Flood Displacement Risk Profile

Addressing Drivers and Facilitating Safe, Orderly and Regular Migration in the Contexts of Disasters and Climate Change in the IGAD Region

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Background

The member states of the Intergovernmental Authority on Development (IGAD) are some of the most vulnerable to disasters globally. it is not unusual that the Region experiences sequences of drought periods contrasted by wet periods that cause widespread flooding, landslides and storm damage, resulting in destruction of property and loss of services and livelihoods. In 2019, more than 1.5 million people were newly displaced, both within their countries, and across international borders. Many of those forced to move had previously been affected by widespread rain shortages in a region classified as 60 -70 per cent arid and semi-arid; in Somalia alone, 1.15 million people were displaced in the context of drought and land degradation during 2017 and 2018.

Severe drought and flooding contributed to extensive displacement in 1993, 1999, 2005, 2011 and 2015; with earthquakes, landslides, tsunamis, wildfires and high winds having similarly contributed to displacement across IGAD over the last fifty years. These examples reflect a persistent pattern of largescale displacement in the context of disasters across the region. Sea level rise, changes in temperature, erratic rainfall and the increasing intensity of extreme weather events related to climate change are projected to further adversely affect people's livelihoods, exacerbating displacement, and making adaptive migration more difficult.

Disaster displaced persons can be particularly vulnerable to rights violations, including through lack of access to essential documentation, security, community life, education, and other basic amenities. Vulnerable groups, including socially marginalised populations, children, older persons and those with disabilities are especially at risk. For governments, both short-term and protracted displacement pose serious socio-economic challenges in terms of basic service provision, social cohesion and individual and collective wellbeing. High levels of displacement moreover prejudice sustainable development 'and have the potential to undermine broader development gains, particularly if the needs of those affected are not adequately addressed.

IGAD member states have consequently recognised the need to develop a coordinated and protection-centred response to disasters that allows people to move in order to mitigate the worst effects of natural hazards, including through the recent endorsement of a Free Movement Protocol, which permits movement across regional borders 'in anticipation of, during or in the aftermath of disaster'. In addition to these developments in migration policy, IGAD members have identified the need to protect against future displacement through effective disaster risk reduction (DRR), climate change adaptation (CCA), and development policies and strategies. Where displacement does occur, these policies also help ensure that the rights of those displaced are safeguarded, and that displaced people are able to build back better when the effects of a disaster abate.

In order to achieve this goal, numerous regional and international agreements, including the Nansen Initiative Protection Agenda on the rights of those displaced in the context of disasters, the Global Compact on Refugees, and the Global Compact for Safe, Orderly and Regular Migration have made clear that DRR, CCA and Development policies should incorporate human mobility concerns. The Sendai Framework for Disaster Risk Reduction (SFDRR) specifically recognises the particular protection needs of the disaster displaced. There remains, however, a lack of comprehensive information on the extent to which human mobility is incorporated in DRR, CCA and development policies and strategies in the IGAD region, which limits progress in advancing the protection of those displaced by disasters and climate change.

To this end, a number of UN agencies and partners established a Joint Programme[1] funded under the Migration Multi-Partner Trust Fund (MPTF)[2] to improve regional and national migration governance in the context of the adverse impacts of climate change and environmental degradation. To enhance this governance, evidence is key. The Joint Programme has therefore

supported this study developing as an innovative solution to addressing risk modelling.
Among the sudden onset hazard that are relevant in determining such important displacement figures flood is the dominant one in the region. Therefore, the compilation of a displacement risk profile forced by flood damages seems an important piece of information to reconstruct the puzzle of displacement risk in the region.

Importance of disaster risk knowledge

Risk Assessment is at the basis of many risk-related activities. As such it needs to be based on scientific risk information that assesses vulnerability, hazard and exposure to estimate disaster impacts - quantifying population and economic losses across different regions and sectors.
As widely known, disasters' consequences depend not only on the socio-economic conditions of the affected communities but also on the institutional preparedness and capacity to manage such events. Thus, to be able to predict when events happen, and which impacts are they likely to have on the ground is of extreme importance to build strong institutional responses.

Disaster displacement refers to situations where people are forced to leave their homes or places of habitual residence as a result of a disaster or in order to avoid the impact of an immediate and foreseeable natural hazard. Forced displacements generally result from the fact that affected persons are exposed to a natural hazard in situations where they are too vulnerable and lack the capacity to face its impacts.
Similarly to disaster risk, disaster displacement risk is linked to the nature and magnitude of a given hazard, and to people's exposure and vulnerability. It is used to estimate the likelihood of future disasters triggering displacement. The assessment of vulnerability levels in particular is useful in understanding why extreme events do not always have extreme impacts on people and territories, while less extreme events can have extreme impacts. It explains why two hazards of similar intensity and duration that occur in two different situations could have very different impacts in terms of damage and the number of people affected and displaced.
Understanding the parameters that influence vulnerability level and disaster displacement risk is essential to inform effective policies and strategies that prevent and manage disaster displacement risk, and so reduce the number of people forced to flee.

The study here reported on flood induced displacement in the IGAD region builds on the results obtained in the framework of the collaboration among WFP, IGAD and CIMA for the development of a regional flood risk profile. Starting from the assumption that science-based predictive tools are in this sense an increasing fundamental tool for climate adaptation, by enabling disaster prediction and by supporting risk management efforts, the regional risk profile has followed a predictive-probabilistic methodology (see next section): using GloFAS (Global Flood Awareness System, link - https://www.globalfloods.eu/), a modelling suit developed by the Joint Research Centre of the European Commission (https://joint-research-centre.ec.europa.eu/index_en) this project developed thousands of flood risk scenarios which were analyzed and interpreted, relating their possible consequences on different exposure categories, such as population, grazing land, infrastructure and crops affected. The analytical

1 - Joint Programme: Addressing Drivers and Facilitating Safe, Orderly and Regular Migration in the Context of Disasters and Climate Change in the IGAD Region bit.ly/Joint-Programme-IGAD Partners include IOM, the International Labour Organization (ILO), the Platform on Disaster Displacement (PDD), UNHCR, and the IGAD Secretariat including the IGAD Climate Prediction and Application Centre

2 - The MPTF is the first and only UN inter-agency pooled funding instrument focusing on migration. It was called for by Member States through the adoption of the GCM (A/RES/73/195) in 2019. More information at www.migrationnetwork.un.org and https://mptf.undp.org/factsheet/fund/MIG00 process was developed under both current (1980-2018) and future climate conditions (2050-2100), considering the IPCC scenario RCP 8.5 which foresees an increase in the global temperature between 1,5°C and 4°C by 2100. Achieved outputs, represented through maps and graphs, aim not only at providing the Greater Horn of Africa region with updated and predictive flood risk information - so to better prepare for future climate conditions - but also to foster the integration of such information with other possible disasters' cascading effects - such as food security, population displacement, disease outbreaks and conflicts.

In a first phase, the regional flood risk profile outputs were linked with the strategic goals of the Word Food Program – to support countries to achieve zero hunger - and to those of IGAD, committed to build stronger regional emergency response interventions. In this second phase, instead, the regional risk profile outputs were instead connected to the analysis of potential displacements in the area.
Approaches to disaster displacement risk assessment have until now calculated vulnerability levels by considering physical aspects linked to the housing sector (see, for instance, the report IDMC 2017). The extent of damage that a hazard is likely to cause to homes is then used to determine the number of people likely to become homeless and by extension displaced. If a disaster renders a home inhabitable it is assumed that its occupants will be displaced at least temporarily.

However, the level of people's vulnerability depends not only on the housing conditions, but also on a range of other critical factors, that should be included in the assessment, to have a better understanding of the situation. In fact, also people living in the same geographical area have different levels of vulnerability, because they could live in different types of dwellings (i.e., concrete houses, huts), they could have different sources of livelihood and income, different social and individual conditions. For this reason, people do not move only as a consequence of losing access to their homes, but also as a consequence of losing their livelihoods and access to basic services such as health and education.

Such elements, however, are not yet included in standard risk models despite the fact that they help to determine whether people flee or not. Next section – after introducing the methodology adopted for developing the flood risk profile – focuses precisely on how to include in this probabilistic approach the additional elements that can trigger displacements.


Photo by AMISOM Public Information

Methodology

Several methodologies exist for the development of a Risk assessment and often there is not a better or worse methodology. They are intimately linked with the application they are intended to be used for. However, some methodologies have a higher information content and allow for more flexibility in their practical use. One of these is the probabilistic risk assessment approach, which is the methodology we are proposing in this study, in continuity with the work done by UNDRR and other actors (e.g., GFDRR) in the African continent from profiles at national and subnational level.

The added value of a Probabilistic Risk Assessment (PRA) is often misunderstood, as audiences tend to view it as a highly technical method that is difficult to apply or understand. These difficulties represent a challenge for communicating risk results.

Within the present risk profile strong emphasis is placed on the knowledge transfer that is a key ingredient of the methodology. The process of risk definition was in fact developed together among all the partners.

A probabilistic disaster risk profile should be seen as a risk diagnosis instrument, as it provides indications on possible hazardous events and their impacts. Both past and probable future events have been taken into consideration in a comprehensive risk assessment exercise. In this risk profile two different climate scenarios were considered:

- **under current climate conditions**: with disaster risk assessed using the observed climate conditions in the 1980 - 2018 period;
- **under projected climate conditions**: with disaster risk being assessed under projected climate conditions (projected period 2050 - 2100), considering the IPCC scenario RCP 8.5 which foresees an increase in the global temperature between 1.5°C and 4°C by 2100, and assuming that further risk mitigation measures will not be put in place. Further details about the choice of the reference climate scenario are given in Section 3

Probabilistic disaster risk profiles consider all possible risk scenarios in a certain geographical area. This means that both low frequency, high loss impact events, as well as high frequency, lower loss impact events are calculated. Included is their probability of occurrence, and all elements of the risk equation (risk = hazard X exposure X vulnerability / capacity), their variability and uncertainty ranges.

Events which have never been historically recorded but might occur in projected climate conditions are also considered in the risk analysis. This feature is particularly useful in the context of climate change which is dramatically increasing uncertainty about future hazard patterns. Thus, societies need to calculate their "worst" possible impacts in order to be prepared. Under this lens, there is no valid alternative to a probabilistic analysis to address this uncertainty in a usable, quantitative way.

By assigning a probability of occurrence to each event magnitude, a probabilistic risk profile usually quantifies the expected direct impacts of disasters through economic metrics and affected population. When dealing with displacement probabilistic risk assessment, direct impacts are translated in terms of potential displacements; more precisely, in this new approach direct effects on residential areas and working places are evaluated and connected to residential population and employees, respectively.

As this risk information is framed within return periods as a conventional probability measure, a displacement PRA approach provides a clear vision of the risk trends.

This disaster displacement risk information - expressed in an annual average displacement (AAD) and a probable maximum displacement curve (PMD) – is calculated both at a national scale, as well as by region, allowing for a geographic and quantitative comparison of displacements, as well as within a country and/or between countries.

These analyses and comparison exercises are an important step of the disaster displacement risk awareness processes, key in pushing for displacement risk reduction, adaptation and management mechanisms to be put in place.

Flood risk assessment involves four main steps:

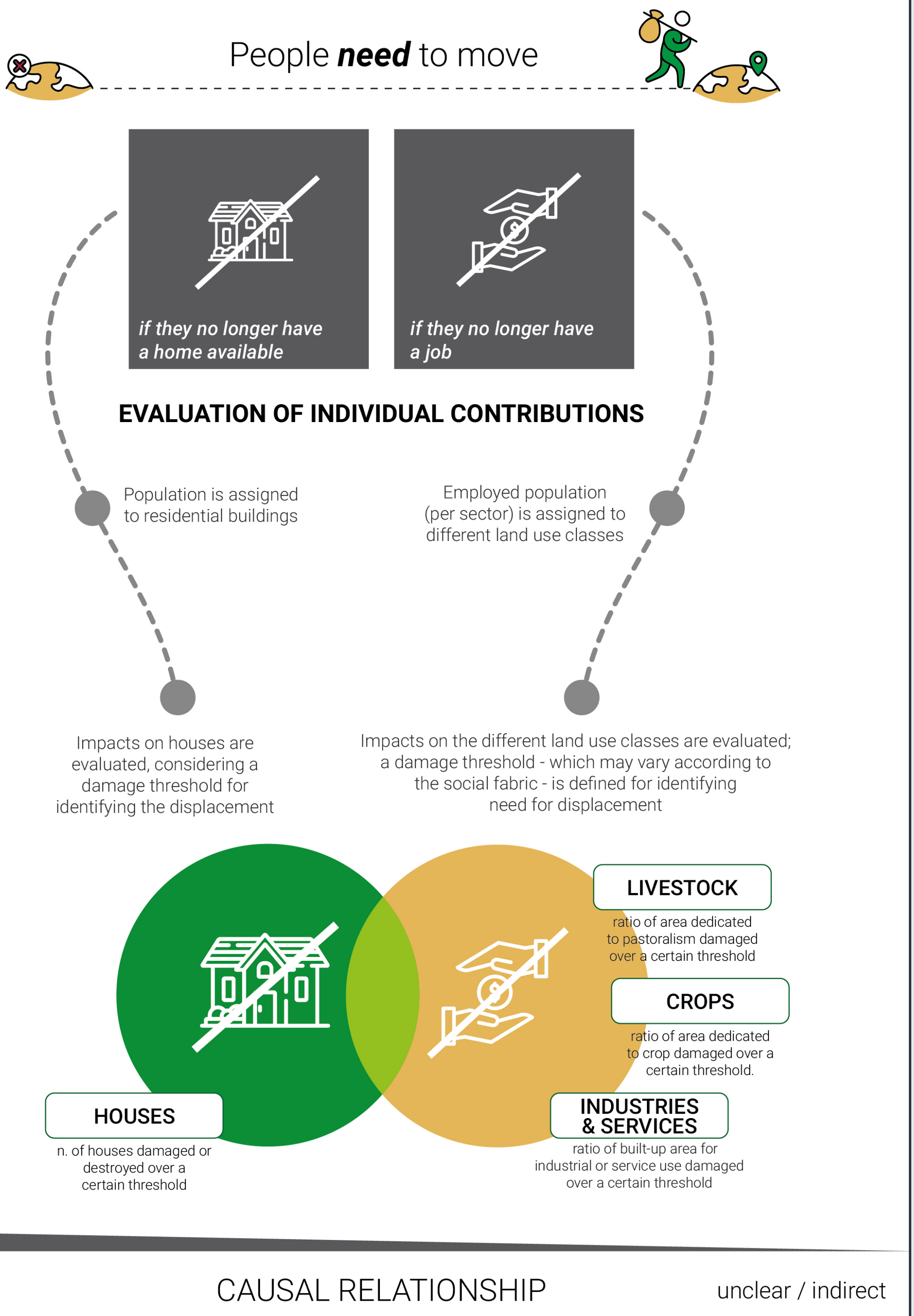
- **flood hazard assessment**;
- **identification and characterization of exposed elements**;
- **vulnerability assessment**;
- **capacity / performance of flood** protection/structural mitigation measures in lowering flood damaging conditions.

From the combination of these four steps into a flood model we are able to determine direct impacts on selected exposure categories, fundamental for determining disaster displacement risk. For obtaining such a result, these further steps are necessary:

- **evaluation of potential displacements as a consequence of loss of housing**;
- **evaluation of potential displacements as a consequence of loss of livelihoods** (possibility to work);
- **evaluation of potential overlays between the two previous figures**.

From the combination of these three elements, it is possible to evaluate potential displacements triggered by flood events.

Displacement risk assessment methodology



Different procedures and methodologies to determine flood risk are used worldwide through a variety of models and approaches. Their common aim is to understand the probability that different magnitudes of damaging flood characteristics - considering flood depth, horizontal flood extent, flood velocity and flood duration - will occur over an extended period of time. These estimates can be calculated both in current and projected climate conditions through a consistent analysis of meteorological, geological, hydrological, hydraulic and topographic properties of the watershed, channels, and floodplains, resulting in detailed hazard maps.
In the case of this study, we have utilized the modelling suit developed by the Joint Research Centre of the European Commission (JRC) called GloFAS (Global Flood Awareness System) validated and adapted using hydrologic data from the region. The modelling suit includes Hydrologic simulations in present and future climate for all the regions as well as the related hazard maps determined by a 2-dimensional hydraulic model mimicking the water behavior in the flood plain.
The obtained Hazard maps are then combined with the reproduction of past events patterns, derived from the joint analysis of multiple simulated streamflow time series. This procedure is replicated for simulations of the projected future events. Information on the performance capacity of flood protection measures is finally added to the analysis. This workflow allows for the estimation of the "expected" water depth for a certain location and/or individual infrastructures, for a set of reference scenarios. From this step on, it is possible to explore the full frequency distribution of events and the consequent damage to exposed assets, taking into consideration their different levels of vulnerability.

Direct damages are computed through the use of physical vulnerability curves, connecting water depth for a given element with the expected percentage damage; different exposed elements are characterized by different vulnerability curves. Each element is characterized by the amount of associated people – residents for residential areas, employees for working places. The number of potential displacements for a given flood scenario is evaluated by defining a threshold in terms of damage: people associated to elements characterized by a damage overcoming such a threshold for the given scenario are considered as potential displacements. Due to the introduction of specific vulnerability curves, the same water depth could lead to potential displacement when insisting on a poorly built building, but not on a well-built one.

The number of of displacements in a selected given area depends on the probability of people being displaced because their homes have been rendered inhabitable, plus the probability of their being displaced because of livelihood loss, minus the probability of their having lost both their home and livelihood.
This concept can be formalized in the following equation:

$$d_{tot} = d_h + d_l - d_h \cap d_l$$

Where:
d_{tot} is the total number of displacements
d_h is the number of displacements due to housing loss
d_l is the number of displacements due to loss of livelihood

The probability of people losing both their home and livelihood can be expressed as $P(d_h|d_l)$: the probability of people being displaced because of their home has been made inhabitable conditioned to the fact that they have been displaced because of the loss of livelihood loss, transforming previous equation as follows:

$$d_{tot} = d_h + d_l \cdot (1 - P(d_h|d_l))$$

The probability of people being displaced because of livelihood loss is subdivided between people those who depend on agriculture, pastoralism, services, or industry. They are evaluated by considering – for any given residential area – the percentage of workers of the specific sector employed in facilities located in hazard prone area.

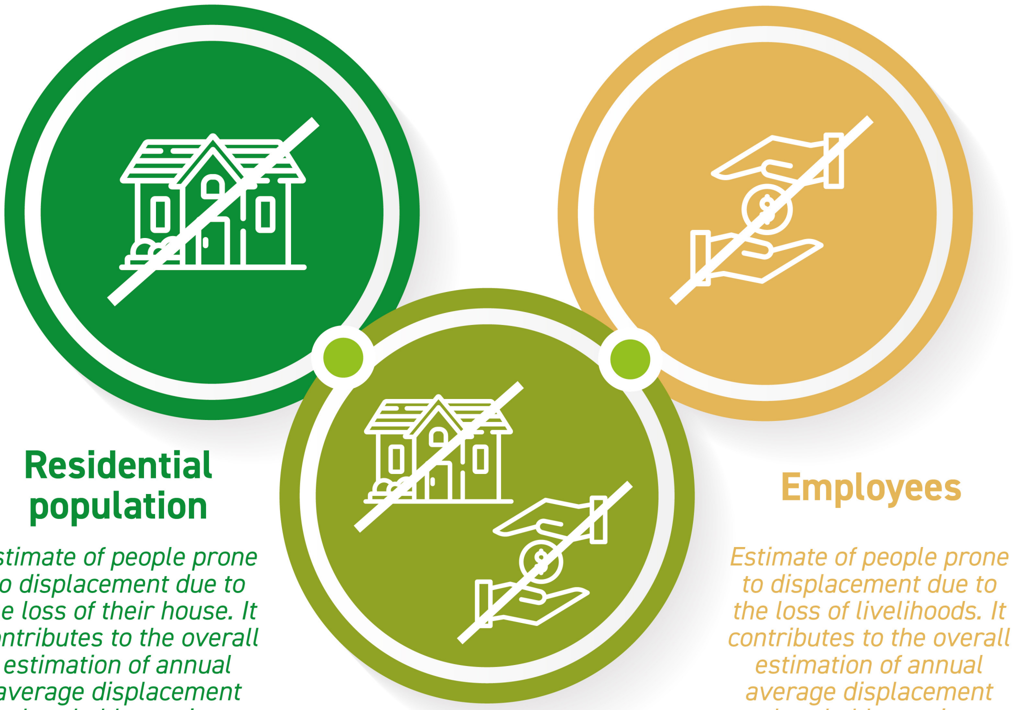
The probability of a given flood magnitude is expressed in terms of the "return period" (or recurrence interval). Return period is the average time interval, in years, separating two consecutive events equal or exceeding the given flood magnitude. The damage assessment is converted into proper metrics through the computation of the average annual displacement - the expected displacement per year, averaged over many years - and the probable maximum displacement - a relationship describing all the potential displacements with a certain probability range.

Exposure model

To evaluate the different components of the model, a spatial representation of the population in question subdivided by the various services/functions is required. More specifically:

- To calculate the number of people displaced because of house damage, the population living in different residential areas and each building is needed.
- To calculate the number of people displaced because of livelihood loss, the distribution of employees in each sector, such as agriculture and industry, is needed. More practically, we need to know where people's workplaces are and how many work there.
- To avoid considering twice people being affected by both loss of house and livelihood, we need to know the ratio of residential population working in hazard prone areas.

These first two distributions are used directly to derive dh and dl, whereas the third one are used to avoid to evaluate the term $P(d_h|d_l)$. Whenever we determine that an asset - a home, or a workplace - is affected by an event, we can derive the number of people affected and identify them as susceptible to displacement.
The three distributions are described, along with the data sources and approaches adopted for obtaining them, in the next picture/table.



Residential population

Estimate of people prone to displacement due to the loss of their house. It contributes to the overall estimation of annual average displacement and probable maximum displacement.

Employees

Estimate of people prone to displacement due to the loss of livelihoods. It contributes to the overall estimation of annual average displacement and probable maximum displacement.

Residential population working in facilities located in hazard prone area

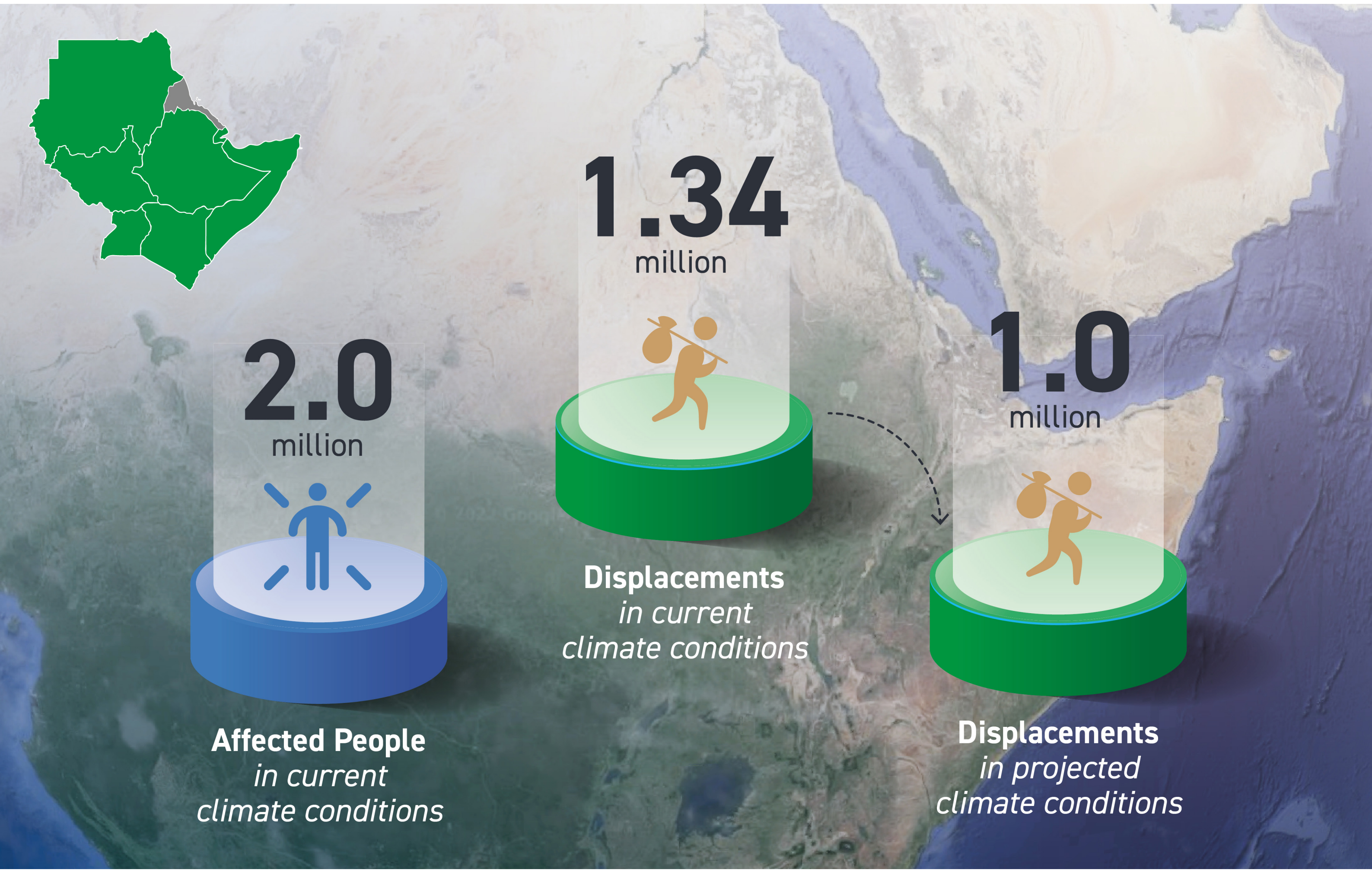
Estimate of people prone to be displaced due to the loss of both house and livelihoods. To avoid overestimation, this contribution must be removed from the overall displacement estimation.

DATA SOURCES FOR THE IGAD REGION AND COMPUTATIONAL ASPECTS		
Residential population	**Employees**	**Residential population working in facilities located in hazard prone area**
Residential population is subdivided according to different layers, each one representing the amount of population living in buildings characterised by a specific construction typology. The distribution of population comes from WorldPop 2021 data for the single countries in the study at 100 m resolution. The subdivision of building typologies is derived from the GAR 2015 exposure model at 5 km resolution.	Employees are evaluated as a percentage of residential population, according to ILO (International Labour Organization) national data; the same source was used to define the subdivision among sectors (industrial, crop production, pastoralism and services). Each figure is distributed at high resolution using different masks: for industrial and services, the same building structure adopted for residential population is used; for crop production and pastoralism, the masks have been derived from the corresponding layers developed by the EC - Joint Research Centre in the ASAP project. (https://mars.jrc.ec.europa.eu/asap/)	For each pixel in the representation of residential population, the ratio of employees working in hazard-prone areas is computed, subdivided per working sectors. To obtain this, an assignment of employees to residential areas is performed by means of an iterative procedure: for each working sector, employees are assigned to available residential areas within a given radius; if no free residential areas are present within the radius, this is increased till all the employees are assigned. In this way, each residential area is characterized by a further exposure information, describing if employees are prone to lose their work too.

Results - Regional level

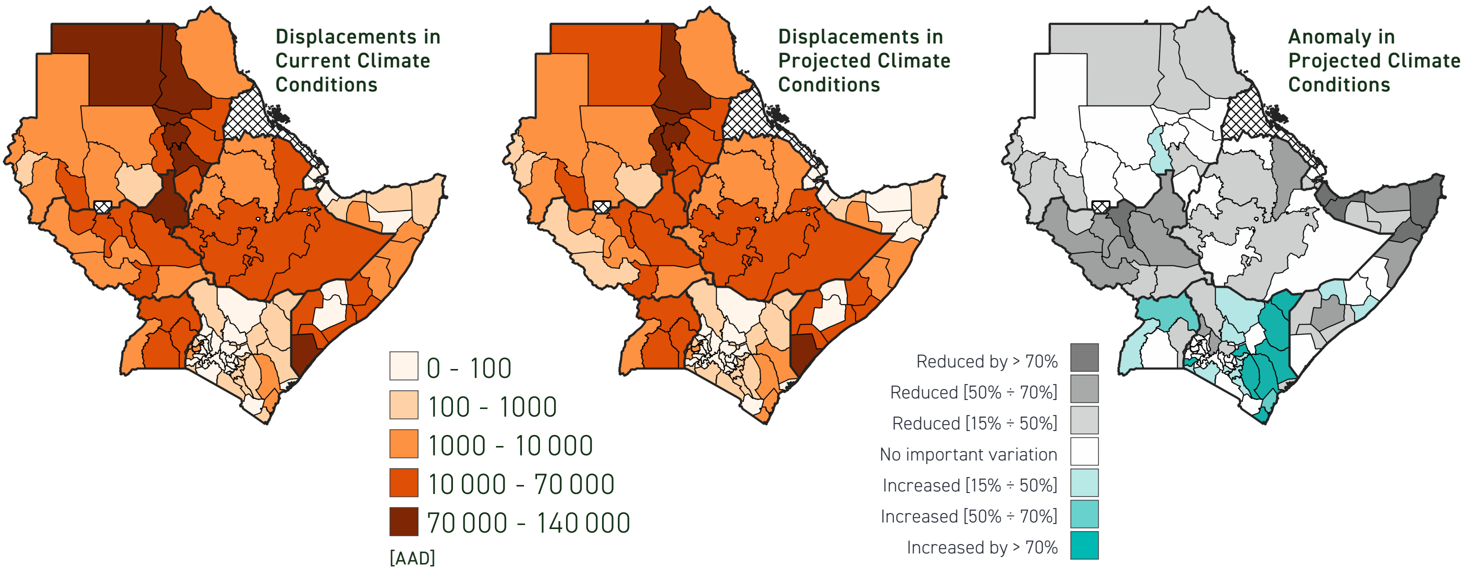
Probabilistic disaster risk profiles consider all possible risk scenarios in a certain geographical area. This means that both low frequency, high loss impact events, as well as high frequency, lower loss impact events are calculated. In the context of disaster displacement risk assessment, losses are represented by the displacements triggered by the phenomena under analysis, in this case floods. Usual metrics of a "traditional" probabilistic risk assessment are Annual Average Losses and Probable Maximum Losses, while in a displacement probabilistic risk assessment they are substituted by Annual Average Displacement and Probable Maximum Displacement. AAD is the expected number of displacements per year, averaged over many years; while there may actually be little or no displacement over a short period of time, AAD also accounts for much larger displacements that occur less frequently.
On the other hand, the PMD curve shows the likelihood of a certain scenario producing an estimated displacement. It is expressed in terms of annual probability of exceedance or its reciprocal, the return period.

In the following picture a summary of the results at IGAD level obtained in connection to current and climate conditions is provided; on average, approximately **2 million** of people are affected each year by floods in current climate conditions; among them, approximately **1.34 million** could be forced to displacement due to lack of house or livelihoods. This last figure decreases to **1 million** when considering projected climate conditions.



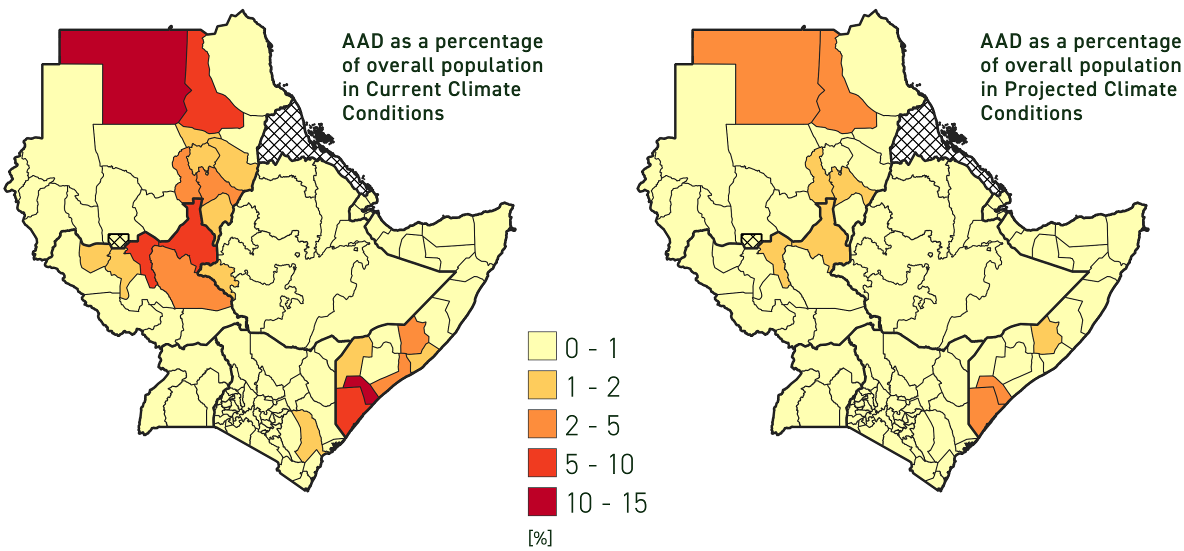
The displacement was assessed also at national and provincial or country level. In the following picture it is possible to observe the spatial distribution AAD triggered by flood events under current climate conditions, under projected climate conditions, and in terms of anomaly. In absolute terms the eastern part of Sudan and the western part of Somalia are the one suffering the highest consequences in terms of displacements triggered by floods both in current and projected climate conditions. Nevertheless, one can observe heterogeneous anomalies between the two climate conditions, with a worsening effect localized in Kenya and in some areas of Sudan, Uganda, and Somalia, whereas in the remaining areas AAD is stable or decreasing.

ANNUAL AVERAGE DISPLACEMENT TRIGGERED BY FLOOD EVENTS AT PROVINCE OR COUNTY LEVEL



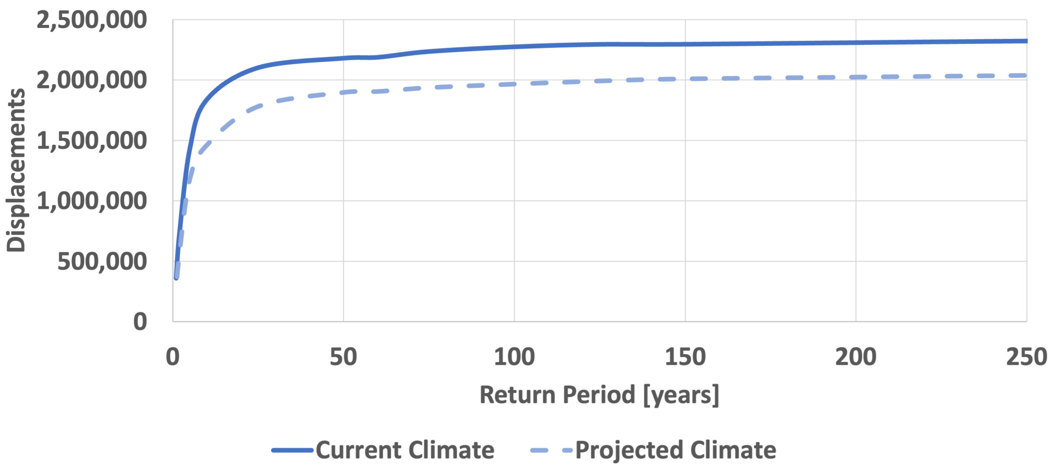
Next picture shows the results in relative terms, as the percentage of AAD with respect to the overall residential population. Also in these terms, the most affected areas are in Sudan and in Somalia; nevertheless – at least in current climate conditions – also some administrative units within South-Sudan show non-negligible results.

ANNUAL AVERAGE DISPLACEMENT TRIGGERED BY FLOOD EVENTS AS A PERCENTAGE OF OVERALL POPULATION AT PROVINCE OR COUNTY LEVEL

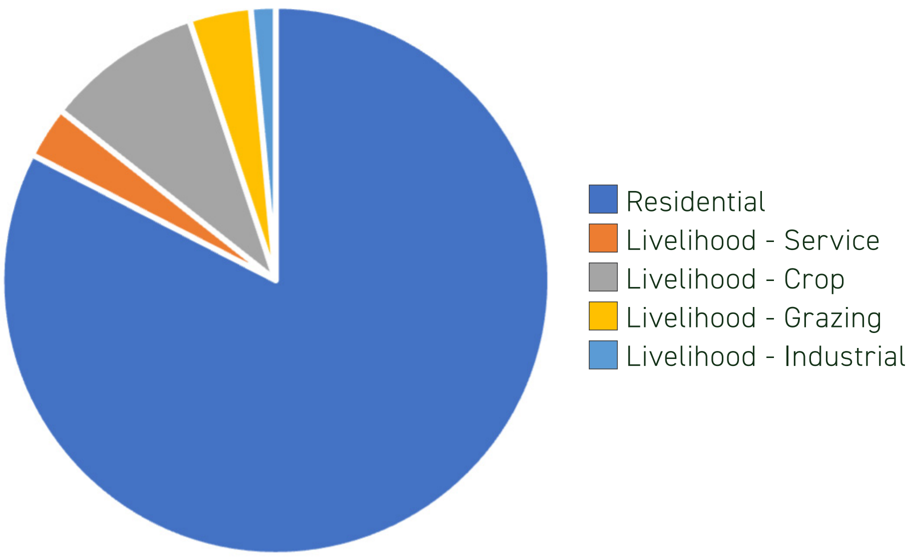


The PMD curve – shown in next picture – gives some interesting information regarding the magnitude of displacements triggered by floods for different return periods. The difference in terms of displacements between relatively frequent events – e.g., 10 years – and rarer events – e.g. 100 years – is quite evident both in current and projected climate conditions: for T= 10 years, the PMD value is roughly 1.8 million in current climate conditions and 1.5 in projected climate conditions; for T=100 years such figures arise up to 2.3 million and almost 2 million, respectively.

PROBABLE MAXIMUM DISPLACEMENT CURVE - REGIONAL LEVEL



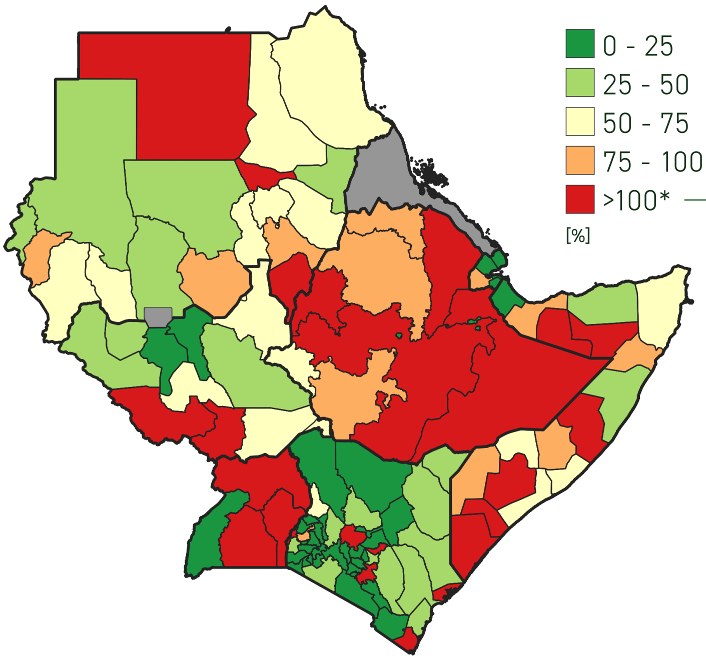
DISPLACEMENTS PER SECTOR OF ORIGIN IN CURRENT CLIMATE CONDITIONS REGIONAL LEVEL



When looking the results in terms of reasons leading to displacement, the loss of housing (i.e. damages to the residential assets) is the main element triggering the movement of people after a flood event; nevertheless, the overall loss of livelihood counts for almost 18% of the displacements, with the jobs connected to crop production playing the major role.

Next picture shows the spatial distribution of reasons leading to displacement at Adm1 level: areas mapped in green are those where displacement triggered by loss of housing is highly dominant, i.e., 50%-75% for the light-green areas, and more than 75% in the dark-green areas. When the colors in the map go from yellow to red, the contribution of displacement due to loss of livelihood in the area increases up to 50% or more. The results show that loss of livelihood plays a significant role for displacement in some areas of Kenya, Ethiopia and South Sudan.

ANNUAL AVERAGE DISPLACEMENT TRIGGERED BY FLOOD EVENTS AS A PERCENTAGE OF RESIDENTIAL POPULATION AFFECTED AT PROVINCE OR COUNTY LEVEL IN CURRENT CLIMATE CONDITIONS



* Displacements can be triggered by both loss of housing and loss of livelihood, the first being calculated by considering effects on residential population and the second on employees in different sectors; for this reason, in areas where the loss of livelihood is not negligible, the overall number of displacements can be higher than the residential population affected by floods.

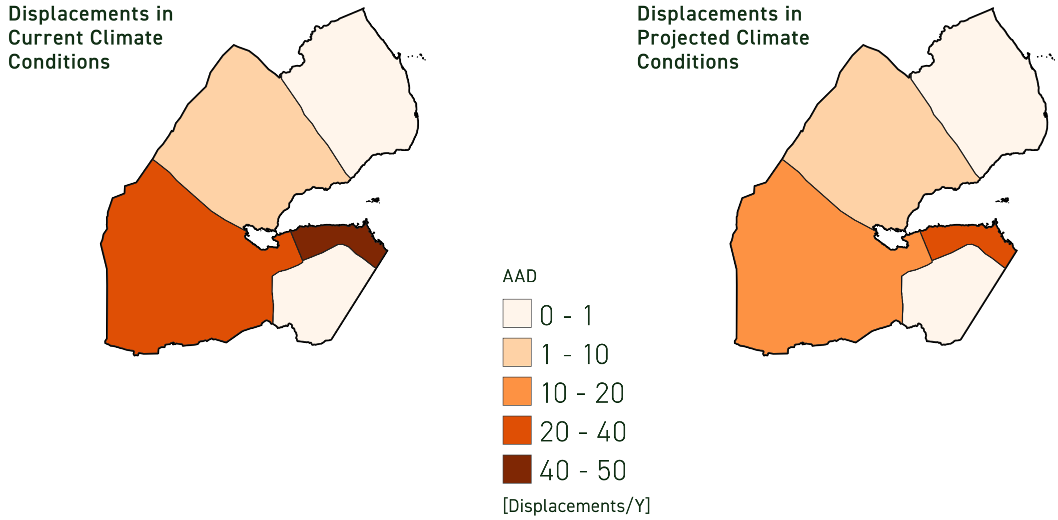
Results - Country level

At country level, the predominant role of displacements linked to the loss of housing is confirmed, even when percentages that can significantly vary country by country (e.g., 61% in Uganda and 89% in Somalia). Also the livelihood sector leading to the highest percentage of displacement changes among the countries, this being crop production – confirming the results at regional level – for Kenya, Somalia, Sudan and Uganda, grazing for Ethiopia and South Sudan, and the service sector for Djibouti.

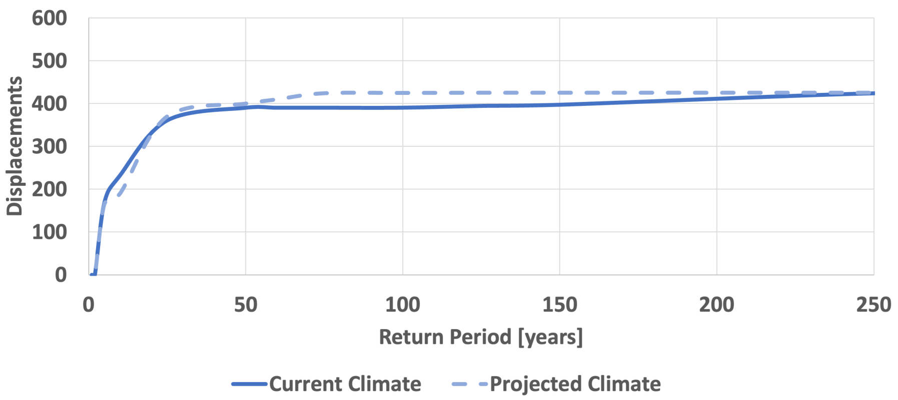
Some heterogeneity in the results is present also when observing the PMD curves at country level. Of course, the magnitude of displacement connected to each return period varies significantly, mainly led by differences in the number of people living in each country. In addition, some differences can be identified also in the results connected to projected climate conditions: for most of the countries, the results show a slight decrease in terms of displacements for all the return periods; nevertheless, Djibouti shows an almost equal pattern between current and projected climate conditions, Kenya and Uganda show an increase of PMD values in projected climate conditions (the increase is slight for Kenya and significant for Uganda); on the contrary, results for South Sudan are strongly decreasing in projected climate conditions. South Sudan shows a peculiar pattern also when analyzing the difference in terms of displacement between medium-rare events (e.g., 50 years) and events with return period equal to 200 years or more: in this case, in fact, South Sudan and Ethiopia are the only countries showing non-negligible differences. For the remaining countries, the highest values of displacements can be red on the PMD curves already for return periods lower than 50 years, this indicating that high-magnitude events can't be considered in these countries as very rare events.

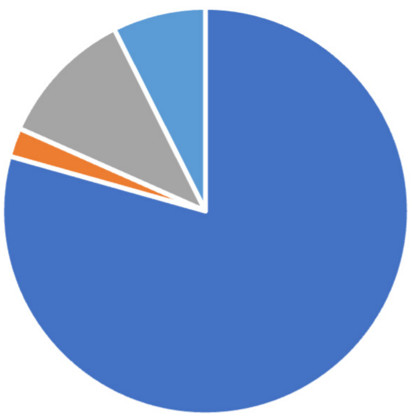
DJIBOUTI

ANNUAL AVERAGE DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN CURRENT AND PROJECTED CLIMATE CONDITIONS IN DJIBOUTI



PROBABLE MAXIMUM DISPLACEMENTS CURVE LINKED TO FLOOD EVENTS IN DJIBOUTI





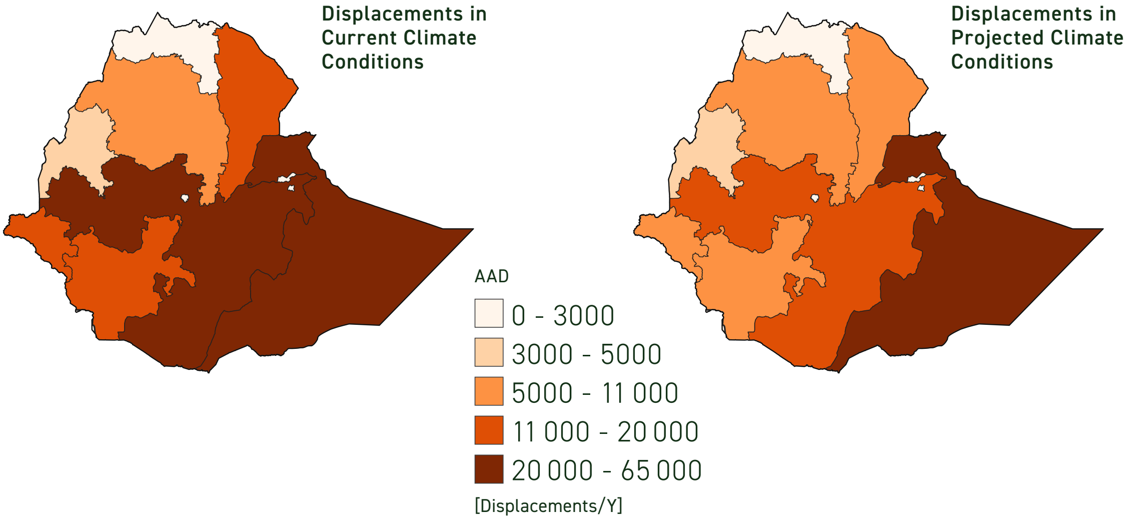
SOURCE OF DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN DJIBOUTI IN CURRENT CLIMATE CONDITIONS

It is assumed that a displacement can be triggered by loss of housing or loss of livelihood, subdivided in main specific working sectors

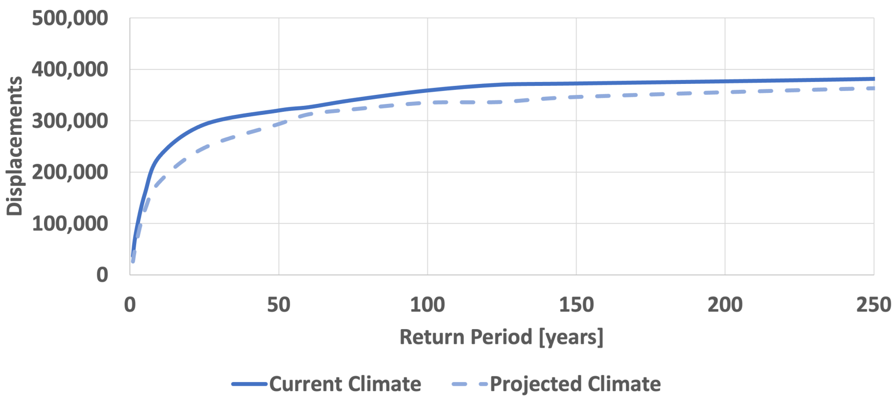
- Residential
- Livelihood - Service
- Livelihood - Crop
- Livelihood - Grazing
- Livelihood - Industrial

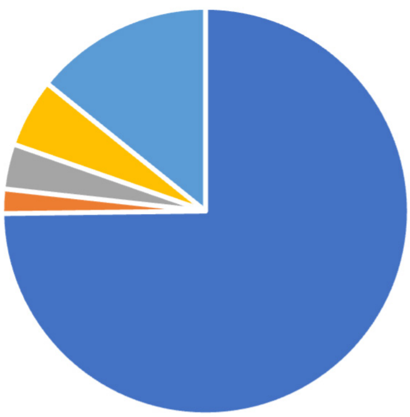
ETHIOPIA

ANNUAL AVERAGE DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN CURRENT AND PROJECTED CLIMATE CONDITIONS IN ETHIOPIA



PROBABLE MAXIMUM DISPLACEMENTS CURVE LINKED TO FLOOD EVENTS IN ETHIOPIA





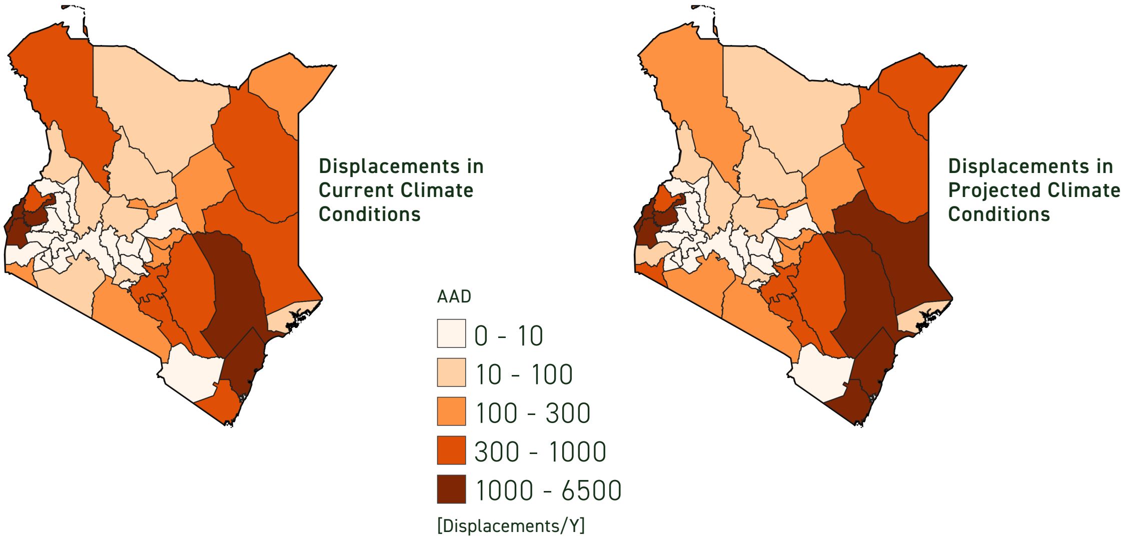
SOURCE OF DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN ETHIOPIA IN CURRENT CLIMATE CONDITIONS

It is assumed that a displacement can be triggered by loss of housing or loss of livelihood, subdivided in main specific working sectors

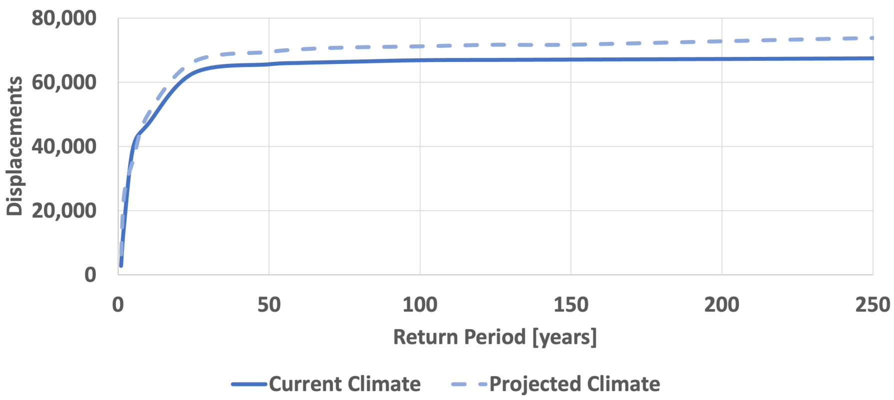
- Residential
- Livelihood - Service
- Livelihood - Crop
- Livelihood - Grazing
- Livelihood - Industrial

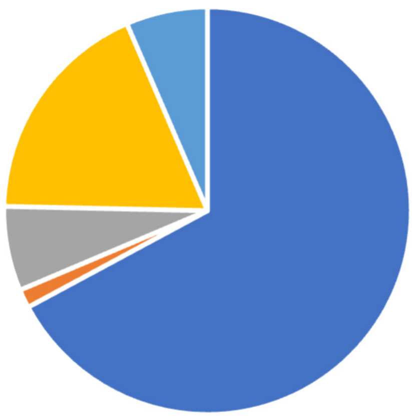
KENYA

ANNUAL AVERAGE DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN CURRENT AND PROJECTED CLIMATE CONDITIONS IN KENYA



PROBABLE MAXIMUM DISPLACEMENTS CURVE LINKED TO FLOOD EVENTS IN KENYA





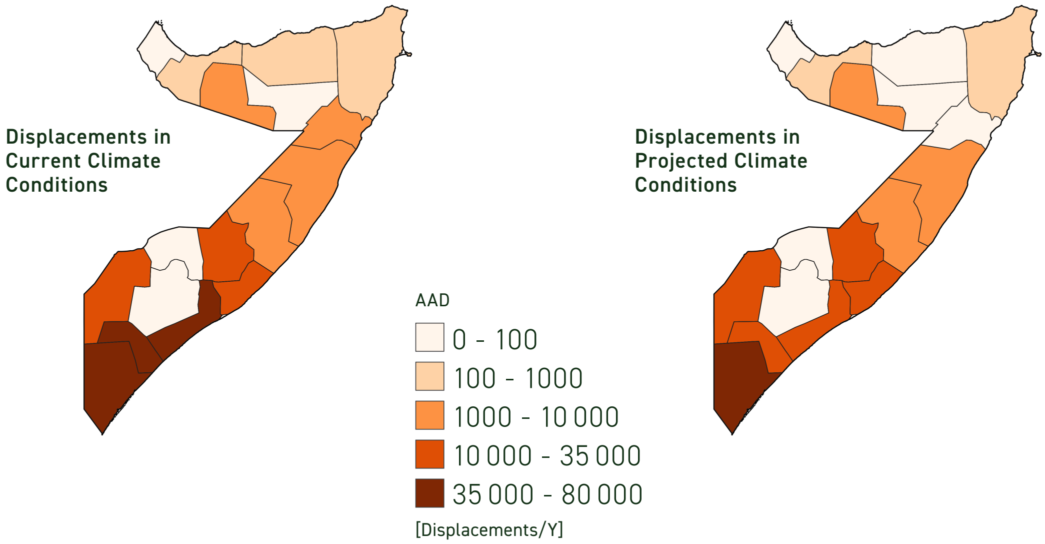
SOURCE OF DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN KENYA IN CURRENT CLIMATE CONDITIONS

It is assumed that a displacement can be triggered by loss of housing or loss of livelihood, subdivided in main specific working sectors

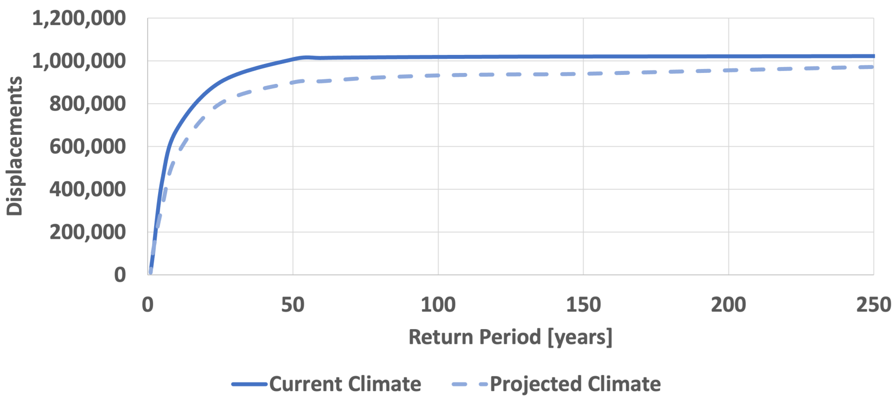
- Residential
- Livelihood - Service
- Livelihood - Crop
- Livelihood - Grazing
- Livelihood - Industrial

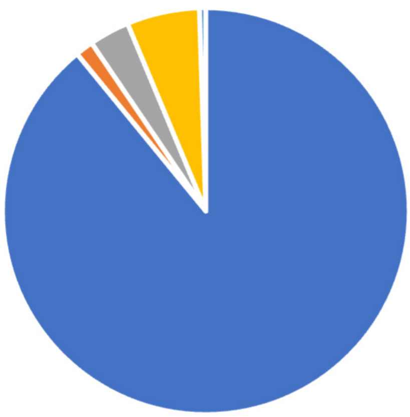
SOMALIA

ANNUAL AVERAGE DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN CURRENT AND PROJECTED CLIMATE CONDITIONS IN SOMALIA



PROBABLE MAXIMUM DISPLACEMENTS CURVE LINKED TO FLOOD EVENTS IN SOMALIA





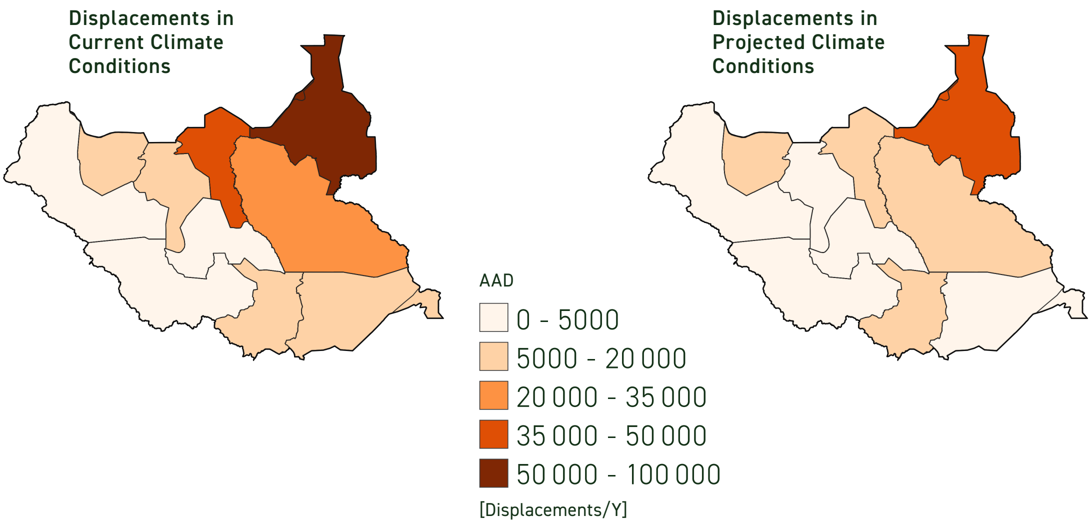
SOURCE OF DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN SOMALIA IN CURRENT CLIMATE CONDITIONS

It is assumed that a displacement can be triggered by loss of housing or loss of livelihood, subdivided in main specific working sectors

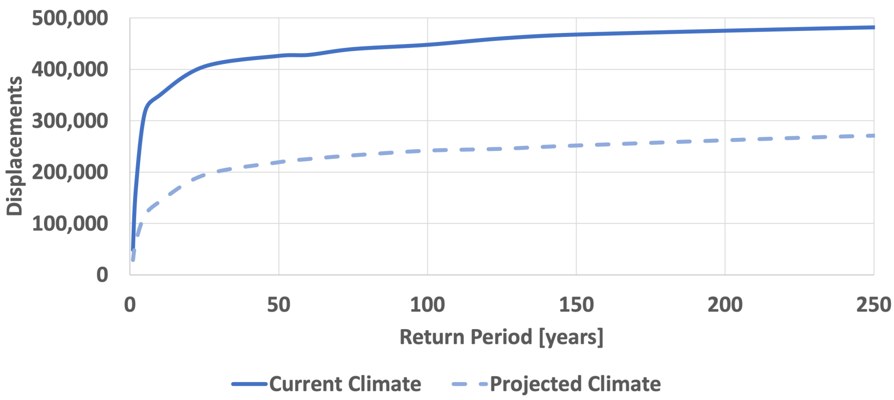
- Residential
- Livelihood - Service
- Livelihood - Crop
- Livelihood - Grazing
- Livelihood - Industrial

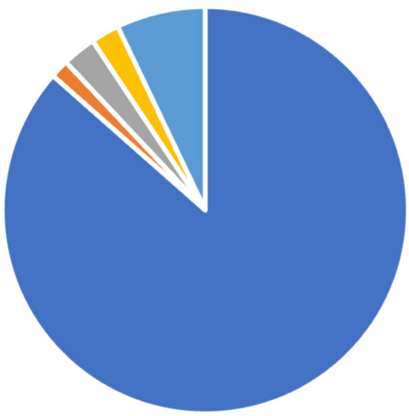
SOUTH SUDAN

ANNUAL AVERAGE DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN CURRENT AND PROJECTED CLIMATE CONDITIONS IN SOUTH SUDAN



PROBABLE MAXIMUM DISPLACEMENTS CURVE LINKED TO FLOOD EVENTS IN SOUTH SUDAN





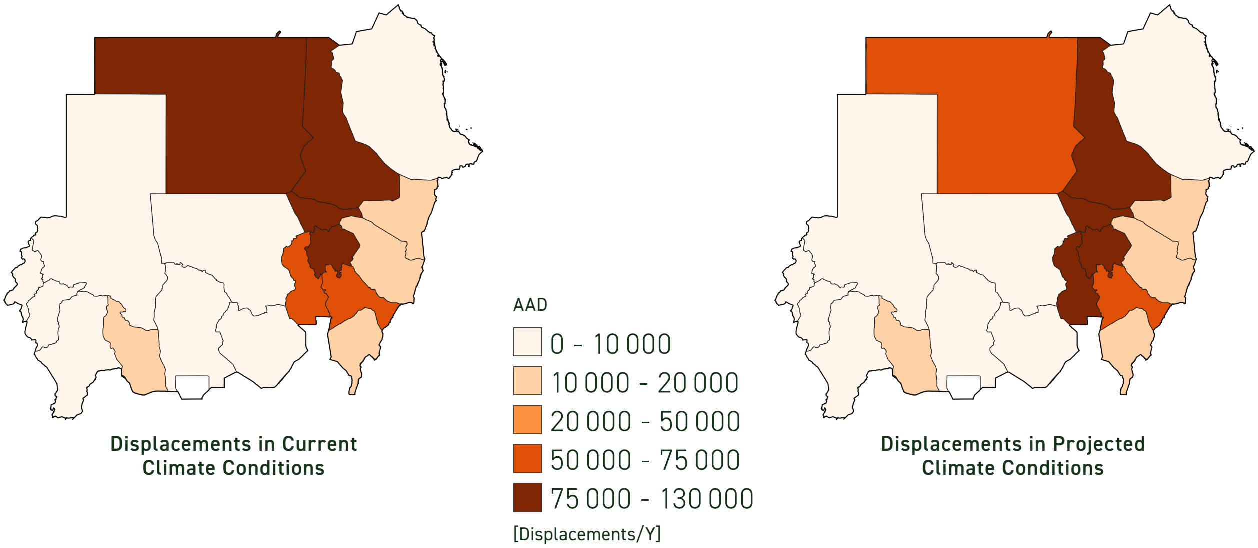
SOURCE OF DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN SOUTH SUDAN IN CURRENT CLIMATE CONDITIONS

It is assumed that a displacement can be triggered by loss of housing or loss of livelihood, subdivided in main specific working sectors

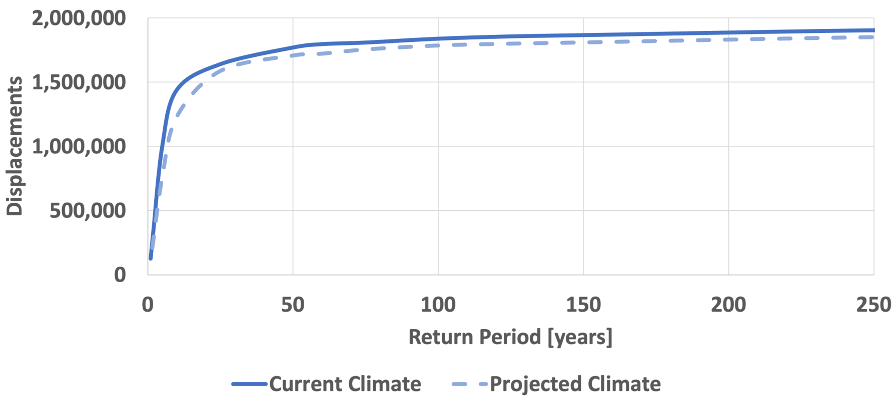
- Residential
- Livelihood - Service
- Livelihood - Crop
- Livelihood - Grazing
- Livelihood - Industrial

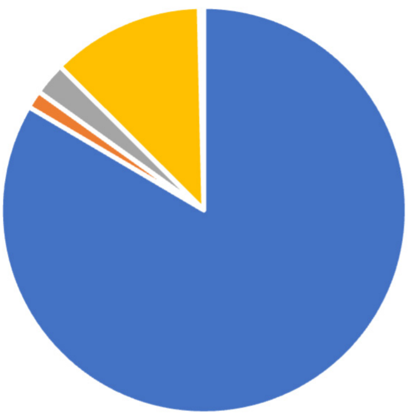
SUDAN

ANNUAL AVERAGE DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN CURRENT AND PROJECTED CLIMATE CONDITIONS IN SUDAN



PROBABLE MAXIMUM DISPLACEMENTS CURVE LINKED TO FLOOD EVENTS IN SUDAN





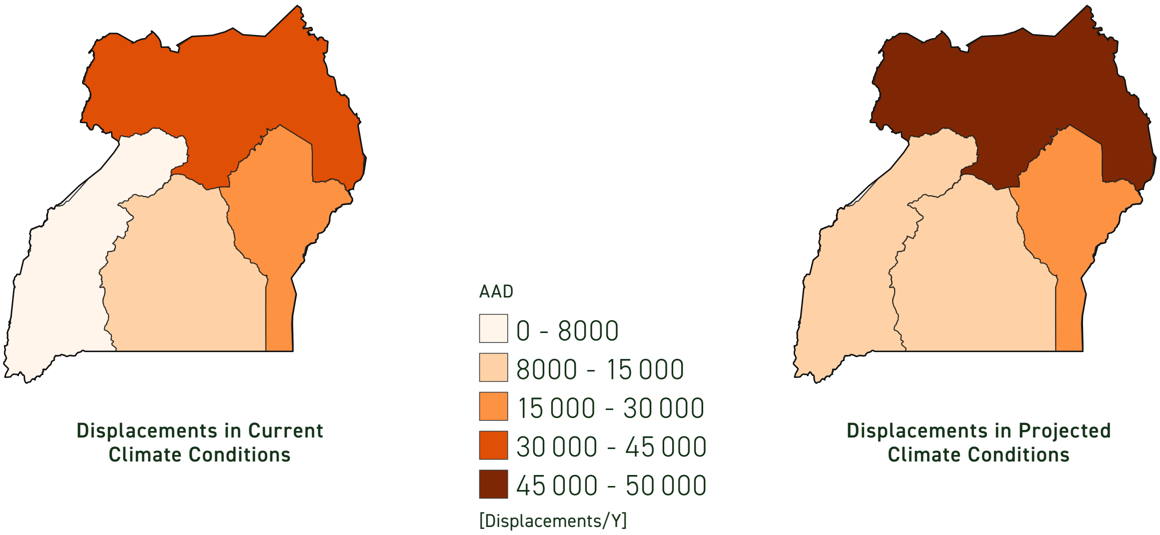
SOURCE OF DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN SUDAN IN CURRENT CLIMATE CONDITIONS

It is assumed that a displacement can be triggered by loss of housing or loss of livelihood, subdivided in main specific working sectors

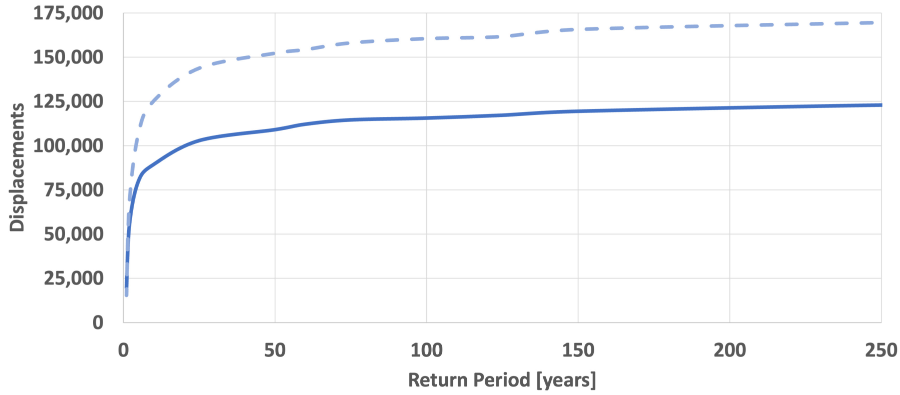
- Residential
- Livelihood - Service
- Livelihood - Crop
- Livelihood - Grazing
- Livelihood - Industrial

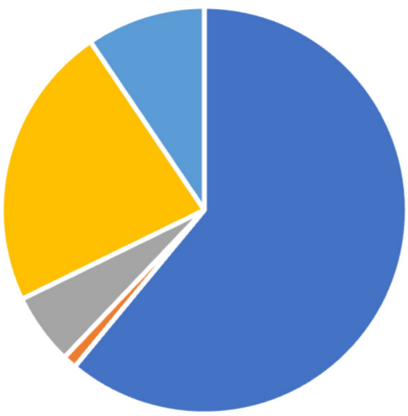
UGANDA

ANNUAL AVERAGE DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN CURRENT AND PROJECTED CLIMATE CONDITIONS IN UGANDA



PROBABLE MAXIMUM DISPLACEMENTS CURVE LINKED TO FLOOD EVENTS IN UGANDA





SOURCE OF DISPLACEMENTS TRIGGERED BY FLOOD EVENTS IN UGANDA IN CURRENT CLIMATE CONDITIONS

It is assumed that a displacement can be triggered by loss of housing or loss of livelihood, subdivided in main specific working sectors

- Residential
- Livelihood - Service
- Livelihood - Crop
- Livelihood - Grazing
- Livelihood - Industrial

Recommendations

The present study represents a strong advancement in the current panorama addressing the quantification of risk of displacement. it proposes and innovative solution to describe vulnerability for displacement providing a more accurate description of disaster displacement risk in probabilistic terms. However, several improvements could be imagined to increase the level of reliability of the results.

As a main area of improvement, a more holistic representation of vulnerability, including socio-economic elements, would help identify effective strategies to reduce vulnerability and, by extension, to reduce the number of people at risk of being forcibly displaced. For example, people who depend on the primary sector of the economy (farming, herding, fishing, etc) – especially for subsistence – are at higher risk of displacement in case of sudden-onset disasters, because of the relatively greater impact on their livelihoods. This diversity in vulnerability is now only indirectly represented in the predictive model used (e.g., through the building typology which is often strongly correlated with the income level). To capture this dimension explicitly an effort is needed on one hand in conceptually clarifying how 'vulnerability' can be captured and on the other hand in collecting more and better disaggregated and local data. in this direction the possibility of using other modelling framework such as Agent Based Models in connection with the physical models classically used in PRA seems a promising research avenue.

Among the various dimensions of vulnerability that can be conceptualised one, extremely connected with the socio-economic dimension, concerns the loss of access to critical infrastructures and services. this might determine displacement on longer time scales and should be explicitly considered and modelled.

The current study is based on regional data available in homogeneous fashion for the entire IGAD region. This choice was made to guarantee cross comparability between the figures within the region and at sub national level. However, this is necessarily reducing the level of detail and disaggregation of data that could be used. national risk profiles, or national zoom-ins for specific countries even if in a broader regional context could be proposed to enhance the information content that can be provided by the PRA.

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PLATFORM ON DISASTER DISPLACEMENT
FOLLOW-UP TO THE NANSEN INITIATIVE

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