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Reducing flood impacts through forecast-based action

Entry points for social protection systems in Kenya

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Key messages

- Interest in forecast-based early action for floods in Kenya is growing as a result of the detrimental floods in 2018.
- There are promising entry points for linking flood forecasts with social protection systems to reduce impacts.
- Anticipatory cash transfers channelled through national social protection systems could have a specific role in helping reduce the impact of longer-term displacement as a result of flooding, supporting timely evacuations and helping protect livestock or other movable assets.
- Social protection systems more generally could be used to enhance flood risk management. As beneficiary registers improve, these can be used for targeting activities and communicating early warnings.
- Further development of a forecast-based early action system for floods in Kenya will require improvements in flood risk data and validation of forecasts, greater coordination between government agencies (at county and national level), and clarity on institutional responsibilities for early action and financing.

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Acronyms

AFDM	Africa Flood and Drought Monitor
ASALs	Arid and semi-arid lands
Cat DDO	Catastrophe Deferred Drawdown Option
CCTP	Consolidated Cash Transfer Programme
CERF	Central Emergency Response Fund
CREST	Coupled Routing and Excess Storage
DFID	Department for International Development
DREF	Disaster Relief Emergency Fund
EAPs	Early Action Protocols
ECMWF	European Centre for Medium-Range Weather Forecasts
ECT	Emergency Cash Transfers
EF5	Ensemble Framework for Flash Flood Forecasting
ENS	ECMWF ensemble prediction system
ENSO	El Niño–Southern Oscillation
ERCC	Emergency Response Coordination Centre
FATHUM	Forecasts for Anticipatory Humanitarian action
FbA	Forecast-based early action
FDFC	Flood Diagnostics and Forecasting Centre
ForPAc	Towards Forecast-based Preparedness Action
FSD	Financial Sector Deepening
GFFS	Galway Real-Time River Flow Forecasting System
GHM	Global Hazard Map
GloFAS	Global Flood Awareness System
GoK	Government of Kenya
GPC	Global Producing Centre
HSNP	Hunger Safety Net Programme
IARP	Innovative Approaches to Response Preparedness
ICPAC	IGAD Climate Prediction and Application Centre
KenGen	Kenya Electricity Generating Company
KHPT	Kenya Humanitarian Partnership Team
KIRA	Kenya Inter-Agency Rapid Assessment
KMD	Kenya Meteorological Department
KRCS	Kenya Red Cross Society
KWSCRP	Kenya Water Security and Climate Resilience Project
LVNCA	Lake Victoria North Catchment Area
MIS	Management Information System

MJO	Madden Julian Osciallation
MLSP	Ministry of East African Community, Labour and Social Protection
MOGREPS-G	Met Office Global and Regional Ensemble Prediction System
NCEP	National Centers for Environmental Prediction
NDDCF	National Drought and Disaster Contingency Fund
NDEF	National Drought Emergency Fund
NDMA	National Drought Management Authority
NDMU	National Disaster Management Unit
NDOC	National Disaster Operations Centre
NDRMA	National Disaster Risk Management Agency
NFFEWC	National Flood Forecasting and Early Warning Centre
NSNP	National Safety Net Programme
OPCT	Older Persons Cash Transfer
OVC-CT	Orphans and Vulnerable Children Cash Transfer
PWP	Public Works Programme
PWSD-CT	Persons with Severe Disability Cash Transfer
QPF	Quantitative Precipitation Forecast
RCMRD	Regional Centre for Mapping of Resources for Development
SAU	Social Assistance Unit
SOPs	Standard Operating Procedures
SP	Social Protection
SPS	Social Protection Secretariat
TERA	Trilogy Emergency Relief Application
VCI	Vegetation Condition Index
WISER	Weather and Climate Information Services for Africa
WFP	World Food Programme
WMO	World Meteorological Organization
WRA	Water Resources Authority
WRF	Weather Research and Forecast model

Executive summary

As interest in forecast-based early action (FbA) grows among donors and humanitarian practitioners (see Wilkinson et al., 2018), so too does the need to find effective large-scale mechanisms for delivering support to vulnerable people in advance of a crisis. Social protection systems could be one answer, given that they already transfer cash and other support to large numbers of vulnerable people, providing them with a safety net when times are tough. Could they therefore be scaled up to provide additional support when a disaster is forecast, to help reduce impacts?

This paper examines the potential for scaling up FbA in Kenya through existing social protection systems, with a focus on reducing flood risk. The authors assess the components of a flood FbA system: flood forecasting capabilities; the types of action that could reduce impact and the institutions that would need to be involved in taking them; options for using social protection systems to deliver support ahead of time, and questions around targeting the most vulnerable; and potential financing instruments. Cash transfers could have a specific role in helping people avoid or mitigate longer-term displacement as a result of flooding. Anticipatory cash transfers could also help support timely evacuations and the protection of livestock or other movable assets. However, these transfers will not necessarily reduce impacts such as mortality from dam failure and river crossing, or damage to critical infrastructure. While crop and livestock losses from localised flooding can be detrimental to households, their aggregate impact at national level may be fairly small, and some crops could benefit from the rains. Determining whether anticipatory cash transfers through national systems would provide effective protection in such cases requires further investigation. Savings and insurance coverage might be more appropriate for managing these kinds of risks at the household level.

Despite the limitations of cash transfers, social protection systems more generally could play a critical role in flood risk management. Kenya is moving towards a Single Registry of social protection transfer beneficiaries, and this could be used for targeting other activities and communicating early warnings. Public works programmes have been used to carry out activities such as clearing water channels in anticipation of heavy rain, but the benefits of linking such programmes more systematically with flood forecasts compared to other options for water system maintenance remain to be tested.

There are considerable challenges in designing and operating an effective flood FbA system in Kenya, including the need for more granular, high-quality information on vulnerability and exposure to floods and historical disaster impacts. Current information on the ability (skill) of rainfall forecasts available to the Kenya Meteorological Department (KMD) is not sufficient to support FbA, especially for weather forecasts with short lead times. A better understanding is also needed around the relationship between rainfall and flood risk. Responsibility for flood risk management is currently fragmented between agencies (including those responsible for early warning and forecasting, information management, disaster mitigation, emergency response and social protection), and this needs clarifying particularly between central and county governments to develop a common understanding of when to use forecasts, who will take decisions about action and how these actions will be funded.

There are plenty of opportunities and new initiatives that can be used to overcome these challenges. Floods during the March–May long rains in 2018 demonstrated the need for a flood forecasting system for all major flood-prone rivers in in Kenya, while the National Disaster Risk Management Bill (currently under discussion in parliament) and the National

Treasury's new Disaster Risk Financing Strategy emphasise the importance of early warning and anticipatory action, providing enhanced legal and financial support for the development of a flood early action system. Although there is currently limited willingness to release funds before flooding among some disaster management actors, the Disaster Risk Financing Strategy offers the potential for developing new financing instruments to enhance flood preparedness. As interest in FbA grows among Kenyan authorities, there is significant potential to link financing instruments with flood forecasts to facilitate swift release of funds and enable early action.

1 Introduction

In recent decades, weather and climate forecasts have become more reliable, skilful and widely available at global, regional and national level. Yet they are not being used effectively for decision-making to reduce disaster impacts. Building on ongoing work referred to generically as 'Early Warning Early Action', several governments and humanitarian organisations, in partnership with the scientific community, are designing FbA mechanisms to promote action in the window of opportunity between a forecast and a potential disaster. These actions can mitigate humanitarian impacts and economic losses, reduce damage to infrastructure and assets and protect people's livelihoods. They can also enable a timely response once the crisis has begun.

A parallel trend has emerged within the social protection sphere. Globally, there is growing interest in understanding how social protection, especially cash transfers to poor and vulnerable households, could be used to reduce disaster impacts. Cash transfer programmes offer the potential for delivering support directly and quickly to the individuals and households that most need it in advance of a shock. Cash transfer programmes under the banner of social protection are usually multi-year and long-term, and part of a wider strategy to address chronic poverty. 'Shock-sensitive' or 'shock-responsive' social protection already entails using these programmes as flexible and scalable platforms to support people affected by a shock. Linking such programmes with forecasts may help to do so more efficiently ahead of time.

The Kenyan government describes social protection as: 'Policies and actions, including legislative measures, that enhance the capacity of and opportunities for the poor and vulnerable to improve and sustain their lives, livelihoods and welfare, enable income-earners and their dependents to maintain a reasonable level of income through decent work, and ensure access to affordable healthcare, social security, and social assistance' (Republic of Kenya, 2012). Kenya's social protection system includes four major unconditional cash transfer programmes grouped under the National Safety Net Programme (NSNP), as well as a pension scheme, public works and school feeding programmes and other types of social safety nets. Within the context of wider efforts to enhance drought risk management, one of the major cash transfer programmes, the Hunger Safety Net Programme (HSNP), has put in place a system for emergency cash transfers in response to drought in four counties.

Humanitarian assistance and social protection are increasingly seen as interrelated instruments for reducing vulnerability to climate extremes. Humanitarian assistance remains important in addressing acute needs in the face of disasters. However, it also risks being used as a long-term instrument to address chronic poverty, whereas scalable social protection might be a more affordable, long-term option (del Ninno et al., 2016; Holmes and Costella, 2017; O'Brien et al., 2018). Particularly in contexts of recurring climate-related shocks and stresses, social protection programmes can help reduce vulnerability and exposure, but may also be an effective mechanism to deliver humanitarian aid in response to or anticipation of a shock (Costella et al., 2017). Social protection can provide additional assistance for existing recipients, temporarily expand assistance to an additional caseload that is vulnerable to the shock, allow humanitarian actors to deliver assistance through existing systems or align with parallel, non-government interventions during humanitarian crises (O'Brien et al., 2018).

This paper examines the potential for forecast-based early action to be taken to scale using cash transfer programmes to reduce the impacts of flooding in Kenya. It assesses the potential of the government's four major unconditional cash transfer schemes to be used in this way. Based on

Kenya's experience with floods in 2018, the paper explores what flood FbA would look like, and how it could be delivered through these systems.

Developing a national flood forecast-based early action system for the people of Kenya will require a delivery system that can quickly target support to areas of the country where forecasts indicate the likelihood of a severe event and potentially devastating impacts. Such a system would need to be able to allocate and disburse anticipatory funding to people likely to be affected, without waiting until the disaster happens. It thus ideally builds on an existing operational structure which might be generally used for the implementation of poverty reduction, resilience-building or disaster risk reduction. This should include well-managed, regularly updated and detailed targeting structures. The system could operate nationwide or in specific parts of the country.

A number of assumptions[1] need to be taken into account when considering the potential for linking FbA to cash transfer programmes, including where:

- Lack of cash is one of the main constraints to people taking measures that could avoid, reduce or mitigate losses and damage caused by a flood.
- If provided with a cash transfer, affected people would be able to take measures to prepare for a flood, thus reducing the impacts of or losses from such a shock.
- If a payment was made based on a forecast and risk analysis, people would have time to take the preparation measures required.
- The sums of money that people could use to prepare for flooding and reduce flood impacts, but which they lack, are regarded as an acceptable payment for social protection systems.
- Using cash transfer programmes as part of social protection systems to make an early payment is quicker, cheaper or more accurate in terms of targeting than using a parallel ad hoc 'emergency' system.

These assumptions are considered but not tested in this report. They would need to be assessed in more detail in the Kenyan context to justify any forecast-based cash transfer system, irrespective of whether this is implemented through government social protection systems or other channels. Efforts to assess some of these assumptions are planned or under way, for instance through initiatives such as 'Towards Forecast-based Preparedness Action (ForPAc)', 'Innovative Approaches to Response Preparedness (IARP)' and the Kenya Cash Working Group.

This study is part of a wider project on 'Scoping and design for taking forecast-based early action to scale', funded by the UK Department for International Development (DFID) under the WISER programme. The project began with an initial report surveying the core features of over 25 FbA instruments designed to anticipate and reduce the impacts of natural and man-made hazards, and providing suggestions for scaling initiatives. This second phase of the project covers three types of humanitarian financing delivery 'systems': an international fund and UN delivery mechanism (the Central Emergency Response Fund (CERF)); enhanced coordination between non-state and state actors (in Bangladesh); and a national social protection delivery system (cash transfer programmes in Kenya – the subject of this report). The studies set out the context and rationale for scaling up each system, and describe the process of co-production used to bring together the necessary stakeholders to develop a sound concept.

The paper starts by outlining the policy, institutional and financing context of disaster risk management and social protection in Kenya (Chapter 2). Chapter 3 characterises flood risks and discusses progress in risk information and gaps in the availability of hazard, vulnerability and exposure data. Current and potential forecasting capabilities are discussed in Chapter 4. Based on this assessment, the paper examines the impacts of, and response to, recent flooding in Kenya (Chapter 5), as well as the types of early actions needed to reduce flood impacts

1 As background to these assumptions in the wider FbA literature, please see Wilkinson et al. (2018) for an overview of cost–benefit analyses of FbA and the FbA Bangladesh focal study for a breakdown of household support needs in the run-up to floods in Bangladesh (Tanner et al., 2019).

considering the very short lead times provided by some flood forecasts (Chapter 6). Chapter 7 explores specific options for developing and financing a flood early action system in Kenya, including the delivery of forecast-based cash transfers through national programmes, as well as other types of relevant early actions, and how existing social protection systems may support them. It concludes by highlighting key findings and outlining next steps for advancing early action to better address flood risks in Kenya (Chapter 8).

1.1 Methodology

This study is exploratory in nature, and draws on qualitative research and political economy analysis approaches. It is based on pre-existing literature and data, as well as original data collected through key informant interviews in Kenya between May and August 2018. Relevant secondary information identified by the authors, contributors and key informants includes peer reviewed articles, grey literature, international open-access databases, newspaper sources, policy and planning documents, legislative bills and records held by government institutions and humanitarian organisations. Interviews and informal consultations were conducted with 24 representatives of key stakeholder institutions in the fields of flood forecasting, disaster risk management and social protection in Kenya. This includes a range of government agencies, international organisations and humanitarian actors.

Initial findings from the analysis were discussed and corroborated during a stakeholder workshop at the KMD in Nairobi in August 2018. This further shaped the study findings and informed the recommendations put forward in this report. The workshop brought together relevant actors from social protection, disaster risk management, flood forecasting and humanitarian fields to provide a platform for raising awareness about flood FbA and explore ways forward.

2 Policies, institutions and financing for flood risk management and social protection in Kenya

Significant progress has been made in monitoring and managing drought risk in Kenya, and the systems and policies for floods are slowly catching on. Experience shows, however, that generating early warning information will not necessarily result in early actions to avoid, mitigate and manage the detrimental impacts of floods. For this purpose, forecasts need to be linked to finance and delivery mechanisms that can target and support vulnerable communities.

In Kenya, governments and donors are keen to increase the 'shock-responsiveness' of public social protection programmes, especially those providing cash transfers. This would mean supporting existing – or targeting additional – beneficiaries in the face of shocks. Scaling up cash transfers in relation to drought has been a priority in Kenya, and experiences from five initial years of implementation show the potential of delivering cash quickly through these structured channels, in comparison with much slower and ad hoc humanitarian disaster response. During a period of very poor rains in the October to December rainy season in 2016, for example, the National Drought Management Authority (NDMA) scaled up cash transfers in Northern Kenya based on observational data from a Vegetation Condition Index (VCI).[2] This was roughly three months before the government declared a drought emergency, on 10 February 2017, four months before a UN appeal, on 16 March 2017, and long before aid arrived on the ground several months later.

A similar mechanism to deliver cash transfers through social protection programmes specifically in anticipation of flooding does not currently exist in Kenya. However, pre-existing early warning and cash transfer structures, increasing government ownership of social protection systems and prior experience with scalable cash transfers based on an automated trigger linked to drought present a foundation for the development of mechanisms to enable FbA for floods.

2.1 Institutional arrangements for flood risk management

Flood risk management in Kenya is fragmented across various national agencies, as well as between national and county governments. Key stakeholders in disaster (risk) management interviewed for this study indicated a need to strengthen capacity and coordination to establish a 'go-to' institution for flood response and risk management.

2 Note that the different ways and timelines in which droughts and floods develop mean that, while the VCI may trigger after rains have already occurred, it aims to do so before a drought crisis develops. Given the sudden-onset nature of floods, forecasting, rather than observing, hazard indicators plays a stronger role in facilitating anticipatory early action in the case of flooding.

Flood risk management, including preparedness and response, brings together the Water Resources Authority (WRA) under the Ministry of Water and Sanitation, with other actors such as the KMD, the National Disaster Operations Centre (NDOC), the National Disaster Management Unit (NDMU), the Kenya Electricity Generating Company (KenGen), the Kenya Red Cross Society (KRCS) and the NDMA. WRA and KMD work together to forecast when and where floods might occur. While KMD has a crucial role in risk knowledge, monitoring, early warning systems and dissemination, its Flood Forecast Unit is small, with only three staff. KMD will now be hosting the National Flood Forecasting and Early Warning Centre (NFFEWC), which could increase national capacity for flood forecasting. As part of the Ministry of the Interior, the NDMU formulated a National Emergency/Disaster Plan, along with Standard Operating Procedures (SOPs), in 2014. NDOC is responsible for public awareness and disaster response, in cooperation with KRCS. However, among non-government actors knowledge of the specific role of government agencies such as the NDMU, as well as of the national SOPs and emergency response plans it has developed, appears to be low (Development Initiatives, 2017).

The Kenya Humanitarian Partnership Team (KHPT), a coordination mechanism established to enhance disaster preparedness, brings together UN agencies, donors, international NGOs, the private sector, local organisations and national and subnational government. According to a 2017 assessment, this platform plays a useful role in influencing government and advocating for better preparedness. There is also a government coordination mechanism, the Humanitarian Services Committee (Development Initiatives, 2017).

2.2 The policy and legal framework

The Kenyan government has established a comprehensive legal and strategic framework for disaster risk management over recent years. Starting from the 2010 Constitution, which established the duty of the state to protect vulnerable citizens, it provides for a declaration of a state of emergency in the event of threatening situations such as fires, floods and droughts. Among the most relevant policies and plans are the National Disaster Management Policy (draft, 2009), the National Disaster Response Plan (2009), the County Governments Disaster Management Act (2014), the National Emergency and Disaster Response Plan and SOPs and the 2016 Water Act (see Annex 8 for details).

This legislative groundwork for flood risk management has been promoted through the National Disaster Risk Management Bill, currently in parliament, and the Disaster Risk Financing Strategy, both of which underscore the importance of better disaster prevention, preparedness, mitigation, response and recovery, including in relation to floods (Republic of Kenya, 2018; Republic of Kenya/National Treasury and Planning , 2018).

2.3 Disaster risk financing

The Kenyan government has emphasised the need for more comprehensive disaster risk financing. This is particularly the case for drought risk, though financing instruments related to other types of hazard are also being considered. The 2017 National Disaster Risk Management Policy highlights the importance of structured funding mechanisms to enable more effective disaster prevention, preparedness, mitigation, response and recovery, thus generally opening the door for financing early action. To support structured funding, the policy suggests the creation of a Disaster Risk Management Fund to pool and harmonise new and existing sources of disaster risk financing at national level. It further proposes that ministries allocate funds for disaster risk management under the guidance of the Treasury, and that county governments make relevant additional allocations. However, the legislative framework for the regulation and administration of funds and donations linked to the policy is not yet in place, and is currently under discussion in the Senate as part of the National Disaster Risk Management Bill (Republic of Kenya, 2018; Republic of Kenya, 2017).

Linked to Kenya's Vision 2030 development blueprint, the Treasury's Disaster Risk Financing Strategy 2018–2022 sets out priorities to reduce the contingent liability related to floods and droughts, estimated at 2–2.4% of annual gross domestic product (GDP). The Strategy aims to enable national and county governments to prepare for and respond more effectively to disasters. One of the strategic priorities is to enhance the government's financial capacity to manage disaster risks. This includes exploring financing instruments for flood preparedness, specifically small-scale and localised floods (see Annex 10) (Republic of Kenya/National Treasury and Planning, 2018).

This specific mention of disaster risk financing for floods is in line with a wider emerging trend in recent budget allocations to flood preparedness and response. In 2018/2019, the government allocated KES 60.4 billion (around $607 million as at March 2019), or 2.4% of the national budget, to environmental protection, water harvesting and flood control. A KES 150 million allocation to the Ministry of Water and Sanitation is designated for flood control measures, and the State Department for Irrigation has reserved KES 8 billion for water storage and flood control. This is 142.4% more than in 2017/2018. However, the State Department for Irrigation has struggled to absorb increased budgets in the past, and the complex web of institutions involved in flood risk management makes it difficult to determine precise allocations for risk reduction, preparedness and response (Development Initiatives, 2017).

2.4 Shock-responsive social protection

Internationally, there is growing interest in understanding how social protection programmes, especially those that aim to provide cash transfer benefits, could be used to reduce disaster impacts by making them 'shock-responsive' or 'shock-sensitive'. This means using social protection programmes as flexible and scalable platforms to support existing beneficiaries, as well as additional households, in the face of shocks, especially climate- and weather-related shocks.

The government operates four large unconditional cash transfer programmes grouped under the National Safety Net Programme (NSNP), and has started implementing emergency transfers in response to drought in four northern counties through the Hunger Safety Net Programme (HSNP). Although the NSNP is currently not responsive to, or anticipatory of, floods, it provides a system and prior experience to build on for flood FbA.

2.4.1 Government cash transfer programmes

Social protection provided by the government comprises three major areas: social assistance, social security and social health insurance, all coordinated through the Social Protection Secretariat (SPS). Within the social assistance stream, the four major cash transfer programmes under the NSNP are the Orphans and Vulnerable Children Cash Transfer (OVC-CT), the Older Persons Cash Transfer, the Persons with Severe Disability Cash Transfer and the HSNP (see Annex 9). While the first three operate nationally, the HSNP focuses on Kenya's arid and semi-arid counties. In its first and second phases, it implemented cash transfers in Mandera, Marsabit, Turkana and Wajir, and plans are currently under development for an expansion to additional counties (Samburu, Isiolo, West Pokot, Tana River, Garissa and Baringo).

All four cash transfer programmes have monthly allocations – KES 2,700 (around $27) under the HSNP, and KES 2,000 (around $20) under the remaining programmes – and make payments to beneficiaries on a bi-monthly basis. These amounts are transferred to a dedicated account, and can be withdrawn from certain banks or affiliated agents through a card held by the beneficiary or a caregiver.

Emphasising the need for greater coordination to ensure coherence and efficiency in delivery, the Ministry of East African Community, Labour and Social Protection (MLSP) is in the process of integrating the three cash transfer programmes implemented under its umbrella (see Figure 1) into a Consolidated Cash Transfer Programme (CCTP). To coordinate and implement the CCTP, the Social Assistance Unit (SAU) was created in 2016 (Republic of Kenya/Ministry of East African Community, Labour and Social Protection, 2017). Consolidation also aims to align these programmes with the HSNP. This includes efforts to document beneficiaries within a Single Registry

Figure 1 Coordination of government cash transfer programmes under the NSNP

Source: Adapted from Ministry of Labour and Social Protection (2018).

and to harmonise targeting criteria and processes.[3] The Single Registry gathers information from all the cash transfer programmes under the NSNP and from the joint government/World Food Programme (WFP) Cash for Assets Programme, a conditional cash transfer programme whose recipients work on community assets aimed at reducing the risk of drought.

2.4.2 Emergency scale-up through government cash transfer programmes

As part of the expansion of cash transfer programming, Kenya has made considerable progress in 'exploring the role of social protection systems to respond to shocks like droughts' (Farhat et al., 2017). While the OVC-CT, Older Persons CT and Persons with Severe Disability CT currently do not have integrated mechanisms in place to scale up in times of crisis, the HSNP has a sophisticated scalability mechanism that delivers emergency transfers to additional households (beyond the regular recipients of the programme) that might be affected by drought in the four counties where it operates. Emergency payouts are triggered by a drought indicator linked to a VCI, which can be disaggregated to sub-county level. Based on a comprehensive registry that ranks household vulnerability, the number of recipients can be expanded from the roughly 25% of households receiving regular benefits to 50% in any sub-county deemed to be in severe drought in any one month. In case of extreme drought, the number of recipients can be increased to 75% of all households (HSNP, 2016).

While drought is the main focus of the HSNP, as part of the NDMA, its scalable cash transfer system has been used on one occasion ahead of predicted flooding. In 2015, based on the El Niño seasonal forecast predicting heavy rains and floods, HSNP donors reallocated funding to provide anticipatory emergency payments to about 186,000 households not covered by regular payments, but that were registered in the system (HSNP, 2015; Tozier de la Poterie et al., 2018). The forecast was available roughly three months before the expected rainy season, and funds were transferred in late October 2015. So far this is the only experience with scaling up government cash transfer programmes for floods in Kenya.

The 2015 HSNP flood transfers were not based on an assessment of specific vulnerability to flooding or any elaborate system for flood FbA, but were a one-off, ad hoc payment based on readily available El Niño early warnings. The extensive coverage was framed as a 'no regrets' transfer due to the high levels of uncertainty related to the seasonal forecast and the perceived urgency to act proactively for a sudden-onset event such as flooding. 'Although not all recipients were ultimately impacted by the floods, … [stakeholders] who were involved in the program believed it had been a success' (Tozier de la Poterie et al., 2018).

2.4.3 Emergency scale-up through other cash transfer programmes and coordination with government activities

In addition to the four large government cash transfer programmes, international agencies operating in Kenya have used emergency cash transfers in response to crises. Coordination between emergency response systems and shock-responsive social protection systems is key. However, it can be challenging, as evidenced by

3 For an assessment of the NSNP harmonised targeting methodology pilot in Turkana, see www.opml.co.uk/files/Publications/a0013-evaluation-kenya-hunger-safety-net-programme/assessment-nsnp-harmonised-targeting-methodology-pilot-turkana.pdf?noredirect=1.

Kenya's experience during the 2016–17 drought. While the government's HSNP transfers were expanded horizontally to support additional households that did not receive regular benefits, the value of the transfer was not increased, either for newly added households or for regular ones. The social protection transfer, which in normal circumstances is intended to act as supplementary income for a household, was considered insufficient during the drought by humanitarian standards. Humanitarian actors argued that households would have lost alternative sources of food and income in the drought, and that the value of the transfer was not sufficient to offset those losses. While there has been some speculation that the government favoured horizontal expansion in order to win support from more households before an election, it appears that the main reason why the size of the HSNP transfer was not increased was at the insistence of the main donor, DFID. As a result of the lack of agreement on transfer values, humanitarian and other non-government agencies implemented separate emergency cash programmes, with larger transfer values that took into account increased need in the face of drought. While efforts to coordinate the transfer value had already resulted in delays in the implementation of emergency cash programmes, coordination between government and non-governmental systems was maintained during the response.

Various non-governmental agencies offered emergency assistance in response to the floods in 2018. Since the four major government safety net programmes were not scaled up during the response (there are no mechanisms for responding to floods in either programme), there were no coordination challenges or duplication in targeting in this instance, but this is a potential concern if cash transfers were to be scaled up for floods.

Overall, there is a trend towards greater integration between government programmes and those implemented by non-government agencies in Kenya. This is evidenced by recent advances in national policy and increased government ownership of social protection programmes, reflected, for instance, in the gradual handover of implementation and funding responsibility for a range of cash transfer programmes from international organisations and donors to the Kenyan government. This entails the integration of WFP's Cash for Assets Programme within the government's Single Registry, as well as a gradual increase in the share of HSNP regular and emergency payments covered by the government in relation to funding from DFID.

3 Flood risk and risk information in Kenya

This chapter reviews the flood risk information available for Kenya and discusses the implications of current levels of information for a potential FbA system. Understanding risk is an essential element for establishing triggers for early actions. Triggers can be defined using impact-based forecasting, which aims to express expected impacts as a result of expected weather (WMO, 2015). Similar to any flood risk assessment, impact-based forecasting requires information on relevant hazards, vulnerability and exposure. This also includes hydrometeorological data, as well as recorded impacts from previous events.

For Kenya, the archive of reports of past flood events is incomplete, but can be used to derive a broad flood risk profile highlighting the most flood-prone river basins and floodplain regions. There are flood risk assessments for certain river basins, most comprehensively for the Nzoia River basin, but a unified, consistent and high-resolution and granular flood risk map for the entire country is not available, to our knowledge. Unlike the advanced drought early warning system in Kenya, for floods there is no unified national flood monitoring system, nor is there a fully comprehensive country-wide multi-basin analysis of river flow and flood frequency or magnitude conducted using hydrological observations (e.g. using data from gauging stations, shown in Annex 2). To address these challenges, the National Disaster Risk Management Bill would provide the basis for enhancing flood risk management, which can be instrumental in FbA and anticipatory financing.

3.1 Flood risk in Kenya

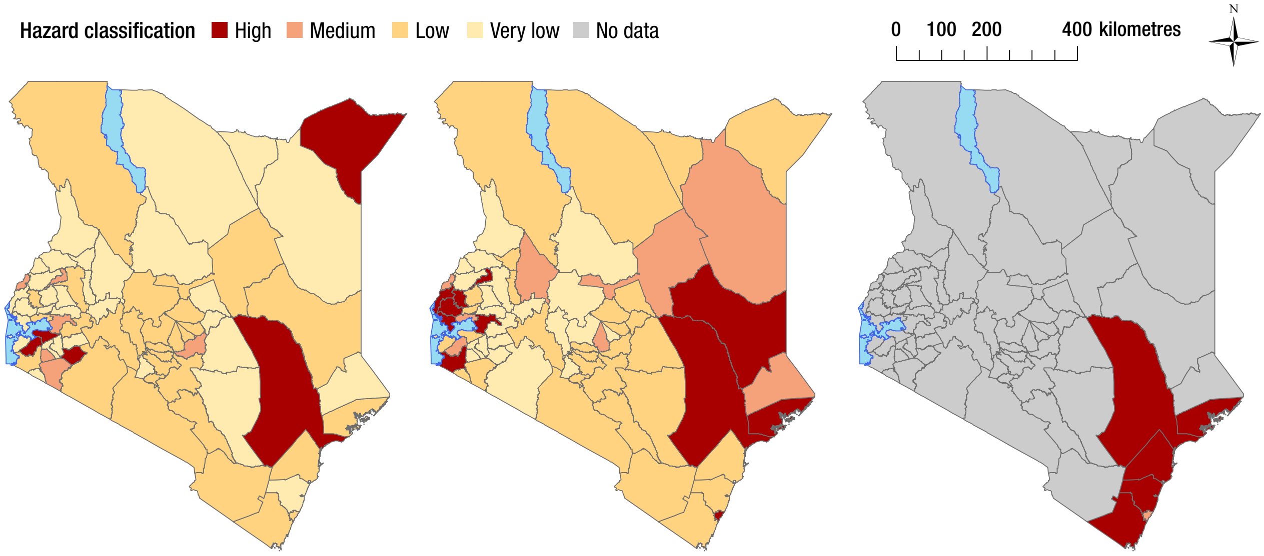
Over the past decades, various areas across Kenya have experienced flash floods, river floods, coastal floods and spot flooding or inundation (water-logging) due to local torrential rain.[4] River floods take several days or weeks to develop and are potentially predictable. North-eastern, coastal and western areas and Nyanza are highly prone to flooding (Figure 2), which means that potentially damaging and life-threatening river (and in some areas coastal) floods are expected to occur at least once every ten years (GFDRR, 2018).

Flash flooding can occur in any region of the country. Hazard levels are expected to increase in the future due to the effects of climate change, while other risk factors such as rapid urbanisation are also expected to increase flood risk, particularly in urban areas. Eastern, Rift Valley and central areas are classified as medium risk. This means that there is a one in 50 years' chance of damaging and life-threatening floods (GFDRR, 2018). Kenya's arid and semi-arid lands (ASALs) also experience periodic flash floods (Parry et al., 2012). Figure 2 presents an overview of flood hazard classifications for different types of floods – urban, river and coastal – in Kenya.

The government has designated several catchment areas and rivers for flood risk management investments. These areas were selected based on the National Water Conservation and Pipeline Corporation (NWCPC) Strategic Plan for 2010–15, which prioritised the Nyando, Nzoia, Lumi, Tana and

4 For a background overview of the Kenyan climate see Annex 1.

Figure 2 Flood hazard classification in Kenya: (a) urban flood; (b) river flood; and (c) coastal flood



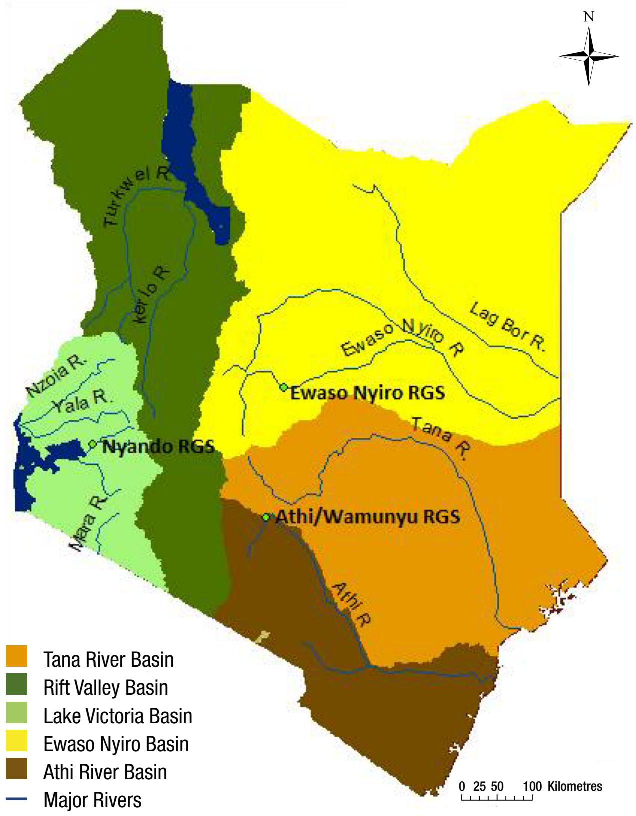
Note: Data is only available at the administrative level for former districts (prior to formation of 47 counties under the current Constitution, implemented in 2013).
Source: Data from GFDRR (2018) Think Hazard (http://thinkhazard.org/en/).

Daua rivers for structural flood management measures, and Gucha River, Narok, Turkana, Mogotio, Isiolo, Sabaki-Galana, Kana and Mogotio for studies and mapping of new flood areas. However, current strategic plans – the NWCPC Strategic Plans for 2010–15 and 2015–2020 (NWCPC, 2015; NWCPC, n.d.), as well as the National Water Master Plan 2030 (Republic of Kenya, 2013) – do not include improvement of flood early warning systems in any of the river basins, with the exception of the Nzoia River.

3.2 Historical impacts of floods in Kenya

To design an FbA system for floods in Kenya, stakeholders will need to understand disaster impacts. However, the historical impacts of major events, at local and national level, are generally much better documented for droughts than for floods. Between 1964 and 2004, Kenya recorded 17 major flood events (Parry et al., 2012). Since the early 1960s, there have been particularly high impacts from flooding in 1961, 1997–98, 2006, 2010, 2012, 2015 and 2018 (CRED, 2018). The El Niño-induced floods of 1997–98 affected more than half a million people (WFP, 1998) and cost

Figure 3 Kenya's major river basins



Source: Onjira (2014).

the country at least $870 million (Mogaka et al., 2006). Impacts included damage to water systems, roads, communications and buildings, the cost of treatment for waterborne diseases, and crop losses. Many key informants mentioned that the events of 1997–98 were as devastating as those in 2018.

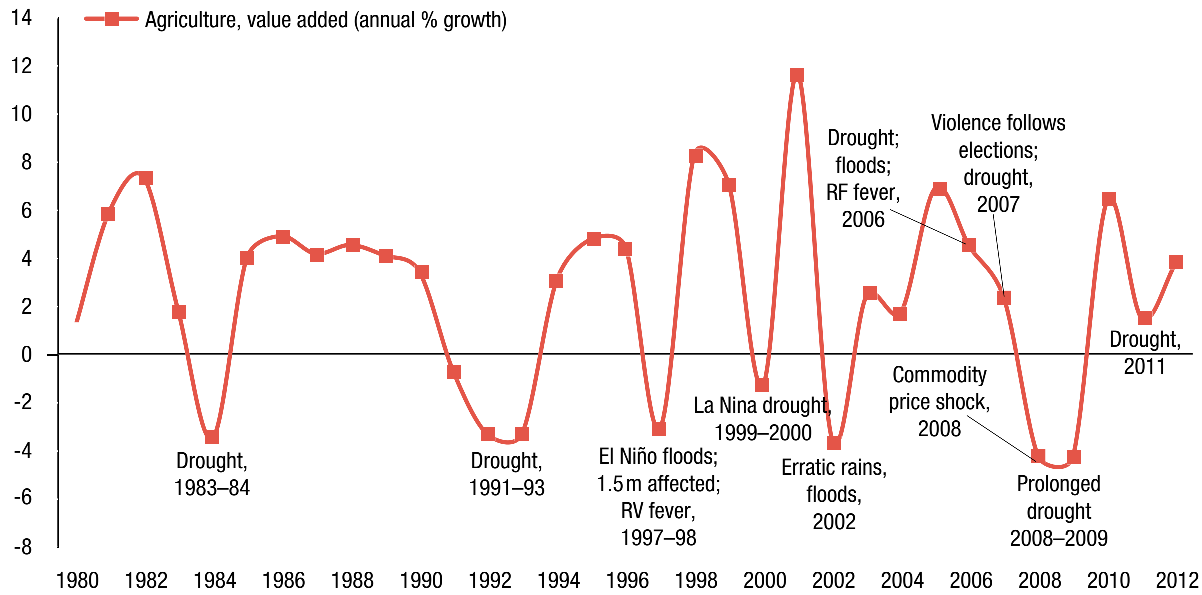
Heavy rainfall from October to December 2015 caused major flooding in western Kenya (with overflow of the Nzoia and Nyando rivers) and in counties including Garissa, Tana River and Kilifi. The death toll from flooding was estimated at 112, with approximately 240,000 people directly affected, and there was extensive loss of livestock and damage to crops and farmlands in Mt. Elgon, Kirinyaga, Narok, Busia, Kisumu, Tana River, Trans Nzoia, Busia and Bungoma counties, as well as damage to infrastructure (buildings, roads and bridges) in parts of Tana River, Marsabit, Isiolo, Mandera, Wajir, Nandi and Machakos counties (IFRC, 2016).

On average, Kenya experiences a flood that costs about 5.5% of GDP every seven years (Parry et al., 2012). Figure 4 illustrates shocks in the agriculture sector over time.

Given the lack of available high-quality and disaggregated data on disaster impacts, it is difficult to establish a detailed description of impacts for various types of floods and in different parts of the country. However, some research has been conducted to analyse historical disaster impacts in specific locations. A 2016 loss and damage study on flooding in Lower Nyando Basin, Kisumu county, revealed how floods during the 2007/08 rainfall season affected households' livelihoods, agricultural production, health, water and sanitation, education, assets and housing and property.[5]

The survey demonstrated that over 99.5% of households in highly flood-affected locations were left with damaged crops and 99.27% lost livestock. 'Disruption of transport, experienced by 97.9% of respondents, hampered access to health services due to damaged and/or washed-away roads, bridges and culverts'. This led to increased disease burden (mainly diarrhoea, coughing and malaria) as people were unable to reach hospitals. Disease incidence was attributed to flooded sanitation facilities and unsafe water sources. Almost all houses were damaged in one way or another. This forced many households to relocate to other areas. The study also established that 73.4% of households lost both productive and non-productive assets (directly and indirectly) (Masese, 2016).

Figure 4 Historical timeline of major agricultural production shocks in Kenya, 1980–2012



Source: D'Alessandro et al. (2015).

5 The same geographical area was affected by floods in 2018 (see Chapter 5).

This example of disaggregated data is a sample of the kind of information that is essential to be able to develop impact-based forecasting models for FbA. The challenge encountered during this research is the lack of a comprehensive long-term dataset with information at household level for the entire country. Data at this level is critical to knowing why, how and to what extent people are impacted by floods, and therefore essential in establishing an FbA system.

3.3 Current and future data trends in Kenya

In recent years, the Kenyan government has significantly improved its information management, with the development of hazard maps of the most at-risk territories, as well as systems to identify the most exposed and vulnerable people. For example, the Lower Koichan Kisiwa Integrated Flood Map incorporates hazard modelling, vulnerability and exposure data, including for roads and infrastructure that could be heavily affected. In addition, global initiatives such as INFORM,[6] ThinkHazard[7] and the 510 initiative[8] now offer disaster risk information and risk scores at national, and sometimes sub-national, level.

3.3.1 Historical flood hazard and impact data

In line with wider efforts to enhance disaster risk information, the Water Resources Authority has established an information management protocol to gather data on disaster impacts once floods have receded. Indicators collected at community level include mortality and injuries, damage and destruction to houses and infrastructure and displacement. This assessment, conducted within the first 72 hours after a disaster, is part of the Kenya Inter-agency Rapid Assessment (KIRA). It is followed by a more detailed Post Disaster Impact Assessment. Other efforts to gather data on impacts include the post-rainfall season assessments conducted by the Kenya food security steering group, with information collection on the ground led by the NDMA and made available online through the NDMA portal. Another initiative, the Kenya Open Data Portal,[9] makes key government disaster data available to the public. Although this initiative has the potential to improve disaster risk data in Kenya, it is not yet fully implemented.

Historical flood hazard information for Kenya remains limited, with no unified national flood monitoring system and no comprehensive country-wide multi-basin analysis of river flow and flood frequency/magnitude, conducted using hydrological observations. At international level, a comprehensive archive of major flood events in Kenya (from 1985 to the present) is hosted by the Dartmouth Flood Observatory and the DesInventar database. The Flood List portal of EU Copernicus also provides reports of recent floods in Kenya and associated damage and losses.

3.3.2 Exposure and vulnerability data

Access to and quality of data describing who is most exposed and vulnerable to the impacts of flooding and where they are represents one of the most challenging aspects of any risk information management system, not only for forecast-based action but also for overall disaster risk management. Often, the most common open data sources are censuses, which in Kenya

6 INFORM, or Index for Risk Management, 'is a global, open-source risk assessment for humanitarian crises and disasters'. It compiles data for national risk profiles and has developed subnational models for some countries or regions, including the Greater Horn of Africa (www.inform-index.org/).

7 ThinkHazard, a tool operated by GFDRR, shows the likelihood of different natural hazards, including various types of flooding. It aims to inform the design and implementation of projects to promote resilience (http://thinkhazard.org/en/).

8 The 510 is an initiative of the Netherlands Red Cross aimed at enhancing the usability of risk data for humanitarian actors, decision-makers and affected populations. Its dashboard provides information on community risk, past impacts and predicted impacts. So far this is only available for a limited number of countries, but expansion efforts are under way (https://dashboard.510.global/#!/).

9 www.opendata.go.ke/.

are conducted every ten years. This means that information is often outdated, for instance when people move or die. Each government agency also has its own sectoral information management system. For example, NDMA hosts data on drought vulnerability related to crops, livestock, water access, commodity prices and nutrition at national level, as well as information on the poorest and most marginalised populations in four counties, as part of the HNSP. However, to our knowledge similar information is not currently available for flooding across Kenya, with the exception of a few individual river basins. A large-scale, disaggregated flood risk data management system would render impact-based forecasting more effective. Current information management systems in Kenya are trying to address problems with fragmented and low-quality data, but the risk data inventory needs to be strengthened.

4 Forecasting floods: status and prospects

Flood forecasting – i.e. information about the likelihood and magnitude of an event – is crucial for establishing an early action system, combined with data on vulnerability, exposure and the historical impacts of floods (discussed in the previous chapter). Current operational flood forecasting in Kenya is limited to the Nzoia River, but the KMD is keen to improve flood forecasting across the country. Considerable potential exists for relatively low-cost options that would permit flood forecasting beyond the Nzoia River, using for example the Ensemble Framework for Flash Flood Forecasting (EF5) and the Global Flood Awareness System (GloFAS), with GloFAS possibly offering the lowest-cost option (see Section 4.2.2).

The use of current and potential flood forecasting for FbA requires a high level of skill[10] in the rainfall forecast. Forecasts of enhanced risk of extreme rainfall at the spatial scales of perhaps the larger Kenya counties may have potentially useful skill at:

- short lead times of a few days;
- intra-seasonal timescales out to around a two-week lead time; and
- seasonal lead times for the 'short rains' season (October–December).

It is important to note that the spatial and temporal detail a forecast can provide generally increases with declining lead time,[11] i.e. closer to the predicted event. At seasonal lead times forecasts tend to show the likelihood of below-normal, normal or above-normal seasonal rainfall totals (three-month) over broad areas. Shorter lead time forecasts can show the rainfall value on a particular day.

While there is a rough idea of the skill of rainfall forecast for these timescales, what is currently not known is what the 'hit and miss rate' – i.e. the likelihood of getting it wrong – would be for a flood FbA system built on these forecasts. This would need to be thoroughly assessed in order to establish triggers for releasing funds and implementing action, a task which could be done in the space of one or two years.

Rainfall forecasts can provide an indication of enhanced flood risk. However, by themselves they cannot easily be utilised for an FbA system without considerable work on establishing appropriate rainfall thresholds that drive flooding events, and ultimately relate to potential impacts from flooding (see Chapter 3). To be most useful for flood FbA, systems need to move from forecasting rainfall to forecasting floods and eventually predicting potential impacts.

4.1 Existing flood forecasting capabilities

The KMD includes a Flood Diagnostics and Forecasting Centre (FDFC), which provides flood forecasts for the Nzoia River (Figure 3). The Nzoia floodplain has experienced almost annual flooding and associated damage. The

10 Forecast skill describes the accuracy of forecasts. It is established through a comparison of the forecast with actual observations (WMO, 2017; American Meteorological Society, 2012).

11 Forecast lead time is 'the length of time between the issuance of a forecast and the occurrence of the phenomena that were predicted' (American Meteorological Society, 2012).

Nzoia flood forecasting system (see Annex 2 for a full description) was established in 2007, with investment support from two World Bank-funded projects on water management and security. One, the Kenya Water Security and Climate Resilience Project,[12] continues to 2020 and involves plans to extend aspects of flood risk management to five other basins. Currently, the WRA is reviewing these plans. Any national flood FbA system should align with these developments.

The Nzoia River flood forecasting system includes a real-time hydro-meteorological monitoring network. The network's data, combined with KMD rainfall forecasts, inputs into a hydrological model providing river level forecasts each day for the floodplain with a three-day lead time. The forecast system and associated floodplain risk management measures, including river training and protective dykes, was funded though the World Bank Western Kenya Community-Driven Development and Flood Mitigation Project (Njogu, 2017). Based on forecasts of river level relative to dyke height, 'amber' and 'red' early warnings are issued daily and disseminated to government agencies including the county administration and the National Disaster Operations Centre, NGOs, local schools and health facilities and a community radio station (Njogu, 2017). The forecast system is perceived to perform well with good skill for one-day lead times with no major missed flood events on record and considerable damage avoided, estimated at around $1 million a year (World Bank, 2016). The Nzoia flood system has the potential to be used for an FbA application. The existing hydrological modelling software system is, however, not sufficiently flexible to allow further development, for longer forecast lead times or for probabilistic flood forecasting, favoured by FbA applications, which would use the ensemble rainfall forecasts from Global Producing Centres (GPCs).

Outside of the Nzoia River, no quantitative forecasts of river flood risks are provided by the KMD. For the rest of Kenya, the KMD only issues qualitative statements of broad areas likely to experience increased flood risk. These advisory statements are inferred from weather and climate forecasts of rainfall, primarily at short lead times of a few days, combined with knowledge of locations prone to both river and flash flooding (see Annex 3 for an example advisory).

4.2 Prospects for improving flood forecasting across Kenya

Ideally, forecasts of flood risk for application in FbA should be produced, with process-based or statistical hydrological models driven by Quantitative Precipitation Forecasts (QPF). This is to provide forecasts of river flow, river levels and flood risk throughout the basin (e.g. the Nzoia River system) at lead times that are relevant for decision-making, and with statistics available on rates of forecasted flood 'hits' and 'misses' (false alarms). This section considers the prospects for providing the necessary tools and information. Many of the necessary components are already available, but integrating them into a forecasting system and evaluating performance would require additional investment.

4.2.1 Forecasting heavy rainfall related to flood risk

Assessing the accuracy of rainfall forecasts can shed light on the potential skill of flood predictions using hydrological models driven by rainfall forecasts. Forecasts of rainfall are available in real time from a number of sources, including the GPCs (e.g. the European Centre for Medium-Range Weather Forecasts (ECMWF), National Centers for Environmental Prediction (NCEP) and the UK Met Office), regional centres (e.g. the IGAD Climate Prediction and Application Centre (ICPAC)) and the KMD. Forecast lead times range from a few hours to a few months (seasonal), and such forecasts could be integrated to provide 'seamless' lead times. Generally, the spatial precision of forecasts increases with shorter lead times. The skill of rainfall forecasts from GPCs is typically well established (though not commonly provided on data portals).[13]

12 http://kwscrp.org/.

13 See for example www.cpc.ncep.noaa.gov/products/international/africa/africa.shtml.

Annex 5 summarises rainfall forecast skill over various lead times from the ECMWF and the UK Met Office. The skill of in-house rainfall forecasts from ICPAC and the KMD is not yet well understood and requires more comprehensive analysis for any application to FbA (see MacLeod et al., 2018). For most of Kenya, the relationship between rainfall anomalies and the spatial distribution, intensity and timing of flooding is not well established.

At seasonal lead times (for a few months before heavy rainfall), there is relatively strong predictability of seasonal rainfall totals during the 'short rains' season in October–December. Kenya is a 'sweetspot' of long-lead predictability in this season, meaning that seasonal forecasts for the short rains have relatively high skill compared to other geographic areas or seasons. This includes the more extreme end of the seasonal rainfall distribution likely to be associated with enhanced flood risk. In addition, there are indications that total seasonal rainfall is related to within-season 'floodiness' in East Africa (Coughlan de Perez et al., 2017; Stephens et al., 2015). For sub-seasonal lead times, forecasts (of weekly rainfall totals from GPC models) have relatively high skill during both rainy seasons, with lead times of around 1–2 weeks. At shorter lead times (up to around seven days), forecast skill (from GPC products and in-house KMD and ICPAC products) is not well established for Kenya, although recent evidence suggests that GPC products have useful skill.

Overall, therefore, there appears to be a comparatively strong basis for flood forecasting in Kenya, although the relationship between intense rainfall characteristics and flood risk and optimum rainfall forecast quantities still needs to be established. These information gaps could be filled quickly by providing additional resources to complement existing work under Forecasts for AnTicipatory HUManitarian action (FATHUM), ForPAc and other initiatives.

4.2.2 Flood forecasting tools

A number of flood forecasting systems have potential for operational application in Kenya in the near term, notably the Ensemble Framework for Flash Flood Forecasting (EF5) system and GloFAS. These are summarised below, and a fuller description is provided in Annex 6. The EF5 system has been installed at the Regional Centre for Mapping of Resources for Development in Nairobi (RCMRD),[14] which is working with the KMD to evaluate the potential to operationalise EF5 for selected basins in Kenya.[15] In summary, EF5 has some institutional support, but it will need to be calibrated using historical forecasts for each river basin. It is not yet clear how long such an exercise might take.

GloFAS provides flow forecasts for rivers globally with longer lead times (up to 30 days) and spatial resolution of around 10km. GloFAS combines weather forecasts with hydrological models and models of river routes to provide a global outlook of river flooding. The system provides probabilistic forecasts of river flow and exceedance of specific return-period values for any point on larger river basins. A seasonal lead time forecast has recently been added. GloFAS is being evaluated through a number of case studies worldwide.[16] These evaluations suggest that the system is able to capture increases in streamflow in advance of significant flood events, though this is not yet demonstrated for rivers in Kenya. Currently, the skill of neither GloFAS nor seasonal GloFAS forecasts is known for rivers in Kenya. To develop a flood early action system in Kenya, the lead-time dependent probabilistic verification of hit rate and false alarm rate for flooding events would need to be calculated. Given data availability, this is likely to require fewer resources for GloFAS than the equivalent task for the EF5 system.

The potential use of GloFAS or EF5 should be considered in light of ongoing plans to extend flood forecasting capabilities to five major flood-prone basins under the Water Security

14 www.rcmrd.org/.

15 EF5 in this configuration includes a hydrological model which can be driven by near-real-time satellite-derived rainfall and KMD-generated 72-hour rainfall forecasts to estimate streamflow for any basin, once calibrated.

16 For more information on these see www.globalfloods.eu/.

and Climate Resilience project, which is likely to make recommendations for appropriate modelling tools for this initiative.

4.2.3 Flood forecasting in urban areas

The major urban centres in Kenya (notably Nairobi) experience regular flooding. This is often pluvial (direct runoff from heavy rain) rather than fluvial (river) flooding, causing significant disruption and livelihood impacts. There is currently no flood forecasting system for flash floods, beyond the heavy rainfall advisories. Examples do exist where such advisories have triggered preparedness action, including at seasonal lead times. This was the case for the 'short rains' of 2015. However, the skill of rainfall forecasts is generally lower for smaller scales, which presents challenges for dense urban areas. Supported by the ForPAc project, KMD is working with a wide range of partners to explore the potential for flood forecasting in Nairobi, including evaluation of high-resolution flood inundation modelling and integration with forecasts of extreme rainfall from multiple global and national modelling systems. The potential for developing FbA protocols for various stakeholders is being explored. Initial results suggest strong potential for such a system, and strong demand and buy-in.

4.3 Dissemination of flood early warnings

As described in previous sections, the only specific flood forecasts in Kenya are generated and disseminated for the Nzoia River, where quantitative flood warnings for specific points in the river floodplain are issued in the form of flood watch bulletins. This information is used to define the flood risk category (high, moderate and no flood risk), based on a risk analysis. Bulletins are widely distributed via email, through community radio (Bulala RANET FM) broadcast in local languages, and in print to various stakeholders, including County Disaster Managers, government departments and humanitarian agencies. The County Commissioner, who co-chairs the Disaster Management Committee, has a mandate to call for evacuation, using information from the flood early warning system. However, key informants also emphasised that responsibilities for acting based on forecasts need to be clarified so authorities can be held more accountable.

Elsewhere in Kenya, early warnings of heavy rainfall are provided over a range of lead times (from a season to a few days), from which broad statements of flood risk are inferred. For example, advisories issued by the KMD may include information about expected heavy rain of more than 30mm or 50mm over several counties. These advisories are disseminated by the KMD to disaster risk management agencies. The KRCS supports the government in the dissemination of warning messages to the wider public, using the Trilogy Emergency Relief Application (TERA) platform. During the 2018 floods, more than 9 million people were reached with warning messages (IFRC, 2018a).

5 Forecasting and understanding impacts: the 2018 floods

5.1 Lessons from forecasting of recent flood events in 2015–16 and 2018

Forecasts of the heavy rainfall and flood events of 2018 compared to the 2015 floods provide a useful example of the potential value of FbA over different time periods based on forecasts, under very difficult conditions. The long rains season of March–May 2018 saw extreme rainfall over much of central Kenya in particular, widely 2–4 times the long-term average (Figure 5a, Kilavi et al., 2018). The event was not predicted in the long lead seasonal forecasts, but subsequent sub-seasonal and short-lead forecasts produced by GPCs provided a good indication of extreme rainfall during the season. Some of that information was used by the KMD in advisories. As described in Chapter 4, the KMD operates the Nzoia River forecast system, which can issue alerts for floods, but for the rest of the country it issues only heavy rain advisories and alerts throughout the rainy season. These advisories highlight enhanced risk of heavy rain and the counties likely to be affected, with lead times of up to seven days. In 2018, for those counties, residents of urban areas were warned of likely flash floods. A high alert was also issued by the government through KenGen, warning families downstream of the hydro-power dam at Masinga (Meru, Garissa, Tana River) to move to higher ground prior to the release of water from the reservoirs. In other parts of the country, including Sondu Miriu and Turkwel, reservoirs were full and started overflowing.

Unlike the October–December short rainy season in 2015, extreme rainfall during the long rainy season in 2018 was not associated with strong seasonal drivers of climate such as ENSO and Indian Ocean conditions. Instead, it was likely associated with a complex combination of intra-seasonal variability, notably the Madden Julian Oscillation (MJO), and synoptic scale weather events, including the effects of tropical cyclones off northern Madagascar, modifying the atmospheric circulation over East Africa and the Western Indian Ocean (Kilavi et al., 2018). This resulted in shorter forecast lead times. As such, the long lead seasonal climate forecasts contained little indication of what was coming (note that skill of seasonal forecasts in March–May is weak in any case, as outlined in the previous chapter). Nonetheless, GPC forecasts issued with a few weeks' lead time captured the rainfall signal, which could have provided a basis for early action.

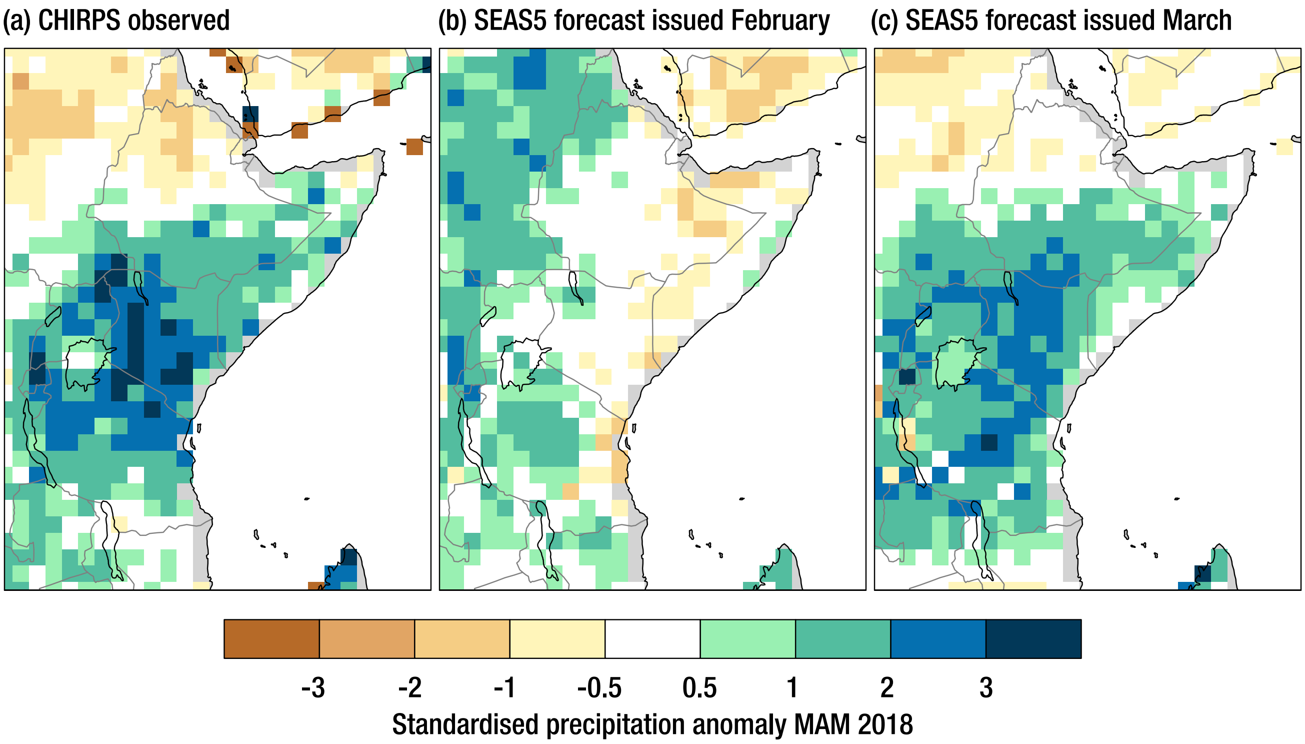
The heavy rainfall in 2015–16, on the other hand, was influenced by a strong seasonal driver of climate (ENSO and IOD), which gave a long lead time. This clarity within the global El Niño forecasts meant that some flood preparedness actions could be taken with seasonal lead times. This included drainage clearance in Nairobi and a one-off triggering of the HSNP in its four ASAL counties. However, the seasonal totals of rainfall in much of Kenya were not especially high, except in the south-west and the central highlands (and indeed were more anomalous in neighbouring Tanzania and Uganda). Three-day flood warnings and alerts for the Nzoia River were also issued in 2015, triggering the evacuation of the local population to higher ground with the help of the local county administration and coordination by humanitarian agencies including the KRCS. In the absence of an existing flood early warning system, only KMD bulletins warning of heavy rain and weak flood risk management procedures were in place in other river basins, including Tana River and Ewaso Ngiro.

Overall, the 2015 case of an extreme October–December short rainy season with available seasonal forecasts, in contrast to the March–May 2018 long rainy season with more skilful sub-seasonal and short-term forecasts supports the case for 'seamless' forecasting across lead times. In an FbA system, these could potentially trigger different types of action at different points in time, depending on lead time, skill and certainty of the various forecasts. In 2015, such a system may have triggered systematic seasonal preparedness actions early on (which in the actual event were taken on a more ad hoc basis) and subsequently fine-tuned activities with sub-seasonal and short-term forecast lead times. The March–May 2018 extreme rainfall case shows the value of shorter lead time and sub-seasonal forecasts in managing flood risk in cases where longer lead forecast has little skill.

5.2 Impacts from the 2018 floods

At national level, the 2018 floods resulted in benefits as well as negative impacts. While this paper focuses on managing the negative consequences of floods, an important positive consequence of the increased rainfall in 2018

Figure 5 Observed and forecast rainfall conditions during the 2018 long rains



Note: (a) shows observed rainfall from CHIRPS station-based observations, while (b) and (c) show the forecast from the ECMWF seasonal forecast SEAS5 initialised in February and March respectively.
Source: Authors' figure based on data from the Climate Hazard Group InfraRed Precipitation with Station data (CHIRPS) (Funk et al., 2015) and the ECMWF seasonal forecast system (Johnson et al., 2019).

was an anticipated 44% increase in maize and wheat production,[17],[18] as well as recharging water resources both for power[19] and domestic use.[20] Potential positive impacts of above-average rainfall should also be considered in the framework of FbA, as there may be potential for boosting prosperity through early action in these cases.

Next to these benefits, there were very severe negative impacts in specific locations. Counties most affected included Garissa, Isiolo, Kisumu, Mandera, Marsabit, Narok, Samburu, Taita-Taveta, Tana River, Turkana, Wajir and West-Pokot (UN OCHA, 2018b). Mandera and Tana River counties saw the highest levels of displacement. The rains triggered land- and mudslides, especially in central parts of the country. Nairobi experienced significant surface flooding. There was significant infrastructure damage, including to dams and roads (with estimated repair costs of $180 million for roads alone (World Highways, 2018)) and other disruption, including the temporary closure of hundreds of schools.

In total, 186 people were reported to have died due to flooding (UNICEF, 2018). It is important to recognise that almost half of the deaths occurred as the result of the collapse of a single dam, killing scores of people in a settlement below. It has been suggested in reviews of the disaster that the poor design of the dam and non-compliance with regulations may have been responsible for the collapse. Newspaper reports suggest that many of the other reported deaths were due to vehicles crossing submerged roads and river crossings (Mwangi, 2018). Again, human action rather than flooding per se is responsible for mortality in these cases.

In March and April, floods were reported to have affected at least 21,700 acres of farmland and killed more than 19,000 livestock across the country (ACAPS, 2018a). It is very difficult to verify such reports, let alone attribute these outcomes to flooding as against other causes. Moreover, these losses represent a miniscule proportion of overall land and livestock in the country, for instance affecting less than 0.04% of Kenya's total agricultural land.[21] From a macroeconomic perspective, the costs of these losses need to be balanced against the overall gains in the agricultural sector as a result of strong rains. Nonetheless, these are important negative consequences for affected individuals. Whether scalable cash transfers through a flood FbA system are the preferable and most effective option to support vulnerable households in addressing such impacts in Kenya, however, remains to be assessed in more detail. Strategies such as savings or insurance protection or escape plans for livestock based on early warning may be more appropriate to manage these forms and scale of losses than forecast-based cash transfer programmes through a national social protection programme.

Another reported consequence of the flooding was displacement, affecting an estimated 300,000 people (UN OCHA, 2018b). As described in Figure 6, in Tana River alone more than 100,000 were displaced. There is little detail on the duration of displacement. Anecdotal evidence and past experience suggest that much of it may have been transitory in areas that were not severely affected, with the impacts managed by individuals without permanent or long-lasting consequences. An exception is the situation along the lower Tana River, which was extreme and required humanitarian assistance from the government and humanitarian agencies (IFRC, 2018a; Oduor, 2018). This included severe impacts in existing refugee camps housing

17 http://farmbizafrica.com/high-yield/2016-agriculture-ministry-projects-44-per-cent-increase-in-maize-production-this-year.

18 www.foodbusinessafrica.com/2018/04/05/kenya-corn-production-to-rebound-high-wheat-output-forecast/.

19 http://energy.go.ke/update-on-water-levels-in-kengen-dams/.

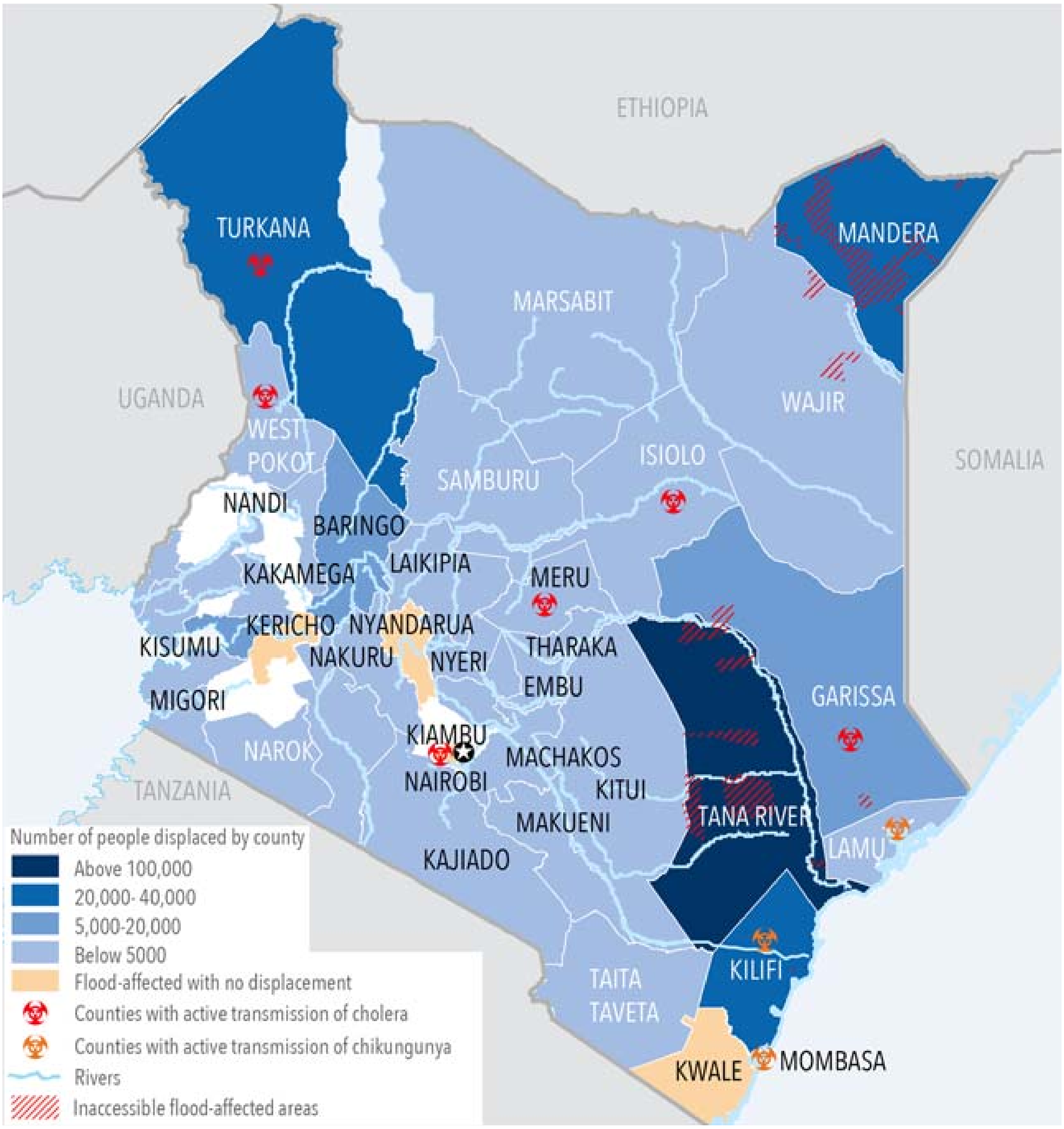
20 For example see: www.kenyaengineer.co.ke/reconstruction-of-sasumua-dam-completed/.

21 Authors' calculations using data from the Food and Agriculture Organization (FAO) on total agricultural land surface in Kenya, estimated at 276,300km^2 in 2016 (https://data.worldbank.org/indicator/AG.LND.AGRI.K2?locations=KE&view=chart).

500,000 people (Agenzia Fides, 2018). According to KRCS staff involved in the relief operation, displacement in Tana River lasted for up to three months. Although the KRCS deployed initial assistance immediately after the declaration of emergency, a full humanitarian intervention to support the displaced communities only arrived weeks later. At the time of writing, there was no hard quantitative evidence of newly emerging risks as a result of the flooding during this period, but according to some emergency reports the likelihood of disease outbreaks increased (ACAPS, 2018a; ACAPS 2018b).

Loss and damage of infrastructure – roads, bridges, buildings – as a result of rain and flooding was geographically widespread (Koech, 2018). While not always life-threatening, destroyed infrastructure is enormously expensive

Figure 6 Affected counties, internally displaced people



Source: UN OCHA (2018a).

and difficult to replace. Economic growth and recovery depend on that infrastructure, particularly in a rapidly urbanising country such as Kenya, and where rural areas are more integrated into markets and the national economy. Damage to infrastructure also reduces the effectiveness of humanitarian action as communities become inaccessible.

Other impacts could also be attributed to the rains. Most important among these were disease outbreaks reported by the Ministry of Health, including cholera and Rift Valley Fever. Cholera cases for the first six months of 2018 were 20% up on the whole of 2017 (The Standard, 2018; Republic of Kenya/Ministry of Health, 2018), with 75 deaths reported. Cases were reported across half of the country. However, local health services were reported to have managed the caseload, hence the relatively low case mortality rate. Fifteen cases of Rift Valley Fever were reported, five of them fatal, and coastal areas experienced active transmissions of chikungunya (UN OCHA, 2018a). At the time of writing, the Ministry of Health had not declared other outbreaks that might have been expected, such as diarrhoea from contaminated water or malaria/fevers from stagnant water.

In sum, many of the consequences of the 2018 floods were on a scale and magnitude that could be managed by individuals, local services or county governments. However, the high levels of mortality, the destruction of basic infrastructure and the displacement of communities along the lower Tana warranted responses from higher levels of government. Chapter 6 will examine these three outcomes from 2018 to determine if forecast-based social protection programmes could have prevented and mitigated some of the impacts discussed above.

5.3 Financing of the 2018 flood response

Unlike in 2015, when seasonal forecasts indicated above-average rainfall well in advance, key informants judged the level of preparedness in 2018 to be low, and mobilisation of resources to address flooding began later than in 2015. To address immediate impacts from the 2018 floods and support relief efforts assisting 150,000 people, the International Federation of the Red Cross launched an emergency appeal for CHF 4.8 million (close to $4.8 million) on 1 May 2018, while heavy rainfall was still ongoing. This included a loan of CHF 480,000 (or roughly $482,000) from the IFRC's Disaster Relief Emergency Fund (DREF) (IFRC, 2018b). Later in May, the Kenyan government committed KES 1 billion (almost $1 million) to be managed by the KRCS to support flood victims, and development partners contributed an additional €3.3 million (over $3.8 million) – including €1.3 million ($1.5 million) from the UK through DFID, €1.5 million ($1.7 million) from the European Union and €400,000 (approximately $465,000) from the Dutch government (Mwere, 2018). These commitments were made at a time when flooding had already resulted in damage, displacement and deaths, but heavy rains were expected to continue for another two months, until July (IFRC, 2018b). According to OCHA's Financial Tracking Service,[22] the Central Emergency Response Fund (CERF) contributed close to $5 million towards flood response, including shelter assistance to flood-affected internally displaced people and management of disease outbreaks.

22 https://fts.unocha.org/.

6 Early action needed for floods

As discussed in Chapters 4 and 5, lead times for flood forecasts differ depending on the type of flood event. Seasonal, sub-seasonal (one to two weeks' lead time) and short-term (less than one week lead time) forecasts have varying degrees of skill. For sub-seasonal forecasts, the time from initial warning to when flooding starts is fairly short. The value of FbA therefore relies on two conditions:

- That any funding released through a forecast-based system can be channelled swiftly and effectively.
- That actions can be taken to prepare for and/or mitigate the impact of anticipated floods with very short lead times, realistically no more than three to four days in some cases. This would require that such actions have been identified and prioritised in advance, and that flood contingency planning has led to a very high state of preparedness. This is particularly relevant for floods that are not captured by seasonal forecasts.

A range of possible early actions can be envisaged, depending on the direct impacts that are anticipated, for example:

- Actions that aim to prevent a disaster or mitigate its impacts, such as reinforcing infrastructure, cleaning drains and helping people move mobile assets.
- Actions to support preparedness for response, such as the preparation of evacuation sites, ensuring that systems are ready to handle possible cash transfers before, during or after the shock, or prepositioning emergency stocks (e.g. shelter material, medical supply, food).

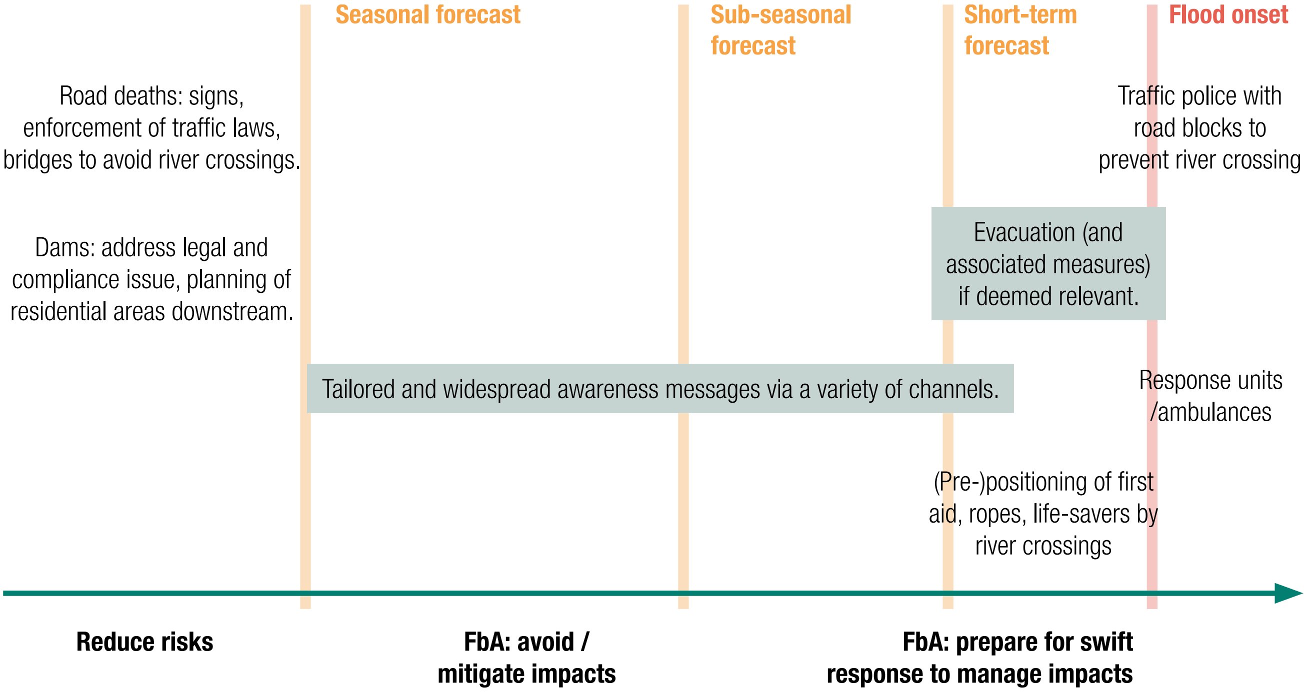
FbA protocols for floods in other countries prioritise actions such as cash transfers to reduce the risk of incurring high interest rates from loans to fund last-minute preparedness measures (when market prices have already gone up) and to recover assets after floods. The distribution of water purification tablets (to reduce the risk of diarrhoea) is also common. In Togo, where the FbA system was designed for floods in relation to a hydropower dam, priority actions include alert messages via radio and the preparation of evacuation sites.

Any forecast-based early action system should prioritise specific flood impacts and identify adequate action to address them. The 2018 impacts can provide an example, but designing an operational flood FbA system in the future would require more thorough assessment of historical impacts than presented in this study.

Analysis of the 2018 floods suggests that flood mortality, destruction of infrastructure and displacement in lower Tana were perhaps the most severe flood impacts that year. The kinds of actions that are needed and when they should be delivered will depend on why the impacts occurred and how important it is to target specific populations or places that are likely to be most affected. Figures 7 to 9 highlight actions that can be taken without a forecast to reduce risks, as well as options for forecast-based early action at different forecast lead times for the major flood impacts in 2018. These actions would need to be further refined in consultation with relevant stakeholders and populations at risk during the design of an FbA programme

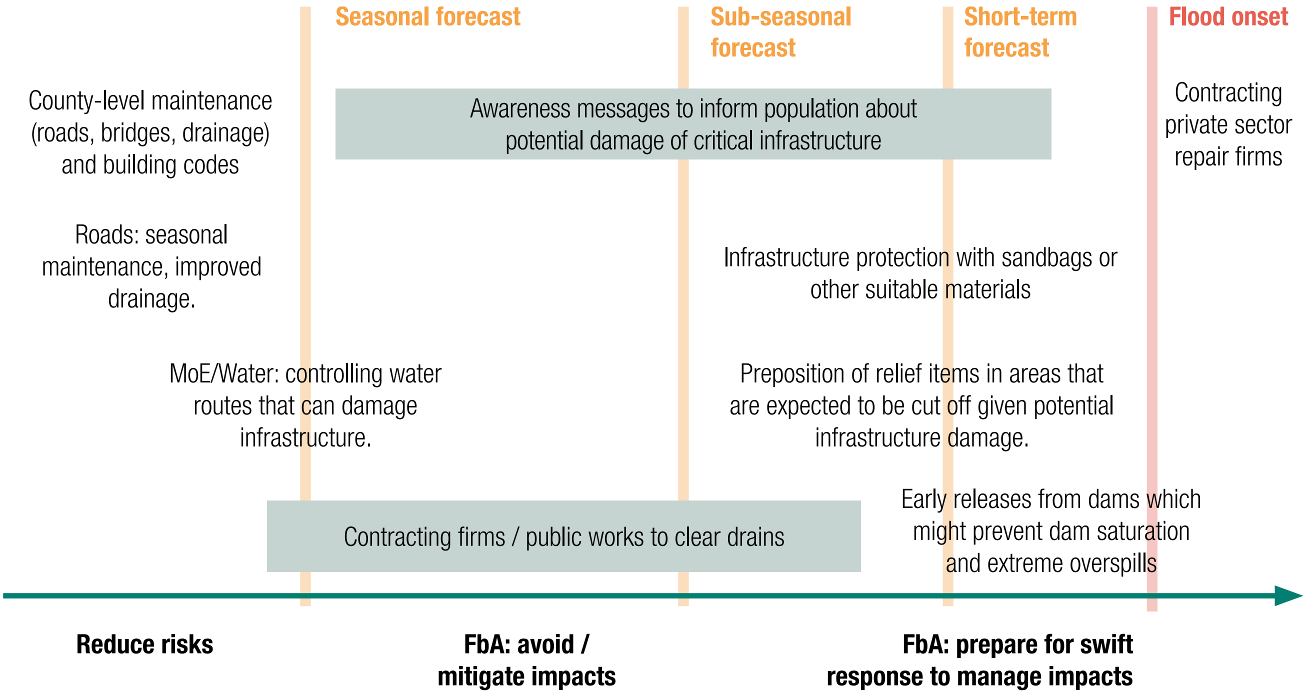
Figures 7 to 9 highlight the diverse range of actions that could be taken to address mortality, infrastructure impacts and displacement at different lead times in advance of an expected

Figure 7 Mortality from river crossings and dam failure



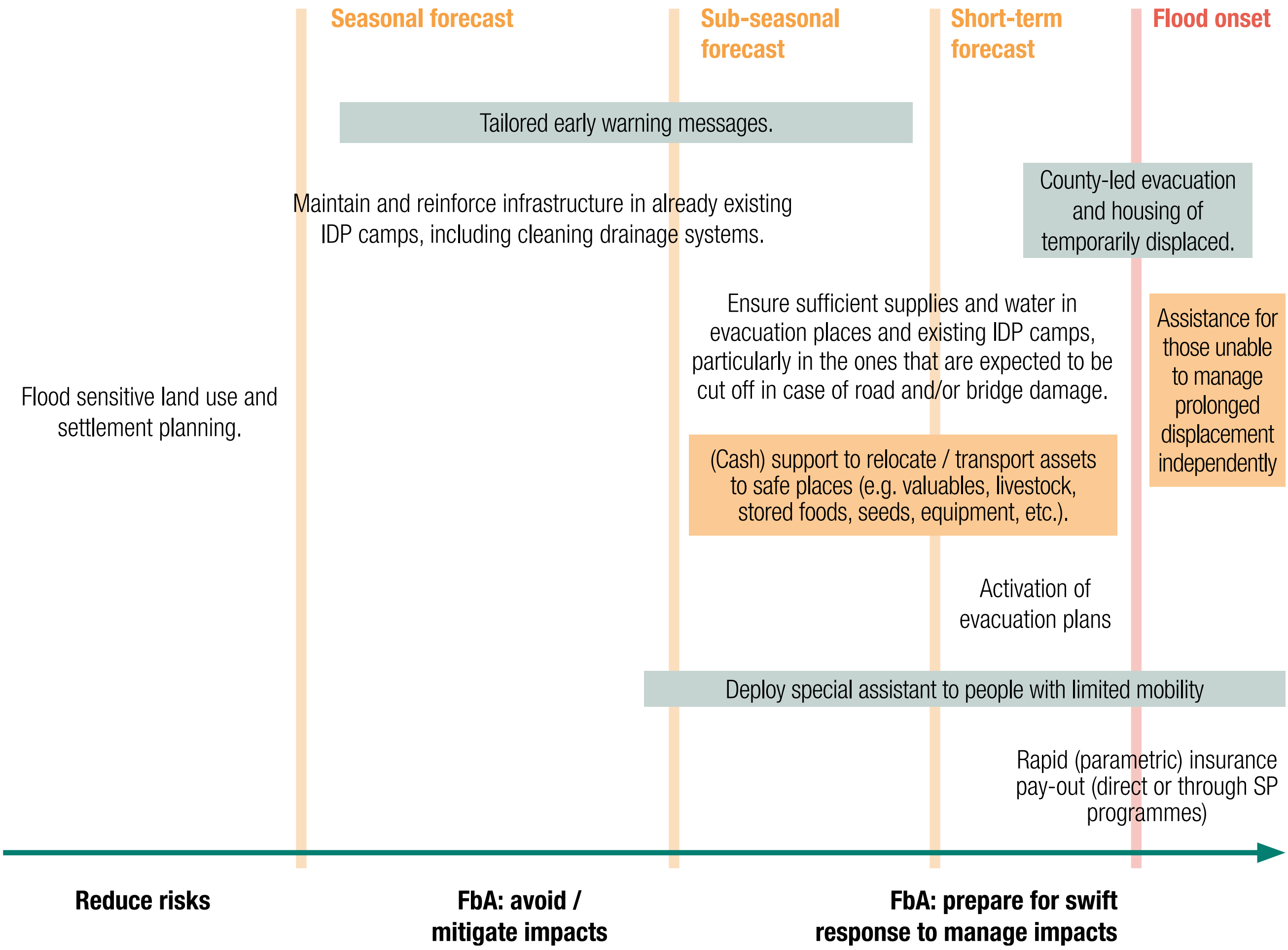
Source: Authors.

Figure 8 Damage to infrastructure



Source: Authors.

Figure 9 Mortality from river crossings and dam failure



Source: Authors.

flood. They show that early cash transfers would not help much in addressing all major identified impacts. Instead, cash would have had the very specific purpose of helping people prepare for and cope with displacement in the 2018 floods (orange highlights). Furthermore, national social protection systems could have a role in supporting other types of action (green highlights), for instance through their registration and targeting mechanisms, communication channels or public works programmes. These options are discussed further in Chapter 7.

It should be noted that these examples are illustrative and based on experience with FbA for floods in other contexts. Furthermore, we recognise that floods may result in impacts other than those identified as major national concerns in Kenya in 2018. These may include people being cut off from markets for a prolonged period, large outbreaks of waterborne diseases or the disruption of critical services (transport, health, food supply, security, finance, communication and energy). In practice, it would be necessary to undertake highly localised research to understand the precise threats from floods (e.g. which roads would flood when), and the potential activities of affected people, businesses and the authorities. Activities could involve moving assets out of danger zones, livestock healthcare measures and business continuity plans for public sector services, such as schools or healthcare facilities, and private businesses. This planning stage would take place well before any specific flood warnings are issued, and should include extensive consultation with public, private and community stakeholders at all levels.

Given that most early action involves sectoral collaboration, it is essential that ministries, specialised agencies, private sector actors and community groups are all involved in identifying and prioritising early actions, and linking them to triggers and financing. This would include key actors involved in risk management and civil protection, forecasting and information management, the National Treasury and Ministry of Finance, county governments and representatives from at-risk communities. In order to select forecast-based actions, this group should consider historical disaster impacts, lead time, implementation capacity, the resources required, evidence that the action can generate effective change and social acceptability, among other elements. This process should also be consistent with other contingency plans by local and central government, businesses, humanitarian actors and households/individuals.

7 Developing an appropriate mechanism for flood early action: the role of social protection

This study does not recommend definitive early actions, but rather assesses whether existing delivery channels could be used to provide appropriate support to reduce flood impacts in Kenya. Specifically, because of the scope and maturity of social protection programmes, we look at the suitability of cash transfer programmes for scaling up relevant actions in advance of an anticipated flood. One of these programmes – the HSNP – is already delivering unconditional cash transfers linked to drought warnings in four at-risk counties. A similar system could be used to extend unconditional payments in anticipation of flooding by linking flood forecasts with the cash transfer system.

Social protection programmes could deliver cash transfers to help households prepare for and cope with significant displacement, as experienced in the Tana River basin in 2018. Cash transfers could be used to assist in evacuation and temporary shelter for people unable to manage on their own, or help people move critical assets to safety. Before putting such a system in place, however, further research is needed on how early cash transfers can be used to reduce flood impacts.[23]

Cash transfers do not seem to be particularly appropriate for reducing mortality from river crossings and dam failures or preventing damage to infrastructure. Nonetheless, the social protection apparatus in Kenya can help support early action for floods in other ways. These entry points include:

- The use of existing social protection/cash transfer systems to enhance communication of early warning messages at various forecast lead times.
- Building on efforts to consolidate social protection/cash transfer programmes and the establishment of the Single Registry of beneficiaries, once fully operational, to enhance targeting for different types of non-cash early action.
- Exploring the suitability of public works programmes as a way to carry out critical infrastructure works (e.g. clearing drains) based on seasonal forecasts.

While the analysis in the previous chapter considers the most relevant, national-level impacts of floods, other consequences are nonetheless important, even if not discussed in more detail here. Quite possibly, for some, cash transfers may have been valuable in cushioning against losses or adverse consequences. However, it would be very difficult to assess need a priori at the national level and target particular households accordingly. This may be more feasible at the county level, and certainly easier after the event, when actual losses and those affected can be verified.

23 Specific assumptions to be tested are outlined in the introduction to this study.

7.1 Challenges to developing a flood early action system

In order to successfully use forecast-based early action at scale to address floods, any proposed systems in Kenya would have to ensure that the following political or bureaucratic challenges are met:

- Adequate coordination between the different state institutions responsible for various aspects of disaster risk management, which are spread across different ministries and institutions (including the military and police). The precise institutional architecture for this, to avoid overlapping or conflicting mandates, clarify responsibility and accountability and include processes for using the National Drought and Disaster Contingency Fund (NDDCF), has yet to be finalised.
- Adequate coordination between county and central government. This coordination must cover agreement on when to use forecasts as a trigger for action; where decisions about actions are taken; and how such actions are funded (e.g. from county budgets, national contingency funds or alternative financial instruments).
- Adequate coordination between the authorities and institutions responsible for early warning and forecasting, emergency response and social protection. This may include both coordination between local and national government, and between different parts of central government.
- Willingness to release money in advance of an actual crisis. Although this does not necessarily entail the use of predetermined triggers, these may be chosen in order to speed up decision-making and depoliticise decisions as they are being made. This is linked to a more collaborative institutional architecture, because rapid decision-making will mean institutions taking decisions based on information supplied by other institutions (e.g. local and central government), rather than insisting on verifying everything themselves. A much higher level of preparedness will also be needed, supported by contingency plans that are action-oriented and scenario-specific. Contingency plans that include 'low-regrets' or 'no-regrets' funding decisions may be useful. Plans may also include sequenced actions that could be taken at different points in time, moving from seasonal to sub-seasonal and short-term forecasts.

For the specific case of using a state social protection system to make household cash transfers in anticipation of a crisis, mechanisms will have to be found that can ensure that:

- Registers of households allow for swift selection based on agreed criteria, which will necessarily include the likelihood of the household being affected in very specific ways by flooding (e.g. being displaced). This should also include other targeting criteria as a proxy for estimating relative need (e.g. poverty criteria). The former implies that quite detailed geographic information is held and easily accessed, so that once an at-risk area is identified people at risk can automatically be selected from the register. These registers will need to be well-managed, i.e. updated regularly – a significant bureaucratic burden.
- Coordination is established regarding registers from different social protection systems, and agreement is reached on whether/when overlapping payments are to be made. This will require registers to be compatible. Efforts in this regard are under way through the Single Registry managed by the SPS, but challenges remain. For example, some registers are in the names of the beneficiaries' proxy, who receives the money on their behalf, making it impossible to cross-check duplication with other SP registers.

7.2 Delivering forecast-based cash transfers

Table 1 provides some options for how a forecast-based cash transfer system could be set up institutionally for floods in Kenya. The table outlines some of the key technical and political opportunities and challenges related to these different options.

Given prior experience and current mandates in social protection and flood risk management, NDMA and SAU are discussed with a focus on cash transfers, while other institutions considered have more experience in flood emergency response and may therefore be a more direct entry point for coordinating anticipatory cash transfers with flood risk management more broadly.

Table 1 Options for delivering forecast-based cash transfers for floods in Kenya

	Opportunities	Challanges
OPTION 1: National Drought Management Authority (NDMA)	**Experience with emergency transfers and demonstrated operational capacity to scale up.** As described above, the HSNP, managed by the NDMA, is currently the only one of the four national government cash transfer programmes that has prior experience with scaling up cash transfers to additional recipients in cases of emergency. Although the VCI used to determine whether these emergency payments are made in a given month is based on satellite data of observed conditions, and not forecasts, the general concept of using predefined triggers for transfers is similar. In 2015, NDMA initiated a one-off emergency transfer to around 180,000 non-regular households in the HSNP counties on the basis of an El Niño forecast prior to expected flooding. NDMA has built a significant degree of trust within the government and with donors because of its proven track record in drought emergency management in general, and scalable cash transfers in particular. **Comprehensive registers in target locations.** Unlike the other cash transfer programmes, which only register households with individuals falling within their specific mandate, the HSNP has attempted to compile a comprehensive register of all households in the targeted counties, currently a total of around 375,000 across Turkana, Marsabit, Mandera and Wajir (registered between December 2012 and June 2013).	**Geographic coverage.** Currently, the HSNP is implemented only in the four northern-most of Kenya's 47 counties. Although expansion to Samburu, Isiolo West Pokot, Tana River, Garissa and Baringo counties is planned, it will remain a programme directed specifically at arid and semi-arid counties, with no objective or mandate to achieve national coverage. This means that flood-prone areas outside of ASAL countries, such as the urban centres of Nairobi, Nakuru, Kisumu and Mombasa, would not fall within the territory covered by the HSNP. **Mandate.** NDMA is mandated by the National Drought Management Authority Act of 2016 to coordinate drought risk management and to work towards ending drought emergencies in Kenya (Republic of Kenya, 2016). Floods are not explicitly featured in this mandate, although there is a link between the cumulative impacts of consecutive cycles of droughts and floods on vulnerability and extreme poverty. Whether NDMA should take on a role in flood risk management, however, is contested. Political representatives from arid and semi-arid counties are pressing to maintain the focus on droughts, as well as the specific targeting of drylands, and appear prepared to block any attempts to widen NDMA's core area of engagement. A widened NDMA mandate could potentially conflict with the mandate of a new National Disaster Risk Management Authority or an extended function of the Ministry of State for Special Programmes to manage disaster risks, options explored under the ongoing process for implementing the 2017 National Disaster Risk Management Policy. **Managing registers.** Although NDMA is able to generate expanded payrolls based on drought conditions within one working day, these are based on registers which have not been updated since 2012. Instituting a system for continuous management of registers to reflect the localised nature of flooding is an additional challenge for the system.

	Opportunities	Challanges
OPTION 2: Social Assistance Unit (SAU)	**Experience with delivering cash transfers and harmonising targeting and enrolment.** Starting in 2004, 2007 and 2011 respectively, the CT-OVC, the OPCT and the PWSD-CT have been building up experience in delivering and expanding national cash transfer programmes in Kenya. Ongoing efforts to enhance coordination, harmonise targeting, develop a Single Registry managed by the SPS and integrate three of the national cash transfer programmes under the CCTP aim to establish a platform to deliver cash transfers more effectively. With the creation of the SAU and the SPS, mandates for managing cash transfer programmes within the Kenyan Ministry of East African Community, Labour and Social Protection have been strengthened, offering an entry point for potential forecast-based cash transfers to address flood risks. **National geographic coverage.** Unlike the HSNP, cash transfer programmes managed by the SAU stretch across all 47 of Kenya's counties. The SAU is not restricted in its mandate to focus on a specific hazard or to prioritise particular counties.	**Population registers and targeting.** The CCTP covers all Kenyan counties, but its registers are currently not exhaustive. Not only are the registers categorically restricted (e.g. to the elderly, orphans etc.), but targeting for the CCTP is also driven by considerations of poverty prevalence, so that only a small minority of households in each of the three categories are actually captured. Considerations of vulnerability or exposure to flooding are not currently among the criteria for registration, so registers would have to be expanded, and would potentially have to collect and manage new data on households. **Lack of experience with scalable systems or situation-based payments.** To this point, the programmes combined in the CCTP have made regular transfers and do not have experience with scaling up for emergencies. Structures or procedures for linking cash transfers with any sort of triggers are not in place. These systems do not currently have the speed to react to flood warnings. Substantive adjustments would be required to bring down payment cycles from the regular 48 days, and additional capacity may be required to roll out activities quickly. **Limited relations with key actors in disaster risk management and flood response.** Contrary to drought, where emergency cash transfers and wider drought risk management activities are organised within one institution (NDMA), engagement between the SAU and key actors in flood risk management, response and forecasting are less established. This could present a challenge to the effective use of forecast-based triggers, as well as to the coordination of early action and response activities.
OPTION 3: County governments	**Closer to the ground.** County governments are more familiar with the local context than national institutions, and may therefore be more likely to know how to address specific needs. This would be the case, for instance, in the identification of critical access routes. Furthermore, county governments are recognised as 'first responders' to crises, so locating early action for flooding at county level could help align early action and early response. **Mandate.** Counties have responsibility for the welfare of their people in respect to all kinds of shock and all sectors relating to shock impacts – although disaster management itself is not entirely decentralised.	**Spatial spread of floods.** The differences in types of flooding and the geographic concentration of flood crises might support an argument for a sub-national approach. However, river basins spread across counties and flooding is not confined within county borders. Managing flood risks for larger rivers and flood-prone areas that extend across several counties could therefore become more fragmented as a result of institutionalising early action for floods at county level. **Unequal capacities.** The capacity and political will of county governments in relation to the protection of their populations varies markedly from county to county, as has been seen in the handling of the 2017 drought response. County-level responsibility for forecast-based cash transfers to support flood preparations could lead to unequal provision of support across the country. **The interpretation of mandates differs between counties.** With the devolution process that started in Kenya in 2010, a number of functions were transferred from national government to the 47 newly created county governments. Disaster management, however, at least partially remains among the main responsibilities of the national government (Transparency International Kenya, 2014). In the area of social protection – including social assistance through cash transfers, health insurance and other components – counties' needs, willingness and capacity to roll out programmes varies. County government engagement in social protection has also received mixed reactions from national stakeholders. While some show an appreciation of counties stepping up, others are concerned about overlapping mandates and a lack of coordination between county and national governments.

	Opportunities	Challanges
OPTION 4: National Disaster Risk Management Authority (NDRMA)	**Clear mandate to work on floods.** The creation of a new National Disaster Risk Management Authority (NDRMA) has been explored as an option for implementing the Kenyan Disaster Risk Management Policy (Republic of Kenya, 2017). If established, flood risk management and early warning would likely fall within the responsibilities of this new authority. As highlighted by several key informants, mandates in flood risk management between different agencies (NDMU, NDOC, NDMA, KRCS, etc.) are overlapping and unclear. The creation of NDRMA – along with the proposed County Disaster Risk Management Committees – could allow for better coordination of disaster risk management activities under a clear policy framework. It could also help establish more effective and consistent links between the various institutions working on flood forecasting, early action and response, and thus present an institutional entry point for a national flood FbA system similar to the way NDMA currently operates the HSNP for droughts. Having all disaster risk management activities coordinated under one roof would also be an advantage in rolling out early actions other than cash transfers, should these be identified as priorities.	**Unclear status and timelines for implementation of the National Disaster Risk Policy.** The Disaster Risk Management Bill, providing a legal framework for disaster risk management and the establishment of a National Disaster Risk Management Authority and County Disaster Risk Management Committees, was introduced to the Senate in March 2018 (Republic of Kenya, 2018). It remains up for discussion whether, when and in what form NDRMA will be set up. There is also the question whether the agency would be able and willing to directly engage in exploring the use of FbA systems, or whether this would require more time to develop capacity and a recognised track record in disaster risk management before running a forecast-based early action programme. There is likely to be some opposition from ASAL counties to creating a new institution to potentially replace the current drought-focused NDMA (see above regarding dilution of drought focus).
OPTION 5: Humanitarian or development partners (e.g. UN, KRCS)	**Faster implementation and opportunity to test what works.** The driving rationale behind shock-sensitive social protection is to remove it as much as possible from the sphere of ad hoc humanitarian action and bring it into state structures, where it will be predictable and permanent and can be entitlement-based. Nonetheless, it may be relevant to look to a humanitarian actor – either international or the Kenya Red Cross – to establish a forecast-based payment system for floods as a pilot and as an interim measure, with the state taking over responsibility once lessons have been learned and systems improved. The advantages might be that the piloting would be depoliticised; it would enable a system to be established more quickly (without waiting for institutional and political disagreements to be sorted out); and it would potentially increase political buy-in if the system were shown to work. **Experience.** Humanitarian agencies (including KRCS) have experience with large-scale (adaptive) cash transfer programming. UN organisations and KRCS both have the trust of the Kenyan government, donors and the general public in running such programmes. UN organisations and KRCS have experience of coordinating cash transfers with local and central government, including working with NDMA on targeting. **Mandate.** Both UN organisations and KRCS have mandates to partner with the government in disaster management, so there could be a smooth transition from a purely humanitarian agency-led system to a fully government-owned system.	**Cost.** A UN-managed system may be more expensive and more difficult for the government to finance. This would be less of a problem if the system were managed by KRCS. **Coordination.** UN agencies have found it difficult to manage a single payment system in crises. Coordinating together with the various institutions of central government, with county government, and with other state institutions to manage early cash transfers for floods in short timeframes would present an additional challenge for an organisation that did not itself have a statutory mandate and responsibility. **Responsibility.** There could be fears that the government would feel less responsible for DRM as a whole nationally if part of the DRM response were run in parallel as 'old paradigm' ad hoc emergency response. This would go against the current trend that sees international humanitarian donors and agencies scaling down their presence in Kenya, with crises increasingly being managed by the state and national partners, rather than by the international humanitarian community. Even among international donors, disaster management is increasingly funded as a development intervention rather than an emergency response. For example, EU support to the 2017 drought response was mainly funded from DEVCO through NDMA, rather than by ECHO through humanitarian agencies.

7.3 Alternative entry points to support flood FbA

The discussion of recent flood impacts and potential early actions in previous sections shows that significant action is required to manage flood risk in Kenya. This will need to extend beyond anticipatory cash transfers. Social protection programmes can nonetheless play a critical role in supporting the development of an FbA system by enhancing early warning communication and targeting other actions through the Single Registry. The potential for public works programmes to be used to carry out preparedness based on seasonal forecasts should also be further explored.

7.3.1 The Single Registry – improving early warning communication and targeting for flood FbA?

The Single Registry is operated by the SPS to consolidate information from social protection programmes operated by various agencies in Kenya within one central Management Information System (MIS). This has been recognised as an important step towards consolidating social protection cash transfer programmes by reducing fragmentation and increasing coordination. Parallel efforts to harmonise targeting aim at increasing the quality of targeting information, as well as identifying and reducing duplication or 'double dipping'.

Once fully operational and comprehensive, the Single Registry can act as a catalyst for flood FbA because it compiles information valuable in pre-identifying areas of intervention or potential target beneficiaries for different types of early action, such as evacuation, pre-positioning goods or providing special assistance to people with limited mobility. Vulnerability information is crucial for designing and operating any FbA system (see Chapter 3). Social protection cash transfer programmes collect some of this data through their registration work. However, the information currently captured relates to the target populations of existing cash transfer programmes (children, elderly, disabled and low-income groups, as well as those vulnerable to drought). In order to be of use for flood FbA, the system needs modification to better capture flood-related vulnerabilities and exposure. This entails, first and foremost, more granular and up-to-date geographic information. Impacts can be very localised, and hence require greater accuracy in targeting than for drought.

The Single Registry is managed by a national institution (the SPS), but it could support targeting for flood FbA by both national and county-level institutions – based on the criteria most relevant for specific interventions – and thus reduce duplication. A 'complementary module' has been developed for the Single Registry to allow national and county-level agencies outside of the SPS to contribute information from other programmes, and to use the Single Registry for their own targeting. However, this is not yet fully operational, and stakeholders pointed out that links with the counties are still weak. More engagement is needed if the Single Registry is to be used for county-led flood FbA.

Communication of early warning information is critical to reducing flood impacts. Experience from disseminating warnings via local radio and text messages in previous floods (see Section 4.3) shows that timely information is important, but it does not always influence people as hoped. For instance, encouraging people to evacuate to higher ground has proved challenging. Offering specific advice on what types of action should be taken and where support services can be accessed is a core component of the TERA text messaging system. Linking TERA messages with the Single Registry would allow these messages to be more tailored, providing useful information for people with specific needs, and messages could communicate information about early actions (cash transfers and others) to beneficiaries. The TERA system allows users[24] to provide feedback and identifies their location via the position from which they placed their last call (IFRC, n.d.). Combined with the Single Registry, these functions could help to enhance geographic targeting for flood FbA.

24 The TERA system includes a function for people to opt out of its services.

7.3.2 Public works programmes

Stakeholders in flood risk management have pointed out the option of linking flood forecasts with public works programmes for infrastructure-related activities before anticipated flooding. In 2015, for instance, the Kazi Kwa Vijana programme, targeted at out-of-work youth, was used to clear water channels based on El Niño early warnings ahead of the October–December 'short rain' season. Establishing more systematic links between flood forecasting (i.e. KMD, WRA and KenGen) and the State Department of Public Works could help avoid or mitigate flood-related impacts on critical infrastructure.

However, public works programmes have generally been slow to react and are limited in their capacity to deliver quality work while ensuring 'basic social protection for the working-age poor' in Kenya and elsewhere (Ludi et al., 2016; McCord, 2012). Part of the reason for this is the high costs related to operating them, compared to other options such as social protection cash transfers. These higher costs could be offset through reduced losses as a result of the works carried out – for example, by clearing waterways and reducing detrimental flood impacts. Whether there actually are net economic and social benefits from such activities, compared to other alternatives available in Kenya (e.g. regular social protection cash transfers and contracting of professional companies to clear waterways) would need to be tested.

Even if this were the case, however, clearing waterways and comparable infrastructure maintenance may be more effectively done as a regular disaster risk reduction measure, rather than based on flood forecasts (irrespective of whether such maintenance is done through public works or contracting). Given the long lead time required to implement this work, seasonal forecasts would be most relevant as a trigger, but these are only sufficiently skilful for the October–December 'short rain' season, not for the March–May 'long rains' (see Chapter 5). Regular seasonal maintenance could thus be a more reliable way to ensure water flows, especially for the long rain season, and would not require triggering through a more complex (and potentially costlier) FbA system.

7.4 Capacity to finance flood FbA through social protection channels

Timely funding is crucial to developing an FbA mechanism for floods through existing government social protection channels. Depending on the type of action and lead times of the forecast used, the window to release funding for implementing early actions (cash transfers and/or others) varies from several months to a few days in the October–December 'short rain' season, and from a few weeks to a few days in the March–May 'long rain' season (see Chapters 4 and 5).

Existing disaster risk financing systems in Kenya have the ability to deliver and channel funds released by a 'hard trigger' (for example the VCI of the HSNP) within a seasonal window. For El Niño-related flooding, a monthly cycle such as the current HSNP drought emergency payments could provide funding with sufficient speed to deliver cash (or other actions) before a flood (as was shown in 2015). However, in their current form DRF instruments and mechanisms under revision by the Kenyan government are not tested or necessarily always able to work reliably in sync with sub-seasonal and short-term forecasts (which range from roughly two weeks to three days). To ensure release of funds for flood emergencies on a shorter timeline, systems would need to be adjusted to address bottlenecks related to budgetary cycles, delivery of physical cash and communication.

Finally, funding and contingency plans should be in place and coordinated with FbA systems to respond to flood-related disasters not picked up by the forecast-based system. Not all floods will be effectively captured, and not all impacts are adequately addressed through an FbA system. Financing measures therefore need to be in place to support disaster responses after a flood.

The following sections review current timelines for cash disbursements under the four large unconditional cash transfer programmes; discuss bottlenecks preventing the swifter delivery of funds; and explore entry points for financing flood FbA through existing disaster risk financing instruments in Kenya.

7.4.1 Processes and timelines for cash delivery through government unconditional cash transfer programmes

Cash transfers under the CCTP are fully funded by the government. Two different sources are currently used to fund HSNP emergency transfers: government budget allocations and donor funds from DFID and the EU. Due to donor requirements, DFID resources are channelled through Financial Sector Deepening (FSD) Kenya[25] rather than the National Treasury and the NDMA. In a context of increasing ownership and harmonisation across government cash transfer programmes, DFID's share of funding for the HSNP is in the process of being phased out by 2022.

Government budgets for the four large government cash transfer programmes are approved by the National Treasury annually, and payments are released every two months to fund regular cash transfers for beneficiaries, based on a payroll. From the initial payment projections all the way through to post-payroll checks and reconciliation, each payment cycle for the CCTP is anticipated to last 48 to 54 days (Republic of Kenya/Ministry of East African Community, Labour and Social Protection, 2017). Channelling resources through existing government systems means following public financial procedures and regulations. This includes alignment with budgetary cycles throughout the financial year. As key informants pointed out, this is a process with limited room for flexibility to scale up or down quickly in relation to specific (anticipated) emergency events, because amounts are annually pre-defined and timeframes are static.

For HSNP emergency transfers, timelines for channelling funds from their source to beneficiaries have been brought down to allow for monthly payments based on VCI alerts. Key informants were confident that this process (through the HSNP or a similar programme) could be rolled out on even shorter timescales of 7–10 days, as digital registries are already in place to facilitate the identification of beneficiaries when paired with forecasting information. The major bottlenecks in speeding up this process, as identified based on prior HSNP experience, include delays in the release of funds through the Treasury due to budgetary cycles, the timely delivery of physical money to banks and agents and reliable communication to targeted people for the specific transfer, so that they are aware when they have been allocated funds and can withdraw them when needed. The first obstacle could be circumvented through a dedicated disaster fund or early action window, but availability of physical cash and communication would remain critical challenges nonetheless. Banks delivering the cash transfers locally under the HSNP usually require about five days to prepare local agents and move cash, which would need further reduction to be timely enough for flooding detected through sub-seasonal or short-term forecasts.

7.4.2 Disaster risk financing instruments for flood FbA in Kenya

The Treasury is in the process of reviewing a range of DRF instruments that are, or could become, part of the government's DRF portfolio (see Box 1; for a full overview of the Kenyan disaster risk financing landscape, see Annex 10).

None of the existing financing instruments being explored by the Treasury is linked to flood forecasts or currently operates on a short-enough timescale to fund flood FbA on the basis of below-seasonal forecasts. If these financing instruments are to make an effective contribution to flood preparedness – and potentially support the implementation of forecast-based early actions to address flood risks – they need to ensure reliable and swift release of funds. As outlined in Chapters 4 and 5, lead times related to forecasting early action for floods can range between several weeks or months for El Niño-induced events to a few days for others. Within this short timeframe, funds need to be released and channelled to beneficiaries in the form of cash transfers, or converted into goods, services and activities to be delivered early in the run-up to an expected flood event.

National or county-level emergency funds may be more suitable for flood FbA, but would still require significant adjustments. A dedicated FbA window, like the one developed for the Disaster

25 FSD Kenya is an independent trust set up by DFID in 2005 to strengthen financial inclusion and support the development of inclusive financial markets (http://fsdkenya.org/).

Box 1 Disaster risk financing instruments in Kenya

Partially in recognition of the need for the timely release of funds and enhanced surge capacity in relation to emergencies, the Kenyan Cabinet approved regulations for operating a new National Drought Emergency Fund (NDEF). In 2017, the government committed KES 2 billion to the fund, with a similar amount to be allocated each subsequent year, according to the Treasury. This is meant to provide earmarked drought emergency funding and increase the efficiency and effectiveness of the country's drought risk management systems . It also allows donors and the government to pool drought risk management funds under the administration of the NDMA (Government of Kenya, 2018; Achuka and Ngirachu, 2017). A quarter of the funds will be used to scale up cash transfers in drought emergencies, but at the time of writing the fund was not yet operational.

In June 2018, the World Bank approved a $200 million credit for Disaster Risk Management Development Policy Financing with Catastrophe Deferred Drawdown Option (Cat DDO). The Cat DDO supports liquidity through a contingent credit line accessible post-disaster. While this can support early response and recovery, it would not free up resources for early action based on forecasts before an event because its release depends on the declaration of a state of emergency in line with local legislation, and linked to the occurrence of an adverse natural event (World Bank, 2018).

Kenya previously participated in the African Risk Capacity (ARC) risk pool for drought coverage, but discontinued its engagement in 2016. ARC does not currently offer a flood pool, and as such would not be suited to financing flood-related cash transfers. The facility has been exploring models for hazards other than drought, including tropical cyclones, floods and epidemics, so this may become an option in the future if payouts can be channelled quickly enough through the system.

Relief Emergency Fund (DREF), could help establish sufficient speed and flexibility to enable flood FbA, even for sub-seasonal and short-term lead times.[26]

Experience with FbA mechanisms elsewhere has also shown the challenges of releasing funding and implementing activities on time for rapid-onset events such as flooding. In Sierra Leone, above-average rainfall and increased risk of flooding and mudslides were forecast in 2017, but early action by the Start Fund Crisis Anticipation Window Fund was held up due to uncertainty about acting early and coordination. Similarly, complex decision-making and uncertainty related to flood forecasts in Niger and forecasts of Hurricane Irma in the Caribbean prevented early action though the Anticipation Window (Start Network, 2017). In Senegal and Niger, the use of payouts from the ARC's drought risk pool for early response in 2015 was significantly delayed because funds were channelled through the National Treasury, which meant they were held up by the budget allocation cycle instead of being rapidly available to implementing agencies in charge of drought response (African Risk Capacity, 2017). These examples underscore the need for timely and flexible ways to channel resources to ensure that a flood early action system in Kenya can deliver support quickly.

26 This has been achieved in many countries through Red Cross/Red Crescent National Societies, including in Bangladesh, where an emergency cash transfer was made with a 7–10-day advance warning of riverine flooding, and in Mongolia, where an emergency cash transfer was made to herding families at seasonal timescale in anticipation of extreme winter conditions. In both instances the distribution was completed with sufficient speed that is was received by beneficiaries before peak disaster impacts. Both of these forecast-based emergency cash transfers were originally funded through pilot projects, but will now draw centrally from the DREF through the forecast-triggered mechanism. It is expected that the release of funds will be similarly efficient from the central fund.

8 Conclusions and ways forward

This report assesses opportunities for linking forecasts with social protection cash transfer programmes to deliver early action before floods. Cash transfers have been channelled through national social protection systems in Kenya for several years to help beneficiaries cope with the impacts of drought, but a similar system is not currently in place for floods.

Existing capacity and recent advances in the field of flood forecasting, disaster risk management and financing and social protection in Kenya provide a valuable basis on which a flood FbA system could be built. Specifically, advances in capturing risk data (e.g. through WRA or initiatives such as the Kenya Open Data Initiative and the global 510 initiative) and in forecasting floods and their related impacts (e.g. through the KMD and WRA collaboration) are promising avenues for further developing flood FbA. In the social protection sector, the establishment of the Single Registry, a repository of information on cash transfer beneficiaries managed by the SPS, has been a major step towards the consolidation of social protection programmes in Kenya, and provides a basis for better targeting of vulnerable households for flood FbA and communicating tailored early warning messages.

Based on a discussion of forecasting and disaster impacts related to recent flooding during the March–May long rains in 2018, the report presents different types of action that could be taken in advance of such expected events. It finds that cash transfers may have a specific role in helping people avoid or mitigate flood impacts such as longer-term displacement. However, they are not necessarily well suited to addressing other impacts, such as mortality from dam failure and river crossing or damage to critical infrastructure. While crop and livestock losses have been detrimental for individual households, their aggregated impact at national level was fairly small and production of certain crops overall benefited from the rains. Determining whether anticipatory cash transfers would provide effective protection in such cases, for instance by supporting timely evacuation of livestock, requires further investigation. Alternatively, savings or insurance protection may be more appropriate to manage these losses at the household level. A better understanding of the relevance of these different instruments for reducing, mitigating or managing flood impacts vis-à-vis cash transfers for different groups of people is needed.

Beyond delivering cash transfers, social protection systems could be critical in supporting alternative actions to reduce or manage human and economic losses. Potential entry points include use of the Single Registry for targeting actions and communicating early warnings or adjustments to public works programmes so that infrastructure works can be carried out in anticipation of heavy rain.

A range of challenges remain in relation to designing and operating an effective flood FbA system in Kenya. These entail the need for:

- More granular, high-quality information on flood risk data (including vulnerability and exposure) and historical disaster impacts.
- Enhancing forecasting capacity and understanding of the skill of available flood forecasts, as well as the likelihood of getting it wrong.
- Seamless integration of forecasts with different lead times (seasonal to a few hours), and related actions that can be taken at different points in time at varying levels of uncertainty.

- Adequate coordination between the state institutions responsible for flood risk management, which is currently fragmented between agencies.
- Adequate coordination between county and central government to clarify when to use forecasts as triggers for action, where decisions about action are taken and agreement on how these are funded.
- Adequate coordination between authorities responsible for early warning and forecasting, information management, disaster mitigation, emergency response and social protection.
- Greater willingness to release money in advance of an actual crisis.

Opportunities for developing flood FbA in Kenya are already being considered in the National Disaster Risk Management Bill, under discussion in parliament at the time of writing. The Bill, together with the Treasury's new Disaster Risk Financing Strategy, would provide enhanced legal and financial backing for flood FbA because it emphasises the importance of early warning and anticipatory action. The Bill also proposes the establishment of a National Disaster Risk Management Authority, which could help clarify mandates in flood risk management and offer an institutional home for flood FbA. Furthermore, ongoing projects such as the Kenya Water Security and Climate Resilience Project (KWSCRP), ForPAc, IARP, various projects within the WISER programme and the Kenya Cash Working Group are improving the scientific basis underlying flood FbA and social protection cash transfer programmes. The latter is working to develop a household minimum expenditure basket to determine adequate amounts for cash transfers, which could be further developed for different types of emergencies. At the same time, the IARP project by the KRCS is developing FbA systems for droughts and floods, aiming at coordinating with the government to set these up. Such efforts and existing systems should be recognised and built on for any future flood FbA system in Kenya.

Overall, recent developments and initiatives offer high potential for establishing a flood FbA system in Kenya. Key stakeholders in flood forecasting and early warning (KMD and WRA), disaster risk management and social protection have shown interest in engaging in this area.

The stakeholder consultations and workshop carried out for this report have helped identify a range of concrete steps for linking flood forecasts with national social protection programmes to enhance flood preparedness in Kenya. These are outlined in the following sections.

8.1 Improve flood risk data for enhanced targeting and impact-based forecasting

Risk data – including flood hazard, exposure and vulnerability data – is scattered across government agencies, UN agencies, the KRCS, NGOs, research institutions and other actors. Sectoral and institutional silos around how information is managed remain a significant challenge for effective risk management.

Tackling this challenge and moving towards FbA at scale would require establishing an open source, collaborative, quality driven and granular data management system. This could radically change the way early warning systems and forecast based action interventions are shaped in the future. A system like this would require multi-stakeholder commitment for effective data management, grounded in recent policies. The Kenyan Disaster Risk Financing Strategy 2018–22 aims to expand on the use of baseline household vulnerability data to coordinate disaster support programmes, identify gaps in coverage, better target beneficiaries and encourage more efficient spending of public resources. The 2017 National Disaster Risk Management Policy has as a strategic priority conducting and reviewing comprehensive surveys on multi-hazard disaster risks and the development of national disaster risk assessments and maps, including climate change scenarios. Better information management through the national policy and strategy will be a significant step forward FbA at national scale.

Disaggregated data and information about historical disaster impacts, exposure and vulnerability to flooding is needed to support the design of an FbA system and the identification of priority actions. Global databases such as the INFORM index, ThinkHazard and the 510 initiative, together with national efforts through the Kenya Open Data Initiative, offer an initial basis for prioritising counties for flood FbA. However, most of the information analysed in this study is only currently available at a high-level geographical scale or for a few locations. For a forecast-based financing/action system to reach the most at-risk areas and the most vulnerable people, it is important to access the lowest administrative-level data available.

Projects such as IARP, which includes a strong data preparedness component, are addressing some of the data gaps. If these kinds of initiatives are closely linked to the government's plans for enhancing data, they could potentially be a key driver to scale FbA. To move towards impact-based forecasting, processes to improve risk information should be closely integrated with the forecasting capabilities of KMD.

8.2 Improve flood forecasting

Current operational flood forecasting in Kenya is limited to the Nzoia River, but there is a clear desire and ambition by the KMD to improve flood forecasting across the country. Significant investment in human and technical capacity is required to expand forecasting beyond the Nzoia River, and to enhance forecasting skill and performance to a level suitable for application in a flood FbA system. Expanding on findings and methodologies from ongoing projects such as ForPAc, SWIFT (African Science for Weather Information and Forecasting Techniques) and W2-SIP (WISER ICPAC – Weather and Climate Information Services for Africa) would be one way to address some of the recommendations outlined below.

Suggested actions to this end include:

- Construction of relevant databases to enhance forecasting. These should be set up with a comprehensive disaster risk data management system in mind (see 8.1) and entail:
  - Compilation of all river flow records for major river basins into a unified database.
  - Compilation of all historical flood reports into a unified single flood risk database, including reports from Kenyan agencies and international databases such as the Dartmouth Flood Observatory.
- Construction of a historical flood extent database based on satellite data.
- Integrated analysis of data from these three databases (river flow records, historical flood reports, historical flood extent database) to determine flood risk for each basin.
- Evaluation, with respect to historical observations of flood reports and flood extent, of the existing global 1km Flood Hazard map derived from simulations using the GloFAS modelling system.
- Development of bespoke flood forecast models or evaluation of existing global models to determine whether they can be used for FbA. The most relevant current models for river forecasting include the EF5 and GloFAS. EF5 has some institutional buy-in but would require additional calibration, while GloFAS already produces river flow forecasts on both a seasonal and daily timescale. In the urban context, new high-resolution weather forecast and inundation models provide strong potential for flood risk forecasting, although major further investment is required towards operationalisation.
- Evaluation of the 'hit and miss rate' for the desired flood forecast in order to define and validate triggers. Of the existing forecasts, evaluation for GloFAS is likely to require fewer resources than the equivalent task for the EF5, given better data availability for GloFAS.
- Real-time overlays of forecast information with vulnerability and exposure data, to identify who is most at risk; real-time analysis of which roads are likely to be flooded and which critical infrastructure is at risk, to inform early actions.
- Linking data systems and analysis of past rainfall and flood simulations (e.g. from GloFAS) in relation to historical flood impacts with data compiled by the SPS in the Single Registry (once a fully operational and comprehensive platform is in place), to assess the location and number of people in the system at risk of being impacted by floods.

8.3 Support anticipatory action and preparedness through cash transfers

As highlighted earlier, the potential role of early unconditional cash transfers in reducing flood impacts is limited to some types of impacts and affected groups. In the 2018 case, cash transfers could have been useful if targeted at people who were likely to be displaced by flooding and needed support to evacuate and protect their possessions. Taking forecast-based cash transfers to scale would require:

- Testing assumptions underlying the provision of cash transfers before a flood (listed in the introduction). This includes, but is not limited to:
  - Research on whether the ex-ante cash transfer is more beneficial than a transfer after the event. An ODI study on the potential for scaling up FbA in Bangladesh outlines a methodology that can be used for this purpose. It examines what measures people can take with the early cash, and how much lead time is needed (Tanner et al., 2019).
  - Detailed assessment of historical flood impacts in Kenya and the role cash may play in addressing mortality, infrastructure damage and displacement, as well as other flood impacts not considered in depth in this study.
- Establishing and verifying suitable triggers and timelines for releasing funds and channelling cash transfers to beneficiaries.
- Determining adequate amounts for cash transfers to meet the needs of people at risk before a flood. This should build on ongoing work in this area by the Kenyan Cash Working Group.
- A cash transfer system that can scale vertically or horizontally to reach people at risk of a forecasted flood in order to deliver cash very quickly. This would require the Single Registry to be regularly maintained and updated. Options for institutionalising such a programme include NDMA, SAU, county governments, NDRMA or humanitarian and development partners.

Any flood-linked social protection cash transfer programme should be closely integrated with the Single Registry set up by SPS and the CCTP. Its operations should either be directly managed by SAU – provided that effective links to forecasting and triggers can be assured – or, alternatively, follow the NDMA/HSNP model. This would mean institutionalising the flood cash transfer system within the government entity responsible for flood risk management, which is likely to be the newly created NDRMA, assuming the National Disaster Risk Management Bill is passed by parliament. While humanitarian or development partners may play a large role in setting up a flood FbA/cash transfer programme and could host the programme in the interim, the aim should be integration with government-led social protection systems. This would reflect the increasing role the government is already taking on in managing and financing social protection cash transfer programmes.

8.4 Explore the potential of public works programmes for reducing flood impacts

The predictability of flooding in Kenya for different lead times is improving, and it is likely that some major impacts can be avoided through early action by reducing the vulnerability and exposure of people, infrastructure and assets. Stakeholders have highlighted public works programmes as a potential option for carrying out such actions. Taking this to scale would require:

- Improvements in flood forecasting (see 8.1) and communication to indicate types and locations of infrastructure most likely to be affected by an upcoming flood, and the intensity of the impact.
- Public works programmes with the operational capacity to scale up horizontally and vertically in time to reinforce infrastructure to avoid flood losses, while providing appropriate benefits to participating households.
- Forecast-based action responsibilities to be defined for authorities and civil society, including enforcement of road closures in areas where roads cross rivers, and visits to dams to ensure that they are safe.

Systematically linking public works programmes with flood forecasts would be particularly relevant for the October–December short rains, where seasonal forecasts have relatively good skill. Given that these programmes require a fairly long lead time, this is less applicable to the March–May long rains, where skill for seasonal forecasts is low. Risk reduction and seasonal maintenance are recommended in this case.

Whether public works programmes are more effective at reducing potential impacts on infrastructure, assets and people than other options (such as cash transfers to households and contracting of professional companies to clear waterways) should be tested before integrating them with an FbA system in Kenya.

8.5 Clarify mandates and collaboration in flood risk management and social protection for FbA

The institutional context for flood risk management in Kenya is fragmented, with no clear 'go-to' agency at national or county level. Responsibility for a potential flood FbA system needs to be clarified for county- and national-level emergencies. Guidance on how FbA would relate to existing social protection caseloads is also needed. The same applies to ownership of the individual components that make up a flood FbA system – e.g. data systems for flood risk and forecasting – and leadership in coordinating different actors involved in designing and operating a flood FbA system in Kenya.

Taking any flood FbA system which includes social protection actions to scale would require:

- Defining the mandate for (flood) FbA in Kenya. The establishment of a National Disaster Risk Management Agency under the Disaster Risk Management Bill would represent a critical opportunity to clarify and institutionalise mandates between agencies and between national and county governments.
- NDRMA and SPS/SAU must each articulate their roles and responsibilities relative to flood FbA, including how the actions of one relate to the other. Those roles and responsibilities must then be embedded at the county level and situated within planned County FbA and flood emergency responses. Lastly, as with the HSNP, funding arrangements must be incorporated into annual budgets.
- Establishing a common platform for actors relevant to FbA, for instance in the form of an FbA working group or an alliance for action. This could build on the work of the Kenya Red Cross under the IARP project.

One of the most important lessons from the FbA systems set up by the Red Cross/Red Crescent, WFP, FAO and the Start Network, among other actors promoting this concept, is the importance of having an alliance for action, in which all key partners participate in processes to set up triggers, prioritise early actions, enable anticipatory funding and collaborate on SOPs (for an overview of relevant actors in Kenya, see Annex 7).

8.6 Link national social protection programmes with county governments to target action

Counties are often the first official responders in an emergency, so rolling out early action at that level may be a logical next step, especially for counties facing high levels of flood risk. As part of the devolution process in Kenya, county governments have taken on increasing responsibilities for disaster response and social protection, and KMD has officers at county level to support forecasts and early warning information. Yet, disaster management also remains among the core functions of national government.

Given that social protection systems are being consolidated and cash transfer structures are well established at the national level, these might be appropriate delivery channels for cash transfers in advance of floods. However, other types of action, such as prepositioning relief items in areas at risk of being cut off by floods, putting in place infrastructure protection and evacuating at-risk areas, will need to be implemented through other structures, including at county level. County-led flood FbA would require:

- Increased engagement between SPS and county governments to ensure that they can draw on the registries to identify locations of high population density or with large numbers of vulnerable people in flood-prone areas. This would require registries to be kept updated, potentially include non-beneficiary households and have sufficient spatial detail. In combination with information available at county level, for instance regarding critical access routes and locations of basic services, this could inform targeting for early actions including pre-positioning goods and preparing evacuation points.

- Establishment of a full FbA system, including a funding structure and EAPs linked to forecasts. As experience from 2015 has shown, El Niño warnings are not necessarily sufficient to prompt action at county level. Unclear responsibilities and lack of resources were among the key constraints for early action by county governments. Financial resources remain a challenge: only a fraction of counties have put emergency funds in place, and resources for FbA and emergency response are limited.

8.7 Identify and establish adequate financing instruments for flood FbA

None of the existing financing instruments under discussion by the Kenyan Treasury as part of the new Disaster Risk Financing Strategy is linked to flood forecasts or currently operates on a short enough timescale to fund flood FbA on the basis of sub-seasonal forecasts. If these instruments are to make an effective contribution to flood preparedness – and potentially support the implementation of forecast-based early actions to address flood risks – they need to ensure the reliable and swift release of funds. New early action funds or early action windows within existing funds are frequently used to finance FbA, and have demonstrated ability to work within flood forecasting timeframes, but other options should also be further explored.

Action in this area would include:

- Establishing adequate financing instruments that can operate at the required timescales. In Kenya, expansion of the County Emergency Funds at sub-national level and establishment of a potential drought and disaster contingency fund under the Disaster Risk Management Bill at national level are direct entry points.
- Assessing the suitability of other financing instruments and developing innovative approaches to finance flood FbA within the framework set out by the new Kenyan Disaster Risk Financing Strategy. This explicitly includes instruments to strengthen preparedness for small-scale localised floods.

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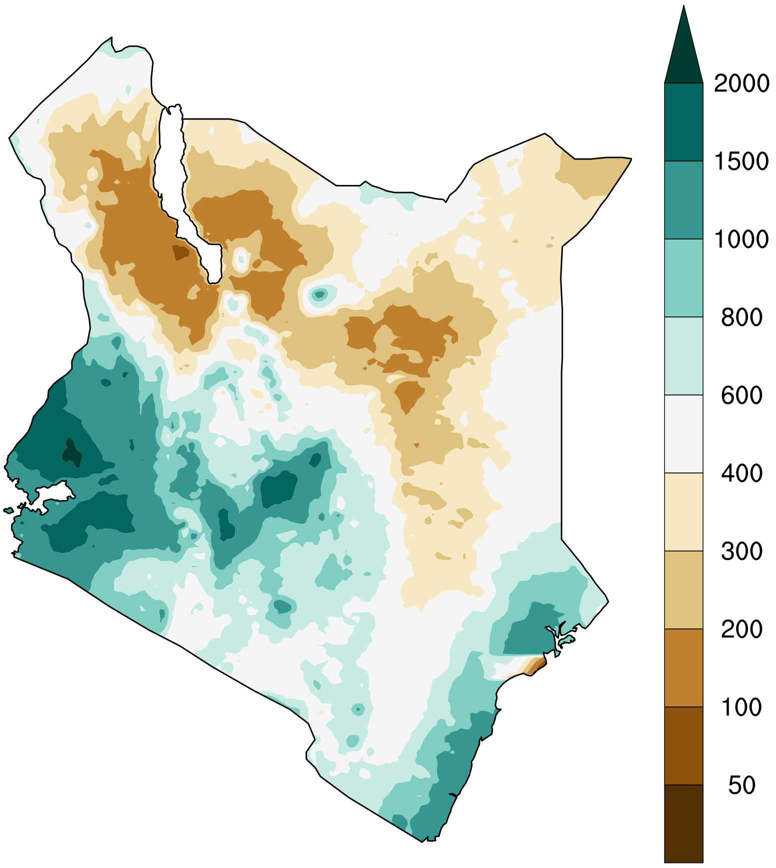
Annex 1 The climate in Kenya

Kenya experiences a wide range of climates (Figure 10), from humid conditions in the south-west, the central highlands and Indian Ocean coastal regions to arid and semi-arid climates in northern and eastern counties (the ASALs). Most of the country experiences two distinct wet seasons, related to the latitudinal movement of the tropical rain belt (Nicholson, 2017): the March to May 'long rains', and the October to December 'short rains', with the former contributing more to total annual rainfall. Flood risk is highest during the wet seasons and is greatest in wetter regions, although basin hydrology is also important. The Tana River, for instance, is flood-prone even in the semi-arid parts of the floodplain zone as it is fed by rainfall over the wetter central highlands. Flash flooding can occur from short but intense convective storms anywhere in the country (Bowden and Semazzi, 2007). Kenya's major river basins are shown in Figure 3.

Figure 10 Annual mean rainfall over Kenya 1981–2017 (in mm)



Source: Authors' figure based on data from the Climate Hazard Group InfraRed Precipitation with Station data (CHIRPS) (Funk et al., 2015).

Annex 2 The Nzoia flood forecasting system

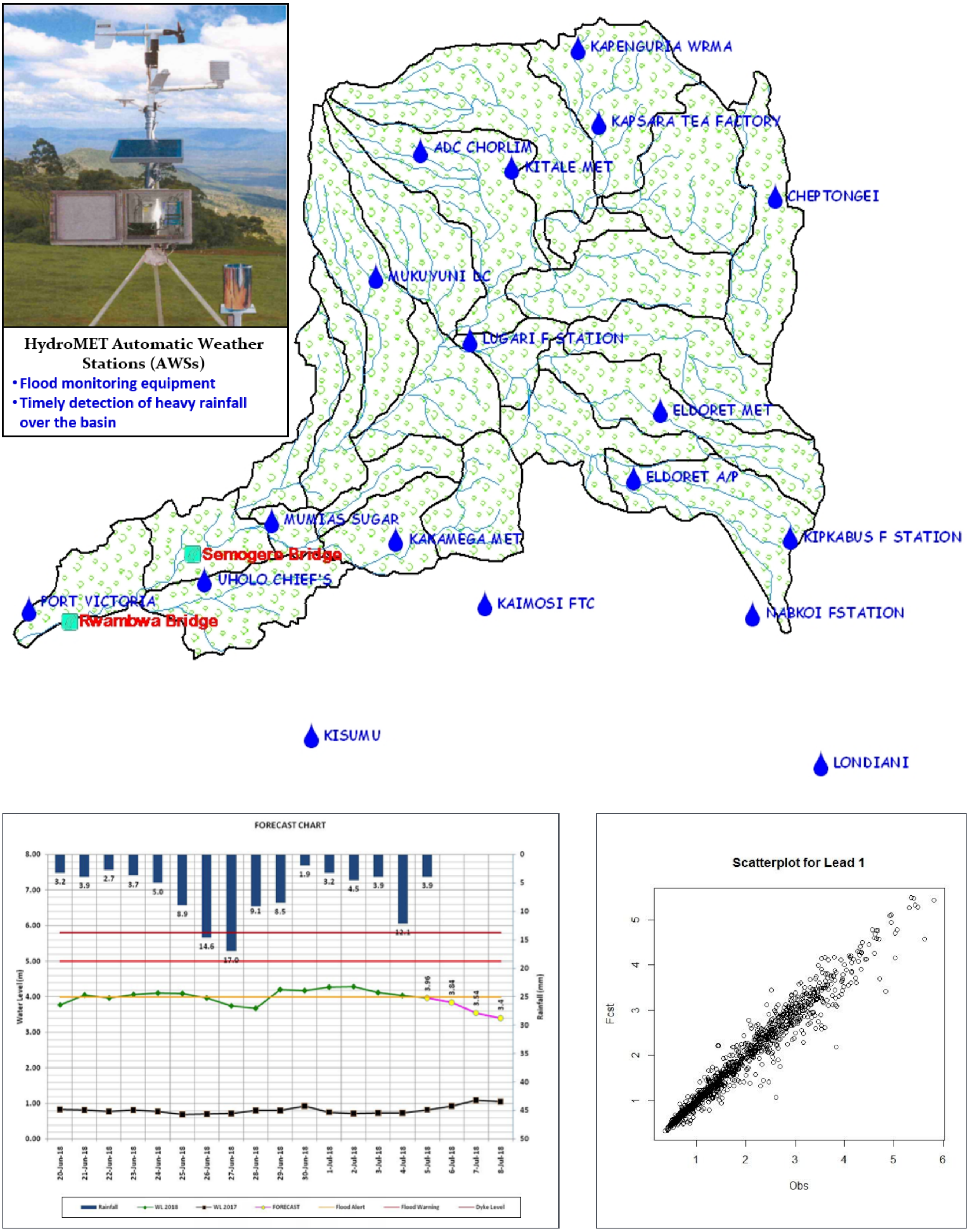
In the Nzoia basin, the KMD operates the most intensive hydrometeorological observation network anywhere in Kenya, with 16 automatic hydromet stations, four synoptic stations and two automatic river gauging stations transmitting data in real time to the FDFC. River flow forecasts are produced using the Galway Real-Time River Flow Forecasting System (GFFS), a lumped conceptual rainfall-runoff model. The model is driven with the observed precipitation and river level observations and QPF generated using the Weather Research and Forecast Model (WRF) at the KMD, as well as those from GPCs. The river flow forecasts are deterministic in nature.

Forecasts of river flow with a three-day lead time are made for Rwambwa Bridge, where the Nzoia River drains into Lake Victoria. The river height forecast here is compared to river height thresholds to determine whether to issue flood alerts or warnings. The river dyke level is set at almost six metres and thresholds are set at four and five metres, above which amber and red warnings are issued. The three-day lead time forecast information is disseminated in a daily flood bulletin email sent to government agencies including the county administration and the NDOC, NGOs, local schools and health facilities and Bulala FM, a community radio station that broadcasts warnings to the local community in the local dialect, Kinyala (Njogu, 2017). Particular challenges to the operation of the early warning system include downtime due to delays in settlement of transmission bills, vandalism (especially of solar panels) and inadequate funding for maintenance and calibration (World Bank, 2016). A tender process is under way to supply, deliver, install and commission an Integrated Real-Time Hydrometeorological Monitoring System to upgrade the Nzoia River Basin Flood Warning System in the Lake Victoria North Catchment Area (LVNCA) (World Bank, 2017).

Assessment of forecast performance suggests that GFFS skill is good for one-day lead times in terms of predicting flood events, with no major missed flood events on record. The early warning system is generally perceived to be useful, with instances where damage has been avoided following warnings (World Bank, 2016). However, a systematic assessment of the forecast skill of the current Nzoia flood forecast system has not been carried out, despite available data to support a full forecast skill evaluation. Such information is vital if the forecast is to be used for FbA.

Investment in the flood forecast system as well as flood mitigation efforts have resulted in successful flood management in the Nzoia River in recent years, compared with other basins. It is estimated that avoided losses are on the order of ~$1 million per year relative to losses in Western Kenya (World Bank, 2016).

Figure 11 The Nzoia river flood system: (a) basin and the location of automatic weather stations covering the Nzoia basin; (b) an example of the Nzoia forecast chart generated at FDFC; (c) validation of river level forecasts ('Fcst') with 1-day lead time against observed flow ('Obs')



Source: Wepukhulu (2015).

Annex 3 Examples of heavy rain advisories issued by the KMD

The KMD issues qualitative statements of areas likely to experience increased flood risk typically at short lead times of a few days (see Figure 12). In some cases, such as the 'short rains' season of 2015, these are also issued at seasonal lead times. These advisories are inferred from weather and climate forecasts of rainfall, and knowledge of locations prone to both river and flash flooding.

Figure 12 Example of short lead time heavy rain advisory from May 2018

Kenya Meteorological Department

P.O. Box 30259-00100, Ngong Road, Dagoretti-Corner, Nairobi.
Tel: +2542038567880-5, +254724255153-4 Email: director@meteo.go.ke

Heavy Rain Advisory

Message Type:	Heavy Rainfall
Message Update No.:	Three
Advisory No.:	06/2018
Date of Issue:	7th May 2018 0700UTC
Validity:	From 7th May to 10th May 2018
Urgency:	Expected
Severity:	Moderate to Heavy
Certainty:	Moderate Probability of occurrence (33% to 66% Chance)
Message Description:	Heavy rainfall is expected to continue along the coastal strip from tonight to Thursday 10th May 2018. On Tuesday 8th May 2018 heavy rainfall of more than 50mm in 24 hours is expected off shore and in all counties along the Coastal strip. On Wednesday 9th May and Thursday 10th May, moderate rainfall of more than 30 mm in 24 hours is expected in the South Coast region. The rains are likely to continue causing flooding in low lying areas near the coastline and water repositories. The Flooding situation may worsen in some parts due to the fact that a lot of water has been accumulating on the ground since last week.
Area(s) of Concern:	Counties expected to be affected include; Lamu, Kilifi, Mombasa, Kwale and Tana-River.
Instructions:	Residents in all the mentioned areas are advised to be on the lookout for flashfloods. People should avoid driving, wading or walking through any fast moving waters. The heavy rains and strong winds off shore may result in storm surge along the coast, hence fishermen and all in the Marine industry should be on high alert. Continue listening to local media as updates will be provided if conditions change significantly. Further advisories will be issued as we follow upon the progress of this weather event.
Message Addressed to:	Office of the president, Kenya Red Cross, Kenya Maritime Authority, Kenya Ports Authority, National Disaster Operations Centre, Media, County Directors of Meteorological Services (CDMs) of Mombasa, Kilifi, Lamu, Tana-River Counties.
Originator:	Director, Kenya Meteorological Department.

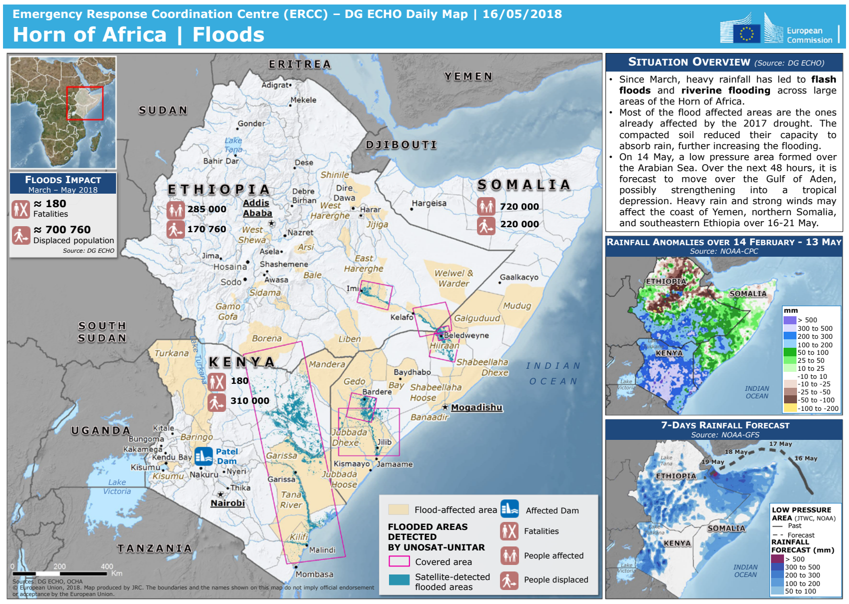
Source: KMD (2018).

Annex 4 Real-time monitoring information for floods

Various agencies run portals providing real-time monitoring of rainfall and flooding.

Real-time rainfall data is available from the NOAA CPC Africa desk[27] and FEWS NET EWX for Africa),[28] among many others. Real-time monitoring of flooding from media and other reports with associated impact commentaries/assessments are provided by ReliefWeb (Figure 13).[29] Real-time monitoring of flooded areas from satellite data is provided by the Global Flood Monitoring System (Figure 14).[30] Real-time river flow observations are provided by River Watch, with 12 locations on rivers in Kenya (Figure 15).[31]

Figure 13 Flood monitor product from ERCC



Source: ERCC Portal (https://erccportal.jrc.ec.europa.eu/Maps/Daily-maps).

27 www.cpc.ncep.noaa.gov/products/international/africa/africa.shtml.

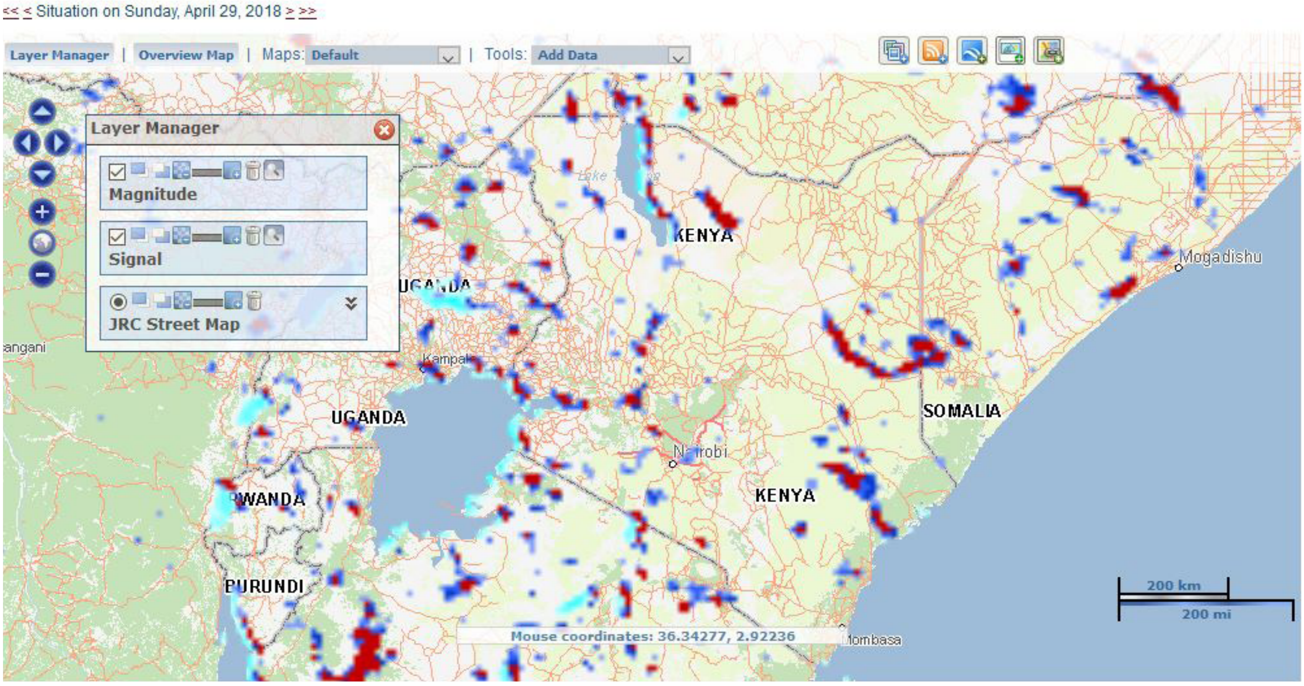
28 https://earlywarning.usgs.gov/fews/ewx/index.html?region=af.

29 https://reliefweb.int/map/kenya/horn-africa-floods-emergency-response-coordination-centre-ercc-dg-echo-daily-map-16052018.

30 www.gdacs.org/flooddetection/overview.aspx.

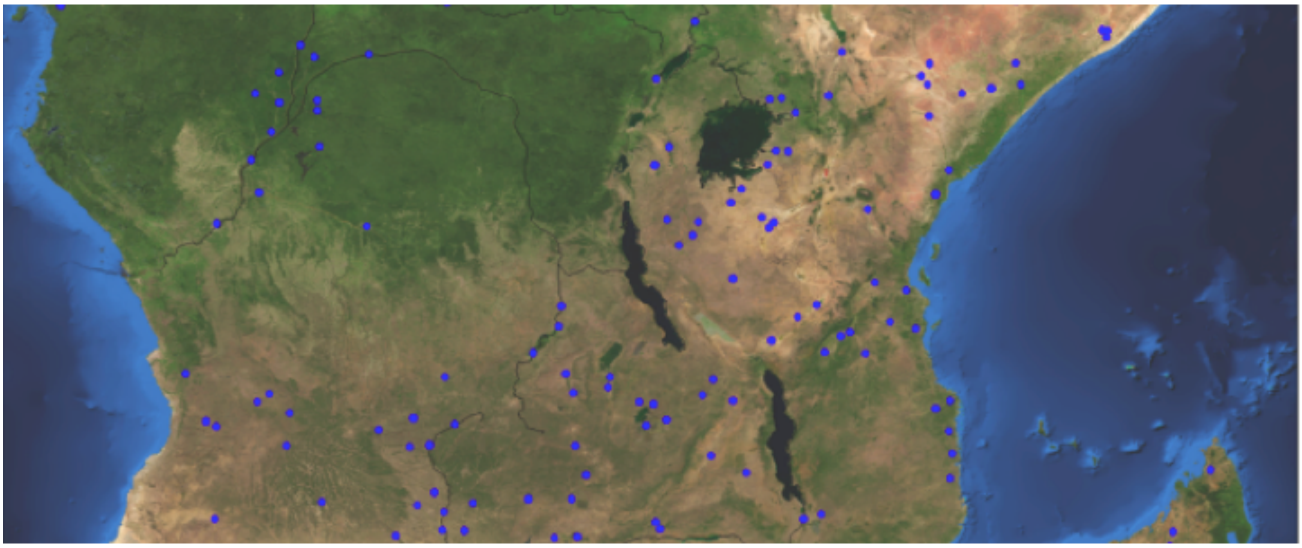
31 http://floodobservatory.colorado.edu/DischargeAccess.html.

Figure 14 Example of real time flood monitor from GFMS during the 2018 flood season



Source: GFMS (www.gdacs.org/flooddetection/global_map.aspx?date=4/29/2018).

Figure 15 Real time observations of river flow in Kenya and surrounding countries from River Watch



Note: Blue dots show sites with normal flow, purple and red are floods and major floods, respectively.
Source: River Watch (http://floodobservatory.colorado.edu/DischargeAccess.html).

Annex 5 Predictability of rainfall in Kenya

A5.1 Seasonal lead times

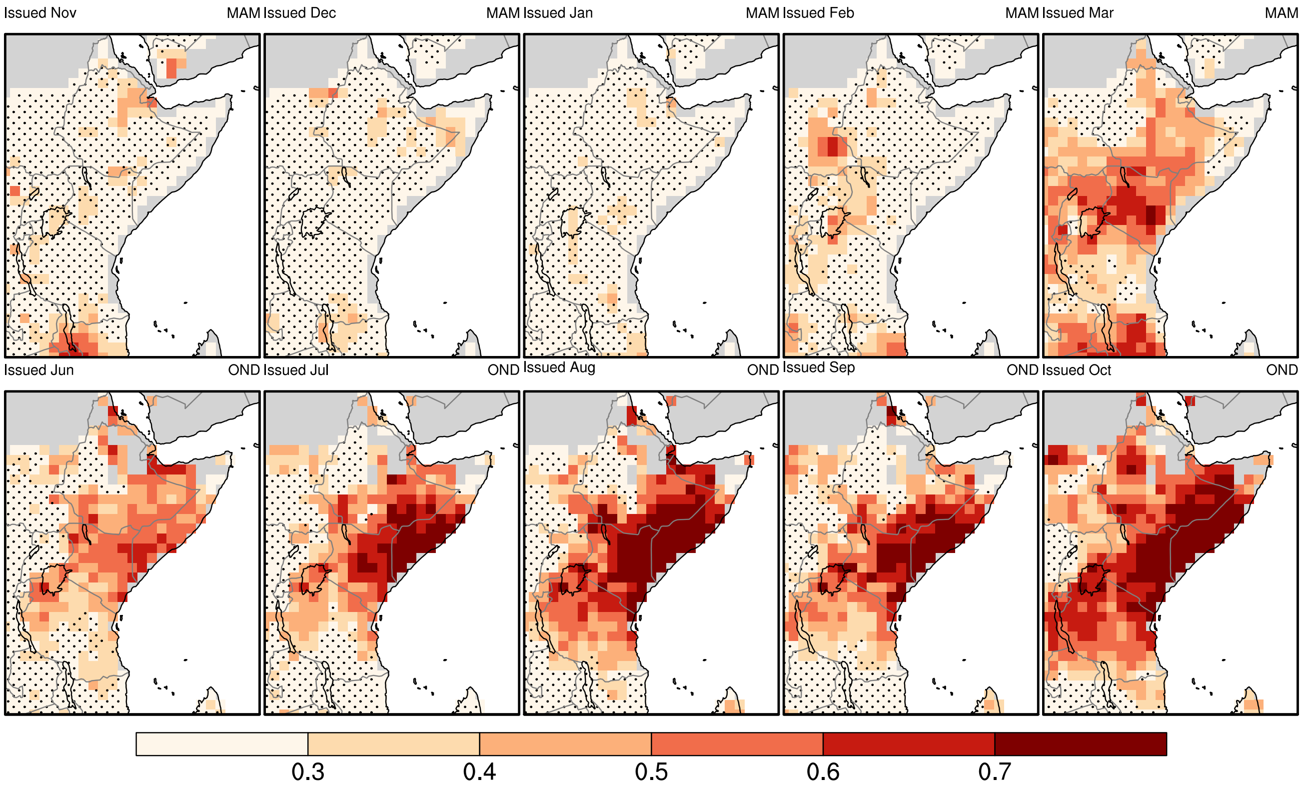
Figure 16 shows the ensemble mean correlation for forecasts of seasonal three-month totals over East Africa across all seasonal lead times, for the long and short rains, from the ECMWF operational seasonal forecast system, SEAS5 (spatial grid of 36km). Over Kenya and East Africa more widely, a clear distinction emerges between the two rainy seasons. The short rains (October–December) show strong predictability even at long lead times up to several months ahead, with forecasts issued at the start of June already showing significant skill. Moreover, forecast skill for the more extreme rainfall quantities (the upper quintiles and deciles) likely to be relevant for flood risk is particularly strong, relative to other parts of Africa (not shown). This high skill for the short rains is related to predictable variations in the large-scale climate oscillations of ENSO and the Indian Ocean Dipole, and is consistent across all studies of seasonal predictability for East Africa. This knowledge underpinned the seasonal outlooks of flood risk issued for Nairobi county during the El Niño event of 2015, when a strong signal for high seasonal rainfall in October–December was made.

In contrast, for the long rains (March–May) forecast skill is relatively weak, with only the forecasts initialised at the start (i.e. on 1 March) showing significant skill. This lack of March–May predictability is well established and relates to (i) the lack of coherence in the structure of the March–May season; and (ii) the lack of influence of large-scale climate drivers. The implication for forecast-based action for flood risk in Kenya is that there is much greater scope for long lead preparatory actions in advance of the short rains, while forecast-based preparations for the long rains are limited to less than one month in advance of the season.

Note that, while these general conclusions on seasonal predictability derived from the ECMWF SEAS5 modelling system are applicable to other GPCs (e.g. UK Met Office Glosea5) and national prediction systems, the skill of the seasonal forecasts produced by the KMD (using a statistical forecast approach) or the GHACOF consensus product is not well established. Within the ForPAc and WISER projects, an objective verification process is currently being undertaken, and the seasonal products of the KMD are being enhanced, including a process to sharpen the strength of the forecasts.

In any case, further research is required to determine the local flood risk associated with seasonal rainfall and seasonal forecasts. Initial studies (Stephens et al., 2015; Coughlan de Perez, 2017) suggest that, although the relationship between seasonal rainfall and simulated flooding is generally weak, over East Africa it is relatively strong. Developing bespoke seasonal lead time flood risk information from seasonal climate forecasts will likely be facilitated using the GPC ensemble rainfall forecasts rather than by those currently produced by the KMD and ICPAC, because the ensemble predictions are more applicable to FbaA, and the skill is well established. We recommend a more comprehensive assessment of flood risk associated with seasonal rainfall metrics (e.g. the upper percentiles of the distribution and statistics of daily rainfall). This has been initiated under the SHEAR FATHUM project.

Figure 16 Accuracy of seasonal forecasts for the long rains (top row) and short rains (bottom row)



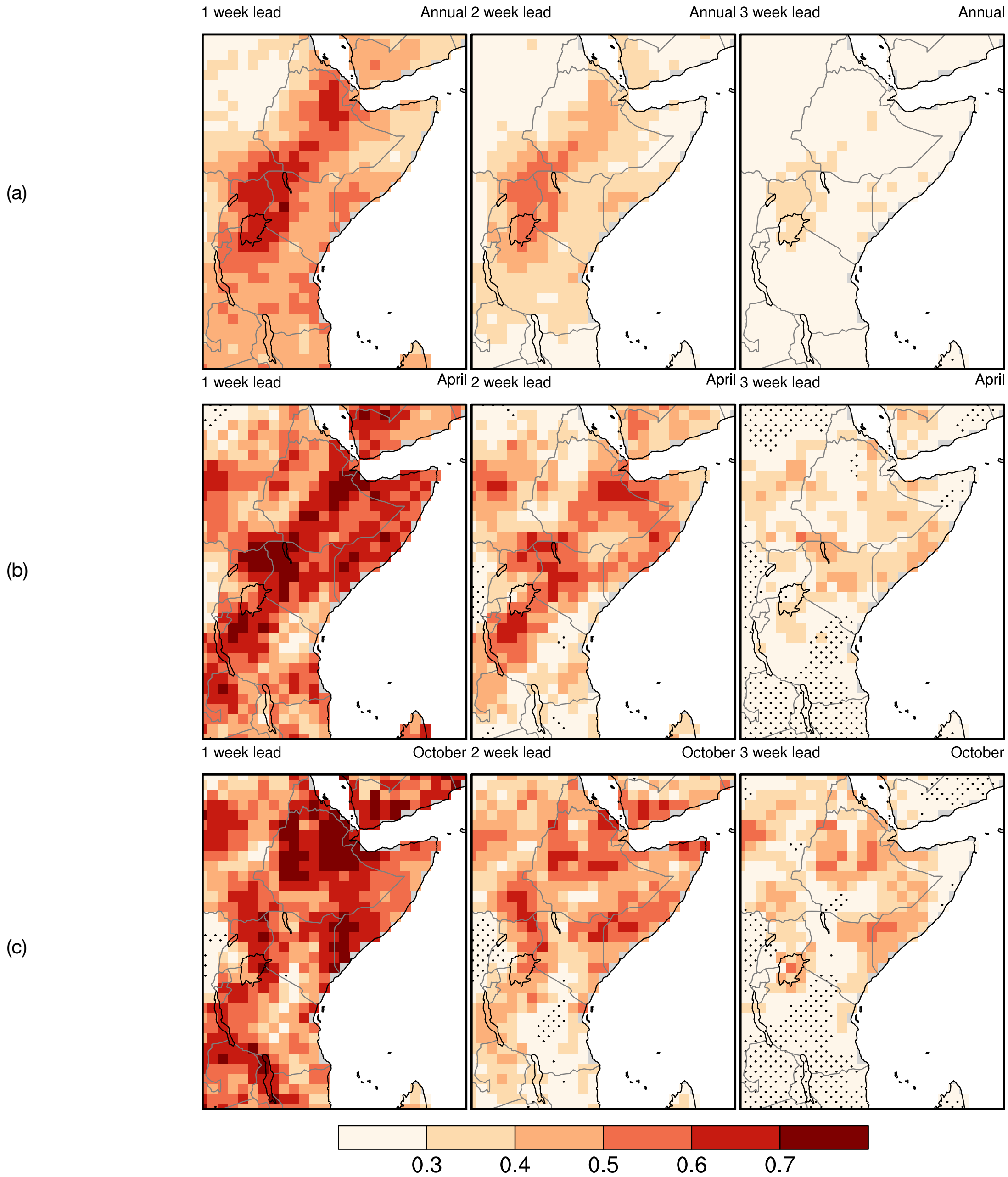
Note: Showing ensemble mean correlation of seasonal total rainfall from the ECMWF SEAS5 seasonal forecast, calculated against CHIRPS observations. All possible lead times are shown, ranging from longest to shortest (left to right). Points where the correlation is below a 95% statistical significant level are stippled.
Source: Authors' figure based on data from the Climate Hazard Group InfraRed Precipitation with Station data (CHIRPS) (Funk et al., 2015) and the ECMWF seasonal forecast system (Johnson et al., 2019).

A5.2 Sub-seasonal lead times

Predictions of rainfall variations on shorter lead times are possible in part due to the relationship between intra-seasonal variability in the Madden Julian Oscillation (MJO) and precipitation anomalies over East Africa (see Berhane and Zaitchik, 2016 for a review). The current generation of sub-seasonal models shows MJO predictability at a maximum lead time of up to 2–3 weeks, depending on the model (Vitart et al., 2017), with the ECMWF 46-day extended range forecast showing the longest lead predictions. Until recently, forecasts from this system have been made available to the KMD by ECMWF through the World Meteorological Organization (WMO)'s Severe Weather Demonstration Project, but this project has now ended. This system is used to drive the GloFAS flood prediction system (Annex 6); while the precise accuracy of GloFAS flood forecasts over Kenya is unknown, the skill of weekly average precipitation anomalies from this system has been assessed as part of the ForPAc project.

Figure 17 shows the skill of weekly average precipitation predictions from the ECMWF sub-seasonal forecast system over East Africa, across all start dates throughout the year. Consistent with the known predictability of the MJO, precipitation predictions are relatively skilful up to two weeks ahead, with lower skill beyond this. Note that this is the skill of the rainfall forecasts, and it is not yet clear whether this translates into useful skill for decisions in an FbA system. On average, forecast skill over Kenya is highest in the west of the country. However, this sub-seasonal skill is dependent on the start date of the forecast, as the pattern of spatial relationships with drivers of predictability changes throughout the year. For example, Figure 17b shows the skill of forecasts for weekly averages falling in April, and Figure 17c shows the skill of weekly averages falling in October. While both times of the year have high skill for west

Figure 17 Accuracy of the ECMWF sub-seasonal prediction system, for weekly precipitation totals one, two and three weeks ahead (left to right)



Note: Ensemble mean correlation is shown, measured across all reforecasts (top row), only those reforecasts where the target week falls in April (middle row) and only where the target week falls in October (bottom row). Points where the correlation is below a 95% statistical significant level are stippled.
Source: Authors' figure based on data from the Climate Hazard Group InfraRed Precipitation with Station data (CHIRPS) (Funk et al., 2015) and the ECMWF seasonal forecast system (Johnson et al., 2019).

Kenya, Figure 17c demonstrates that, during October, forecasts over north-east Kenya show some skill out to three weeks ahead. The implication for FbA is that skilful flood predictions are potentially possible out to three weeks ahead for the west of the country, and during certain times of the year forecasts over other regions may show skill. However, it is not yet established whether such relatively high rainfall forecast skill is actually useful for taking decisions in an FbA system. However, following the discussion above, a full assessment of the skill of GloFAS flood forecasts for Kenya should be carried out before these forecasts are used in an operational context.

A5.3 Short lead (up to one week) weather forecasts

The KMD produces daily deterministic rainfall forecasts with 24-hour lead time and an average rainfall forecast over the next five days. A seven-day average forecast is produced at the start of each week. These form the basis for the country-wide heavy rainfall advisories issued by the KMD. These forecasts are based on subjective interpretation of output from a variety of external Numerical Weather Prediction models: ECMWF, GFS, UK Met Office, ARPEGE and the East Africa configuration of the Met Office unified model, along with in-house forecasts from the WRF. ICPAC produces three bulletins of rainfall forecasts for average conditions over the forthcoming ten days (decadal, three times per month) and one month (from the start of each month) from in-house runs of WRF (single member deterministic forecast at 36km spatial resolution). While the KMD and ICPAC forecasts are 'optimised' through experience from comparison with rain gauge observations, the statistics of skill for various rainfall amounts are not currently published, and the necessary information to support FbA is not available.

Under the ForPAc project, the UK Met Office, the KMD and ICPAC have been working to assess and evaluate the Met Office Global Hazard Map platform (GHM). The GHM is now available to both KMD and ICPAC, and there are plans to develop a dedicated East Africa platform if the tool proves useful in operational forecasting and risk management. The GHM portal presents the risks of high-impact weather events across the globe over the coming week, using global ensemble forecast data. The system visualises forecast layers at a 0.5° grid resolution from the global component of the Met Office Global and Regional Ensemble Prediction System (MOGREPS-G) and the ECMWF ensemble prediction system (ENS). GHM includes forecasts (with a lead time of up to seven days) of 24-hour precipitation accumulation (among other weather hazards, such as wind and heat). GHM runs routinely twice a day and is made available to operational forecasters via a webpage at c.1100/2300UTC for the 00/12UTC forecasts. When the risk of extreme rainfall (i.e. high probability of greater than 99th percentile of daily rainfall) is identified, this is indicated by symbols for quick identification by users. To provide further information on likely flood risk and associated impacts there is an option to visualise the rainfall forecasts with seven-day antecedent rainfall and modelled soil moisture, as well as vulnerability and exposure layers such as population density.

The GHM forecasts of extreme weather have undergone extensive validation with respect to global rain gauge data, though without a specific focus on performance over East Africa (Titley and Robbins, 2016; Robbins and Titley, 2018). Results show that the multi-model ensemble provides better skill than the individual models. Within ForPAc, the KMD and ICPAC report that the GHM is a useful tool for severe weather forecasting operations, notably during the heavy rains and flooding of 2018.

Annex 6 Currently available potential tools for flood forecasting in Kenya

A6.1 The Ensemble Framework for Flash Flood Forecasting (EF5)

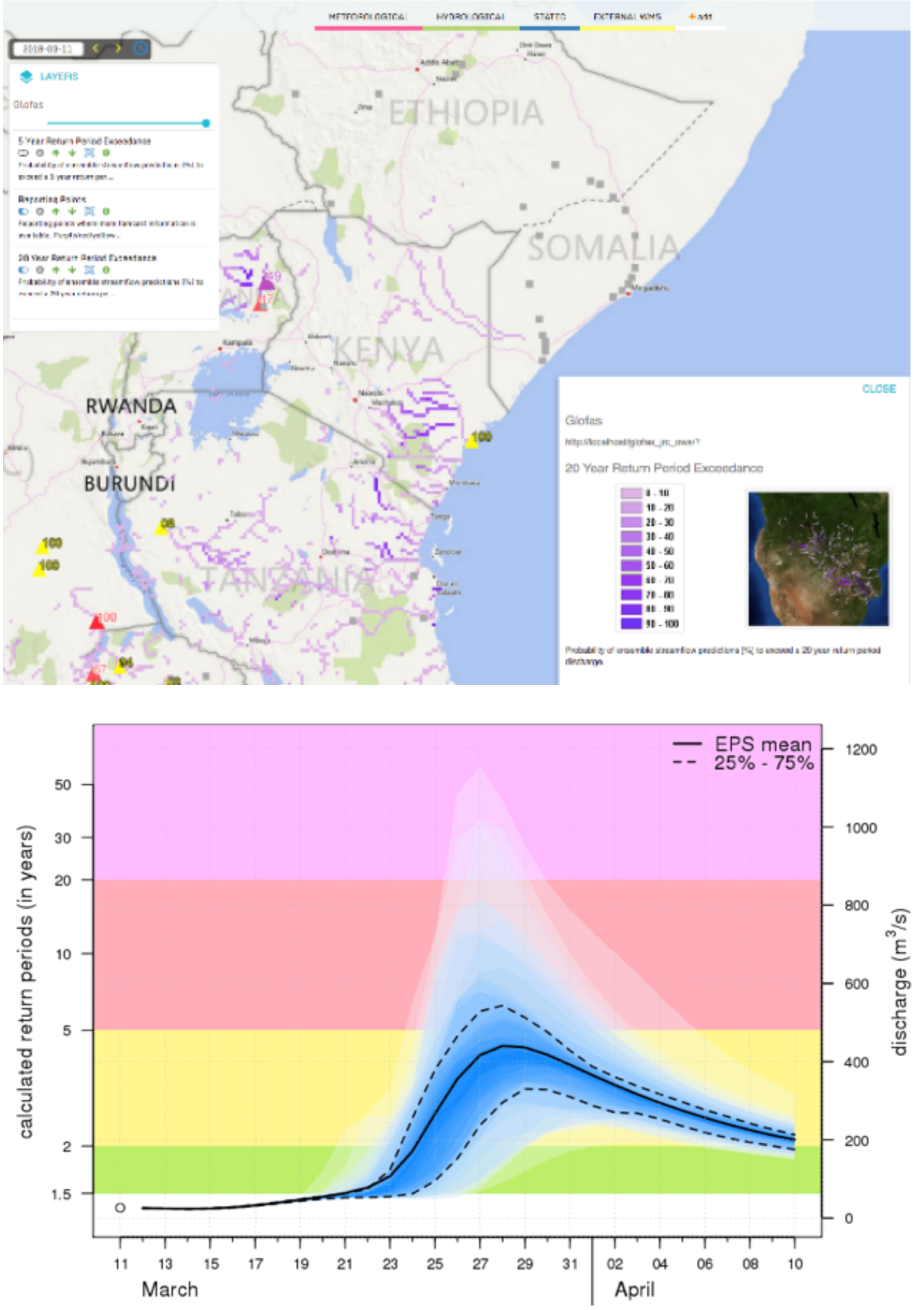
Under the NASA SERVIR-Africa initiative, in 2017 the Ensemble Framework for Flash Flood Forecasting (EF5) system was installed at the Regional Center for Mapping of Resources for Development (RCMRD) in Nairobi, the regional SERVIR hub for East and Southern Africa (Thiemig et al., 2011). RCMRD is now working in collaboration with the KMD on evaluating this system. A framework for flood modelling, EF5 can support multiple distributed hydrological models, which could ultimately provide an ensemble probabilistic river flood and flood risk model. The default model provided is the CREST (Coupled Routing and Excess Storage) Hydrologic Modeling Tool, developed by the University of Oklahoma. CREST is driven by near-real-time satellite-derived rainfall and KMD-generated 72-hour rainfall forecasts to estimate streamflow for any basin, once calibrated. KMD are currently evaluating the potential to operationalise EF5 over selected basins in Kenya. As such, the skill of likely flood forecasts is not yet established. In sum, the EF5 has some institutional buy-in, but will require calibration and forecast validation basis-by-basin for future application to FbA.

A6.2 GloFAS

Longer lead time streamflow forecasts up to 30 days are freely available through the Global Flood Awareness System (GloFAS), which couples state-of-the art ECMWF ensemble weather forecasts with a hydrological model (HTESSEL) and a river routing model (LIS-FLOOD) to provide a global outlook of river flooding. GloFAS forecast products may be accessed through a web-mapping platform (www.globalfloods.eu) providing the probability of flow exceeding return period thresholds of 1-in-5-year and 1-in-20-year events, as well as probabilistic river flow graphs. An example from the spring 2018 floods is shown in Figure 18. An experimental seasonal flooding outlook with up to four months' lead time has been added to the GloFAS viewer, giving outlook of risks of unusually high or low weekly-averaged river flow (greater/less than 80th/20th percentile) occurring at some point within the season. The system uses the same HTESSEL/LIS-FLOOD hydrological models but driven by ECMWF system 5 seasonal climate predictions. The seasonal forecast products are updated once a month on the tenth of each month. This is shown for basin average as well as individual rivers.

These experimental seasonal flooding outlooks should be treated with caution and no indication of skill at this lead time is provided. Instead the portal states: 'the user is advised to evaluate forecast skill'. However, as the previous sections indicate, over East Africa the short rains show much higher predictability out to several months ahead, while for long rains seasonal predictability is much lower. It is therefore likely that short rains seasonal flooding forecasts will be more reliable than for long rains, though an impact-based verification should be carried out to understand the precise level of skill.

Figure 18 Example of the GloFAS viewer from forecasts issued on 11 March 2018



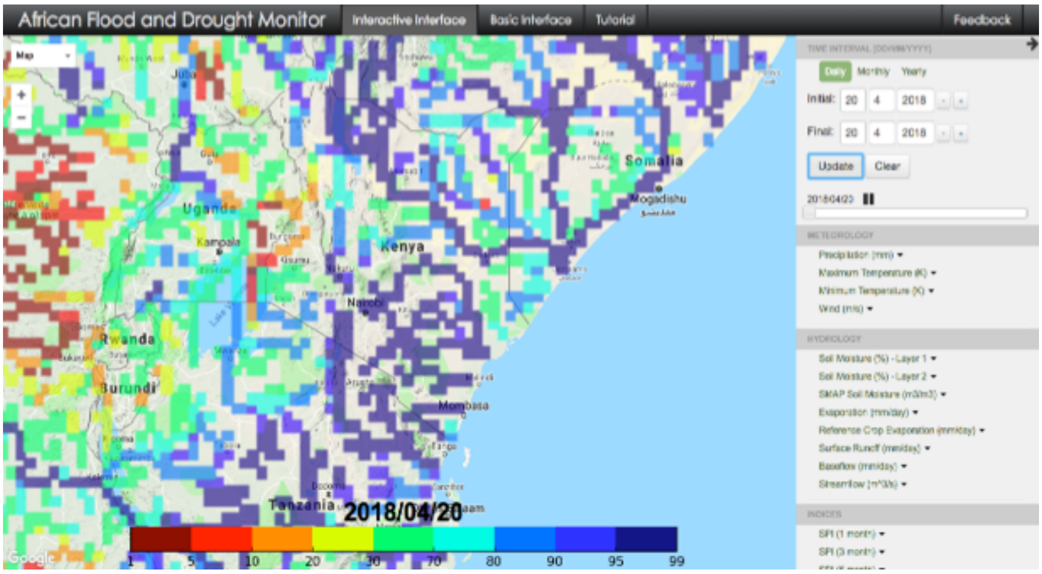
Note: Purple pixels represent the probability of a 1-in-20-year flood event occurring over the forecast window (left) and a hydrograph forecast for the termination of the Tana River (right).
Source: GloFAS (www.globalfloods.eu/accounts/login/?next=/glofas-forecasting).

GloFAS is being evaluated through a number of case studies worldwide (www.globalfloods.eu/), but none for Kenya. These evaluations suggest that the GloFAS model is able to capture increases in streamflow in advance of significant flood events. Currently, the skill of neither the GloFAS nor seasonal GloFAS forecasts is known for rivers in Kenya and would have to be calculated. GloFAS has been used operationally in FbA pilot studies in Africa and is under assessment within the SHEAR FATHUM project. Some very initial analysis of the performance of GloFAS for the Nzoia River has been undertaken through an informal collaboration between the FATHUM and ForPAc projects. Further research is required to complete this analysis.

A6.3 The Africa Flood and Drought Monitor (AFDM)

The AFDM (http://stream.princeton.edu/AWCM/WEBPAGE/index.php?locale=) developed by Princeton University is a portal providing both monitoring and forecast information for climate and hydrological conditions across Africa. Monitoring products include standard climate indices of rainfall as well as surface hydrology derived from the VIC land surface model. Forecasts of daily river flow, with up to a seven-day lead time, are provided. These are expressed either as absolute values or as percentiles of the daily climatology. The forecasts are derived by driving the VIC land surface hydrology model with rainfall forecasts from the NCEP Global Forecast System and routing surface runoff through a river routing model. No assessment of forecast skill is provided. ICPAC have received training in the use of the AFDM but do not currently disseminate the products. An example product is provided in Figure 19. Currently (as of end July 2018), only the gridded surface runoff directly from GFS are provided and the river flow forecasts are not available.

Figure 19 Sample products from the AFDM (a) simulated river flow as percentile of climatology during April 2018 by the VIC model; (b) simulated historical river flow at 0.5S, 39.6E on the Tana River



Source: AFDM (https://platform.princetonclimate.com/PCA_Platform/). Hydrograph forecast for the termination of the Tana River (right).
Source: GloFAS (www.globalfloods.eu/accounts/login/?next=/glofas-forecasting).

Annex 7 Key actors for early warning systems in Kenya

Table 2 Current key DRM actors in the framework of the four elements of people-centred early warning systems in Kenya

Risk knowledge NDOC, KMD, NDMA, NDMU, KRCS, KenGen, county governments, SAU, humanitarian and development organisations such as UNICEF, WFP, FAO, OCHA and UNDP	**Monitoring and warning services** KMD, ICPAC and WRA
Dissemination and communication KMD, KRCS, media, NDOC, NGOs, county governments	**Response capacity** County governments, KRCS, NDOC, NDMU, Disaster Management Committees/County Steering Groups, line ministries, social protection agencies (SPS, SAU), NGOs, UN agencies (WFP, FAO, UNICEF, OCHA among others)

Annex 8 Policy frameworks for disaster risk management and financing in Kenya

Box 2 Kenyan Disaster Risk Financing Strategy 2018–2022

Strategic priority 2: Improve financing capacity by strengthening and expanding the government's portfolio of disaster risk financing instruments.

To create a diverse [disaster risk financing] portfolio for Kenya, the National Treasury will:

- Consider increasing the size of the Contingencies Fund (current annual allocation is KSh5 billion) in light of the increasing disaster risk financing gap.
- Incentivise county governments to establish a County Emergency Fund. As of FY 2015/16, only 19 out of 47 county governments had allocated money toward emergency response and relief.
- In conjunction with the National Drought Management Authority, operationalise the National Drought Emergency Fund.
- Explore sovereign risk transfer instruments as part of its overall DRF portfolio.
- Set up a contingent credit line with the World Bank through a Development Policy Loan with a Catastrophe Deferred Drawdown Option (Cat DDO). With this operation in place, the Government of Kenya will be able to access financial resources once it declares a national disaster.
- Explore financing instruments to enhance preparedness for localised, small-scale floods and other non-drought emergencies, which largely remain without coverage.

Source: Republic of Kenya/The National Treasury and Planning (n.d.)

Table 3 DRM legislation

Document	What it says about EWS and preparedness
Constitution of Kenya 2010	The constitution provides for a declaration of a state of emergency, to meet the circumstances of threatening situations. A state of emergency is declared by the President under Article 132 (4) (d), when the state is under threat by massive disasters, including overwhelming fires, floods and droughts. The national assembly can extend the period of the state of emergency if necessary, and the supreme court establishes the legality of the declaration. The constitution also places a duty on the state to protect the vulnerable.
National Disaster Management Policy (draft 2009)	EWS is one of the eight principles envisioned as a prerequisite in establishing an efficient DRM system. The policy proposes to establish a comprehensive National Early Warning System that is reliable and inclusive, using the latest scientific and expert opinion, while consulting all relevant stakeholders including communities. Strengthening of multi-hazard end-end early warning systems is seen as one of the actions in aiding recovery operations as it reduces vulnerability. Although the policy is still in draft form, many of its provisions are already in use. For example, the draft policy has been used to create a template for developing model laws on disaster management, and subsequently, the template has been used to formulate the Nairobi County Disaster and Emergency Management Bill 2015. The draft policy has also been adopted by the National Disaster Management Unit to streamline its plans and standard operating procedures (SOPs) to be appropriate to national demands.
National Disaster Response Plan (2009)	The plan was developed by the National Disaster Operations Centre (NDOC). It involves four phases, with EWS integrated in Phase 1 (Alert) and Phase 2 (Standby). The NDOC Director is at the centre of decision-making; when he/she receives information of an impending disaster from a concerned agency, he/she puts staff and relevant agencies on alert. If the disaster increases in likelihood, relevant agencies are activated to be on standby. SOPs are contained in the plan and adopted by the NDOC Joint Operation Centre.
National Adaptation Plan (2015–2030)	EWS are mentioned in the NAP in regard to mainstreaming climate change adaptation in the environment, agriculture and water sectors, and as a critical action for enhancing the resilience of the livestock value chain and ASAL counties.
The County Governments Disaster Management Act (2014)	This Act provides uniform legislation for disaster management by county governments and a collaborative framework for the stakeholders involved. In each county, the Act establishes a County Disaster Management Authority mandated to develop the county disaster management policy; approve the County Disaster Management Plan; co-ordinate the implementation of the County Plan; and make recommendations to the county government on the provision of funds for mitigation and preparedness measures.
National Emergency and Disaster Response Plan and Standard Operating Procedures (SOPs)	The plan and SOPs provide a list of major executive actions involved in responding to disasters and necessary measures for preparedness, response and relief. It indicates various actions that should be taken and by which actors within their sphere of responsibilities in their contingency plans.
Water Act 2016	The Act establishes two authorities: The Water Resources Authority – increasing the Authority's mandate to include flood mitigation The National Water Storage Authority – responsible for national public works for water resource management, including dams and flood control.

Annex 9 Unconditional cash transfer programmes of the Kenyan government

Orphans and Vulnerable Children Cash Transfer (OVC-CT): The OVC-CT was launched by the Kenyan government and its development partners in 2004 in response to the HIV/AIDS epidemic. It targets extremely poor households which do not benefit from other social assistance programmes, with at least one OVC – meaning a child who has lost one or both parents, is chronically ill, has special needs or who has a chronically ill or otherwise unfit caregiver. Since 2004, the Kenyan government has gradually taken over the funding and became the major contributor to the programme in the 2013/2014 financial year. In 2016–17, the programme reached 355,000 households. To put this coverage into perspective, estimates of the total number of orphans (who have lost at least one parent) in Kenya range from 1.8 million to 3 million (Lee et al., 2014; Afwai, 2013). Of the 1.8 million orphans identified by Lee et al. from the 2012 Kenya AIDS Indicator Survey data, 270,000 had lost both parents and 750,000 were found to be 'vulnerable'.

Older Persons Cash Transfer (OPCT): The OPCT also started out as a pilot in 2007, before being expanded to a larger number of beneficiaries nationwide. Extremely poor households with members over 65 years old, with no member receiving a pension or enrolled in any other cash transfer programme, that have resided in a specific location for over a year and where the respondent has Kenyan citizenship are eligible for the programme. In 2015–16, 310,000 households were covered by the OPCT.

Persons with Severe Disability Cash Transfer (PWSD-CT): The PWSD-CT aims to strengthen caregivers in supporting people with severe disability and reducing the impact of disability on their households. Extremely poor households not enrolled in another cash transfer programme with a severely disabled person, without a member receiving pension, that have resided in a specific location for over a year and with Kenyan citizenship of the respondent are eligible for the programme. In 2015–16, the programme provided transfers to 47,000 households.

Hunger Safety Net Programme (HSNP): The HSNP, initiated in a pilot phase in 2007, targets very poor households in arid and semi-arid counties of northern Kenya. All of the approximately 372,000 households in the targeted counties were registered through the HSNP. Currently, around 85% of registered households in the four counties have opened bank accounts and could receive payments. In 2016–17, the HSNP reached just over 100,000 households in Mandera, Marsabit, Turkana and Wajir counties with regular transfers. A further 25% of households in drought affected sub-counties receive transfers when severe drought levels are detected in any given month. If extreme drought levels are reached, an additional 25% of households are covered by the programme. Households receiving payments under the OVC-CT, OPCT and PWSD-CT may also receive regular or drought emergency transfers, as overlap is currently not systematically addressed.

Source: Republic of Kenya/Ministry of East African Community, Labour and Social Protection (2017); www.hsnp.or.ke/; Merttens et al. (2017).

Annex 10 Disaster risk financing instruments in Kenya

Table 4 Disaster risk financing instruments in Kenya

Instrument	Description	Status (as of Feb 18)	Hazards covered	Max. annual value	Population/ Geographical coverage	Administrator
Reserves funds						
Contingencies Fund	National level fund to respond to emergencies	Active	All disasters	Ksh 10B capped by Constitution 2010 but can vary based on draw down and demand as per the PFMA, 2012	Entire country as determined by the GoK	National Treasury
County Emergency Funds	County-level funds to respond to emergencies	Active [19 Counties as of FY 15/16)	All disasters	Not exceeding 2% of total revenue, PFMA 2012	19 counties as at 2015/16 financial year	County governments
National Drought Emergency Fund	National emergency fund to finance preparedness and response activities during drought	Not Active	Drought	Initial capital of KSh2Bn appropriated in FY 16/17 – no prescribed maximum	23 ASAL counties approx. 15 million people)	NT, NDMA, county governments and development partners
Disaster response programmes (Agricultural insurance/Shock-responsive safety net						
KLIP	Fully subsidised index insurance for selected pastoralists in ASALs. (Partially subsidised cover to follow)	Active	Drought	US$ 13.5 million	14,500 beneficiaries in 6 counties (to be expanded to 20,000 pastoralists in 8 counties in 2018)	MALF, SDL, NT, Insurance Regulatory Authority, insurance industry, counties
KAIRMP	National Area Yield Index Insurance Scheme for maize and wheat farmers	Active	Multiple peril loss of yield protection	US$ 5.13 million (during first year 2016)	10 counties+ Acre/IAF portfolio of about 200,000 small maize farmers	SDA-MALF, NT, ACRE Africa, 7 Pool Co-insurers, GoK
Scalable Component of Hunger Safety Net Program (HSNP)	Component of cash transfer program allowing to reach up to 272,450 additional HHs during drought.	Active		US$ 63 million	Turkana, Marsabit, Wajir and Mandera counties (up to 368,000 households)	County governments, NDMA, DFID, EU
Contingent financing						
WB DPC with a Cat DDO	Contingent line of credit	Not Active	Natural disasters	US$ 200 million (TBC)	Entire country as determined by the GoK	National Treasury, WBG
Sovereign insurance						
African Risk Capacity	National level drought insurance to finance relief efforts	Under review	Drought	US$ 60 million	23 ASAL counties (approx. 15 million people}	National Treasury, NDMA, NRC
Ex-post humanitarian assistance						
Humanitarian assistance	Contribution from international donors to respond to disaster emergencies	Ad hoc	Natural disasters humanitarian emergencies	US$ 267 million per year on average (2002–2012)	NA	GoK, donors, UN system

Source: Ochieng (2018).

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