courts to access and utilise water allocation and market data to estimate accurate assessment of harm and opportunity costs, and we would strongly recommend that they do so in future under a consistent set of MDB water theft laws, rules, and procedures.

Correctly setting and implementing appropriately severe penalties for water theft across the MDB—and Australia more broadly—offers capacity to generate a wider appreciation for the value of the environment as a basis for our economic, social, cultural, and recreational systems. Any continuation of lenient sanctions that does not offset the cost of water theft signals to others that such activity is not taken seriously and that there will be little certainty of punitive consequences. Addressing water theft issues consistently and with certainty, including penalty setting/applying procedures, offers an opportunity for Australia to again lead the way in effective water governance and compliance reform globally and set the standard for others to follow, which will have benefits for our international engagement and reputation. For example, transboundary water sharing between the United States and Mexico is complex and often poorly managed, leading to non-compliance by some water users where certainty of prosecution and punishment remains limited [48]. Further, emerging understanding of water theft and its impacts features as an objective for a recently announced European Project that is expected to draw upon satellite and other measurement techniques to identify/quantify illegal water uses; including environmental/legal harm [49], where several authors are participants in this future work. Australia is also one of the only countries with substantial environmental water rights held on behalf of the public. Yet while the Federal Government has enacted some of the most severe penalties for interfering with those rights, they are no different to other commercial (i.e., irrigation) rights and are often viewed as having equal status legally, which they do. Perhaps their status needs to be upgraded in any changes to State legislation to ensure that they are better protected over other rights and enjoy more tangible capacity to bring a civil case where those rights are breached.

Finally, as shown here, the threat of theft will dramatically increase as water supply is negatively affected by climate change. Recent findings suggest that the 1900s—on which many climate models (e.g. CSIRO) are based as a reference period—may have actually been relatively wet for the inland West of Australia over the last 600 years [50]. If accurate for that area, and Australia more broadly, the future for agriculture may in fact be far worse than predicted to date. Water theft greatly diminishes a market and delivery system’s resilience, making it vulnerable to collapse under future change. This highlights the urgent need for researchers to inform effective policy/program changes ahead of such problems across the entire MDB via co-design with government agencies. Following this paper, we intend to explore and firmly identify the conditions necessary/sufficient for the detection, assessment and penalty setting in any available cases more deeply using qualitative comparative analysis techniques. This is expected to lead us to improved processes for dealing with water theft given: expected increases in dry years and uncertain climate change supply conditions, specific factors required for more severe and certain water theft penalties, how these differ between the States, separate studies of surface and ground water theft where possible, and what can be done to better structure/normalize legislative arrangements at lower levels. With many countries beginning to readdress water reallocation, water inequality and theft from first nations via public funding the preservation of gains from rebalancing the share of water and the expenditure will become increasingly important. When water theft prevents water flowing to urban areas, there will be clear social, political, and economic costs.

# Methods

The context for this study was the Murray–Darling Basin (MDB), which stretches across five States and Territories in the south-east of the country (see Figure 1). The MDB offers a useful case study for our analysis given its relevance politically, environmentally, culturally, and economically for Australia as well as providing a transboundary water sharing example relevant to other countries. Within the MDB Federal and State governments have entered into a joint-agreement to manage water resources effectively and to invest in reforms aimed at increased environmental flows and future sustainability, most recently under the *Water Act 2010* (Cth) and the MDB Plan [51] which involves four levers including: using the best available science to assist decision making; recovering additional water for the environment to maintain the national welfare gains; on-going refinement of water sharing plans and drought management; and using the water market to reallocate water at the margin. These reforms have sought to incorporate environmental water needs and delivery into basin management, which relies heavily on political cooperation [52]. Considering environmental harm in penalty setting is challenging due to the relative novelty of such arrangements and limited comprehension of how best to establish legal harm that results [53, 54], and may not contemplate water market factors to obtain reasonable estimates of economic costs associated with unlawful extraction to help establish harmful outcomes. Extracting water resources from environmental users (e.g., mainly Federal government agencies that manage watering events [55]) should therefore effect significant public harm from private actions, yet all rights are treated equally at present in legal harm assessments.

However, there is no agreed framework for assessing water theft cases to capture issues that result in certainty and consistency [8]. The State legal and regulatory systems establish offences and penalties for breaches of those offences, authorise regulatory bodies (e.g., NRAR) to monitor and prosecute breaches, establishes the factors that must be considered by the Courts when penalising offenders, and ensures that issued penalties are complied with [see for example 56]. Further, the Federal Government has referred Constitutional powers in water management that limit intervention. However, under the *Environmental Protection and Biosecurity Act* Cth (1999) [1] the Federal Government can intervene to purchase, store, and deliver environmental water to key sites for ecosystem benefits and any infringement of those rights should arguably create larger legal harm and carry greater penalties—but may not due to inconsistent State approaches [3, 40]. A general framework for collating, assessing, and determining/scoring factors driving increased water theft penalty certainty and compliance is therefore needed.[9]

A map of a large area with many rivers

Description automatically generated

VIC

ACT

WA

NT

SA

NSW

QLD

**Figure 1:** MDB map showing irrigation areas, major rivers, wetlands and regional centres [29]

As discussed, theoretical drivers of water theft are various and complex spanning design (i.e., institutional) and natural context (i.e., drought) factors [8]. Common pool resource (CPR) management principles allow researchers to detail and study interactions between designed and natural context factors to arrive at robust or sustainable management outcomes when evaluated using multiple case studies [30]. This approach enables an in-depth examination of water theft and, as complexity grows under future water supply constraints, how regulators might best address changes to detection, enforcement, and the application of sanctions. The degree to which water theft is deterred by sanctions remains an open question [57]; while Becker’s [12] work suggests early harsh sanctions will reduce crime, Ostrom [30] recommends graduated sanctions for shared resources.

Further, the classic theory of supply and demand [58] suggest that scarce future water supply from climate change impacts will result in lower seasonal allocations to irrigation and environmental users driving higher water allocation/entitlement (i.e., permanent right) market prices, increasing motives to steal water. Evidence for this association has already been identified in countries such as Spain, Australia and the United States [8]. Validation models to inform optimal deterrence and compliance measures remain absent from the sustainability literature [59]. Harsher penalties may diminish cooperation [60], with graduated sanctions encouraging compliance [61]. However, despite useful evidence in support of graduated water sanctions historically [in ancient Spain for example according to 57] lenient sanctions violate Laffont’s [62] compliance-cost calculus framework, which seeks to limit rents captured by agents by imposing profit-reducing or performance worsening outcomes; that is, harsher penalties.

High water allocation prices may also undermine the effectiveness of fixed penalties where the value of water productively or on the market may far exceed any financial burden from being caught stealing. This reinforces the need to incorporate the often rapid and dynamic context for water supply and demand where sanctions established in normal supply-demand states (i.e., high probability of occurrence and experience by all users) may underestimate the rents that can accrue during scarcity events (i.e., drought events with a higher probability of theft incentives). As such, Morrison [63] argues optimal court systems penalize contract breaches (e.g., actions that ignore delivery constraints and legal extraction conditions) by imposing fines equal to the legal harm done, but establishing that harm is never straightforward. The complex nature of this topic area and the identification of a suitable framework required an application of three methods as follows:

1. An updated review of changes to State water theft legislation, sanctions, and penalty-setting mechanisms using Bricknell [1] as a format to replicate using recent case history (mostly from NSW) for outcome details. A review of water theft legislative provisions was last conducted by Bricknell [1] as part of a larger exploration of environmental crime, providing a useful template for us to follow and update.
2. A practical understanding of the penalty setting process for water theft cases and what factors are considered, if available. Given the theoretical advantages to theft harm assessment from higher severity, coupling those penalty setting criteria to allocation and water market price data to establish a historic compilation of non-zero value annual State water allocation data [see for example 42] and linked market prices from the national Bureau of Meteorology water resources database [7] for sMDB areas. This allows us to calculate weighted average prices under different state of nature outcomes (i.e., dry versus normal supply conditions). We can then test if the application of a weighted average State water allocation price at the time of the offence would be valid for setting commercial and environmental harm values and practical evidence for increased severity where warranted.
3. Simple modelling of expected climate change reductions to runoff levels in the sMDB via publicly-available modelling platforms [64, 65] and previous climate change impacts assessments for and by the Garnaut Review [43, 44] to provide a perspective on the urgency of legislative consistency. This last analytical approach is critical because, while it may be easy to blame climate change for harm to the environment, Raju et al. [66] argue there is more likely to be an association between climate change impact vulnerability and a propensity for ecosystems to be harmed via illegal activity.

**References**

1. Bricknell, S., *Environmental crime in Australia.* AIC reports. Research and Public Policy series., 2010: p. xviii.

2. White, R., *Water theft in rural contexts.* International Journal of Rural Criminology, 2019. **5**(1): p. 140-159.

3. Cochran, J.C., et al., *Court Sentencing Patterns for Environmental Crimes: Is There a “Green” Gap in Punishment?* Journal of Quantitative Criminology, 2018. **34**(1): p. 37-66.

4. NRAR. *Compliance and enforcement activities | April - June 2023*. 2023 [cited 2023 21 August]; Webpage]. Available from: <https://www.nrar.nsw.gov.au/progress-and-outcomes/qrt-reports/quarterly-reports-april-june-2023>.

5. Australian Labor Party. *Labor's Five-Point Plan to Safeguard the Murray-Darling Basin*. 2022 [cited 2023 19 July]; Policy pamphlet]. Available from: <https://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22library%2Fpartypol%2F8519504%22>.

6. Alexandra, H., *Water laws have more loopholes than a monopoly board: regulator*, in *Sydney Morning Herald*. 2023, Nine Entertainment Company: Sydney, NSW.

7. BoM. *Australian Water Outlook: National hydrological projections*. 2022 [cited 2022 16 January]; Available from: <https://awo.bom.gov.au/>

8. Loch, A., et al., *Grand theft water and the calculus of compliance.* Nature Sustainability, 2020. **3**: p. 1012-1018.

9. Kohlberg, L., *Essays on moral development: The psychology of moral development (Vol. 2)*. 1984, San Francisco: Harper & Row.

10. Akers, R.L., *Deviant behavior: A social learning approach*. 1973, Belmont CA: Wadsworth.

11. Tyler, T.R., *Why People Obey the Law: Procedural Justice*. 1990, London: Yale University Press.

12. Becker, G.S., *Crime and punishment: An economic approach.* Journal of Political Economy, 1968. **76**: p. 169-217.

13. Dib-Slamani, H., G. Grolleau, and N. Mzoughi, *Is theft considered less severe when the victim is a foreign company?* Strategic Change, 2021. **30**(5): p. 501-504.

14. Weissing, F. and E. Ostrom, *Irrigation Institutions and the Games Irrigators Play: Rule Enforcement without Guards*, in *Game Equilibrium Models*, R. Selten, Editor. 1991, Springer: Berlin. p. 188-262.

15. Holley, C. and D. Sinclair, *A New Water Policy Option for Australia? Collaborative Water Governance, Compliance and Enforcement and Audited Self-Management.* Australasian Journal of Natural Resources Law and Policy, 2014. **17**(189-216).

16. Bretreger, D., et al., *Remote sensing’s role in improving transboundary water regulation and compliance: The Murray-Darling Basin, Australia.* Journal of Hydrology X, 2021. **13**: p. 100112.

17. Mallawaarachchi, T., et al., *Water allocation in Australia's Murray-Darling Basin: managing change under heightened uncertainty.* Economic Analysis and Policy, 2020. **66**: p. 345-369.

18. Loch, A., et al., *Markets, mis‐direction and motives: A factual analysis of hoarding and speculation in southern Murray–Darling Basin water markets.* Australian Journal of Agricultural and Resource Economics, 2021. **65**(2): p. 291-317.

19. De Stefano, L. and E. Lopez-Gunn, *Unauthorized groundwater use: institutional, social and ethical considerations.* Water Policy, 2012. **14**(S1): p. 147-160.

20. Trawick, P.B., *Successfully governing the commons: Principles of social organization in an Andean irrigation system.* Human Ecology, 2001. **29**(1): p. 1-25.

21. Castilla-Rho, J., et al., *Sustainable groundwater management: How long and what will it take?* Global Environmental Change, 2019. **58**: p. 101972.

22. Grafton, Q. and S. Wheeler, *Economics of Water Recovery in the Murray-Darling Basin, Australia.* Annual Review of Resource Economics, 2018. **online**.

23. Wheeler, S.A., et al., *The rebound effect on water extraction from subsidising irrigation infrastructure in Australia.* Resources, Conservation and Recycling, 2020. **159**: p. 104755.

24. Marshall, G.R. and J. Alexandra, *Institutional path dependence and environmental water recovery in Australia's Murray-Darling Basin.* Water Alternatives, 2016. **9**(3): p. 679.

25. IGWC, *Compliance and enforcement across the Murray–Darling Basin*. 2022, Inspector-General of Water Compliance: Canberra, ACT.

26. Page, J. and A. Pelizzon, *Of rivers, law and justice in the Anthropocene.* The Geographical Journal, 2022. **00**: p. 11.

27. O'Donnell, E. and J. Talbot-Jones, *Creating legal rights for rivers: lessons from Australia, New Zealand, and India.* Ecology and Society, 2018. **23**(7).

28. Pérez-Blanco, C.D. and C.M. Gómez, *Insuring Water: A Practical Risk Management Option in Water-Scarce and Drought-Prone Regions?* Water Policy, 2014. **16**(2): p. 244-263.

29. Pittock, J., et al., *A review of the risks to shared water resources in the Murray–Darling Basin.* 2023. **27**: p. 1-17.

30. Ostrom, E., *Governing the commons: the evolution of institutions for collective action*. 1990, Cambridge: Cambridge University Press.

31. NRAR, *Regulatory policy*. 2021, Natural Resources Access Regulator: Sydney, NSW.

32. Australian Parliament, *Water Legislation Amendment (Inspector-General of Water Compliance and Other Measures) Bill 2021*. 2021, Parliament of Australia: Canberra, ACT.

33. Farrow, K., G. Grolleau, and L. Ibanez, *Social norms and pro-environmental behavior: A review of the evidence.* Ecological Economics, 2017. **140**: p. 1-13.

34. Holley, C. and D. Sinclair, *Water extraction in NSW: Stakeholder views and experience of compliance and enforcement.* CWI at <http://www>. water. nsw. gov. au/waterlicensing/compliance, 2015.

35. Hovi, J., C.B. Froyn, and G. Bang, *Enforcing the Kyoto Protocol: can punitive consequences restore compliance?* Review of International Studies, 2007. **33**(3): p. 435-449.

36. Greiner, R., et al., *Reasons why some irrigation water users fail to comply with water use regulations: A case study from Queensland, Australia.* Land Use Policy, 2016. **51**: p. 26-40.

37. Earnhart, D. and L. Friesen, *Certainty of punishment versus severity of punishment: enforcement of environmental protection laws.* Land Economics, 2023. **99**(2): p. 245-264.

38. Sorensen, J., et al., *Capital punishment and deterrence: Examining the effect of executions on murder in Texas*, in *Experiencing Social Research*. 2020, Routledge. p. 197-212.

39. Hanemann, W.M., *The economic conception of water*, in *Water crisis: Myth or reality?*, P. Rogers and R. Llamas, Editors. 2006, Taylor & Francis: New York.

40. IGWC. *Inspector-General of Water Compliance*. 2023 [cited 2023 8th May]; Available from: <https://www.igwc.gov.au/>.

41. BoM. *Water Information - Water Dashboards*. 2020 [cited 2020 12 February]; Available from: <http://www.bom.gov.au/water/dashboards/#/water-storages/summary/state>.

42. DELWP. *Victorian Water Register*. 2020 [cited 2020 21 February]; Available from: <https://waterregister.vic.gov.au/>.

43. Garnaut, R., *The Garnaut climate change review: Final report*. 2008, Cambridge: Cambridge University Press.

44. Quiggin, J., et al., *Garnaut Climate Change Review: The Implications for Irrigation in the Murray-Darling Basin*, Risk and Sustainable Management Group, Editor. 2008, School of Economics, University of Queensland: Brisbane.

45. Loch, A. and D. Adamson, *Water challenges in a drying World*, in *Global sustainability education and thinking for the 21st century*, M. John, Editor. 2023, Taylor and Francis Publishing: Perth, WA. p. 12.

46. Hanemann, W.M., *The Problem of Water Markets*. 2022, Oxford University Press.

47. Dixon, P., M. Rimmer, and G. Wittwer, *Saving the southern Murray-Darling Basin: The economic effects of a buyback of irrigation water.* Economic Record, 2011. **87**(276): p. 153-168.

48. Garrick, D., *Water allocation in rivers under pressure*. 2015, Cheltenham: Edward Elgar Publishing.

49. Perez-Blanco, D., *Tackling water theft: Forecasting adaptation surprises*. 2023, European Research Council, Consolidator Grant Program: European Union, Australia, United States.

50. O’Donnell, A.J., et al., *Megadroughts and pluvials in southwest Australia: 1350–2017 CE.* Climate Dynamics, 2021: p. 1-15.

51. MDBA, *Water Act 2007 - Basin Plan*. 2012, Murray-Darling Basin Authority: Canberra.

52. Loch, A. and D. Gregg, *Salinity management in the Murray-Darling Basin: a transaction cost study.* Water Resources Research, 2018. **54**(11): p. 8813-8827.

53. *Natural Resources Access Regulator v Maules Creek Coal Pty Ltd*, in *NSWLEC (per Pain J.)*. 2021, NSWLEC. p. 184.

54. *Grant Barnes, Chief Regulatory Officer, Natural Resources Access Regulator v O’Haire*, in *NSWLEC (per Pepper J)*. 2020, NSWLEC p. 116.

55. DEE, *Supplementary submission to the House of Representatives inquiry into the management and use of Commonwealth Environmental Water*. 2018, Australian Department of Environment and Energy: Canberra, ACT.

56. NSW Parliament, *Water Management Act*. 2000: Sydney.

57. Donna, J.D. and J.-A. Espin-Sánchez, *Water theft as social insurance: south-eastern Spain, 1851-1948.* Economic History Review, 2021. **74**(3): p. 721-753.

58. Inoua, S. and V.L. Smith, *The classic theory of supply and demand*, in *ESI Working Papers*. 2020, Economic Science Institute, Chapman University: Orange, CA. p. 43.

59. Keane, A., et al., *The sleeping policeman: understanding issues of enforcement and compliance in conservation.* Animal Conservation, 2008. **11**(2): p. 75-82.

60. Ray, I. and J. Williams, *Locational asymmetry and the potential for cooperation on a canal.* Journal of Development Economics, 2002. **67**: p. 129-155.

61. Ostrom, E., *A general framework for analyzing sustainability of social-ecological systems.* Science, 2009. **325**(5939): p. 419-422.

62. Laffont, J.-J., *The new economics of regulation ten years after.* Econometrica, 1994. **62**: p. 507-507.

63. Morrison, R., *Efficient Breach of International Agreements.* Denv. J. Int'l L. & Pol'y, 1994. **23**: p. 183.

64. CSIRO. *Climate change in Australia: Projections for Australia's NRM regions*. 2017 [cited 2020 15th January]; Available from: <https://www.climatechangeinaustralia.gov.au/en/support-and-guidance/faqs/eight-climate-models-data>.

65. CSIRO. *Australian climate futures*. Climate change in Australia: Climate information, projections, tools and data 2021 [cited 2021 30 Sept]; Available from: <https://www.climatechangeinaustralia.gov.au/en/projections-tools/climate-futures-tool/introduction-climate-futures/>

66. Raju, E., E. Boyd, and F. Otto, *Stop blaming the climate for disasters.* Communications Earth & Environment, 2022. **3**(1): p. 1.

**Table 1:** Summary of relevant MDB water theft legislation, sections, penalties, and changes over time (2008 to 2023): June 2023 values

|  |  |  |  |
| --- | --- | --- | --- |
| **MDB State/Federal** | **Act and associated selected theft offences** | **Changes to maximum penalty:** | |
| **2010** | **2023** |
| QLD | *Water Act 2000* (QLD) |  |  |
|  | Unauthorised taking, supplying, or interfering with water (s 808(1)(2)) | $172,203 | $257,742 |
|  | Taking water without an operator’s licence (s 820) | $103,425 | $154,800 |
| NSW | *Water Act 1912* (NSW) |  |  |
|  | Failure to comply with licence conditions (s 17B(1c)) | $15,169 (I) $30,338 (C) | $11,000 (I) $22,000 (C) |
|  | *Water Management Act 2000* (NSW) |  |  |
|  | Taking water without, or otherwise authorised by, an access licence (s 60A) | $1,516,900 or 2 years prison (I) $3,033,800 (C) | $1,100,000 or 2 years prison (I) $5,005,000 (C) |
| ACT | *Water Resources Act 2007* (ACT) |  |  |
|  | Unlicenced taking of surface or ground water (s 77A) | $7,585 or 6 months prison (I) $37,223 or 12 months prison (C) | $8,000 or 6 months prison (I) $40,500 or 6 months prison (C) |
| VIC | *Water Act 1989* (VIC) |  |  |
|  | Unauthorised taking of water from a waterway, aquifer, spring or soak, or dam in a declared water system (s 33E) | $9,384 or 6 months prison (I) $18,768 or 12 months prison (C) | $230,772 or 10 years prison (I) $1,153,860 (C) |
|  | Unauthorised taking of water from a waterway, aquifer, spring or soak, or dam in an undeclared water system (s 63(1)) | As above. | As above. |
| SA | *Landscape South Australia Act 2019* (SA) |  |  |
|  | Unauthorised, unallocated, or unentitled taking of water from a prescribed watercourse, lake or well or take surface water from a surface water prescribed area (ss. 104(1)(a) and ss. 104(7)) | $48,265 (I) $96,530 (C) (under *Natural Resources Mgmt. Act 2004* (SA)) | $25/kilolitre of water taken or $50,000 (I) / $100,000 (C), whichever is greater |
| Cth | *Water Act 2007* (Cth) |  |  |
|  | Taking water from a water resource for which a water resource plan for the area applies and that taking of water would constitute a contravention of the law of a State if any fault element or state of mind requirement were to be satisfied in relation to the taking of the water (s 73A) | $91,014 (I) | $56,340 (I) fault-based law $313,000 (I) non-fault law  $3,130,000 (C) non-fault law |
|  | As above, but penalty change if any of the following circumstances exist e.g., a tier 3 water sharing arrangement is in place; the water is taken downstream from where environmental watering was being held; the taking of the water significantly contributes to environmental harm; or water was taken from a wetland that is protected under Commonwealth or State law (s 73B). | As above. | $1,560,000 (I) non-fault law for taking environmental water $15,650,000 non-fault law for taking environmental water |

Notes: (I) indicates penalty applied for individuals and (C) indicates penalty applied for corporations, where relevant.



Table 2: MDB regulated river system final annual water allocations, 2004/05 to 2021/22. Colours denote full allocation (green) to zero allocation (red).



Table 3: Weighted average water allocation market prices, by MDB major state trade zones 2008/09 to 2021/22. Colours denote low (green) to high (red) prices in real values for each year.

1. For examples see: Natural Resources Access Regulator v Maules Creek Coal Pty Ltd [2021] NSWLEC 135 (per Pain J) at [260]; Grant Barnes, Chief Regulatory Officer, Natural Resources Access Regulator v Henry Payson Pty Ltd [2023] NSWLEC 5 (Pepper J) at [202]-[206]. [↑](#footnote-ref-1)
2. See Water Management Act 2000 (NSW) Section 364A; Crimes (Sentencing Procedure) Act 1999 (NSW) Sections 3A, 21A(2)(g), 21A(2)(o), 21A(2)(m). [↑](#footnote-ref-2)