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Using mobile phone technologies for Disaster Risk Management:

Reflections from SHEAR

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Introduction

The reach of mobile networks has expanded significantly over the last decade, with approximately 93% of the global population being covered by a mobile broadband network.[i] Mobile phone ownership has also proliferated rapidly, with global smartphone connections doubling in just five years and rising sixfold in South Asia.[ii] At the end of 2019, more than 3.7 billion people were connected to mobile internet.[iii] Increased mobile phone coverage, ownership, and use, has improved communications access to more people and vulnerable communities than ever before. Such access presents new **opportunities for reducing risks from disasters**.

Disasters related to natural hazards have killed 1.35 million people in the last 20 years, 90% of which were in low-and-middle-income countries.[iv] Disasters result in severe economic losses, undermining development progress and reinforcing poverty and its impacts on households, communities and countries. The destruction and damage can take decades from which to fully recover. As the effects of climate change become increasingly tangible, vulnerable and hazard-prone communities face growing, complex, and **worsening challenges**.

In addition to supporting resilience building and response activities, the expansion of mobile coverage, the increase in mobile phone penetration and use, and advancements in mobile enabled technologies provide **new opportunities** to support Disaster Risk Management (DRM) in emerging economies.

However, mobile phone technologies are not a universal panacea; we must **learn and adapt** our approaches to enable us to make the most of technologies in an appropriate and inclusive way.

The Science for Humanitarian Emergencies and Resilience (SHEAR) programme supports world-leading research to enhance the quality, availability and use of risk and forecast information. Researchers and practitioners are working with stakeholders to co-produce demand-led, people-centred science and solutions to improve risk assessment, preparedness, early action and resilience to natural hazards.

In October 2020, SHEAR hosted a virtual workshop which explored the **use of mobile technologies to support DRM**. The workshop brought together approximately 45 members from 20 organisations across the SHEAR Programme and a selection of external experts to share and record their experiences. Participants included physical and social scientists, public and private researchers, technological developers, Non-Governmental Organisations (NGOs), and federal, local, and intergovernmental officials.

The educational and professional backgrounds of these workers was highly varied and included: scientific experts involved in trialling new technologies; experts working more closely with communities in developing countries over long time periods; those involved in the short-term distribution of emergency aid; non-professional participants ("citizen scientists") in community-level initiatives; and data visualisation and risk communication experts.

The **breadth and depth of expertise and experience** from workshop participants provided an opportunity to gather key learnings and examine common challenges and opportunities where mobile technologies could be usefully harnessed through different stages of the DRM lifecycle, and across different regions.

This publication summarises the key learnings from the workshop: how mobile phone technologies are used in DRM, and the opportunities and lessons for applied research.

Examples of mobile phone technologies used in DRM[v]

Apps

>Huge variety
>Usually context-specific
>Data upload
>Contribute to modelling
>Information display
>Often integrated platforms

Photo and video

>Can be geotagged
>Used by apps, social media
>Direct calculations
>Most smartphones
>Tangible and engaging

Sensing technology

>Attached to smartphones
>Increasing sophistication
>Link to professional science
>Suitable for most hazards
>Becoming cheaper

Social media

>Popularity location-specific
>Emergency response
>Rapid information sharing
>Informal and formal use

Position data

>Emergency response
>Evacuations
>Mobile signal is enough
>Mobile GIS
e.g. Open Street Map
>Risk, vulnerability maps

SMS messages

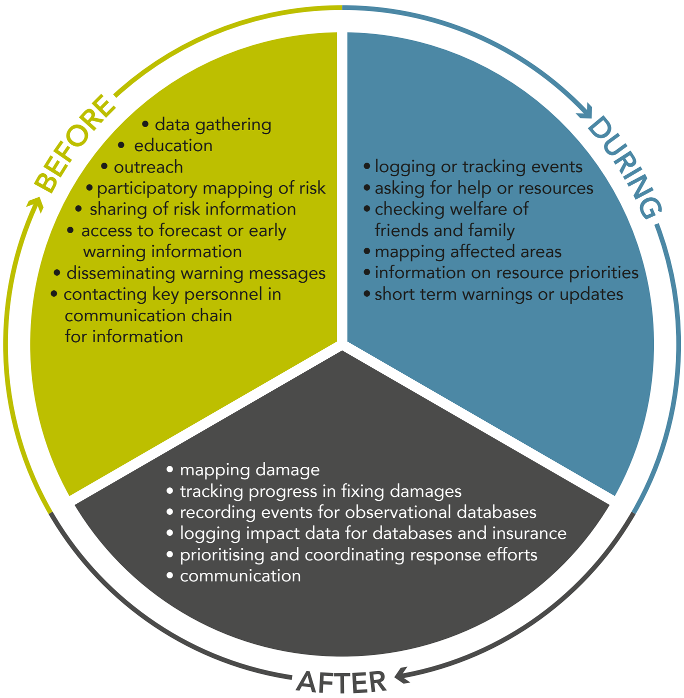
>Low cost
>Minimal information
>Target a mass audience
>Marginalised communities
>Generalised alerts

Voice calls

>Non-smartphone
>Manual data transfer
>Uncommon today in DRM

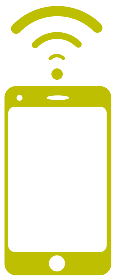
Mobile phones in Disaster Risk Management

Disaster Risk Management is the application of policies and strategies to prevent new disaster risks, reduce existing disaster risks, and manage residual risks, contributing to the strengthening of resilience and reduction of losses. Mobile phone technologies have been used or tested throughout the DRM cycle and can be active before, during and after a hazard event.



BEFORE

SHEAR example: SHEAR PhD students working in the Indian Himalayas used mobile phones extensively for conducting research to understand the disaster context and people's experiences related to landslides. They used phones for contacting participants, recording in-person interviews, conducting remote interviews, and capturing geo-tagged photos of landslides. It was noted participants preferred talking over the phone rather than corresponding via email, and the multi-use nature of mobile phones helped with portability of equipment for field work.



DURING

SHEAR example: In the Landslide-EVO project in western Nepal, text messages are used by community stakeholders to report informal measurements of river level and propagate flood alerts downstream.

AFTER

SHEAR example: Technology developed by FloodTags by using real-time Twitter data is being used in the Philippines by responders to map out flood impacts and advise disaster response action. This approach is providing information that did not exist for responders to use previously.

Opportunities

The expansion of mobile coverage and the increase in mobile enabled technologies provide new opportunities to support Disaster Risk Management in emerging economies. Four broad themes were identified during the workshop and are outlined in the following sections.

INSTANT DATA

Mobile phone technologies have the potential to provide access to instant and immediate data which aids early response action.

The ability of mobile phone technologies to transmit information instantly, or to connect with someone directly in numerous remote geographic location allows rapid and reliable collation, access, and dissemination of data and/or information useful in disaster contexts.

Rapid data and information for decision-making

Faster information flows increase capacity for early response and encourage efficient resource delegation in disaster response actions. In this way, mobile phone technologies can bridge a gap in disaster management by enabling rapid and reliable dissemination of information before, during and after a disaster, when decisions and actions need to be taken quickly in order to save lives.

Access to remote locations

Natural hazards occur across the world and do not align to human administrative boundaries. Often, they occur in remote or difficult-to-access locations, and can increase the difficulty of accessing affected communities. Fast expanding coverage also means that data can also often be sent in near real-time to **remote or disparate locations**, circumventing geographic remoteness.

Providing new data from citizen science

This can, for example, allow data to be gathered by citizens or key people in instances when monitoring or observational scientists or officials are based in a different location. This circumvents the need for scientists to physically travel across long distances to collect the data themselves, reducing time delays, potentially missed observational data, and resources needed to collect the data. Data collection is not restricted to what is achievable from finite specialist team resources; mobile technologies can provide direct access users over wider geographical areas, enabling a greater quantity of data to be collected in a way which is significantly more time, labour, and capital efficient than static observational networks or intensive field visits. This increases access to more information from the local context, **creating richer**

data sets and providing an opportunity for people to more actively participate in data gathering activities, where they chose to.

Data quality

Apps or online forms can also provide a filter for data quality checks, ensuring **consistency of data** collection without the requirement of specific expertise and reducing errors in data gathering.

Direct dissemination of warning information

Mobile phone technologies can allow information, such as early warning messages, to be shared immediately and directly with people at risk in remote locations, reducing the amount of time this vital information takes to reach them and therefore providing **longer lead times** for them to take action or prepare in advance of a disaster and potentially reducing the impact of the event on them.

Workshop example: The myHAZ app allows data on natural hazards to be collected by community members across remote and disparate Caribbean islands, transmitting it directly to a central location for analysis by authorities and specialists.

SHEAR example: In India, the national level actor mandated with overseeing and maintaining a landslide inventory for the whole country is the Geological Survey of India (GSI). The GSI landslide team and staff of the District Disaster Management Authority are sometimes unable to physically travel in a timely manner to every landslide occurrence to record it, as the landslides are often removed within the days following their occurrence (e.g., if blocking a road). The LANDSLIP project has developed the content for a landslide tracker methodology to engage local actors, in both paper and mobile app format, with the app's concept and software developed by Amrita University and available for free on Google Play Store. The content for this methodology was developed and fine-tuned by domain and field experts from within the LANDSLIP consortium, and provides a way for local officials, NGOs, or volunteers to collect the appropriate data needed for the GSI to use for further analysis, such as landslide susceptibility or forecasting. This enhances both the quantity and quality of data that can be collected, without the need for experts to travel to every landslide event.

WIDESPREAD COMMUNICATION

Mobile phone technologies can enable widespread and real time communication between experts and vulnerable communities.

Direct information sharing with more people

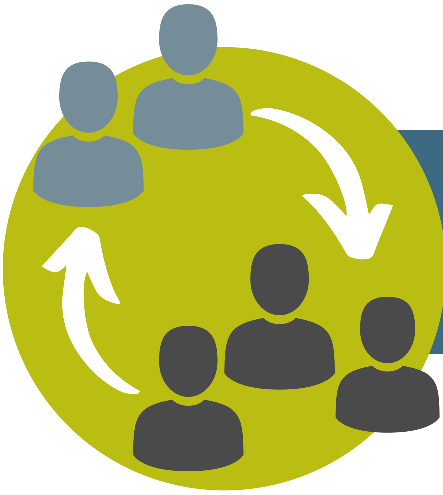
Many people across the world are affected by disasters on a regular basis; between 1998 and 2017, natural hazard-related disasters killed 1.3 million people and left a further 4.4 billion injured, homeless, displaced or in need of emergency assistance.[vi] The widespread reach of mobile phone connectivity simultaneously allows **direct access** to people at risk and to information by those people. In some circumstances, this direct access has been more effective than traditional instrumentation and communication practices in terms of speed of transmission of information and number of people reached.

The penetration of mobile phone ownership allows direct access to a large proportion of the population, improving the ability to **share vital information more widely** with those potentially at risk. For example, social media can be harnessed to share information to a wide audience base, such as through Twitter or Facebook. Similarly, using WhatsApp to communicate with a group of stakeholders and share information can provide a communication channel that is widely used in many countries and can be easily adopted for Disaster Risk Management purposes.

Varied and tailored communication methods

Effective DRM is built on communication and active engagement across a wide range of stakeholders with diverse backgrounds, including local community members, government officials, civil society actors, and experts. Communication via mobile phone technologies can be **tailored for specific audiences,** responding to their needs and preferences. Mobile phone technologies provide access to a range of ways of communicating, including verbally, through written text, numerical, and/or via visual information. Mobile-enabled services can be designed to provide different levels of complexity for different levels of expertise, allowing the information, language, content, and delivery channel to be appropriately designed for specific stakeholder groups.

SHEAR example: In the Landslide-EVO project it was observed that flood warnings and predictions (such as magnitude and timing of flood waters) in Nepal are sent directly to mobile phones of people at risk via push SMS messaging by the Department of Hydrology and Meteorology.



TWO WAY COMMUNICATION

There is opportunity for 2-way + conversations through mobile phone technologies where communication between citizens, scientists and disaster managers is possible.

A vehicle for feedback

Disaster Risk Management relies upon collaborative working and communication across many different types of stakeholders. The changing nature of disasters, and the rapid advancements of science and technology, mean that DRM strategies and interventions need to continually evolve and improve to respond to the changing environment. Mobile phone technologies not only provide a way of disseminating information to stakeholders, but can also provide a vehicle for **feedback mechanisms** that allow for open dialogue and discussion across stakeholders.

Improved understanding between science and users

This ability to have a conversation across and within stakeholders can not only improve the education and outreach of risk information to a wider population, but can also provide insight for scientists and experts into the needs and capacities of people at risk, improving **scientific literacy** both ways. This leads to both greater understanding of risk among the local community and also sensitisation of local or national government officials or scientists about the vulnerabilities and concerns of the region.

Supported engagement from users

This feedback can not only help improve the system, but can also promote further **engagement** in the project or system in the longer term. For example, volunteers who collect data can be rewarded with feedback on what action was taken as a result of data collected to encourage greater use and increase motivation for further data collection. This is particularly important in contexts where government resources are limited and DRM relies on the support and engagement of local communities, civil society actors and volunteers.

Enabling better relationships for impact

Mobile phone technologies can often result in benefits by providing a focal point and method of communication which can enable project members to **build relationships and networks** between key stakeholders and create spaces for conversations about data collection, access, and use. These benefits can often be overlooked and may be less appreciated or valued, particularly in physical-science focused research projects. However, these benefits are essential in achieving real-world impact and change, for example, mobile phone technologies can have a democratising effect by eliminating barriers between stakeholders that would never have spoken to each other before, such as a farmer in a remote location in western Nepal speaking directly with senior scientists from the Department of Hydrology and Meteorology. These relationships are vital when dealing with disasters and collaborating across stakeholder groups. The knowledge generated from the process related to developing mobile-enabled services which are useful and used, centred on targeted users and their needs, can continue to be valuable beyond the project and for other applications.

Workshop example: The myHAZ app has been designed as a three-way communication tool between citizen users, scientists, and disaster management authorities. The app can be used to collect data and share information, allowing open access to all users. It is also a platform for feedback to facilitate improvements and for discussion.

Workshop example: The Dartmouth Flood Observatory (DFO) flood application incorporated a feedback button within the app after requests from the users. The new button allows users to suggest improvements and report challenges directly to the producers of the app.

EDUCATION AND EMPOWERMENT

Mobile phone technologies can provide a way to educate and empower people by increasing access to hazard related information and knowledge.

A mechanism for outreach and education

Communities at risk are central to Disaster Risk Management. Mobile phone technologies can provide a channel for **outreach and education** of those at risk. Easy-to-use mobile-enabled services and access to the internet can be a means of providing education and information materials to more people at risk. New technologies in particular can encourage student and youth engagement and access to information. Targeting youth education is a useful pathway for propagation of information to parents and wider community members, as well as a useful means of enhancing and safeguarding future scientific capacity.

Supporting empowered decision-making

Access to information and to other people via mobile technologies can also provide people with the tools and knowledge which can in turn **empower** them to make decisions, participate actively and confidently in discussions, and take actions to reduce their risks to disasters.

Improved accessibility and inclusivity

The range of platforms and ways of communicating via mobile phones can also increase **accessibility and inclusivity** to a wider population. Technologies such as group chat and video conferencing can remove some of the barriers to participating in discussions and decision making, particularly barriers related to physical distance and remoteness. For example, focus groups can be run on WhatsApp, providing an accessible way of communicating or entering into dialogue without the need for physical travel to a central location. This can enable conversations to be more inclusive by removing the time and resource intensity of attending in-person focus group discussions.

Higher tech solutions such as apps are not the only way to increase accessibility. For example, Interactive Voice Response (IVR) and Unstructured Supplementary Services Data (USSD) can widen participation in solutions based on basic mobile handsets. It is important to acknowledge the existence of the digital divide and understand what barriers may exist to meaningful participation for all individuals. Existing inequalities need to be recognised, understood, and inform design of solutions so that mobile phone technologies and dissemination channels can meet people "where they are". For example, if individuals only have access to a basic phone and are illiterate, IVR may be a more appropriate solution for reaching them.

A platform for shared learning

Mobile phone technologies also provide a way of **learning from each other** by providing a means or platform for getting different stakeholders dealing with disasters together. This can be within a project, for example, bringing different specialists together to design a mobile-enabled service. It can also be a way of facilitating engagement between community members and scientists or researchers.

Workshop example: The HazardAlert group run by the civil society organisation SaveTheHills, uses WhatsApp to distribute information about landslides and weather forecasts across its network to reach more people at risk in the Himalayan region of Darjeeling and Sikkim, India. To maximise impact, members of the group have been carefully selected to capitalise on key people and organisations as effective nodes to enable further dissemination of information beyond the group.

Lessons learned

Despite the opportunities mobile phone technologies present, there remain some challenges. Some of the considerations that may help to improve either safety, efficiency or effectiveness of mobile phone technologies in disaster management are outlined below.

There is a need to understand local contexts, dynamics and needs before utilising or creating new mobile-enabled services. The product should be demand-driven as far as possible, involving action-based training and a human-centred design methodology to elicit user requirements. The workshop developed six key lessons learned from project experience, which are outlined in this section.

1 AVOID PARACHUTE SOLUTIONS

Local contexts, dynamics and needs should be understood before utilising or creating new mobile apps. Ideally mobile products should be demand-driven, involving action-based training and a human-centred design methodology to elicit user requirements. This requires avoiding parachute solutions, and instead encouraging research that understands the needs of specific communities before developing any solutions.

Interventions or applications that are “parachuted in” are chosen without prior knowledge, consultation, or understanding of the local context. These parachute solutions are problematic as they often do not respond to the **needs of stakeholders** and are not **appropriate** for the context. This often results in “solutions” that do not work in application and are not sustainable beyond project funding. In worst case scenarios they can introduce more problems than they solve.

Design technologies that support engagement

Approaches that rely on the participation of citizens need to consider **motivation and incentivisation** for engagement to increase likelihood of uptake and sustainability of technologies. Whether the mobile phone technology is locally relevant and useful from a participant livelihood perspective should be considered; rewards for active contribution such as financial payment or recognition and social reward can support engagement.

Avoid stakeholder disillusionment

Parachute solutions can result in unsustainable, unnecessary or inappropriate technologies. This can lead to **disengaged and frustrated stakeholders**, particularly in contexts where disasters occur. The gap between what is needed by stakeholders in-country to deal with the ever-present challenge and damages from disasters, compared to the requirements and interests of researchers can lead to damaged relationships and perceived “wasted” resources.

A challenge for applied research

This is a particular **challenge with research into application** projects where project funding cycles can mean that researchers are working in contexts they do not have previous experience in or existing connections to; researchers have limited time for activities to understand the context before developing proposals; and/or researchers are encouraged or required to propose new or innovative technology and science solutions that may not be appropriate in application, particularly in developing country contexts. This needs to be considered carefully as mobile phone technologies are a topic of increasing interest in research funding calls.

Design appropriate technological solutions

Research that understands the needs of specific communities or user groups should be encouraged before developing any solutions. It is important not to enter into a community with pre-ordained assumptions about what their challenges are and what your proposed solution is. Before beginning designing a solution, researchers need to **understand the local context**, including relevant actors, power dynamics and local economies. This can help with designing an appropriate solution that could be sustainable beyond project funding.

Social scientists, practitioners, and local actors are essential resources. Their knowledge, skills and connections can be harnessed to help capture and better understand existing and/or indigenous knowledge. This knowledge is invaluable for ensuring that solutions are designed appropriately for the context in which they are being applied and to help prevent 'reinventing the wheel'.

Understand users

The most appropriate solution will depend on the user group identified. This can vary, including mobile phone technologies aimed at the public, selected key champions, emergency responders, professionals, civil society actors, and/or government officials. **Clearly defining the user groups** is essential to designing and tailoring technologies appropriate for their needs.

Utilise existing technologies

Communities in different contexts often have preferred and widely used specific social media platforms. These vary between contexts. It is important to identify what platforms are available and already being used before designing any new intervention. **Building on existing platforms** or "piggy-backing" them can ensure greater uptake, acceptance and retention. This is a more sustainable approach compared to developing a new mobile phone technology or service that require people to learn and develop new behaviour patterns to use. This is particularly important in Disaster Risk Management contexts where ease of use is a vital component to improve engagement in high-risk situations.

Recognise cultural differences in the use of technologies

During the workshop, there were also discussions on the different cultural or user group **expectations** in the use and purpose of mobile phone technologies, including the response expectations to different platforms. For example, some people mute messages in WhatsApp if a channel is overactive or if they receive messages during the night when phones are on silent, or turn their phones off in contexts where access to or costs of mobile phone charging is a barrier, potentially reducing the platforms effectiveness, particularly in disseminating urgent warning information in disaster events.

SHEAR example: The mobile phone app, developed by Amrita University in conjunction with other partners within the LANDSLIP project, to collect landslide observation data has different levels of access, specifically tailored for different user groups, with the higher levels requiring more expertise in landslides and geology. Level one is designed for the general population, whilst the highest level is designed for Geological Survey of India and other expert geologists to collect more detailed data during field visits.

2 RECOGNISE VULNERABLE COMMUNITY MEMBERS

Vulnerable members of communities, such as the elderly and women, should be recognised within design. Design that recognises pre-existing socio-economic vulnerabilities allows for more equitable access to information and equitable participation in data generation.

Gender inequality and social marginalisation increases vulnerability to disasters. The less economic, political, and cultural power people have before an event, the greater their suffering during and in the aftermath. Mobile phone technologies need to be **designed according to the needs, capabilities, and preferences of vulnerable groups** in order to reach those most in need.

Potential for improved inclusivity

Vulnerable community members risk being excluded from Disaster Risk Management decision making. Mobile phone technologies can provide a way of increasing accessibility and **inclusivity** to participate in decision making processes, but it is not without barriers and challenges.

Existing inequalities affect access and use of technologies

Inequality in economic capital, access to technology, and social capital have a direct impact on access to mobile phone technologies, resulting in a **"digital divide"** particularly for poorer community members. For example, women living in low- and middle-income countries are 8% less likely than men to own a mobile phone, and this gap increases to 20% when it comes to mobile internet.[vii] This gap varies depending on the context, for example in South Asia the mobile internet gender gap is significant at 51% in 2019.[viii] Further these digital divides are accentuated in post-disaster contexts.[ix] This results in women and other marginalised groups being excluded if such divides and barriers are not taken into account, and mobile-enabled services are not designed with their needs in mind.

Inequality in education and literacy levels affects the capacity to receive, understand, and act upon complex risk information. The method of communicating needs to be carefully considered, including potentially providing **alternative ways of communicating** that can circumvent literacy and language barriers, for example verbally, visually or using translators. **Training** in the use of technology may also be necessary to enable active participation, and the resources to support this should be built into project design.

Technologies need to be designed inclusively

Vulnerable members of communities need to be **recognised and consulted** with to design appropriate mobile-enabled services. Efforts to consider vulnerability when designing appropriate mobile phone technologies for DRM need to be intersectional including understanding ethnicity, age, health, disability, lack of political rights, low social capital, gender, gender identity, and sexuality.

SHEAR example: A SHEAR PhD researcher found that in communities in Nepal, women had less access to mobile technology despite being the subset of the population most vulnerable to disaster effects. During the SHEAR workshop, the researcher encouraged an approach that was sensitive to these vulnerabilities and called for more thought on how technology can address these root causes of vulnerability.

SHEAR example: The NIMFRU project identified different vulnerabilities of individuals within the Katakwi district in Uganda, informing the development of the RAINWATCH application.

Workshop example: The GSMA Mobile for Humanitarian Innovation programme advocates extensive assessment of local contexts to understand who is able to access technologies, and who is excluded before implementation of solutions. The GSMA Connectivity Needs and Usage Asssessment can be used to understand mobile phone access, usage, preferences and digital skills amongst populations of concern in a robust and standardised manner.[x]

3

LANGUAGE AND LITERACY

Factors such as language and literacy should be discussed before apps are developed to ensure relevance to target communities.

People affected by disasters vary widely including for example their education, capacities, language, and literacy levels. Considering factors such as language and literacy should be **discussed and considered before interventions are designed**.

Make use of the variety of communication methods

Mobile phone technologies provide access to a **range of ways of communicating**, which can support inclusive access to appropriate forms of information, including verbally, through written text, numerical, and/or via visual information. Mobile-enabled services can support moving away from words and barriers to language by using more visually-based communication methods such as images and icons. This can be a useful alternative method of communicating as long at the images used are contextually specific and unambiguous. In the absence of smart phones, text message, images, and/or photos of hand-written information can be sent via SMS, IVR can enable interaction with recorded audio content, and USSD can enable the simplified access to content menus.

Technologies can circumvent language barriers

Using mobile phones to access the internet, use chatbots, or use apps for **translations** can remove some of the barriers to accessing information in other languages, particularly in contexts where multiple languages are spoken within a country. This provides an opportunity to incorporate local languages, which not only results in greater outreach, but also increases access to a wealth of information that spans and includes a wide and diverse range of perspectives, experiences and capacities.

Workshop example: The GSMA Mobile for Humanitarian Innovation programme supports GeoPoll, an organisation providing remote, mobile-based research in emerging markets, who are working alongside the World Food Programme (WFP). Computer-Aided Telephone Interviews (CATI) are used to collect information from large numbers of individuals via voice call surveys. CATI are undertaken across sub-Saharan Africa to support the WFP analysis of food insecurity patterns and to generate predictive modelling of where interventions may be needed.

4 DATA OWNERSHIP AND PROTECTION

Having a clear understanding of the intellectual property of the app or system and a clear long-term plan for how data will be appropriately managed and maintained is important to think through from the outset. Having clear and transparent data management protocols, especially when social media platforms such as WhatsApp and Twitter are being used, is imperative for trust and success

Data ownership and protection is an important issue for developing mobile phone technologies that collect or use data. It is critical to consider the type of data that is to be used or collected, and the associated privacy requirements. This can be complex and evolving, but should be **considered, discussed, and agreed collectively and transparently.** It should be remembered that who has access to the data may be different to who has the intellectual property rights of the technology, and this can also be different to who owns and maintains the data longer-term.[xi] Data Protection and data ownership protocols do not necessarily mean that the data will be used in way that maintains the user's privacy, including their expectations and rights.[xii]

Consider privacy and ethical issues related to data access

Access to data needs to be agreed, such as whether to be open access, selective access, or closed. This needs careful consideration particularly when data contains sensitive information as there are **privacy and ethical** issues. For example, when using social media applications like WhatsApp, it is important to consider how privacy can be maintained as personal information such as phone numbers are accessible to anyone included in a WhatsApp group.

Intellectual property rights need to be clear

Intellectual property of the technology needs to be transparent and clear from the beginning. This needs to consider both who has recognition for the technology, who "owns" the technology, whether the technology is "open" or "black-box", and how this might evolve when moving from research into operational settings.

Consider the lifetime of the data

Agreement on **sustainability, ownership, security, and maintenance of data** is an important consideration when embarking on this sort of activity. It should be recognised that often this role or responsibility for taking ownership of data can be highly resource intensive to maintain long-term, requires funding to run beyond the project lifetime, and demands specialist skills to be done effectively. It is important to determine whether the data being used or collected is considered personal data. There are laws and regulations guiding who the data processor and data controller of personal data is, and these will usually stipulate how long a company or organisation can hold on to users' personal or sensitive data for.

Formally agree clear rules and regulations

Developing written **guidance, rules and regulations** based on best practice examples can help to provide an approach to dealing with these issues that is clear, unambiguous, and agreed a-priori.

Workshop example: SaveTheHills reflected that maintaining the HazardAlert WhatsApp service in Darjeeling and Sikkim, India is administratively highly intensive and requires significant time and resources to manage and maintain full-time. However, SaveTheHills also reiterated that the success of the group is attributed to the disciplined and voluntary involvement of all its 228 members.

5 AN APP IS NOT A PANACEA

Recognising that an App is not a panacea and may not be the most appropriate solution for the users in certain contexts. For example, the Landslide EVO project demonstrated that some elderly populations in Nepal did not own smartphones and were not interested in engaging with them anyway.

Research projects that exploit innovative technologies such as apps are increasingly well-funded, responding to the global spread of smart phones and cutting-edge technology. Despite the availability of funding for developing new apps, it should be recognised that they are **not a universal solution** and may not be the most appropriate solution in certain contexts, for a variety of reasons.

Technologies may not respond to needs

In many situations, particularly in developing countries, it may be that an app is **not a useful or appropriate tool** to address the existing challenges and needs of communities. A completely different solution or low-technology approach might result in greater impact and benefit to communities at risk.

Access and use of technologies are affected by social inequalities

It should be remembered that **smartphone ownership is not universal**, particularly in developing countries, and especially for the poorest or most marginalised within communities. Globally, smartphones account for around two thirds of total mobile connections, but the rate is lower in low- and middle-income countries. In Sub Saharan Africa, in 2020 smartphones accounted for below half of total connections.[xiii] There is a significant gender gap in smartphone ownership, with women in low and middle-income countries 20 per cent less likely than men to own one.[xiv]

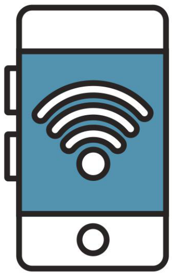
Technological literacy is not guaranteed even across those who own or have access to a smart phone. This may mean intensive training is required to educate people on how to use new mobile-enabled services.

The **costs** associated with owning smartphones, accessing or buying applications, or using the internet may be prohibitive to many, particularly poorer people.[xv] Often a solution to ensure longevity and maintenance beyond the development of an app is to require purchase of the app to self-fund over longer timescales. Making apps free is often a challenge for developers. Cost to users may exclude those who cannot afford to do so.

Approaches place burden of responsibility on users

Developing new mobile-enabled services for use assumes a **burden of responsibility on users**, requiring them to change behaviours to use something new on top of their normal habits. This can be difficult to guarantee as new technologies are often far down the priority list of many of the most vulnerable communities, who might be more concerned with, for example, ensuring a good harvest, putting children through school, supporting elderly relatives etc. Designing systems that provide positive feedback to promote using new mobile-enabled services may be needed, or focusing efforts on user groups, such as government officials, who may have resources to support continued use, to increase incentivisation and uptake.

SHEAR example: The FloodTags project targeted volunteers and first responders to be data collectors in Tanzania to complement the existing media data available. In order to encourage involvement of these reporters, the FloodTags team chose to use an existing and commonly used platform (Telegram) and build on the users' pre-existing behavioural patterns. The team also communicated information and actions to the volunteers and responders via the platform, rewarding their use and provision of data with information that was useful to them.



6

INTERNET ACCESS

Variability in internet access, due to cost and connectivity, was outlined as potentially prohibitive for some communities that were using mobiles in DRR.

For many people, mobile phones are the only means of accessing the internet, helping to unlock significant and life-enhancing knowledge, products and services. At the end of 2019, more than 3.7 billion people were connected to mobile internet.[xvi] But over half the world's population remains unconnected and there are significant disparities in its availability and use across regions.[xvii] There are barriers to accessing the mobile internet, particularly in developing countries, including lack of connectivity, variable network strength, lack of access to technology, or affordability barriers.

Connectivity varies spatially and temporally

Connectivity may vary depending on geographic location. For example, in urban areas **mobile coverage** is often better, as the infrastructure is developed to respond to the population density and needs of communities. In more remote areas, mobile coverage is not as widespread. Rural populations are 37% less likely than urban populations to use mobile internet.[xviii]

Mobile connectivity can vary from place to place and temporally. For example, disasters or monsoon periods can result in damage or disruption to infrastructure, which can affect continuity of mobile networks.

Access to the internet is not universal

Access to the internet is also not an automatic given. There is a **digital divide** in access to technology, including the internet. The COVID-19 pandemic has highlighted this in 2020, where there has been an increased reliance on personal access to technology to stay connected and simultaneously maintain social distancing.[xix]

Even if internet connectivity is available, there are many that may not be connected due to a wide range of barriers including affordability; literacy and skills; and safety and security. **Costs can be prohibitive** for poorer, and therefore more vulnerable, communities.

Technologies that do not rely on the internet can provide alternatives

Mobile services that do not require a smartphone such as phone calls or text messages can be used to circumvent some of these issues related specifically to internet access. However, even these more basic phone technologies can be affected by: prohibitive costs; access to mobile phones; strength or disruption of mobile phone coverage in mountainous or remote locations, or during disaster events for example caused by disruption or damage to infrastructure; and/or variability in consistent access to energy sources to charge mobile phones particularly in poorer communities, during disaster events, or within displaced populations. Back-up or alternative methods of communicating or transmitting data should be considered for these contexts, building redundancies into the system.

SHEAR example: The Landslide EVO project set up student rain gauges in two secondary schools in western Nepal. Students took photos of the rain gauge records and sent them via text to Kathmandu, where the readings were recorded in Excel in a central database. The results from the database were then transformed into graphs and sent back to the students via text message.

Workshop example: In response to user requests, producers of the DFO Floods app redesigned the app so that maps, such as flood extent and population data, can be downloaded and available on the app whilst offline. This allows users to access the data and information whilst out in the field, without requiring internet connectivity.

Sustainability

The issue of sustainability was discussed in detail during the SHEAR workshop. Participants defined a sustainable project as one that can be taken up locally and which continues beyond the end of project funding cycles. This allows for the projects to achieve long-term meaningful change and having direct impact on real world issues.

Researchers across the projects highlighted the importance of involving users and stakeholders throughout the design and implementations process of using mobile phone technologies in Disaster Risk Management. The goal is for mobile phone technologies to be "useful, useable, and used", which can be facilitated by the approaches outlined in this section.

PLACE USERS AT THE CENTRE OF DESIGN

Interventions need to be demand-driven as far as possible, responding to the needs of users. Focus on digital needs assessments to determine availability of and access to technology as well as levels of digital literacy. This will increase the chances of uptake, retention, and sustainability, and promote trust in the mobile phone technology within communities.

PLAN FOR SUSTAINABILITY FROM THE BEGINNING

Think about sustainability and ownership of technologies and data from the beginning. Be aware that technologies will need to be updated and maintained in the future if they are to be continually used beyond project timelines.

VALUE SOCIAL SCIENCE AND PRACTITIONER EXPERTISE

Social scientists and practitioners are invaluable in designing evidence-based assessments of user needs, and providing a bridge with users. Their skills and expertise should be considered equally valuable alongside the development of mobile phone technologies. Interdisciplinary teams will likely lead to more successful real-world applications and sustainable innovations.

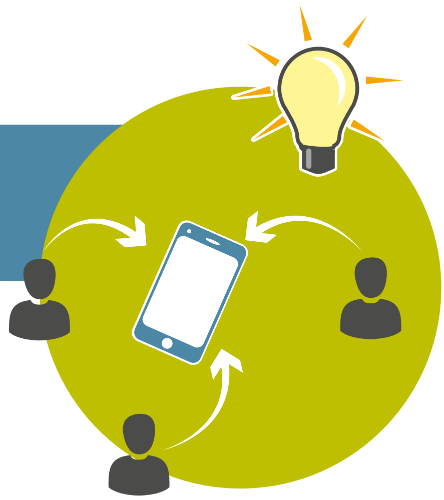
TAKE AN ITERATIVE APPROACH

Continuously and iteratively adapting the functionality of the mobile-enabled service being developed is needed in order to cater to the needs of the particular context or user group. An evolving and flexible approach is needed to respond to real-world needs and integrate feedback from users.

BE TRANSPARENT IN DATA MANAGEMENT

Data management protocols, and the roles of who maintains the data, need to be clear and agreed amongst stakeholders.

CONSIDER PARTICIPANT MOTIVATION



Designing approaches to support participant motivation will directly affect the uptake and use of technologies. Consider issues related to technology relevance, usability, social rewards, and financial incentivisation.

Conclusions for applied research

The **SHEAR programme** is a useful example of applied research and has multiple examples where mobile phone technologies can and are being used for Disaster Risk Management. As an interdisciplinary, international research programme working with stakeholders to co-produce people-centred science and solutions to improve risk assessment, preparedness, early action and resilience to natural hazards, the **learning** from programme members can be useful for others embarking on applied mobile phone technologies research.

Workshop participants recognised the tension between the **dual demands of applied research**; balancing user needs by focusing on application and impact, and the requirements of carrying out new, cutting-edge innovations in science and technology for research purposes. **Involving stakeholders** throughout a project was agreed to be essential to achieving impact. Also, there was recognition of the benefit the **range of skills and expertise** SHEAR projects provide to responding to challenges in developing countries, by bringing together specialists from physical science, technical fields, social science, and practitioner organisations. This range of expertise working together was essential to developing research-based solutions to real-world challenges.

Many SHEAR projects took an **evolving approach** to deal with this challenge: some started with the technology and science and what might be possible and developed something that might be useful through engagement and consultation with users; others began with pre-existing relationships with users and developed proposals for technologies that addressed a specific need or challenge, evolving and tweaking the technology as it was tested.

It was recognised the **sustainability** of technologies or systems beyond research projects needs to be considered carefully and communicated transparently with users, to manage expectations and avoid over-promising something that cannot be continued long-term.

Whilst not all research funding can or should be used to implement a sustainable mobile phone technology intervention, research projects can often be very useful in **providing proof of concept**. This will provide evidence that a particular technology can be operationalised. For example, the mobile phone app, developed by Amrita University in conjunction with the LANDSLIP consortium, can be used to collect landslide observation data, which could be integrated into various landslide early warning and mitigation programs in India in the future because it was designed with that in mind. Another example is the system and platform developed by FloodTags is currently being used by the Philippines Red Cross to inform and coordinate disaster response.

A reflection from the workshop was that the process of developing a mobile phone technology for Disaster Risk Management, such as an app, can develop **benefits beyond the technology** itself. For example, it can form a point of focus for improving communication, networks, understanding and relationships, both within project teams, and between producers and users of the technology. These advancements are beneficial in and of themselves, even if the technology is not used beyond the project.

SHEAR research has demonstrated that mobile phones are useful or promising for all elements of DRM. Mobile phone technologies have the potential to provide **access to instant and immediate data, which increases rapid and reliable dissemination of information and action during a disaster in the short term, educates and empowers local people in the medium term, and ensures scientific capacity building in longer-term**.

The SHEAR-hosted workshop highlighted that effective use of mobile phone technologies in DRM requires **appropriate consideration of local context, should continuously and iteratively adapted to cater to the needs of the users and stakeholders, and project design should be human-centred, and demand-driven** as much as possible.

Useful resources and further information

Arnhardt, C., Guntha, R., Singh, G., K.R Viswanathan, V., Rao, P., Halan, G., Ramesh, M. V., and Malamud, B. 2021. A Landslide Tracker Methodology to Support Local Reporting of Landslides in India, EGU General Assembly 2021, online, 19–30 Apr 2021, EGU21-15618.

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Von Engelhardt, J., and Jones, L. 2020. Using mobile phone surverys to track resilience and post-disaster recovery: a how-to guide, BRACED.

Mobile phone technologies for humanitarian purposes

Connectivity is a lifeline for people affected by humanitarian crises. Communities affected by disaster, disease, conflict and displacement prioritise mobile phone technology, not only to communicate, sustain and recover their livelihoods, seek information and protection and reunite with loved ones, but also as a tool to access humanitarian assistance. It is important to consider the broader role of mobile-enabled solutions in addressing the impacts of crisis, beyond data monitoring and early warning DRM purposes. Mobile phones can enable dignified, safe and inclusive aid for communities affected by humanitarian crisis. Mobile phones can enable access to utilities services in complex humanitarian settings, and facilitate the distribution of cash assistance. Mobile phones can provide access to critical two-way communication channels and enhance community resilience. Increasingly, humanitarian organisations are developing and delivering new mobile-enabled innovations and services to address pressing humanitarian challenges, from preparedness and early warning, through to response and long-term recovery.

For further information, read the GSMA M4H Annual Report, 2021.

Workshop projects

LANDSLIP: Landslide multi-hazard risk assessment, preparedness and early warning in South Asia integrating meteorology, landscape and society: The SHEAR project, LANDSLIP, is bringing together physical and social scientific expertise to improve landslide risk assessment and early warning in India. As part of the project, the team are working with in country project partners (e.g. Geological Survey of India, Amrita University, Practical Action Consulting India, and the NGOs SaveTheHills and the Keystone Foundation) to inform and support the development of an app and/or refine protocols to record landslide observations.

Landslide-EVO: Citizen Science for Landslide Risk Reduction and Disaster Resilience building in Mountain Regions: The SHEAR project, Landslide-EVO, is working to develop an existing flood early warning system in Nepal into a multi-hazard early warning system that also supports resilience to landslides. The team are using mobile phones to support a "citizen science" approach to build community disaster resilience through participation, in order to reduce the risk of landslides.

FloodTags: The FloodTags projects in the Philippines and Tanzania were co-funded by the SHEAR programme as part of the Challenge Fund project, a joint initiative of the Global Facility for Disaster Reduction and Recovery and the UK's Foreign, Commonwealth and Development Office. Working with local actors like the Philippine Red Cross, the FloodTags team combined natural language processing and flood modelling to improve risk information via social media activity, presenting the information in standardised maps, tables, and graphs to effectively support Red Cross response and preparedness procedures. The technology was then adapted and applied in Tanzania, developing a complimentary chatbot to be used on volunteers' phones to provide additional data and communicate back information and actions. Two years later, FloodTags brought the technique to global coverage.

NIMFRU: National-scale IMpact-based forecasting of Flood Risk in Uganda: The NIMFRU project is a SHEAR Catalyst Grant project which offers a new approach that will provide comprehensive flood impact assessments for forecast based financing across all areas of Uganda, complementing the SHEAR - FATHUM project's outputs on forecast skill with basic household economy/socio-economic information, to guide preparedness, protection and response. The NIMFRU project has been informing the development of the RAINWATCH app by improving the targeting, relevance, and communication of flood early warning in Uganda.

SHEAR PhD Studentships: The SHEAR Studentship Cohort is a cohort of 13 PhD studentships that complement and integrate further the current SHEAR-funded projects. The PhD topics have included research into the transboundary impacts of multi-hazard early warning systems and their cultural context in Nepal and India. The PhD students have also been using mobile phone technologies for disaster risk reduction research purposes in the Himalayas.

Big Data for Resilience: Under the SHEAR Programme eleven case studies and pilots explored the links between big data and resilience. The concept of the myHAZ app for St. Vincent and the Grenadines was explored by this pilot project and then taken forward by the British Geological Survey through its Official Development Assistance (ODA) Programme.

GSMA: Mobile for Humanitarian Innovation Programme: The GSMA represents the interests of mobile operators worldwide. The GSMA Mobile for Humanitarian Innovation programme works to accelerate the delivery and impact of digital humanitarian assistance through a programme of work and is supported by the UK Foreign, Commonwealth & Development Office. During the SHEAR workshop, presenters highlighted the case study of the Hunger Map project led by GeoPoll with the World Food Programme, where information is collected in voice call surveys to inform analysis of food insecurity issues and preparations to respond.

HazardAlert: SaveTheHills, an NGO in the Himalayan region of Darjeeling-Sikkim in India, uses WhatsApp as a means of communicating landslide risks. WhatsApp is a popular communication tool in India and SaveTheHills uses this platform to successfully share news and information on hazards and risk effectively to the mountain communities at large. The WhatsApp group "HazardAlerts" is five years old and is used to routinely disburse information on weather conditions, heavy rain, landslides, status of roads, and important DRR announcements, directly to key members of the community.

DFO Floods application: The freely-available DFO Floods app was developed to provide central access to a wide range of information useful for flood response, including weather forecasts, flood predictions, flood maps, and population data. The application enables one location to access all relevant maps for flood response, and recent updates have supported the maps to be downloaded and accessible offline.

Links to workshop videos

- Summary video: Improving the use of mobile technologies in Disaster Risk Management
- Applying citizen science for sustainable development: rainfall monitoring in Western Nepal
- Real-time flood information using citizen posts in the media
- GSMA Mobile for Humanitarian Innovation programme
- Landslide documentation in India using "Landslide Tracker" — a crowdsourcing mobile application
- The NIMFRU project and RAINWATCH application
- Role of mobile phones in Disaster Risk Management research: perspectives from SHEAR PhD students
- The complexities in risk communication for flood early warning system in Nepal and India
- myHAZ: A multi-hazard citizen science app for St Vincent and the Grenadines
- The experience of SaveTheHills in disaster information exchange and knowledge sharing using WhatsApp
- Free mobile app of the DFO Global Flood Observatory data layers for flood response

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