CMF CLIMATE MAINSTREAMING FACILITY

Nigeria

Urban Flood priorities

High-Level Review to inform the economic case for UK investment

November 2021

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Version: Final

UKaid from the British people

Paul Watkiss Associates

SOUTH SOUTH NORTH TOWARDS CLIMATE RESILIENCE

Acronyms

BAU	Business as usual
BCR	Benefit Cost Ratio
DRR	Disaster Risk Reduction
EBA	Ecosystem-based adaptation
EWS	Early Warning Systems
EAD	Expected Annual Damage
FCT	Federal Capital Territory
FFEWS	Flood Forecasting and Early Warning System
FRM	Flood Risk Management
GDP	Gross Domestic Product
HFCs	Hydrofluorocarbons
IDF	Insurance Development Forum
IFI	International Financial Institution
JRC	Joint Research Centre
LEMA	Local Emergency Management Agency
LGA	Local Government Area
MCA	Multi-criteria Analysis
NAP	National Action Plan
NBS	Nature-based Solutions
NEMA	National Emergency Management Agency
NDCs	Nationally Determined Contributions
NIHSA	Nigeria Hydrological Services Agency
NEWMAP	Nigeria Erosion and Watershed Management Project
NIMET	Nigerian Meteorological Agency
NUCR	Nigeria: Urban Climate and Resilience Programme
PV	Present Value
SLCPs	Short-lived Climate Pollutants
SEMA	State Emergency Management Agency
SDGs	Sustainable Development Goals
SUDS	Sustainable Urban Drainage Systems
WRI	World Resource Institute

Contents

List of figures

List of Tables

Disclaimer

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Summary

Nigeria has Africa's biggest economy and a population of over 200 million people. The country faces numerous challenges as it struggles to achieve its sustainable development goals (SDGs), with flooding one of the most frequent and recurring challenges, having wide-reaching impacts. Moreover, climate change is set to increase floods through more severe and more frequent events, driven by changes in rainfall patterns and intensity, and rising sea levels. Climate considerations are currently being embedded in the country's plans and policies, and more recently (mid-2021), Nigeria submitted its nationally determined contributions (NDCs). However, embedding climate change into planning, and consequently into investment choices, remains challenging with an absence of strategic flood risk management adaptation plans and options.

Mapping the present-day flood risk landscape, this high-level analysis shows that 16 million people are currently exposed to flooding (living within the 1 in 100-year floodplain), with 4.2 million people in urban areas. Rivers, Delta and Borno States each have over 1 million people exposed to flood hazards, with the urban exposed population concentrated in Rivers, Delta, Lagos and Borno. In terms of GDP exposed, approximately a quarter of the national GDP or GBP ~105.5 billion generated is exposed, being within the 1 in 100-year floodplain, with around GBP 36.7 billion of this exposure in urban areas. With climate change, these figures are likely to increase.

Assuming the floodplain remains undefended, expected annual damages (EAD) from flooding today would be ~GBP 82.7 billion (include residential damage and a simple approximation of loss of economic activity), with damage around GBP 28 billion in urban areas. Delta, Rivers, Lagos, Bayelsa, Borno and Ogun are all highlighted as states with the largest potential damage.

This report was commissioned to recommend several intervention options to reduce flood risk and undertake an initial high-level economic appraisal of options. Following interviews with stakeholders and a review of the existing literature and projects being done in Nigeria, seven options were considered for FCDO investment:

- **Option 1** Do nothing (no investment)
- **Option 2** Opportunistic and reactive support (no specific investment sum)
- **Option 3** Focus on national capacity
- **Option 4** Focus on state, city, and community capacity
- **Option 5** Focus on non-structural capabilities
- **Option 6** Focus on structural measures
- **Option 7** Focus on promoting innovation

The options were assessed using multi-criteria considerations as follows:

- **Effectiveness and efficiency:** Considers the typical efficiency (benefit-cost ratio) and effectiveness for each type of investment. Under conditions of change, including climate change, potential benefits of flood resilience development is likely to increase. Hence estimates in the study, although reasonable in the short term, are likely to understate the long-term benefits.
- **Equity:** Considers the pro-poor/socially vulnerable outcomes and distributional benefits.
- **Long-term outcomes:** Considers the ability of the option to address long-term adaptive capacity and deliver a range of outcomes robustly over the long term.
- **Feasibility:** Considers how likely it is that an option will achieve the benefits anticipated in a way that is attributable to the FCDO.
- **Opportunity for the UK:** Considers the ability of the option to harness or develop UK competitiveness in supporting Nigeria to enhance urban resilience.

The results from the high-level, multi-criteria assessment are summarised in **Table ES1** below, with the preferred options in bold. The level of investment needed is also included in the table, where 1 indicates a high investment need and 5 indicates a low investment need. The analysis suggests a focus on capacity development, as well as non-structural approaches and innovation, all of which offer value for money. This includes supporting the development of national policy and planning capacity (such as basin planning approaches, consistent policies, and insurance and financing approaches), as well as building capacity at the state, city, and community level (including for development planning, flood management guidance, community awareness and action) and investment in non-structural options (forecasting and early warning systems and associated innovations). Investment needs in structural interventions are likely to require substantial financing (e.g. major infrastructure investment loans for most interventions) and IFIs are better placed to serve this need. Developing innovative financing mechanisms to support more strategic planning is an area that offers significant opportunity.

Table ES1: Summary of the options appraisal (preferred options in bold)

	Option 1	Option 2	**Option 3**	**Option 4**	**Option 5**	Option 6	**Option 7**
Level of investment	n/a	n/a	**3**	**4**	**3**	1	**5**
Effectiveness and Efficiency	n/a	n/a	**4**	**3**	**5**	1	**1**
Equity (Pro-poor outcomes)	1	1	**3**	**3**	**3**	3	**3**

	Option 1	Option 2	**Option 3**	**Option 4**	**Option 5**	Option 6	**Option 7**
Long-term outcomes	1	1	**3**	**4**	**5**	1	**5**
Feasibility	n/a	n/a	**5**	**4**	**4**	1	**5**
Opportunity for UK	5	5	**5**	**4**	**4**	1	**5**
Overall Assessment	n/a	n/a	**5**	**4**	**4**	1	**4**

Source: Authors

Any activities taken today will need to be resilient in the context of a changing climate and development context, from the way infrastructure is designed to the flood hazards mapped and the catchments and cities managed. Climate change, in particular, is likely to have a profound impact on Nigeria's flood risk. The expected annual benefits of the options have been assessed in the context of today's climate and population/GDP distributions. The suggested preferred investment options, however, focus on actions that will enhance Nigeria's flood resilience both today and in the future, as Nigeria's climate change and development continues.

1. Introduction

Nigeria has Africa's biggest economy and a population of over 200 million people. The country faces numerous challenges as it struggles to achieve the sustainable development goals (SDGs), with flooding one of the most serious, having wide-reaching impacts (Echendu, 2020).

Flooding is one of the most common natural disasters in Nigeria. Most of Nigeria's states suffer from increasing annual flooding during the rainy seasons, caused by increased precipitation linked to climate change (Aja & Olaore, 2014). Flooding often leads to substantial damages and losses. The widespread floods in 2012 caused an estimated USD 16.9 billion (N 2.6 trillion) in damages and losses across Nigeria's most flood-prone regions (Federal Government of Nigeria, 2013). The impact of less severe (but more frequent) floods is difficult to quantify, given incomplete reporting and inconsistent statistics, both at the national and sub-national level (Lucas 2021), but some of the literature notes frequent harmful flooding in more than 30 states of Nigeria (Sojobi, Balogun & Salami 2016). Climate change is set to drive increasing floods through more severe and more frequent events, driven by changes in rainfall patterns and intensity and rising sea levels (Haider, 2019).

1.1 Context of study

ODI was commissioned by the FCDO Nigeria office to recommend several promising intervention options and undertake an initial high-level economic appraisal. The objective was to develop ideas identified in the concept note, provide estimates of what interventions might cost, and identify the potential beneficiaries and benefits of tackling flood risk. The study was expected to include engagements with other development partners and actors in the flood-risk space in order to form a better understanding of the gaps and feasibility of proposed interventions.

In general, interventions to reduce flood risk are considered great 'best buys' (in the FCDO Development Adaptation Best Buys paper, produced by the Chief Economists' Office). This means that, in general, investment in flood risk management deliver a strong return. The information provided in this report will inform the FCDO business case for a Nigeria Urban Climate and Resilience (NUCR) programme that focuses on flood risk.

Note: The analysis is based on a high-level rapid assessment, including stakeholder interviews (gratefully acknowledged) and a very initial quantified analysis. Various assumptions and expert judgements have necessarily been made. These are highlighted throughout. The commission allowed for 27 days of research time in total.

1.2 Overview of report structure

This report first discusses flooding hazards, exposure and vulnerability in the country, outlining future flood risks and the challenges to flood adaptation in the face of climate change. This is followed by a review of the outcomes from stakeholder discussions, a list of the various flood risk options to enhance resilience, based on those discussions and the literature, and a multi-criteria analysis of the various options, which includes rough estimates of the benefits and costs of each option proposed.

2. Present-day flood risk in Nigeria

2.1 Overview

The context of flooding in Nigeria is set out below. This high-level review brings together various datasets (noted in order to enable replication or further research). These underlying datasets are used to provide an approximation of the expected annual damages (EAD), which is used in Section 4 to determine the likely benefits and costs of the alternative investment actions.

2.2 States

Nigeria's governance arrangements are based on a federal system with significant devolution of decision making to the state level (**Figure 1**).

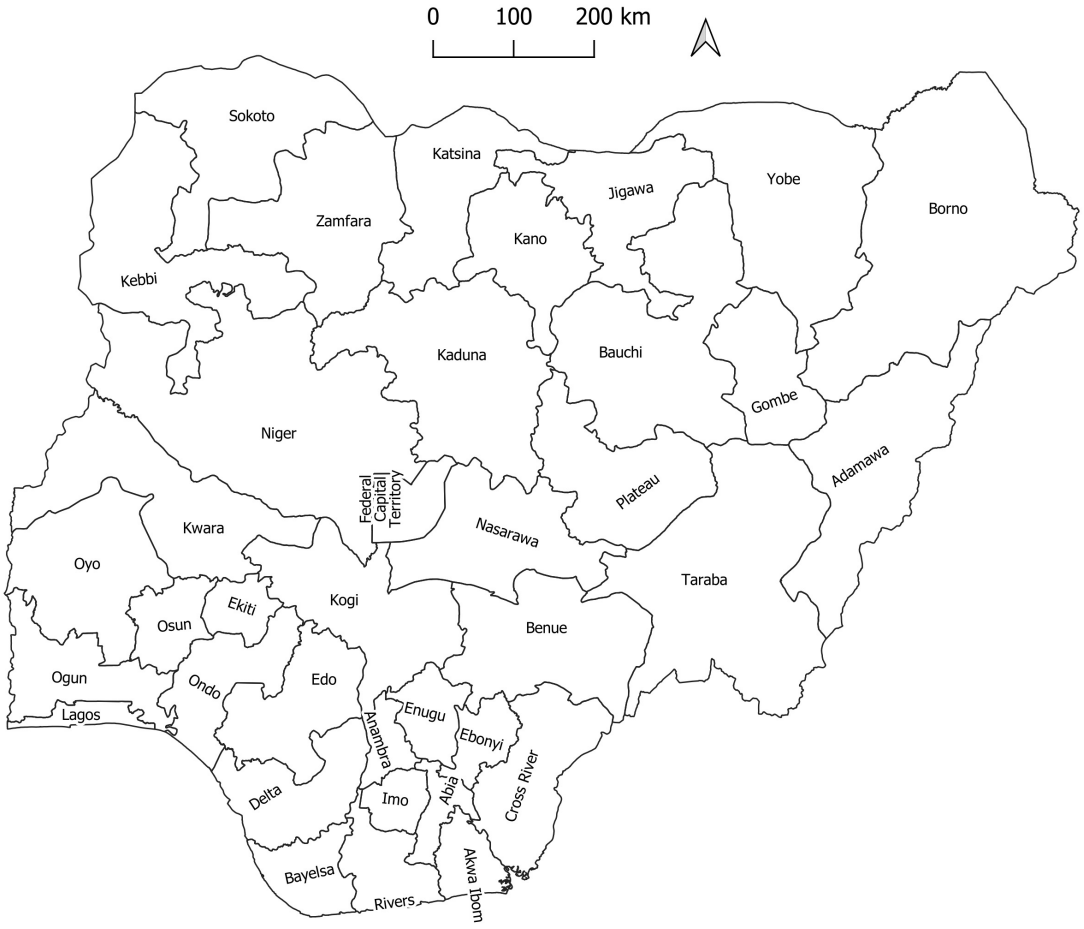


Figure 1: Nigerian states (Source: The Humanitarian Data Exchange (HDX)

2.3 Geography

2.3.1 Rivers and shoreline

The basic geography of the rivers (river length by state) and the coast (shoreline length) are shown in **Figure 2** and **Figure 3**.

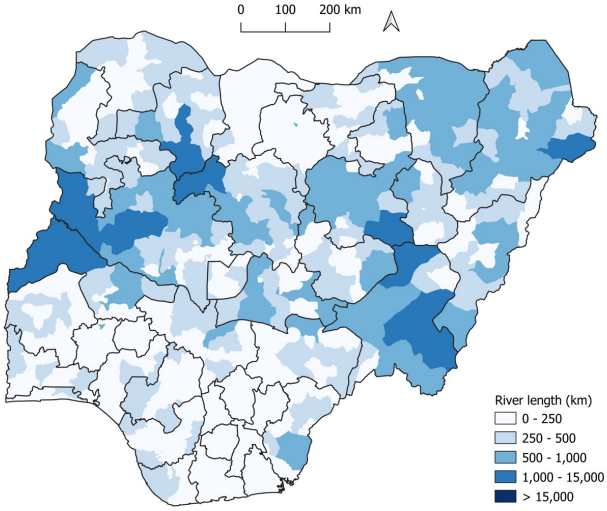


Figure 2: Distribution of the river length by state (Source: Aggregated from WWF HydroSHEDS river network. Note: FCDO started refining the river network definitions as part of the Grid 3 project (https://grid3.gov.ng/). This initiative could be built on in future analysis but is not used here.)

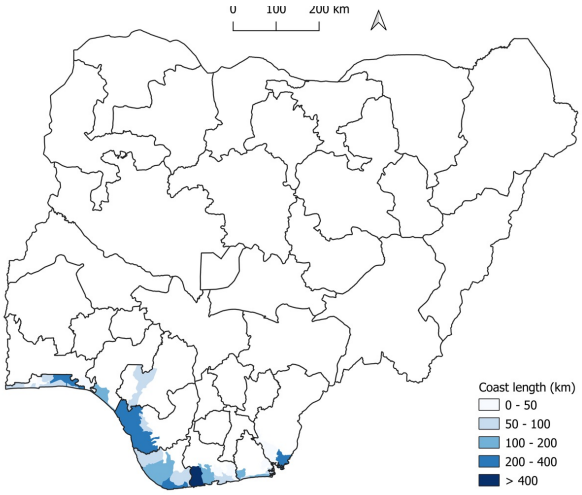


Figure 3: Distribution of the coastline length by state (Source: Aggregated based on Global Self-consistent Hierarchical High-resolution Geography (shorelines – high resolution)

2.3.2 Urban and population centres

As in many countries, a single definition of the spatial extent of Nigeria's urban jurisdictions is not readily available. Instead, the urban classes in the Global Settlement Data have been combined with population data from WorldPop (100 m) to support the spatial distribution of urban living (**Figure 4**).

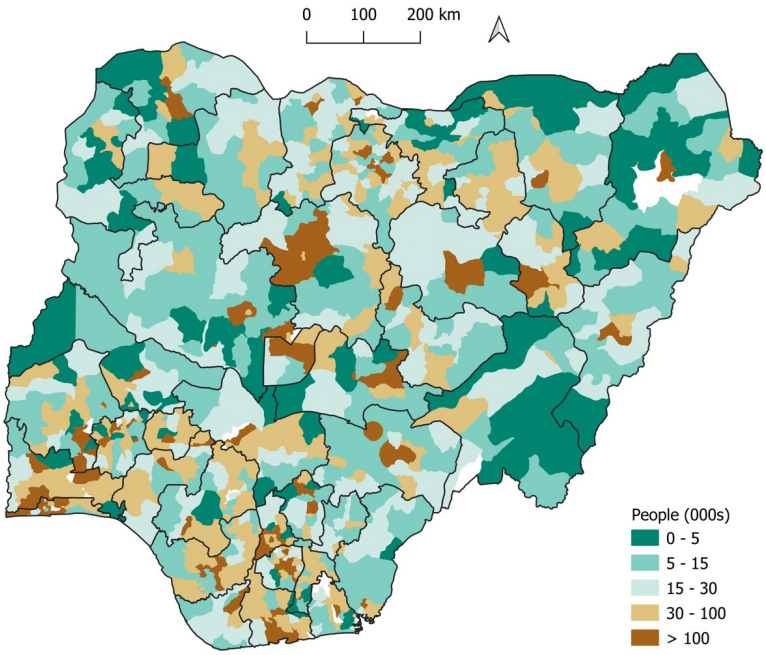


Figure 4: Spatial geography of Nigeria's urban population (Source: Based on a combination of the WorldPop (100 m) and Global Settlement Datasets – Urban classes – Class 30: Urban Centre; Class 23: Dense Urban Cluster; Class 22: Semi-dense Urban Cluster and Class 21: Suburban or peri-urban. Unclassified has been assumed to be urban state boundaries based on The Humanitarian Data Exchange Admin Level 1 (shown in black outline) and Local Government Authority insert shading is based on Admin Level 2.)

2.3.3 Changing catchment characteristics

Global forest loss data (Hansen et al, 2013), updated to 2019, has been used to explore forest loss since 2000 across Nigeria (**Figure 5** and **Figure 6**). Although not explicitly modelled as part of the analysis here, this data provides a useful context for the changing landscape of Nigeria and the importance of connecting good catchment management (and mitigation and adaptation across multiple risks) with urban flood management. The development of the fluvial flood plain has also been extensive (**Figure 7**).

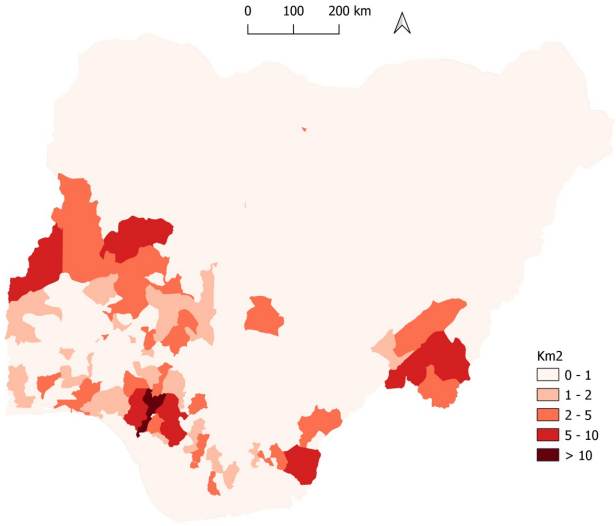


Figure 5: Nigeria's forest canopy loss since 2000 (Source: Based on the Global Forest Watch (loss of canopy between 2000 and 2019)

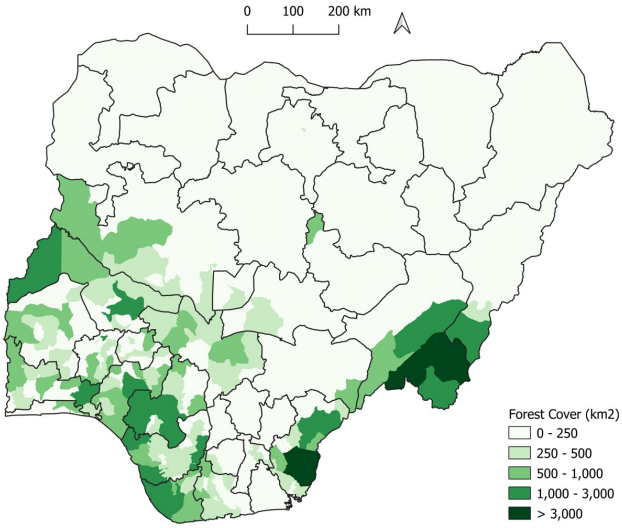


Figure 6: Nigeria's remaining forest canopy cover (Source: Based on the Global Forest Watch (2019))

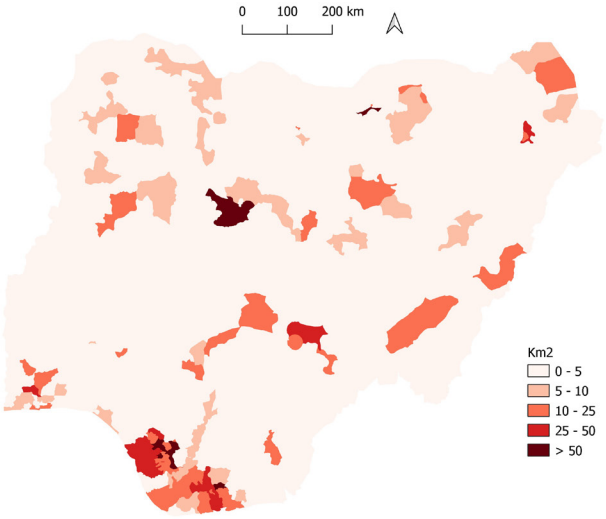


Figure 7: Nigeria's loss of functional floodplains – Floodplain development (Source: Based on an intersection of the Global Settlement and the functional fluvial floodplain (defined here as 1 in 25 years, taken from the World Institute Resources Aqueduct Flood Tool river and coastal maps excluding subsidence (Sayers et al, 2021) in km^2.)

2.4 Hazard

2.4.1 Fluvial (river) flooding

Communities alongside the Niger and Benue Rivers and those downstream of dams are at high risk of flooding (Oladokun & Proverbs, 2016)rapid urbanization and extreme weather events. This study provides a critical review and characterisation flood risk management (FRM. Fluvial flooding happens when water breaches its natural and artificial barriers and overflows to areas not usually submerged, usually caused by excessive rainfall. This type of flooding accounts for most of the flooding incidents in areas where the two rivers of the country meet (Nkwunonwo & Baily, 2015; Ugonna, 2020). In July this year, Nigeria Hydrological Services Agency (NIHSA) reported widespread flooding in Jalingo, the Taraba state capital, citing poor or lack of drainage systems and floodplain development as aggravating the flood impacts (Floodlist).

As many as 300 homes were damaged after heavy rain from 9 July 2021 (*FloodList*)

Figure 8: Severe flooding in Jalingo, Taraba State, in North-Eastern Nigeria

Note: The World Resource Institute (WRI) flood hazard maps (at a 1 km resolution) for the present-day 1 in 25, 1 in 50, 1 in 100, and 1 in 1000 return period provide the underlying **fluvial hazard** data used here.

2.4.2 Coastal flooding

Coastal floods in Nigeria affect the low-lying southern parts of the country, particularly along Nigeria's coastline that stretches over 853 km alongside low-lying areas and industrialised areas. This includes the dense city of Lagos (Nigeria's economic powerhouse, a low-lying city on Nigeria's Atlantic coast and home to more than 24 million people) and the commercial hubs of Warri and Port Harcourt (Oladokun & Proverbs, 2016)rapid urbanization and extreme weather events. This study provides a critical review and characterisation flood risk management (FRM.

Note: The World Resource Institute (WRI) flood hazard maps (at a 1 km resolution) for the present-day 1 in 25, 1 in 50, 1 in 100, and 1 in 1000 return period provide the underlying **coastal hazard** used here.

2.4.3 Pluvial (intense rain-driven surface water) flooding

Pluvial floods occur when rainfall overcomes the capacity of drainage systems and soil infiltration to absorb oncoming water. Pluvial flooding, occurring in the rainy seasons of July and October, is a problem for urban areas such as Lagos. Lagos, the biggest city in Nigeria, is densely populated and situated in a low-lying coastal area. Its rapidly growing urban population, poor urban planning, and other anthropogenic factors have made it susceptible to flooding. Historically it has always experienced floods, but pluvial urban flooding (linked to rainfall) has been increasing (Nkwunonwo & Baily 2015; Nkwunonwo, Whitworth & Baily 2016; Nkwunonwo, 2017). During the drafting of this report, four people lost their lives in flash floods that swept through areas of Abuja and the Federal Capital Territory (FCT) of Nigeria (**Figure 9**).

12 September 2021. Photo: FCT Emergency Management Agency (*Floodlist*)

Figure 9: Flood damage in southern Abuja, Nigeria

Note: Pluvial hazard maps are not available as open data to download. This is not to suggest that pluvial flooding (i.e. storm-duration rainfall) is of limited interest, but recognises that fluvial hazard maps are likely to include pluvial flood hazard areas, since distinguishing between pluvial and fluvial flooding is often difficult (although possible through more detailed analysis). A detailed study of Lagos suggests pluvial flooding adds little to the coastal and fluvial risk (see Box 1). Based on this, an uplift of 5% is applied to the fluvial and coastal damages to account for pluvial flood risks not implicit in the fluvial maps (see the calculation of expected annual damages later in this section page 22). This should be revised in any follow-up studies.

BOX 1: Previous estimates of fluvial and pluvial flood risk in the coastal states

Flooding is a significant driver of coastal degradation which, in turn, can lead to deaths, decreased quality of life and economic damages (loss of assets, critical ecosystems). Flooding can also have significant costs in terms of lost livelihoods, destruction of assets (both public and private), expenditures on welfare and health, and loss of ecosystem services. A report from the World Bank estimates the costs of coastal flood impacts in terms of damage to assets, economic production and mortality; Lagos suffers a significant amount owing to higher value assets and the size of the at-risk population (Croitoru et al, 2020). The estimates here are similar for Lagos, but the suggestion is that the risks to both Delta and Rivers States are more significant. This may be a function of differences in underlying mapping – hazard and/or exposure. This would be useful to consider further in downstream studies.

Economic cost of flooding on the coast in USD million (2018).

	Cross River	Delta	Lagos
Damages due to Fluvial floods	82	285	3835
Damages due to Pluvial floods	7	9	103
Mortality (From Pluvial and Fluvial floods)	5	6	55

2.4.4 Groundwater

Groundwater flooding in the absence of either surface water, coastal or fluvial flooding is rare, but can occur after a prolonged period of rainfall or when water extraction from an aquifer ends (Lucas, 2020). Pollution of the often shallow (and in many parts of Nigeria, lowering) groundwater is a significant challenge.

Note: Further consideration of **groundwater flooding** is excluded from the analysis here.

2.4.5 Multiple source flood hazards

In many locations, flood sources – both pluvial and fluvial flooding – interact with surface water run-off, which is increased by urbanisation, urban fluvial peak flows, or surface waters and fluvial flows interacting with extreme sea levels and overtopping. Understanding these interactions and how they may change is likely to become increasingly important.

Note: WRI flood hazard maps (at a 1 km resolution) for the present-day 1 in 25, 1 in 50, 1 in 100 and 1 in 1000 return period maps for both **fluvial and coastal flooding** have been used. Given the lack of data on the correlation between fluvial and coastal flooding, the probability of flooding within any 1 km grid has been determined as the mean of in-combination probability, based on two bounding assumptions of full dependence and full independence.

2.5 Exposure

2.5.1 People

An assessment has been made of the number of people exposed to flooding in the absence of flood defence or control infrastructure (even where they exist). This high-level analysis suggests 16 million people are exposed to flooding from coastal or fluvial sources (with a return period of 1 in 100 years, excluding the influence of flood defences and other controls). Over 4 million people living in Nigeria's towns and cities (as defined by the Global Settlement Data urban classes) are exposed to flooding more frequently than 1 in 25 years. This excludes surface water flood-prone areas (although these will often overlap with fluvial floodplains).

A summary of fluvial and coastal flooding is presented graphically in **Figure 10** and summarised by state in **Table 1** in terms of total and urban exposure. Rivers, Delta and Borno States each have over 1 million people exposed to flood hazards. Despite the fact that around half of the population resides either in Delta or Borno States, Lagos has the third-highest urban population at risk from flooding (~530,000).

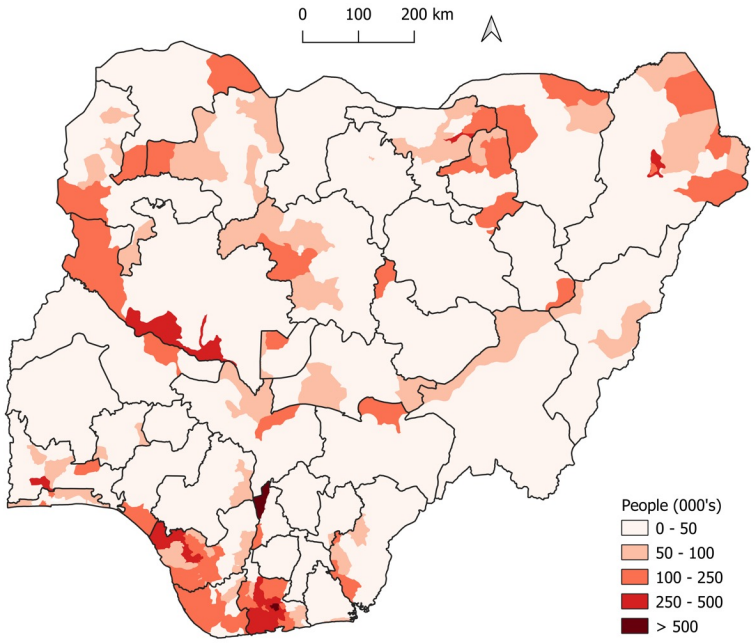


Figure 10: People exposed to 1 in 100-year flood today – fluvial and coastal
(Source: Authors. Based on a combination of the WorldPop (100m) and World Resource Institute (WRI) flood hazard mapping present day 1 in 100-year return period.)

Table 1: People exposed to 1 in 100-year flood today – total and urban

State	Total people exposed (1in100)	Total people exposed in urban areas (1in100)
Abia	63,287	5,236
Adamawa	290,476	23,555
Akwa Ibom	211,273	19,511
Anambra	280,912	44,063
Bauchi	502,406	35,434
Bayelsa	665,896	122,017
Benue	184,533	28,630
Borno	1,219,366	416,510
Cross River	315,175	26,245
Delta	1,761,172	953,407

State	Total people exposed (1in100)	Total people exposed in urban areas (1in100)
Ebonyi	176,519	10,741
Edo	135,757	13,409
Ekiti	393	0
Enugu	23,936	2,218
Federal Capital Territory	124,728	42,573
Gombe	119,945	7,297
Imo	34,486	1,129
Jigawa	919,377	168,284
Kaduna	390,458	116,000
Kano	271,361	27,430
Katsina	83,658	3,258
Kebbi	443,021	38,814
Kogi	228,437	26,448
Kwara	87,901	342
Lagos	610,329	528,458
Nasarawa	118,605	7,903
Niger	393,404	21,788
Ogun	383,640	156,895
Ondo	253,967	13,080
Osun	196,436	70,113
Oyo	77,480	776
Plateau	48,583	1,686
Rivers	3,717,682	1,117,511

State	Total people exposed (1in100)	Total people exposed in urban areas (1in100)
Sokoto	535,703	82,718
Taraba	195,599	10,598
Yobe	465,157	37,687
Zamfara	401,590	60,327

2.5.2 Gross domestic product (GDP)

Gridded global datasets for the gross domestic product (GDP 1 km grid scale as of 2015 and not uplifted here) combined with the 1 in 1000-year coastal and fluvial flood hazard maps from WRI are used to derive GDP exposed within the 1 in 1000-year coastal and fluvial floodplains. This analysis suggests that approximately 25% of the national GDP (GBP 105.5 billion of ~ GBP 448.1 billion in 2019[1]) lies within this broad definition of the floodplain. The spatial distribution of this value is mapped in **Figure 11** and summarised by state in **Table 2** (in terms of total and urban exposure, 1 in 100).

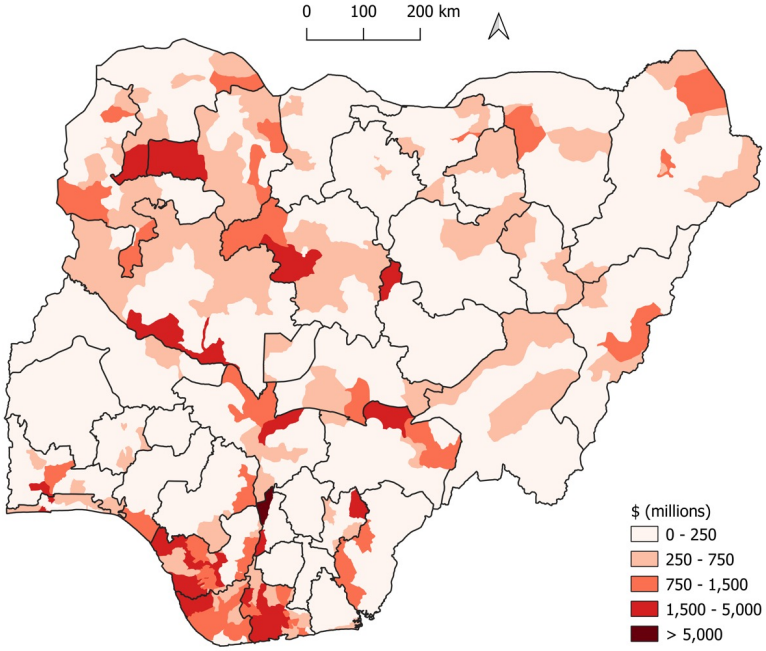


Figure 11: GDP exposed to 1 in 1000-year flood today – fluvial and coastal. (Source: Based on gross domestic product 2015, at a 30 arc-sec resolution, combined with the World Resource Institute (WRI) flood hazard mapping present-day 1 in 1000-year return period.)

1 https://datatopics.worldbank.org/world-development-indicators/

Table 2: GDP exposed to 1 in 100-year flood today – total and urban

State	Total GDP exposed (1in100) £m	Total GDP exposed, Urban Areas (1in100) £m
Abia	385.62	24.84
Adamawa	1,527.39	108.95
Akwa Ibom	1,450.17	262.15
Anambra	1,758.66	420.22
Bauchi	2,135.94	285.30
Bayelsa	5,662.37	2,789.76
Benue	2,899.17	635.10
Borno	4,450.71	1,914.19
Cross River	2,913.20	801.00
Delta	13,431.06	9,159.69
Ebonyi	1,687.99	110.61
Edo	843.65	129.56
Ekiti	-	-
Enugu	72.24	3.41
Federal Capital Territory	390.79	216.98
Gombe	472.57	68.49
Imo	28.24	-
Jigawa	2,542.99	767.45
Kaduna	2,911.48	768.04
Kano	1,155.22	113.76
Katsina	783.99	14.31
Kebbi	3,005.91	456.08
Kogi	2,359.60	257.79
Kwara	296.07	-
Lagos	4,887.62	4,563.41
Nasarawa	1,043.60	114.40
Niger	2,937.08	277.69

Ogun	2,236.34	1,556.13
Ondo	1,239.72	117.84
Osun	1,163.40	627.71
Oyo	245.00	9.76
Plateau	346.97	44.93
Rivers	27,732.67	7,987.20
Sokoto	4,193.03	635.37
Taraba	1,186.88	104.78
Yobe	1,184.47	625.51
Zamfara	3,907.53	695.85
Grand Total	**105,469.00**	**36,668.25**

2.6 Vulnerability

The latest data from the World Bank suggests that around 40.1% of the Nigerian population live below the national poverty line (in 2018).[2] The high level of poverty, lack of development and reliance on rain-fed agriculture increases the vulnerability of poor households to climate-related shocks and constrains their ability to mitigate such risks (World Bank, 2021). This includes flooding.

An in-depth understanding of socially constructed vulnerabilities can lead to more effective flood management solutions. For example, the Abeokuta 2007 flood disaster revealed how socio-economic factors and lack of social protection affected victims' ability to cope with the flooding (Adelekan, 2011). Gender outcomes should also be considered. Ajibade, McBean and Bezner-Kerr (2013) find that gender becomes a significant factor when assessing flood risk, when gender intersects with income, employment and access to healthcare. This means socially and economically marginalised women suffered more and take longer to recover after a major flooding event.

Note: Social vulnerability based on demographics and social metrics has not been included in this report, but should be considered in future studies. This is particularly important to promote 'leave no one behind' and pro-poor outcomes.

2 Please see https://data.worldbank.org/indicator/SI.POV.NAHC?locations=NG

2.7 Expected Annual Damage (EAD)

The Expected Annual Damage (EAD) is widely used as a convenient measure of the average annual damage associated with flooding. For simplicity, annual exceedance probabilities (AEP) is used here to refer to the return period, in years, of the flood hazard, although it is recognised that one is not exactly a reciprocal of the other. Given information on flood hazards for a range of AEP and associated damage (in the form of economic impact or any other measure), the EAD can be readily approximated using a trapezium rule to integrate the product of the probability and the damage value as:

$$EAD=\sum(P(i+1)-Pi) \times ((D(i+1)+Di)/2) \qquad \text{Eq. 1}$$

Where Pi is the AEP of the storm and Di is the associated damage.

This equation approximates the mean (expected) annual damage as the area under the probability versus damage curve. When annualising damage in this way, there is an implicit assumption that the damage varies linearly between Di and Di+1; an assumption assumed to be reasonable for the purposes here.

To evaluate Equation 1, the following inputs have been used:

Residential damage: To determine the residential property damage conditional upon the probability of flooding (i.e. the combined probability from the previous step), two aspects are considered:

i. the number of residential homes impacted, based on WorldPop population estimates (at 100 resolution) and an assumed average household occupancy of 5[3];

ii. a residential damage function based on data from the JRC (Huizinga et al, 2017).

Commercial damage: There is limited readily available geospatial data on commercial activities property by property. This makes a bottom-up assessment of the non-residential damage meaningless in the context of this rapid study. Nonetheless, commercial damages are of central importance in determining urban risks. To approximate the damage associated with commercial activities, a simplified method has been applied, assuming the value of damage to be equivalent to exposed GDP. It is assumed that this is full loss (direct and indirect).

The EAD is then directly calculated using Equation 1, as presented in **Figure 12** and summarised by state in **Table 3** (in terms of total and urban damages; the urban damages determined using the urban mask set out in **Figure 4**). Rivers, Delta and Borno States are all highlighted as having significant EAD.

3 https://dhsprogram.com/pubs/pdf/FR148/02Chapter02.pdf section 2.2

Note

Damage depth functions: It is noted that the Joint Research Centre (JRC) depth damage functions are not Nigeria-specific but aggregated for Africa and are generally found to need local validation/calibration. This has not been possible here. Nonetheless, they are used here in simplified form to avoid false precision, as a high-level approximation given a single data value where the flood depth is estimated to be greater than 1m depth, and a lower value where the flood depth is estimated to be below 1m (with an associated damage value of ~£3500 and ~£8400). The JRC values are typically considered to represent direct damages. To account for indirect damages, a notional 1.7 has been applied. This is based on evidence from the UK only (Sayers et al, 2015). Future analysis should follow this to be more Nigeria-specific, based on a primary assessment of past floods.

Pluvial flooding uplift: This is represented through an uplift in damage of 5% (see earlier in this section).

Agricultural damage: This is excluded here, given the urban focus. It could be addressed in downstream studies.

Processing environment: Given the spatial resolution and large scale of the analysis calculation, a spatial analysis function with spatially aggregated outputs is summarised in the associated spreadsheet of results. The analysis is repeatable using the rules and datasets set out here. If required, user focused tools could be developed to support this, but this is beyond the current scope.

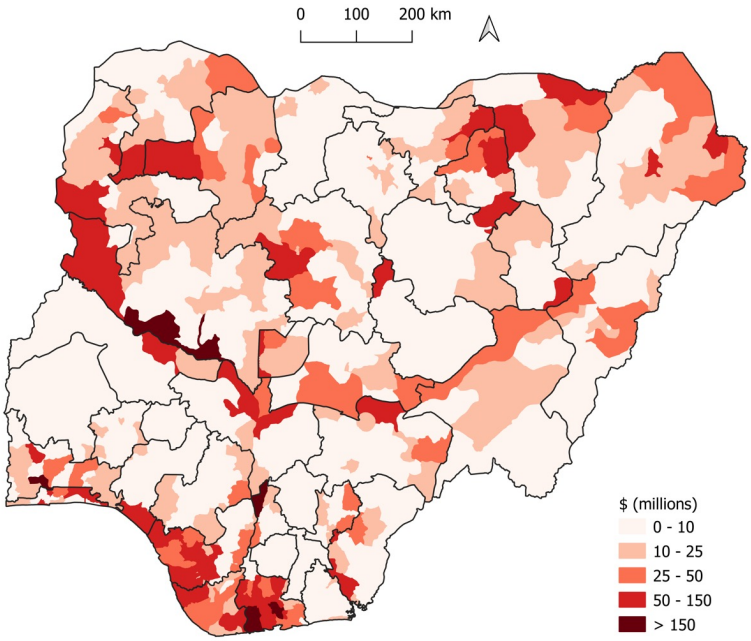


Figure 12: Expected annual damage (residential direct) – fluvial and coastal
(Source: Spatial analysis using the rules and dataset presented in this section.)

Table 3: Expected annual damage (residential and non-residential)

State	Urban – EAD (Total) £m	All – EAD (Total) £m
Abia	21	299
Adamawa	102	1326
Akwa Ibom	199	1078
Anambra	267	1183
Bauchi	212	1824
Bayelsa	1956	4300
Benue	481	2148
Borno	1588	3789
Cross River	536	2223
Delta	6998	10436
Ebonyi	86	1327
Edo	91	603
Ekiti		
Enugu	4	66
Federal Capital Territory	183	371
Gombe	54	349
Imo	1	41
Jigawa	573	2145
Kaduna	658	2377
Kano	95	931
Katsina	12	603
Kebbi	314	2283
Kogi	210	1766
Kwara	1	273
Lagos	3381	3659
Nasarawa	87	768
Niger	208	2220
Ogun	1224	1899

State	Urban – EAD (Total) £m	All – EAD (Total) £m
Ondo	92	1037
Osun	491	956
Oyo	7	231
Plateau	33	274
Rivers	6305	21689
Sokoto	494	3190
Taraba	80	946
Yobe	433	1116
Zamfara	518	3005
Grand Total	**27997**	**82732**

3. Future flood risks: Pressures, challenges and initiatives

3.1 Pressures: Climate change

Climate change is likely to have a profound impact on Nigeria's flood risk. Any activities taken today will need to be resilient in the context of a changing climate, from the way infrastructure is designed to the flood hazards mapped and the catchments and cities managed.

Several headline findings emerge from a review of the impact of climate change on Nigeria's flood risks from the literature, including:

Nigeria is not spared from the negative impacts of climate change. The evidence of climate change affecting Nigeria is increasing, with reports of higher temperatures, variable rainfall, higher sea levels, drought and extreme weather, among others (Haider, 2019).

Changing rainfall patterns in Nigeria signal a worrying trend. While some studies show Nigeria had its driest decades between 1970 and 1990, this trend has shifted considerably, with the first 15 years of the 21st century (2001–2015) witnessing greater annual rainfall (but with high variability). This has contributed to flooding (Ogunrinde et al, 2019). Similar work finds that rainfall duration and intensity increased over the past three decades, leading to runoffs and consequent flooding in vulnerable areas of the country. In time, with climate change, precipitation is expected to increase 5% to 20%, further raising the risk of flooding (Haider, 2019).

Beyond an increase in rainfall, rising sea levels can also exacerbate flooding. Flooding in areas near the coast is expected to worsen with higher sea levels. Some villages along the south were submerged in recent incidents as sea levels rose (Akande et al, 2017; Haider, 2019). By 2070, an estimated 550,000 people are expected to be affected by flooding owing to sea level rise (World Bank, 2021). For cities on the coast, rising sea levels not only increase the risk of floods but can cover significant land areas. It is estimated that a sea level rise of 1m could overrun 75% of the Niger delta's land area (Haider, 2019; Oloyede, Williams & Benson, 2021). Oloyede et al. (2021) estimate sea levels for the coastline of Lagos may rise to 11.9, 24.9, 38.1 and 49.2 cm by 2025, 2050, 2075, and 2100, respectively (using RCP 2.6). This is a worldwide problem, with Chapter 4 of the latest IPCC report dedicated to 'sea level rise and implications for low-lying islands, coasts, and communities'.

Future climate scenarios show climate change will likely increase flood risk in Nigeria, making it imperative to improve resilience and reduce flood risk. The World Bank's recently published climate risk profile for Nigeria acknowledges that rainfall in Nigeria is highly variable, with no clear trends for precipitation. However, it projects that heavy rainfall will intensify in climate future scenarios, with extreme events likely to lead to flooding. The impact will be uneven in the country, as in their highest emissions scenarios, rainfall is expected to decrease in the northern regions and increase in the south and along the coast. Overall, intensifying heavy rainfall and more frequent extreme events are expected to lead to more floods, especially during the rainy season (World Bank, 2021). With rising risks, it becomes more pressing to consider measures to adapt to these expected changes.

Moreover, climate change and the changing landscape of risks will have to be considered when choosing flood interventions. For example, Löwe et al. (2017) find that the performance of different adaptation strategies (structural and non-structural) varied, depending on the different climate or urban development scenarios considered. These considerations were incorporated in past studies, such as Doroszkiewicz and Romanowicz (2017), who posit using a strategy that considers flood risk assessment and adaptation in the context of changes brought on by climate change. Zhou et al. (2012) develop a framework where they combine climate-modelling and economic cost-benefit analysis to assess climate adaptation measures for pluvial flooding in urban areas. In all, the increasing likelihood of hazards brought on by climate change will have an impact on a country's adaptation choices.

3.2 Pressures: Urban development and catchment change

Nigeria's flooding is mainly human induced, with current poor urban planning practices and inadequate to non-existent environmental infrastructure contributing to and exacerbating flood risk (Echendu, 2020). These include issues of informal development, inadequate drainage systems, poor waste management systems, lack of institutional capacity, lack of strategic long-term coastal and river basin planning, lack of early warning and lack of public awareness (Echendu 2020; Lucas 2021). More specifically:

- **Uncontrolled urbanisation and catchment changes:** Nigeria is rapidly urbanising but lacks the supporting systems to make this growth sustainable. Authorities struggle to enforce the regulations that deter construction on flood-prone areas. Agricultural lands are also being converted without the necessary controls, exacerbating the flooding problem (Echendu, 2020; Lucas, 2021).
- **Inadequate drainage systems:** This is considered a major challenge in Nigeria, with significant investments ongoing in Lagos and Ibadan. Drainage systems in the country do not exist for most places and when they do, they are incapable of handling rainfall volumes and are prone to blockages.
- **Poor waste management systems:** Trash and debris collect and block the drainage system, in part, from poor waste disposal and sanitation habits.

3.3 Challenges to flood adaptation

Based on a review of the literature, Nigeria faces a number of challenges to adaptation for climate change-related flood risks. These include a lack of spatial planning and institutional coordination, weak flood modelling capacity, lack of early warning systems, information gaps, issues with communication and reception, and unfamiliarity with alternatives such as green infrastructure.

3.3.1 Limited capacity in strategic planning and institutional coordination

Nigeria has urbanised and is continuing to urbanise without the benefit of proper spatial planning, land use management and the requisite governance systems. With weak systems in place, the design and use of buildings and other potential flood-inducing modifications can be added to city plans without an environmental impact analysis or other geotechnical studies (Oladokun & Proverbs, 2016)rapid urbanization and extreme weather events. This study provides a critical review and characterisation flood risk management (FRM. In light of this, Adedeji, Odufuwa and Adebayo (2012) emphasise proper spatial planning and land use to reduce urban flooding, noting that a better understanding of the spatial dimensions of flooding and more tailored responses could help more people. Spatial planning can also be used for early warning systems, risk assessments and mapping, etc. Echendu (2020) conveys a similar message, stating that spatial planning, coordinated across different agencies and stakeholders, can lead to sustainable flood mitigation, especially as Nigeria is in a stable geological zone with few natural disaster events.

Planning across states might also be necessary. Nigeria is home to 36 autonomous states that have 750 local authorities, and within each are local players such as private companies, non-profits, international organisations and individuals. Currently, each actor can install a flood risk management (FRM) measure without consulting nearby stakeholders, and there have been reports of measures that protect one locality yet harm another (e.g. a measure affecting downstream communities with direct runoff water) (Oladokun & Proverbs, 2016)rapid urbanization and extreme weather events. This study provides a critical review and characterisation flood risk management (FRM. Strategic river basin plans and coastal zone management or shoreline management plans do not appear to have a significant role.

Notably, Nigeria needs stronger and more responsive institutions. Nigeria has institutional frameworks with a complicated chain of command that make it difficult for the country to respond to urgent threats of flooding (Nkwunonwo & Baily, 2015). The country needs to embolden state authorities and give them shorter and less complex chains of action.

3.3.2 Inconsistent and limited flood hazard understanding and local capacity

Flood modelling capacity is weak and often poorly done, especially with the dearth of data (flood and other ancillary data). A more scientific approach to addressing the flood challenge is necessary, as it would inform decisions, feed into the information given to stakeholders, and inform policy, particularly for strategic planning and more effective FRM (Nkwunonwo & Baily, 2015). Information on floods and flood modelling is integral to tackling floods, but such information is lacking in Nigeria. Proper assessments of vulnerability help those in charge to understand differences in sensitivity, exposure, and capacity to cope with flood events.

Komolafe, Adegboyega and Akinluyi (2015) review flood risk analysis in Nigeria and come to a similar conclusion: There is a need for more state-of-the-art flood models, particularly those that integrate hydrological processing. Currently, the models in the country do not incorporate some hydrological and physical components that help determine flood waves. Their inclusion would allow more accurate predictions and maps. They also note the need for more detailed stage damage function/flood damage curves to assess physical and economic vulnerability.

Scholars from Nigeria have attempted to map flood risk with help from GIS. Komolafe et al. (2015) summarise a few of these studies and outline some of the techniques they use. They also summarise research on exposure and vulnerability to floods. Many studies use GIS and remote sensing, with few using hydrological, run-off or floor modelling, or surveys. Tables can be found in the Appendix.

3.3.3 Limited early warning systems (EWS)

An effective early warning system for flooding, as well as a systematic means to communicate these warnings, is missing at the federal, state and local/community levels. Nigeria's Third National Communication in 2020 notes that there is no systematic process to disseminate information on early warnings for disaster in the country, and that the capacity of NiMET is limited. NiMET has around 54 network stations, making for inadequate observation density. To help NiMET, ten automatic weather stations were donated by WASCAL (West African Science Service Centre on Climate Change and Adapted Land Use) (Federal Government of Nigeria, 2020a).

In general, information dissemination is done through local radio and newspapers, but even these warnings are not location-specific (except for Lagos, which specifies areas that will be affected by floods). Elsewhere, rainfall volumes are the main focus of warnings and instructions, and advice for listeners is not specified. Olorunfemi, Olokesusi and Onwuemele (2015) note that this is slowly changing, with messages to vacate flood-prone areas. However, flood warnings have been received and not acted upon, making the flood warnings ineffective (Olorunfemi, Olokesusi & Onwuemele, 2015).

As with flood modelling, data constraints remain a challenge for setting up early warning systems. For example, rainfall data is reported in 'hourly amounts' and is not sufficient for flood monitoring (which needs intensity-duration-frequency). More accurate flood assessment models are also needed to warn people of the various risks of flooding. Warning systems need to inspire the correct response to be effective, which highlights the importance of risk communication. During the 2012 floods in Kogi, research shows that while most (86.7%) heard the flood warnings, few people heeded the warning (Nkwunonwo, 2020). Some studies fault social and technical barriers for this lack of response. Social barriers include lack of social support (Lamond et al, 2018; Adelekan, 2011; Odemerho, 2015), while technical barriers include missing technical information and implicit knowledge issues that limit the community's capacity to respond to early warnings (Lamond et al, 2019; Sukhwani et al, 2019).

3.3.4 Information gaps

Information that would be useful for flood risk is mostly available at a national scale, with limited information at a more local level. Even at the national level, records are incomplete, only available for selected disasters, and difficult to find as flooding information is not organised in a single database (Lamond et al, 2019). Different stakeholders also have different data requirements (in terms of detail, scale and time) and the lack of a centralised source of information makes the data difficult to access.

In addition, research shows that there is a poor perception of flooding in local communities and indifference when responding to research/questionnaires and surveys, which further contributes to the knowledge gap (Nkwunonwo & Baily, 2015).

3.3.5 Lack of effective communication to support community action

For information to be effectively conveyed to its target audience, respondents require a trustworthy source of information. Lamond et al. (2019) interviewed stakeholders in Calabar and Makurdi and found a lack of trust in the nature and source of information. The research highlights the need for localised delivery of climate information, considering the diverse needs of each community, to ensure a more effective response.

Perception of flooding and education on the environment is still lacking in Nigeria. Flood hazards may be widespread, but information and knowledge are still inadequate among the wider population. There is a need for information on how to cope and prepare for flooding. Studies on flood risk perception show that awareness among respondents surveyed in Lagos is high (coupled with feelings of dread and worry). The lack of information contributes to high perceptions of flood risk, and residents need to be better equipped with information on how to cope and prepare for flood events (Adelekan & Asiyanbi, 2016).

3.3.6 Limited/little take-up of ecosystem-based interventions

Ecosystem-based interventions are relatively uncommon in Nigeria. The extent of adopting ecosystem-based interventions in Lagos is unknown, although some pilot studies are starting to explore afforestation to attenuate coastal flood issues.[4] In Calabar, the government set out to plant five million trees every year and took steps to deter logging activities to increase forest cover (Lucas, 2021). Consultations with stakeholders revealed a low preference for ecosystem-based and behavioural approaches to addressing flood risk; instead most favour structural approaches, government interventions, and regulation (Lamond et al, 2019). Reconnecting functional floodplains (making room for the river), catchment afforestation (including reinstating lost forest where appropriate), urban green spaces and sustainable urban drainage systems (including swales, green roofs, etc.) all provide potential, recognised opportunities for stakeholders. However, the guidance and strategic planning needed to underpin such activities is limited. Providing the capacity to better consider and encourage wider uptake appears to be an important gap.

There is a case for incorporating green infrastructure interventions. Changes in land use and land cover dynamics have already altered some of the ecosystem services provided in Nigeria. This includes climate and water regulation which contributes to the incidence of flooding (Arowolo et al, 2018). The degradation of mangroves, which protect the coast from flooding, has exacerbated the flood impact (Nigeria Hydrological Services Agency, 2021).

G**reen infrastructure can also help with the management of water quality.** Research shows that the 2012 flood water in North Central Nigeria reduced surface water and groundwater quality after the flood. Surface water quality was around 72% (fair quality) before the flood and 51–53% after the flood. Groundwater was 69% (fair quality) before declining to 55–61% (marginal quality). In all, the researchers found a 27% and 20% reduction in surface and groundwater quality, respectively (Utsev, Nnaji & Nnennaya, 2015).

4 See ('Lagos to Plant 230,000 Trees to Prevent Flooding, Promote Climate Friendly Environment' 2020).

4. Stakeholders: Roles, responsibilities, and consultations

4.1 Public sector stakeholders

4.1.1 Roles and responsibilities

The government plays a central role in flood management in Nigeria, as summarised in **Table 4**. While the National Emergency Management Agency (NEMA) is responsible for disaster preparedness and response at the federal level, in practice, the state governments have a much bigger role in this area, with some more effective than others.

Table 4: Main institutions and roles in flood risk management

Government Stakeholder	Role
National Emergency Management Agency (NEMA)	Coordinates resources towards efficient and effective disaster prevention, preparedness, mitigation, and response at their level of jurisdiction (national)
State Emergency Management Agency (SEMA)	Coordinates resources towards efficient and effective disaster prevention, preparedness, mitigation, and response at their level of jurisdiction (state)
Local Emergency Management Agency (LEMA)	Coordinates resources towards efficient and effective disaster prevention, preparedness, mitigation, and response at their level of jurisdiction (local)
Relevant ministries and departments	Responsible for carrying out responsibilities as set out by NEMA, SEMA or LEMA at the respective level of jurisdiction. This includes the **Department of Climate Change.**
Nigerian Meteorological Agency (NIMET)	Advises the federal government on all aspects of meteorology and collects data (weather reports, other meteorological information, issues early warning and forecast on impending flood disasters).
Nigeria Hydrological Services Agency (NIHSA)	Assesses Nigeria's surface and groundwater resources in terms of quantity, quality, distribution and availability in terms and space for efficient and sustainable management of water resources.
Military, police, rescue agencies, fire services	First responders when emergency strikes and can assist with the disaster management plan (preparedness).

Source: 'Urban Flood Risk Management and Transfer in Lagos: Feasibility study' by FSD Africa (2021).

4.1.2 Maturity of climate policy

Several government plans and policies have been released over the last few years that have been drafted to incorporate climate considerations. These include the National Disaster Risk Management Policy in 2019, the Lagos Climate Action Plan 2020–2025, Nigeria's National SLCP Action Plan (NAP) to reduce short-lived climate pollutants (SLCPs) in 2019, the National Climate Change Policy for Nigeria 2021–2030, a National Forest Policy 2020 and the submission of the country's updated nationally determined contributions (NDCs) for 2021. A team from the Department of Climate Change in the Federal Ministry of Environment is responsible for ensuring that climate change considerations are incorporated in sectoral policy planning and programmes (based on a consultation with the department).

The country submitted its final updated NDCs in July 2021. The new commitments feature some enhancements. Among other additions, the NDC now includes expanding the covered emissions to include hydrofluorocarbons (HFCs) and small pollutants, enhanced contributions from the waste sector, and other nature-based solutions previously not mentioned in 2015. Notably, the new submission takes into consideration improvements in the data, and updates its baseline business-as-usual (BAU) projections. The new projections also account for the lower than expected GDP growth from 2015 to 2021, the impact of Covid-19 and the country's recovery. The resulting GHG predictions are now lower in absolute terms than the 2015 projections. All things considered, Nigeria affirms its original unconditional commitment of 20% below BAU and raises its conditional commitment from 45% to 47% below BAU by 2030 (Federal Government of Nigeria, 2021).

Underscoring Nigeria's adaptation priorities is the National Adaptation Plan (NAP) Framework published in mid-2020. The NAP aims to serve as a reference point for the country's adaptation plans, with a focus on using a sectoral approach. The framework allows for the coordination of the country's medium- and long-term adaptation plans, and will require the collaborative efforts of ministries, departments and agencies, as well as the inclusion of the private sector and non-government organisations. The latter is especially needed to help facilitate financing. In addition, part of the approaches mentioned in the NAP process include community-based adaptation and ecosystem-based adaptation (EBA) approaches (Federal Government of Nigeria, 2021; 2020b).

Despite this useful progress, embedding climate change into planning and investment choices remains challenging, in light of an absence of strategic flood risk management adaptation plans.

4.2 Stakeholder responses: Perceived gaps and opportunities

4.2.1 Responses received

Through August and early September 2021, the team reached out to members of the federal government, international development partners, UK-affiliated programmes and academic researchers involved in flood risk to discuss the projects they were involved in and what they perceive as potential gaps and opportunities in the flood risk space where the FCDO UK could intervene. Of those approached, the team was able to consult with several stakeholders (**Table 5**), many of whom inform the following section.

Given time constraints, the team acknowledges that the information gathered will be limited and will not be a comprehensive picture of flood risk activities in Nigeria. For example, interviews with the government have been few and may introduce a slant away from efforts at the federal government level. Consulting additional developing partners could also be done. The team recommends future research to include a wider interview list and to consult the federal government and state governments beyond Lagos for a more complete picture.

Table 5: Responses received

Government	International Development Partners	UK Affiliated ProgramMEs	Academic Researchers
Department of Climate Change at the Federal Ministry of Environment	World Bank	UK Centre for Disaster Protection	Prof. Taibat Lawanson (University of Lagos)
Office of the drainage services and water resources, Lagos State Ministry of the Environment and Water Resources	UN Agencies (e.g., UN-Habitat)	Future Cities Nigeria Programme	Prof. Ibidun O. Adelekan (University of Ibadan)
Lagos State Resilience Office	British Red Cross/ Nigeria Red Cross Society	The DARAJA project	Prof. Jessica Lamond (University of the West of England)
	Heinrich Böll Foundation Nigeria	FSD Africa	Prof. Victor Oladokun (University of Ibadan)

4.2.2 Perceived gaps and opportunities

Based on discussions with stakeholders, some of the biggest gaps in addressing the flood challenge include:

- **Lack of federal coordination and leadership.** In interviews, most stakeholders refer to the importance of the state government (below), but few mention what the role of the federal government is. The need for better coordination across states (for example to improve flood forecasting and warning) was, however, seen as an opportunity. In the literature, the absence of a national flood risk management (FRM) strategy or comprehensive flood risk maps, for example, are seen as indicators of the lack of attention paid to Nigeria's flooding problem (Oladokun & Proverbs, 2016). This suggests that designing and implementing adequate FRM strategies comprising proper spatial planning and infrastructure would help to control the floods which adversely impact Nigeria's sustainable development (Ouikotan et al, 2017).
- **The importance of political will at a state level.** All interviews emphasised the importance of the role of state governments in flood management decision making, highlighting the substantial political will that is necessary for the success of any project.
- **The improvement of planning policies and making them more inclusive.** Many stakeholders mentioned that a lot of work needs to be done to upgrade all planning policies and building standards. There is also a need to include social vulnerability when thinking about flooding, and to engage in knowledge transfer and policy work to reduce the human impacts of flooding along multiple facets. This includes ways to help communities protect and rebuild their livelihoods.
- **Establish more integrated FRM systems.** Interviewees mentioned that Nigeria needs a more systems-based approach that incorporates all actors to be successful. There appears to be a great deal of disconnect or 'silo-ed' efforts among FRM stakeholders in Nigeria. Interviews revealed that there is an opportunity for the UK to help inter-agency and donor collaboration; for example, creating and supporting platforms for stakeholder engagements. FRM is multi-faceted and needs to be addressed systematically.
- **Enhancing flood risk research, data, and capacity development.** This includes identifying the underlying factors and consequences and making this information easy to access. Interviews show information is not being used properly and there is no consolidated source.
- **Education and capacity building to increase awareness among citizens.** This can include, for example, awareness campaigns on the need for people to stop dumping waste in the drainage channels or incorporating climate and environmental awareness in school curricula. Stakeholders suggest supporting FRM-related curricula development across the Nigerian education system.
- **Flood alert and flood early warning systems could be improved.** This can also include improved forecasting and communication plans. Stakeholders interviewed mentioned that early warning has a lot of potential but is not much explored. For example, the World Bank may be looking at Ibadan, but this would need to be linked to a wider federal system that is not yet in place.

- **Strengthen institutional capacity, particularly at the state level.** Flood risk management is often carried out at a state level with minimal input from the federal government. Indeed, interviews with stakeholders emphasised the importance of state governments in projects. In addition, the responsibility of flood management should be delineated and incorporated within the community.

4.3 Ongoing projects and initiatives in development

4.3.1 Ongoing projects and programmes

From the literature review (particularly the K4D background paper of FCDO by Lucas, 2021) and from additional updates given during discussions with various stakeholders as part of this study (including the World Bank), it is clear that there is significant interest in improving Nigeria's flood resilience. Many ongoing initiatives focus on improving surface water drainage in urban areas and supporting community action. It is also clear that there is much left to do. **Table 6** features a summary of the current state government efforts to address flooding identified through the review.

Table 6: Efforts to mitigate flood

Lagos (Lagos State)	• **The government has certain rules in place to steer proper urban planning.** The Lagos state government discontinued developments in flood-prone areas and wetlands and provides land to developers at rates that discourage development on marginal lands. However, informal settlements have been constructed on low-lying lands, as people cannot afford housing elsewhere. • **Structural solutions** such as 'constructing drainage channels, breakwaters, and revetments, dredging and channelising waterways,' though notable, have been inadequate. Lucas (2021) notes that only 45% of Lagos has a drainage system and less than 30% is maintained. • Lagos authorities conduct flood awareness campaigns. • Some **communities organise themselves to mitigate flood impacts.** They do this by filling sandbags, building bridges, clearing drainage and so on.
Calabar (Cross River State)	• There were efforts to supplement and canalise the drainage system. • The state government set targets to plant more trees and to disincentivise logging, aiming to increase forest cover. • **Communities purchase sandbags and adopt flood protection strategies** such as constructing concrete walls, installing flood boards and elevating buildings.

Ibadan (Oyo State)	• The state government attempted to **clear rivers channels, floodplains, and areas that disrupt the natural flow of rainwater** by removing illegally built structures, although without much success. Social and political pressures have prevented the removal of houses obstructing water flow. • Flooding was reduced with the **canalisation of the Ogunpa River.** Similar canalising efforts along the Awba Stream are being done and the state government is working to **construct street drainage channels**. State and local governments have also made efforts to **dredge river channels**, but there is currently no information on how effective they have been. • The Oyo state government has taken steps to 'expand waste collection services, provide more refuse bins, and advertise on radio and television to encourage better waste disposal practices'. • The World Bank Ibadan Urban Flood Management Project resulted in the creation of the Ibadan City Master Plan and Integrated Flood Risk Management and Drainage Masterplan, and the team is working to support the government to adopt and institutionalise the documents. The team also worked on a pilot for an early warning system for a specific catchment base in the city.

4.3.2 Pipeline and recent initiatives

Several stakeholders discussed projects they are part of or aware of. Many of these are pipeline initiatives in varying states of readiness. Others are projects that are ongoing (for example data improvements) or possible projects (for example around insurance and integrated financing) with opportunities for the FCDO to contribute (**Table 7**). Note that the table below is a non-exhaustive list.

Table 7: Projects related to flood risk

Project	Description of work/ potential work
The Daraja Project with Resilience.io	Resurgence, a social enterprise based in the UK, has been exploring the possibility of setting up a project in Lagos that would enhance the resilience of the city's circa 20 million population to severe weather events and climate stress. Like their work in East Africa, **the DARAJA project**[5] aims to provide better and more locally accurate weather information services. This project caters to local needs and helps to set up early warning and disaster preparedness systems based largely on community-based disaster risk management.

5 See https://www.resurgence.io/solutions/climate-risk-visualisation-and-communication/daraja/

The Global Future Cities Programme with the UN	The Global Future Cities Programme[6] works in collaboration with the FCDO on urban planning and transportation projects in Lagos and Abeokuta. The team developed spatial analysis for the two cities to better understand the context of the projects implemented. Notably, the programme itself does not work directly on flooding in Lagos or Nigeria as a whole. The team from the UN was able to share a flood vulnerability assessment and mapping of Lagos state using GIS from LASEMA (Lagos State Emergency Management Agency).[7]
The Lagos State Resilience Strategy	The Lagos State Resilience Strategy[8] has a proposed intervention on **community participatory flood management**, to equip communities with the capacity to predict and respond to flooding.
Urbanisation Research Nigeria of the DFID funded UIREM project	Under the 'Adaptation of urban infrastructure to enhance climate resilience in Nigeria' project, research was conducted by an international research team led by Professor Jessica Lamond. The report is still currently unpublished.
Flood Risk Insurance with FSD Africa	The project commissioned **a feasibility and scoping analysis on flood risk management and risk transfer for Lagos in early 2021**. The work provides an overview of stakeholders in flood risk in Lagos and their perceptions and needs, an assessment of the state of flood risk insurance and management, an assessment of available data and risk models and subsequent gaps, and an outline of potential use cases of flood risk management and transfer (as well as the associated stakeholders). A parallel initiative for the InsuResilience Solutions Fund to fund a project that would **structure parametric insurance for flood risk in Lagos** is underway. It was requested by UNDP Nigeria and members of the Insurance Development Forum (IDF). The government of Lagos is expected to be the primary client of the insurance product that will be offered through Nigerian insurers and backed by global insurers. Terms of the payouts ensure that disbursements will go to emergency relief and reconstruction in low-income communities. FSD is liaising with this initiative, and the UNDP/IDF await a decision from the InsuResilience Fund on the proposal. FSD Africa also has a separate project concept that will see the team a**dvising the Lagos State Government on flood resilience interventions**. It is also supporting it in raising a green bond which might help fund some of the infrastructure.

6 See https://www.globalfuturecities.org/federal-republic-nigeria/cities/lagos

7 See https://ludi.org.ng/wp-content/uploads/2020/06/FLOOD-VULNERABILITY-ASSESSMENT-AND-MAPPING-OF-LAGOS-STATE.pdf.pdf

8 See http://www.lagosresilience.net/Downloads/Lagos_Resilience_Strategy.pdf

Projects with the World Bank	The World Bank **Ibadan Urban Flood Management Project**[9] is an ongoing initiative to help improve the capacity of Oyo State to manage flood risk in the city of Ibadan. It is in its final year and activities include a flood risk master plan and a pilot for an early warning system for a specific catchment base in the city. The first phase of the flood risk masterplan was financed by the World Bank and was being implemented at the time of writing. It includes urban planning, mapping with GIS, solid waste management, and early warning. A related project is the **Nigeria Erosion and Watershed Management Project (NEWMAP)**[10] which aims to reduce erosion across the country in terms of natural waterways, embankments and dredging. The project includes Erosion and Watershed Management Infrastructure Investments. Another related project is the **Multi-Sectoral Crisis Recovery Project for Northeast Nigeria**[11] which has components for flood risk management.
Nigeria Red Cross	The Red Cross team is currently looking at three states (Lagos, Imo and FCT), to make decisions for an intervention that includes looking at flood risk. The team focuses on disaster risk reduction (DRR) in four communities (all in one LGA) in the states, following a phased approach to build on geographical coverage and programme complexity. Their programme plans to take a **bottom-top approach to building the resilience of community members** so that they can support their communities, while also connecting community members to other stakeholders that can be of assistance. Their team provides technical assistance that uses knowledge of vulnerabilities, capacities and needs to come up with an action plan led by the community (with constant support from the Red Cross) and provides **training and guidance in all parts of the DM cycle**. They work through the Red Cross local branches in the states, and through their relationship with the communities (and their community resilience teams).
Heinrich Böll Foundation Nigeria	The programme is working with a community in Lagos to develop a flood resilience and action and finance plan. Previously, the team worked on a local government report on flood risk in 2014 (A Participatory Climate Risk Reduction and Management Strategy for Amuwo Odofin Local Government). However, the project has yet to be implemented.
The GRID3 Nigeria project funded by the Bill & Melinda Gates Foundation and FCDO	The project collects **geospatially referenced data** linked to various sectors. It is part of a wider global initiative that aims to 'facilitate the production, collection, use, and dissemination of high-resolution population, infrastructure and other reference data in support of national sectoral development priorities, humanitarian efforts, and the United Nations' Sustainable Development Goals (SDGs)'.[12]

9 See https://projects.worldbank.org/en/projects-operations/project-detail/P130840

10 See https://projects.worldbank.org/en/projects-operations/project-detail/P124905

11 See https://projects.worldbank.org/en/projects-operations/project-detail/P157891

12 See https://grid3.gov.ng/

5. Flood Risk: Options to enhance resilience

5.1 The scale of current expenditure

The Nigeria signed budget for 2021 includes funding for flood risk reduction and management projects (Nigeria Budget Allocation for Flood Projects, 2021). While many of the listed projects can be found in the appropriations for the Ministry of Environment and the Ministry of Water Resources, many other departments list erosion and flood control projects under the subheading 'preservation of the environment'. The team identified some sample flood projects in the 2021 budget and have included them in the Appendix. A search for flood projects in 2021 reveals a minimum of 158 flood projects funded by the budget, with 70 new and 88 ongoing.[13] Of these sample projects identified across ministries, many have budgets of less than NGN 21 million (**Figure 13**).

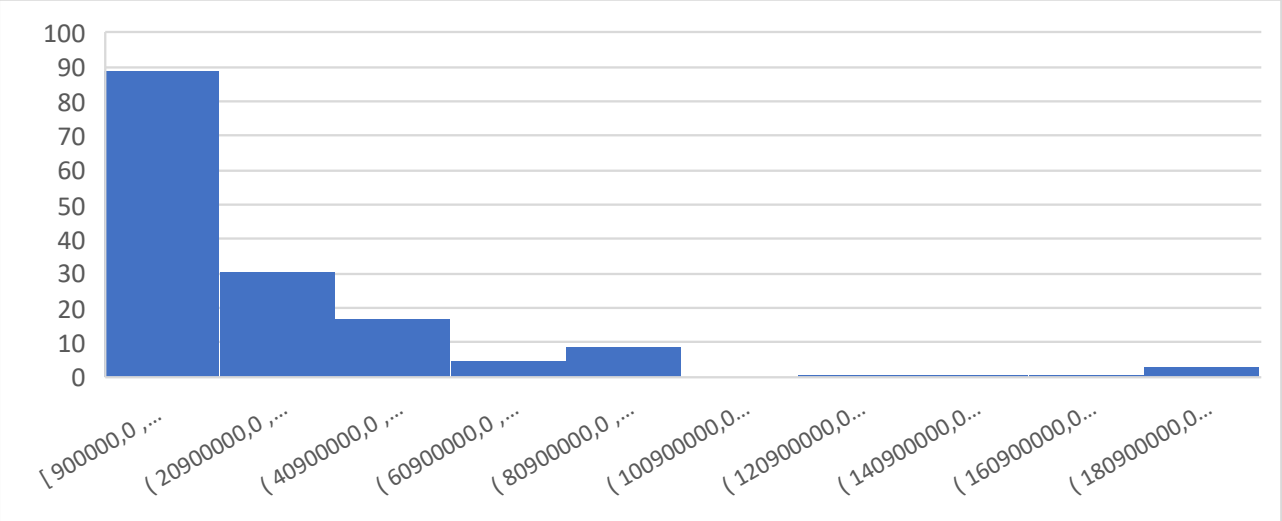


Figure 13: Budget distribution of identified projects (Source: Author calculated from PDF lists from the Budget Office.)

Note: An outlier for one project under the Ministry of Education for NGN 377 million was dropped to avoid distorting the histogram.

13 The team searched the budget files for projects with the term 'flood'. The published budget is in the form of scanned documents and owing to potential software constraints, we posit the number of projects to be a minimum. A proper scan of the original table files will be necessary to count all projects within the budget.

While many projects are for typical structural solutions, there are some non-structural projects listed. For example, there are some ongoing budgeted projects under NIHSA such as the outdoor flood alert (siren) system for NGN 12 million and the flood vulnerability/hydrogeology mapping for NGN 80 million. New items in the NIHSA budget are notable, such as an allocation for an EU-assisted flood forecasting and early warning system, for around NGN 4.9 million, and a needs assessment for institutional strengthening for flood and drought mitigation, for NGN 7.2 million.

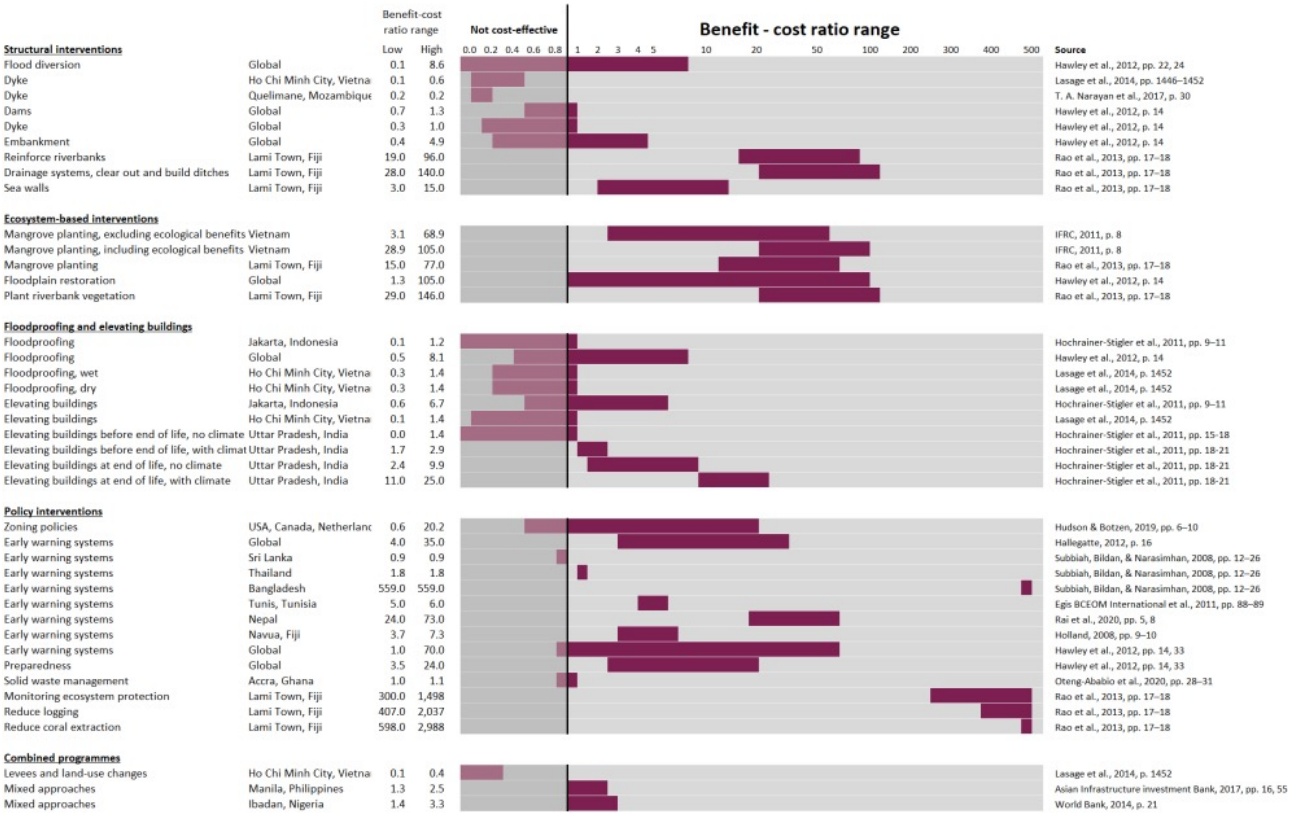
5.2 FCDO and DFID recent expenditure in Nigeria

It is understood that the FCDO and DFID have had limited investment in urban flood risk management issues in Nigeria in the recent past.

5.3 Assessing the benefits and costs of flood risk management activities

The benefit-cost ratio (BCR) for any particular action, from investment in capacity building to structural measures, will vary with the context in which they are developed and delivered. The political, economic and social dynamics, as well as the specific design and implementation of the programme, will all influence outcomes and the BCRs achieved.

The study commissioned by FCDO in 2020 (Lucas, 2020) to review evidence for the benefits and costs typically achieved reflects this, with BCRs ranging significantly for notionally similar intervention types (**Figure 14**). However, broad conclusions may be drawn that reinforce generally accepted positions. For example, Lucas shows that conventional structural interventions to address flood risk are generally more costly and offer lower BCRs than more innovative and non-structural measures. For example, ecosystem-based interventions (e.g. nature-based solutions), early-warning systems (EWS), and regulations on land use were generally found to be highly cost effective (when allied with ongoing enforcement). Building upon this work, the following paragraphs explore the benefit-cost ratios for EWS, community-level engagements, and national policy plans further. Just to highlight, the BCRs discussed are in the context of the current climate and are expected to increase, in view of climate change. These findings underpin the assessment of costs and benefits presented later.



		Low	High	Source
Structural interventions				
Flood diversion	Global	0.1	8.6	Hawley et al., 2012, pp. 22, 24
Dyke	Ho Chi Minh City, Vietna	0.1	0.6	Lasage et al., 2014, pp. 1446–1452
Dyke	Quelimane, Mozambique	0.2	0.2	T. A. Narayan et al., 2017, p. 30
Dams	Global	0.7	1.3	Hawley et al., 2012, p. 14
Dyke	Global	0.3	1.0	Hawley et al., 2012, p. 14
Embankment	Global	0.4	4.9	Hawley et al., 2012, p. 14
Reinforce riverbanks	Lami Town, Fiji	19.0	96.0	Rao et al., 2013, pp. 17–18
Drainage systems, clear out and build ditches	Lami Town, Fiji	28.0	140.0	Rao et al., 2013, pp. 17–18
Sea walls	Lami Town, Fiji	3.0	15.0	Rao et al., 2013, pp. 17–18
Ecosystem-based interventions				
Mangrove planting, excluding ecological benefits	Vietnam	3.1	68.9	IFRC, 2011, p. 8
Mangrove planting, including ecological benefits	Vietnam	28.9	105.0	IFRC, 2011, p. 8
Mangrove planting	Lami Town, Fiji	15.0	77.0	Rao et al., 2013, pp. 17–18
Floodplain restoration	Global	1.3	105.0	Hawley et al., 2012, p. 14
Plant riverbank vegetation	Lami Town, Fiji	29.0	146.0	Rao et al., 2013, pp. 17–18
Floodproofing and elevating buildings				
Floodproofing	Jakarta, Indonesia	0.1	1.2	Hochrainer-Stigler et al., 2011, pp. 9–11
Floodproofing	Global	0.5	8.1	Hawley et al., 2012, p. 14
Floodproofing, wet	Ho Chi Minh City, Vietna	0.3	1.4	Lasage et al., 2014, p. 1452
Floodproofing, dry	Ho Chi Minh City, Vietna	0.3	1.4	Lasage et al., 2014, p. 1452
Elevating buildings	Jakarta, Indonesia	0.6	6.7	Hochrainer-Stigler et al., 2011, pp. 9–11
Elevating buildings	Ho Chi Minh City, Vietna	0.1	1.4	Lasage et al., 2014, p. 1452
Elevating buildings before end of life, no climate	Uttar Pradesh, India	0.0	1.4	Hochrainer-Stigler et al., 2011, pp. 15-18
Elevating buildings before end of life, with climat	Uttar Pradesh, India	1.7	2.9	Hochrainer-Stigler et al., 2011, pp. 18-21
Elevating buildings at end of life, no climate	Uttar Pradesh, India	2.4	9.9	Hochrainer-Stigler et al., 2011, pp. 18-21
Elevating buildings at end of life, with climate	Uttar Pradesh, India	11.0	25.0	Hochrainer-Stigler et al., 2011, pp. 18-21
Policy interventions				
Zoning policies	USA, Canada, Netherlanc	0.6	20.2	Hudson & Botzen, 2019, pp. 6–10
Early warning systems	Global	4.0	35.0	Hallegatte, 2012, p. 16
Early warning systems	Sri Lanka	0.9	0.9	Subbiah, Bildan, & Narasimhan, 2008, pp. 12–26
Early warning systems	Thailand	1.8	1.8	Subbiah, Bildan, & Narasimhan, 2008, pp. 12–26
Early warning systems	Bangladesh	559.0	559.0	Subbiah, Bildan, & Narasimhan, 2008, pp. 12–26
Early warning systems	Tunis, Tunisia	5.0	6.0	Egis BCEOM International et al., 2011, pp. 88–89
Early warning systems	Nepal	24.0	73.0	Rai et al., 2020, pp. 5, 8
Early warning systems	Navua, Fiji	3.7	7.3	Holland, 2008, pp. 9–10
Early warning systems	Global	1.0	70.0	Hawley et al., 2012, pp. 14, 33
Preparedness	Global	3.5	24.0	Hawley et al., 2012, pp. 14, 33
Solid waste management	Accra, Ghana	1.0	1.1	Oteng-Ababio et al., 2020, pp. 28–31
Monitoring ecosystem protection	Lami Town, Fiji	300.0	1,498	Rao et al., 2013, pp. 17–18
Reduce logging	Lami Town, Fiji	407.0	2,037	Rao et al., 2013, pp. 17–18
Reduce coral extraction	Lami Town, Fiji	598.0	2,988	Rao et al., 2013, pp. 17–18
Combined programmes				
Levees and land-use changes	Ho Chi Minh City, Vietna	0.1	0.4	Lasage et al., 2014, p. 1452
Mixed approaches	Manila, Philippines	1.3	2.5	Asian Infrastructure investment Bank, 2017, pp. 16, 55
Mixed approaches	Ibadan, Nigeria	1.4	3.3	World Bank, 2014, p. 21

Figure 14: Benefit-cost ratios discussed in Lucas (2020) (Source: Lucas (2020))

5.3.1 National policy and planning capacity

Effectiveness

The impact of policy and planning on risk reduction is difficult to determine directly. Effectiveness will vary according to the type of policy and other factors such as implementation capacity and enforcement. In the literature, policies can include regulations for land-use, zoning or spatial planning. In a coastal area in Belgium, Koks et al. (2014) estimate land-use zoning can offset 15–20% of future flood risk owing to land-use change. For Indonesia, Januriyadi et al. (2020) find measures such as managing land-use zone can reduce flood risk magnitude by 29%. These echo similar findings by the UK Climate Change Risk Assessment flood projections that highly spatial planning is a central consideration in managing future risk (Sayers et al, 2015). Effectiveness in terms of managing present day (i.e. the existing adaptation deficit) is lower and difficult to quantify without detailed context-specific analysis. Given this, we conservatively estimate a reduction in damage of 5% of present-day risks, recognising that capacity in national policy and planning can have a much greater influence on minimising future increases in risk.

Summary assumption: Investment in national policy and planning has the potential to reduce expected annual damage by 5%.

Efficiency

While BCRs for regulatory changes, technical assistance to national policymakers, and capacity building at the government level are sparse in the literature, there have been some estimates for regulations of land use and some national policies. A review by Hudson and Botzen (2019) assesses the benefits and costs of flood risk zoning (i.e. development control) regulations. After an extensive search in the literature, they find BCRs that range from 61:100 in a study that omitted environmental benefits, to a maximum of 2020:100. Developing capacity around planning policy (for developing basin plans, building regulations, grant marking, etc.) is difficult, but is generally considered to offer high value for money.

Analysis by the FCDO more broadly on adaptation 'best buys' also recognises the highly context-specific returns on investment, but reinforces that investments in disaster risk reduction for floods is a 'great' best buy, with strong evidence for very high cost-effectiveness based on international reviews (e.g. Shreve & Kelman, 2014; Mechler, 2016; GCA, 2019), with BCRs that were >5:1 across all areas, including structural measures that are likely to bring down the overall average.

Summary assumption: Given the above, it is assumed here that investment in national capacity (if well-structured and targeted) has an opportunity to provide an economic return on investment of around 20 to 1.

5.3.2 State, city and community capacity and engagement

Effectiveness

The impact of policy and planning on risk reduction is difficult to determine directly. In general, the ability to reduce risk is more tangible and the opportunities are greater. The effectiveness of engagements at the community level can be seen in the results of programmes such as the Community Rating System (CRS) in the United States. The programme incentivises communities to engage in flood mitigation measures to receive discounts in flood insurance premiums. Kousky and Michel-Kerjan (2017) find that insurance claims from class 8 and 9 communities (or communities that just make the cut to qualify for discounts in the CRS) are 13.5% lower than those from non-participating communities. They posit that even minimal effort to be part of the CRS can lead to lower insurance claims.

Summary assumption: Investment in state, city and community has the potential to reduce expected annual damage by 10%.

Efficiency

Community-level engagements vary in scope and return, with many (not all) being localised efforts that are relatively inexpensive to pursue. For example, an interview with a development partner who conducted a community-level capacity building project[14] revealed that it cost only the equivalent of EUR 10,000 to implement. Despite the low costs, returns can be significant with high BCRs.

Determining the benefits and costs is difficult, however, as community engagements are often difficult to separate from the structural and non-structural interventions that may be part of the same multiple-component project or initiative. The 2012 IFRC Community-Based Disaster Risk Reduction (CBDRR) case study in Bangladesh suggests that the BCRs of a programme of measures across four communities was likely to achieve a BCR of up to ~5:1 (a BCR likely to be depressed by the inclusion of various allied structural measures). More recently, a study by Yaron and Wilson (2020) reviewed the return on investment in community-level interventions to build flood resilience in Myanmar (projects by the DFID-funded BRACED programme). The study found BCRs varied between 107:100 and 1089:100, with the highest returns associated with community-planned, small-scale infrastructure resulting from a collaborative planning process involving both communities and local governments.

Summary assumption: It is assumed that developing local capacity (at state, city or community level) offers a potential economic return of around 10 to 1.

5.3.3 Early Warning Systems (EWS)

Effectiveness

The effectiveness of EWS varies in its ability to reduce risk. Following the 2012 IFRC case study in Bangladesh mentioned above, the flood early warning system was cited by community members as beneficial. In total, 83% of respondents reported shifting assets to safer places before the floods, which helped to reduce losses.

This is, of course, site-specific. Day (1970) continues to be used to relate lead time to percent damage reduction. According to Day's curve, the maximum practical reduction

14 The project was to develop a participatory risk reduction and management blueprint for the local government. It was developed through a series of focus group discussions conducted with multiple stakeholders that represented grassroots and communities, the private sector, local councillors, legal experts, government officials and legislators, NGOs, etc.

in damages is 35% with more than 48 hours of warning time. But this is generally accepted as too optimistic. Reviews by Pappenberger et al. (2015) suggest between 4% and 40%; Scotland & Northern Ireland Forum for Environmental Research (2009) suggest 7.3% and Penning-Rowsell et al. (2014) suggest 4.5% to 6%. Here, it is assumed to be 15% for those living in the 1 in 25-year flood plain (and likely to be more able to respond), dropping to 5% in the 1 in 100-year floodplain.

Summary assumption: Investment in non-structural approaches has the potential to reduce damages in more frequent flood events (<1 in 25 years) by 25% and in less frequent events (up to 1 in 100 years) by 5%. Damages in very rare events are not considered an impact.

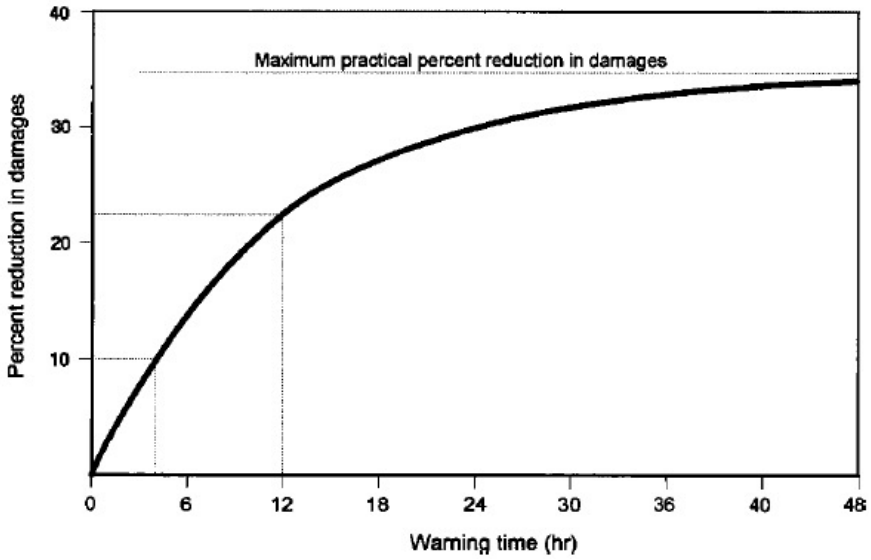


Figure 15: Day's curve which relates reduction in damages to warning time (Carsell et al. (2004))

Efficiency

Timely and actionable forecasts and warnings play a significant role in reducing risk and enhancing resilience. EWS gives people time to prepare for imminent threats, for example, adding flood-proofing measures to homes, moving property to safer locations and so on. EWS leads to benefits in the form of avoided damages and costs, in the form of investments in equipment, improving forecast capacity and accuracy, communication tools to disseminate information, and capacity building for communities. Climate change may influence the type of storm events, their frequency, and how they impact communities. Ensuring the EWS are themselves capable of capturing the changing structures of future events (for example, the increase in intense storms) will be an important consideration.

The FCDO works on adaptation 'best buys' and also recognises the high return EWS provides. Sometimes the opportunity is significant, particularly in locations where structural measures are limited or poorly suited to managing the type of flood hazard. For example, a technology-based EWS project in Laguna, Philippines, recorded a BCR of 33:1 (Arias et al, 2015) in Sri Lanka, Thailand and Bangladesh for early warning systems. The BCR was assessed to be 93:100, 176:1, and 558:1, respectively (Subbiah, Bildan & Narasimhan, 2008). Sri Lanka was noted to have a low BCR owing to the infrequency of floods, reinforcing the general observation from the UK (Sayers et al, 2015) that forecasting and warning are most effective in reducing damage in locations that experience frequent storms. A case study for EWS set up in Navua, Fiji, found that it would cost the government less than FJD 0.6 million for less than the 20-year lifespan of the system for a BCR between 37:10 to 73:10. Hallegatte (2012) takes a more global approach and analyses the benefits of upgrading the hydrometeorological information production and EWS capacity of developing countries to developed country standards, finding BCRs between 4 and 35 with co-benefits.

Summary assumption: It is assumed that EWS typically (if well-designed) achieves an economic return of around 15 to 1.

5.3.4 Nature-based solutions (NBS)

There are multiple definitions of NBS, but they are generally understood as the purposeful management of natural infrastructure in a way that delivers multiple benefits for people and nature. These multiple benefits often include the management of environmental resources, such as water or soil and restoration of biodiversity, which normally involves restoration of natural ecosystem structure and function. Acreman et al. (2021) demonstrate that landscape-scale natural infrastructure such as forests and functional floodplains play a key role in determining downstream water resources (quality and quantity) and flood management, particularly supporting a reduction in risk associated with more frequent floods (but less likely to reduce the most extreme floods). The benefits and costs are difficult to determine, with many emerging programmes and few longstanding monitored activities. It is, however, widely acknowledged that the multiple opportunities they provide are significant. As part of the recent UKCCRA3 flood projections, at a national scale, the return was estimated to be 1 in 10 and 1 in 20. Although Nigeria was not included in the projections, analysis of opportunity for NBS across Africa by WWF suggests similar or higher returns (Sayers et al, in press).

Given the high-level nature of the analysis here it is assumed that NBS approaches offer similar performance to the early warning systems as part of a non-structural portfolio of measures. Future downstream studies should consider this further, and could particularly examine approaches to developing bankable projects, recognising that the real benefit of NBS approaches lies in the multiple benefits they provide rather than only flood reduction benefits, which is the focus here.

5.3.5 Conventional structural measures

Effectiveness

Well-designed structural measures can significantly reduce the risk to the areas they are designed to protect. It is assumed here that any structural measure is designed to provide a 1 in 100-year standard of protection. It is also assumed that flood management activities are implemented in a good-practice progression, focusing first on community and non-structural measures, and designing structural measures to address the residual risks. This implies that structural measures are effective in reducing the residual risk associated with the 1 in 100-year flood hazard (or more frequent), after accounting for these other activities (as set out in the section above).

Summary assumption: Structural measures can be highly effective, and it is assumed here that all residual risk (after accounting for non-structural measures) is addressed up to the 1 in 100-year return period flood.

Efficiency

Structural solutions are expensive to pursue. To illustrate, the World Bank's 'Integrated Flood Risk Management and Drainage Masterplan for Ibadan City' summarises the costs of all the proposed drainage elements in channelisation works, structures (culverts/bridges) and dams at a projected cost of USD 1557.8 million or NGN 475.1 billion (**Table 8**). Unfortunately, readily accessible information is not given on the anticipated benefits.

Table 8: Cost estimates of all proposed drainage elements (Masterplan) (Source: World Bank (2019), see Table 1.15.)

	Length (KM)/No.	Cost (MUSD)	Cost (BNaira)
Channels	418.1	381.1	116.2
Culverts	1336	88.3	26.9
Bridges	61	90.5	27.6
Dams	4	997.9	304.4
Total		**1557.8**	**475.1**

Lucas (2020) notes that structural measures such as dikes or engineered defences are only economically feasible if they are protecting significant assets. Lucas confirms that readily transferrable BCRs are difficult to find in the literature but does report BCRs from five studies on flood diversion ranging between 6:100 and 855:100. The BCRs for dams, dikes, levees and embankments range between 29:100 and 490:100 (Lucas, 2020; Hawley, Moench & Sabbag, 2012). Again, the wide range reflects the context but also the detail of the design and implementation.

The cost of structural measures is highly context specific. To provide recognition of this, the length of the river channel and coastline is used to differentiate the cost in different locations. For example, those local authorities with the most complex river networks (determined by length – see Section 2) are assumed to have higher costs per unit of risk reduced, and those with the least complex (determined by length) cost less.

Summary assumption: Investment in structural measures is assumed to offer an economic rate of return of between 2 to 1 (in complex urban settings, defined here as those in the top 50 percentile by river and coastal length) and 10 to 1 elsewhere. The presence of a coastline is also assumed to increase the cost per unit of risk reduced by 50% (given that coastal defences are typically more costly than equivalent fluvial defences).

5.4 Strategic FCDO support options

Several options are available to the FCDO for investing in urban flood risk management and to enhance urban flood resilience in Nigeria. These are organised into seven overarching options that reflect the gaps and opportunities discussed by stakeholders, and a standard counterfactual 'do nothing' and a do minimum 'reactive' option. The assessment of the benefits and costs bring together the assessment of the expected annual damages from Section 2 with the effectiveness and efficiency associated with each option from the evidence presented in Section 4. This process is illustrated in **Figure 16**.

A spreadsheet with the associated 'by option' and 'by state' results is provided alongside the report.

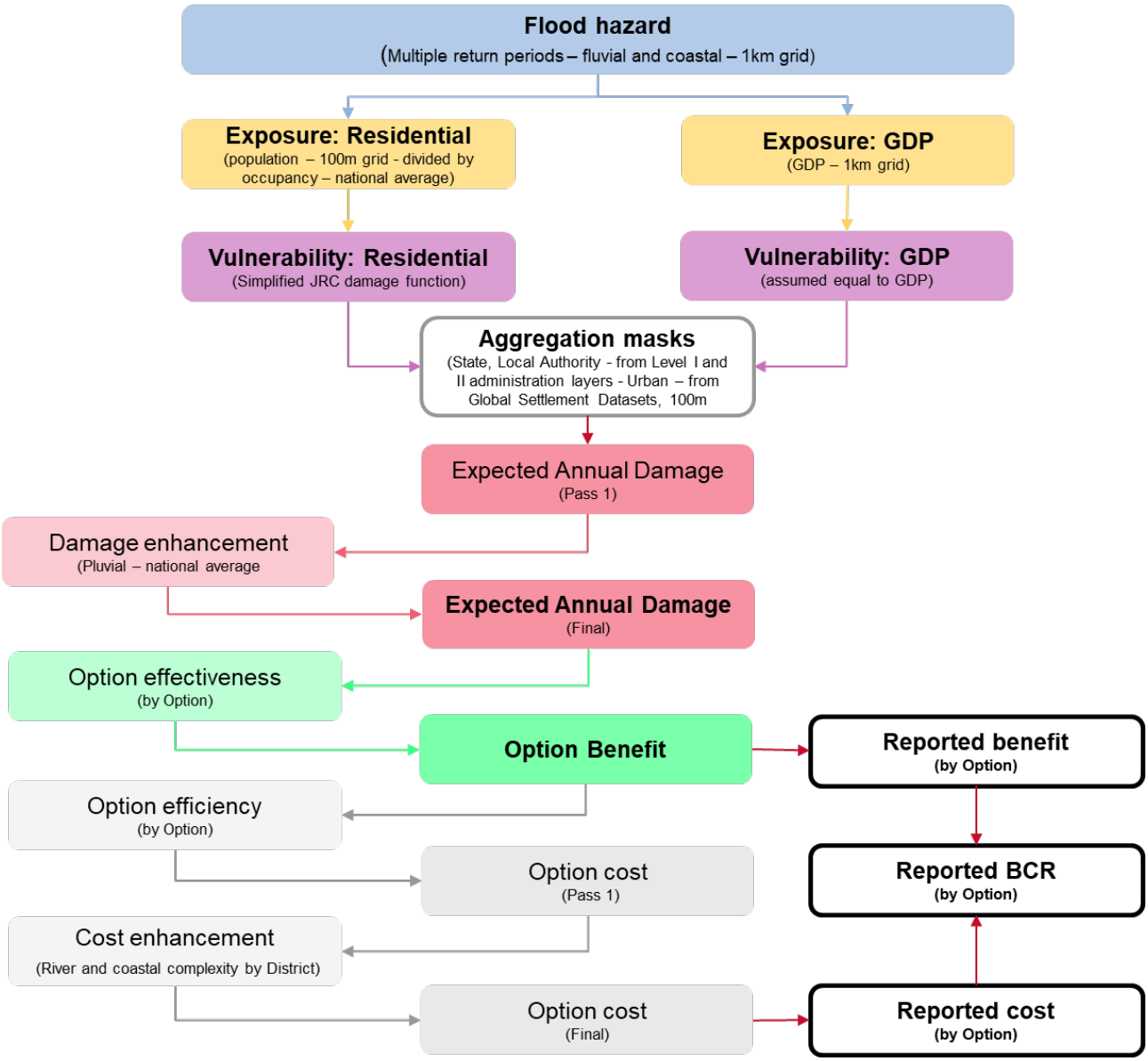


Figure 16: Overview of the option assessment process

Option 1 Do nothing (no investment)

The FCDO UK **does not invest** in urban flood risk management. In this case, UK expertise does not include future flood risk in Nigeria, with opportunities missed to both enhance capacity in Nigeria and showcase UK expertise.

Investment need: n/a

Option 2 Opportunistic and reactive support

The FCDO **reacts to opportunities as they arise**, joining projects led by others on an ad hoc, project-by-project basis.

Investment need: Not set.

Note: The FCDO spending allocation process means agile investment is unlikely to be possible, as programme spend needs approving and then allocating in advance.

Option 3 Focus on national capacity

The FCDO UK focuses on **policy and strategic planning**, working to address urban flood policy inconsistencies, provide technical assistance to upgrade and update planning policies, incorporate more vulnerable groups in the planning process, engage policymakers and stakeholders, and embark on a systems approach to flood risk management. This would involve improving inter-agency coordination and engaging in capacity building for carrying out and enforcing policies. The UK has significant skills in the underlying analysis (climate change – one of the first countries to establish a cycle of climate risk assessment and earth observation – through significant investment in the UK Space Agency programme, including many in Africa), planning (strategic coastal zone and river basin planning etc. – one of the first countries to establish process-based shoreline management and catchment management planning frameworks) and policy development (including pro-poor decision approaches through past DFID programmes and ongoing programmes such as BRACED).

Investment need: Low (<£1m) to moderate (<£10m). The level of investment needed to make a significant contribution to national capacity is limited. The most significant challenge will be to design the activity that influences policy and its implementation in practice. This requires close working with national stakeholders to co-design the activities.

Option 4 Focus on state, city, and community capacity

The FCDO focuses on supporting **urban planning and community action.** Engage in practical and strategic activities to update and incorporate modern concepts in spatial planning, and provide technical assistance and capacity building to improve city planning capabilities (planning, zoning, building regulations to manage climate and flood risk). This could include, for example, community engagement in debris management (to reduce the chance of blockage), low-cost monitoring systems, good channel management practice and surface water drainage (appropriate for informal settings). Access to data

and the use of appropriate analytics to improve target expenditure also feature under this option of capacity building. Other possibilities: Supporting asset management good practice around data and data management systems, maintenance, scheduling and monitoring (informal and remote sensed approaches) of flood defence embankments, channel, pumps, culvert etc; and developing the evidence for and developing pilot NBS programmes in urban areas, with local communities.

Investment need: Low (<£1m) to high (<£30m). The level of investment needed to make a meaningful contribution on the ground is likely to be significant, involving detailed working and support for pilot projects in selected high-risk states. A lower level of ambition would seek to support capacity through, for example, the development of good practice and consistent flood management policies and guidance documents.

Option 5 Focus on forecasting and early warning capabilities

The FCDO invests in developing **forecasting and early warning systems and associated capacity** (e.g. impact-based forecasting, warning and response systems for formal and informal settings). This includes capacity building for communities in flood risk zones and flood warning awareness (training community leaders, public awareness campaigns, drills, etc.). The World Bank is working on a pilot with Ibadan, and Nigeria state ministries are seeking to develop community programmes in Lagos. Multiple opportunities exist across all other states or at the federal level, and there are opportunities to work with and contribute to many projects; for example, the DARAJA project.

***Investment need*:** Moderate (<£10m) to very high (<£100m). The level of investment needed to develop the telemetry, forecasting tools and implementation of effective action-based warning systems is significant and particularly challenging for intense rainfall events with short lead times. This means that making a meaningful contribution to on-the-ground implementation of new forecasting and warning capability would require ongoing significant collaboration with the Nigerian Meteorological Agency. These activities could be prioritised according to the high-risk states. A lower level of ambition would seek to support capacity through, for example, a detailed review of forecasting and warning capabilities – the gaps and the required actions, through to guidance on forecasting and warnings illustrated through pilot studies.

Option 6 Focus on structural measures

The FCDO invests in engineered structural measures to reduce urban flood risk; in particular, investment in surface water drainage (in informal and formal settings), river embankments, dam improvements/removal, flood resilience urban infrastructure (energy, water, communications, transport, bridge upgrades, culvert upgrades) channel management programmes, etc.

***Investment need*:** Low (£1m) to extremely high (>£100m). The level of investment needed to develop new urban drainage infrastructure, dams, levees, etc. is significant and unlikely to be of direct interest to the FCDO as such activities are typically supported by development banks. Providing primary support is therefore unlikely, but developing capacity in improving the environmental, social and climate resilience of the infrastructure choices (through guidance, advisory activities and workshops, etc.) does provide an opportunity to secure long-term outcomes for Nigeria. This latter focus could be achieved with more modest investments.

Option 7 Focus on promoting innovation

The FCDO focuses on developing new financial instruments (working with private-sector insurers on innovative insurance mechanisms), financing (marshalling multiple donor projects, payment of services and asset management approaches), adaptation planning approaches, use of earth observations, and whole system (coastal and river, city) approaches that use nature-based solutions to deliver triple win outcomes for people, nature, and the economy. These could all form the basis of innovative pilots or collaborative research and development. In urban settings, focusing on low-cost sustainable urban drainage (SUDS) and retrofitting green spaces and resilience into informal urban developments have all been raised as challenges during the study that was supported through innovation funds.

***Investment need*:** Low (£1m) to moderate (<£10m).

5.5 Options appraisal: Multi-criteria considerations

Multi-criteria considerations are used to help assess the options set out in the previous section, namely:

Effectiveness and efficiency: The typical efficiency (benefit-cost ratios, or BCRs) and effectiveness for each type of investment set out in the previous section are used to determine a spatially disaggregated BCR at the state level. It is assumed that the calculated expected annual damage (EAD – see Section 2) is reduced according to the effectiveness of the option being considered (referred to here as the expected annual benefit – EAB). The EAD before and after the measure is then used to determine the benefit. Given the focus here on urban settings, only the risk in urban areas is used. The benefit is then translated to a cost using the assumed efficiency. The expected annual benefit is assessed for the conditions today – the people, GDP and climate. Under conditions of change, including climate change, potential benefits of flood resilience development are likely to increase. Hence the estimate here, although reasonable in the short term, are likely to understate the long-term benefits.

For some measures, the complexity of the physical flooding context will influence the cost of taking action. For example, for structural measures, a greater cost is assigned to those states with a coastal frontage (reflecting the relatively higher cost associated with coastal structures compared to fluvial defences) and to those states with the most complex river networks (determined by length).

Equity: Considers the pro-poor/socially vulnerable outcomes or distributional benefits, i.e. whether interventions are pro-poor. A score of 5 (*targets the most socially vulnerable explicitly*) to 1 *(likely to increase the risk for the most vulnerable)* was assigned.

Long-term outcomes: Considers the ability of the option to address long-term adaptive capacity and deliver a range of outcomes robustly over the long term, including: economic, i.e. physical damage to buildings, infrastructure, and assets, crop/livestock damage and losses (using the global damage functions, tailored to Africa), production losses in manufacturing and industry, and high-level losses from traffic disruption, people, in casualties, humanitarian and emergency response costs, health and medical costs; and *environmental*, i.e. degradation of habitats and cost of loss of functional floodplains. Assessed qualitatively. A score of 5 *(very strong multiple long-term outcomes)* to 1 *(none or few multiple outcomes and unlikely to be sustained)* was assigned.

Feasibility: Considers how likely it is that an option will achieve the benefits anticipated in a way that is attributable to the FCDO. A score of 5 *(highly likely to succeed)* to 1 *(highly unlikely to succeed)* was assigned.

Opportunity for the UK: Considers the ability of the option to harness or develop UK competitiveness in supporting Nigeria to enhance urban resilience. A score of 5 *(UK's comparative advantage is very strong)* to 1 *(UK's comparative advantage is very weak)* was assigned.

Overall assessment: Assessed qualitatively. A score of 5 *(very high)* to 1 *(very low)* was assigned.

Table 9 presents the scores for each option, with a short supporting rationale.

Table 9: Options appraisal – summary of MCA

Option 1 Do nothing (no investment)		
Level of investment	n/a	**n/a**
Effectiveness and Efficiency	Benefits: n/a Cost: n/a Benefit to cost ratio: n/a	**n/a**
Equity (Pro-poor outcomes)	Urban flood risks increase, particularly through informal development impacting the most vulnerable.	**1**

Long term outcomes	No outcomes supported – Nigeria is not supported in making well-adapted choices to manage urban flood risk.	**1**
Feasibility	Not applicable.	**n/a**
Opportunity for UK		**5**
Overall assessment	**Not applicable.**	**n/a**

Option 2 Opportunistic and reactive support		
Level of investment	Agile	**n/a**
Effectiveness and Efficiency	Benefits: n/a Cost: n/a Benefit to cost ratio: n/a	**n/a**
Equity (Pro-poor outcomes)	Humanitarian aid provides support to the most vulnerable during shocks. There are already a few initiatives by other stakeholders (World Bank in Ibadan, etc.) but FCDO would be reactive, offering little proactive support to enhance long-term outcomes for those most in need.	**1**
Long term outcomes	Humanitarian aid does not address the underlying drivers of flood risks in urban areas. Little progress is made on supporting Nigeria to adapt to cope better with future floods.	**1**
Feasibility	Not applicable.	**n/a**
Opportunity for UK	Ad hoc.	**5**
Overall assessment	**Not applicable.**	**n/a**

Option 3 Focus on national capacity		
Level of investment	Low (<£1m) to moderate (<£10m)	**3**
Effectiveness and Efficiency	In-year benefits (across Nigeria): £1.5bn In-year cost (across Nigeria): ~£50–100m Benefit to cost ratio: ~20	**4**
Equity (Pro-poor outcomes)	Targeted policies expand the effective use of resources and can better reach vulnerable groups. Relies upon translation to implementation to achieve outcomes. Whether or not allied to communities and state activities is a central consideration.	**3**

Long term outcomes	Updated and inclusive policies can address long-term and underlying drivers. Support for institutional strengthening and improvements in inter-agency coordination can make government efforts more efficient and effective.	**3**
Feasibility	Moderate to high. FCDO is well placed to build upon and develop strong collaborative engagement with relevant ministries as a flood risk management partner for the long term.	**5**
Opportunity for UK	High. The UK is leader in climate risk assessment and resilience (e.g., two of the four World Bank framework providers for urban flood risk are from the UK in recognition of this expertise).	**5**
Overall assessment	**High**	**5**

Option 4 Focus on state, city, and community capacity		
Level of investment	Low (<£1m) to high (<£30m)	**4**
Effectiveness and Efficiency	In-year benefits (across Nigeria): ~£3bn In-year cost (across Nigeria): ~£300m Benefit to cost ratio: ~10	**3**
Equity (Pro-poor outcomes)	Enables local context; informal and the most socially vulnerable to be included in the local context.	**3**
Long term outcomes	Improved urban development planning can address some underlying drivers of flood risk (prevent negative impacts of unorganised urbanisation) and help communities adapt to and mitigate climate change and flood risk. When communities are engaged in the planning process, this approach can benefit long-term ability to control and enforce related policies.	**4**
Feasibility	High. Benefits will depend on the ability to engage and work with the right partners.	**4**
Opportunity for UK	High. Involves city planning and developing innovation in urban flood risk management, with the UK recognised as taking a leading role in major urban initiatives such as the Blue-Green Dream, alongside urban resilience centres of excellence in our leading universities. Urban planning and design are also areas of strength for UK consultancies.	**4**
Overall assessment	**High. Has opportunities to maximise returns by focusing on high-risk states and communities.**	**4**

Option 5 Focus on non-structural capabilities		
Level of investment	Moderate (<£10m) to very high (<£100m)	**3**
Effectiveness and Efficiency	In-year benefits (across Nigeria): £6.9bn In-year cost (across Nigeria): £450m Benefit to cost ratio: ~15	**5**
Equity (Pro-poor outcomes)	Good forecasting and early warning are central to any good flood strategy and, if well configured and developed in partnership with local communities, can effectively respond to flood risk and reduce the risk of damage and losses. Disability, language, age, and other social factors need to be considered to ensure all benefits.	**3**
Long term outcomes	Capacity building and improving flood risk awareness at the community level can help target groups to plan for the long term and make behavioural changes. Improvements in forecasting capacity can help government warning systems and response.	**5**
Feasibility	High. Although telemetry, radar and hardware are capital intensive, FCDO opportunities are likely to lie in analytics and implementation.	**4**
Opportunity for UK	High	**4**
Overall assessment	**High**	**4**

Option 6 Focus on structural measures		
Level of investment	Low (£1m) to extremely high (>£100m)	1
Effectiveness and Efficiency	In-year benefits (across Nigeria): £28bn In-year cost: £6.9m Benefit to cost ratio: ~4 to 5	1
Equity (Pro-poor outcomes)	Protection if appropriately designed and prioritised, taking account of the community – particularly where NBS approaches are used alongside conventional infrastructure to deliver multiple outcomes.	3
Long term outcomes	High, assuming climate change and adaptive capacity is embedded in the infrastructure designs.	1
Feasibility	Likely to require significant capital commitments. Low	1

Opportunity for the UK	UK contractors have an excellent global track record, but in recent years, few feature as the largest international contractors. Many leading engineering consultancy, construction and civil works firms are found in the UK, and many will be interested in exploiting opportunities in Nigeria. The competition for construction contracts is likely to be significant with greater opportunities associated with supporting consultancy and construction management.	1
Overall assessment	**Low**	**1**

Option 7 Focus on promoting innovation		
Level of investment	Low (£1m) to moderate (<£10m).	5
Effectiveness and Efficiency	In-year benefits: n/a In-year cost: n/a Benefit to cost ratio: 1.6 (return estimate)	1
Equity (Pro-poor outcomes)	High potential through reconfigured insurance (for example) or pilots in informal developments, data management and use, etc.	3
Long term outcomes	High potential	5
Feasibility	High	5
Opportunity for UK	UK comparative advantage is high. EO, analytics, strategic planning and policy innovation are all areas of expertise.	5
Overall assessment	**High**	**4**

5.6 Preferred options

5.6.1 What to focus on

A summary of the high-level multi-criteria assessment is given in **Table 10**. This suggests that several connected areas of activity offer significant value, including the development of national policy and planning capacity supported by activities at the state, city and community level, and investment in non-structural options (forecasting and warning and associated innovations). Developing innovative approaches to flood management (around nature-based approaches) and financing mechanisms to support more strategic planning are also areas that offer significant opportunity. The investment needed to support structural interventions is likely to be significant and other donors are well placed to service this need.

Table 10: Summary of the options appraisal (preferred options in bold)

	Option 1	Option 2	**Option 3**	**Option 4**	**Option 5**	Option 6	**Option 7**
Level of investment	n/a	n/a	**3**	**4**	**3**	1	**5**
Effectiveness and Efficiency	n/a	n/a	**4**	**3**	**5**	1	**1**
Equity (Pro-poor outcomes)	1	1	**3**	**3**	**3**	3	**3**
Long term outcomes	1	1	**3**	**4**	**5**	1	**5**
Feasibility	n/a	n/a	**5**	**4**	**4**	1	**5**
Opportunity for UK	5	5	**5**	**4**	**4**	1	**5**
Overall Assessment	n/a	n/a	**5**	**4**	**4**	1	**4**

All the preferred options in bold in **Table 10** include various possible activities that represent opportunities for FCDO investment across a wide range of budgets – low (<£1m) to moderate (<£10m) – without undermining the return achieved. Each of these options was supported by stakeholder consultations, and all four are expected to be in line with Nigeria's climate adaptation goals. To cite a few examples:

Option 3: Supporting national capacity

Supporting national capacity was mentioned by stakeholders as part of the gap in the current flood risk response, noting the need to develop a better national FRM strategy. Stakeholders also suggested developing a more integrated systems approach to dealing with floods, addressing the disconnect and lack of coherent response to the issue. In addition, support at the national level would also need to consider the country's NDCs and other climate commitments, ensuring that the country's policies are in line with adaptation goals and are not carbon intensive. The National Adaptation Plan will require the collaborative efforts of ministries, departments and agencies to reduce overlap of adaptation programmes and projects.

Depending upon the chosen focus, Option 3 provides an opportunity to scale the level of investment without losing impact. Assuming a project is well structured (i.e. has a meaningful and achievable capacity-building goal), the scale of ambition can be readily scaled according to available funds. This could include, for example:

- *Low-cost activities (<£1m): Providing technical assistance to embed climate resilience, and in particular flood resilience, across national policy to support Nigeria to develop a strategic understanding of flood risk in the short and longer term, and exploring scenarios of investment that will be needed to manage urban flood risks successfully.*

- *Moderate- to higher-cost activities (£1–10m or more): Supporting national data and mapping capacity could also be a focus – helping with (or directly supporting) risk mapping and developing flood risk indicators across Nigeria, and working on improving coordination across federal agencies and state governments.*

Option 4: Supporting states, cities and communities

Enhancing state, city, and community level capacity can provide significant returns across a wide spectrum of activities and investment levels. Activities could include offering guidance on how to manage debris, establishing good channel management practices, and supporting structural projects such as flood defence asset management and monitoring systems. Opportunities of leveraging the return on investment could be generated through collective action, such as facilitating and supporting peer-to-peer learning across multiple states and cities, through to working with multiple communities with similar issues.

Stakeholders highlighted the importance of state-level actors in dealing with flood risk, and focusing on actions that enhance the capacity of a state-level central mechanism for reducing flood risk at scale. One area of focus could be supporting a more inclusive planning and decision-making process (including among the most vulnerable groups). This has the potential to ensure greater buy-in from communities and allows them to better protect their homes and livelihoods.

Enhancing community-based adaptation is highlighted as a need in the NAP. Responding to this offers significant scope for good-value investment. The scale of the investment needed to work with all communities across Nigeria is significant and beyond the scope of FCDO investments. There is, however, an opportunity to scale the actions to be commensurate with the available investment, with benefits also scaled accordingly.

Investment in data improvements also provides an important opportunity under this option. Conventional primary data gathering can be expensive and ongoing. If this is a chosen focus, FCDO investments should be aligned with existing programmes and initiatives. More innovative data programmes – for example, earth observation – or frameworks for good data management standalone FCDO investment would be viable (given >£1m).

Option 5: Supporting non-structural measures

Non-structural measures are central to any successful flood risk management programme. This can include investing in training to improve forecasts and early warning capabilities, at either the national or regional level. Other non-structural measures could include alternative technologies and their forecasting tools, or working with community-level programmes to increase awareness and encourage community involvement in debris management and asset management. This latter focus was mentioned multiple times by stakeholders during this study. In particular, investing in activities that build capacity

at community level was emphasised; these should help increase resilience and enable more timely and effective forecasting and warnings, since this is a prerequisite for flood resilience in urban areas.

The benefit of action can be considered to scale with the level of investment (assuming the project to be well structured, with clear activities and outcomes that are commensurate with the scale of investment).

Option 7: Supporting innovation

Innovation comes in many forms, and a variety of options would offer good value for money. These could include new forms of financing (such as blended finance solutions using public/philanthropic capital to crowd in private investment), developing evidence to support the mainstreaming of nature-based solutions in Nigeria in the catchment area (to prevent flood flows from arriving in urban areas), and low-cost approaches to sustainable urban drainage systems (SUDS). All of these areas were mentioned and reinforced during consultations.

Moreover, some of these innovative climate-friendly solutions can help in Nigeria's path towards more sustainable low-carbon growth and in meeting its NDCs. Depending on the innovation, it can also help strengthen the financing of adaptation.

As with many other options, the benefit of action can be considered to scale with the level of investment (assuming the project to be well structured with clear activities and outcomes that are commensurate with the scale of investment).

5.6.2 Where to focus

It is important to note that to maximise the return on investment, the decision is not simply about choosing the 'right type' of investment, but also the 'right spatial focus'. Where possible, activities should be targeted to the states with the greatest need. Urban flood risk is not evenly distributed across Nigeria (as illustrated in Section 3). Although geography is not the only consideration (strong partnerships and collaborative involvement with country stakeholders will also be important, if not more so), focusing on those states and local authorities with the greatest risk provides a means of tailoring efforts to the available FCDO budgets as they become better known. The twelve states with the highest expected annual benefits are summarised in **Table 11** to support this process in follow-on projects.

Table 11: States with the highest potential expected annual benefits from each Option (£)

State	Expected Annual Benefit			
	Option 3: Focus on national capacity	Option 4: Focus on State, city, and community capacity	Option 5: Focus on non-structural capabilities	Option 6: Focus on structural measures
Delta	367,393,216	734,786,431	1,736,964,696	7,203,576,526
Rivers	331,025,069	662,050,138	1,561,616,697	6,476,889,334
Lagos	177,490,376	354,980,752	832,120,596	3,455,929,210
Bayelsa	102,704,462	205,408,923	484,718,373	2,011,683,987
Borno	83,354,928	166,709,856	394,349,909	1,635,304,294
Ogun	64,276,084	128,552,167	303,037,661	1,257,623,116
Kaduna	34,525,103	69,050,206	162,910,493	676,245,955
Jigawa	30,096,661	60,193,322	141,281,465	587,495,581
Cross River	28,161,057	56,322,114	133,131,365	552,349,507
Zamfara	27,173,503	54,347,007	128,300,762	532,277,123
Sokoto	25,950,443	51,900,887	122,521,324	508,280,551
Osun	25,767,618	51,535,235	122,013,211	505,908,438

Because climate change is expected to increase the frequency and severity of flooding events, these options need to consider future climate scenarios. Considering the options in the context of climate policy for Nigeria will also be needed in the next step of the appraisal.

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Appendices

Photo by Hanniel Yakubu on Unsplash

Appendix 1

Appendix Table 1: Some case studies on flood mapping in Nigeria (Source: Komolafe et al (2015))

Major Outputs	Methods	Study Area	References
Flood hazard extent	GIS and Remote Sensing	Niger-Benue-Kogi	Ojigi et al. (2013)
Flood hazard extent	GIS and Remote Sensing	River Kaduna	Ismail & Saanyol (2013)
Flood hazard extent	GIS and Remote Sensing	Kogi state	Aderoju et al. (2014)
Flood probability map, probable peak discharge	GIS and Remote Sensing	Lagos	Adeaga (2009)
River discharge for each climate change scenario	Hydrological modelling,	River Kaduna	Haruna et al. (2013)
Inundation model	Remote sensing and GIS, digital elevation model (DEM), flood discharge	Kaduna Metropolis	Jeb & Aggarwal (2008)
Flood risk zones	GIS and Remote Sensing	Markurdi	Abah (2013)
Flood plain map	GIS and Remote Sensing		Aderoju et al. (2014)

Appendix Table 2: Some case studies on flood vulnerability in Nigeria (Source: Komolafe et al (2015))

Types of vulnerability	Methods	Study area	References
Qualitative physical vulnerability	GIS and Remote Sensing	Gwagwalada town	Oyatayo et al. (2014)
Qualitative physical vulnerability	GIS	Adamawa	Ikusemoran et al. (2013)
Qualitative physical vulnerability	Questionnaires, GIS	Akure	Oyinloye et al. (2013)
Socio-economic vulnerability	Questionnaires survey	Lagos	Ajibade et al. (2013)
Awareness, qualitative physical vulnerability	Questionnaires survey	Abeokuta	Adelekan (2011)
Social and Qualitative physical vulnerability	Run-off modelling	River Ogun	Sobowale & Oyedepo (2013)
Qualitative physical vulnerability	GIS and Remote Sensing	Niger-Benue-Kogi	Ojigi et al. (2013)
Qualitative physical vulnerability	Remote Sensing	Niger-Benue basin	Nkeki et al. (2013)
Qualitative physical vulnerability	Flood modelling, Remote Sensing	Adamawa	Nwilo et al. (2012)
Qualitative physical vulnerability	Remote Sensing and GIS	Bayelsa	Mmom & Akpi (2004)

Appendix Table 3: Sample flood projects from the 2021 Nigeria budget (Ministry of Environment)

Project Code	Project Name	Budget	Status
ERGP19117246	Erosion, flood control/road improvement in Woda Otakpa Yala, cross river	20,000,000	Ongoing
ERGP19160347	Construction of drainage dykes to protect irrigated lands from annual floods at Gante, Kebbi north senatorial district	100,000,000	New
ERGP20103894	Re-activation of existing and installation of new automated flood early warning system (fews) in 2 river basins of the country	8,000,000	Ongoing
ERGP201 04470	Erosion and flood control project at Lassa town Askira-uba Lga Borno state	40,000,000	Ongoing
ERGP201 04526	Erosion and flood control in Unguwan Faransa Gombi Lga ongoing Adamawastate	36,000,000	Ongoing
ERGP20125764	Eziama ntigha flood channelization project, Isiala Ngwa north Lga Abia state	10,000,000	Ongoing
ERGP20125787	Construction of flood control works at Amao farm. I Lorin west Lga Kwarastate'	10,000,000	Ongoing
ERGP19160347	Construction of drainage dykes to protect irrigated lands from annual floods at Gante, Kebbi north senatorial district, Kebbi state	100,000,000	New
ERGP20139042	Channelization and flood control in Tudunwada, Kaduna south, Kaduna state	80,000,000	Ongoing
ERGP20139059	River Jamtari flooding control in Mayo Belwa Lga Adamawa state	50,000,000	Ongoing
ERGP20139133	Erosion and flood control work on Iyi Okwo-Ogubi road at Agboha, Abia state	10,000,000	Ongoing
ERGP20150108	Oke-aofin flood control works, Eriti Akoko north west, Ondo state	20,000,000	New
ERGP20150110	Kainji town flood and erosion control works. Niger state	20,000,000	New
ERGP20150111	Flood control project at Doemak, Quanpaa Lga, Plateau state	20,000,000	New

Project Code	Project Name	Budget	Status
ERGP20150118	Construction of drains and culverts to control erosion and flood problem behind old army barrack. Suleja Niger state	20,000,000	Ongoing
ERGP20150119	Anguwan Makarfi/railway gully erosion and flood control Katcha, Niger state	5,000,000	New
ERGP20150120	Anguwan Yorubawnrailway gully erosion and flood control Katcha Niger state	5,000,000	New
ERGP20150121	Erosion and flood control works in Uke, Nasarawa state	10,000,000	New
ERGP20150122	Flood and erosion control project at Amankalu, Alayi and Ozuitem in Bende federal constituency. Abia state	5,000,000	New
ERGP20150127	Erosion and flood contorl/road improvement works at four corner Ogbudo Umuogazi/ Umudiji Ugwuorie Ukpor Nnewi south Lga. Anambrastate	5,000,000	New
ERGP20150128	Erosion and flood control/road improvement works at ergp20150128 Ugwu Orie Ukpor Umuochi Lilu Orsu south/Ihialnorsu Lga's Anambra state	5,000,000	New
ERGP20151536	Erosion and flood control at y any an Oyo road. Iwo Lga Osun state	17,000,000	Ongoing
ERGP20151748	Flood control with drainage in Boripe community, Egbedore Lga. Osogbo, Osun state	60,000,000	New
ERGP20152627	Erosion and flood control at Usungwe Uvete Ukehi Lga. Kogi state	20,000,000	New
ERGP20153386	Igbp oja it an la gra flood and erosion control works. Ondo state	25,000,000	Ongoing
ERGP20157192	Flood and erosion control works at emeyal 2 community Ogbialga Bayelsa state	30,000,000	New
ERGP20157631	Flood and erosion control in Aboto-alfa asa Lga Kwara state.	10,000,000	New
ERGP20158375	Erosion and flood control/road improvement works at Memunat Abeje crescent under Gogbomosho, Oyo state	5,000,000	Ongoing
ERGP20159069	Completion of erosion and flood control works in Gumel, Gumel Lga Jigawa state.	15,400,000	Ongoing

Project Code	Project Name	Budget	Status
ERGP20159762	Erosion and flood control works at Obantoko Gbonogun Odo Eran, Ogun state	85,000,000	New
ERGP20161174	Flood control and slum upgrading/road improvement wadatastreet. Naharati Sabo area Asharaabattoir area Abaji area council. Fct Abuja	55,000,000	New
ERGP20161175	Erosion and flood control/road improvement works at Onusorogu-enu Atta-Ukwu acharnebe-kpata nye onu-obiofo umuakasi umungwu in Nnewi south Lga aAnambra state	5,000,000	New
ERGP20161176	Flood control works and stormwater channelisation at Magajiy n awala in Rijau, Rijau Lga and Auna stormwater channelisation/Kainji road improvement works, Magama Lga, Niger state	10,000,000	Ongoing
ERGP20161213	Erosion and flood control works at Agbadani/ Obeagu/Adama Nri general hospital, Enugu Ukwu road. Anaocha Lga Anambra state	35,000,000	Ongoing
ERGP554004423	Erosion and flood control works in Auyo, Guri and Kiri Kasamma Lgas, Jigawa north east senatorial district, Jigawa state	100,000,000	New
ERGP554004430	Erosion & flood control works@ 30m each in Rigasa, Igabi Lga & Kawo, Kaduna north Lga. Kaduna central senatorial district. Kaduna state	60,000,000	New
ERGP554004447	Erosion & flood control works in Bela town, Bungudu Lga. Zamfara central senatorial district, Zamfara state	50,000,000	New
ERGP554004569	Erosion & flood control works in Ekiti north senatorial district, Ekiti state	60,000,000	New
ERGP554004599	Erosion & flood control works in Ideato/ Ogboko, Imo west senatorial district, Imo state	200,000,000	New
ERGP554004600	Erosion & flood control works in Imo north senatorial district, Imo state	200,000,000	New
ERGP20160093	Erosion and flood control works at Yagba east and west, Kogistate	34,000,000	New
ERGP55191 04631	Flood chanelling/drainage works at Jos north senatorial district of Plateau state	10,280,700	New

Project Code	Project Name	Budget	Status
ERGP55191 04631	Erosion control, flood channelization and drainage project at iso idim	50,000,000	New
ERGP554004016	Training on sandification and empowerment to cushion flood in Anambra north senatorial district, Anambra state	50,000,000	New

(Source/note/caveat: These tables were pulled directly from scanned PDFs published by the Budget Office, found here: https://www.budgetoffice.gov.ng/index.php/resources/internal-resources/budget-documents/2021-budget/2021-signed-budget. For future research, this table may need to be checked against the original table files from the government, as the researchers were limited to PDF scanning software. These tables are just to illustrate the extent of the list of projects found in various ministries.)

Appendix Table 4: Sample flood projects from the 2021 Nigeria budget (other ministries)

Project Code	Ministry	Project Name	Budget	Status
ERGP14106309	Ministry of interior	Construction of flood rescue props. In nfa sheda. Abuja	42,973,963	Ongoing
ERGP1159686	Federal ministry of special duties & intergovernmental affairs hqtrs	Flood/erosion control works and construction of 2.86km road pavement at Nko in Obot Akara Lga, Akwa Ibom state	10,000,000	Ongoing
ERGP1159687	Federal ministry of special duties & intergovernmental affairs hqtrs	Flood/erosion control works and construction of 2.89km road pavement at Nko Ekpe- Atan i bong in Obot Akara Lga, Akwa Ibom state	10,000,000	Ongoing
ERGP12153358	Federal ministry of agriculture and rural development hqtrs	Channelization of flood prone college road	5,000,000	Ongoing
ERGP554054698	Federal ministry of agriculture and rural development hqtrs	Niomrs hqtrs flood control and landscaping of impacted areas	100,000,000	New
ERGP12157677	Ministry of mines and steel development- hq	Provide for control of flooding in central workshop Ijora Lagos.	5,000,000	Ongoing
ERGP12159731	Federal ministry of works and housing	Flood control in Darazo township road in Bauchi state	131,621,482	New
ERGP30140501	Federal ministry of works and housing	Shoreline protection & Coastal erosion and flood control surveys (Apapa to Badagry)	9,355,175	Ongoing

Project Code	Ministry	Project Name	Budget	Status
ERGP1161 035	Federal ministry of water resources	Odonget-ekuri/etara road flood and erosion control programme {section 1): Odonget-Lotuni Strem section	100,000,000	New
ERGP28124581	Federal ministry of water resources	Studies for developing mitigation ways on dam related flooding incidencies in Nigeria	10,000,000	Ongoing
ERGP30151599	Federal ministry of water resources	Development of flood master plan for rivers Niger and Benue	10,335,000	New
ERGP281 01910	Nigeria hydrological service agency	Outdoor flood alert (siren) system	12,081,150	Ongoing
ERGP28102013	Nigeria hydrological service agency	Flood vulnerability/hydrogeology mapping	80,100,000	Ongoing
ERGP28158758	Nigeria hydrological service agency	Consultancy service for flood and drought mitigation	6,750,000	New
ERGP281591 05	Nigeria hydrological service agency	Nationwide flood assessment and gid/ multicriteria analysis of flood events	4,500,000	New
ERGP28160068	Nigeria hydrological service agency	Hydrologicail assessment of flood and drought occurrence across the country	9,108,000	New
ERGP29156872	Nigeria hydrological service agency	Development and maintenance of flood app	18,675,000	New
ERGP301 5691 1	Nigeria hydrological service agency	Eu assisted flood forecasting and early warning system (fan far project) for West africa	4,950,000	New

Project Code	Ministry	Project Name	Budget	Status
ERGP30156943	Nigeria hydrological service agency	Need assessment for institutional strengthening for flood and drought mitigation	7,200,000	New
ERGP12131273	Federal ministry of water resources	Flood and erosion control at Uzomiri Ariamgu village Ihiagwa Imo state	20,500,000	Ongoing
ERGP12138961	Federal ministry of water resources	Flood and erosion control in Akwa Ifitedunu Dunu, Ofia Lga Anambra state	22,500,000	Ongoing
ERGP12138969	Federal ministry of water resources	Flood and erosion control in Umuanugo Ifitedunu Dunukofia Lga Anambra state	22,500,000	Ongoing
ERGP12139072	Federal ministry of water resources	Flood and erosion control in Umueze Umuanugo Ifitedunu Dunukofia Lga Anambra state	22,500,000	Ongoing
ERGP12139080	Federal ministry of water resources	Flood and erosion control in Nkwelle Umunachi Idemili north Lga Anambra state	22,500,000	Ongoing
ERGP12139433	Federal ministry of water resources	Flood and erosion control works at Ania Ezie Umuokwara Ikuku Umuna Orlu Lga Imo state	18,000,000	Ongoing
ERGP12139489	Federal ministry of water resources	Construction of Umunwanwa irrigation. Erosion and flood control works, Abia state	22,500,000	Ongoing
ERGP12139947	Federal ministry of water resources	Flood and erosion control works at ash i mole akuwa ibeku road	22,500,000	Ongoing
ERGP12157451	Federal ministry of water resources	Access road i flood control in Redemption estate, Obinze Imo state	22,500,000	Ongoing

Project Code	Ministry	Project Name	Budget	Status
ERGP28155848	Federal ministry of water resources	Flood & erosion control rural access road along Nazeobibiezena road Owerri north Lga Imo state Benin/ Owena rbda	180,000,000	ONGOING
ERGP28158459	Federal ministry of water resources	Construction of erosion and flood control structures at Mubi cross river rbda	15,000,000	ONGOING
ERGP19139215	Federal ministry of water resources	Construction of erosion and flood control works near PCN, Effi, Okuni, Ikom Lga. Cross river state	27,000,000	NEW
ERGP5113598	Federal ministry of water resources	Construction of calabar river irrigation/drainage/ flood control project, Odukpani Lga, crs	31,500,000	ONGOING
ERGP5113554	Federal ministry of water resources	Construction of owakande/ obubra irrigation/ drainage/flood control project, Obubra Lga, crs	49,500,000	ONGOING
ERGP5113568	Federal ministry of water resources	Construction of itu irrigation/ drainage/ flood control project, itu aks. Hadejia-jama'are rbda	54,000,000	ONGOING
ERGP 19152022	Federal ministry of water resources	Flood and erosion control at Sabon Gari, Jigawa state	30,000,000	ONGOING
ERGP19152061	Federal ministry of water resources	Katagum flood control and land reclamation project, Bauchi state	30,000,000	ONGOING
ERGP 19152065	Federal ministry of water resources	Kaidaji-alkamawa flood protection and land reclamation project, Kano state	30,000,000	ONGOING

Project Code	Ministry	Project Name	Budget	Status
ERGP19152095	Federal ministry of water resources	Maigatari flood control and land reclamation project Jigawa state	80,000,000	Ongoing
ERGP191521 00	Federal ministry of water resources	University of dutse flood and erosion control project	32,800,000	Ongoing
ERGP19152125	Federal ministry of water resources	Rafin arewa (misau) flood erosion control	24,600,000	Ongoing
ERGP19152132	Federal ministry of water resources	Costruction of flood/erosion works at Behun, Yan Barau and Busaye	5,000,000	Ongoing
ERGP19152191	Federal ministry of water resources	Flood control at Dugwal & Zar/Awa Ajingi Lga Kano state	20,000,000	Ongoing
ERGP 19152227	Federal ministry of water resources	Flood and erosion control at Nassarawa Kano state	5,000,000	Ongoing
ERGP19159121	Federal ministry of water resources	Flood and erosion control works at Dambatia	5,000,000	Ongoing
ERGP19159123	Federal ministry of water resources	Flood and erosion control works at Birnin Kudu	5,000,000	Ongoing
ERGP8159065	Federal ministry of water resources	Flood and erosion control works at Dan Hassan town, Kura Lga, Kano state	15,000,000	New
ERGP554003090	Federal ministry of water resources	Construction of embarkment for water erosion flooding in Auyo / Hadejia / Kafin hausa federal constituency, Jigawa state	100,000,000	New

Project Code	Ministry	Project Name	Budget	Status
ERGP554001888	Federal ministry of water resources	Provision in the capital project budget live as to construct an embarkment against flood and erosion in the strategic areas to avoid future occurrences in Hadeijnkafin Hausnauyo federal constituency, Kano	50,000,000	Ongoing
ERGP28157512	Federal ministry of water resources	Construction of flood protection dyke for Makurdi project	18,000,000	Ongoing
ERGP554002075	Federal ministry of water resources	Flood channelization & construction of Fwavwei – Jiku to old airport road, Jos south Lga Plateau state	30,000,000	Ongoing
ERGP554001998	Federal ministry of water resources	Flood and erosion control at Anguwan Dodo Gwagwalada fct lower Niger rbda	190,000,000	New
ERGP12151222	Federal ministry of water resources	Flood and erosion control at Oloffa way Kunlede estat phase Kwara state	4,500,000	New
ERGP12151224	Federal ministry of water resources	Flood and erosion control at Ah-lu Rosul community, Gbaako area, Oko olowo Ilorin, Kwara state	4,500,000	New
ERGP12153574	Federal ministry of water resources	Construction of flood and erosion control at Shalom community area off university road, Tanke, Ilorin	27,900,000	New
ERGP121 53664	Federal ministry of water resources	Flood and erosion control works at Aderoju Sagaya street, off Awolowo road, Tanke, Ilorin	27,900,000	New

Project Code	Ministry	Project Name	Budget	Status
ERGP12159026	Federal ministry of water resources	Flood and erosion control at Jooro Isale phase i community, Ilorin west Lga Kwara state	28,800,000	New
ERGP 19147029	Federal ministry of water resources	Flood erosion control within Agric estate at Ilorin	15,000,000	Ongoing
ERGP20125938	Federal ministry of water resources	Ajibesin-oniru air force channelization and flood control Oloje housing estate, Ilorin, Kwara state	9,900,000	Ongoing
ERGP6150651	Federal ministry of water resources	Flood and erosion control at Gbaradogi road Patigi, Kwara state 2018 liability	30,000,000	Ongoing
ERGP554002091	Federal ministry of water resources	Flood and erosion control behind ecss, Akanchi, Nagazi Uvete, Adavi Lga Kogi state NIger Delta rbda	50,000,000	New
ERGP12160779	Federal ministry of water resources	Construction of phase 2 Buguma flood and erosion control	50,000,000	Ongoing
ERGP20125665	Federal ministry of water resources	Flood and erosion control projects in Bugumaatiegoba rivers state Ogun/ Osun rbda	49,500,000	Ongoing
ERGP191 08849	Federal ministry of water resources	Study, design &. Construction of flood and erosion control ongoing works at Oyefeso mosque in Agurnsabo, Sagamu, Ogun state	4,500,000	Ongoing
ERGP191 08865	Federal ministry of water resources	Construction of flood and erosion control measures at Ayetoro road, oloruntedo community, Abeokuta	10,500,000	Ongoing

Project Code	Ministry	Project Name	Budget	Status
ERGP19112281	Federal ministry of water resources	Construction of flood and erosion control works at gra. Ijebu ode Ogun state	13,000,000	Ongoing
ERGP19121498	Federal ministry of water resources	Completion of flood and erosion works at Osun senatorial districts	4,500,000	Ongoing
ERGP19131544	Federal ministry of water resources	Completion of sagamu flood and erosion control works	900,000	Ongoing
ERGP19140483	Federal ministry of water resources	Construction of flood and erosion control works at Psero	13,500,000	Ongoing
ERGP19140490	Federal ministry of water resources	Flood and erosion control works at Obasanjo hilltop. Abeokuta. Ogun state	12,000,000	Ongoing
ERGP19140499	Federal ministry of water resources	Construction of flood and erosion control works at Obagun, Osun state	9,000,000	Ongoing
ERGP19140519	Federal ministry of water resources	Construction of flood and erosion control works at Inukonu, Adigbe, Ogun state	12,000,000	Ongoing
ERGP19140531	Federal ministry of water resources	Construction of drainage, flood an erosion control works at ish un farm settlement road, Obafemi Owode Lga Ogun state	6,300,000	Ongoing
ERGP19140546	Federal ministry of water resources	Construction of flood and erosion control works at ita Morin, Oke Itoku. Abeokuta Ogun state.	13,000,000	Ongoing

Project Code	Ministry	Project Name	Budget	Status
ERGP19143742	Federal ministry of water resources	Construction of flood and erosion control works at Isheri, Lagos state	13,000,000	Ongoing
ERGP19143745	Federal ministry of water resources	Construction of flood and erosion control works at Olowo-ira Lagos state	13,000,000	Ongoing
ERGP 19150937	Federal ministry of water resources	Flood and erosion control in Isokan Oluwa community, Tara area Oke Bale, Osogbo. Osun state	9,000,000	New
ERGP19150946	Federal ministry of water resources	Flood and erosion control on Awesin river in Oke Ayepe area including culvert to connect irepodun Lga with Orolu Lga in New Osun state'	9,000,000	New
ERGP19150953	Federal ministry of water resources	Flood and erosion control on _____ area of new arenja compound in Ifon, Osun state	9,000,000	New
ERGP19151 032	Federal ministry of water resources	Construction of flood and erosion control works across Isale-oba Oke-odo community in Oyo state	10,500,000	New
ERGP19151 035	Federal ministry of water resources	Rehabilitation of concrete drainage, flood and erosion control works in Ibarapa Oyo state	10,500,000	New
ERGP19151158	Federal ministry of water resources	Construction of flood and erosion control works at Gaa II village, Iree, Boripe Lga Osun state	18,000,000	New
ERGP19154754	Federal ministry of water resources	Construction of flood and erosion control works at prayer warrior area Ilesa east Lga Osun state	27,000,000	New

Project Code	Ministry	Project Name	Budget	Status
ERGP19154776	Federal ministry of water resources	Construction of flood and erosion control works at Harmony, Funaab area Odeda Lga Ogun state	22,500,000	New
ERGP19154799	Federal ministry of water resources	Construction of flood and erosion control works at Emere-ayaarea camp, Odeda Lga Ogun state	13,500,000	New
ERGP19155340	Federal ministry of water resources	Construction of flood and erosion control works at Ilupeju community, camp, Odeda Lga Ogun state	13,500,000	New
ERGP 19155390	Federal ministry of water resources	Construction of flood and erosion control works at Owwi ewekoro Lga Ogun state	13,500,000	New
ERGP19155758	Federal ministry of water resources	Construction of flood and erosion control works at Apakila Odeda Lga Ogun state	17,000,000	New
ERGP19155813	Federal ministry of water resources	Construction of flood and erosion control works and rehabilitation of Fajebe street at Ikenne Lga Ogun state	17,000,000	New
ERGP19155891	Federal ministry of water resources	Construction of flood and erosion control works at Rosarium estate, Ilaho-agunrete, laderin extension, Abeokuta Ogun state	18,000,000	New
ERGP 19155899	Federal ministry of water resources	Construction of flood and erosion control works in New Eweye street, Ilisan, Ogun state	31,500,000	New
ERGP 19155929	Federal ministry of water resources	Construction flood and erosion control works including drainage at Oyo state	4,500,000	New

Project Code	Ministry	Project Name	Budget	Status
ERGP19156110	Federal ministry of water resources	Flood and erosion control works including culvert at Unity crescent Orobiyi Banjo community Oshodi-isolo Lga Lagos	17,000,000	New
ERGP19159095	Federal ministry of water resources	Rehabilitation of drainage structure, flood and erosion control works at Abimbola Okulaja close, Oladimeji Alo street, Lekki, Lagos state	10,000,000	New
ERGP28136272	Federal ministry of water resources	Construction of drainage flood and erosion control works ongoing at Job Ademowo street, Ijebu-ode	18,000,000	Ongoing
ERGP28136278	Federal ministry of water resources	Construction of flood and n control works at Idode	18,000,000	Ongoing
ERGP28136283	Federal ministry of water resources	Construction of flood and erosion control works at Olumide farm road, Asero, Abeokuta	18,000,000	Ongoing
ERGP28150204	Federal ministry of water resources	Flood mapping and catechment plan of Ogun basin	9,000,000	New
ERGP30151217	Federal ministry of water resources	Construction of drainage, flood and erosion control works at Orimerunmu town, Mowe, Obafemi-owede Lga. Ogun state	27,000,000	New
ERGP5131 040	Federal ministry of water resources	Construction of flood and erosion control works at Epe, Lagos state Sokoto Rima rbda	18,000,000	Ongoing

Project Code	Ministry	Project Name	Budget	Status
ERGP 19156520	Federal ministry of water resources	Flood and erosion control and rural. Water supply project in Hayin Kara Kafur Lga. Katsina state	50,000,000	Ongoing
ERGP28157 503	Federal ministry of water resources	Flood and erosion control and rural water supply project in Budawa village, Kafur Lga Katsina state	76,000,000	Ongoing
ERGP5128504	Federal ministry of water resources	Rehabilitation of 10km flood protection dyke at (MRVIP, BIP & ZPP) project irrigation schemes	10,800,000	Ongoing
ERGP81597 49	Federal ministry of water resources	Flood and erosion control opposite highcourt low-cost area and Bakin Kasuwa- Garkar Lailaba. Argungu – Kebbi north senatorial district	40,000,000	New
ERGP28149637	Federal ministry of water resources	Jankai/Bubayero primary school flood control project (400m), Gombe state	90,000,000	Ongoing
ERGP28149639	Federal ministry of water resources	Tudun wada flood control project (400m), Gombe state upper Niger rbda	93,600,000	Ongoing
ERGP19120094	Federal ministry of water resources	Drainage, flood and erosion control with surface dressing at Lade Tsubaworo. Kwara state	10,000,000	Ongoing
ERGP 19128293	Federal ministry of water resources	Flood and erosion control works in Kaduna. Niger and FCT	158,400,000	Ongoing
ERGP20138796	Federal ministry of water resources	Construction of drainages for flood and erosion control at Taidnaand environs, minna2020	40,000,000	Ongoing
ERGP19104180	National water resources institute- kaduna	Erosion & flood control	13,500,000	ONGOING

Project Code	Ministry	Project Name	Budget	Status
ERGP191 04181	National water resources institute- kaduna	Erection of flood marks accross Nigeria	10,800,000	Ongoing
ERGP19130409	Federal ministry of niger delta hqtrs	Sandfilling of Ukparam new city opposite Bolowohu, ese-odolga/flood control Ondo state	60,000,000	Ongoing
ERGP19158179	Federal ministry of niger delta hqtrs	UGEP main market erosion/flood control Yakurr Lga cross river state.	10,000,000	Ongoing
ERGP23142542	Federal ministry of education – hqtrs	Upgrading of infrastructure. Erosion control repairs of flooding, rainstorm and damages in FUCS	377,402,175	Ongoing
ERGP554003452	National emergency management agency	Flood control in Ogbia/Nembe Lga Bayela east senatorial district	80,000,000	New

Source/note/caveat: These tables were pulled directly from scanned PDFs published by the Budget Office, found here: https://www.budgetoffice.gov.ng/index.php/resources/internal-resources/budget-documents/2021-budget/2021-signed-budget. For future research, this table may need to be checked against the original table files from the government, as the researchers were limited to PDF scanning software. These tables are just to illustrate the extent of the list of projects found in various ministries.