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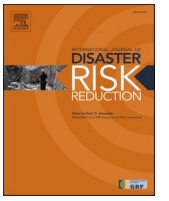

Universities and multiple disaster scenarios: A transformative framework for disaster resilient universities

Lisa Gibbs [a,b,*], Hamza bin Jehangir [c], Edwin Jit Leung Kwong [a], Adrian Little [c]

[a] Melbourne School of Population and Global Health, University of Melbourne, Australia
[b] Centre for Disaster Management and Public Safety, University of Melbourne, Australia
[c] School of Social and Political Sciences, Faculty of Arts, University of Melbourne, Australia

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ABSTRACT

Recent years have provided stark insights into the challenges of dealing with multiple, overlapping disasters in many parts of the world. Climate change reports indicate that these severe and complex disaster scenarios are likely to become more frequent. This paper provides a reflective oversight of the changing roles of universities in the context of these new disaster risk scenarios. A transformative approach is encouraged as part of an array of resilience strategies, interconnected systemically and temporally. A framework for disaster resilient universities is proposed based on the literature relating to the different spheres of university responsibilities and respective stakeholder groups, with due consideration for underlying principles and social responsibilities for disaster resilience.

1. Background

Disasters arising from extreme weather events and natural and human caused hazards have always been a threat to human health and wellbeing and capacity to thrive. Disasters are defined as "A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources" [1](p. 9). Existing knowledge about how to prepare, respond, and recover has primarily been based on experience and evidence arising from single disaster events. The rapid onset of climate change is changing these risk scenarios [2,3]. We are now seeing the predicted increases in the frequency, severity, scale, and complexity of disaster events. In addition to the devastating impacts of the COVID-19 pandemic, climate and geophysical disaster events in 2020 exceeded the annual averages for the past two decades, affecting over 98.4 million people worldwide [4]. Exposure to the impacts of multiple disasters occurs through related, cascading events such as droughts followed by bushfires [5], through recurring events in the one location such as floods [6], and through unrelated disaster events such as hurricanes and oil spills [7]. These heightened risk scenarios increase the complexity of dealing with recovery from a disaster event, given those involved may also be simultaneously experiencing phases of preparedness, response, and recovery to multiple other hazards with increased risk of poor mental health and wellbeing outcomes [8]. Existing evidence about the respective stages of disaster prevention, preparedness, response, and recovery (PPRR) can contribute to strategies to promote disaster resilience, but there is still very limited evidence to address the emerging complexities involved in multiple disaster exposures.

* Corresponding author. Melbourne School of Population and Global Health, University of Melbourne, Australia.
E-mail addresses: lgibbs@unimelb.edu.au (L. Gibbs), hamza.jehangir@unimelb.edu.au (H. Jehangir), edwin.kwong@unimelb.edu.au (E.J.L. Kwong), little@unimelb.edu.au (A. Little).

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The priority for scientific knowledge and political action to reduce risks from disasters must be on climate mitigation [2,3]. However, new knowledge and thinking are also required concurrently to enable future resilience within current risk scenarios. Universities have a central role as knowledge generators and educators in society and so are uniquely placed to contribute to this process. The role of academia, scientific and research entities, and networks was highlighted in the Sendai Framework for Disaster Risk Reduction 2015–2030 [9] to:

> increase research for regional, national, and local application; support action by local communities and authorities; and support the interface between policy and science for decision-making.

In this paper, we present a critical review of the literature and a case study to provide insights into the different roles of universities and their social responsibilities and capacities as actors in disaster resilience events. This informs the development of a proposed framework for disaster resilient universities.

1.1. Use of the term 'resilience'

In order to consider the ways in which universities can become more resilient, the term itself needs to be clarified. The concept of resilience has been utilised and applied across an extensive range of disciplines including, but not confined to, psychology, international development, politics, economics, engineering, energy systems, environmental and sustainability science, disaster and risk management, and urban planning. Therefore, its definitions and interpretations have also been similarly broad and varied. We refer to resilience as a dynamic process defined by the United Nations International Strategy for Disaster Reduction (UNISDR) as *"the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions*" [1](p. 24). Manyena and colleagues in their 2019 review of the disaster resilience and capability literature [10] presented five capacities as a means of operationalising resilience: **prevention**, **anticipation**, **absorption**, **adaption**, and **transformation**.

Prevention refers to measures taken "to completely avoid potential adverse impacts through action taken in advance" [1]p.22. Given it is rarely possible to completely avoid the impact of hazards, the terms 'mitigation' and '**anticipatory**' measures are also often used in disaster risk management to refer to proactive systems and preparedness strategies to reduce the impacts of potential future events [10]. Prevention and preparedness strategies are significant in the management of known and predictable risks, and as such are identified as the first and second stages of the Prevent Prepare Response Recovery (PPRR) cycle. However, the multiple disaster paradigm requires more than prevention and anticipation strategies, insofar as the intersection of disaster events creates new kinds of risks that cannot be anticipated and apprehended in advance.

Absorption refers to the capacity of systems to maintain their functions in the face of adversity or to return to that equilibrium once the disturbance has passed [11–13]. The absorptive approach if considered alone tends to interpret resilience as a static concept and a binary notion – i.e., an all-or-nothing concept which is insufficient for the current multidimensional conceptualisation of resilience [14,15]. Combining this approach with other resilience capacities helps to accommodate the complexity of the real world within the theoretical construct of resilience.

With this in consideration, another relevant conceptualisation of the operationalisation of resilience is that of transition, or incremental **adaptation**. The adaptive view of resilience is the most common, mainstream concept of resilience today across disciplines – recognising that it is not simply the "bounce-back" to a previous stable state, and not just a matter of survival. However, at the same time this conceptualisation of resilience perhaps signifies an unwillingness to commit to substantial structural changes where they may be needed.

The final element in the Manyena et al. (2020) model reminds us that radical change can also be considered as a legitimate option in times of adversity. **Transformation is** the capacity to undergo constant and radical change without necessarily a stable state to arrive at or return to. This promotes the opportunity for positive change, a "bouncing forward" [16] and allows for the fact that in disaster affected societies, things may have been so fundamentally changed that it is not possible to return to the previous circumstances. In climate change and climate sustainability science, this understanding of resilience is most prevalent. Indeed, in settings where the structures or systems in question are undesirable and unjust, efforts to build resilience within this conceptualisation seek to change such structures purposefully and fundamentally. This is somewhat analogous to André Gorz's concept of non-reformist reforms, where changes are conceptualised "not in terms of what is possible within the framework of a given system and administration, but in view of what should be made possible in terms of human needs and demands" [17]. In this sense, it is recognised that resilience itself may exist as an undesirable trait, and thus it ought to be understood as a "non-normative and a deconstructable attribute" that is neither inherently good nor bad [18]. For example, Hills examined the resilience of sub-Saharan Africa's police forces and argued that some of these undesirable statist institutions have demonstrated high levels of resilience [19].

Given the devastating impacts of the COVID-19 pandemic on almost every aspect of our societies and the increasingly devastating impacts of the anthropogenic climate crisis, resilience theory and practice need to incorporate scope for radical transformation and move beyond a linear model of simply moving from point A to point B. We should embrace the fact that resilience, and the process of defining the vision of resilience, is an emergent, emancipatory, "highly contested, political, and participatory process", which demands flexibility, continual iteration, and improvement [20]. Resilience is a condition often necessitated by adverse circumstances, and

regardless of whether these structural factors can be changed or not, the questions of resilience for whom; for what; for when; for where [20–22]; and for what reason must be posed and answered. Otherwise, there is a risk that unjust and repressive conditions will be perpetuated, since neoliberal[1] agendas [23,24] can be upheld through resilience, and structural and institutional factors may be ignored in favour of focusing on individual responsibilities. Disaster resilience can contribute to neoliberal ideology through its emphasis on preparedness, self-awareness, active citizenship, and shared responsibility [25]. Emphasising self-reliance and individual resilience is an important element of risk reduction, but if it is not balanced with the obligations of other parties, it may constitute a strategy for government and the private sector to abdicate responsibility in times of crises [26].

Therefore, we suggest that resilience should exist as a boundary object, instead of a normative vision or a reified concept. The meaning of a boundary object is that it is "malleable", allowing it to be adapted by diverse disciplines and stakeholders [27]. It can serve as an interdisciplinary site of contestation amongst scholars from different epistemological and disciplinary backgrounds. Therefore, given that it is a malleable and emergent process, the conceptualisations of resilience capacities – preventive, anticipative, absorptive, adaptive, and transformative – exist along a continuum, and may all be simultaneously utilised to different degrees according to the changes required. Resilience on this account is an ongoing dynamic process rather than something to be 'achieved'. Whichever form of resilience, or combination of resilience capacities, is utilised, the concept that resilient systems are safe to fail, and not just fail-safe is a useful and necessary one to bear in mind [14]. Even in the event of failure, a resilient system should be able to flexibly pivot, "continually iterate and respond to external developments" in an agile manner, considering both short and long term implications simultaneously [28]. Woods' concept of graceful extensibility is also applicable here, in considering how a system can "extend its capacity to adapt when surprise events challenge its boundaries" [29,30].

In a similar manner, the post-pandemic university can also embrace this notion of malleability, facilitating efforts to increase local and global resilience capacities, allowing interdisciplinary contestations to occur, and adopting dynamic, multi-state notions of resilience that provide space for transformation to occur. Given the growing size and purview of modern international universities, the scope of their social responsibilities has also increased, and thus their contributions towards disaster resilience must also operate within this broader context. While the concept of transformational resilience may represent the ideal and the most equitable approach, pragmatically universities also have to invest in a range of preventive, anticipative, absorptive, and adaptive activities. Resilience unfortunately can sometimes actively extend crises while responding to them, and therefore universities must make sure that their resilience building efforts are directed towards a transformative process focused on social impact.

1.2. The changing roles of universities

The emergence of increased disaster risk scenarios provides a challenging environment for universities to marry together their traditional objectives with new realities. While, globally, universities vary considerably in many tangible and intangible ways including funding regimes, regulatory structures, disciplinary scope, and cultural perceptions of the value of universities, the experience of global phenomena such as climate change and the COVID-19 pandemic has once again reopened an older set of questions around what universities are for and what they can do to mitigate the impacts when disasters strike. The traditional roles of universities in knowledge production through research and the education of new generations of students has not altered, but the means of achieving these objectives does change and, in the age of increased disaster exposures, in some significant ways. Moreover, given the emergence of disaster challenges, a range of new questions come into clearer view for universities as they seek to ensure their own security and reproduction as well as address their social mission, that is, the needs of the wider societies to which they belong.

Let us turn first to the traditional research and education roles of universities in times of increased and multiple disaster exposure, before addressing the intersection of place and global imperatives. In research, the importance of targeted knowledge production must be reiterated as a means of mitigating risks and enabling social and political decision-makers to access the requisite information to address major and multiple disasters. This may include things such as deeper research into the particular impacts of climate change and extreme weather events, and alternative technologies to reduce these deleterious impacts. In terms of debates over the Anthropocene for example, the Great Acceleration in the second half of the Twentieth Century is now being discussed in a more disaggregated fashion to highlight that, alongside the cumulative effects of climate change, there are significant variations in impact between different types of countries [31](p. 92–94). Even more obviously, it may involve the creation of new vaccines to manage the impact of pandemics, or the identification of policy opportunities and blockages in the logistics of distributing vaccines around a world characterised by vastly unequal distribution of resources. It can also involve examination of the social processes of disaster recovery to identify opportunities to promote better health and wellbeing outcomes, and thus guide recovery policy, funding, and service delivery [32]. In short, universities can produce knowledge that facilitates societies trying to tackle the immediate and long-term impacts of disasters. This involves seeing universities as part of the critical infrastructure of society and highlighting their role and their resilience as a public good [33](p. 4).

However, there is also a need for basic knowledge production for unforeseen problems in equipping researchers with the ideas, tools, and technologies that enable them to meet urgent societal challenges. The capacity of universities to meet societal needs in times of emergency is predicated on more fundamental forms of discovery that produce researchers capable of addressing the kinds of issues that emerge with multiple disasters. Often this will require cross-disciplinary research that can grapple with the multi-faceted nature of concurrent hazards and their impacts. This necessitates physical research infrastructure and researchers with adaptive mindsets that

[1] The use of the term 'neoliberal' is commonplace in contemporary academic literature, often without definition. We wish to be clear that our use of the term here is not merely descriptive of the impacts of neoliberal economics, but more concerned with the biopolitical sense of the term as 'governance of the self'. (Rose, 1999; see also Venugopal, 2015).

can challenge the overly orderly and rigid nature of human-made systems and processes such as traditional public policy-making [34,35]. Therefore, universities must be adaptive to the emergence of new, unforeseen problems, requiring not only in-depth research to help to better predict which problems will emerge as the most serious challenges and how to address them, but also investment in people and physical infrastructure to enable knowledge generation and translation into policy and practice at speed and scale.

In an era of increased disaster risk, the reification of social and cultural elitism in universities is not defensible. The commitment to generating and sharing knowledge should encompass the whole of society rather than merely privileging social or cultural elites. While the traditional model of the university was of course a place of privilege, this was never justifiable, and the emergence of heightened disaster risks does a lot of levelling work. In and of themselves, disasters do not differentiate by class or ethnicity or gender; rather the differential impacts of these phenomena are predicated on human-made social and political constructions [36]. While this involves who universities teach and how, it also affects what they teach. One example here is the ways in which Indigenous land and resource management techniques were marginalised as 'knowledge' to be taught in universities. These techniques are now acquiring renewed focus in the context of managing severe bushfires in Australia. Yet there is still very little recognition of disaster recovery impacts and expertise that is unique to Indigenous groups [37,38]. Like many institutions, universities are prone to path dependence in terms of

Case study: Washington State University's response to the 2014 Oso landslide

On March 22, 2014, a deadly mudslide devastated the Washington state community of Oso. The landslide resulted in the death of 43 individuals, destruction of several homes, and blocked access to transport routes of economic importance near the cities of Arlington and Darrington, in the northwest of the state of Washington [48]. As a part of their response, WSU and their Extension in Snohomish County utilised a multidisciplinary team to assist impacted communities in adapting to the immediate effects of the disaster as well as providing them with support for rebuilding efforts to anticipate, and mitigate against, future disasters. The team consisted of experts in community development and emergency management as well as student interns. In their efforts, the WSU team partnered with different stakeholders from the region such as Indigenous communities and tribal officials, affected citizens, elected officials, government agencies, and non-governmental organisations [49].

The WSU recovery team helped the local community build adaptive capacity and mitigate against potential future disasters in the immediate aftermath of the landslide in two important ways. First, the recovery team partnered with the university's engineering centre on composite materials and the rural community design initiative to assist citizens and Indigenous communities in their efforts to mitigate flood risks and explore biofuel development as an adaptive strategy to reduce energy costs [49]. Elected officials partnered with WSU's recovery team which helped translate local concerns about post disaster internet access and availability to the Federal Communications Commission. The subsequent report highlighted areas with limited internet access and consequently WSU's Governmental Studies and Services division co-led the effort alongside broadband service providers to improve internet access by creating two more internet hotspots for residents, businesses, and the Sauk-Suiattle tribe [50].

Second, the WSU team worked with local government organisations and citizens to lead sustainable economic development and reconstruction efforts. These efforts resulted in collaborative development of a research-based workforce plan which provided citizens with an opportunity to take part in relevant certificate and degree programs at WSU on sustainable timber use and production. These programs facilitated local economic development expertise essential for adapting to post-disaster rebuilding problems [50]. WSU's efforts highlight that universities can draw on their expertise in applied research to help communities translate local concerns to policy makers to develop effective disaster response and mitigation initiatives.

However, adaptive and mitigatory strategies which primarily focus on economic and resource problems are not sufficient for a multidimensional disaster response that also takes seriously the importance of mental health, care, and support. WSU's team expanded their disaster recovery efforts by collaborating with school and community leaders to develop an intervention model for supporting children in their psychosocial wellbeing. *The Collaborative Learning for Educational Achievement and Resilience* (CLEAR) intervention model in local schools helped teachers limit the impact of disaster related trauma on children while providing them with relevant skills training for dealing with development risks associated with childhood adversity. WSU's CLEAR model was presented as a successful program for work on disaster-related child trauma in the federal effort to continue funding for the National Child Traumatic Stress Network in the United States of America [50]. This reveals the impact that university efforts in disaster response can have on advocacy for legislative reforms which provide resources, training, and support for disaster adaptation.

Finally, efforts by WSU also highlight how universities can play an important role as infrastructure in disaster recovery courtesy of their physical presence and capacity for resource flows [34]. WSU Extension in Snohomish County allowed the university to do this by raising funds for disaster recovery, translating concerns of the local stakeholders, and incubating Glacier Peak Institute (GPI). GPI was supported in its efforts to empower youth in building resilient and sustainable rural communities in western Washington by WSU through housing employees, extra fundraising, and organisational development. This work helped convert GPI into a federal non-profit institute reflecting the long-term contribution of WSU to disaster recovery initiatives [50]. Such moves by WSU foreground the crucial role that universities can play in disaster impacted areas through combining their physical presence with research expertise, connections with local communities, and the social and human infrastructure at their disposal.

what they value, teach and research [39]. However, in conditions of emergent multiple disasters, such institutional inertia hinders the capacity to provide the types of teaching and research that are most relevant to the societies to which they belong. For example, in their discussion of the need for engagement between and reform of the physical and social sciences to meet the infrastructure challenges of the Anthropocene, Allenby and Chester make the case for a substantial revision of curricula in engineering [34](p. 61–62). While universities should respect older traditions of knowledge (in both the classical and Indigenous sense), this need not be passive. Rather universities need to understand how best to combine more traditional forms of knowledge with the products of contemporary research – often focused on fundamental discovery – to inform curricula and equip a wide range of students with the knowledge and skills to tackle disasters as they take effect in everyday life.

In recent years, universities have looked beyond their basic functions as educational institutions characterised by excellence in teaching and research to focus more on their 'place' and the communities in which they are located [40]. Place-based strategies often emphasise regional development, but they can also engender resilience, adaptive capacity and social transformation [41]. For example, it is no longer unusual to see universities in settler colonies like Australia rethinking their relationships with First Peoples and beginning to take greater responsibility for their role in the marginalisation of Indigenous communities (although there is still a very long way to go in this process). The location of universities has become a more distinctive part of their identity and social mission, but also a means of understanding the social responsibility of universities to open their doors to communities that have often found them to be less than accommodating institutions. Disasters do affect different groups in variable ways, but often for no good reason other than ingrained social privilege or lack of resources [42,43]. The universal and general nature of disasters asks us to question the equity and inclusiveness with which universities operate, and the ways in which they can be considered to have responsibilities to the communities they serve (many of which have traditionally been excluded from campus life). In short, universities must attend to the ways in which they are 'experienced' by those that share their place [44].

The commitment to responsibilities that the multiple disaster paradigm invokes for universities also goes beyond 'place' as a purely local environment. Places are comprised of peoples and the relationships between them, as well as the environment (human and non-human) in which these relationships exist [45]. They involve a historical legacy, a responsibility of current generations to those that will succeed them in the future, and the connection between locality and the regions and global domains where they operate [45,46]. Universities have become more international in terms of the sheer number of overseas students studying within them, but this does not mean they have become more diverse, less elite, or more global in terms of the diversification of what constitutes knowledge. The capacity to pay has become the hallmark of internationalisation, rather than intrinsic valuing of diversity of experience and knowledge. This is partly driven by the financial reality of universities' need to operate as viable businesses. And yet, the experience of multiple disasters – and their intersection with one another – provides an opportunity for universities to rethink their social missions, engage with communities that have previously been excluded both domestically and globally, and contribute to knowledge and capacity to withstand large scale and multiple disasters when they occur. This requires universities to build from their traditional strengths, but also to understand the need for resilience and transformation if they are to deliver on both their core purpose and their social role.

1.3. Universities and disaster resilience

The role that universities have played in previous disasters demonstrates that universities have the potential to build from their traditional strengths, while also being open to the transformation that is required to take on new social roles.

Contributions vary depending on the location, expertise and resources of the universities and the nature of the disaster event. The built environment of universities can be used for evacuation shelters and temporary accommodation. At other times, universities can provide human capital. For example, university students initiated and led a massive 'Student Volunteer Army' to provide local support and assist in shovelling up the silt and mud arising from liquefaction in earthquake affected areas of Canterbury, New Zealand [47]. Universities can also draw on traditional resources and expertise to co-develop multiple strategies in support of stakeholders in disaster impacted areas. A case study is provided below of the collaborative evolution of resilience strategies undertaken by Washington State University (WSU) in its response to a catastrophic landslide disaster in 2014.

The engagement strategy outlined in the case study above between the university, citizens, Indigenous leaders, schools, and local government officials demonstrates the potential for resilience to be operationalised as a dynamic, contextual, multi-strategy process in the aftermath of a disaster. This process illustrates that universities need not focus on one conceptualisation of resilience, but rather they are best placed to operationalise different ideas of resilience depending on community needs, context, and the nature of complex disasters. The pragmatic process exemplified here is useful as it provides universities with different strategies, operationalising varying understandings of resilience, without thinking of these strategies as operating in a zero-sum environment. Furthermore, equally significant is the contribution that these strategies make to cultivating resilience capacity building in disaster affected communities through partnerships with local stakeholders. The efforts to promote biofuel use, sustainable timber harvesting practices, and design initiatives to mitigate flood risks, as well as models to mitigate the impact of disaster trauma on children, illuminate how universities can work in partnership with local stakeholders to help build resilience capacities [51].

A focus on universities as promoting resilience capacities allows scholars to understand their role in disaster settings beyond the confines of deploying expertise to solve immediate problems, informing decision-making in technocratic policy circles, and translating local concerns to policymakers in the aftermath of a disaster.

It is still worth noting that universities are constantly grappling with the challenges which characterise concurrent and cascading disasters and that these efforts are nowhere near complete. Regional and international networks as well as coalitions between universities provide additional opportunities to exchange ideas and experiences, and to potentially explore transformative possibilities in disaster resilience. One example is the Academic Network for Disaster Resilience to Optimise Educational Development (ANDROID)

that operates with the European Union's support. ANDROID brings together universities in Europe to actively collaborate and to strengthen societal resilience to disaster through partnering with industry, local communities, and humanitarian agencies. The network works alongside partners from Sri Lanka, Australia, and Canada, and has contributed towards enhancing the capacity of European public administrators to address disaster risk. ANDROID hosts an open access platform for shared educational resources relating to disaster resilience education and best practices [52].

Similarly, the Global Resilience Research Network (GRRN) was founded by the Global Resilience Institute (GRI) at Northeastern University, USA in collaboration with the Fraunhofer Ernst-Mach-Institut, Germany. The GRRN is now an international network of

FRAMEWORK FOR DISASTER RESILIENT UNIVERSITIES

DISASTER CONTEXT

Multiple major disasters involving different types of hazards	Combination of exposures, capacities and vulnerabilities for different groups of stakeholders across the different spheres of responsibility	Different temporal flow for each hazard with different types of (overlapping) direct and indirect impacts

DELIBERATIONS

Consider which combination of **resilience strategies** (preventive, anticipative, absorptive, adaptive, **transformative**) are required for different **spheres of responsibility** and the related **stakeholders**, taking into account the university **principles**.

Determine **decision making processes** involved in developing resilience strategies, recognising there will be tensions between different views, competing interests and limited resources.

SPHERES OF RESPONSIBILITY	STAKEHOLDERS	PRINCIPLES
Place & physical assets	Local community Current & future staff and students	• Legacy • Environmental sustainability • Accessibility
Employer	Academic staff Administrative/Professional staff Union	• Health & wellbeing • Inclusion/diversity • Professional development
Educator	Students Employers of graduates	• Health & wellbeing • Quality • Inclusion/diversity
Knowledge generator	Academia End-user organisations Informal learners/general public	• Quality • Local & global perspective
Advocacy & knowledge translation	Policy makers Service providers	• Citizenship – local and global
Business	Funders Current & future clients & partners Alumni Government	• Integrity • Legacy • Accountability • Compliance

Fig. 1. Framework for disaster resilient universities.

leading universities, institutes, non-profit organisations, and companies [53]. A final example is the Association of Pacific Rim Universities (APRU) which hosts annual conferences and supports inter-country collaborations in relation to multi-hazards [54]. These network examples signify the increasing role of universities as not just local actors with responsibilities to their closest geographical communities, but also as institutions with regional and international responsibilities towards knowledge sharing, capacity building, and networking. These responsibilities are manifest in efforts to support disaster resilience education and disaster response practices, and have the potential to refashion the university as a global actor in disaster settings.

1.4. Transformative leadership for universities in developing disaster resilience

The previous sections of this paper have discussed literature relating to changing disaster risk scenarios and a framework of complementary resilience capacities; the different roles of universities with different stakeholder considerations; and a case study example of how universities can contribute to disaster resilience. In this section we combine these insights to guide resilient universities that are equipped to provide leadership for their communities and broader society. Our argument suggests that this necessitates a reconsideration of how to advance traditional university roles within a transformative approach to multiple disaster risks and impacts. As such, we present Fig. 1 as a proposed framework for operationalising preventive, anticipatory, absorptive, adaptive and transformative capacities [10] within the university sector, accounting for different spheres of responsibility and the different needs of the respective stakeholder groups. Application of this framework, with consideration for universities' social responsibilities, is explained further below.

1.4.1. Disaster context

Why does the constitution, composition, and outlook of universities matter to the era of increasing and compounding disasters? The tangible and intangible impacts of disasters on universities will manifest in different ways but with similar implications in terms of loss, damage, disruption, uncertainty and change. Multiple disaster events occurring concurrently or in succession can undermine capacity to prepare, respond, adapt, and recover. We suggest that as large organisations, with an established social mission and multiple core activities and stakeholders, universities can demonstrate transformative change by example. Our argument suggests that the current era is not an aberration, but an indicator of some of the challenges that universities and wider society will face for many years to come. This demands that institutions are capable of embracing and building on uncertainty about the future in the knowledge that they will be faced with many unforeseen challenges [55]. Universities are in a unique place to harness this uncertainty, based upon their capacity for knowledge production, their privileged role as organisations designed to innovate and push at the frontiers of extant knowledge, and their capacity to engage a wide range of partners and audiences.

1.4.2. Spheres of responsibility

Disaster events will impact all of the spheres of responsibility for universities including their built environments, research and teaching capacity, responsibility for staff and students, business viability, and as regional and global citizens. The resilient university will need to consider important historical legacies around campus sites and library holdings [56–58], and the production of knowledge and the dissemination of that knowledge to students, but it must do so in a much more engaged fashion with communities beyond the traditional base. Universities need to invest in and support basic research, but resilient universities will be those that take up opportunities to go beyond preventive, anticipative, absorptive, and adaptive disaster resilient strategies and advocate for transformation in light of the research that they produce. They will recognise that a complex array of all of these resilience strategies will be needed and that each will be interconnected systemically and temporally. Resilient universities will be institutions which are intrinsically collaborative, forging partnerships that bring external partners into the work of knowledge production and translation and which open new vistas in so doing [9]. These partnerships can provide pathways that bring new and different constituencies into the staff and student body.

1.4.3. Stakeholders

Importantly, this framework demands a series of more fundamental questions around who comprises university communities, which knowledges are reflected in our core activities, and where do our responsibilities lie in promoting resilience and transformation? Moreover, while insisting on the urgency of university leadership in addressing complex social challenges, universities cannot solve these questions by themselves. Instead, the framework here calls for a much more collaborative partnership model, connecting universities to multiple stakeholders for the different core activities of the university: staff, students, governments, NGOs, community organisations, marginalised groups, entrepreneurs, industry – in a wider variety of places – university campuses, digital platforms, communities, the city, the state, the region, and the international domain. In the era of increasing and compounding disasters, the scope of the university becomes much broader and more focused simultaneously, linking together global agendas with local places and communities to ensure that we bring expertise and advocacy to bear across a wide spectrum of activities, practices, and policies.

1.4.4. Principles

There are explicit and implicit values and principles that underpin the way the university meets its different spheres of responsibilities and the needs of the respective stakeholder groups. These principles can guide discussions about university resilience strategies. A transformative approach provides an opportunity to review if these principles are being met or indeed whether the principles themselves need to be reviewed to guide changes to the status quo. For example, resilient universities will require robust transformational thinking around diversity and inclusion: asking serious questions about who is taught, what is taught, how students' own knowledge informs the curricula, and who has been excluded traditionally and what impact that exclusion has had. Providing equity for the latter groups demands that resilient universities not only focus on building a more diverse point of entry, but also invest

in support for these students in recognition of the structural factors and inequalities that have prevented greater participation in the past. Equity targets in terms of participation will only have real value if they are accompanied by appropriate support mechanisms alongside critical questioning of what is taught to students when they are on campus [59,60]. As Indigenous scholars such as Moodie and Walter have pointed out, in settler colonial contexts, this involves recognition of epistemic injustice – the exclusion of Indigenous knowledge from the academic canon. In short, the commitment to place involves significant effort inside and outside of the classroom.

1.4.5. Deliberations

This framework is intended to provide a guide for discussion and development of university disaster resilience action plans. It provides a mechanism for intensive review as well as ongoing reflexivity, rather than an expectation of progress towards a definitive end-state. Adaptation and change can bring new forms of fragility alongside improvement. Resilience for universities is therefore founded on the capacity to address new and unforeseen outcomes in the future that emanate from the generative practices of the present. The process of developing a wide array of integrated university resilience strategies that address different and potentially multiple hazard types and account for the different spheres of university responsibility and stakeholder groups, is likely to be challenging, resource-intensive and at times controversial – particularly for transformative approaches. In some cases, confidentiality or time pressures in a crisis necessitate decisions being made without consultation. However, maximising opportunities for informed deliberation with stakeholder groups and transparency about decision making is likely to achieve greater shared commitment to the outcomes.

2. Conclusion

The role of universities in disaster contexts needs to be reviewed, given the increasing threat of extreme weather events and multiple disaster exposures arising from climate change. These changing disaster risk scenarios require a more sophisticated resilience approach by universities that moves beyond risk management planning or response to single disaster events. A proposed framework for disaster resilient universities is presented to support deliberations which consider the different spheres of responsibility for universities as educators, knowledge generators, and businesses with multiple stakeholders and broad social responsibilities. It encourages development of a combination of practical and philosophical changes as part of a system of interconnected resilient strategies, including transformative approaches to support positive and equitable outcomes.

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.

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