

Institution: University of Salford		
Unit of Assessment: 13		
Title of case study: Enhancing community preparedness for disasters in Sri Lanka		
Period when the underpinning research was undertaken: January 2014 – September 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Prof. Terrence Fernando	Professor of Virtual Engineering	July 1997 – Present
Prof. Bingunath Ingirige	Professor in Urban Resilience and Adaptation	July 2003 – May 2016; June 2018 – Present
Dr Kaushal Keraminiyage	Reader in Quantity Surveying	February 2005 – August 2015; April 2018 – Present
Period when the claimed impact occurred: January 2018 – December 2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact		
<p>World Bank data in 2018 revealed that over 800,000,000 people could see their living standards worsen by 2050 due to major disaster events. At present the decision-making processes in addressing disaster risk reduction (DRR) take place in silos, conducted by different agencies, institutions and other actors, all with their own priorities, perspectives and time horizons. Salford's research team has made a significant impact in shifting the focus of DRR from pure emergency response to building resilience through digitally enabled multi-agency collaboration. Their research has led to the development of an advanced technology platform: MOBILISE. The platform allows previously disconnected data on vulnerability, hazard prediction and exposure to be shared, enabling collective decision making in DRR and disaster response to save lives and prevent disruption in the context of Sri Lanka. Approximately 50,000 families have benefitted directly from the digital platform to date, with the platform's detailed landslide early warning messages reaching more than 50% of the nation's population, allowing them to better prepare in an emergency.</p>		
2. Underpinning research		
<p>The impact presented here is based on the interdisciplinary research on technology enhanced collaborative working environments by Professor Fernando [3.1, 3.2] and equitable resilience by Professor Ingirige [3.3, 3.4] and Dr Keraminiyage [3.5, 3.6].</p>		
2.1. Technology enhanced collaboration working environments (2000 – Present)		
<p>Fernando has been conducting research on technology enhanced collaborative working environments for industry sectors such as aerospace, building construction, space exploration and sustainable city development over the last 20 years. For example, his research has explored how advances in data modelling, simulation, interaction and visualisation can be brought together for multi-functional teams in the space industry, countering the fragmentation of datasets and expertise that leaves little scope for collaborative activities in current space exploration and mission planning tasks [3.1]. This expanded upon Fernando's previous research [3.2] in which his team studied how communication and collaboration can be enhanced among multi-functional teams to debate and explore 'what-if' scenarios and build consensus to produce sound design solutions [3.1, 3.2]. The EU-CIRCLE project (Horizon 2020 grant) adopted this within the Critical Infrastructure Resilience Platform against climate change. This platform provided multi-agency access to physical infrastructure, climate, and weather data on demand,</p>		

therefore greatly improving the ability of agencies to model natural hazards and their impact on the built environment.

This fused into the research on disaster risk reduction conducted by Ingirige, in which he argued for a change in mindset to tackle a disaster event, where the front-end process is impeded by the level of confusion and chaos that prevails during the immediate aftermath of a disaster event such as floods or tsunamis. Shattered lives and livelihoods could be addressed because *'developing such knowledge and skills (knowledge of disaster management in integrating community needs with their livelihoods and social contexts) [...] could potentially translate into successful recovery and reconstruction'* [3.3, p. 603]. Ingirige theorised that a flexible approach and participatory skills development would integrate multiple stakeholders and supply chains in disaster management [3.3]. This research was further strengthened through the MOBILISE project (GCRF - EPSRC grant) and the resilience frameworks initiative as part of the MOBILISE project to improve multi-agency collaboration with a focus on low- and middle-income countries in the Asia-Pacific region to support implementation of the Sendai Framework for Disaster Risk Reduction (Priority 1: Understanding disaster risk and Priority 2: Risk governance).

Salford's research created a multi-agency collaboration platform that combines scattered risk information (hazard, exposure, vulnerability) to allow multiple agencies to gain a common understanding of the local risks and then prepare and respond to disasters such as floods and landslides. This platform, based on a micro-service architecture principle, offers integration of scattered risk information from agencies as well as real-time data from sensor networks, satellites, drones and social media [see 3.1, 3.2, 3.3]. This research is being conducted in collaboration with government agencies and non-governmental organisations in Sri Lanka and has significantly contributed to planning, preparedness and response by designing a multi-agency approach and applying cutting-edge technology in Sri Lanka.

2.2. Building equitable resilience (2019 – Present)

Keraminiyage researches community engagement within localised settings to study aspects of relocation after disasters. The long-term dissatisfaction of post-disaster resettlement communities has been an issue which was particularly recognised within the post-tsunami phase in Sri Lanka. One major reason behind this dissatisfaction was the process followed and the priorities considered by the authorities when designing and implementing such resettlement programmes. Often only short-term priorities (such as land and funding availability) were considered and the authorities did not have the experience, knowledge or capacity to incorporate factors leading to long-term satisfaction among resettled communities [see 3.4, 3.5]. In addition, the perspective/interests of the host community were often ignored [3.4]. Salford's research found that there were significant latent factors that were perceived very positively by the host community such as more access to public services, social security, food and health as a result of the newly resettled community [3.4]. This prevented resentment towards integration between the newly resettled and host communities.

In a further study, Ingirige focused on small- and medium-sized enterprises (SMEs), an important component of the community that are vulnerable to flooding, to study their coping capacities and vulnerabilities to flood impacts. He worked closely with SMEs and the stakeholders that interact with SMEs to develop an approach that bridges the divide between science and policy makers, ensuring that transparent knowledge transfer takes place between the SME and policymaking communities [3.6]. Building this aspect of collaboration further into policy making, Ingirige studied disaster risk reduction, giving more emphasis to broadening multi-stakeholder perspectives in reconstruction and rehabilitation after recent hazard events and climate change impacts [3.6].

This work has led to joint research by Fernando, Ingirige and Keraminiyage, known as the TRANSCEND project (GCRF - ESRC grant). The project explores how to transform current urban development from practices that create risks, as well as unfairly distributing risks to vulnerable communities, to a new practice that is equitable and resilient for all.

3. References to the research

3.1. Garcia, A.S., **Fernando, T.**, Roberts, D.J., Bar, C., Cencetti, M., Engelke, W and Gerndt, A. (2019) Collaborative virtual reality platform for visualizing space data and mission planning, *Multimedia Tools and Applications*, 78, pp. 33191-33220.

<https://doi.org/10.1007/s11042-019-7736-8>

3.2. Bassanino, M., **Fernando, T.**, and Wu, K. (2014) Can virtual workspaces enhance team communication and collaboration in design review meetings?, *Architectural Engineering and Design Management*, 10(3-4), pp. 200-217. <https://doi.org/10.1080/17452007.2013.775102>

3.3. Ingirige, B 2016, Theorizing construction industry practice within a disaster risk reduction setting : is it a panacea or an illusion?, *Construction Management and Economics*, 34(7-8), pp. 592-607. <https://doi.org/10.1080/01446193.2016.1200735> (REF2)

3.4. Geekiyanage, D., **Keraminiyage, K.P.**, **Fernando, T.** and Jayawickrema, T. (2020) Factors influencing acceptance or rejection regarding being the host community for post-disaster resettlements in developing countries, *International Journal of Disaster Risk Reduction*, 53, (available online from 26/11/2020). <https://doi.org/10.1016/j.ijdr.2020.101973>

3.5. Keraminiyage, K., and Piyatadsananon, P. (2013) Achieving success in post-disaster resettlement programmes through better coordination between spatial and socio-economic/cultural factors, *International Journal of Disaster Resilience in the Built Environment*, 4(3). <https://doi.org/10.1108/IJDRBE-03-2013-0007>

3.6. Ingirige, B., and Wedawatta, G. (2014), Putting policy initiatives into practice: Adopting an "honest broker" approach to adapting small businesses against flooding, *International Journal of Building Pathology and Adaptation (previously: Structural Survey)*, 32(2), pp. 123-139.

<https://doi.org/10.1108/SS-01-2013-0011>

All journal publications **3.1 – 3.6** have been subject to external peer review. Associated grants comprise: Horizon 2020 (EU-CIRCLE grant 653824) for GBP218,388 (06/2015 – 09/2018); GCRF - EPSRC (MOBILISE grant EP/P028543/1) for GBP1,241,231 (05/2017 – 03/2021); GCRF - ESRC (TRANSCEND grant ES/T003219/1) for GBP855,528 (11/2019 – 10/2022).

4. Details of the impact

In light of the devastating natural hazards faced by Sri Lanka in recent times, it is vital that a coordinated approach is taken to the work of Government departments and the multiple agencies, international and community-based organisations whose role is to manage 'disaster risk reduction' (DRR). Previously, these organisations, which have both complementary and overlapping roles, caused chaos and confusion at times of disaster as a result of the cluttered and fragmented information available. The introduction of Salford's innovative MOBILISE digital platform is enabling Sri Lanka to implement priorities 1 and 2 of the Sendai Framework for Disaster Risk Reduction [see 2.1] through multi-agency collaboration, while creating a pathway to introduce a community-based approach to develop DRR and build disaster resilience.

4.1. Evidence-based response to disaster preparedness to inform digital strategy

Since 2016, Salford's researchers have conducted 8 workshops to bring the agencies in Sri Lanka together to promote the value of multi-agency collaboration [3.1, 3.2], as well as data sharing for implementing evidence-based decisions for disaster preparedness and response [3.6]. The team subsequently installed a MOBILISE platform within Sri Lanka's Disaster Management Centre (DMC) so that risk information can be collected from agencies such as the Government's survey department, irrigation department, the DMC's district offices and local authorities to plan collective intervention before floods and better response during floods.

As the apex body, the DMC collects and shares data sets among its stakeholders. Before the MOBILISE platform was installed, this process was haphazard and not carried out in real time. The MOBILISE platform has created a **step-change in DMC's service delivery** to key stakeholders, whilst capturing some of the data services, so that **stakeholders are able to conduct their roles more efficiently and share more comprehensive data sets** across the digital platform [5.1]. The platform is not only a sharing mechanism, but through its visualisation

functions is also able to provide more meaningful **situational updates for complementary data sets to be shared** among several stakeholders. These updates assisted decision makers at DMC with **critically analysing impending disasters and disruptive events** as they gradually unfolded in order to make **more informed decisions that safeguard communities [5.1]**. This helps other organisations and officials that assist communities affected by disasters: the DMC at district level now receives **more community-level information** such as data on river levels during an impending flood hazard and the platform communicates this information directly to local-level DMC representatives' mobile phones [5.1]. The visualisation functionality of MOBILISE creates a need for further comprehensive data sets and has transformed processes, thereby influencing the emergence of a **new digital strategy within the DMC [5.1]**.

At the same time, the World Bank is heavily investing in Sri Lanka to strengthen its capabilities for disaster management and has **cited the MOBILISE platform as a key contributor** to its project with the Sri Lankan Government, by demonstrating capability to **improve the flow of information** and enable information from multiple sources to be integrated and analysed to **improve decision support [5.2]**. MOBILISE is considered an **'integral part of the solution'** in building on existing capabilities in early warning and disaster risk reduction and response [5.2].

4.2. Digitally enhanced response to landslide early warnings

The National Building Research Organisation (NBRO) is a multi-disciplinary research and development institute functioning under the Sri Lankan Ministry of Defence and is the focal point for landslide risk management. It serves approximately 12,000,000 people who are categorised as urban, rural and estate communities (over half of the population of Sri Lanka) [see 5.3, 5.4].

The technologies developed by Salford have been described as a *'silver lining'* amidst the backdrop of increasing numbers of natural disasters in Sri Lanka, one of the countries most vulnerable to climate change [5.5]: Salford's research [3.1, 3.2] has informed a **new digitisation process** adopted by the NBRO to issue landslide early warning messages to other agencies (DMC, District Secretaries, Divisional Secretaries) and to community representatives, with a view to **reducing the potential threat to those living in landslide areas [5.3]**. The MOBILISE platform allows NBRO to **detect landslide threats** from remote sensors and alert relevant agencies through the platform. This then conveys appropriate information for contacting officers on the ground, enabling the communities served by NBRO to better prepare **through mobilisation into risk categories and implementation of an evacuation procedure before the hazard occurs [5.4]**. According to the Director General at NBRO, *'these messages enhance the community preparedness much quicker and we are more confident of the messages as the communications have been prepared with the common understanding amongst the stakeholders'* [5.4]. This work is now creating the functionality to **send warning information directly to citizens' mobile phones [5.4, 5.5]** and as a result of Salford's collaboration with NBRO, communities have been alerted to impending natural disasters much earlier than previously, thereby **'saving many lives'** [5.5]. The platform additionally *'provides the drone-based analysis for the landslide mitigation activity monitoring and provides the Virtual Reality (VR) experience of the site before the constructions'* [5.4].

4.3. Provision of real-time situational updates and flood early warnings

As part of a joint initiative with the Lions Club of Colombo, a community service organisation operating across the globe, new sensors have been installed to monitor river water levels in critical areas in the Gampaha District in Sri Lanka [5.6]. This area encounters flooding due to heavy rain, causing rivers to overflow during the monsoon season each year. Utilising the MOBILISE platform, key areas of the district are now able to send river level data to the monitoring stations, in addition to rain gauge information, therefore overlaying **more comprehensive data sets** and **improving local-level disaster response capability**, enabling them to **perform their key tasks with more confidence** in terms of evacuating people and preparing them in advance of a disaster [5.6]. Salford's researchers identified that the platform's effectiveness improves as numbers of stakeholders utilising the platform grow, because data and data-sharing capabilities are enhanced [3.1, 3.2]. This has enabled the translation of research into valuable community outputs so that there is greater uptake of flood advice and

enhanced preparedness measures [3.6]. According to the Divisional Secretary of the Dompe division, Gampaha District, the MOBILISE platform's quick and comprehensive situational updates allow them to '**prioritise the deployment of our flood recovery officers to the places of need within our [...] division with more confidence**' [5.7]. The Divisional Secretary added that '**this benefits our community very significantly as nearly 5000 families live in areas at risk of flooding**' [5.7]. The Lions Club's District Governor commented that extending the river gauges to other divisions of the Gampaha district has extended the number of communities served as a result of this project: '**The monitoring stations have substantially improved flood warning capacity at the local level, which directly benefits more than 50,000 families in the targeted area**' [5.6].

This new capability to effectively communicate real-time early warnings **enables communities to protect their livelihoods in advance of the flood's arrival** [5.8]. Previously, warnings were conducted manually via the local authority officers. This led to delays in reacting to impending flood events because there was little confidence in the data or accuracy of communications [5.7]. The Divisional Secretary confirmed that '**as part of the pilot, we were able to conduct a dry run to put in place a quick situational update and deploy a robust real-time early warning communication [...] The community was able to come together to implement quick measures to protect their livelihoods, most of their agriculture, and their housing under our guidance**' [5.7]. Flood victims have praised the technology for bringing them timely warnings by phone, allowing them to save their assets and reach safety before a flood event [5.8].

4.4. Improving post-disaster relocation of communities

Salford's research [3.3, 3.4, 3.5] contributed to the **enhancement of the design and execution of resettlement programmes** in Sri Lanka by informing the relevant parties of the importance of latent factors. NBRO used the outcome of these findings to **design their tools and guidelines** to capture and integrate the host community's perceptions, requirements and concerns about the resettlement programmes between 2016 and 2017, following the floods and landslide disasters faced by the resettled communities [5.9]. The new guidelines that NBRO currently use have **more strategies in place to look after the concerns of the host communities** by building disaster-resilient human resettlements [5.9]. The Director of the NBRO Human Settlements Planning and Training Division testifies that '**this helped the resettled communities to integrate better with the host communities successfully leading to a sustainable and long-term satisfaction**' [5.9].

5. Sources to corroborate the impact

5.1. Testimonial: District Disaster Coordinating Unit (December 2020), on the use of MOBILISE to inform DMC service delivery and digital strategy (4.1)

5.2. E-mail Testimonial: World Bank (March 2021), confirming the contribution of MOBILISE to its investment project with the Government of Sri Lanka (4.1)

5.3. Newsletter Article: '**MOBILISE to mobilise NBRO**', National Building Research Organisation (NBRO) (November 2020), on how the MOBILISE project informs the digitisation process (4.2)

5.4. Testimonial: Director General, NBRO (December 2020), on the use of MOBILISE to detect landslide threats and save lives (4.2)

5.5. Newspaper Article: '**MOBILISE project to fight SL's climate change vulnerability**', Daily Mirror Sri Lanka (28 December 2020), citing Salford's research and explaining the use of MOBILISE to detect landslide threats and save lives (4.2)

5.6. Testimonial: Lions Clubs International, Sri Lanka (December 2020), on the use of MOBILISE to provide flood early warnings and better prepare communities for disasters (4.3)

5.7. Testimonial: Dompe Divisional Secretariat, Gampaha District, Sri Lanka (December 2020), on the use of MOBILISE to provide flooding situational updates and protect communities (4.3)

5.8. Video Link: '**Flood warning system: bring innovation to the community**', Lions Club (December 2020), available at: <https://fb.watch/4oeEhcljil/> demonstrating the benefits of MOBILISE on communities, with comments from flood victims and Lions Club officials (4.3)

5.9. Testimonial: Human Settlements Planning and Training Division, NBRO (December 2020), on new strategies and enhanced programmes to improve relocation of communities (4.4)