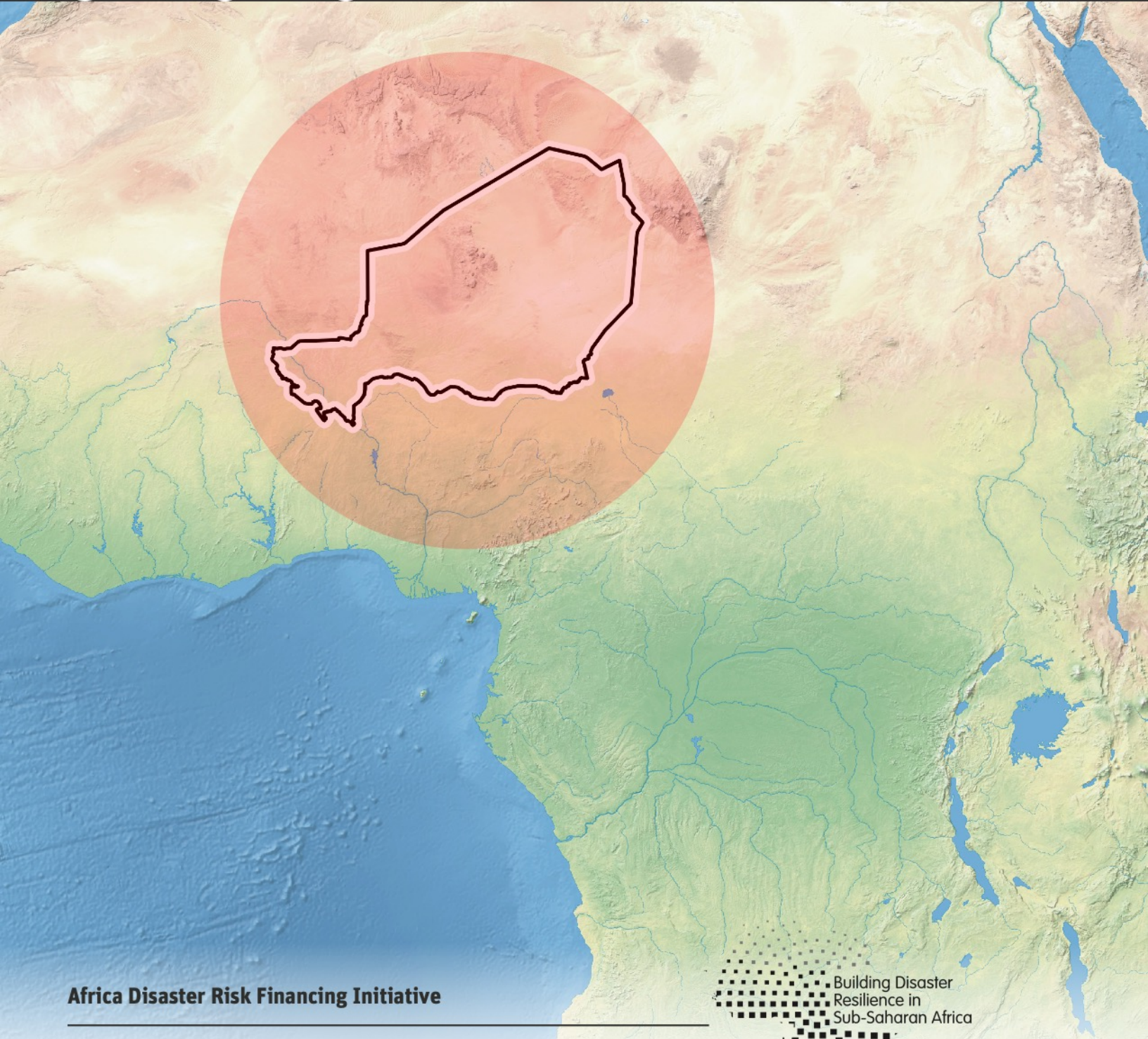# DISASTER RISK PROFILE
Niger

Drought ⬡ Flood ⬡ Landslide

Africa Disaster Risk Financing Initiative

Building Disaster
Resilience in
Sub-Saharan Africa

WORLD BANK GROUP

GFDRR
Global Facility for Disaster Reduction and Recovery

An initiative of the African, Caribbean and Pacific Group of
States funded by the European Union

INTRODUCTION

Overview

The Africa Disaster Risk Financing (ADRF) Initiative is one of five Result Areas of the European Union (EU) - Africa, Caribbean and Pacific (ACP) cooperation program *Building Disaster Resilience in Sub-Saharan Africa*, which is implemented by several partners, including the African Development Bank (AfDB), African Union Commission (AUC), the United Nations International Strategy for Disaster Reduction (UNISDR) and the World Bank (WB)- managed Global Facility for Disaster Reduction and Recovery (GFDRR). The Program's overall objective is to strengthen the resilience of Sub-Saharan African regions, countries and communities to the impacts of disasters, including the potential impact of climate change, to reduce poverty and promote sustainable development.

The ADRF Initiative, launched in 2015 and implemented by GFDRR and the World Bank, supports the development of risk financing strategies at regional, national and local levels to help African countries make informed decisions to improve post-disaster financial response capacity to mitigate the socio-economic, fiscal and financial impacts of disasters. One of the operational components to achieve this objective is to create an enabling data environment for risk financing. This aims to build the understanding and awareness of disaster and climate risks in Sub-Saharan Africa, providing a fundamental input to developing disaster risk financing strategy, approaches, and tools for financing risks. One of the activities is to develop national-level multiple-peril country risk profiles using globally available and readily accessible local datasets, in combination with scientifically proven methodologies. These are used to catalyze dialogue with government counterparts in the region on the primary disaster risks they face to formulate Disaster Risk Management strategies, such as financial protection and risk reduction investment programs. Furthermore, the risk profiles provide datasets that are a critical input for developing risk financing and insurance strategies.

National Risk Profiles

To create an enabling environment for dialogue on risk financing strategies and to further the understanding of disaster risk, national risk profiles have been developed for **eight countries** in the region. The risk profiles provide **visual information and data on the hazards, exposure, and risk for multiple hazards** in each country. The profiles provide an overview of which hazards, sectors and regions are most at risk of disasters, and contribute most to the national level of risk.

Specifically, the national risk profiles provide the estimated impact of disasters on population, building stock, transport networks, critical facilities, and agriculture at the national and sub-national levels. These profiles can guide initial strategic dialogue on financial protection and / or risk reduction investment opportunities to manage disaster risk, as well as help identify priorities for more detailed risk assessments if specific interventions are to be made.

Countries and Hazards

	Drought	Flood	Landslide	Earthquake	Volcano	Cyclone
Cabo Verde	⬤	⬤	⬤	⬤	⬤	⬤
Ethiopia	⬤	⬤	⬤	⬤	⬤	
Kenya	⬤	⬤	⬤	⬤	⬤	
Malawi	⬤	⬤		⬤		
Mali	⬤	⬤	⬤			
Mozambique	⬤	⬤	⬤	⬤		⬤
Niger	⬤	⬤	⬤			
Uganda	⬤	⬤	⬤	⬤	⬤	

Uganda
1966 Toro earthquake: Mw6.8, 10 deaths, 500 injuries, over 5800 house damaged

Niger, Mali
1968-1972 drought: 100k deaths, >100k dependent on food aid

Ethiopia
1983-1985 drought: Hundreds of thousands killed, millions affected by famine

Mozambique
1998 Mt Tumbine landslide: 200 deaths, 4k displaced. Roads, bridges and water supply destroyed

Mozambique
2000 floods & Cyclone Eline: 700 deaths, >460k displaced, $500million damage

Ethiopia, Kenya
2006 floods: >640 deaths, 200k affected in Ethiopia; In Kenya 2000 people displaced, 600 livestock killed.

Ethiopia, Kenya
2006 drought: $190 million aid for 2.5 million people; 11 million affected across Horn of Africa

Mozambique
2007 floods & Cyclone Favio: affected 500k people, $71mn damage, 277k ha crops destroyed

Uganda
2010 Mt Elgon landslide: 350 deaths and 500k relocated

Ethiopia, Kenya
2011-2012 drought: 13 million affected, tens of thousands of deaths. $1.4billion in aid required

Malawi
2015 flooding: >1 million affected, $335 million damage; 250 fatalities

METHODOLOGY AND LIMITATIONS

Use

These risk profiles provide a preliminary view of disaster risk at the national level, and distribution of risk across regions of the country and types of assets. They enable the identification and prioritization of risk drivers, to guide risk management activities and identify the need for further, more detailed risk assessment.

Due to limitations in the content and resolution of the publicly available global and national level exposure and hazard data used in their development, these profiles do not provide sufficient detail for taking final decisions on disaster management investments and policies, or for planning subnational and local scale mitigation projects, such as construction of flood defenses. Such decisions should be informed by a local, and possibly sector-specific disaster risk assessment, which estimates risk at a higher resolution with more locally-specific exposure, hazard, and vulnerability input data.

These risk profiles present a substantial part of the analysis results. However, it has not been possible to present all results in these documents. Full results for all asset types are available from GFDRR Innovation Lab.

Risk

Risk calculations require input data describing the hazard, assets ('exposure'), and vulnerability of those assets.

Disaster risk to structural and infrastructure assets is quantified here by estimating the cost to repair and/ or replace assets damaged or destroyed in a disaster, i.e. due to ground shaking, flood depth or wind speed, over various time horizons. Assets analyzed are private and government-owned building stock, critical facilities (education and health), and transport networks (road, rail, and bridges).

Risk to population is quantified by assessing the number of people that are expected to be affected by the hazard.

For volcanoes, an indicative measure of volcano risk is given by estimating population and value of assets exposed to the volcanic hazards (no estimation of impact is made).

Losses additional to those incurred due to physical damage are not included in this analysis (e.g., business interruption due to disrupted infrastructure or supply chains).

The cost or number affected is estimated for most hazards at three time periods: a decade (this refers to the 1 in 10 year return period, or 10% chance of a loss being exceeded in any given year); a person's lifetime (1 in 50, or 2% in any year), or for an extreme event (1 in 250, or 0.4% in any year).

Hazard and Vulnerability Data

Drought hazard analysis comprises agricultural (soil moisture deficit) and hydrological (river flow) drought. Drought duration and deficit volume per year are determined by event-based modeling to estimate population affected by water scarcity. Monetary loss reflects the loss in yield and long term average price for each modelled per crop.

River flood risk (urban/surface flooding is excluded) is estimated at 1km resolution using global meteorological data, global hydrological and flood-routing models. Loss estimates are generated by simulating rainfall statistics for 10,000 years based on 40 years of previous rainfall data. Damage functions for four types of buildings, and for roads/railways, are used to estimate loss as a function of flood depth. Population are considered 'affected' if flooding of any depth occurs in the same 1km area. Agriculture loss is estimated by assuming that catastrophic flooding will result in a loss of the annual crop yield.

Earthquake hazard describes the distribution of ground shaking intensity (i.e., peak ground acceleration), based on the locations of known seismic faults and location/size of previous earthquakes. Losses are estimated using fragility and vulnerability models that translate ground shaking into the expected level of (a) damage to different types of structure, and (b) displacement of roads and rails. Based on damage to buildings, a casualty model has been used to estimate the risk of fatalities as well as the population affected by ground shaking. This study includes losses due to damage from earthquake ground shaking only. Secondary hazards (liquefaction and fire following an earthquake) are not accounted for. Landslide hazard is considered under the separate landslide section, where ground shaking is considered as a potential trigger of landslides.

Landslide susceptibility has been defined across each country using an assessment of factors that increase potential for landslides (including slope, vegetation and soil types) combined with landslide trigger events (rainfall and seismic shaking) to create landslide hazard maps. Long-term average annual cost to structures and transport networks has been estimated using vulnerability of different asset types to landslides, based on extensive literature review, empirical data, and expert judgement.

Average annual population affected, and fatalities, are estimated.

Volcanic eruption scenarios at a small number of key volcanoes are used to estimate the population, and replacement cost of structures and infrastructure exposed to ashfall hazard (i.e. are located in an area that could receive ash in an eruption) and topographic analysis is used to determine the assets and population exposed to flow hazards. Full quantification of risk at all volcanoes is not possible due to limited information on potential frequency and eruption style at many volcanoes in Sub-Saharan Africa.

Cyclone and storm surge hazards are assessed using a record of historical cyclone tracks and wind field modelling, to determine maximum wind speeds on land and accompanying water levels along the coast. Vulnerability of structures to wind and surge is estimated based on previously observed damage sustained at different wind speeds and literature on flood depth impact of different types of structures.

Asset Database

Open and freely available national, regional, and global data sets are used to develop, for the first time, a database of population and multiple built asset types for risk analysis. This is used to inform this risk assessment, in a region where there is significant variability in the availability and content of inventories describing building stock and infrastructure.

Population density is described using WorldPop data. Building stock is described using six development types: rural, residential, high-density residential, informal, urban, and industrial, based on land use data and satellite imagery. In each cell of a 0.5 km resolution grid, the number of buildings and total floor area of each development type is given. The number of buildings is further disaggregated into different construction types to account for the impact different levels of structural vulnerability in the risk analysis.

Critical facilities include education and health facilities. Where possible, the assets have been analyzed using accurate geolocation given in an available building inventory. However, many assets had no geolocation given and were distributed using building density as a proxy for their location; the proportion of geolocated assets varies by country. Education facilities (classified as primary school, secondary school, or universities) and health facilities (hospital or clinics) have been assigned an estimated construction type based on interviews with structural engineers in each country and used to approximate construction cost per square meter.

Transportation data include roads, railways, and bridges, where present. Road surface type (paved, unpaved) is also included where available. Agriculture exposure is described by crop type and subnational distribution, average annual yield, and crop price for risk calculations.

Replacement costs for building stock and critical facilities are calculated using construction cost per square meter for each building or facility type, and cost per kilometer for roads based on road type and for railway lines, based on terrain. Estimates of replacement cost were developed through interviews with local engineering and construction professionals (numbers and sources varied in each country). These were validated and adjusted where necessary using several sources, including site surveys and international literature on construction. Replacement costs used are representative of typical building infrastructure and replacement costs for the entire country. Subnational variations in costs and building distributions (due to cost of materials and labor) will vary and are not accounted for.

NIGER

GDP $7 billion*   Population 20 million*   *2015 estimates

In 2015, Niger had a population of 20 million, and a population growth rate of 3%, one of the fastest in the world[1]. Approximately 80% of the population lives in rural areas[2]. An estimated 50% of the population lives below the poverty line[3]. The country's Human Development Index is 0.348 indicating one of the least developed countries in the world[4].

Niger's agricultural sector accounts for 40% of GDP[5]. Agriculture provides livelihoods for most of the population with 82% dependent on farming[6]. Ten percent of children under five years old suffer from acute malnutrition and 44% of children suffer from chronic malnutrition[7].

The predominantly agricultural and subsistence-based economy in Niger is frequently affected by droughts common to the Sahel, but also floods regularly have an impact, predominantly in the southwestern part of Niger.

2010 Population
People per km²

0   100

2010 GDP
US$ per km²

0   100,000
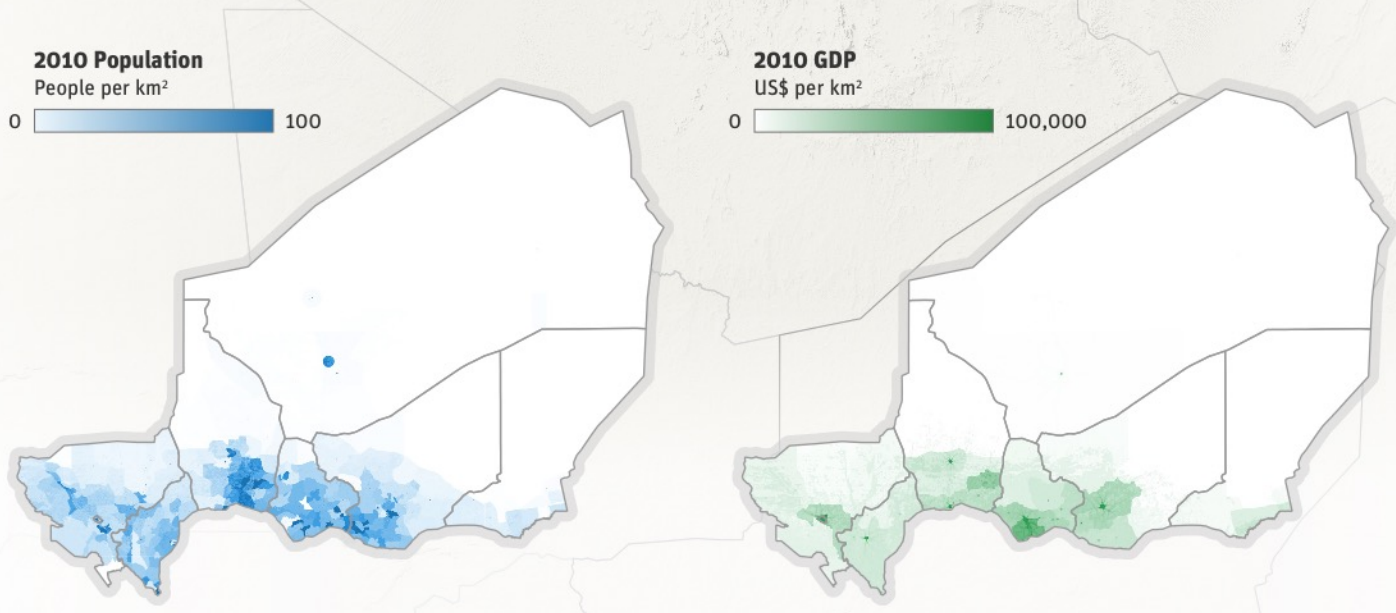
Relatively uniform building stock in the Nigerian city of Agadez.

NIGER

Drought   Flood   Landslide

Droughts and floods pose the most significant and recurring risk to Niger. Drought affects the entire country, whereas floods mainly affect the southwestern regions in Niger.

Droughts affect most people due to Niger's climate and uneven distribution of water resources. On average, 4 million people are affected by drought every year, but this number can be substantially higher in dry years.

Flooding poses a threat mainly in the River Niger basin with about 100,000 people affected by floods each year, on average. A much smaller number of people are at risk from **landslides**.
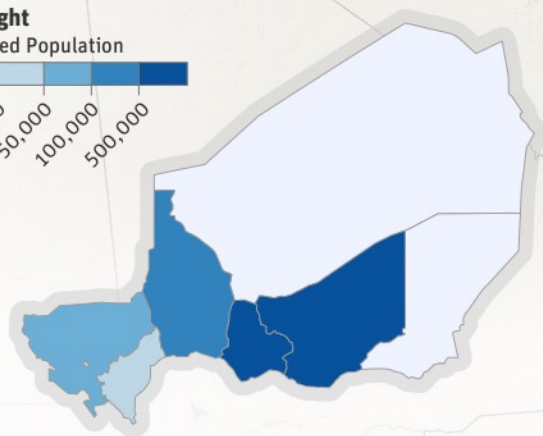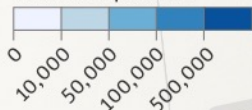
Future changes in Niger's population and economy, coupled with changes in climate-related hazards, are expected to increase the impacts of droughts and floods.

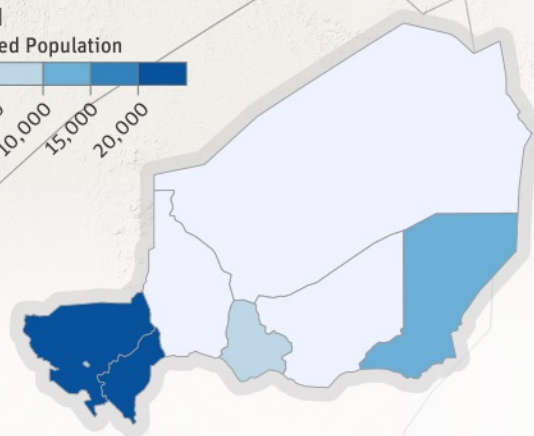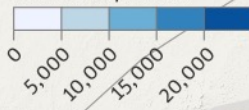## Modeled Impact on Population*
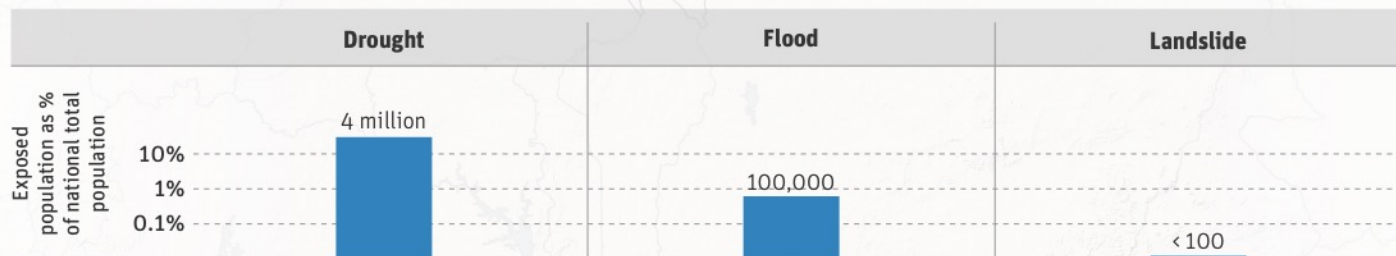
*All data is from 2010

Drought
Affected Population

0
10,000
50,000
100,000
500,000

Flood
Affected Population

0
5,000
10,000
15,000
20,000

Modeled Impact*

*All data is from 2010

Population

	Drought	Flood	Landslide
Exposed population as % of national total population	4 million	100,000	< 100

10%
1%
0.1%

Hazard Summary Table

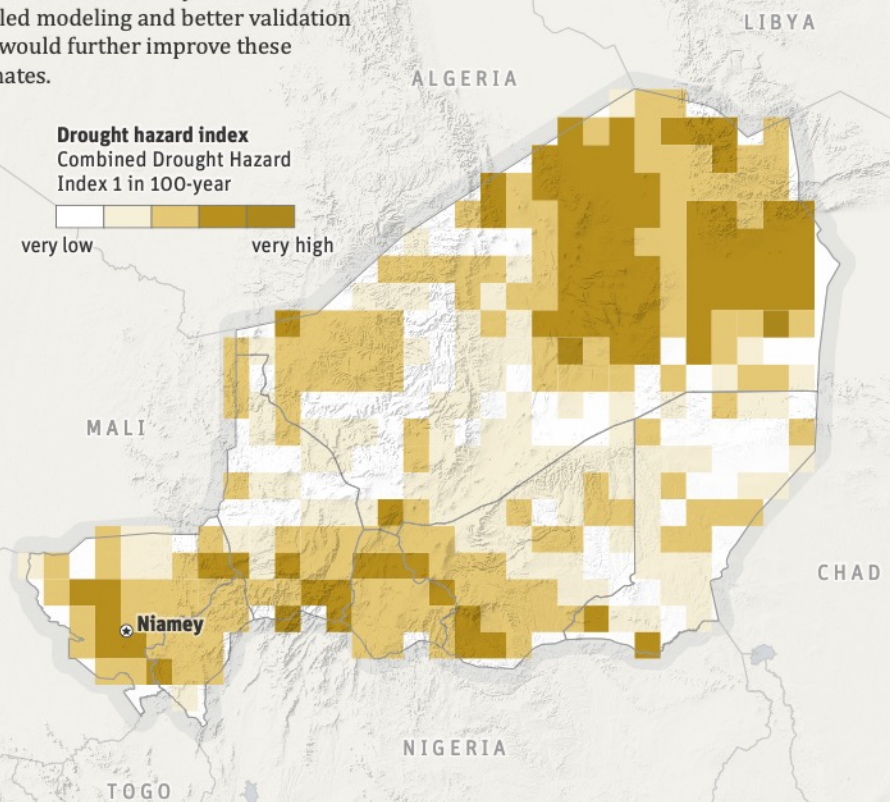| HAZARD	IMPACT
(drought)	Around 4 million people are affected by water scarcity each year on average, as a result of hydrological drought.
(flood)	On average, 100,000 people and 200 education and health facilities across the country are affected by river flooding each year.
(landslide)	Landslide is a very localized hazard with low overall risk to people and other assets due to the flat topography of Niger.

Droughts are sustained periods of below-normal water availability. Droughts occur due to natural atmospheric variability (e.g. El Niño conditions) and desertification caused by land degradation. Increasing rainfall variability and extremes are increasing drought hazards. Niger has faced recurrent droughts in recent times (e.g. 2011 and 2017) with several million people requiring food assistance.

This risk profile assesses hydrological drought impacts on population and the effects of agricultural drought on crop income. Hydrological drought is characterized by estimating the potential deficit of water availability in rivers and reservoirs. Large deficits occur in all regions in Niger with the Agadez region in the northeast of Niger being the most affected area (see main map). Agricultural drought is assessed by estimating the potential for lack of rainfall and its impact on rainfed crops.

The bars below indicate the number of people located in areas affected by a lack of water availability. Agricultural income loss refers to the value of crops lost due to agricultural drought, based on long-term crop prices and estimated yield loss. These are modeled estimates and are inherently uncertain. Based on the limited historical numbers recorded from previous droughts, the modeled numbers for affected population and agricultural

income loss seem to be conservative estimates. Further analysis with more detailed modeling and better validation data would further improve these estimates.

Drought hazard index
Combined Drought Hazard Index 1 in 100-year

very low ——————— very high

Modeled Impact

Population

Annual average —————————————— 4 million people affected

Agricultural Income Loss

AAL ▬ $15 million
1-in-10 year ▬▬▬ $60 million
1-in-50 year ▬▬▬▬▬▬ $150 million
1-in-200 year ▬▬▬▬▬▬▬▬ $300 million

AAL = Average Annual Loss; 1-in-10 year return period equates to a 10% annual probability; 1-in-50 to 2% annual probability; and 1-in-200 to 0.4% annual probability.

Key Facts

- Droughts are a recurrent hazard in Niger and the wider Sahel region. They have contributed to severe food crises including in 1980, 1988, 1990, 1997, 2001, 2005, 2009, 2011-2012 and 2017.
- The 2011 drought left several million people in need of food assistance, and in 2017 1.5 million people required emergency food assistance.
- Livestock are an important component of the agricultural economy of Niger, and livestock are adversely effected during droughts. However, this analysis does not account for impacts on livestock.

ⓘ The distribution of drought risk is determined by the occurrence of drought hazard/events, the location where assets intersect with this hazard, and the vulnerability of those assets. For more detail, see the Methodology section.
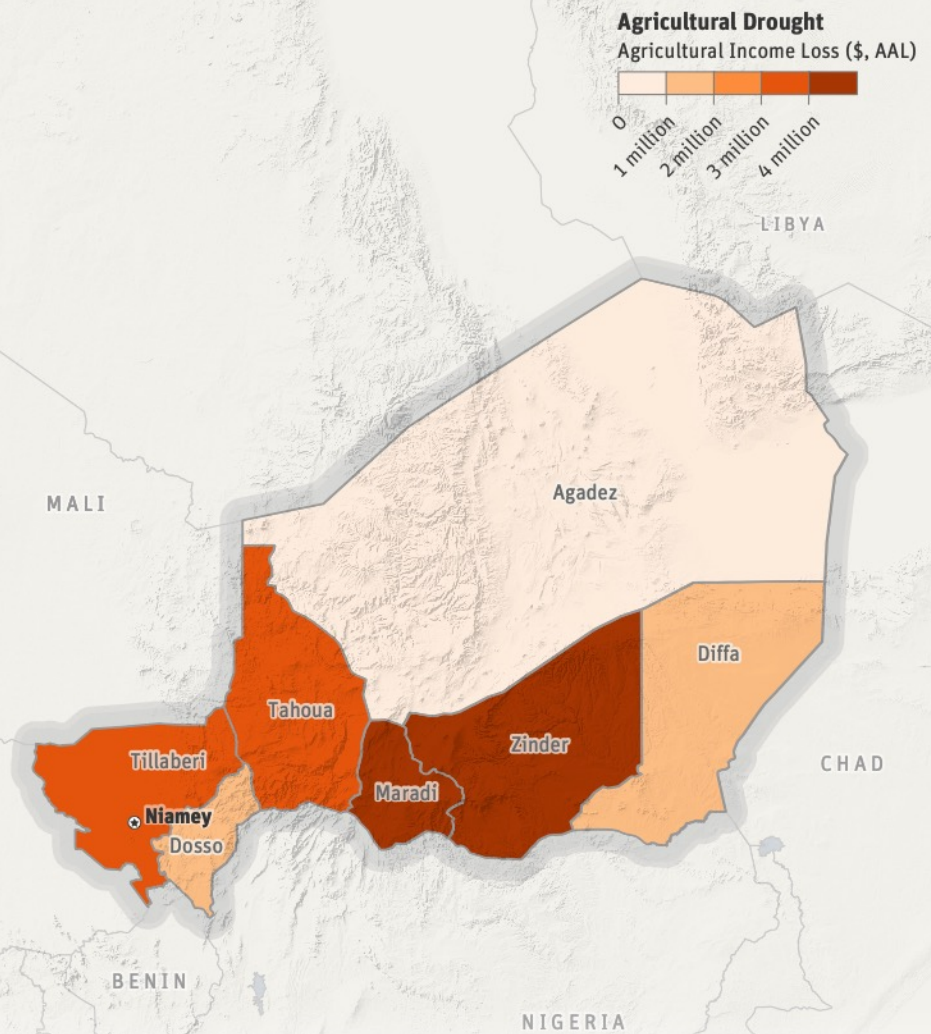
Hydrological drought risk is greatest in the regions of Maradi, Zinder and Tahoua. In Maradi 3 million people live in areas expected to suffer water scarcity each year, with a further 0.8 million people in Zinder and Tahoua. As indicated previously, these numbers are probably conservative estimates. These do not factor in emergency measures taken during drought periods to improve the water availability in certain regions.

On average, once every 10 years a loss of at least $60 million in agricultural income is expected to occur in Niger. Maradi, Tahoua and Zinder are the regions most at risk of crop loss.For more extreme events these losses will increase further: a loss of the order of $150 million would be expected approximately once in a lifetime.
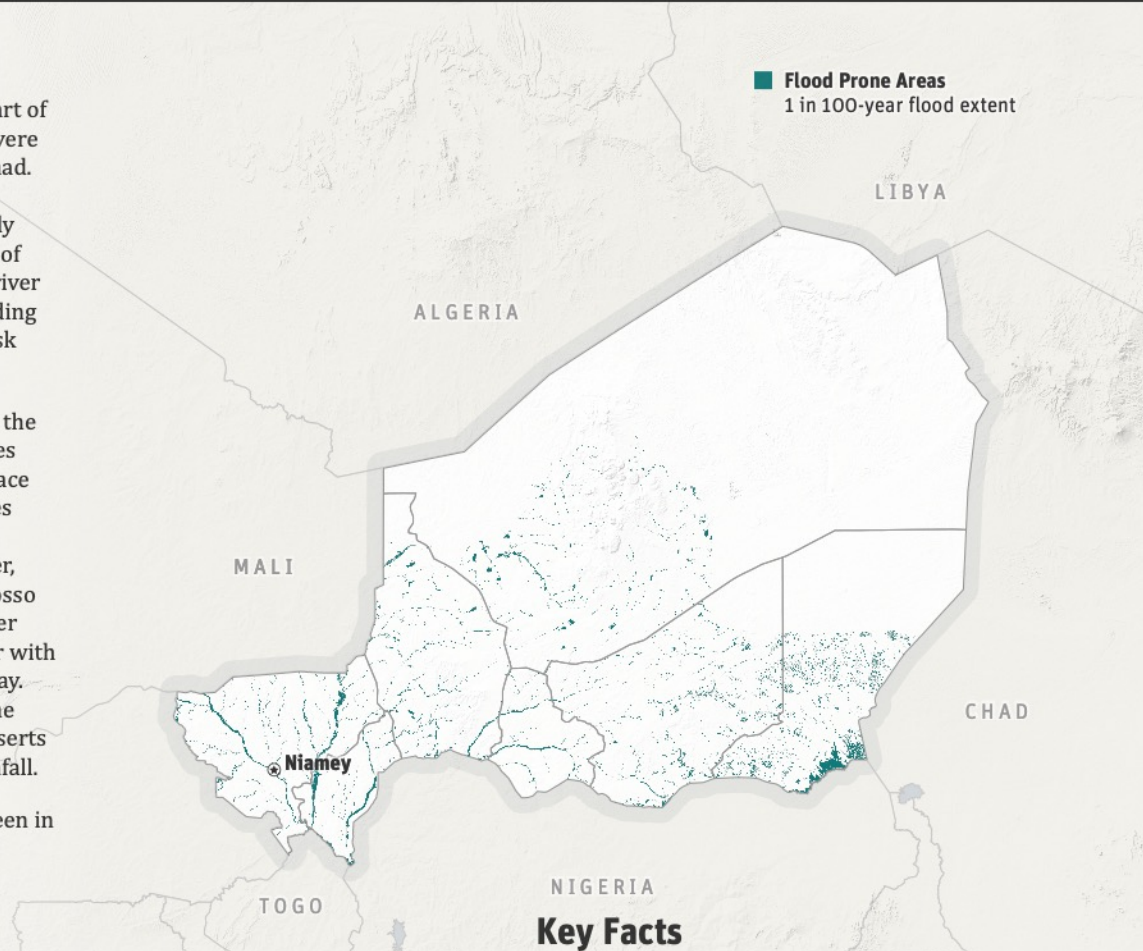
Agricultural Drought
Agricultural Income Loss ($, AAL)

0
1 million
2 million
3 million
4 million

LIBYA

MALI

Agadez

Tahoua

Diffa

Tillaberi

Zinder

CHAD

Maradi

Niamey

Dosso

BENIN

NIGERIA

Asset Distribution	Average annual affected (water scarcity) Per region	Average Annual Loss Contribution to national average loss

Population
Pop. exposed to water scarcity

1 million
100,000
10,000
1,000
0

20%
10
2
1
0

Flood Prone Areas
1 in 100-year flood extent

Flood hazard in Niger is mainly concentrated in the southern part of the country. It is particularly severe along the border with Nigeria and Chad. In addition, the land along the Niger River and its tributaries is particularly prone to flooding. The national scale of these profiles means the focus is on river flooding, and surface flooding (including urban flood) is not included in the risk estimates.

The western part of Niger belongs to the River Niger basin. This area comprises about one-third of the country's surface and about 40% of the population lives within this basin. Various tributaries of the River Niger are present in Niger, including the Mékrou River, Dallol Bosso River and Tapoa River. The River Niger floods yearly beginning in September with a peak in November and ending in May. The eastern part of Niger is part of the Chad Basin. This basin consists of deserts and savannahs with very limited rainfall.
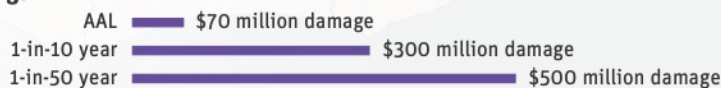
The flood potential in Niger can be seen in the main map.

LIBYA

ALGERIA

MALI

NIGERIA

CHAD

Niamey

TOGO

Modeled Impact

Population
Annual average	90,000 people exposed
1-in-10 year	400,000 people exposed
1-in-50 year	650,000 people exposed

Buildings
AAL	$70 million damage
1-in-10 year	$300 million damage
1-in-50 year	$500 million damage

Education and Health Facilities
Annual average	200 facilities exposed
1-in-10 year	900 facilities exposed
1-in-50 year	1,500 facilities exposed

Transport
Annual average	200 kilometers exposed
1-in-10 year	900 kilometers exposed
1-in-50 year	1,500 kilometers exposed

Agriculture
AAL	$1.5 million crop damage
1-in-10 year	$7.5 million crop damage
1-in-50 year	$15 million crop damage

AAL = Average Annual Loss; 1-in-10 year return period equates to a 10% annual probability; and 1-in-50 to 2% annual probability.

Key Facts

- Floods in 2012 were called "the worst flooding in more than 80 years"[8]. These floods caused very high human, material and production losses. Approximately 300 people were killed, 6,000 injured and 4 million people were affected. Given its extremity, the impact of this event is beyond the estimates for affected population or damage provided for the various return periods herein.

- According to the Desinventar database of disaster impacts, there have been 1.3 million people affected by flooding in Niger in the past decade. In that time, over 130,000 Hectares of crops have been damaged.

- Erosion of topsoil by wind and by water during heavy rain and flooding is common. This causes loss of agricultural productivity and also damage to properties. This additional hazard has not been quantified here.

ℹ The distribution of flood risk is determined by the occurrence of flood events, the location where assets intersect with these hazards, and the vulnerability of those assets. For more detail, see the Methodology section.

There is significant flood risk in the western part of Niger. Over $500 million of damage to the building stock may occur in at least one flood in a person's lifetime based on the modeling results. It is expected that on average each year, 90,000 people will be affected by flooding. With climate change and increased population, these numbers will very likely increase substantially.

On average, each year flooding is expected to affect areas that cause exposure of 200 kilometers of transport infrastructure and 200 education and health facilities. The areas contributing most to the national estimated building damage and affected population are Diffa and Tillaberi. These areas are also dominant in terms of the contribution to the flood exposure of transport and education and healthcare facilities.

Based on the historical records, the estimated affected population from the modeling results is probably a good preliminary estimate for the actual situation. The estimated building damage, however, cannot be validated due to absence of good validation data. These numbers should be interpreted therefore with care and further analysis is needed for Niger to fine tune these numbers.

Flood
Exposed Population (average per year)
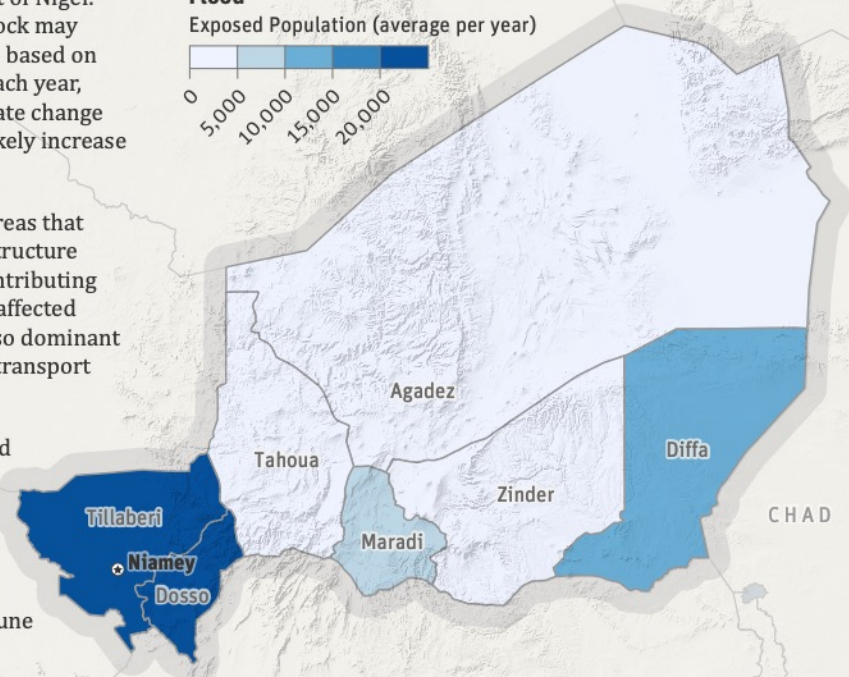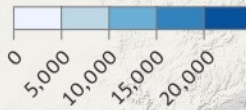
0   5,000   10,000   15,000   20,000

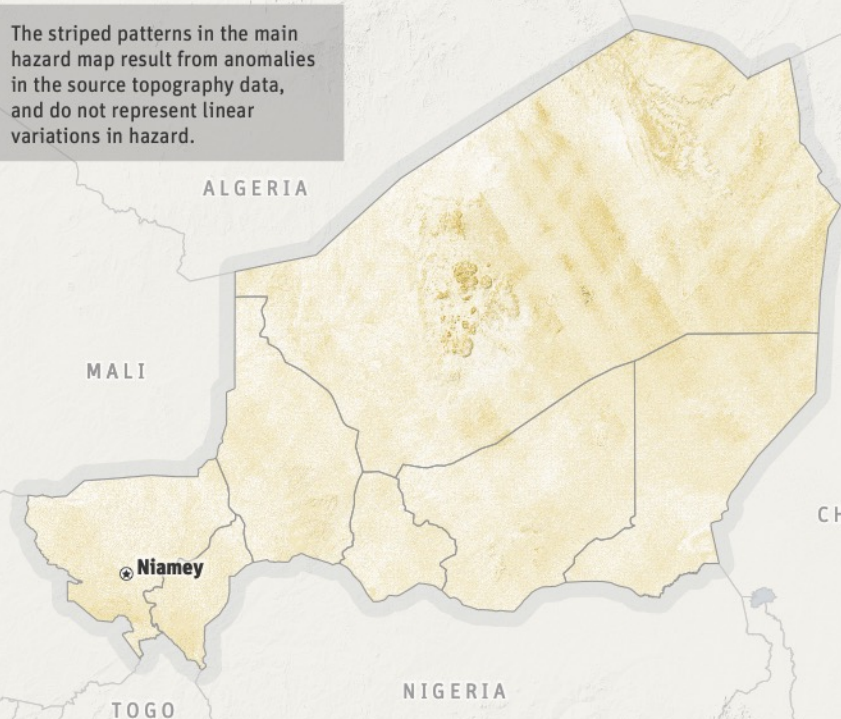|	Asset Distribution	Average Annual Loss Per Province	Average Annual Loss per Province Relative to national total
Buildings $ Damage		10 million / 5 / 2 / 1 / 0	40% / 30 / 20 / 10 / 0
Education and Health Facilities Facilities exposed		60 facilities / 50 / 20 / 10 / 0	40% / 30 / 20 / 10 / 0
Transport Km exposed		40 m / 30 / 20 / 10 / 0	40% / 30 / 20 / 10 / 0

Landslide hazard in Niger is generally low, due to the relatively flat topography in much of the country. The exception, with very localized moderate to high landslide hazard is in Aïr Mountains in the center of the country in Agadez region. This area has higher topographic relief, with mountains rising to 2000m high. Similarly localized moderate susceptibility exists in the Djado Plateau in the northeast of Agadez region.

The terrain of the southern border areas and southwest areas around the capital city Niamey have generally low susceptibility to landslides, based on slope, land-use and soil conditions. However, the potential for heavy rainfall during the rainy season in these areas leads to moderate landslide hazard in southern Tillaberi and Dossa regions, and also in Tahoua and Zinder.

The areas of moderate landslide hazard in the south coincide with the greatest density of population and economic activity in the country. There is the potential that future development of these areas could increase local landslide

hazard by destabilizing slopes through activities related to urbanization, such as road cutting, deforestation and construction on slopes.

The striped patterns in the main hazard map result from anomalies in the source topography data, and do not represent linear variations in hazard.

Rainfall-triggered landslide hazard index

very low   very high

Modeled Impact

Population
Annual average   < 100 people affected

Buildings
AAL $100,000 damage

Education
AAL $50,000 damage

Health
AAL $25,000 damage

Transport
AAL $20,000 damage
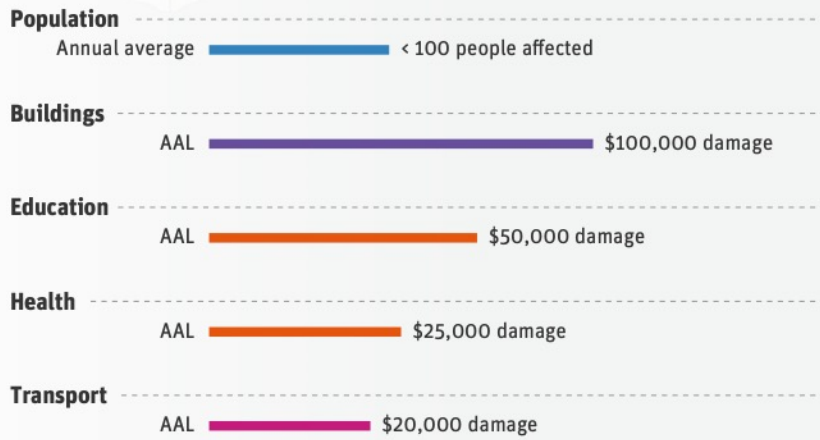
Key Facts

- Despite the low landslide hazard and absence of reported major landslide events, this profile objectively quantifies the landslide hazard risk across the country for use in disaster risk management.
- Damage due to landslide has been estimated across the whole country using a novel method that enables estimation of annual average risk using landslide susceptibility factors combined with rainfall triggers, and the potential impact of different sizes of landslides on the population, buildings, and transport networks.

ⓘ   Landslide risk is a function of population and assets being located in areas susceptible to landslides (based on slope angle, vegetation cover and soil type), and the potential for earthquakes and rainfall to trigger landslides there. For more detail, see the Methodology section.

LANDSLIDE
NIGER

Due to the generally low landslide hazard in Niger, the risk to population and risk of damage to the building stock, critical facilities and transport networks from landslides are also low.

On average, each year only around 20 people are at risk of being affected by landslides, which reflects the very localized nature of the hazard.

Damage to the building stock (including health, education and energy facilities) would be expected to be less than $100,000 per year. The regions contributing most to the risk are Tillaberi, Dossa, Tahoua, Maradi, and Zinder.
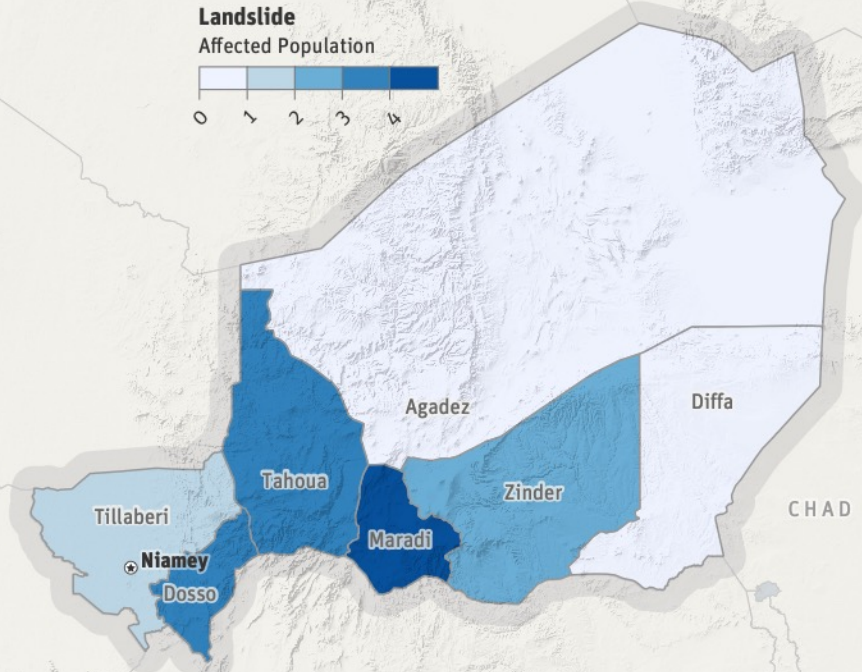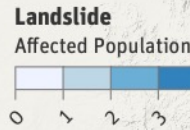
Landslide
Affected Population

0 1 2 3 4

CHAD

Asset Distribution	Average Annual Loss Per Province	Average Annual Loss per Province Relative to national total
Buildings $ Damage	8,000 / 6,000 / 4,000 / 2,000 / 0	20% / 15 / 10 / 5 / 0
Health Facilities $ Damage	600 / 500 / 400 / 300	20% / 15 / 10 / 5 / 0
Education Facilities $ Damage	2,500 / 2,000 / 1,500 / 1,000 / 0	20% / 15 / 10 / 5 / 0

GLOSSARY AND NOTES

Glossary

Average annual loss

Average annual loss (AAL) is the estimated impact (in monetary terms or number of people) that a specific hazard is likely to cause, on average, in any given year. It is calculated based on losses (including zero losses) produced by all hazard occurrences over many years.

Exposure

Exposure refers to the location, characteristics, and value of assets such as people, buildings, critical facilities, and transport networks located in an area that may be subject to a hazard event.

Hazard

Hazard refers to the damaging forces produced by a peril, such as ground shaking induced by an earthquake or water inundation associated with flooding.

Risk

Disaster risk is a function of hazard, exposure, and vulnerability. It is quantified in probabilistic terms (e.g., Average Damage Per Year, and return period losses) using the impacts of all events produced by a model.

Vulnerability

Vulnerability is the susceptibility of assets to the forces of a hazard event. For example, the seismic vulnerability of a building depends on a variety of factors, including its structural material, quality of construction, and height.

Notes

[1] Central Intelligence Agency, The World Factbook, 2015, https://www.cia.gov/library/publications/the-worldfactbook/.

[2] Ibid.

[3] United Nations Data, 2016, http://data.un.org/Default.aspx.

[4] United Nations Development Programme, *Human Development Report 2015: Work for Human Development* (New York: United Nations Development Programme, 2015), http://hdr.undp.org/en/data.

[5] Central Intelligence Agency, The World Factbook, 2015, https://www.cia.gov/library/publications/the-worldfactbook/.

[6] World Food Programme, 2016, https://www.wfp.org/countries/niger/operations/unhas-current-operations.

[7] Ibid.

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