DELL SAULNIER
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TOWARDS HEALTH SYSTEMS RESILIENCE TO EXTREME WEATHER EVENTS: MANAGING HEALTH NEEDS DURING FLOODS IN CAMBODIA

EBA

Towards health systems resilience to extreme weather events:

Managing health needs during floods in Cambodia

Dell Saulnier

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Abstract

Extreme weather events like floods are expected to become more common as climate change continues, putting health at risk. Systems should be able to continue delivering essential health services when shocked by events like floods and provide care for the expected new health needs caused by the shock. Resilient health systems have the capacity to maintain their functions and to change when shocked, enabling them to continue delivering these health services, yet there is little evidence about what creates resilience. The contribution of this thesis was to identify capacities that foster health systems resilience, by assessing the effects of flooding on health and the capacity of the public health system to manage health needs during floods in Cambodia.

Well-functioning health systems are key to reducing the health impacts of extreme weather events and to achieving Universal Health Coverage. This is also an issue of great relevance to Swedish development cooperation within the areas of equitable health, sustainability and climate change. Recommendations based on the findings include to: recognize context as a driving factor in developing resilience; incorporate existing community actions into health system shock responses to strengthen trust and resilience; learn from repeated exposure to shocks; and strengthen health system stability and flexibility through collaboration and relationships.

Background

By the end of this century, the health, security, and prosperity of most of the world's population will be affected by climate change (Whitmee et al. 2015). With the adoption of the Sustainable Development Goals, the Paris Agreement, and the Sendai Framework for Disaster Risk Reduction in 2015, climate change rose to the forefront as a cross-cutting issue for health and as one of the greatest threats to sustainable development (UN 2015). These three agreements call for action to achieve their respective targets by 2030. If global warming continues at its current rate, the global mean surface temperature will rise by 1.5 degrees Celsius compared to pre-industrial times by the middle of this century. This will cause a continued rise in the frequency and intensity of extreme weather events, like floods (IPCC 2014).

Extreme weather events directly cause morbidity and mortality. They can also disrupt, damage, and destroy societal systems; infrastructure for transport, communications, electricity, water supply and sanitation systems; agricultural systems and crops, livestock and food supplies; households and community buildings; and economic activities (IPCC 2012; Whitmee et al. 2015; Costello et al. 2009; Hallegatte et al. 2016). This has been shown to lead to loss of livelihoods, billion-dollar economic losses, poor sanitation and hygiene, food and water insecurity, displacement, and mental and physiological stress (IPCC 2012; Whitmee et al. 2015; Costello et al. 2009; Hallegatte et al. 2016). All these impacts can indirectly affect health, creating and exacerbating health needs in affected populations. Yet the impacts are unequally distributed to the vulnerable, who are more likely to be exposed to extreme weather events, have inadequate access to essential services like healthcare, or have fewer resources to cope (Costello et al. 2009; Hallegatte et al. 2016; Neumayer et al. 2007).

In addition, extreme weather events are challenging health system performance and undermining progress towards goals like universal health coverage. They can reduce access to health services, damage health system infrastructure, interrupt supply chains, and cause the loss or diversion of human, economic and physical resources (Curtis et al. 2017; Costello et al. 2009). The impacts test health systems' ability to provide quality, accessible, essential health services to all people without financial hardship (Global Governance Project 2019).

Floods affect more people globally each year than any other kind of extreme event – 23 million in 2018 alone – the majority of whom live in Asia (UNISDR 2015; CRED 2019). Climate change is expected to cause more frequent and extreme precipitation and longer monsoon seasons, particularly in tropical regions such as Southeast Asia. As a result, floods are expected to become more frequent and more extreme over time (IPCC 2014). The potential for exposure to floods is high worldwide, with more than one billion people in 155 countries living in flood-prone areas (Pesaresi et al. 2017).

As with extreme weather events in general, floods can affect health directly and indirectly through their impact on society. Earlier research shows that contact with flood waters has direct effects, including drowning, minor injuries, and water-borne infectious diseases like leptospirosis (Du et al. 2010; Ahern et al. 2005; Few et al. 2004). Indirect impacts include malnutrition, infectious diarrhea, malaria and other vector-bone diseases, cardiovascular events, worsened chronic illnesses, and poor mental health, caused by a combination of food insecurity, displacement, overcrowded shelters, contaminated drinking water, increased stress, and greater exposure to vectors (Du et al. 2010; Ahern et al. 2005; Few et al. 2004; WHO et al. 2013)

Health systems play a key role in protecting health and minimizing the health consequences of extreme weather events like floods (World Health Organization 2019). Health systems may need to prioritize services, functions, and resources based on the expected health needs of the population when a

flood occurs (World Health Organization 2015), a challenge that can be more difficult for low-resource systems (World Health Organization 2015). Ensuring that health systems are responsive to a diverse range of health needs is key to enhancing trust and the utilization of health system services during times of crisis, and ultimately, to improving health outcomes (Kruk et al. 2017; Kruk et al. 2015; Mirzoev et al. 2017). People need to be able to rely on the health system to provide the necessary preventive, promotive, and curative care as well as skilled management for their changing health needs during floods (WHO 2015; World Health Organization 2013; Kamal-Yanni 2015). New health needs that are caused by floods and their impact on society will emerge, as described earlier (e.g. leptospirosis). Concurrently, people will continue to experience routine health needs that persist regardless of flooding (e.g. routine vaccinations, chronic disease management) and may form the highest burden for care (World Health Organization 2013; UN Interagency Task Force on NCDs 2016).

Floods can shock health systems by decreasing the availability of system resources and/or increasing the demand for health services (Mladovsky et al. 2012). During shocks, populations may no longer have access to functioning health services to receive care for new or routine health needs (Jakubicka et al. 2010; UN Interagency Task Force on NCDs 2016; WHO 2015). When health services are disrupted, the health needs of the population are unmet. This can cause additional harm, as observed during the West Africa Ebola outbreak (Bolkan et al. 2014; Brolin Ribacke et al. 2016; Jones et al. 2016), when the epidemic caused a major reduction in health service delivery, leading to significant morbidity and mortality. Health systems should be able to manage and change if needed when they are exposed to a shock, so that they are able to continue delivering health services. In other words, they should be resilient.

Resilience is generally recognized as the ability of a system to absorb a shock while still retaining its fundamental functions and characteristics (Baggio et al.

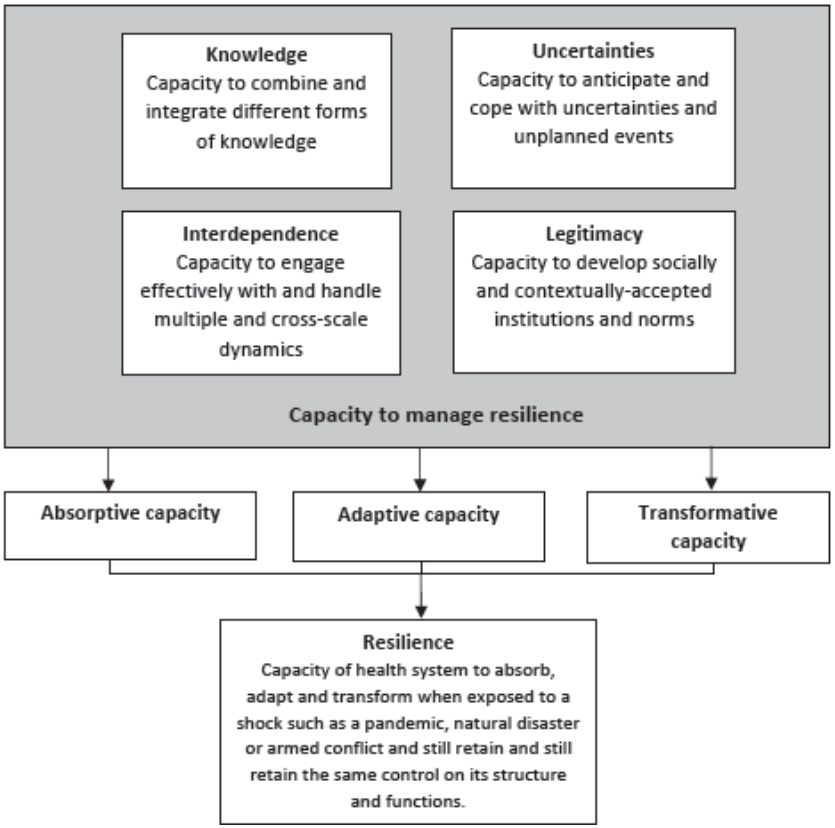
2015). It rose to prominence in multiple disciplines from psychology to economics and disaster risk reduction after its initial development within the field of ecology (Holling 1973; Alexander 2013). From there, a more dynamic interpretation of resilience arose that incorporated adaptation and transformation (Folke et al. 2010). Including the capacity to adapt and transform moved the concept of resilience away from the idea that systems can and should maintain their original state, since the original state may be a vulnerable one (Folke 2006; van de Pas et al. 2017). Instead, systems can adapt by adjusting or changing to mitigate future shocks while retaining their basic structure, or they can transform by fundamentally changing their structure to eliminate a risk altogether (Folke et al. 2010; Bene et al. 2012).

The concept of resilience has swiftly gained popularity since the 2014-2016 Ebola outbreak in West Africa. The systems in Guinea, Liberia, and Sierra Leone were viewed as vulnerable and resilience was raised as a way to strengthen health systems for acute shocks, including extreme weather events, in the future, (Kruk et al. 2015; Haldane et al. 2017; Barasa et al. 2017). Since then, the focus has broadened to include the idea of 'everyday resilience', or resilience to stresses that continually challenge the system or its ability to adapt (Barasa et al. 2018). Despite the quick adoption of resilience in the global health and health systems sphere (Abimbola et al. 2018; Turenne et al. 2019), there remains little consensus on what it actually means or how it is interpreted and conceptualized (Turenne et al. 2019; Haldane et al. 2017). There remains little evidence on how to generate or strengthen resilience in reality, a crucial step to developing strategies to promote resilience (Barasa et al. 2018; Ling et al. 2017). What behaviors, processes, and structures are needed to keep health systems functional and able to deliver services when faced with a shock and let resilience emerge?

A conceptual framework by Blanchet et al. (2017) proposes that a system's capacities to absorb, adapt, or transform when exposed to a shock is derived

from the its ability to manage four other capacities: knowledge, uncertainty, interdependence, and legitimacy (Figure 2). If a system can integrate and process knowledge about its resources, risks, and health needs, anticipate and cope with uncertainty, manage interactions with other systems, and create a legitimate system that provides socially acceptable and contextually appropriate care, then it is capable of absorbing, adapting, or transforming.

Figure 1. The Dimensions of Resilience Governance framework (Blanchet et al. 2017)



Health systems resilience has been criticized for overlooking the social, political, and economic realities of human systems (Haldane et al. 2017; van de Pas et al. 2017; Bene et al. 2012; Kelman et al. 2015; Weichselgartner et al. 2014). Haldane (2017) and Martineau (2016) argue that health systems resilience needs to be reframed as more than a single state measured through health outcomes, and acknowledge "that each health system is unique, influenced by context and circumstances" (Haldane et al. 2017). They are shaped by factors, relationships, actions, and the variety of interactions and decisions that actors inside and outside the system are able or willing to take (Martineau 2016; Van Olmen et al. 2012). These interactions and rules will depend on governance, or the people, their agency, and the power structures in a health system's context (Martineau 2016; Hanefeld et al. 2018). Governance and the governance framework are then useful for understanding what it is a system does that creates the capacity to absorb, adapt, or transform to different kinds of shocks, rather than what the system has (Bene et al. 2012).

Health systems resilience has similarly been criticized for ignoring issues of power and returning systems to a state of vulnerability without addressing the underlying causes that created vulnerability in the first place (van de Pas et al. 2017; Topp et al. 2016). Understanding how governance and issues of power influence resilience capacity will depend on the perspective that it is viewed from, which has remained underexplored in the health systems resilience literature (Ling et al. 2017). This includes the perspective of the population as both the beneficiaries of health services and the co-producers of health (Frenk 2010; Sacks et al. 2018). The actions of the population when they are exposed to extreme weather events—how they care for their health and their own capacity and resources to manage a shock—will have implications for the health system (Martineau et al. 2017; Martineau 2016; Hanefeld et al. 2018; Kieny et al. 2015).

Rationale

Extreme weather events present a growing threat to human health and can challenge the ability of health systems to function and deliver health services. As the trend for global warming continues with climate change, populations and systems may be faced with shocks like floods, and health systems will need to be able to manage the changing health needs after such events. If health systems should be able to continue to deliver health services for new and routine needs when shocked, it is necessary to know what health needs are expected. Assessing the impact of floods on health can help identify the expected health needs after future shocks and build understanding about what health systems should be resilient to.

The concept of resilience has been co-opted as a way to strengthen health systems for shocks (Kruk et al. 2015; Haldane et al. 2017; Barasa et al. 2017), but the concept is in its infancy and few studies have addressed what strategies or processes can foster resilience. If health systems are expected to be resilient, there must first be a better understanding of how resilience is generated or strengthened in health systems in reality (Barasa et al. 2018; Ling et al. 2017). Studying how existing health systems manage when exposed to a shock is one way to build understanding on what resilience actually entails. In this thesis, maternal health services – essential to maintaining health and likely to be affected by shocks (Kruk et al. 2016) – were used as an indicator of a health system's ability to cover both new and routine health needs during floods. Pregnancy represents routine health needs that do not change because of floods but still require preventive and promotive care that can be planned in advance. Childbirth and complications represent new health needs that can emerge during floods, occur suddenly or unexpectedly, and require skilled management and emergency care (Sochas et al. 2017; Kruk et al. 2016).

The research conducted for this thesis focuses on Cambodia, a country that is regularly exposed to seasonal flooding in the Mekong River flood plains and to

occasional floods in the coastal regions, and that is highly vulnerable to climate change (Yusuf et al. 2010). Cambodia provides an opportunity to not only explore the effects of repeated flooding on health, but also to examine how the health system manages health needs during floods and to assess what capacities for resilience currently exist.

Aim and objectives

The aim of the thesis summarized in this brief was to identify capacities that foster health systems resilience to extreme weather events, by assessing the effects of flooding on health and the capacity of the public health system to manage health needs during seasonal and occasional floods in two provinces in Cambodia.

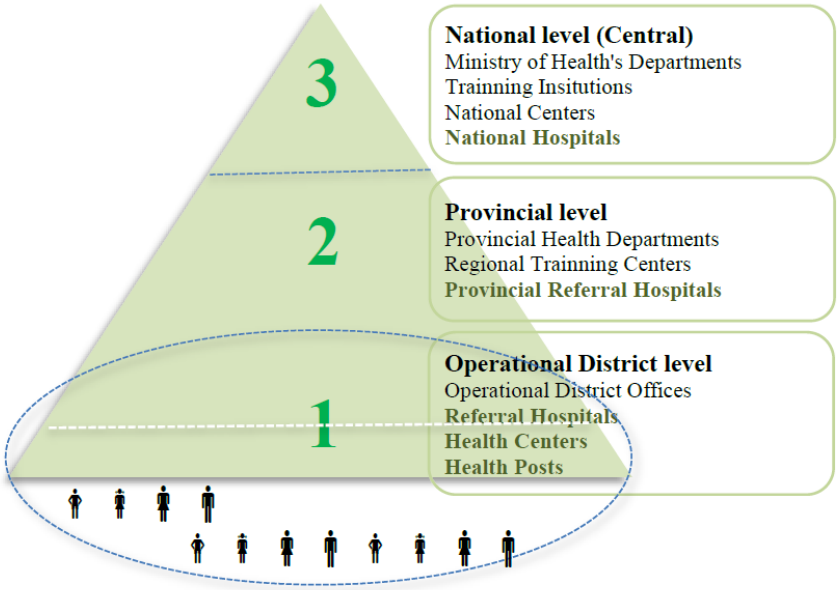
The specific objectives were to: (1) quantify the short- and long-term effects of seasonal and occasional floods on health problems seen at public healthcare facilities, (2) understand if and how the public health system's capacity to absorb, adapt, or transform is linked to the community's own capacity to absorb, adapt, or transform when managing antenatal and childbirth care needs during floods, and (3) generate knowledge about the influences on public antenatal and childbirth health service delivery during floods that are related to the system's capacity to absorb, adapt, or transform.

Study setting

The research was conducted in the Kingdom of Cambodia, a country of approximately 15 million people in Southeast Asia (National Institute of Statistics et al. 2019). The country has developed substantially since the 1990s and became a lower-middle income country in 2015 (World Bank 2018). Between 2004 and 2011, the national poverty rate fell from 53.2 % of households to 20.5 % (World Bank 2014).

The Cambodian health system is pluralistic, with a large, widely unregulated private for-profit and not-for-profit sector that provides the majority of outpatient curative care (Annear et al. 2015; Jacobs et al. 2018). The Ministry of Health is responsible for all aspects of public sector health care. The national and provincial levels oversee and support service delivery at the lower levels (Figure 4). Operational district health departments are responsible for most service delivery, although the districts remain highly accountable to higher levels of the health system and have limited decision-making power (Annear et al. 2015).

Figure 2. The three levels of the public health system in Cambodia (Ministry of Health 2016)



Health centers constitute the primary healthcare structure and provide a minimum package of preventive and curative primary care activities, including antenatal care and services for normal deliveries (Ministry of Health 2007). District, provincial, and national referral hospitals provide progressively higher levels of complementary treatment activities (Ministry of Health Cambodia 2006). However, care seeking often does not follow the intended pathway due to a variety of challenges in the public sector. There is a lack of trust in perceived low-quality services, an inadequate number and mix in the health workforce, a lack of supplies and medicines, and limited competency of health workers (Annear et al. 2015; Ministry of Health 2016). However, uptake of maternal health services is high in the public sector, with nearly 90 % of antenatal visits performed at public health centers and deliveries at public hospitals. The government has invested widely in maternal health services to strengthen emergency obstetric care, improve skilled childbirth attendance rates, change health seeking behavior, and remove barriers to care. This has included policies to promote facility-based antenatal and childbirth care and prevent the use of traditional birth attendants (Ministry of Health Cambodia 2010; Ministry of Health Cambodia 2016; Cambodia 2012).

Since 2010, the Ministry of Health has identified the potential risks to health caused by climate change and the continued limited capacity of the public sector to deal with public health emergencies, disaster preparedness, and disaster response as key priorities. The Ministry has developed several strategic plans to reduce morbidity and mortality and to enhance preparedness for and responses to extreme weather events, including floods (Ministry of Health 2016; Ministry of Health Cambodia 2013; Ministry of Health 2015). This has included developing preparedness and response plans for disasters and emergencies at all levels of the health system and for all types of healthcare facilities.

The studies summarized here were set in two provinces in southern Cambodia. Prey Veng province experiences seasonal floods during the rainy season when

excessive rainfall across the region causes the Mekong River to overflow its banks (Mekong River Commission 2015; MRC 2012). Kampot province experiences occasional inundation floods and flash floods from rainfall (Mekong River Commission 2015; MRC 2012).

Methods

Three out of the four studies included in the thesis are presented in this brief. The first study (Study I) is a time series analysis that quantifies the short- and long-term effect of seasonal and occasional floods on six health problems observed at public healthcare facilities in the two provinces: diarrhea, acute respiratory infections, skin infections, injuries, vector-born disease (malaria or dengue fever), and noncommunicable diseases (heart disease or diabetes). We hypothesized that there would be an association between the extent of flood water in the provinces and the number of visits to facilities. The number of square kilometers of flood water was mapped using NASA satellite data for each month during the period 2008–2013 and compared to the total visits per month for each health problem, taken from the national Health Information Management System (Ministry of Health 2017). We built Poisson regression models, controlling for season and year, to assess the relationships up to three months after flooding onset.

The two remaining studies (Studies II and III) were designed and conducted in conjunction with each other. Both used qualitative methods. Study II used focus group discussions and semi-structured interviews and thematic analysis to understand if and how the health system's capacity to absorb, adapt, or transform is linked to the community's own capacity to absorb, adapt, or transform when managing antenatal and childbirth care needs during seasonal and occasional floods. Data was collected in eight villages in the two provinces and included women who were pregnant or gave birth during the most recent flood or men whose partner met the same criteria, village chiefs, village health

support groups, traditional birth attendants, paternal or maternal grandmothers, and commune administrators for women's affairs.

Study III used semi-structured interviews and thematic analysis to understand the health system's capacity to deal with shocks from the health service delivery perspective. Data was collected from health centers, district referral hospitals, and the district and provincial health departments that had recently experienced flooding in the two provinces. Public healthcare providers or health department staff who had been working in their current role at the time of the recent floods, and who were expected to have experience providing or managing antenatal or childbirth services during floods, were enrolled. All focus groups and interviews in both studies were structured around the Dimensions of Resilience Governance framework (Blanchet et al. 2017).

Findings and discussions

Summary of findings

The results showed that floods had a sustained impact on new and routine health needs in the context of the Cambodian health system (Study I). These impacts presented as an increase in new health needs – for diarrhea, acute respiratory infections, and skin infections – at public facilities that lasted for up to three months. The rates of visits for diarrhea increased by 5–55 % immediately following floods and remained elevated by 6–17 % three months post-flood. Similar patterns were observed for acute respiratory infections (4–44 % increases immediately following floods, 3–20 % three months after) and skin infections (increases from 5–182 % immediately after and 5–28 % after three months). The impact on routine health needs remains unclear; there was little to no clear evidence of changes in visits for injuries, noncommunicable diseases, or vector-borne diseases.

The public sector of the health system appeared to have the capacity to absorb and adapt to manage antenatal and childbirth health needs during seasonal and occasional floods (Study III). The system's capacity was influenced by collaboration and relationships across the system and between actors and sectors that enabled stability and flexibility in their approach to preparing for and responding to floods. This was derived from the theme 'Collaboration across the system creates adaptability in the response'. The theme describes how collaboration and social relationships appeared to create clear boundaries to decision-making around antenatal and childbirth care among public healthcare providers and health department staff. Providers and staff discussed seasonal and occasional floods as strains rather than shocks. With a firm understanding of the boundaries, providers and staff reported their ability to prepare and respond to these floods in a flexible but stable manner, resulting in absorptive and adaptive capacity. Figure 3 illustrates the results using health outreach services at health centers as an example.

According to healthcare providers and staff, seasonal and occasional floods did not have a serious impact on health services but were just one of many consistent challenges to providing services. Standard routines and plans to prepare for and respond to floods existed at the health departments and facilities, with clear roles and responsibilities. Based on previous experiences with floods, facilities and health departments were able to capitalize on the available decision-making space within their role or responsibility to adjust their routines and plans to fit flooding conditions. During floods, providers and staff recognized collaboration across public health sector levels and with other government ministries, groups, and external actors as key to keeping health services functional. Providers and staff were aware of the limited that they faced in solving problems and making decisions outside their roles and responsibilities during floods and relied on teamwork and contact with higher level decision-makers to take responsibility for decisions. Relationships – particularly between the community and health center providers – made it

possible to continue providing services during floods, facilitated or sometimes hampered information sharing, and facilitated access to affected villages. According to the participants, public health centers struggled to compete with private facilities, but staff continued to improve the quality of services at their facilities and felt pride in their work and the health system during floods.

The public sector's capacity was aided by the community's own capacity to absorb, helping to relieve the burden of managing health needs on the health system during floods (Study II). The fundamental theme of the study, 'Responsible for the status quo', revealed the responsibility placed on the community to have the capacity to manage antenatal and childbirth care during seasonal and occasional floods. The theme represents the balance community members had to find when they received little additional support or help in managing their antenatal or childbirth care during floods. At the same time, they still wanted antenatal and birth care and felt that village leaders and healthcare providers expected them to continue receiving care during floods.

Community members described floods as an unpredictable force that made managing pregnancy and childbirth more difficult and felt that they needed to be ready to manage their care themselves, without the expectation of help. Men and women learned strategies to cope with pregnancy and childbirth through experience and shared knowledge and prepared to implement these primary strategies during floods. However, the strategies that they used did not always eliminate the challenges that they encountered during floods. Figure 4 illustrates the results using health outreach services at health centers as an example.

Public health centers and village leaders strongly espoused messages about appropriate pregnancy care. Women felt that their ability to make a choice about how to care for pregnancy had been reduced to one correct option: getting facility-based antenatal and childbirth care.

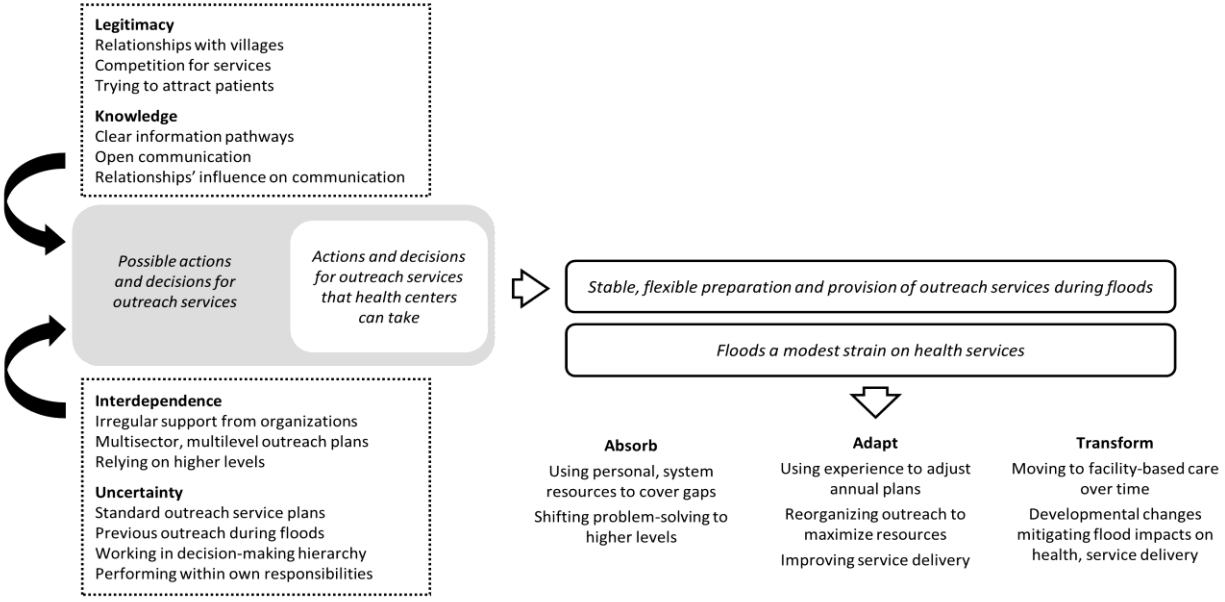


Figure 3. Representation of the four dimensions of resilience and the system's capacity to absorb, adapt, and transform as they relate to the main theme, using health center outreach services for antenatal and childbirth care as an example. The dotted line boxes contain ideas from the five categories as they relate to the four dimensions of the resilience governance framework. The midline boxes and arrows illustrate their contributions to the main theme and to the public sector's capacity to absorb, adapt, and transform in response to floods.

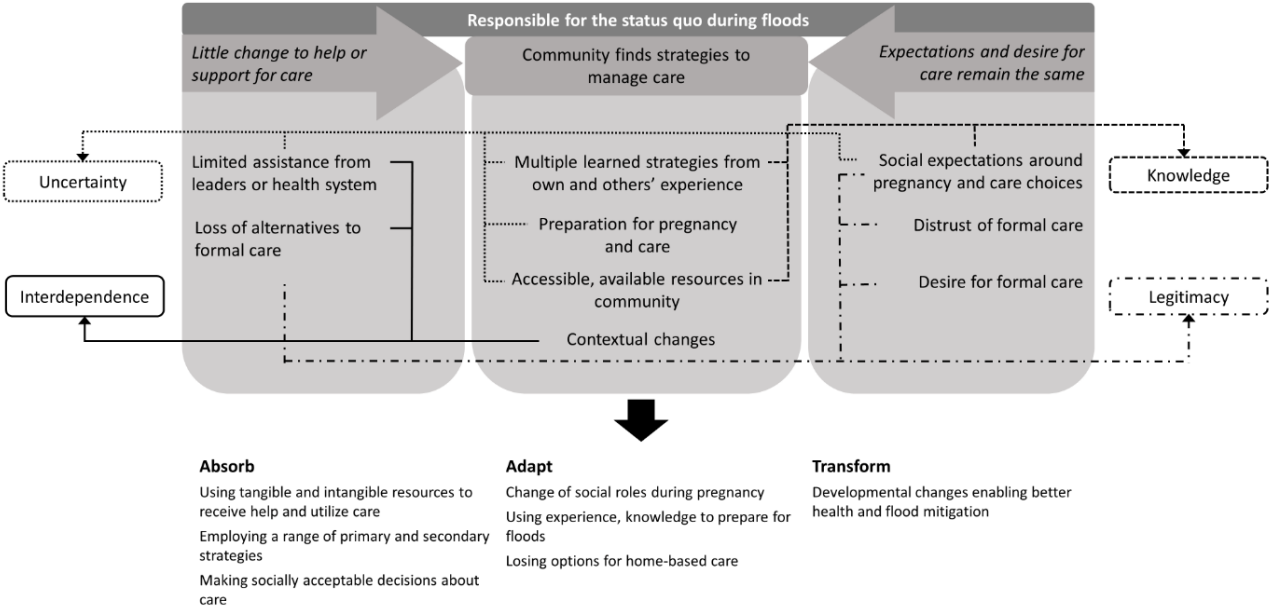


Figure 4. Representation of the findings as they contribute to the four dimensions of resilience governance and lead to the community's capacity to absorb, adapt, or transform during floods. The theme is represented in the dark grey boxes. Results from across the four categories are represented in light grey. The four different line types represent the connections between the findings and the four dimensions in the framework.

Women and men could seek assistance and resources from within the community to help them navigate care during floods. They also described regaining power over their decisions through actions such as clandestinely seeking informal care from traditional birth attendants. In order to feel secure during floods, they sought formal care, despite misgivings about the quality of care from the public health facilities. The fear of delivering, experiencing complications, or missing out on the benefits of antenatal care during floods outweighed the mistrust in the public sector.

Floods as a shock to health and the public health system

When thinking of floods as a shock to health systems, the findings from the thesis show that it could be beneficial to further differentiate between the concepts of shocks and stresses. In theory, resilience characteristics may vary depending on the kind of shock that a system faces (Barasa et al. 2018; RESYST). The health systems resilience literature has broadly described shocks as sudden or extreme external phenomena that challenge the system, such as pandemics, hurricanes, or financial crises (Turenne et al. 2019). Moving beyond the idea of sudden crises, health systems stresses have been discussed as internally generated, chronic, everyday challenges to the system, such as political instability or chronic underfunding (Turenne et al. 2019). The floods in the thesis fall between the concepts of shocks and stresses – they were repeated external shocks that ranged in scope and severity and aggravated health services. The seasonal and occasional floods in the studies were not perceived as a major challenge to the health services (Study III) and were described as overwhelming but expected natural phenomena by the local population (Study II), which could be the result of repeated exposure to the same shock. A flood disaster in the year 2000 was repeatedly described as the greatest shock to the community and the health services in memory (Study II, III), suggesting that the normal flooding patterns are not seen as a comparable threat. As climate change is expected to gradually increase the frequency of

floods, it may be worthwhile to apply the principles of everyday resilience – building resilience to chronic challenges – to repeated seasonal and occasional flood shocks. This may in turn promote resilience to more acute, extreme events (Kruk et al. 2015; Barasa et al. 2017).

Floods as a shock in context

In the Cambodian context, the increase in the number of visits to public healthcare facilities for diarrhea, acute respiratory infections, and skin infections immediately and three months following increases in flood water may be related to poor sanitation, contact with contaminated flood water, and changing living conditions (Study I). All of these risk factors have been linked with floods in other settings and remain high in Cambodia (Hashizume et al. 2008; Milojevic et al. 2012; Cann et al. 2013; WHO et al. 2017). Noncommunicable and vector-borne diseases made up the smallest proportion of visits to public facilities, yet in Cambodia, dengue fever is endemic (Arima et al. 2013; Choi et al. 2016) and cardiovascular disease and diabetes are prevalent (King et al. 2005; Ir et al. 2010). Other studies have found that public facilities are the second choice of care for these conditions because communities lack confidence in the quality of care and the availability of medications (Khun et al. 2007; Bigdeli et al. 2016; Jacobs et al. 2016). Understanding the full scope of new and routine health needs following floods in the Cambodian context would require investigating the population's relationship with the private sector. For instance, healthcare providers and staff identified the main challenge to health services during floods as the difficulty in delivering the appropriate quality or quantity of care because floods exacerbated the usual limitations and lack of resources in the public sector (Study III). The public sector also chose to prioritize new health needs in their community outreach services during floods, leaving community members responsible for seeking facility-based antenatal care and dissatisfied with the outreach services (Study II, III). This was coupled with a perceived decline in

demand for routine services at public health centers (Study III). If the community does not trust the public sector, they may be more inclined to visit private providers for new and routine needs during floods, when access to care was described as more difficult. Visiting private providers may also be an active choice to exert control over health-related decisions, as seen in other studies from Cambodia (Page et al. 2019; Gryseels et al. 2019; Ith et al. 2013).

The delay in increases until three months post-floods may also be related to previous exposure to flooding (Study I). The flood mapping data shows that districts in both provinces had been repeatedly exposed to floods. District- and facility-level strategies to respond to health needs during floods are already in place in the public health system in Cambodia, for example clinical outreach during floods and health education prior to floods (Ministry of Health 2015). Experiences from previous exposure may have generated strategies among the population for managing infections and diarrhea in the short-term without seeking or receiving care at public facilities. This idea is partially supported by our findings that: i) the rates for all consultations at facilities remained stable during floods (Study I), ii) community members, healthcare providers, and health department staff reported that maternal health services remained functional throughout floods (Study II, III), and iii) community members reported being able to seek out and access care during floods, although with more difficulty (Study II). The results suggest that the availability of services at public facilities and the population's ability to seek and access services are not greatly restricted by floods in these districts in Cambodia.

Capacities of the public health system in Cambodia to manage antenatal and childbirth health needs during seasonal and occasional floods

The findings from Studies II and III show that the public sector of the health system had some capacity to absorb and adapt when managing health needs

during seasonal and occasional floods, aided by the community's own capacity to absorb. Transformational capacity was comparatively difficult to observe and interpret.

We considered the capacities of the public health services and the community to be linked. The community took on the responsibility of managing their antenatal and birth care during floods, relieving some of the burden on the health services to respond to their needs (Study II). For example, they referred themselves to and between facilities when they had pregnancy-related emergencies during floods (Study II, III). In the community's experience, the health system had few strategies to help the community manage care during floods, though antenatal and birth services continued to function at public facilities (Study II). To the community, this meant that responsibility for managing care lay with them rather than the health system.

Mladovsky et al (2012) understood shocks from the perspective of their impact, as events that have a substantial negative impact on the availability of health system resources or a substantial positive impact on the demand for health services (Mladovsky et al. 2012). Neither a substantial increase in demand for antenatal and birth services during floods nor a decrease in available resources were noted (Study I, II, III). The unchanged demand for services during floods may be linked to the community's capacity to manage their own health needs, which appeared to allow the health services to function and continue providing health services as normal during floods. However, the ability of the public sector antenatal and birth services to continue functioning as usual may be at risk if future floods exceed the community's ability to absorb and adapt, and the responsibility to manage health needs is fully shifted to the public sector system. Health system investments in adaptive or transformative measures over time that could relieve the responsibility on the community during floods were not described, leaving the community vulnerable to more severe floods and

different shocks if their absorptive and adaptive capacities are exceeded (van de Pas et al. 2017).

Trust and ownership between the community and the health system

Trust and ownership affect the community's involvement in decision-making and interactions with the health system (Kittelsen et al. 2019; Hanefeld et al. 2018). Men and women reported feeling powerless to choose the antenatal and birth care they wanted during floods because of top-down interactions with the public sector and, as a result, lost trust and a sense of ownership in the public system (Study II). Health service providers and staff also reported that they felt that the community had a low degree of trust in public facilities, which they described when talking about the relationships between health centers and communities and how community members utilized public facilities normally and during floods (Study III). Providers and health department staff were actively engaged in trying to improve the quality and reliability of everyday services in order to attract community members to their services (Study III). Providers and health department staff also strongly believed in the value of their work and the system's capability to function during floods.

The public sector participants' work to improve services, and their belief in their work and the system during floods, could be a starting point for developing strategies to build trust between the community and the public health system. This would be especially relevant during floods when relationships between the community and public facilities play a vital role in enabling health services to function smoothly (Study III). For antenatal and childbirth health services, this might be helped by the fact that community members see maternal health services as more trustworthy than services for other kinds of health needs (Study II and Ahmed et al. 2016; Annear et al. 2015). The Ministry of Health has invested heavily in maternal health reforms,

which has led them to improve to a greater extent than other services (Ahmed et al. 2016; Annear et al. 2015; Jacobs et al. 2017) and is likely to have influenced the community's trust in these services.

Decision-making in the context of relationships

The relationships, choices, and interactions between actors inside and outside the system have been identified as influencing resilience (OECD 2014; Barasa et al. 2018; Witter et al. 2017; Bene et al. 2012; Barasa et al. 2017). Limits on decision-making seemed to influence the community and the health system differently. Restricted decision-making in combination with limited support were described by the community as influencing their capacity to primarily absorb rather than adapt (Study II). Throughout the study, participants highlighted how a top-down approach to information sharing from village leaders and health centers to the men and women living in the village seemed to force them onto a single pathway for actions and decisions about their care. This crowded out community-based knowledge and strategies for managing pregnancy and childbirth, and affected the community's sense of trust and ownership in the public health system, as found in previous studies of Cambodia (Page et al. 2019; Gryseels et al. 2019; Ith et al. 2013). The lack of alternative knowledge and strategies may have created a risk to the health system, if the provinces are exposed to shocks that disrupt health services and these community-based alternative strategies for coping have been lost. Being excluded from decision-making processes and losing the power to make decisions may be what is primarily influencing the community's capacity to absorb, adapt, or transform, rather than having a limited set of decisions. This has been described in organizational resilience research (Barasa et al. 2018).

For the health services, collaborations and relationships across the system created known limits on decision-making and actions by the facilities and health departments. It created a stable but flexible process for preparing and

responding to floods and appeared to give them the capacity to adapt and absorb in response to floods (Study III). The findings support the idea that understanding the limits to the decision-making space is a key component in taking action (Alonso-Garbayo et al. 2017). The hierarchies that exist in the Cambodian health system might have helped to counteract uncertainty in the flood response by allowing participants to have the power to make choices in their domain and in collaboration with, and with support from, other levels and actors in the health system. This may be a prominent factor in the public system's apparent stability and flexibility when preparing for and responding to floods, together with the existing plans and routines (Witter et al. 2017; Barasa et al. 2018; Bene et al. 2012). However, hierarchical decision-making is normal in the Cambodian health system (Kelsall et al. 2016; Liverani et al. 2018) and its potential influence should not be taken out of context.

Examining capacities and the factor of time

The studies in this thesis offer insight into the Cambodian health system as it existed in the recent past. Our studies cannot provide a full picture of resilience since they cannot explain how and why the system reached its current state (Kelman et al. 2015; Weichselgartner et al. 2014). This was evident in relation to the dimension of interdependence and capacity to transform. Cambodia has undergone numerous and rapid economic and developmental changes in the last twenty years, which were described as fundamentally changing the landscape for managing health needs after floods. For example, the construction of better roads was described as improving access to facilities during floods (Study II, III). We interpreted this as a change in the infrastructure sector that had a transformative effect on the health system and the community, highlighting the interdependence of systems. However, how changes in the past are influencing current capacities remains unclear.

A similar difficulty was encountered when trying to determine where one capacity might begin and another capacity ends, when viewing them at multiple health system levels and also comparing them between the community and the health system. For example, the policy to limit the use of traditional birth attendants (Cambodia MOH. 2012) could be considered transformative for the health system by fundamentally changing how services are delivered, a change perhaps most prominent at the facility level. For the community, however, it may have been the impetus behind some of their absorptive and adaptive capacity by creating the need to seek care beyond the community during floods at their own expense (Study II, III). A wider and deeper exploration of the context and capacities is needed in order to better explain how capacities are developed and intersect.

Conclusions

- In the Cambodian context, repeated seasonal and occasional floods had a prolonged effect on new health needs, as visits to public healthcare facilities for diarrhea, acute respiratory infections, and skin infections increased immediately and up to three months afterwards; the impact on routine health needs was indeterminate (Study I).
- The public sector of the Cambodian health system appeared to have the capacity to absorb and adapt in order to manage antenatal and childbirth health needs during seasonal and occasional floods (Study III). The public sector's capacity was aided by the community's own capacity to absorb, helping to relieve the burden on the health system for managing health needs during floods (Study II).

- Collaboration across health system levels and sectors and relationships that set boundaries on decision-making were described as a fundamental component of the public sector's capacity to adapt antenatal and childbirth health services when exposed to seasonal and occasional floods. Strategies that enhance stability and flexibility in contexts where extreme weather events are perceived as strains rather than shocks may enhance system capacities for resilience. (Study III)
- Greater support for the community from the public health system during floods and involvement in decision-making may generate resilience capacities in the community and, in turn, strengthen the health system's resilience to repeated extreme weather events (Study II).

Implications for policy and practice

Recognize and incorporate context as a driving factor in developing health systems resilience

- When engaging in health systems strengthening intiatives, stakeholders should consider whether suggested strategies for building resilience capacities from other contexts are likely to be effective or acceptable in their own context.

Acknowledge and address the role of the community in managing health needs and its interlinkages with health systems resilience

- At the local level, stakeholders and actors are encouraged to work with communities to understand how community management of health needs could be incorporated into the health system response. Communities can also help to identify existing gaps in community management of health needs that should be filled by the health system during extreme weather events like floods.

- Incorporating the community into planning processes for shocks may enable a greater sense of trust and ownership in the health system.

Learn from repeated exposure to shocks

- Stakeholders and researchers should consider the role of repetition of shocks in strengthening the capacity for the community and health system to absorb, adapt, and transform. This may be of particular importance and urgency if climate change increases the frequency of extreme weather events.

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Resilient health systems are able to adapt to shocks like extreme weather events. This DBB identifies capacities that foster resilience by exploring how the public health services in rural Cambodia respond to floods.

Motståndskraftiga sjukvårdssystem har förmågan att anpassa sig till kriser. Denna DDB identifierar egenskaper som främjar motståndskraft genom att undersöka hur den offentliga sjukvården på den Kambodjanska landsbygden hanterar översvämningar.

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