

Integrating stakeholder perspectives and attitudes to flood impacts in inland rivers

Michael C. Rupić¹, Tim J. Ralph²

¹ Macquarie University, School of Natural Sciences, Sydney, NSW, 2019. Email: michael.rupic@hdr.mq.edu.au

² Macquarie University, School of Natural Sciences, Sydney, NSW, 2019. Email: tim.ralph@mq.edu.au

Key Points

- Major floods in 2016 and 2022 led to the formation and rearrangement of debris rafts on the lower Macquarie/Wambuul River in NSW, which contained logs, branches, and rubbish from upstream.
- Stakeholders expressed concerns about these rafts, but not all were in agreement about the broader impacts and response.
- Media discourse focused on themes of water diversion, wildlife impacts, and pollution levels, while community discourse focused on themes of ecological sustainability and resilience-building.
- NSW government intervention was required to address the environmental issues stemming from the secondary impacts of flooding related to the debris rafts.

Abstract

Major floods in 2016 and 2022 led to debris rafts forming on the lower Macquarie/Wambuul River, NSW. The rafts contained logs, branches, and rubbish from upstream. Stakeholders were vocal about their concerns, but not all were in agreement about broader impacts and responses. News articles and social media posts followed. NSW government agencies are involved, but the matter is still unresolved. The debris rafts illustrate the need for the integration of different approaches to prepare for, respond to, and recover from such events. As part of this study, a literature review of responses to flood hazards and risks, surveys of maps, photographs, and assessment of news articles and social media responses to these flooding events were conducted. A series of word clouds, as well as a framework of responses, were developed to explain the main discourses. Maps and photos show that the debris rafts have been relatively stable, since the most recent flood event in 2022. The rafts that have become bedded down (rafts 4 and 7) pose greater risk of erosion and water diversion, which were themes of media discourse, along with wildlife and pollution impacts. While the government takes time in its efforts to respond to events, this may not be in alignment with other stakeholder timelines or wishes. However, appropriate communication, consultation, and agreement on preliminary actions (e.g., scientific surveys) can be useful to better integrate community perspectives. Targeted communication and consultation regarding flood impacts and associated issues is needed to move collectively towards the development of long-term strategies for holistic and adaptive management, conservation, and sustainable use of rivers and wetlands.

Keywords

Flood debris, community responses, risk and resilience, environmental discourse, natural resource management

Introduction

Water management and natural flows and floods are critical to the health of ecologically significant inland rivers and wetlands such as the Macquarie Marshes. Yet, extreme events and river flooding can have significant negative impacts on environmental systems and their urban and rural communities. According to McMartin et al. (2017), the short- and long-term effects of river flooding on local communities include the following: health and wellbeing impacts, economic and livelihood impacts, and environmental impacts.

Flooding can have long-term mental health impacts on communities, causing stress, trauma, and chronic illnesses. Vulnerable populations like the elderly and disabled are often less able to cope and recover. Contaminated flood waters can lead to waterborne illnesses, even after the flood has receded (Westling et al., 2014). Disruption to critical infrastructure like hospitals, water treatment, and transportation can have lasting effects on community health and access to services.

Vardoulakis et al. (2022) explains that flooding can destroy homes, businesses, crops, livestock, and other assets, setting back economic development and pushing communities deeper into poverty. Damage to public infrastructure like roads, bridges, and utilities can have significant long-term impacts on regional and national economies. Flooding in agricultural areas can reduce crop yields and disrupt food supplies, leading to higher prices and food insecurity. Loss of livelihoods and reduced purchasing power can leave communities economically vulnerable long after a flood event.

Contamination of water supplies and ecosystems by floodwaters can have lasting environmental consequences. Damage to natural flood defences, such as riverbanks and wetlands, can increase future flood risk. Flooding can also have some positive long-term environmental impacts, like recharging water resources and rejuvenating soil fertility.

The flooding of the Macquarie Marshes has been of primary concern to the communities of northwestern New South Wales (NSW) for decades. Heavy rainfall during the 2016 and 2021-22 seasons caused minor to major flooding along the Macquarie/Wambuul River and its tributaries, the majority of which experienced major flooding (Poff et al., 2017). Major flooding was also observed in downstream towns of Dubbo, Narromine, and Warren. The flooding of the Macquarie Marshes has been a significant factor in community vulnerability and resilience to climate change-related impacts.

The aim of this paper is to explore the secondary impacts of riverine flooding on local communities, including the long-term social, economic, and environmental consequences stemming from changes to the river. This topic is explored through a case study of flooding of the Macquarie/Wambuul River throughout 2016 to 2022, particularly the impacts of wood-dominated debris rafts in the river near Warren. The paper also provides insights for policymakers and practitioners on how to support and empower local communities to better prepare for, respond to, and recover from, flood events.

Literature Review

Impacts of Floods on Communities

Community responses to flooding events in Australia have garnered significant attention due to the country's vulnerability to floods and the increasing frequency of such events over the past decades (Hromadka & Rao, 2017). The impact of floods on Australian communities has been substantial, with floods resulting in personal injury, death, and significant economic costs (Yan & Liu, 2016). The emergency response system in Australia has been successful in saving lives during flood events, highlighting the importance of effective disaster management strategies (Nafari et al., 2016).

Research has shown that Australia is already experiencing the effects of climate change, including higher temperatures and more frequent and severe droughts, which contribute to the increased risk of flooding (McAlpine et al., 2009). The association of El Niño with drought and La Niña with floods in Australia further complicates flood risk management efforts (Gamble et al., 2017). Studies have also examined the social and political capacities of communities in Australia, particularly in regions like NSW, in response to major flooding events, emphasizing the need for community engagement and effective response strategies (McMartin et al., 2017).

The resilience, vulnerability, and adaptive capacity of Australian communities have been studied in the context of climate change adaptation and flood risk management (Keogh et al., 2011). The importance of mental health and wellbeing following flood events in rural Australia has been highlighted in the literature, underscoring the need for comprehensive approaches to address the psychological impacts of floods on communities (Longman et al., 2019). Additionally, the media plays a crucial role in framing discussions around flood events, as seen in the analysis of themes of resilience in the aftermath of these events (Bohensky & Leitch, 2013).

Flood Debris Rafts

In the case of the Macquarie/Wambuul River, flooding from 2016 to 2022 has led to large accumulations of woody debris, including logs and branches, as well as rubbish such as plastic bottles, chemical drums, fridges, and tyres, forming several large rafts that are blocking parts of the river. These debris rafts are causing concerns about erosion of the riverbanks, as the water is forced to flow around the blockages, as shown in Figure 1. There are also concerns that the debris rafts could potentially divert the course of the Macquarie/Wambuul River, which would disrupt local farming activities and potentially could deprive sections of the lower Macquarie/Wambuul River of water.

The debris accumulation and altered river flows could negatively impact the aquatic community of the Macquarie/Wambuul River, which is listed as an endangered ecological community. Certain types of wood, like willow logs, are more prone to floating and binding together to form these problematic rafts, compared to native timbers that tend to sink and create better fish habitat. The large woody debris blockages are impeding light from reaching significant stretches of the river, which can spook and deter fish from swimming through. Other pressures include river regulation, destruction of habitat, agricultural and urban runoff, introduced species, and the impacts of climate change, such as more frequent and severe droughts and floods. These pressures have contributed to the overall deterioration of freshwater fish communities in the Murray-Darling Basin, including the Macquarie/Wambuul River.

Raft 1 – December 2022 (Photo: Bron Powell)



Raft 7 – December 2022 (Photo: Bron Powell)



Raft 4 – December 2023 (Photo: Tim Ralph)



Raft 4 – December 2023 (Photo: Tim Ralph)



Figure 1. Debris rafts in Macquarie/Wambuul River in December 2022-23.

Study Area

The Macquarie Marshes is a large, semi-arid floodplain wetland system located in central western NSW, Australia. The marshes are situated on the lower floodplain of the Macquarie/Wambuul River, approximately 100 km north of the town of Warren (Figure 2). The Macquarie Marshes Ramsar site, which is part of the greater Macquarie Marshes area, comprises four major sections: (1) the northern nature reserve section; (2) the southern nature reserve section; (3) the private property “Wilgara;” and (4) the private property “U-block.” The channel of the Macquarie/Wambuul River leading to the marshes is highly sinuous, and in places has several branches and distributary channels that share flow with the main channel. Wetlands are fed by overbank and floodout flows from the primary and secondary channels.



Figure 2. Map of debris raft locations on the Macquarie/Wambuul River near Warren, NSW, as of June 2023. Proceedings of the 11th Australian Stream Management Conference, 11-14 Aug, 2024, Victor Harbor, SA.

The lower Macquarie/Wambuul River and the Macquarie Marshes support a diverse aquatic ecological community and contain a variety of wetland types, ranging from semi-permanent and frequently inundated marshes to ephemeral wetlands inundated only by the largest floods. The Macquarie Marshes have numerous endangered and vulnerable species listed under the Environment Protection and Biodiversity Conservation Act 1999, such as the Australian Painted Snipe, Australasian Bittern, and Murray Cod (Docker & Robinson, 2014). The core areas of semi-permanent wetlands within the nature reserve include river red gum forests, woodlands, and common reed beds fed by overbank flooding from numerous small channels.

Prioritising the delivery of environmental water to support the ecological functions and values of the Macquarie Marshes is an ongoing challenge (Poff et al., 2017), especially since the planning and delivery of Commonwealth environmental water undertaken in coordination with various stakeholder groups.

Methods

As outlined in Table 1, this study employed a mixed methods approach to provide insight into not only *what* topics people talk about, but also *how* people talk about them (Wankhade et al., 2022). Analysis was undertaken using two widely used text analysis techniques: sentiment analysis, which is a technique that helps identify the underlying sentiment (positive, neutral, and/or negative) of text responses, and ; topic detection/categorisation, which is a technique that groups (i.e., buckets) similar themes into categories. These methods involved a query using artificial intelligence (AI) - OpenAI GPT-4o to analyse text from each of the news/media articles and NSW EPA press releases for the following criteria: (a) most used adjectives (i.e., keywords) within text: positive, negative; and (b) general sentiment (i.e., tone) of text: positive, negative, neutral.

Table 1. Summary of methods

Method	Description
Literature Review	A comprehensive literature review was conducted to examine the existing research on responses to flood hazards and risks (what had been published on this topic before this event). This involved surveying academic publications, reports, and other relevant sources to understand the current state of knowledge in this domain (to establish the primary dialogues that emerged from this event).
Media and Social Media Analysis	The study entailed a thorough assessment of news articles and social media responses related to the flooding events. This allowed for the identification of the main discourses and themes emerging from the public and media discussions around the flooding impacts, including wildlife, pollution, and government response. The study generated a series of word clouds, which helped visualise the frequently used words throughout these texts.
Framework Development	The study developed a conceptual framework to explain the main discourses and stakeholder perspectives surrounding the flooding events and responses. This framework aimed to integrate the insights gained from the literature review, mapping and photographic assessment, and media/social media analysis.

Results and Discussion

The media search and the AI query produced the following results (Table 2), indicating the potential influence of media discourse on community perceptions.

Coverage of Events, Keywords, and Dialogues

The results from this search contrast positive keywords like “optimism,” “resilience,” and “perseverance” with negative ones such as “disaster,” “hazardous,” and “misconception” commonly found in news headlines. This

juxtaposition highlights how media outlets use language to evoke emotional responses and frame stories, potentially influencing public perception and engagement with news content.

Table 2. Timeline of media (news outlets + social media) headlines.

Date	Headline	Keywords	Source
News/Media Articles			
August 2019	Flood concerns as war on willows leaves major river clogged	N/A	The Land
September 2022	700 metres of rubbish: farmers grapple with choked rivers amid Australia’s third La Niña	Positive: beautiful, resilience, optimism, perseverance, resourcefulness, acknowledge, responsible, critical, difference, community Negative: disaster, extreme, draining, disconnect, wiped out, knock, anaerobic, erosion, uneven, misconception	The Guardian
September 2022	Macquarie Marshes flooded in ‘wettest period in living memory’ as farmers face mounting losses	Positive: N/A Negative: longest, wet, flooded, significant, several, wetter, average	ABC News
February 2023	Macquarie River blocked in stretches as flood-time debris accumulates	Positive: important Negative: unprecedented, large, mess, forced, erode, gouged out, exacerbated, dark, significant	ABC News
March 2023	Drought and flooding rains: the Murray-Darling Basin water rights balancing act	Positive: critical, healthy, thriving, big, large Negative: struggling, declined, browning, dreadful, small	The Guardian
June 2023	Next steps for lower Macquarie River rafts	Positive: leading, good, positive Negative: pending, rapid, ominous	Western Plains
June 2023	Removal planned as unwanted ‘rafts’ clog Macquarie River	Positive: valuable, native Negative: unprecedented, ongoing, threatening, fixed, hazardous, exotic, dark, big	Western Plains
June 2023	Macquarie River Raft Management Update	Positive: safe, additional, ongoing, complex Negative: hazardous, manmade, exotic	Mirage News
August 2023	Largest bird-breeding in decades as water for the environment flows	Positive: rejuvenate, revitalising, increased, widespread, large-scale, natural, critical, complementary, best Negative: poor	Australian Government, Department of Climate Change, Energy, the Environment and Water
December 2023	Floods and environmental flows a boon for south-east Australia’s waterbirds, survey shows	Positive: widespread, significant, critical, strengthened, lift, healthier, sustainable, long-term Negative: decline, decreased, less, little, lower, drying out, below average, decreased considerably	The Guardian

March 2024	Raft removal set to start	Positive: ready, native, clean-up, natural, overall, biggest Negative: clogging, dark, human-made, big, impacting	Coonamble Times
NSW EPA Press Releases			
June 2023	Update on management of Macquarie River rafts	Positive: safe, additional, ongoing, complex Negative: hazardous, manmade, exotic	NSW EPA
March 2024	Removal works on all Macquarie River rafts to begin soon	Positive: ready, clean-up, native, assist, preserving, aquatic Negative: N/A	NSW EPA

Figure 3 visually represents the frequency of positive and negative keywords used in news headlines, with larger text indicating more commonly used terms. The positive cloud likely features words like “critical,” “healthier,” and “widespread,” in more prominent sizes, while the negative cloud emphasizes terms such as “hazardous,” “manmade,” and “unprecedented,” in less prominent sizes, offering a stark comparison of how media outlets frame stories to evoke different emotional responses.

a) Positive keywords



b) Negative keywords



Figure 3. Word cloud of (a) positive keywords and (b) negative keywords amongst sources assessed in this study.

The discourses that have been emerging from these headlines emphasise the need for a comprehensive, collaborative, and forward-looking approach to flood risk management that addresses both short-term emergency response and long-term resilience-building (Table 3).

Table 3. Dialogues from media (news outlets + social media) headlines.

Emerging Dialogue	Primary Characteristics
Improving flood preparedness and resilience	<ul style="list-style-type: none"> • The need for accurate and up-to-date flood mapping to better understand risks. • Investing in public and private flood defences to mitigate impacts. • Improving public awareness and education about flood risks to encourage preparedness. • Limiting or restructuring post-disaster financial assistance to incentivize flood mitigation efforts.
Enhancing emergency response and recovery	<ul style="list-style-type: none"> • Strengthening coordination and leadership in flood response, including through governance arrangements and the role of emergency management agencies. • Improving flood warning systems and communication to the public. • Supporting community-led recovery efforts and ensuring affected families receive adequate support.

	<ul style="list-style-type: none"> Addressing housing needs and coordinating reconstruction efforts in flood-impacted areas.
Addressing the growing threat of flooding	<ul style="list-style-type: none"> Recognizing that flooding is becoming more frequent and severe due to climate change, land use changes, and ageing flood infrastructure. Adopting an integrated, multi-stakeholder approach to flood risk management involving national, local, and community actors. Exploring insurance solutions to shift the financial burden of floods away from governments and individuals. Leveraging the role of non-governmental and civil society organisations in flood response and recovery.

Flooding: Lived Experience

Flooding events present significant challenges to communities, necessitating effective responses to mitigate risks and enhance resilience. Community responses to flooding that are shared via media outlets enhance adaptive capacity to flooding through strengthening social capital, as risk perception has been identified as a crucial factor in improving community resilience to flood events (Anderson et al. 2019; Bixler et al., 2021). The media coverage of this event has shown the importance of local responses in empowering communities and enhancing their resilience to future flood events (Dunham et al., 2018; Percival et al., 2020; Vardoulakis et al., 2022). This case study shows the importance of understanding community perceptions in developing effective flood risk management strategies (Postel & Richter, 2013; Wang et al., 2018, Westling et al., 2014). Community responses to floods demonstrate the importance of integrating water management and spatial planning strategies to flood risk management.

According to Anderson et al. (2019), flood events in Australian communities illustrate the deeply rooted connection between human beings and their surrounding environment (i.e., the socio-ecological system) for several reasons:

- i) **Floods pose significant threats to human life and property:** Flooding is one of the most dangerous and destructive natural disasters in Australia, causing a number of fatalities per year. Floods can lead to widespread damage to homes, businesses, infrastructure, and agricultural lands, resulting in billions of dollars in economic losses.
- ii) **Floods have far-reaching environmental and ecological impacts:** Floods can disrupt and degrade natural ecosystems, harming wildlife habitats and biodiversity. However, small, regular floods are also essential for maintaining the health of river systems and replenishing groundwater and soil nutrients.
- iii) **Flood risks are increasing due to climate change:** Climate change is driving more frequent and severe flooding events in Australia through sea-level rise and changes in precipitation patterns.

The responses to these events in news media and on social media platforms highlight the importance of effective flood management that requires community engagement and preparedness. Engaging local communities in flood risk awareness, early warning systems, and resilience-building efforts is crucial for saving lives and minimising damages. Improving public preparedness through education and coordination between authorities and the public can significantly enhance flood response and recovery.

Responses: Where to from here?

Actions have been taken to address environmental issues associated with the debris rafts by the NSW government (led by the Environment Protection Authority; EPA), in response to these events on the Macquarie/Wambuul River. According to the latest update from the EPA, “work to remove debris from the Macquarie River rafts is proceeding well” (EPA 2024). Stable weather has allowed for significant progress to be made on these removal projects, since these efforts have been undertaken. These projects are primarily aimed at removing debris, such as hard and soft plastics, polystyrene, chemical containers, oil drums, and glass bottles from the Macquarie/Wambuul River (EPA 2024). The EPA is continuing to work with the

community and provide regular updates via its dedicated website; however, whether these responses will be sufficient in addressing community concerns has yet to be determined.

Conclusions

The analysis from this project shows the disparity between responses from media versus perceptions of communities in relation to floods in the Macquarie Marshes. Media discourse focused on themes of water diversion, wildlife impacts, and pollution levels, while community discourse focused on themes of ecological sustainability and resilience-building. This diversity in responses is representative of the need to integrate stakeholder perspectives and attitude to flood impacts during the environmental planning process.

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