

# Improving Flood-Resilience of Small Businesses in Kigali

Findings and recommendations from a research project funded by Climate Development Knowledge Network (CDKN)

## Introduction

The intensity and frequency of extreme precipitation events in Rwanda is projected to increase due to climate variability, such as the El-Nino Southern Oscillation, and climate change. These changes are projected to lead to shorter rainy seasons while extreme-precipitation events – that can trigger floods – will increase in frequency. The overall amount of annual rainfall is projected to increase. However, Asumadu-Sarkodie et al. (2015) modelled different future scenarios for flooding and concluded that the main driver of increased flood damage in Rwanda by 2030 will be socio-economic change (68.8% to 74.2%), whereas climate change only plays a minor role (25.8% to 31.2%).

Floods are among the most serious natural hazards for economic development in Kigali, Rwanda and have been recognised as such by citizens and the government for many years now (mentioned early on e.g. in Kigali Economic Development Strategy 2001: 100). The government is addressing flood risk with a range of instruments, for example: research on risk documented in different risk atlases has increased knowledge about vulnerability, the Green Growth and Climate Resilience Strategy (2011) and the National Disaster Management Policy (2012) have coordinated a range of governmental actions including capacity building on lower administrative levels and in urban areas the Organic Law that prohibits developments in and around wetlands has contributed to reducing flood risks.

In 2014, the population of Kigali was estimated to be 1.1 million. According to the Kigali City Master Plan, the city authority expects that this figure will grow to approximately 4.2 million citizens in 2040. Such a rapid growth will lead to large-scale land-use changes and requires improvements of the cities'

infrastructure. Some parts of the city already experience annual flooding due to developments in natural floodplains, inadequate drainage systems, and the city's hilly topography. These floods are a significant threat to the people living close to these floodplains and their livelihood opportunities. In face of the rapid population growth in the city of Kigali this calls for the integration of flood risk reduction in development planning processes to avoid future calamities, flood damages, and loss of livelihoods of people living or working in or close to Kigali's wetlands.

One major flooding event occurred in the Nyabugogo wetland in the City of Kigali in December 2013. The flood took the lives of four people, severely damaged infrastructure, small businesses, and households, and disrupted economic activities for several days.

It is against the background of such events that a research project funded by the Climate & Development Knowledge Network (CDKN) investigated the impacts of flooding on businesses. This project led by adelphi and the Institute for Policy Analysis and Research (IPAR-Rwanda) surveyed 355 businesses in a Nyabugogo river catchment in the eastern part of Kigali (around Gatsata) and had a number of key informant interviews to investigate past flood damage costs, strategies for dealing with flood risk, and support needs to better deal with future flood events. The work focused on small- and medium-sized enterprises.

The key findings of this survey and recommendations for suitable actions to reduce flood damage costs from future floods are presented in this policy brief. The content is tailored to governmental decision-makers and provides

recommendations on which appropriate action can be taken to improve the resilience of small business in Kigali against flooding. The policy brief is organised in two sections: a brief overview on the research findings and then a longer section on recommendations for actions to take.

### **Flood-damages among businesses in Nyabugogo river catchment**

The survey showed that floods can interrupt the operations of enterprises for longer periods of time; they can damage premises and goods of businesses, or even injure workers and shopkeepers. In order to reduce the negative impacts that floods have on individual businesses and on the local economy, it is important to understand how floods originate, how businesses are affected and what business owners have done to protect their enterprise. The aforementioned research project and this policy brief focus on the two later issues.

Of the 355 surveyed businesses in the Nyabugogo river catchment area, 273 were affected by flooding between 2013 and 2014 (77%). The most common direct physical impacts were damages to items that were supposed to be sold (experienced by 74% of affected businesses), damage to building or premises (e.g. the door or walls of the building were damaged; 36.8%), damage to equipment or machinery (e.g. cash register or tools; experienced by 18.8% of affected businesses) and damage to production inputs (e.g. raw materials like wood; 3.1%).

These direct damages lead to significant costs for the business owners. Based on the single most severe flood event of each business between 2013 and 2014 an estimated 144,800,000 RWF (around 200,000 USD) of direct damage costs from floods were calculated. Most of these damage costs (122,700,000 RWF; circa 170,000 USD) occurred in 2013. In 2014 the flood damage was significantly less which could be related to the major investment of 265,000,000 RWF by the local government for reconstructing a drainage channel connected to the Nyabugogo river at the end of 2013. Both years experienced the same amount of days with intense rainfalls (more than 20mm; in a fairly similar spread across the year) thus it seems less likely that a difference in weather patterns could explain this strong reduction in costs. Increased awareness of flood risk among business owners however could have contributed to this change. But the figures show that the scope of the action taken is not sufficient: in 2014, 45% of businesses still suffered from being flooded at least once, for 27% (95 businesses) the flood damages were worse in 2014 than in 2013.

Additional to these direct damages the floods created indirect damage costs through business interruptions for the enterprises in the river catchment area. The most common reason for such interruptions was identified to be the lack of access for customers and employees to the premises during and after a flood (mentioned by 216 businesses). Other reasons were that the premises were in a state that did not allow sale of products or services (164 businesses), and a lack of electricity (111 businesses). The total income loss caused by these flood-impacts over two years amounted to 18,558,000 RWF (around 25,800 USD).

The combined direct and indirect damage costs for the businesses surveyed add up to 139,308,500 RWF (around 194,000 USD) in 2013 and to 24,049,500 RWF (around 33,500 USD) in 2014. To interpret these figures it is important to take into account that the estimated damage costs are solely based on the most severe flood events experienced by the surveyed businesses in 2013 and 2014. This focus was taken to ensure that the survey covered years and events that were still relatively present in the respondents' memories thus reducing the probability of distorted results due to memory problems. However, considering the frequency of businesses being affected by floods, the real damage costs are very likely to be much higher than these estimates. It should also be noted, that flooding can of course lead to other damages aside from those for businesses that in the focus of this policy brief. Floods can for example also cause damages to ecosystems by flushing waste or hazardous substances into protected areas.

These figures demonstrate that past floods have seriously affected the economic welfare of businesses in the surveyed area, reducing profits, and causing damages in a way that was threatening the bottom-line of many businesses: For 2013, the total damage costs resembled 22% of the total annual net profit of the interviewed businesses in the area. On average, each affected business in 2013 suffered direct and indirect flood damage costs of around 737,000 RWF (circa 1,030 USD), which is more than the annual net profit of around 25% of the businesses in the area.

The findings underline the urgency of addressing flood risks in the area to avoid future damages. This need is also reflected by another highly relevant study, which calculated that "Rwanda has [a] more than 20% probability of inland flooding in any given year [and] a 10-year flood has a 10% probability of occurring in any given year." (Asumadu-Sarkodie et al., 2015: 969). The latter could lead to an estimated 6.1 million USD urban damage and affect 837,000 people in the country (Asumadu-Sarkodie et al., 2015). Thus it can be said with high confidence that flood risk issues need to be addressed both by

public authorities as well as by businesses to ensure climate compatible growth of the Rwandan economy. At the same time, there is still need for research especially with respect to the type and size of drainage infrastructure needed for the valleys of the rapidly growing city.

### **Recommendations for reducing flood-risk in Nyabugogo**

Based on the findings of the survey, qualitative interviews were conducted with business owners in the target area as well as with public officials; in March 2016 preliminary findings and recommendations were discussed in a workshop with representatives from public institutions like MIDIMAR and REMA as well as business owners, scientists and international experts. After thorough analysis of these inputs, IPAR-Rwanda and adelphi compiled a number of suitable actions of public authorities for reducing future flood damage costs in Kigali. Measures pertain to improving regulations, improving infrastructure, investigating insurance, and education.

#### ***Introduce a zoning plan into the Kigali Master Plan that displays flood risk***

As Kigali is projected to keep growing rapidly, it is important to ensure that this growth will not increase existing risk for flood damages. An instrument suitable for this is the development and enforcement of a zoning plan with flood-specific regulations. The City of Kigali identifies floods as a major natural threat to infrastructure and humans in the Kigali City Master Plan Report 2013 which sets out the target to have a flood free city for a 50 year flood return period. The Organic Law prohibits developments within 20 metres of wetlands; however, for reasons of flood protection it would be important to offer definitive guidance on where the borders of the wetlands are located and implement this law more strictly – while offering business owners attractive alternative locations for their enterprises. The last point is of high relevance as some past relocation activities were criticised by businesses on the basis that their new location was less well known to customers, does not have enough parking etc.

To reduce future flood damage costs further, it is recommended that the City of Kigali upgrades zoning plans so that they not only indicate a definite delineation of wetlands but also show where flood risk is considered to be high and/or where floods have damaged buildings in the past. Providing information on this in a consistent way has several long-term benefits: 1. Owners of real estate in higher risk zones can be motivated to take structural flood protection measures for protecting their property; 2. Developers can use this information for selecting areas with low flood risk for development and/or take extra precautions when designing buildings in higher

risk zones; 3. When looking for a space to rent for their business, business owners can use this information to find a suitable location with a lower flood risk in this or other areas of Kigali. The last point is of high importance for the Nyabugogo area as the findings of the survey showed that 99% of the businesses are renting their space.

#### ***Prohibit new developments in high risk zones***

The survey also showed that some business owners might be underestimating the risk of flooding. Because of this and of the possibility that some people are likely to accept certain degrees of flood risks as they cannot or do not want to pay (the possibly higher) rent in more secure locations, the City of Kigali should combine the provision of information on flood risk with regulations for prohibiting developments in high risk zones and with specific requirements for development in medium risk zones. Such requirements can pertain to what type of development is allowed and what structural flood protection features buildings need to have in that specific area. If regulation along these lines is introduced it should be taken into consideration that the reduction of space available for development is likely to increase prices for renting or selling property in attractive locations. Here businesses might be in need of support for finding affordable locations.

#### ***Introduce structural requirements for flood protection of new buildings in the Kigali Master Plan***

Very specific structural requirements for the design of new buildings and for the upgrade of existing buildings can already be found in the Kigali City Masterplan 2013 (“Detailed district physical plans for Kicukiro & Gasabo; Task order 4: Schematic plans”). This demonstrates that there is a high level of awareness among city officials for the importance of planning in such a time of rapid growth. However, the issue of flooding does not receive any attention when it comes to the requirements for building design.

The number of buildings in zones that are at risk of flooding is increasing rapidly. It needs to be ensured that these new buildings are relatively flood proof and that these developments do not increase the risk of flooding in the area, e.g. by additional sealing of surfaces. Thus it is recommended that the City of Kigali updates and enhances the requirements in the Kigali Masterplan. For buildings in flood risk zones, the structural requirements should recommend or require certain features for buildings to reduce likelihood and extent of future flood damage: e.g. for larger roofs there should be a tank for rainwater collection to slow down the runoff of rainwater (see for example Mingming 2009 on rainwater tanks and their potential for flood risk reduction); parking spaces should be solid but the surfaces should not

be sealed so that water can still drain away into the ground.

***Increase efforts for systematic collection of data on weather and flood impacts***

Unlike the existing Organic Law mentioned above, the suggested zoning prohibitions, restrictions for development and requirements for building design would not be justified only on the basis of proximity to wetlands but on the likelihood and extent of future flooding or the frequency and magnitude of past floods. In order to have a sound evidence basis for determining flood risk zones, it is recommended that MIDIMAR, MINIRENA, MININFRA and Meteo Rwanda collect and share more information on rainfall, topography, built environment, flood water levels and flood damages. While the Rwanda Meteorology Agency has made progress to improve data collection and dissemination however most of the efforts have focused on agriculture. It is recommended that these efforts are extended and linked to urban flooding issues.

***Reduce amount of waste thrown into the drainage canals by providing more bins, raising awareness, moving street vendors***

During past heavy rain events in the Nyabugogo area, the drainage of water has been slowed down by solid waste that was lying in the drainage canals. Because of the increase in flood risk that the waste causes, around 92% of the businesses surveyed mentioned that they want people to stop throwing garbage onto the streets or into the canals. The apparent problem and the strong consensus among businesses call for action on this issue. Two other facts underline the urgency to act: the total amount of daily waste produced in Kigali has increased by the factor four between 2007 and 2013 (in 2013: 2,000 metric tonnes daily waste in total, according to the Kigali State of Environment and Outlook Report 2013). The same report estimated that in 2012 and 2013 only 25% of the waste is properly collected and disposed – the rest remains uncollected or is dumped into water drainage systems.

Waste management in a rapidly growing city like Kigali is a very complex issue but there are three fairly simple things that officials and community leaders in the City of Kigali can do in the area to reduce the additional pressure that waste puts on the constrained drainage system: (1) Making it easier for individuals on the street to dispose their garbage properly by putting up more public rubbish bins that are emptied on a regular basis. (2) Using signs or awareness campaigns, informing people how throwing waste into the drainage canals increases the flood risk in the area and threatens the livelihoods of the residents. (3) In qualitative interviews with business owners it was mentioned that most of the littering is done by street vendors,

thus enforcing the recently introduced fines for both sellers and buyers of street vendors could also contribute to reducing flood risk.

However, in order to protect the livelihoods of the mostly poor and disadvantaged street vendors, this enforcement should remain coupled with public initiatives for finding alternative income sources (like the currently offered low-interest loans for hawkers who open a permanent stall) and with efforts of city officials for building new, attractive markets for street vendors (as done in early September 2016 in Nyabugogo with the opening of a market for up to 2,000 traders).

***Clean the drainage canals more frequently***

To further reduce the problem of waste blocking rain water in the drainage canals, these channels need to be cleaned and maintained on a regular and frequent basis. This could be done by staff of the city, commissioned cleaning cooperatives, neighbourhood initiatives and/or as part of Umuganda. This type of work could also be carried out or be coordinated by the Sector Disaster Management Committees (SEDIMAC). SEDIMACs could also be in charge of assisting with evacuation.

***Upgrade and extend the existing drainage system***

The regulatory measures mentioned above can reduce the pressure on the drainage system a little. But looking at past damage costs of flooding, the projected rapid growth of the city and probably more frequent heavy rain events in the future due to climate change, it is apparent that the drainage system in the Nyabugogo area needs to be upgraded and extended further. This is also reflected in the fact that 85% of the surveyed businesses are asking for an improvement of the current drainage system. From the perspective of business owners this should be the top priority of public officials at City of Kigali and MININFRA with respect to flood risk reduction.

The reconstruction of the Mpazi drain (end of 2013) and the construction of a drainage facility close to the lower Nyabugogo road (early 2014) has contributed to a reduction of flood damage costs for businesses as the survey showed; in qualitative interviews with selected business owners the efforts were recognised but deemed insufficient: In 2014, 45% of the businesses in the area were still affected by flooding and suffered mostly from damages to goods that were to be sold and damages to buildings. Thus the City of Kigali should assess what additional drainage measures can make the best contribution to reduce the flood risk in the area.

There are three general ways how to deal with massive amounts of rain water: retain the water in

larger containers or ponds, let the water percolate/trickle into the ground through unsealed (green) surfaces or lead the water away from the area via contour lines or drainage channels. Once it has been determined what action could make the biggest and most cost-effective contribution to reducing flood risks in the area, action should be taken for implementing these measures.

***Construct effective drainage measures alongside streets and pavements during the upcoming roadworks in Nyabugogo***

Flooding should also be taken into account when developing the road infrastructure in the area: The recently approved loan agreement between Rwanda and the Export and Import Bank of China for 58.7 billion RWF will also flow into extension works on roads in Nyabugogo. This will be of high economic value for the area that hosts the major bus terminal in Kigali. When planning and constructing the new road networks, the roadside drainage should be of a quality and extent that it can absorb current and future rainfall quantities in the area without contributing to floods.

It should be assessed whether it would be advantageous to use a type of porous asphalt for road construction to improve rainwater management: these varieties of asphalt reduce runoff as they allow water to permeate the surface and perk into the ground naturally. This way the rain can recharge the groundwater and less effort might be needed for other drainage infrastructure. However, the building and maintenance costs are usually higher than for conventional asphalt. It is recommended in particular for parking lots where maintenance costs for porous asphalt are lower than on busy roads.

For these and other types of flood protection activities, local businesses and residents should be asked or offered to participate in the design and implementation. The survey showed a strong willingness for collective action: 72% of the business owners mentioned that the people should work together in implementing common flood protection measures.

***Offer innovative financial incentives for rain water harvesting tanks***

To further reduce runoff in the area, owners of properties with larger roofs should be encouraged by MINIRENA, MININFRA and/or the City of Kigali to engage in rain water harvesting. The collection of rain water in tanks can take a little bit of pressure off the drainage system and has the added benefit of providing businesses and households with affordable (grey) water for different uses. 78% of the businesses questioned in the survey think that property owners should install rainwater harvesting

tanks to reduce the flood risk in the area. And in 2010 already, MININFRA commissioned a feasibility study for rainwater harvesting on public buildings which recognises the flood protection benefits of such activities. Rainwater harvesting can be encouraged or enforced by recommending or requiring it as a feature of buildings in the Kigali Master Plan as mentioned above.

But such efforts should be accompanied by offering financial incentives and expertise on how to properly install and maintain such systems. In selected areas there are loan programmes for households who want to purchase a rainwater tank which are currently strengthened by the FONERWA-finance project on *Rooftop Rainwater Harvesting (RWH) in high-density areas* with a volume of 2.2 billion RWF (from 2014 to 2017). The loans are directed at individual households. However, for commercial areas like Nyabugogo where 99% of the businesses are renting their premises in larger buildings with several floors, the incentives for the landlords to purchase and install rain water tanks are poor: usually the owners of the building – if they do not live there – will neither benefit from the increased availability of affordable water nor from reduced flood risks (unless the harvesting prevents floods that would have seriously damaged the property). Thus, the loan programmes and business associations should offer ideas and incentives for property owners and tenants to both benefit from the installation of rainwater tanks. One way would be to allow several businesses (with permission of the owner) to get a common loan for purchasing a rainwater harvesting tank for their common use. Another possibility would be for the property owners to purchase a loan and charge the renting business for using the water that is collected.

***Evaluate recent funding of rain water harvesting activities and ensure competition in the market***

Furthermore, during the evaluation that is planned in the above mentioned FONERWA-funded project, the actual contribution of rainwater harvesting to flood protection should be analysed by independent experts to estimate the effects of upscaling this approach.

To make this technology viable in the long run, one also needs to take a look at the prices of such installations in Rwanda: Currently, the market for rainwater tanks is dominated by only two manufacturers (RotoTank and Afritank) and consumers are complaining about the high prices of such installations. Thus, attention should be paid by MINECOFIN so that this oligopoly of two suppliers does not lead to inflated prices for tanks.

***Consider the introduction of bancassurance to increase number of suppliers in the insurance market***

The topic of insurance cover seems to be of great interest for businesses in the area: while only 10% of the entrepreneurs have insurance (Business Owner's Policy) for their enterprise, 60% of the surveyed business owners are thinking about obtaining insurance that would cover flood damages. However, the current offer for insurance for businesses is very limited after SONARWA has reduced its range of products three years ago. Of the twelve insurance companies in Rwanda, SORAS, UAP and Phoenix Assurance have the widest range of insurances for businesses but the business-related products offered are mostly geared towards larger enterprises. The most diverse range of products is offered by Phoenix Assurance where businesses cannot only insure their assets against physical damages from disasters but also receive compensation for business interruptions and subsequent income losses after natural disasters. Still, the insurance penetration rate in Rwanda has been stagnating at very low rate of around 2%.

One reason for this low rate might be the limited competition in the market. There might be only a few suppliers because the margins for insurances are relatively small and the amount of capital needed for setting up a brokerage firm is fairly high in comparison. Other countries in East Africa have dealt with this problem by making it easier for banks to enter the insurance market via cooperation with larger insurance companies ("bancassurance"). Thus, the MINECOFIN should assess whether a change of the insurance law towards permitting bancassurance could benefit the market for business insurances.

### ***Collaborate with insurers on introducing micro index-based insurances for businesses against disasters***

Insurance providers on the other hand need to start considering small enterprises as potential customers. While there are a few micro insurance products aimed at farmers in Rwanda (e.g. MicroEnsure) there aren't any insurance products aimed specifically at micro or small-sized businesses.

If disaster or flood insurance products for small businesses are introduced on a wider scale, suppliers need to take into account moral hazard issues, e.g. that businesses who buy insurance do not protect their premises properly as they feel safe under the cover of insurance. Moral hazard is usually lowest for index-based insurance. In contrast to traditional insurance schemes, these products link payouts to specific trigger levels of weather data (e.g. amount of rainfall or flood water level), which allows an immediate payout after a disaster. Payouts are not bound to the value of the asset. Instead insurance credits can be purchased and

payouts are related to the amount of credits that a household (enterprise) holds. These schemes offer an unbureaucratic, cost-effective insurance cover under which there are still strong incentives for businesses to implement flood protection measures. However, with an index-based insurance there is the risk of damages occurring to insurance holders without payouts being triggered if the defined thresholds are not met. Aside from index-based insurance there are mixed forms of insurance schemes including components of traditional damage-inspection based products and aspects of index-based schemes.

Moral hazard can further be reduced by offering businesses information on how to implement flood protection activates at low costs. These recommendations should be offered alongside the process of purchasing insurance. For this purpose, a handout for businesses on flood protection can be used: This six page handout illustrates what business owners can do before, during and after floods to minimise damages for their enterprise. The document was produced taking into account the results of the above mentioned business survey; it can be downloaded [here](#).

To address the interest in insurances by business owners and the current lack of suitable products, the government together with micro insurance experts and insurance providers should facilitate the development of new micro insurance products incorporating the needs of business owners in Kigali. Given the above mentioned advantages of index-based schemes it is recommended to focus on this type of insurance.

Globally, experience with micro-disaster-insurance for small business is very limited: The case study of the insurance Afat Vimo from India (see AIDMI and CDKN 2014) shows that there is a neglected demand for micro-disaster-insurance products for businesses. As a pilot initiative in Haiti, the insurer Alternative Insurance Company (AIC) has managed to insure around 60,000 micro entrepreneurs against disasters with the index-based insurance MiCRO which has proven very valuable after the intense hurricane seasons of 2012 and 2013. More information on micro-insurance and funding sources can be found at the website of the Global Index Insurance Facility: [www.indexinsuranceforum.org](http://www.indexinsuranceforum.org).

### ***Increase efforts on informing businesses about flood risks and effective protection measures***

Another way to improve the flood resilience of businesses in Kigali is to increase awareness for flood-risk among business owners as well as increasing the knowledge on what to before, during and after floods to minimise resulting damage costs. This area of action is of great interest to local businesses: When asked about what the local or

national government should do to reduce damage costs from flooding, 78.3% (278 businesses) responded that more information should be provided on how one can effectively protect one's business from flood damages. For these types of businesses more information on how to protect their enterprises should be provided. Among the above mentioned 278 businesses, more than 50% have implemented flood protection measures themselves. Thus for businesses like them, the communication should focus on how to do better flood protection. Recommendations should focus on cost-effective measures that are easy to implement.

On the other hand, there is a group of 77 businesses (21.7%) that did not express any interest in receiving more information on the issue of flood protection. Most businesses in this group have not implemented any flood protection measures and consider flooding an irrelevant topic as they do not believe to be affected by floods in the future. It should be noted that around half of these businesses have actually suffered from flood damages in the past. For businesses like these it is important to communicate that extreme weather events are very likely to become more frequent and intense in the future in Kigali and that preparing for flood risk can significantly reduce damage costs. For these communication activities it is of great interest that the business survey on flooding in Nyabugogo showed that businesses who took precautionary measures recovered significantly quicker than those businesses who did not prepare (see Tsinda et al. 2016).

Communication activities could be carried out by MIDIMAR, by business associations, the City of Kigali with its one-stop-business centre and/or by insurances (see above). It is recommended that the above mentioned business brief on flood protection is used as part of the communication as it illustrates many low-cost flood protection measures for business. Communication could take some of the following forms: information about flood protection on billboards in the area, information on flood protection for businesses and households alongside communication regarding the Kigali City Masterplan, features in newspapers, brochures for business owners to be distributed in the area, at the Kigali business centre or banks or insurance offices, short radio features about the importance of flood protection and presentations, posters or notice boards at events related to business issues and/or disaster management.

Three specific communication activities are recommended in particular:

(1) During the upcoming Disaster Risk Reduction week of MIDIMAR, the costs of flooding for

businesses and effective flood protection measures should be put on the agenda. If resources allow for this, a model house (real-size or downscaled) should be presented to interested businesses and households where public officials can present and explain flood protection measures for businesses and households. Alongside this, initiatives of the government to reduce flood risk should be presented. Ideally this would be done in the Nyabugogo area close to businesses and households at risk.

(2) During the upcoming upgrade of roads in Nyabugogo, signs should be put up at the construction explaining the benefits of the developments also with respect to improved flood protection.

(3) Business associations should distribute information on flood risks and how to effectively protect ones business against damages.

#### ***Implement the envisioned early warning system with localised warnings for everyone***

Apart from this information about effective flood-risk reduction measures, there is a need to improve the quality of available weather information and means of communication of early warnings. 110 businesses (31%) said that they would like to receive early weather (flood) warnings through a Short Message Service (SMS) by their mobile phone providers. This appears to be an effective way of communication early weather warnings that has successfully been implemented in countries like Viet Nam and Australia.

MIDIMAR is initiating an early warning system to warn individuals of impending disasters. It is not fully clear yet how this system will look like but the following points are highly recommended to be considered in the development of said system: (1) the warning should be communicated directly to individuals via SMS or via a smartphone app after individuals have signed up for this service; (2) The warnings should be localised, i.e. be as specific as possible about where danger is looming; (3) Warnings should be well timed so that recipients have enough time to react to a warning, e.g. by leaving the area; (4) Allow feedback from the recipients of the warnings, e.g. by allowing citizens to describe the situation they are experiencing via SMS or to send a photo via the app.

## **Further reading**

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