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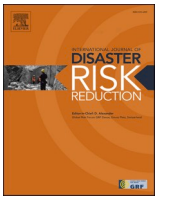

Bridging gaps between disaster risk reduction and drowning prevention

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ABSTRACT

Drowning is a form of silent and neglected disaster. Hundreds of thousands die every year from drowning, with cumulated fatalities surpassing that of large-scale disasters. However, research on drowning is largely absent from disaster studies and global and national disaster risk reduction policy frameworks rarely mention drowning risk and the related strategies for strengthening water safety. Drowning is mainly framed as a public health issue being studied predominantly by scholars from injury prevention, public health, and medicine. This paper argues that both disaster studies and disaster risk reduction policies have a critical role to play in progressing drowning prevention. It reviews the existing drowning literature and highlights trends, challenges, and opportunities to bridge gaps in knowledge, policy, and practice for reducing drowning risk. The article highlights the strong conceptual underpinnings that characterize both the disaster risk and drowning fields, the need for data sharing, the potential for community-approaches to drowning risk reduction, and ultimately recommends a more systematic integration of drowning in disaster risk reduction initiatives. The paper ends by underlining some of the barriers and requirements to foster collaboration between the disaster risk domains and drowning prevention.

1. Introduction

The dominant focus in disaster research is on large-scale disasters. The 2004 Boxing Day tsunami in the Indian Ocean, the 2005 Hurricane Katrina in the United States, the 2011 earthquake and tsunami in Japan, and the 2015 Earthquake in Nepal are over-represented in peer-reviewed publications compared to disasters of lower magnitude [1]. Policy frameworks for disaster risk reduction (DRR) at the global, regional, and national levels concentrate mainly on rare and extreme events supported by evidence from academic research and government agencies' reports on losses and damages. Small-scale disasters, in turn, get little attention from the media, are under-researched by disaster scholars and struggle to garner consideration from policy makers and practitioners involved in DRR. Such events, nevertheless, can be devastating, with long lasting and compounding effects, often impacting those already vulnerable and marginalised [2]. Small-scale disasters have thus been called invisible, silent, and neglected, with several academics and practitioners advocating for greater attention to small-scale events and their lingering effects [3,4].

Drowning seems to fall in the category of small-scale, recurrent, and neglected disasters. Drownings might include one to several fatalities per 'event', but their cumulative impacts are enormous. In 2021, over 236,000 people died from drowning globally; this represents 27 people drowning every hour [5]. The political awareness of the need to address the burden of drowning resulted in a UN resolution signed in 2021 [6]. Drowning can occur on coastal beaches, rivers, lakes, estuaries, wetlands, harbours or during floods (not

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an exhaustive list) [7]. Statistics on drowning indicate that children, the poor, males, and ethnic minorities are disproportionately affected, although these patterns can vary from one country to another. Fatalities often result from environmental conditions coupled with factors like age, gender, ethnicity, socio-economic level, local knowledge, swimming skills, and the availability of rescue services [8,9]. The risk of drowning thus involves a combination of exposure to a hazard, vulnerability, and limited capacities – concepts that are well-known in disaster studies. Importantly, drowning is preventable [5].

Research on drowning is almost non-existent in disaster studies and is absent from the DRR policy frameworks, which rarely, if at all, mention drowning risk and related strategies for increasing water safety. A few scholars have emphasised the connections between drowning prevention and the disaster fields [10,11,12], yet drowning prevention is generally framed as a global health issue and is studied mainly by scholars from injury prevention, public health, and medicine [13]. This paper argues that drowning prevention should not be confined to such fields. Both disaster studies and DRR policies have a critical role to play in progressing drowning risk reduction while drowning knowledge in DRR can also help progress the disaster risk domain. The paper aims at bridging the gaps between DRR and drowning prevention in policy, research, and practice. The following section defines drowning and reviews its diverse impacts. Section 3 explores who is prone to drowning and why. Section 4 examines the dominant policy and practice geared towards drowning prevention, while section 5 focuses on existing drowning prevention research, highlighting trends, gaps, and challenges. It is followed by section 6, which discusses the potential contribution of disaster scholars and policies to reduce drowning risk – calling for more collaborations across fields to tackle the issue.

2. Understanding drowning hazards and their impacts

Drowning is defined as "the process of experiencing respiratory impairment from submersion/immersion in liquid: the outcomes are classified as death, morbidity and no morbidity" (Van Beeck et al. ([14]:853). It is well-recognised that weather conditions are a risk driver for drowning, including wind velocity and direction, water temperatures, rip currents, rain intensity, tides, water depth, water flow velocity, and sometimes a combination of these [15]. Furthermore, scientists increasingly emphasise that climate change shall contribute to increase drowning risk by influencing both exposure to and behaviour around and in aquatic locations [16]. For example, warmer temperatures generally mean that people spend longer in the water, which potentially leads to more drowning fatalities [17]. Drought and water scarcity may force the poorest households to adopt more risky behaviour to make a living, including more dangerous fishing practices [18] and longer times on boats that might not be suited to certain water conditions [19]. The Global Burden of Disease contends that landlocked nations have lower drowning mortality than countries with coastlines, which tend to present higher risk of drowning [20]. For example, in Iran, 85% of the drowning over a five-year period occurred on coastal waters [21] and 76% of all drowning fatalities occurred in the ocean in Port Elizabeth, South Africa [22]. However, drowning occurrences differ from one country to another, and in some regions, inland waterways pose the main risk of drowning [23,24].

Drowning can be either non-fatal or fatal, with impacts occurring at multiple levels: individual, family, community, and society. The social and psychological impacts can be devastating as they may involve the traumatic experience of witnessing drowning, resuscitation, physical or mental impairment, death, body recovery and grieving. There are also substantial economic costs associated with both non-fatal and fatal drowning [25]. In the United States, the cost associated with drowning represents about US$273 million annually, while in Australia and Canada, the yearly cost linked to drowning is US$85.5 million and US$173 million, respectively [5]. These figures are linked to costs associated with hospitalisation, emergency services, and loss of productivity related to fatal drowning [26]. They do not include the impacts of non-fatal drownings, such as successful rescues and other costs associated with measures developed to prevent drowning. It is estimated that for every fatal drowning, there are between one and four non-fatal rescues that require hospitalisation [27].

There are several gaps and weaknesses associated with data on drowning: it is, for example, recognised that the existing figures do not capture the full extent of drowning. This is mainly due to poor, inconsistent, or even the absence of formal recording systems [8]. Besides, non-fatal drownings are generally unreported since, most of the time, no medical treatment is required [27]. Furthermore, the current statistics exclude drowning deaths resulting from flood disasters, tropical storms, storm surges, and water transport incidents such as when vessels carrying migrants and refugees capsize. These omissions constitute a major gap in drowning data often raised in the existing literature [5]. The size of the drowning burden, both social and economic, is thus likely to be significantly higher, with some claiming it is four to five times the recorded drowning statistics [28]. This has led multiple scholars, practitioners, and policymakers to assert that there is still a poor comprehension of drowning, including who dies, who survives drowning, and why [8,9,29–32].

3. Who is subject to drowning and why?

While exposure to hazards (such as rip currents, lakes, rivers, and floods) is a key driver of drowning risk, increased by climate change effects, it is the social, economic, political, and cultural factors that first and foremost create the conditions for drowning to occur. In total, 91% of drownings occur in low- and middle-income countries (LMICs), where about half of those who die from drowning are under 25 years old [8]. Children are particularly vulnerable to drowning: the drowning rates in LMICs are six times higher than those in high-income countries [33]. It ranks as the 13th leading cause of death among children under 15 years of age, with the 1–4 years age group at greatest risk [28]. The risk factors for children drowning include exposure to water hazards with limited or no preventive barriers, the lack of supervision when children are in or around water, limited awareness of dangers due to their young age, and reduced capacity or non-ability to swim [33,34].

Drowning statistics tend to display gendered patterns. Males are recognised as being at higher risk of fatal drowning, representing about twice the mortality rate of females globally [9]. Figures in Australia, the United Kingdom, and Aotearoa New Zealand indicate

that males account for most coastal drowning fatalities, with 80%, 78% and 87%, respectively [35–37]. This pattern is generally attributed to riskier behaviour in and around the water: males tend to overestimate their water abilities, placing them in particularly vulnerable situations. Studies show that males are more inclined to dangerous water-related practices, alcohol consumption when in or around water, and adopt riskier behaviour when attempting to save others [38,39]. For example, Işın et al. [40] found that in Turkey, males drown almost nine times more frequently than females when trying to rescue others. In Aotearoa New Zealand, between 1987 and 2014, about 80% of the 87 people who drowned while conducting rescue were males [38]. In Australia, a significant percentage of fatalities in river floods was associated with males driving through flooded roads and crossing waterways [41].

The gendered patterns of drowning are not uniform across countries. Who drowns and why is often complex and contextual. Intersecting factors such as social practices, norms, and culture, play a key role in shaping vulnerability to drowning. Thirty years ago, Chowdhury et al. [42] found that during the 1991 cyclone in Bangladesh that triggered floods, women were over-represented in the drowning fatalities. The authors attributed this to women staying in their flooded houses rather than evacuating because of the need to be accompanied by a male relative to leave their home and because it was not culturally appropriate for women to learn to swim, thus increasing considerably the risk of drowning. During the Indonesian tsunami, female mortality was far higher than that of males, largely because of cultural norms making it less likely for girls and women to learn to swim [43]. This pattern has led to several initiatives to reduce female drowning, such as the 'teach a girl to swim' campaign implemented in different countries worldwide.

Socioeconomic status has been shown to influence vulnerability to drowning, as it does with most natural hazard-related disasters. Independent of the country's economic development, drowning regularly affects the poorest and least-educated people who reside around waters and have limited access to resources to safely adapt or deal with the risks they are exposed to. Economic factors may include access to swimming lessons, dangerous practices to make a living, and the lack of safety standards and legislation [32]. Studies show that fatal drowning is disproportionately higher amongst minority populations, including in high-income countries [8]. In Australia, Aboriginal and Torres Strait Islanders, as well as those from culturally and linguistically diverse (CALD) backgrounds, have been identified as being at greater risk of drowning compared with the rest of the population [44]. In Aotearoa New Zealand, Māori, Asian, and Pasifika and "Other ethnicities", display drowning rates at least double that of New Zealand Europeans, with "Other" (representing all other ethnicities) being at least ten times higher than New Zealanders of European origin [37].

Those vulnerable to drowning may nonetheless display capacities to deal with water hazards. The concept of capacities relates to the strengths people possess to prepare for, cope with, and recover from hazards and disasters. Capacities include, but are not limited to, local and/or traditional knowledge, social organizations and solidarity networks, norms, culture, skills, and technology [45]. Capacities also refer to the abilities to access and use resources and thus link to the notions of entitlement and the ability to claim critical resources when needed [46]. Importantly, capacities are not the opposite of vulnerability as those vulnerable can also have strong capacities. For example, poor individuals with no access to formal social security systems and high exposure to natural hazards can also have strong knowledge of their local environment and develop effective mechanisms critical to facing hazards and disasters. Furthermore, capacities can be both individual and collective: everybody holds a unique set of knowledge, resources and skills that are often shared and combined with those of their neighbours, relatives, and community members [47]. While strongly linked, capacities and resilience are different concepts [48]. Strengthening capacities contributes to building individual and community resilience. Building resilience encompasses mitigating hazards, preventing exposure, and reducing vulnerability, alongside enhancing capacities [49,50].

In the drowning prevention literature, the notion of capacities is generally referred to as 'aquatic readiness' or 'water competence', and is recognised as critical in influencing drowning risk. For example, indigenous people, while over-represented in the drowning statistics, often have strong traditional knowledge about waters and their behaviours acquired over centuries of close interactions and connections for their livelihoods [51]. Furthermore, experienced board riders like surfers have strong local knowledge about the ocean and abilities to identify hazardous conditions, with different studies showing they play a critical role in saving lives and drowning prevention [52–54]. Kjendlie et al. ([55]: 243) conceptualised water readiness as dependent on "(a) all-around aquatic skill and competence, (b) knowledge of general and local conditions, (c) an attitude of healthy respect for the elements and for human frailty and human error, and (d) the ability to make correct judgments in risk situations". The authors emphasise that all four elements are critical to preventing drowning and that focusing on one or two attributes is not sufficient. For instance, good swimming skills alone are not enough to prevent drowning, as experienced swimmers still drown.

Drowning risk is thus a combination of exposure to hazardous conditions (such as rip current, flood, heavy rainfall affecting river flow, etc.) coupled with high levels of vulnerability, which is shaped by different elements (such as social, economic, cultural, physical, political, etc.) and limited capacities (such as local environment knowledge, swimming skills, etc.) (Fig. 1). Reducing drowning risk thus requires preventing hazards, reducing vulnerability, and enhancing people's capacities – concepts that are central to the disaster risk domain. The next section examines the dominant strategies developed to reduce drowning risk.

4. Current policies and strategies on drowning

The dominant strategies to prevent drowning have focused on top-down and command-and-control[1] approaches to reduce the dangers associated with water hazards [24,56]. In high-income countries, strategies are commonly centred on attempting to define and

[1] Command-and-control refers to the exercise of authority through a hierarchical chain of command from the top towards the bottom where a situation (i.e. emergency, disaster, etc.) is perceived as chaotic and needs to be controlled [95]. The approach has been criticized for being centralised and rigid, overlooking the capacities of local people and ultimately undermining their resilience [96].

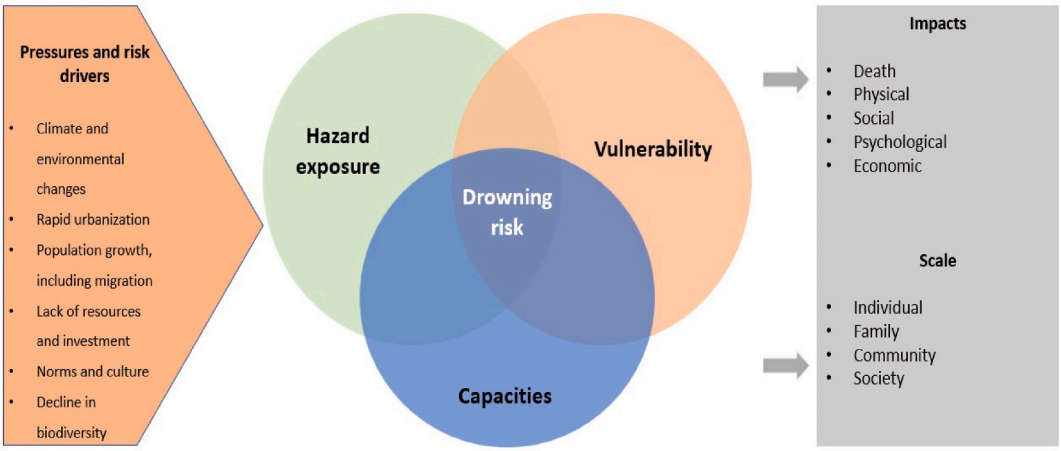

Fig. 1. Drowning risk and its impacts.
Source: Author's own. Note: the pressures and risk drivers of drowning and drowning impacts might extend beyond those listed.

oversee specific areas where it is safe to swim, such as lifeguard supervised zones or flagged patrol areas. Programmes like 'swim between the flags' are applied across many countries worldwide. These generally prove effective in preventing drowning at popular areas where surveillance takes place [37]. However, a major limitation of this approach is that not all locations can be patrolled. The areas that are patrolled only involve surveillance at certain times of the year (i.e., summer) and during specific hours during the day (i.e., morning and afternoon), which constitutes an important gap as most fatal drownings occur outside of patrolled areas and times [57,58].

In LMICs, drowning prevention policies have a strong focus on reducing the unintentional drowning of children and young people [59–61]. This is not surprising since drowning patterns in LMICs indicate a very high mortality rate amongst this population [13]. Strategies often focus on supervision of safe spaces, the use of barriers to restrict access to certain areas, teaching children how to swim, and rescue training. For example, De Buck et al. [60], who assess the effects of day care programmes for children under 6 years in LMICs, find that the roll-out of a formal day care programme, mixed with parental education, use of playpens, and community-based actions are a promising drowning prevention intervention for regions with a high burden of drowning. Rahman et al. [62], who focus on drowning prevention strategies in Bangladesh, highlight that childcare centres and swimming lessons are highly cost-effective interventions that could be replicated in other countries. A number of policy recommendations in rural/remote areas of LMICs emphasise community-based approaches to overcome limited governmental resources. For example, Gupta et al. [63], who review the policies in West Bengal, India, highlight that the training of health volunteers in their community to act as first responders, as well as the self-help group initiatives are highly relevant.

Policies on drowning in coastal waters usually recommend the promotion of educational messaging aimed at raising awareness about hazard risk and foster behavioural change [9,59]. Most frequently, the communication campaigns are linked to strengthening awareness about rip currents (identification of, and escape/survival from rips), swimming in lifeguard supervised areas (i.e., "swim between the flags", "swim in front of a lifeguard"), and raising individuals' awareness about their water abilities (i.e., "know your limits", "wearing a lifejacket", "old4New Coastguard Lifejacket Upgrade"). These strategies are conducted at the national level through mass media, and the use of local signage to communicate about dangers or indicate evacuation areas [64]. In their large majority, these educational strategies are top-down and seldom, if at all, involve a two-way communication approach with local people. For example, Leavy et al. (2016:437), who review drowning prevention interventions for children and young people in high-, low- and middle-income countries, note that "all of the studies used education and information as a key strategy to prevent drowning". The focus is mainly on awareness, perceptions, and intentions. Education and information campaigns usually entail one-size-fits-all strategies with uniform messaging that lack considering people in their diversity, including specific vulnerabilities or factors accruing risk. Several scholars claim that such dominant top-down approach, based on communication and awareness raising, simply does not work [41], while others pinpoint that these strategies are based on limited evidence and/or experts' views with their effectiveness being rarely evaluated [9,59].

Drowning strategies linked to floods tend to provide similar recommendations to those developed in coastal beaches, lakes, and rivers. Prevention strategies generally include engineering measures to limit access to floodwaters (i.e., motorists), and the utilisation of public awareness and education, as well as predictive modelling and evacuation procedures [65]. Some note the challenges associated with flood-related drowning, which are small-scale events, reasonably rare, multi-causal, and occur in dispersed geographical locations, thus making it hard to gather meaningful data and develop effective prevention strategies [41,66]. There is a consensus amongst policymakers, practitioners, and scholars focusing on flood-induced drowning strategies about the importance of working with stakeholders involved in DRR and disaster response. They usually pinpoint the gap in drowning data related to floods as well as in the operational synergies across sectors [8,32,41]

There are several cases where such collaboration occurs. For example, during flooding caused by the 2023 cyclone Gabrielle in

Aotearoa New Zealand, Surf Live Saving New Zealand, an organisation dedicated to coastal water safety, mobilised their skills and resources to conduct search and rescue operations and support locals affected to prevent drowning [67]. They successfully coordinated efforts with regional and local emergency management agencies in charge of flood response. Focusing on Australia and the United Kingdom, Peden et al. [12] highlight that lifeguards have a strong awareness of water conditions, swimming and rescue skills, are knowledgeable about rescue boat operation and teamwork, radio communication protocols, and the use of ropes and rescue equipment. The authors conclude that lifeguards represent a workforce that is both capable and willing to collaborate with agencies involved in flood mitigation and response (some of whom are already being tasked with such work). In the same vein, studies focusing on drowning prevention initiatives in the Philippines [61] and India [63] stress the potential for drowning prevention and DRR actors' collaboration. However, cross-agency collaboration is sporadic and generally does not translate into formal arrangements or policy frameworks for flood preparedness or response [12,61,63].

Although drowning and DRR are strongly connected and overlap, they are rarely integrated into international and national policy frameworks. For the last 15 years, the World Health Organization has called for all countries to develop national water safety plans incorporated in disaster risk management, highlighting this shall lead to more robust drowning prevention strategies [8]. The UN resolution on global drowning prevention signed in 2021 [68] has developed 10 priorities to address drowning, one of them being to "encourage the integration of drowning prevention within existing disaster risk reduction programmes". It also draws attention to the connection between the efforts to reduce drowning globally and the Sendai Framework for Disaster Risk Reduction [69]. However, while the Sendai framework stresses the need to "raise awareness and improve understanding of water-related disaster risks and their impact on society" ([69]:22), it does not mention drowning once. The national DRR frameworks of most countries do not highlight the issue of drowning either. This appears as a critical policy gap for integrating drowning in DRR [19].

5. Research on drowning: an overview of trends and gaps

The literature on drowning is recent and fast growing. Scarr and Jagnoor [13] conducted a review of the drowning literature and found that research increased 100-fold between 2005 and 2014. More than 40% of the literature has been published since 2014, mainly through the expansion of research on drowning in LMICs. To date, much of the research on drowning is conducted in high income countries such as the United States, Australia, Canada, and the United Kingdom [9,13]. This is problematic since about 90% of the drowning fatalities occur in LMICs [8,32]. For example, the Global Burden of Disease 2017 study attributed more than 51% of drowning mortality to China, Bangladesh, India, and Pakistan, while only a small percentage of drowning research publications are authored in these countries [20]. Such patterns reflect the lack of funding opportunities for conducting research in LIMCs and the only recent recognition of drowning as an issue in LMICs.

Research on drowning is published in a wide array of peer-reviewed journals, a reflection of the fact it is a cross-disciplinary issue with interconnected topics such as child and adolescent health, climate change, migration, transport, water, sanitation and hygiene, injury prevention, medicine, and disaster (among other themes). Remarkably, drowning is mainly framed as a public health issue. Scarr and Jagnoor [13] analysed research on drowning from 1995 to 2020. From 935 articles selected, they found that the top 20 journals are all injury prevention, public health, or medical journals. Disaster studies seem largely absent from this trend. Their bibliometric analysis highlights that the *Journal of Coastal Research* and *Natural Hazards* were the only two nonmedical or public health journals in the top 50 journals and account for a small percentage of the publications. Koon et al. [9], who conducted a literature review of coastal drowning, found similar patterns and gaps.

The dominant research approach has been quantifying the impacts of drowning on people and societies as well as on the health determinants of those who drown. Several studies have focused on national data on fatal drowning [70], the epidemiology of children drowning [71,72] and drowning risk in CALD communities [73]. This focus might be explained by the fact that the literature on drowning is recent and there is a need for data on both fatal and non-fatal drowning to inform policy for drowning reduction. Koon et al. [9] further note that the World Health Organization reports on drowning have had great impacts on both the amount of research produced and what is being studied. Another part of the drowning literature has focused on water hazards and understanding people's perceptions and behaviour towards them. For example, studies have focused on the role of alcohol in drowning risk [74], the lack of awareness and behaviour in the face of water hazards [75], the motivations and risks linked to bystanders and professional drowning rescues [58], as well as the use of safety equipment and people's perception towards them [76]. This approach somehow mirrors what has been termed the *hazard paradigm* in disaster scholarship, with social scientists focusing on people's perception of risk associated with natural hazards and how they 'adjust' to such events [77]. This hazard paradigm has contributed to shaping the policies involving top-down communication strategies aimed at strengthening people's awareness and changing their behaviour in the face of natural hazards and disasters [78].

The focus on individuals' behaviour and their management of risk generally dominates in drowning research. This could be because the health sector, like emergency medicine, paramedicine, or injury prevention, typically deals with intervention at individual levels. However, the risks and impacts linked to fatal drowning are often place-based and are shaped by economic, social, political, and cultural factors that exist at local community and societal levels [79]. Drowning prevention strategies should therefore entail approaches that go beyond focusing on individuals but work closely with local communities towards strengthening their capacities for reducing drowning risk. In recent years, research initiatives have been developed in collaboration with local communities to explore community-based or -led approaches. For example, research in Australia and Aotearoa New Zealand has showed that the surfing community plays a significant role in drowning prevention and water safety [53]. Programmes such as the Surfer Rescue 24/7 (SR24/7) have been developed to train the surfing community with rescue and resuscitation skills with the aim of capitalising on surfers' capacities to save lives [54,80]. In Bangladesh, research has explored the effectiveness of community-based initiatives to

reduce drowning of children aged 1–5 years old in creches, recognizing the importance of local communities' role and resourcefulness on this issue [24,34]. Similarly, Kamstra et al. [10] highlight the fishing community's knowledge about unintentional fishers' coastal drowning. The study emphasizes the potential for community-based approaches, where fishers' expertise could be integrated in the drowning prevention strategies targeting coastal fishers. Nonetheless, these initiatives remain scarce and research or practices involving community-based approaches for drowning prevention are limited.

More generally, drowning scientists recognize the need for alternative approaches to drowning prevention. The drowning literature emphasizes a tendency of the field to operate in silo [9,13]. Hence, academics and policy makers working on drowning risk reduction increasingly highlight the need for cross-disciplinarity in both research and practice ([8,9], [11,16,61]). In their work on reducing children drowning in the Philippines, Guevarra et al. [61] stress the importance of further collaboration amongst agencies, including those involved in disaster risk management, in creating more robust data on drowning and joint interventions that strengthen drowning prevention. Scholars working on flood-induced drowning argue for the use of methodological approaches involving hazard mapping for risk assessment and planning, the development of early warning systems, and the implementation of evacuation plans, while catering for those identified as particularly vulnerable [16,19]. This currently constitutes a gap in both drowning prevention research and practice. Furthermore, several authors emphasise that the most visible impact of climate change on drowning risk is an increase in cyclone- and flooding-disasters, and that involving disaster scholars and practitioners is critical to prevent drowning [16, 19]. The following section aims to discuss the potential contribution of disaster scholars and policies to reduce drowning risk – calling for more collaborations across fields to tackle the issue of drowning.

6. On the relevance of disaster studies to reduce drowning risk: bridging gaps

Drowning research is almost non-existent in disaster studies, nor is drowning mentioned in policies aimed at reducing disaster risk. Yet, as previous sections in this paper have demonstrated, drowning risk is, in fact, underpinned by the same conceptual framing used in the disaster risk knowledge domain (see Fig. 1). The risk of drowning involves the exposure to hazards (i.e., rip current at the beach, rivers that overflow, tides and waves making risky rock fishing or water transport, etc.) that intersect with people's vulnerabilities. Studies show that drowning is linked to age, gender, socio-economic status, norms, cultural elements, and sometimes a combination of these. Furthermore, both individual and collective capacities contribute to reducing the risk of drowning. These may include knowledge about a specific area and/or environmental conditions, swimming abilities, strong social networks, or skills to save or resuscitate someone. Reducing drowning risk thus requires acting upon the hazards, vulnerability, and capacities jointly, which aligns with the comprehensive approach recommended for DRR [69,77]. The disaster risk and drowning prevention fields thus use the same concepts, speak the same language, and have similar goals. There is immense potential in drawing upon such synergies to both strengthen our understanding of drowning and prevent it.

The dominant approaches to preventing drowning have been top-down, with a focus on individuals' risk perception of water hazards and communication campaigns aimed at raising awareness. Disaster scholars have criticised this approach since the late 1970s for placing too much emphasis on nature as the cause of risk and people's incapacity to perceive dangers or adjust to them [81]. The DRR field has, since the late 1990s, argued for a shift from top-down, externally driven approaches, towards working closely with local communities and drawing upon their capacities, resources, knowledge, and skills [1]. This has been coined community-based, community-led, or community-driven approaches, recognizing the importance of community participation in matters that affect their lives [82]. Although not without difficulties [83], the disaster literature shows community-based approaches usually lead to actions that are culturally and socially adapted, tailored to the local environmental contexts, empower local people on issues that matter to them, and ultimately foster sustainable solutions [84,85]. Despite the work of a few scholars who emphasise the importance of building upon people's capacities [10,54,63,79], community-led, -driven or -based approaches are still largely missing in the drowning literature, representing an area where disaster scholars could help bridge this research and action gaps.

Drowning scholars pinpoint the need to find alternative approaches to drowning prevention, such as hazard mapping for risk assessment, using early warning systems and developing evacuation plans [16,19]. Disaster academics and practitioners have extensive experience in the development of early warning systems and evacuation plans during emergencies that cater for local communities, specifically their socio-economic functioning, norms, culture, vulnerabilities, and resourcefulness, amongst other aspects. Early warning systems have helped to significantly decrease the number of disaster fatalities over the last two decades, including in coastal areas [86], flood hazard zones [87], and tsunami-prone communities [88]. This approach could be applied to prevent drowning related to lakes, rivers, mangroves, beaches, and other areas where there is a high risk of drowning. In line with this, disaster studies have long used mapping tools to both assess and reduce disaster risk, such as aerial photos or satellite images, balloon or kite mapping, and mapping using GPS and drones. The recent advances in technology with devices such as mobile phones, digital cameras, tablets, virtual reality, and video games provide new opportunities to conduct mapping with local people and actively involve them in prevention and risk management [89]. These represent different prospects where disaster scholars could collaborate with drowning researchers and practitioners towards novel approaches to reducing the risk associated with drowning. Such approaches are not only relevant to flood- or tsunami-related disasters but can also be applied to a wide range of contexts relevant to drowning prevention.

Disaster scholars, practitioners, and policymakers could contribute to drowning reduction by sharing data related to floods, storm surges or tsunami disasters, which could help fill existing gaps and weaknesses associated with data on drowning. This gap in data has led to several scholars and policymakers to stress how drowning is both under-estimated and limitedly understood [29,32]. Disaster studies, too, could benefit from a close collaboration with drowning scholars and practitioners to strengthen DRR [66]. For example, drowning research often uses forensic analysis involving coroner reports, which generally provide detailed information on the exact time and location of fatality, the person's behaviour and health conditions, and if any attempt to rescue was made, among many other

aspects [39,90,91]. These insights and methods represent one of the opportunities for mutual learning across fields, which ultimately may provide a basis for the formulation of more robust disaster prevention strategies.

Lastly, drowning could be more systematically included in DRR and Climate Change Adaptation (CCA) initiatives. Currently, swimming abilities, the vulnerability factors that prevent people from learning to swim or capacities to rescue and/or resuscitate someone are rarely integrated into DRR and CCA research and policies involving floods, tsunamis, or tidal storms. The dominant focus of disaster prevention strategies is on planning to reduce physical exposure, designing buildings/houses able to cope with flood water level and flow, increasing the effectiveness of communication, and evacuation to safe areas. Early warning systems, which are a key component of DRR [69], emphasise the importance of people-centred approaches with tools that cater for diversity in terms of gender, age, ethnicity, language and physical, mental, and cognitive abilities. However, they do not account for swimming abilities, diverse perception of and behaviour in and around water, or any other aspect linked to drowning [92]. These elements are nonetheless critical to influencing the death toll associated with a disaster and climate change and may contribute to shaping individuals' and local communities' resilience. Disaster studies can therefore learn from drowning prevention academics and vice versa. Ultimately, a closer and more systematic collaboration amongst the drowning prevention and DRR fields would enable the bridging of drowning knowledge and policy gaps.

7. Concluding remark: on the challenges to closing the research, policy and practice gaps

This paper points out the synergies between the DRR and drowning prevention fields. It argues that they share the same conceptual underpinnings, use the same language, deal with the same problematics, and have similar goals. Yet, the two fields largely operate separately in research, policy, and practice. There is thus a need to bridge existing gaps towards greater collaboration amongst scientists, policymakers and organizations involved in disaster and drowning reduction. Nonetheless, there are several barriers and challenges to collaborative/cross-disciplinary approaches.

First, disaster scholars keep devoting particular attention to large-scale 'sensational' disasters, which are infrequent but intense and lead to extensive death toll, damages, and losses, generally requiring significant work for response and recovery [1,93]. While the study of large-scale events is critical to advancing disaster response and DRR practices, there is a need for disaster studies to also focus on smaller-scale and less visible events such as drowning linked to beaches, mangroves, lakes, rivers, or floods that do not affect a large number of people but have critical cumulated impacts at local levels.

Second, there is a lack of dialogue between drowning and disaster scholars and practitioners. The drowning field tends to operate in a silo, while disaster studies, although cross-disciplinary in nature, do not include drowning in current research or policy documents. There is a need to break down this siloed approach by fostering dialogue amongst a wide diversity of stakeholders from both disaster and drowning studies. Dialogue is a pre-requisite for collaboration bridging both fields and developing research, policy, and practice in a respectful way, such as avoiding what has been termed a 'gold rush' [94].

A third barrier lies in the availability of funding that encourages such collaboration. On the one hand, drowning seems to fall between the cracks of disaster-based funding guidelines that tend to focus on hazards involving earthquakes, tsunamis, floods, landslides, and cyclones or typhoons (not an exhaustive list). On the other hand, health funding places little attention on drowning - even though it is one of the leading causes of mortality worldwide. Nor does it encourage cross-disciplinary approaches with DRR and CCA [9]. It is thus critical for policy makers and donors to promote the funding of projects that foster DRR and drowning prevention collaboration.

Lastly, drowning reduction is multisectoral in nature with clear connections between the United Nations' Sustainable Development Goals, the World Health Organization's guide to prevent drowning and the Sendai Framework for DRR. However, to date, drowning is not mentioned in existing disaster policy frameworks. Solutions for reducing drowning risk will require research partnerships and actions across multiple sectors and actors, including stakeholders not yet working in drowning prevention. It thus appears critical that the DRR policy frameworks, both at global and national levels, start integrating drowning in their priorities for action.

CRediT authorship contribution statement

Loïc Le Dé: Conceptualization, Formal analysis, Investigation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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